

FOREST SUCCESSION ON THE
POORLY-DRAINED SOILS IN THE HIGGINS
LAKE AREA OF MICHIGAN

Thesis for the Degree of Ph. D.
MICHIGAN STATE COLLEGE

Tao Ku
1954

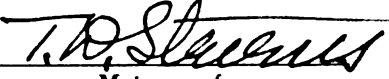


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Major professor

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FOREST SUCCESSION ON THE POORLY-DRAINED SOILS
IN THE HIGGINS LAKE AREA OF MICHIGAN

BY
TAO KU

A THESIS

Submitted to the School of Graduate Studies of Michigan
State College of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Forestry

1954

Final examination
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Dissertation: F
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Final examination, Friday, July 30, 1:30 P.M., Forestry
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To my wife, Victoria Ku, who contributed to certain phases of the manuscript, and her continuous encouragement and support, grateful acknowledgment is given for her patient effort.

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By
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AN ABSTRACT

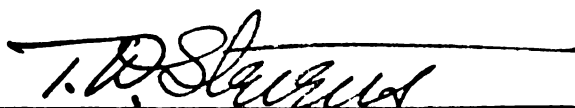
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ABSTRACT

The objective of this study is to distinguish and identify the various types of vegetation found on the poorly-drained soils in the Higgins Lake area and to determine their probable trend of succession upon the ecological basis.

The Higgins Lake area is located in the northern central part of the lower peninsula of Michigan. Ecologically, it is within the Hemlock-White Pine-Northern Hardwoods Formation as defined by Nichols (1935), Braun (1950), among others.

Five types of vegetation were recorded on the poorly-drained soils in the area. They were: (1) The Marsh or Open-meadow type, (2) the Swamp Shrubs of Salix-Cornus-Alnus Association, (3) the Lowland Aspen of Populus-Salix Association, (4) the Swamp Coniferous forest, and (5) the Swamp Hardwood forest. Quadrats of three sizes were used for the vegetation study, i.e., 1/5 acre quadrat for tree vegetation; 1/10 acre quadrat for shrub vegetation; and 1/1000 or milacre quadrat for vegetation below six feet tall, the herbaceous layer.

Ecological factors were considered in three groups: (1) Climatic, (2) Edaphic, and (3) Biotic. Among the climatic factors discussed, evaporation is believed to show the combined effect of the other three, temperature, relative humidity, and precipitation. Data of evaporation rates in three

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different vegetation types were obtained by using Livingston atmometers. Results show that the evaporation rate decreases from the Marsh to the Swamp Shrubs type and to the Swamp Forest. This indicates that although the forest cover may be the cause of the lower evaporation, the higher evaporation rate in the Marsh may still be an important factor in retarding the establishment of forest cover on that area.

Soils of all the quadrats were investigated. Samples of seven soils were collected by horizon to determine their characteristics. Statistical analyses were applied to analyze all the laboratory data. Results show that there were no differences between the volume weight and the total porosity of the soils. Only the Newton sand had a lower capillary porosity than the others. Results of field determinations of soil moisture leads to the belief that soil moisture content decreases from the Marsh to the Swamp Shrubs and to the Swamp Coniferous Forest. The peaty soils had higher organic contents than the mineral soils. Soils of the Marsh type were strongly acid in reaction, followed by the two Rifle peat soils of the Swamp Shrubs and the Swamp Conifers. The Bergland soils of the Swamp Hardwood type were almost neutral in reaction.

Biotic factors are not believed to be of great significance to influence the forest succession on the poorly-drained soils in the region. Fire which is usually caused by man is probably the most important factor that will induce secondary succession.

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Diagrams of forest succession on the poorly-drained soils in this area is shown in Fig. 12. The principal trend of succession is believed to be that from Marsh to the Swamp Shrubs to Swamp Conifers to Swamp Hardwoods and finally after a relatively long period of time to the upland, mesophytic, climax type of the Hemlock-White Pine-Northern Hardwoods. The Lowland Aspen type is most commonly thought to be the fire or temporary type after the original forest has been burned over or otherwise denuded. The Swamp Hardwoods, the Swamp Conifers of Thuja-Abies-Picea, and the Marsh type are all believed to be the physiographic subclimax type to the area.

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3. PRECIPITATION

4. EVAPORATION

5. METEOROLOGICAL

1. SOIL

2. SOIL

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8. BIOLOGICAL

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INTRODUCTION

The objective of this study is to distinguish and identify the various types of vegetation found on the poorly-drained soils in the Higgins Lake area and to determine their probable trend of succession upon the ecological basis.

This study was begun in 1952. At that time, this study was intended to be entitled: "Forest succession on the poorly-drained soils in the Higgins Lake State Forest, Michigan." However, for administrative reasons, the Higgins Lake State Forest is not existing at the present time. It has been divided into two parts which belong to two separate State Forests: The AuSable State Forest and the Houghton Lake State Forest. The area formerly of the Higgins Lake State Forest in Roscommon County and Missaukee County is now a part of the Houghton Lake State Forest, whereas the area in Crawford and Kalkaska Counties is now a part of the AuSable State Forest.

Therefore "the Higgins Lake area" as appeared in the title is equivalent to that of the former Higgins Lake Forest region. It is for the same reason that some of the maps produced and statements made remain to be referring to the Higgins Lake State Forest area.

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REVIEW OF LITERATURE

A. Ecological Concepts

Before the establishment of Ecology as a science, the study of vegetation was unchanging. It was a mere description and delimitation of plant communities as absolutely static.

Warming (1909) made a great advance by gathering together records of vegetative change or succession. He stated that

"In early times plant societies were looked upon as stable groups which were in a state of quiescence, complete in their development, and peacefully living side by side. In reality no such relations exist in the plant world. Everywhere and continuously there is going on a struggle between plant societies; each individual society constantly strives to invade the field of others, and each small change in the living conditions immediately produces shiftings and changes in the mutual relations of these group."

This dynamic view leads to the early works of Cowles (1899, 1901, 1911), who conceived the modern concept of succession. He stated that

"At the close of the vegetative cycle there is the final vegetative aspect varies with the climate, and hence is called a climatic formation. --- The ultimate stage of a region is mesophytic. The various plant societies pass in a series of successive types from the original conditions to the mesophytic forest."

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Beginning at about the same time, the publications of Clements included much that served to shape our present concepts of succession. His "monoclimax" theory is that "only a single climax exists in a given climatic region, although other permanent communities determined by other factors in addition to climate may occur there also; these would be termed sub- or proclimaxes." He also attempted to distinguish between primary and secondary succession, the former being those on newly formed soils, and the latter those on denuded soils.

Nichols (1923) has defined plant association as "a group or community of plants which occupy a common habitat, and are essentially similar throughout its extent in physiognomy, ecological structure, and floristic composition." This concept of "association" is used in this paper by the author applying to the various associations encountered. Nichols recognized the plant association as the fundamental unit of vegetation whereas it parallels to the "Climax" or "Formation" by Clements. Nichols described succession simply as "the replacement of one plant association by another", and proceeded to classify successions into progressive and retrogressive in regard to "Trend"; whereas there is no such a thing as retrogressive succession in Clement's concept. In relation to "Climax", Nichols' idea was that the nature of climax in any area is controlled by geographic conditions,

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At the Conference of Plant and Animal Communities, which was held at Cold Spring Harbor, Long Island, New York, August 29 to September 2, 1938, Conard (1939) brought together the teachings of various schools which have had special influence upon the description and classification of nature vegetation. Six schools were considered by him: (1)The Zürich-Montpellier School : Kerner (1863) sketched with permanent precision the major lineaments of central European vegetation. The conspicuous feature was the stability of the magnificent plant mosaic of central Europe and Alps when left undisturbed, and the concept of association was developed. It was defined by its floristic composition as a unit actually found in nature, and upon which all phytosociological study centered. (2)The Scandinavian School: Influenced by its geographical location where the vegetation is that of the marginal lands, "two oft repeated emphases were developed: (a)The soil is the product of vegetation, and is independent of the nature of the substratum; (b)the fundamental unit of vegetation is the layer or synusia" (Conard, 1939). (3)The Danish School: Raunkiaer (1934) divided the species of the world into "life-forms". The percentage of species in each group drawn from all over the earth gave the "normal spectrum" for the earth

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During the Conference, Gleason (1939) defended the Individualistic Concept of the Plant Association. He stated that the fundamental question basic to all ecological work is, "what is a plant association?" In answering to this question he presented his theory:

"The vegetation unit is a temporary and fluctuating phenomenon, dependent, in its origin, its structure, and its disappearance, on the selective action of the environment, and on the nature of the surrounding vegetation. Under this view, the association has no similarity to an organism and is scarcely comparable to a species."

In defense this theory, the so called Individualistic Concept, Gleason presented a series of theses, the main

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points were: (1) Every species of plant has reproductive powers in excess of its need; (2) every species of plant has some method of migration; (3) the environment in any particular station is variable; and (4) the development of a vegetational unit depends upon one or the other of two conditions, the appearance of new ground, or the disappearance of the existing association. Two general statements were introduced by him to clarify these theses:

"First, an association, or better one of those detached pieces of vegetation which we may call a community, is a visible phenomenon. As such it has dimensions and area, and consequently boundary. While its area may be large, the community is nevertheless a very tangible thing, which may be mapped, surveyed, photographed, and analyzed. Over this area it maintains a remarkable degree of structural uniformity in its plant life. Homogeneity of structure, over a considerable extent, terminated by definite limits, are the three fundamental features on which the community is based. Without these three features, Grisebach would never have published his statement a century ago; without them, all of our studies of synecology would never have been developed. Also besides its extent in space, every community has a duration in time. Uniformity, area, boundary, and duration are the essentials of a plant community.

Second, every community occupies a position in two series of environmental variation. In the space series, as the community exists here, in this spot, it is part of a space-variation, and its environment differs from the adjacent communities. In the time series, as the community exists now, at this time, it is part of a time-variation and in its environment differs from the communities which preceded it or follow it."

The climax and its complexities have been ably discussed and summarized by Cain (1939). In his paper, he made

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the following statements concerning the "Monoclimax" and "Polyclimax" theories:

"Since support of the polyclimax hypothesis (Du Rietz, Nichols, Tansley, Gams, Gleason, Nordhagen, Scharfetter, Tuxen, Domin, Conard) rests largely on the recognition of "edaphic climaxes", it should be stressed that Clements too recognizes edaphic climaxes in the concept of 'seration'.

Clements has met exponents of the polyclimax hypothesis in the following ways: (1) chorologically different stable communities are considered to be faciations and lociations of an association; (2) chronologically different stable communities are disposed of as subclimax, proclimax, preclimax, postclimax, held in stability by a continuing repressive factor; (3) stable communities not of the climatic climax but due to biotic factors are disclimax, in part; (4) topographically different stable communities, different because of continuing edaphic factors are called serations; (5) variations due to different soil types within a geological formation, or to different geological formations, are recognized (Phillips, 1934), apparently under the name of lociation. The polyclimax view includes many different things, while Clements uses a different term for a different thing."

In his concluding statement, Cain pointed out the difficulties in description and classification of vegetation as a result from lack of a standard terminology with the following statements:

"----- Clements' disposition of the variations within the climax (or climax region) through the concepts of faciation and lociation, through subclimax, proclimax and seroclimax, through seration, and through preclimax and postclimax presents a scientifically and philosophically sound system. A description and classification of all the stable (climax) communities of a region might necessitate dealing with all the above concepts. A very large number of investigators have chosen not to follow

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Clements' in this but to treat all such cover types as 'associations'. The plant sociologists go even farther and include successional communities (associates) under the term. This may have some justification if the seral nature of the communities is not proven. The result, however, is to include many different things under the term, whereas Clements has a different term for a different thing."

Curtis and McIntosh (1951) have proposed the Concept of Vegetation Continuum for the upland forest of southwest Wisconsin. In their paper:

"The relative ecological importance of each tree species in each stand was expressed by a summation index of the relative frequency, relative density, and relative dominance herein called the importance value.

Climax adaptation numbers were used to weigh the importance value of each species in a stand. The summation of these weighted numbers resulted in an index which served to locate the stand along a gradient. ----- the entire series of communities formed a continuum in which a definite gradient was exhibited from initial stages composed of pioneer species to terminal stages composed of climax species."

Braun (1935, 1950) has developed an interpretation of climax vegetation, the "association-segregate". It is a climax unit, which refers to space-time segregates of the ancient mixed forest evolved by conditions of the environment, and it includes consociation, faciation, and lociation, regardless of the number of dominants in a stand. In her *Deciduous Forests of Eastern North America*, Braun has devoted a chapter to Forest Ecology and Terminology

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Dansereau (1951) has proposed a new system for the description and recording of vegetation upon a structural basis. He suggested six criteria for the study of vegetation in floristic mapping, life-form statistics, and ecological classifications: (1) life-form, (2) size, (3) function, (4) leaf shape, (5) leaf texture, and (6) coverage.

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B. Climax forest of the northern lower Michigan

There are two types of climax forest vegetation in the state of Michigan: the Deciduous forest formation in the southern lower peninsula, and the Hemlock-White Pine-Northern Hardwoods Forest Formation in the northern part of the lower peninsula and throughout the upper peninsula.

The boundary between these two formations is generally being recognized as near the latitude 43 degrees North. It is also commonly described as a line running from Saginaw to Muskegon. This boundary is not sharply defined and is represented by an "ecotone" or a zone of tension. Beal and Wheeler (1892), Livingston (1903, 1905), Quick (1923), Gleason (1924), Veatch (1932), Darlington (1945), Potzger (1946, 1948), Braun (1950), and others have pointed out the presence of this tension zone between the two forest formations.

The forest vegetation which lies north of the tension zone forms a part of the mixed conifer-northern hardwood forest formation. A number of descriptive names have been given to this formation by many ecologists and botanists. The region to be studied in this paper lies within the "northern hardwood" region of Frothingham (1915), the northeastern "transition forest" region of Nichols (1918), and the "Great Lake" or "south Canadian forest" region of Hardy (1920). It is also corresponded to the "lake forest" region of Weaver & Clements

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(1929), the "eastern hemlock" region of Nichols (1935), and the "St. Lawrence-Great Lake" region of Harshberger (1911). More recently, in Braun's Deciduous Forests of Eastern North America (1950), the area is described as the Hemlock-White Pine-Northern Hardwood region.

Frothingham (1915) described the northern hardwood forests as occupying "the fresh, well-drained, fertile soils of the northern pine region". In discussing the differences between the northern and southern hardwood forests, he stated that the northern hardwood forest is distinguished by the presence of yellow birch, white pine and eastern hemlock, and the absence of yellow poplar, red gum, sycamore and several other more southern species. The northern hardwood forest is more simple in composition and usually divided into two regions: (1) the eastern mountain region, and (2) the Great Lakes region. He stated also that the greater abundance of basswood and elm is perhaps the most striking characteristic of this forest formation in the Lake States.

Nichols (1935) designated this region as "eastern hemlock-eastern white pine-northern hardwood region" or simply the "eastern hemlock region". He said that the climax is a mesophytic forest comprising a mixture of evergreen coniferous and deciduous broadleaf trees. The characteristic species are: hemlock, sugar maple, beech, yellow birch, white pine, basswood, American elm, white ash, red oak, black cherry,

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance with a desired state. For example, if a company's sales are declining, it may indicate a problem with its marketing strategy or product quality. Once a problem is identified, the next step is to define it clearly and specifically. This involves determining the scope of the problem, its causes, and its effects. For instance, if sales are declining, the problem might be defined as "a 10% decrease in sales over the last six months due to increased competition and outdated marketing tactics."

2. The second step is to analyze the problem. This involves gathering data and information to understand the problem more deeply. This can be done through various methods, such as interviews, surveys, and data analysis. For example, a company might conduct a survey of its customers to identify their needs and preferences, or it might analyze its sales data to identify trends and patterns. Once the data is gathered, the next step is to identify the root cause of the problem. This is often done using the "5 Whys" technique, which involves asking "why" five times to drill down to the underlying cause of the problem. For instance, if sales are declining, the root cause might be "a lack of understanding of customer needs and preferences."

3. The third step is to develop a solution. This involves brainstorming ideas and evaluating them to determine the best course of action. For example, a company might brainstorm ideas for improving its marketing strategy, such as using social media or targeted advertising. Once the ideas are generated, the next step is to evaluate them based on factors such as cost, feasibility, and potential impact. The goal is to identify a solution that is both effective and sustainable. For instance, a company might decide to implement a targeted advertising campaign that focuses on reaching its core audience.

4. The fourth step is to implement the solution. This involves putting the chosen solution into action and monitoring its progress. For example, a company might implement a targeted advertising campaign by creating ads and running them on social media. Once the solution is implemented, the next step is to monitor its progress and evaluate its effectiveness. This can be done by tracking key performance indicators (KPIs) such as sales volume and customer satisfaction. If the solution is not working, it may be necessary to make adjustments or try a different approach. For instance, if the targeted advertising campaign is not resulting in increased sales, the company might decide to try a different marketing tactic.

red spruce, balsam fir, white spruce, red maple, and Norway pine. He considered these trees into four groups with reference to their geographical distribution: (1) those whose centers of north-south distribution are far to the south (beech, white ash, black cherry, white elm); (2) those whose centers are partly within and partly immediately to the south (sugar maple, basswood, and northern red oak); (3) those whose centers are within the region and whose ranges are more or less coextensive with it or some part of it (hemlock, white pine, yellow birch, Norway pine, and red spruce); (4) those whose centers of north-south distribution are to the north of the region (white and black spruce, fir, tamarack, balsam poplar, and paper birch).

Weaver and Clements (1929) described the "Lake Forest" formation as consisting of a single association in which white pine, Norway pine and hemlock are the climax dominants.

A brief glacial history of the Lake Forest Formation was presented by Potzger (1946), in discussing the different opinions to characterizing the climax of the "lake forest" region, he grouped the different interpretations into two lines: "-----one favoring the pine-hemlock complex as climax, the other favoring hemlock-northern hardwoods as climax". The latter group, which includes Potzger, considered pines participating crown cover as relics, or post-climax.

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Braun (1950) has designated the extent of the Hemlock-White Pine-Northern Hardwood region as: "It extends from northern Minnesota and extreme southeastern Manitoba through the upper Great Lakes region and eastward across southern Canada and New England, including, toward the southeast much of the Appalachian Plateau in New York and Northern Pennsylvania." She stated that the region is characterized by the pronounced alternations of deciduous, coniferous, and mixed forest communities. She listed sugar maple, beech and basswood, sugar maple and beech, or sugar maple and basswood as the usual dominants, and yellow birch, white elm and red maple more or less frequent associates in primary deciduous communities. The coniferous communities which occur at intervals almost throughout the region are of two general types: (1) those of more or less dry sand plains and ridges where white pine, red, or Norway Pine, and jack pine prevail; and (2) those of poorly-drained areas, bogs or muskegs, where black spruce, northern white cedar, and tamarack prevail. The primary mixed communities in this area are hemlock and northern hardwoods, principally sugar maple, beech, basswood, and yellow birch, in which there is or was an admixture of white pine. These, the most characteristic communities give to the region its name, Hemlock-White Pine-Northern Hardwoods.

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Braun divided the Hemlock-White Pine-Northern Hardwoods region into four sections: (1) the Great Lakes Section; (2) the Superior Upland; (3) the Minnesota Section; and (4) the Laurentian Upland Section. Northern lower Michigan and eastern upper Michigan fall into the Great Lake Section. She stated that beech-maple as a forest type or as an ecological climax community is as well illustrated in this region as it is in northern Ohio or southern Michigan. "However, maple is generally more abundant than beech in the more northern communities and usually has a higher frequency." She also pointed out that the sandy outwash plains of glacial topography afford suitable environment for the pine forests and the morainal ridges if the soil is fine-grained and loamy are occupied by deciduous forest communities or a mixture of deciduous species with hemlock and perhaps white pine.

Northern lower Michigan is a region of low relief and predominantly of glacial topography. There are extensive sandy outwash plains and morainal ridges as well as innumerable lakes, ponds, and poorly-drained areas. This paper, as the title indicates, deals with the forest succession on poorly-drained soils of area near the Higgins Lake, therefore is limiting itself to a much confined scope.

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C. Pertinent literature to the study of vegetation on poorly drained soils

Warming (1896) made variations in the water content of the soil as a basis for classifying plant societies into hydrophytes, mesophytes, and xerophytes. Cowles (1901), after efforts were made to classify the vegetation in northern Michigan in 1898 in accord with Warming's principles, felt the need of another classification. An attempt was therefore made by Cowles to relate the facts of distribution to combinations of factors and to group plant societies according to their relationship and their evolution. He stated that the climatic factors determine the distribution of plant societies in large while local differences are produced by changes in the edaphic or soil factors. Hence, he proposed a "physiographic classification" and stated:

"In a young topography, such as the recently glaciated areas of Michigan, Wisconsin, and Minnesota, there is a great variety of topographic conditions and of plant societies. Among these are many hydrophytic lakes and swamps and many xerophytic hills. In passing from youth to old age then, a region gradually loses its hydrophytic and xerophytic areas and the ultimate stage of a region is mesophytic. The various plant societies pass in a series of successive types from the original condition to the mesophytic forest which may be regarded as the climatic type."

Whitford (1901) followed Cowles' principle in his study of the genetic development of the forests of northern

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Michigan. He pointed out the successive stages of the swamp societies and stated that in each series the climax plant growth is a "deciduous-hemlock combination".

Ecological studies on bog or swamp communities in northern lower Michigan have been made by a number of botanists and ecologists, such as Transeau (1903), Rigg (1916), Gates (1926, 1942), Wilson and Potzger (1943), Dutro and Cohoe (1938), Olson (1943), among others.

Livingston (1905) recognized three types of vegetation to be distinguished on the lowland in Roscommon and Crawford Counties, Michigan. They are: (1) Open-meadow type, (2) Tamarack-Northern White Cedar swamp, and (3) Mixed swamp. He also pointed out that the swamps are generally in much more nearly their original condition than are the upland forests due to the fact that swamps have not been subjected to burning nearly so often as the uplands. As to the factors of distribution of vegetation in the lowlands, he explained:

"----- but the mixed type (of both coniferous and hardwood species) is always found on the better drained portions, where there are humocks raised out of the saturated soil, and the general level is a few inches higher. Often this better drainage seems to come about merely by accumulation of vegetable debris, a fact which suggests that perhaps in time the conifer swamp might give way to the mixed, and at last possibly to the hardwood upland type."

In another paper, "The distribution of the plant societies of Kent County, Michigan, Livingston (1901) stated

that probably the main factor in determining the distribution of lowland societies is water. However, he stated further:

"----- the amount of water is practically the same in an undrained and in a drained swamp and on a brook margin; yet the floras are dissimilar, especially the first two. It has been suggested that the great amount of organic materials in the solution of the undrained swamp may effect the plants physically or chemically and thus exclude those which occur in the drained swamp. ---- There remains the other suggestion that the undrained swamp owes the peculiar character of its flora to the chemical nature of the soil solution. It may be lack of oxygen in the soil which shuts out the plants of the drained swamp."

Davis (1906) has ably discussed the peat and the occurring vegetation. He has defined and distinguished the differences between the "bog", the "marsh", and the "swamp"; and also grouped the peat lands into eight groups: (1) Elm and black ash swamps, (2) Tamarack swamps, marshes, and bogs, (3) Cedar swamps, (4) Spruce swamps, (5) Willow and alder swamps or marsh, (6) Heath swamps, marshes, or bogs, (7) Grass and sedge marshes and bogs, and (8) Rush marshes.

Harper (1918) made a study on the plant population of northern lower Michigan. He believed that some of the imagined successions on the poorly-drained areas can never take place without profound topographic changes, which may or may not come to pass. In illustrating his point, he made the following statement:

"Two genuine types of succession can be studied to advantage in this region. The first is that connected with the filling of lakes, etc. with vegetation and the gradual accumulation of peat and humus. ----- In such humus grow many plants which are equally characteristic of the upland hardwood forests, and this has led some to believe that the swamps, barring human interference and unforeseen complications, will ultimately be replaced by beech-maple-hemlock forests. But there are quite a number of plants in this region which seem to demand both humus and access to mineral soil or alkaline peat such as Acer saccharum, Tsuga, Fagus, Tilia, Ulmus, Quercus alba, Viburnum acerifolium etc., and we have no evidence that these will ever grow on top of deep sour peat. Furthermore, the swamps are colder at night than the adjoining slopes, and lack some of the characteristic soil fauna of clayey uplands, and these fundamental differences can hardly be obliterated by succession."

Gates (1926) has made a study on the plant successions about Douglas Lake in Cheboygan County, Michigan. He stated that cedar bog forest will be the terminal stage before reaching the upland type, whereas the lowland forest of ash, elm, and red maple is the stage next to dryland on land which is subject to overflow or spring flooding.

In 1942, Gates made another investigation on the bogs of northern lower Michigan. He defined the bog as "an area vegetated by a flora in which peat-forming types of plants (including certain herbaceous, ericaceous shrubs, and coniferous trees) are particularly abundant." In his paper, trends of succession are diagramed and the characteristic vegetation of each stages also are listed.

Clements (1936) has stated that the bogs and muskegs

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are the prisere subclimaxes of the boreal and lake forests. In discussing subclimax, he proposed the term "serclimax" and made the following statement:

"Serclimax is suggested with a meaning of a seral community usually one or two stages before the subclimax, which persists for such a period as to resemble the climax in this one respect.

For the most part, serclimaxes are found in standing water or in saturated soils as a consequence of imperfect drainage. The universal sample is the reed-swamp with one or more of several consociates, such as Scirpus, Typha, Zizania, Phragmites, and Glyceria. ----- In boreal and subalpine districts the distinctive serclimax is the peat bog, moor or muskeg, more or less regularly associated with the other seral communities of Carex and usually of Larix and Picea also in the proper region."

Potzger (1934, 1941, 1943, 1946, 1947, and 1948) has made a number of studies on the history and succession of vegetation in Michigan, principally on the bogs and lowland forests, by means of pollen analysis. He considered the bog forests of Abies, Picea and Larix to be relics of the boreal forest caused by the retreat of glaciers.

In "The history of the vegetation of Michigan", Potzger (1947) pointed out the existence of a "tension zone" in central lower Michigan, between oak forests of the south and the coniferous forests of the north.

Nichols (1935), in discussing the physiographic climax forests in the "Eastern Hemlock" region, has recognized the poorly-drained swamp coniferous forests of balsam fir, black spruce, white spruce (Picea glauca), northern white

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Bowman (1944) pointed out that 26 percent of the forest land in Michigan has been classified by the Forest Survey as either coniferous swamps or spruce-balsam fir land. He stated that black spruce is usually found on the swamp or bog sites frequently associates with tamarack where as it may be accompanied by northern white cedar on better sites. As for the northern white cedar, he claimed that it is unable to withstand great soil acidity but can endure shade and a surplus of soil water quite as well as black spruce; and when conditions are favorable, it will surpass black spruce and all other swamp species in reproducing itself.

Swamp and bog floras have been listed and discussed by Darlington (1945). He pointed out that there are numerous swamps in northern lower Michigan, often covered with dense stands of northern white cedar, tamarack, and black spruce as well as some bogs with shrub growth.

Braun (1950) has discussed the succession of various forest communities to one another in sequences of decreasing water requirements from the bog to the highest ridges of the forests in northern lower Michigan. She stated that the replacement of bog or transitional communities by hardwood forest can not take place until the swamps are filled or drained.

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In discussing the bog communities Braun said that most of the bogs and swamps are occupied by coniferous communities with a few are hardwood swamps. She pointed out the general sequence of vegetational stages of a developing bog ---- aquatic, sedge mat, bog shrub, and bog forest; and stated that the principal trees of bog forests are Larix laricina, Picea mariana, and Thuja occidentalis, and the Thuja bog is the ultimate in bog forest development in lower Michigan. She further mentioned that in many cases the Thuja was wanting from the Thuja-Larix-Picea association where the other two were present in about equal number, with the presence of balsam fir, white spruce, black ash, white elm, balsam poplar, red maple and a few other species of swamp trees to give a mixed character to the type.

She also discussed the river swamp communities in lower Michigan and stated:

"Shrubby species of willow, alder and spiraea form a shrub border, white elm, black ash and some times silver maple dominate in the swamp forest strip. The royal fern (Osmunda regalis) is a frequent subdominant. On better drained stream margins, a few additional hardwood species may enter the elm-ash communities, suggesting its replacement under good drainage condition by mesophytic hardwood forest."

The peat bogs of eastern North America have been studied by Dansereau and Segadas-Vianna (1952). In the first of their papers, "Structure and evolution of vegetation", succession on the bogs has been well illustrated.

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Forest succession in northern Minnesota has been discussed by Bergman and Stallard (1916), and by Stallard (1929). Of these, parts of the papers have been devoted to the hydrarch succession. Likewise, plant succession in bogs of central Minnesota has been studied by Conway (1949).

Four distinguished forest types on wet sites in "northern forest region" of the eastern United States have been recognized by the Society of American Foresters (Hawley and others, 1932). They are:

1. Black spruce type ----- composed of black spruce, pure or mixed with a minor portion of balsam fir, tamarack, northern white cedar, black ash, red maple and occasionally paper birch. It is a subclimax type to be found in swamps, on acid peat with little or no drainage.

2. Northern white cedar type ----- composed of northern white cedar, pure or predominating. Associates may include tamarack, balsam fir, yellow birch, paper birch, black ash, red maple, black spruce, white pine, and hemlock. Sometimes has an under growth of alder. If undisturbed, it maintains itself as long as the swamp remains wet. It is usually found on sites with slow drainage, high water-table, and not strongly acid.

3. Tamarack type ----- composed of tamarack pure or predominating. Common associates either black spruce or northern white cedar or less commonly both. Other associates,

mostly, subordinate, include red maple, black ash, and aspen. It is chiefly found in peat swamps with little or no drainage, and is succeeded by black spruce on undrained acid peat or by northern white cedar in better drained less acid swamps.

4. Black ash-American elm-red maple type ----- Black ash occurs least often in other types and therefore may be considered as an indicator species for this type. It is a climax for the site. In Lake States, the associates include balsam poplar, balsam fir, yellow birch, and less commonly white pine, tamarack, northern white cedar, basswood, etc.. It occupies moist to wet muck or shallow peat soils in swamps, gullies, and small depressions of slow drainage or along sluggish streams.

Gates (1930) has made a study on the aspen association in northern lower Michigan. He pointed out the occurrence of aspen association is the result of virgin or second growth forest from burning. In his paper, he recognized three types within the aspen association : (1) Lowland type, (2) Sandy upland type, and (3) Clayey upland type. For the lowland type, he stated:

"The sandy lowland types of aspen association is distinguished by the dominance of Populus tremuloides, and it will be replaced by either Thuja association, or a mixture of spruce-balsam, or the lowland forest of black ash and American elm."

DESCRIPTION OF THE REGION

A. History and general description

Ecologically speaking, the Higgins Lake area is located within the Hemlock-White Pine-Northern Hardwoods Formation which lies north of the tension zone between this Formation and the Deciduous Formation of the south in the state of Michigan (Fig. 1).

Geographically, the area is located in the northern central part of the lower peninsula of Michigan, and is within the scope of the Higgins Lake State Forest which is composed of parts of four Counties: Missaukee, Kalkaska, Crawford, and Roscommon (Fig. 2). The Higgins Lake State Forest encloses an area of 311,480 acres within its boundary, and has a net state ownership of 196,475 acres (Michigan Department of Conservation Biennial Report, 1951-1952).

In 1899, a State Forestry Commission was authorized to study the forest situation in Michigan, and set up reserves but nothing was accomplished until 1903. That year, two "Reserves", the Higgins Lake Reserve in the northern half of T24N, R4W and the southern half of T25N, R4W, Crawford County, and the Houghton Lake Reserve in T21N, R3W and T21N, R4W, Roscommon County together comprising 35,000 acres of tax-reverted, cutover and burned over land were set aside.

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Fig. 1. May

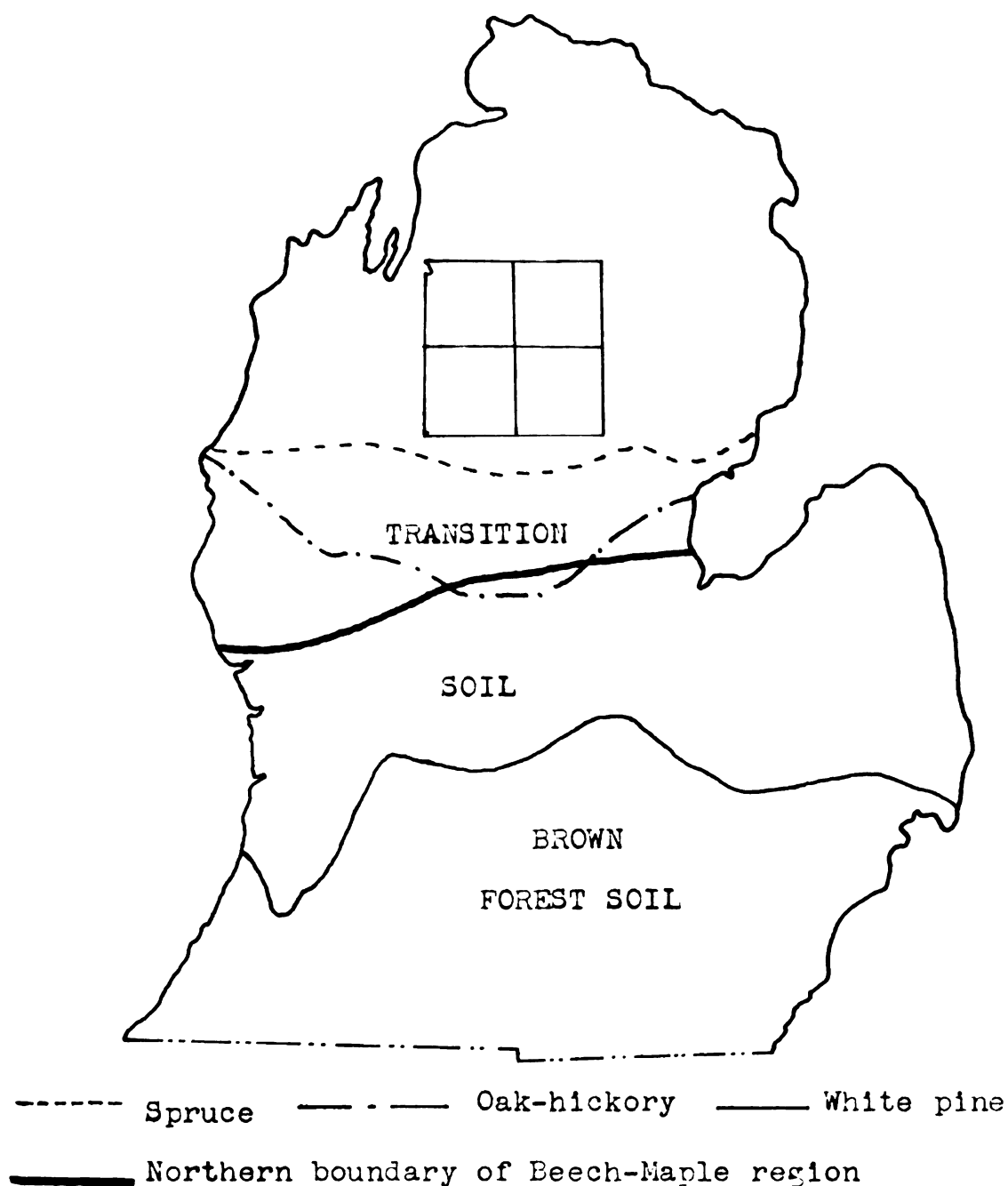
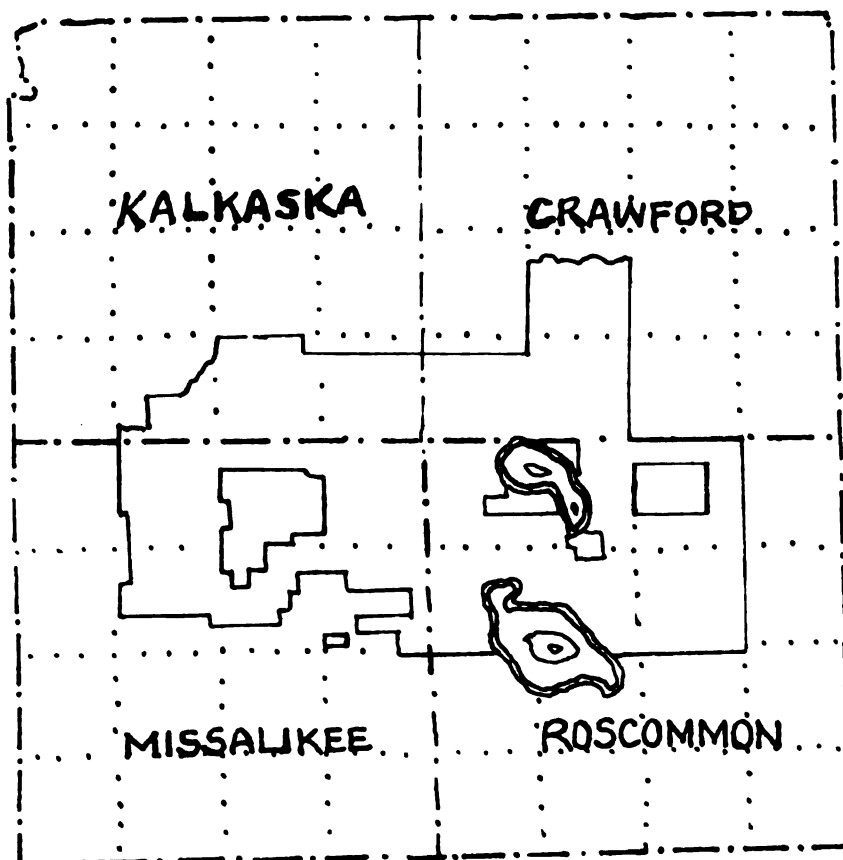


Fig. 1. Map of Lower Michigan showing the location of the Higgins Lake area in relationship to the Hemlock-White Pine-Northern Hardwoods region and also its relation to some of the tree ranges and soils. (After Braun, 1950, and Veatch, 1932)



LEGEND

- — — — — COUNTY BOUNDARIES
- TOWNSHIP BOUNDARIES
- BOUNDARY OF HIGGINS LAKE STATE FOREST
-  LAKES

Fig. 2. Map of Higgins Lake State Forest showing its boundary within the four adjoining Counties: Missaukee, Kalkaska, Crawford, and Roscommon. (After the State Ownership Maps of the four Counties, Michigan Department of Conservation, June, 1951.)



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However, no activities were being carried out on the Houghton Lake Reserve until 1911, therefore the Higgins Lake State Forest was the first of the State Forests to be put under active management.

The entire land area of the Higgins Lake State Forest, at the time of its first occupation by white men, was covered by a dense forest except for a small acreage of bog or marsh and some open land in the drier sandy plains. The lumber industry of pine on large scale started about 1870 and of hardwoods about 1900. At the present time, the original forest has long been cut over except in a very few small areas and woodlots, and may be a few places in swamps.

Several types of forest were represented in the virgin forest as recorded by the Soil Economic Survey: (1)The hardwood forests, in which sugar maple and beech were the dominant species, and elm, ash, basswood, yellow birch, and hemlock were the subdominant species; (2)the mixed conifer and hardwood forests, in which such species as elm, ash, red maple, aspen, and yellow birch were intimately associated with white pine, hemlock, spruce, and fir; (3)the pine forests, in which white pine, red pine and Norway pine or red and jack pine predominated; and (4)the swamp forests, in which the dominant species were northern white cedar, spruce, balsam fir, and tamarack. Much of the forest land is at present covered with

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a dense growth of brush, briars, and grass or grown up to scrubby aspen, oak, and red maple, with little natural reproduction of the original dominant species.

In the early days of the area's development the lumber industry unquestionably brought the largest number of people into the area. During this period of the late seventies the railroads were extending their lines into the northern regions of the state and opening the way for further settlement in this area. At the same time agriculture was also gaining a foothold so that the population on farms was being increased. Between 1900 and 1910 the rate of farm settlement was considerably increased by the activities of outside real estate companies that sold cut-over lands to new settlers.

With the decline in the lumber industry after the excessive cutting, the farmers lost an important and easily accessible market for their produce and surplus labor. Without this market, many farmers were forced to leave their farms. Extensive abandonment has since occurred on the lands of low productivity and least favorable locations which were chiefly those lands sold by the previously stated companies. The tracts and lots which have been abandoned by their owners now make up a large part of the present area of the Higgins Lake State Forest.

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The recent development in this area has centered on resort and recreational property. With the advent of improved roads and motor transportation, Houghton and Higgins Lakes began to attract more visitors each year. There are now a tremendous numbers of dwellings in the resort villages of Houghton Heights, Houghton Lake Village, Prudenville and others. Higgins and Houghton Lakes have since become a famous hunting, fishing and outing ground.

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B. Climate

Michigan is located in the heart of the Great Lakes region and has the longest shore line in the States. The large bodies of water tend to equalize the nearby land temperatures and this is especially true of lower Michigan, where the effect of cold waves sweeping down from the northwest is modified by the warmer water of the Great Lakes. This makes for lower Michigan a more equal and less extreme climate than occurs in the states of similar latitude on the other side of Lake Michigan.

In the Higgins Lake area, the climate alternates between continental and semi-marine conditions. The marine type is due to the influence of the lakes and governed by the force and direction of the wind. The weather becomes continental in character when there is little or no wind, and a strong wind from the lakes will transfer it into a semi-marine type.

The winters are long and rigorous in this area, as temperature below freezing prevail from November to March, inclusive; and occasional freezes may well be expected in September and May, or even in June. This limits the frost free or the growing season to a comparative short period. The average period for the region as a whole is about 105 days. It is derived from the data of six weather stations

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in and near the Higgins Lake State Forest which range from 88 to 125 days. The low of 88 days at Houghton Lake Station and 95 days at Roscommon Station are probably due to the presence of large bodies of lakes and swamp lands in these areas.

The main climatic features of this region are a mean annual temperature of about 43°F. (average January temperature 18°F., and average July temperature of 68°F.); a normal precipitation (including melted snow) of about 29 inches; an average snowfall of approximately 70 inches; low evaporation; low percentage of possible sunshine; and rigorous winters and mild summers.

The precipitation is distributed relatively even throughout the year with a slightly greater amount for the six-month period from May to October. Most of the precipitation occurs as slow rains with rare occasions of destructive downpours. Snow ordinarily forms a permanent ground cover from November to March and serves to prevent the soil from freezing to a great depth. The prevailing winds are westerly and rarely attain high velocity to cause any destructive damages.

Weather data of this region are presented in Table 1. The data are adapted from "Climate of Michigan" in Climate And Man (U.S.D.A. Yearbook, 1941), and expanded by using Climatological Data for Michigan, U. S. Department of Commerce,

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Weather Bureau, from 1938 to 1952. The locations of Weather Stations which are near the Higgins Lake are shown in Fig. 3.

Table 1. Weather data of the Higgins Lake area..

Station	Temperature °F.				Killing Frost Ave. Dates				Precipitation	
	Jan. July		a	b	Last in First in		2		tation	
	1	ave. ave.			1	Spring Fall			1	Inches
Higgins Lake	50	17.7 66.9	106	-39	17 June	6 Sept.16	102	48	29.39	
Houghton Lake	36	19.8 67.4	107	-48	36 June	10 Sept. 6	88	37	27.40	
Rescommon*	8	18.6 67.3	---	---	8 June	2 Sept. 5	95	7	29.98	
Grayling	51	17.7 67.6	106	-41	54 May	29 Sept.18	112	53	31.07	
Kalkaska	22	17.6 67.8	106	-34	24 May	23 Sept.25	125	35	30.20	
Lake City	30	19.3 68.6	106	-41	30 May	28 Sept.21	116	29	26.44	

*Data compiled from Climatological Data for Michigan, U.S. Department of Commerce, Weather Bureau, from 1939 to 1946 only.

1 ----- Length of record years

a ----- Maximum temperature recorded

b ----- Minimum temperature recorded

2 ----- Length of growing season in days

Station	1	Precipitation					in		Inches				
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Higgins Lake	36	1.46	1.47	1.82	2.44	2.79	2.59	2.68	2.90	3.21	2.65	2.29	1.62
Houghton Lake	24	1.34	1.21	1.99	2.53	2.74	2.77	2.38	2.73	2.92	2.97	2.37	1.45
Grayling	39	1.56	1.52	1.70	2.36	3.37	2.89	3.41	2.90	3.43	3.16	2.73	1.70
Kalkaska Lake	23	1.49	1.23	1.94	2.20	2.94	2.60	3.07	3.19	3.30	2.87	2.40	1.95
City	17	1.47	1.65	1.50	1.96	2.52	2.65	2.30	2.25	2.94	2.33	1.79	1.29

1 ----- Length of record in years

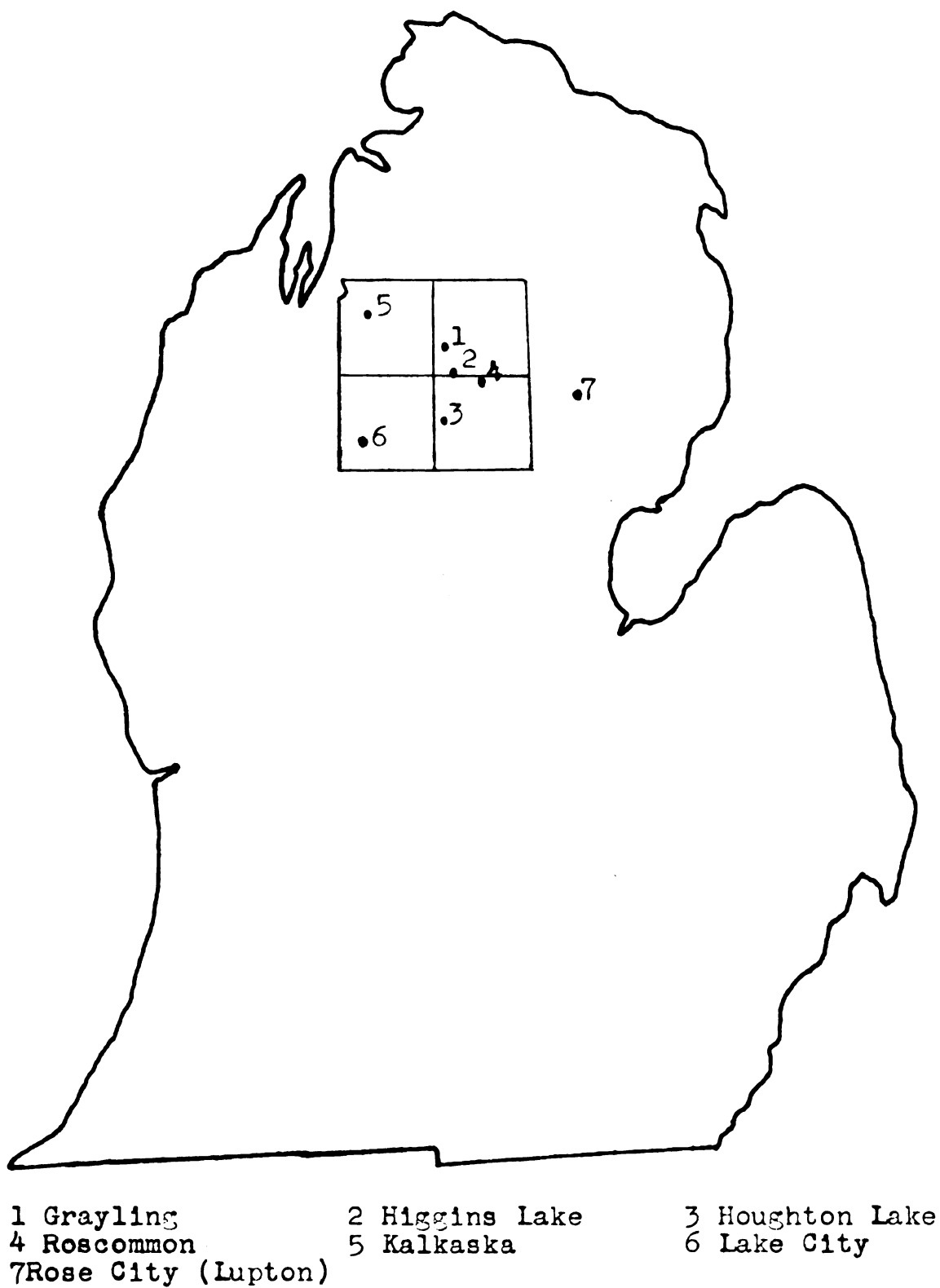


Fig. 3. Map of Lower Michigan showing the location of U. S. Weather Bureau Stations in and near the Higgins Lake area whose weather data are used in this study.



C. Geology

The surface features of the southern peninsula of Michigan are product of glaciation. The glacial drift, which covers so deeply much of the rock surface of the southern peninsula, was brought in largely by an ice sheet or continental glacier which moved southeastward from the highlands of Canada. According to Leverett (1912), "----- the average thickness of the drift in the southern peninsula is about 300 feet, whereas in the high interior of the north part of the peninsula may have over 1,000 feet."

In the Higgins Lake area, the surface features have been changed very little since the close of the last period of glaciation. Much of the land formation in this region is level or gently rolling which can be grouped into three physiographic divisions: (1) The outwash plains, (2) the till plains, and (3) the moraines. The underlying bedrock has been covered to a considerable depth by glacial drift and outwash so that no surface outcroppings of hardrock occur. According to Michigan Geological Survey, it is 417 feet at Roscommon in Roscommon County. The structure of the drift is rather variable in Michigan. Leverett (1904) stated that:

"----- Sand and gravel form a notable part of the drift material and much of the till is loose textured. This great amount of loose textured drift seems attributable to the excessive glacial drainage resulting from the convergence of the ice lobes."

Surface land formations of the Higgins Lake State Forest are shown in Fig. 4. The outwash plains are mainly level while the smooth rolling uplands occupying the till plains and the moraines make up the rolling to hilly uplands. Considerable areas of swamp and wet lands occur around the lakes and along the rivers, chiefly on the outwash plains; and also some of the swamp soils which are scattered in spots occur in the deeply cut valleys and on the rolling to hilly uplands.

A table-land ranging in height from 1,200 to 1,400 feet which embraces parts of Crawford, Kalkaska, Missaukee, and Roscommon Counties to form a divide between three large river systems. As a result, three drainage basins are formed as shown in Fig. 5. In the Higgins Lake State Forest region, area in Crawford County and roughly the eastern one third of the area in Roscommon County drain into the AuSable River, which flows eastward to Lake Huron. The area in Kalkaska County and approximately the northern one third of the area in Missaukee County drain into the Manistee River; while the rest of the area drains into the Muskegon River which heads in Higgins and Houghten Lakes. Both the Manistee and Muskegon Rivers flow westward to Lake Michigan.

The abundance of lakes in the southern peninsula is an indication of the incompleteness of the drainage. There

Legend

Higgins Lake State Forest boundary

County boundary

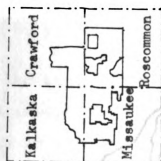
Streams

Lakes

Outwash Plains

Till Plains

Moraines



Key Map

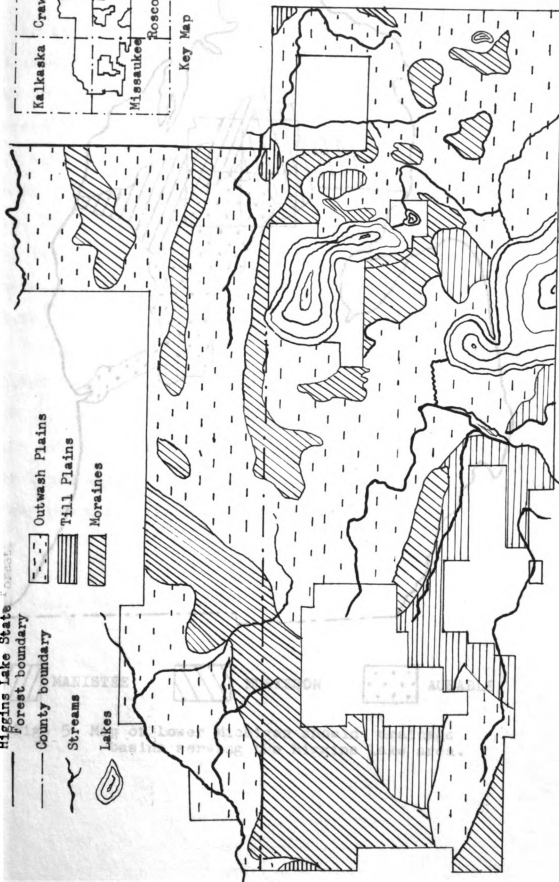


Fig. 4. Map of the Higgins Lake State Forest showing its surface geology. (After Leverett, 1924, and Michigan Conservation Department State Ownership Map, 1951.)

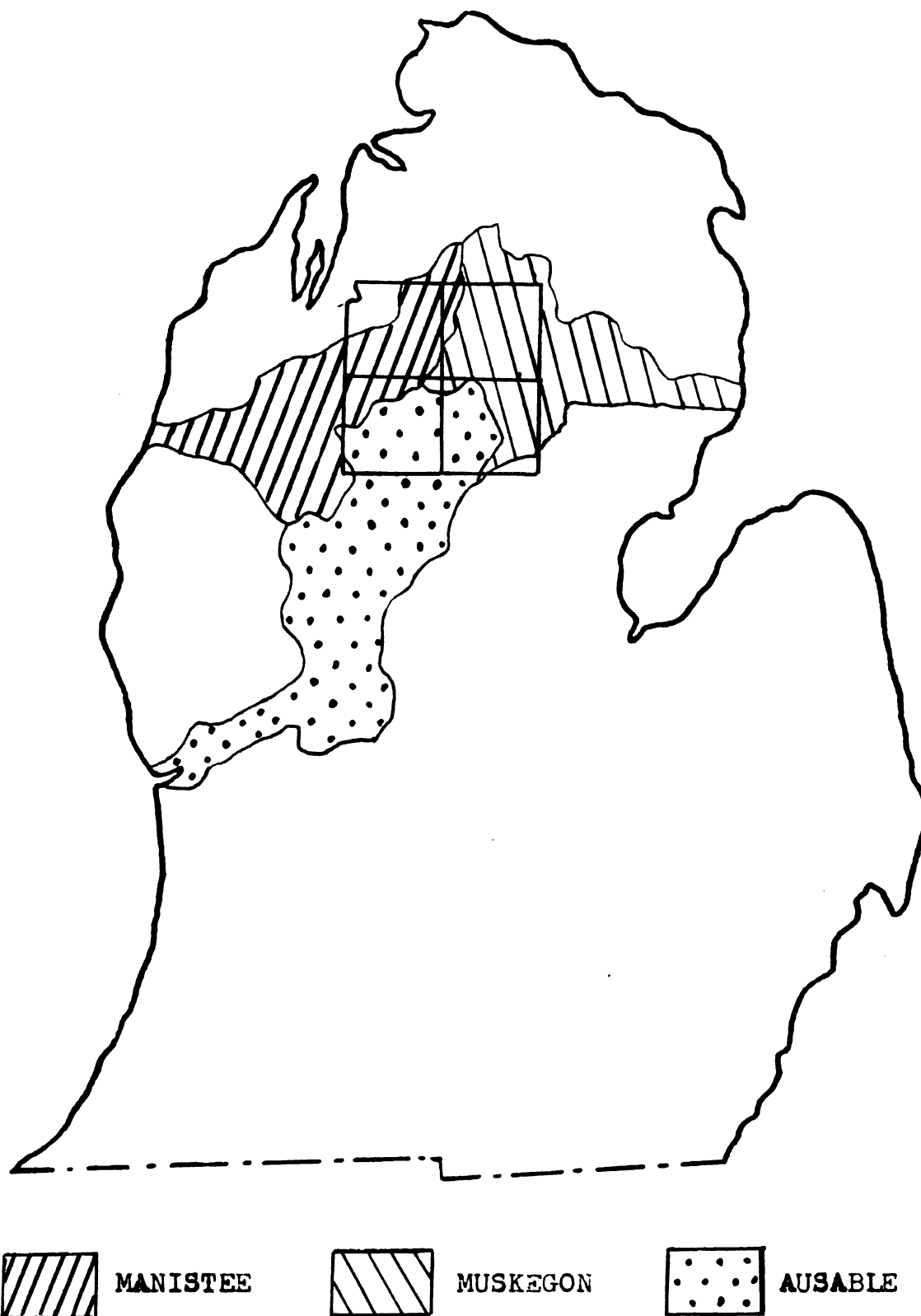


Fig. 5 Map of Lower Michigan showing drainage basins serving the Higgins Lake area.

are two large lakes and a few smaller ones in the Higgins Lake area. Houghton Lake is the largest inland lake in the State of Michigan. It has an area of approximate thirty-one square miles and is more than eight miles long and over four miles wide. It is a shallow lake which does not exceed 25 feet in depth, and has heavy growth of vegetation. In contrast, Higgins Lake, which has an area of about 15 square miles is deep and is fed by springs. It also is located on a higher elevation, 1,160 feet above the sea level, as compared to 1,125 feet of Houghton Lake.

The general elevation of the region ranges from 1,000 to 1,400 feet above the sea level or about 400 to 800 feet above the level of Lake Michigan and Lake Huron. Elevations of the level plains vary from 1,000 to 1,200 feet, while the hilly lands usually reach an elevation of 1,150 to 1,300 feet and may reach as much as 1,400 feet at places.

D. Soil

The soils of Michigan are developed from the materials deposited by repeated glaciers which covered the state at the close of the Tertiary. This glacial drift, which covers so deeply much of the rock surface of the lower peninsula has an average thickness of about 300 to 600 feet (Leverett, 1915).

The soil conditions are chiefly determined by the surface geology and the topography. The original character of the soil, whether rock, sand, clay or marl, depends upon the geological relations. From the vegetation standpoint the topographic relations are much more important, since they condition the presence or absence of drainage and cause variations in aeration and humus contents.

The soils in the Higgins Lake region can be classified into two major divisions: Those developed under conditions of good drainage and medium moisture and those developed under poor drainage or excessive moisture. In this paper only that of the latter are to be discussed.

Poorly-drained areas or the swamp land makes up a considerably large portion of the land area in the northern counties of lower Michigan. The soils developed under conditions of poor drainage in the area of this study are grouped into three series. They are the Newton soils, the Bergland soils, and the organic soils. General descriptions of these soils are as follows:

1. Newton soils

These soils occur on poorly-drained sand plains, on the flat wet borders of shallow lakes and swamps. They consist of a dark layer of leamy sand or sandy loam soil underlain by gray or dingy-white wet sand. The dark color, due to organic matter accumulated under wet conditions extends to a depth ranging from 3 to 15 inches. Most of these soils are medium or strongly acid in reaction.

The original tree growth consists mainly of white pine (Pinus Strebis) with more or less northern white cedar (Thuja occidentalis), black spruce (Picea mariana), and balsam fir (Abies balsamea) (Soil Survey of Roscommon County, Michigan, 1924). At the present time, most of the land is covered with a dense growth of alder, willow, and aspen.

2. Bergland soils

These are the heavier mineral soils which have developed under conditions of poor drainage. They occur only in small areas as swamp lands in swales and on the borders of peat and muck swamps. These soils are nearly neutral in reaction. The surface soil is dark gray or nearly black loam or clay loam with high content of organic matter. It is underlain by a gray or drab plastic clayey layer, mottled with yellowish or rust-colored spots showing the typical characteristics common to clay soils existing under permanent wet conditions.

The native vegetation consists mainly of elm and ash, with smaller amount of red maple (Acer rubrum), basswood (Tilia americana), spruce, balsam fir, northern white cedar, hemlock (Tsuga canadensis), and white pine.

3.Organic soils

The organic soils are composed dominantly of plant remains, and constitute a distinct class in comparison with soils which are composed principally of mineral or inorganic matter. In this region, the organic soils occur in swamps, bogs, and marshes. The deposits have accumulated in permanent wet situations such as in irregular shaped flat areas where the under drainage is obstructed, in stream valleys, and in certain types of lakes, some of which have been completely filled by vegetation. The organic deposits range from one foot to as much as 40 feet. Based upon the vegetational origin of the organic deposits, and the degree of its decomposition, the organic soils in this region are further grouped into the following types:

a.Rifle peat

Rifle peat is brown or dark brown, coarse, woody or loamy muck or peat very rich in organic matter, which is underlain at a depth ranging from six to 20 inches by fibrous or coarser textured plant material with very little decomposition. The average depth of the water-table is about 10 to 20 inches. This organic soil is acid or nearly neutral in reaction. It occupies the largest aggregate acreage of the

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The vegetation consists of a dense swamp growth of northern white cedar, black spruce, balsam fir, and tamarack (Larix laricina), with occasional hemlock and white pine. Where the swamp land has been logged and burned over it has grown up in dense thickets of aspen, alder, willow, and birch, whereas treeless open areas are covered with a heavy growth of sedges and bluejoint (Calamagrostis canadensis).

b. Greenwood peat

This is fibrous or coarse-textured, loose, brownish peat in which the plant material is only slightly decomposed, even at the surface. This kind of peat is uniformly strongly acid in reaction. The water-table is at or near the surface, except during very dry periods.

Much of the Greenwood peat land has a semi-floating substratum. The open heath bogs support leatherleaf (Chamaedaphne calyculata), labrador tea (Ledum groenlandicum), blueberry (Vaccinium sp.) and Sphagnum moss (Sphagnum sp.) with occasional growth of tamarack and black spruce (Soil Survey of Roscommon County, Michigan, 1924). Some of the more open land is marsh grown up chiefly to sedges.

- *Pharmaceutical industry* - the largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Automotive industry* - the second largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Food and beverage industry* - the third largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Chemical industry* - the fourth largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Textile and apparel industry* - the fifth largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Electronics industry* - the sixth largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Health care industry* - the seventh largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Energy industry* - the eighth largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Transportation industry* - the ninth largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.
- *Real estate industry* - the tenth largest and most profitable of the major industries in the United States. It is a highly competitive industry with a high degree of innovation and research and development. The industry is characterized by a high degree of concentration, with a few large firms dominating the market.

E.Cover type

In the northern counties of Michigan, swamp land makes up a considerable portion of the land area. Most of the timbered swamp lands at the present time are occupied by coniferous swamp species; the rest of the areas are occupied by the swamp hardwood species and in some open places, marshes and bogs.

The swamp forest growth varies considerably in age and size. Many areas have been closely cut over and are now occupied by dense reproduction. Other areas are well along the second growth stage and a few lightly cut or virgin stands still remain. Generally speaking, the swamp stands are nearly all well stocked. This may trace back to the fact that the swamps are usually wet, their cover has suffered less from fire than that of the uplands.

The poorly-drained or swamp land in the Higgins Lake area can be grouped into the following vegetation types (Land Economic Survey Reports of Roscommon, Crawford, and Kalkaska Counties, Michigan.):

1.Swamp Hardwood type

The major species of this type are elms, black ash (Fraxinus nigra), red maple, and yellow birch (Betula lutea). On the better-drained areas, aspen, white birch (Betula papyrifera), and alder may enter, while poorer drained sites

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The Swamp Hardwood type is usually found on areas of lowlands that possess a very moist mineral soil or more frequently where a shallow muck layer overlies a wet sandy subsoil. The usual location for such site is the swamp margins bordering the highlands. It also occurs commonly on those areas of swamp land that are occupied by better decomposed types of peat and muck of relatively shallow depth on a mineral substratum.

The Swamp Hardwood type usually exists as an uneven aged stand and rarely attains the volume produced by the upland hardwood type.

2. Swamp Conifer type

Northern white cedar, black spruce, balsam fir, and tamarack predominate the Swamp Conifer type with the associated species of red maple, yellow birch, elm, black ash, and aspen.

This mixture of species will vary in composition with the site on which the stand is found. On better drained sites balsam fir, northern white cedar, red maple, and yellow birch predominate, while black spruce and tamarack become more prominent on the poorly drained sites. Between these two extremes are found many variations in composition depending on drainage, depth of the peat, acidity, and soil temperature.

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The majority of the stands have been cut over, or at least culled over once or several times. Cut-over areas reproduce themselves well, while the severely burned over areas are occupied by a dense growth of alder and willow which offer much opposition to the coniferous reproduction.

3. Lowland Aspen type

Aspen stand is found to occur on nearly every class of soils and site, from the denuded hardwood and pine uplands down to the swamp lands. On most of the soils it exists as a temporary cover and is quite easily replaced by other species in time. However, repeatedly burned over areas generally restock the aspen type because of its ability to reproduce from sprouts.

Trembling aspen (Populus tremuloides) is the major species in the Lowland Aspen type. The most important invaders are northern white cedar, balsam fir and spruce, black ash and American elm (Ulmus americana).

4. Swamp Shrubs of Salix-Cornus-Alnus type

This type consists of a mixture of Salix, Cornus, and Alnus, or any one species alone. It occurs frequently on swampy or poorly drained areas which have been subjected to repeated burning, in addition to be a common associate in the Swamp Hardwood and Swamp Conifer types. It is also the principal growth along narrow stream bottoms.

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5. Marsh and Bog types

These are the vegetation types which occur on open poorly-drained land.

a. Marsh

In this region, there is one considerably large area of marsh, among other places, located just west of the Houghton Lake along Highway US-27.

These marshes occupy the low flat lands which are wet but have a surface drainage outlet, principally along narrow winding streams.

Sedges (Carex), bluejoint and other grasses form the principal vegetation. The wettest sites usually contain some cattails (Typha latifolia) while the relatively better drained areas have more grass. A patchy growth of willow (Salix sp.) is often associated with this type.

b. Bog

This type occurs on the bog areas and has a growth that consists mainly of leatherleaf, with a mixture of Sphagnum moss, labrador tea, and Vaccinium.

These bogs are usually treeless but in case the drainage is somewhat better, an open stand of black spruce or tamarack may be present.

VEGETATION ANALYSIS

A. Field procedure

1. The field work was conducted during the summer of 1952. A preliminary reconnaissance was made to investigate the areal extent, gross aspects of vegetation cover, associated soils, topography, and other local conditions of the entire region.

Typically representative stands were chosen as sample plots based on the vegetation and soil type and the consideration that they had the least disturbances either due to natural or human causes, such as fire, destructive cutting, etc.

Five types of vegetation were recognized on the poorly drained soils in the Higgins Lake area:

a. The Swamp Hardwoods of Elm-Black Ash-Red Maple Association.

b. The Swamp Conifers of Black Spruce-Balsam Fir-Northern White Cedar Association.

c. The Lowland Aspen of Populus-Salix Association

d. The Swamp Shrubs of Salix-Cornus-Alnus Association.

e. The Marsh or Open-Meadow Association.

2. Sampling method

Quadrats were used in sampling the vegetation in order to obtain maximum accuracy. The quadrats were placed in each vegetation type according to the various successional

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance with a desired state or goal. Once a problem is identified, the next step is to define the problem more precisely. This involves determining the scope of the problem, the resources available, and the constraints that may be affecting the problem. The third step is to analyze the problem. This involves identifying the causes of the problem and the factors that are contributing to it. The fourth step is to develop a solution. This involves brainstorming ideas and evaluating them to determine which one is the most feasible and effective. The fifth step is to implement the solution. This involves putting the solution into action and monitoring its progress. The sixth step is to evaluate the results. This involves comparing the actual results with the desired results and determining whether the problem has been solved. If the problem has not been solved, the process may need to be repeated.
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stages. This would probably give a better interpretation for the objective of this study, forest succession.

Sample plots were established depending upon the extent and configuration of the stand, and are laid in such a way so as to avoid the border effect. They were being dispersed and randomly distributed in the entire region. However, stands which were located too deep in the swamps, too remote from the roads, or too widely scattered were avoided so as to reduce much of the travelling time especially during the period of collecting instrumental data.

The number of sample plots in each vegetation type were determined by the homogeneity of stand composition, the extensiveness of the type referring to the region as a whole, and in some instances, the accessibility of the stands.

Nested quadrats were used in this study. The sizes of different quadrats were:

a. 1/5 acre quadrat for tree species more than six feet tall, and shrub species more than 25 feet tall.

b. 1/10 acre quadrat for shrub species or any vegetation from 6 to 25 feet tall.

c. 1/1000 or milacre quadrat for all vegetation below six feet tall.

This classification is a common practice in forestry research work. The principle is to select the right size plot

which is small enough to work with, and fairly effective in representing the population and to achieve the objective of the study.

Individual tree species, on 1/5 acre plots, were tallied and recorded according to the size classes designated by Weaver and Clements (1938), with a slight adjustment in the size class 2:

Size class 2. Medium reproduction ----- tree species more than 6 feet tall or up to 0.9 inches D.B.H..

Size class 3. Large reproduction ----- 1 inch to 3.5 inches D.B.H..

Size class 4. Small trees ----- 3.6 to 9.5 inches D.B.H..

Size class 5. Large trees ----- 9.6 inches or more D.B.H..

Individual shrub species on 1/10 acre plots were tallied according to Height classes arbitrarily set up by the author based on the natural height growth of the shrubs in the region. Two classes were used in this study:

Height class 1. Vegetation from 6 to 15 feet tall.

Height class 2. Vegetation over 15 feet and up to 25 ft..

In the milacre plots, all vegetation was recorded by classes arbitrarily designated by height in order to show their stratification as occurring in nature. Three classes were used:

Class 1. Plants up to 0.9 foot tall.

Class 2. Plants from 1 foot to 3 feet tall.

Class 3. Plants over 3 feet and up to 6 feet tall.

Tree and shrub species were recorded by number of stems into their corresponding height class in the milacre plots, with a few exceptions where some of the shrubs were difficult to count and therefore were recorded by "coverage". Coverage in this paper is defined as the ocular estimation of the plants which cover the ground surface in vertical projection as expressed in percentage. All herbaceous plants and pteridophytes were tallied by coverage..

B. Office procedure

1. Summerization of field data

a. Concerning tree species ----- The objectives are to provide data which upon processing will yield the following indices for the tree components of the stand.

(1) Frequency ---- a measure of dispersion expressed as the percentage of quadrats in which:

(a) a given species occurs (i.e., frequency per species)

$$F_q \text{ of sp. A} = \frac{\text{No. of quadrats in which sp. A occurs} \times 100}{\text{Total no. of quadrats examined}}$$

(b) a given size class of a given species occurs (i.e., frequency per size class per species)

$$F \text{ of sp. A} = \frac{\text{No. quad. in which size class n of A occur} \times 100}{\text{Total no. of quadrats examined}}$$

(c) Relative frequency ----- a relative expression as a percentage of the frequency value for a given species and based on the total of the frequency values for species.

$$Fr \text{ of sp. A} = \frac{\text{Frequency of species} \times 100}{\text{Sum of frequency values for all sp.}}$$

(2) Density ---- a quantitative measures of the number of individuals of a species per unit area.

$$D \text{ of sp. A} = \frac{\text{Total no. of individuals of sp. A counted} \times 100}{\text{Total no. of quadrats examined}}$$

(3) Relative density ---- a relative index of plentifulness expressed as the percentage representation of :

- (a) each species, based on the total number of individuals counted (i.e., relative density per species)

$$\text{Drs of sp. A} = \frac{\text{Total no. of individuals of sp. A counted} \times 100}{\text{Total no. of individuals of all species}}$$

- (b) each size class of a species, based on the total number of individuals in that size class (i.e., relative density per size class per species)

$$\text{Dr of sp. A} = \frac{\text{Total no. of size class n stems of sp. A} \times 100}{\text{Total no. of size class n stems of all species}}$$

(4) Basal area ----- a quantitative measure of dominance as expressed by summation of the area occupied at breast height by boles of a given species.

(5) Relative basal area ----- a relative index of dominance expressed as the percentage of basal area occupied by a given species.

$$\text{Br of sp. A} = \frac{\text{Total B.A. occupied by individuals of sp. A} \times 100}{\text{Total B.A. occupied by all species}}$$

(6) Importance value ----- a summation index indicating overall importance of a given species and calculated by adding the separate values for relative frequency, relative density, and relative basal area for that species.

$$\text{Importance Value of sp. A} = \text{Fr} + \text{Drs} + \text{Br}$$

b. Concerning shrub species ----- the following indices are produced from field data:

(1) Frequency

(a) a given species occurs (Fq)

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(b) a given height class of a given species occurs (F)

(c) relative frequency (Fr)

(2) Density (D)

(3) Relative density

(a) of each species (Drs)

(b) of each height class of a species (Dr)

(4) Abundance (A) ----- the average number of individuals of a species per quadrat considering only quadrats in which the species is presented.

$$A \text{ of sp. B} = \frac{\text{Total number of individuals of sp. B counted}}{\text{No. of quadrats in which sp. B occurs}}$$

$$\text{But } D = \frac{\text{Total individuals}}{\text{Total quadrats}}$$

$$\text{And } Fq = \frac{\text{Quadrats of occurrence} \times 100}{\text{Total quadrats}}$$

$$\text{Therefore } A = 100D/Fq$$

(5) Relative abundance (Ar) ----- a relative index of abundance expressed in percentage

$$Ar \text{ of sp. B} = \frac{\text{Abundance of sp. B}}{\text{Abundance of all sp.}}$$

c. Concerning herbaceous species ----- All plants below 6 feet tall were grouped into form groups of Tree, Shrub and Vine, Fern and Fern-like plants, and Herb. They are listed by species alphabetically by percentages of coverage according to the three classes designated.

The second part of the document provides a detailed overview of the accounting system used by the organization. It describes the various accounts and how they are organized, as well as the methods used to record and process transactions. This section includes a list of the accounts and a brief description of each, as well as a summary of the accounting cycle and the steps involved in preparing financial statements.

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2. Collection, identification and nomenclature of the vegetation

Specimens of all plants found in the quadrats were collected and deposited in the Herbarium of Michigan State College.

Nomenclature for the trees and part of the shrubs are following the "Check List of Native and Naturalized Trees of the United States (Including Alaska)" (U.S.D.A; F.S. Agr. Handbook No. 41, 1953). All other plants follow Gray's Manual of Botany (Fernald, 1950).

A check list of the plants encountered in this study is supplemented in Appendix, listing 171 species of which there are 20 trees, 51 shrubs, 10 pteridophytes, and 90 herbaceous species.

C. Vegetation inventory

As mentioned previously, five different vegetation types were found on the poorly-drained soils in this region. Vegetation inventory was carried out in 1952, from June to October.

An increment borer was used in the field to determine tree age. The largest tree was selected in order to determine the sequence of ecesis of various species in each 1/5 acre quadrat.

To each of the 1/5 acre quadrats, four milacre plots were set up to study the ground vegetation. Plants in the milacre quadrats are grouped into four presence classes as following:

Abundant ----- Plants present in all four quadrats.

Frequent ----- Plants present in three quadrats.

Common ----- Plants present in two quadrats.

Rare ----- Plants present in one quadrat.

Summarized data of tree species by size classes, and plants of the herbaceous layer by height classes, and, if there is any, the shrub species by height classes are compiled and summarized for each vegetation type.

1. Swamp Hardwoods of Black Ash-American Elm-Red Maple
Association

The principal hardwood species to be found in this type were the black and green ash, red and silver maple, American and slippery elm, basswood, and yellow birch. Northern white cedar and balsam fir were the associated coniferous species. Four stands were selected as sample plots:

a. Black Ash-Northern White Cedar-Balsam Fir stand

Location ----- Roscommon County, Markey Township,
T23N, R3W, SE 1/4, Section 24.

Soil type ----- Rifle peat.

This stand was a mixture of hardwood and coniferous species. Black ash was the predominant species which was associated with northern white cedar and balsam fir. A few green ash, red maple, yellow birch, hemlock, American elm, and black spruce complete the tree species found in the quadrat. Speckled alder (Alnus rugosa) was the only shrub species present.

The largest tree was a northern white cedar, 13.5 inches D.B.H., 160 years old. The remaining species of balsam fir, red maple, green ash, and yellow birch were all about the same age, around 60 years.

Black ash and balsam fir were reproducing well, followed by northern white cedar. Reproduction of red maple was abundant, but almost all were one year old seedlings.

Plants of the herbaceous layer were grouped separately into tree, shrub and vine, fern and fern-like plants, and herb groups according to the four presence classes, with the number of tree seedlings also listed:

Trees

Abundant --- Acer rubrum (299)
Abies balsamea (18)

Frequent --- Fraxinus nigra (18)
Ulmus rubra (3)

Common ----- Thuja occidentalis (10)
Betula lutea (10)

Rare ----- Quercus rubra (1)

Shrubs and Vines

Abundant --- Rubus pubescens

Common ----- Alnus rugosa Clematis virginiana
Ilex verticillata Mitchella repens

Rare ----- Lonicera canadensis Ribes lacustre
Rubus idaeus

Ferns and Fern-like Plants

Common ----- Dryopteris spinulosa Dryopteris cristata
Onoclea sensibilis

Sedges, Grasses and Herbs

Abundant --- Galium triflorum Carex intumescens

Frequent --- Agrostis hyemalis Aster lateriflorus
Cornus canadensis Galium trifidum
Lycopus americanus Maianthemum canadensis
Mitella nuda

Common ----- Aralia nudicaulis Glyceria striata
Lysimachia thyrsiflora Viola blanda

Rare ----- Aster puniceus Ranunculus sp.
Scutellaria lateriflora
Solidago ulmifolia Thalictrum dasycarpum

1. The first part of the document is a letter from the President of the United States to the Congress, dated January 3, 1862. It is a very important document, as it contains the President's annual message to Congress. The letter is written in a formal, dignified style, and it is one of the most important documents in the history of the United States.

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b. Ash-Red Maple-Elm stand

Location ----- Roscommon County, Lake Township,

T23N, R4W, NW 1/4, Section 3.

Soil type ----- Bergland loam.

This was a well stocked stand composed of black and green ash, red maple, American and slippery elm as dominant species, which associate with northern white cedar, balsam fir, and a few basswood. A few shrubs were the Amelanchier sp. and Corylus cornuta.

The largest tree was an American elm, 20.1 inches D.B.H., 160 years old. Many large red maple were present in the stand. The largest one, 13.5 inches D.B.H., was 70 years old. Black ash ranked next in age being about 45 years old.

Reproduction of both black and green ash was abundant. Red maple, northern white cedar, and balsam fir were also doing well.

Plants of the herbaceous layer were:

Trees

Abundant --- Acer rubrum (341)

Common ----- Fraxinus nigra (2)

Rare ----- Abies balsamea (9) Ulmus thomasi (22)
 Betula lutea (1)

Shrubs and Vines

Frequent --- Parthenocissus inserta

Rare ----- Amelanchier intermedia Corylus cornuta
 Nemopanthus mucronata Rhus radicans
 Ribes lacustre

2. In the second section, the author addresses the challenges of data management in a rapidly changing environment. It highlights the need for flexible and scalable solutions that can adapt to new technologies and evolving business requirements. The text also touches upon the importance of data security and privacy, noting that organizations must take appropriate measures to protect sensitive information from unauthorized access and breaches.

3. The third part of the document focuses on the role of technology in enhancing operational efficiency. It explores various digital tools and platforms that can streamline processes, reduce errors, and improve overall productivity. The author argues that embracing technology is not just a choice but a necessity for organizations looking to stay competitive in the modern market.

4. The fourth section discusses the importance of continuous learning and development for the workforce. It suggests that organizations should invest in training and development programs to equip their employees with the skills and knowledge needed to thrive in a dynamic environment. The text also mentions the benefits of fostering a culture of innovation and creativity, where employees are encouraged to think outside the box and propose new ideas.

5. Finally, the document concludes by emphasizing the need for strong leadership and strategic vision. It states that effective leaders are those who can inspire their teams, set clear goals, and navigate the organization through complex challenges. The author encourages leaders to stay informed about industry trends and to make data-driven decisions that align with the organization's long-term vision.

PteridophytesCommon ----- Dryopteris spinulosaRare ----- Botrychium dissectum Dryopteris thelypteris
Onoclea sensibilisSedges, Grasses, and HerbsAbundant --- Lysimachia terrestris Maianthemum canadensis
Viola blandaFrequent --- Carex intumescens Cornus canadensis
Fragaria virginianaCommon ----- Agrostis hyemalis Carex trisperma
Cephus groenlandica Galium obtusum
Glyceria pallidaRare ----- Solidago ulmifolia

c.Ash-Elm-Basswood stand

Location ----- Roscommon County, Lake Township,

T23N, R4W, SE 1/4, Section 33.

Soil type ----- Bergland loam.

Predominant species in this quadrat were the green and black ash, slippery and American elm, and basswood. Few birches (Betula lutea and Betula lenta) and northern white cedar, one small red maple completed the stand composition. Three or four medium sized hemlock were dead and remained standing.

The largest trees were found to be mostly ash and elm, both approximately 60 years old.

Plants in the four milacre wuadrats were listed as:

TreesFrequent --- Fraxinus pennsylvanica (14)Common ----- Fraxinus nigra (10)Rare ----- Acer rubrum (1)
Betula lutea (2)Shrubs and VinesAbundant --- Parthenocissus inserta
Rubus pubescensFrequent --- Ribes americanumCommon ----- Cornus stolonifera
Ilex verticillataRare ----- Alnus rugosaPteridophytesAbundant --- Dryopteris thelypterisFrequent --- Onoclea sensibilisCommon ----- Equisetum sylvaticumSedges, Grasses, and HerbsAbundant --- Impatiens pallida Lycopus rubellus
Lysimachia thyrsifloraFrequent --- Calamagrostis canadensis Eupatorium purpureum
Galium obtusum Glyceria pallida
Viola blandaCommon ----- Agrostis hyemalis Bidens cernua
Carex intumescens Carex trisperma
Fragaria virginiana var. illinoensis
Lysimachia nummularia { Lemna minor
Scutellaria lateriflora { Lemna trisulca
Solidago ulmifolia { Spirodela polyrhizaRare ----- Aster lateriflorus Maianthemum canadensis
Sium suave

d. Elm-Maple stand

Location ----- Roscommon County, Lake Township,
T23N, R4W, SW 1/4, Section 13.

Soil type ----- Bergland clay loam.

Red maple, silver maple (Acer saccharinum), and slippery elm were the dominant species with both black and green ash as associate species. Two American elm, one balsam fir completed the tree species of the quadrat. A few Carpinus caroliniana and one Amelanchier canadensis were the only occurring shrubs.

The largest tree was a red maple, 26 inches D.B.H., about 90 years old. A 19.9 inches D.B.H. silver maple was approximately of the same age. A 10.8 inches green ash, the largest among the ashes, was about 60 years old. The American elm was the oldest in the stand at 100 years.

Vegetation of the herbaceous layer were:

Trees

Abundant --- Acer rubrum (962) Ulmus sp. (451)
 Fraxinus nigra (35)

Common ----- Fraxinus pennsylvanica (3)

Shrubs and Vines

Rare ----- Smilax tamnoides var. hispida

Pteridophytes

Abundant --- Onoclea sensibilis

Common ----- Osmunda regalis

Sedges, Grasses, and Herbs

Abundant ---	<u>Bidens frondosa</u>	{ <u>Lemna minor</u> <u>Lemna trisulca</u> <u>Spirodela polyrhiza</u>
	<u>Carex intumescens</u>	
	<u>Cicuta bulbifera</u>	
	<u>Lycopus americanus</u>	
Frequent ---	<u>Agrostis hyemalis</u>	<u>Galium obtusum</u>
	<u>Impatiens capensis</u>	<u>Lysimachia thyrsiflora</u>
Common -----	<u>Geum aleppicum</u> var. <u>strictum</u>	
Rare -----	<u>Coptis groenlandica</u>	<u>Glyceria striata</u>
	<u>Maianthemum canadensis</u>	<u>Sium suave</u>
	<u>Viola blanda</u>	

Species

Bes balsa

Ber rubrum

Ber saccha

Beta rugo

Belarchier

Betula lent

Betula lute

Berymus

carolinia

Berylus cor

Braximus ni

B. pennsylv

Boca maria

Bula occid

Bula ameri

Buga canad

Bizus ameri

Bizus rubra

Table 2. Summarization data of four 1/5 acre Swamp Hardwood stands by size classes.

Species	Size Classes												Totals								Importance Value								
	2				3				4				5				Frequency					Density				Basal Area			
	Freq.	Density	#	Dr	Freq.	Density	#	Dr	Freq.	Density	#	Dr	Freq.	Density	#	Dr	T	Fq	Fr	Ts		D	Dr	Ft ²	Rel.	BA/acre			
Abies balsamea	3	75	17	11.4	2	50	42	10.0	2	50	20	6.1					3	75	7.9	79	19.8	8.2	4.5	3.2	5.6	19.3			
Acer rubrum	3	75	14	9.4	3	75	34	8.1	3	75	29	8.8	2	50	26	41.3	4	100	10.5	103	25.8	10.7	36.2	26.0	45.2	47.2			
Acer saccharinum	1	25	2	1.4	1	25	2	0.5	1	25	1	0.3	1	25	6	9.5	1	25	2.7	11	2.7	1.2	10.2	7.3	12.8	11.2			
Alnus rugosa	1	25	2	1.4	1	25	3	0.7									1	25	2.6	5	1.2	0.5	----	---	----	3.1			
Amelanchier sp.	1	25	4	2.7	2	50	6	1.4									2	50	5.3	10	2.5	1.0	0.1	0.1	0.1	6.4			
Betula lenta					1	25	1	0.2	1	25	4	1.2					1	25	2.6	5	1.2	0.5	0.8	0.6	1.0	3.7			
Betula lutea	1	25	3	2.0	1	25	3	0.7	2	50	13	3.9					2	50	5.3	19	4.7	2.0	3.0	2.2	3.7	9.5			
Carpinus caroliniana					1	25	8	1.9									1	25	2.6	8	2.0	0.8	0.3	0.2	0.3	3.6			
Corylus cornuta	1	25	8	5.4													1	25	2.6	8	2.0	0.8	---	---	---	3.4			
Fraxinus nigra	3	75	53	35.8	3	75	145	34.8	4	100	81	24.5	3	75	5	7.9	4	100	10.5	284	71.0	29.6	19.9	14.3	24.9	54.4			
F. pennsylvanica	2	50	24	12.6	3	75	58	13.8	4	100	58	17.5	2	50	5	7.9	4	100	10.5	145	36.2	15.1	17.7	12.7	22.2	38.3			
Picea mariana									1	25	1	0.3					1	25	2.6	1	0.2	0.1	0.1	0.1	0.1	2.8			
Thuja occidentalis	1	25	16	10.8	3	75	71	17.0	3	75	64	19.3	1	25	3	4.8	3	75	7.9	154	38.5	16.0	14.4	10.3	18.1	34.2			
Tilia americana	1	25	2	1.4	2	50	14	3.3	2	50	14	4.2	1	25	1	1.6	2	50	5.4	31	7.8	3.3	3.7	2.7	4.6	11.4			
Tsuga canadensis					1	25	1	0.2	1	25	4	1.2					1	25	2.6	5	1.2	0.5	0.5	0.4	0.6	3.5			
Ulmus americana	1	25	1	0.7	3	75	3	0.7	2	50	4	1.2	3	75	7	11.1	4	100	10.5	15	3.8	1.6	11.6	8.3	14.4	20.4			
Ulmus rubra	1	25	2	1.4	3	75	28	6.7	3	75	38	11.5	3	75	10	15.9	3	75	7.9	78	19.5	8.1	16.2	20.3	20.3	27.6			
	--	148	15.4	--	--	419	43.6	--	--	331	34.4	--	63	6.6	--	950	100.0	961	---	100.0	139.2	100.0	173.9	300.0					

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Species	Total Freq. (%)	Black Ash-White Cedar-Balsam Fir				Ash-Red Maple-Elm		Stand			Ash-Elm-Basswood			Stand			Elm-Maple			Stand	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
		0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3				
<i>Bidens cernua</i>	12.5										T	1%	T								
<i>Bidens frondosa</i>	25.0														1%	T	1%		1%	1%	
<i>Cicuta bulbifera</i>	25.0														T		T		T	1%	
<i>Coptis groenlandica</i>	18.7					2%		T							5%						
<i>Cornus canadensis</i>	37.5	3%		T	T	2%	3%		2%												
<i>Eupatorium purpureum</i>	18.7									T	2%	T			2%						
<i>Fragaria virginiana</i>	18.7					T	1%	T													
<i>F. virginiana</i> var. <i>illinoensis</i>	12.5										T				T						
<i>Galium obtusum</i>	50.0						T	1%		T	T	T			T		T		T		
<i>Galium triflorum</i>	25.0	2%	T	1%	T																
<i>Galium trifidum</i>	18.7		T	1%	1%																
<i>Geum aleppicum</i> var. <i>strictum</i>	12.5																T		T		
<i>Impatiens capensis</i>	18.7														T		T		T		
<i>Impatiens pallida</i>	25.0									3%	1%	3%	1%	2%	1%	2%					
<i>Lemna minor</i>																					
<i>Lemna trisulca</i>	37.5									5%	1%				T		T		T		
<i>Spirodela polyrrhiza</i>																					
<i>Lycopus americanus</i>	75.0		2%	5%	5%	1%	1%	2%	T	T					3%	3%	2%		2%	1%	
<i>Lycopus rubellus</i>	25.0										5%	2%	3%	1%	3%	1%	5%	T			
<i>Lysimachia nummularia</i>	12.5										1%				T						
<i>Lysimachia thyrsoiflora</i>	68.8		T		T	T		T		1%	3%	1%	T	1%	1%	1%	1%	T	T	1%	
<i>Maianthemum canadensis</i>	56.2	T	T	T		T	1%	T	T		T				T						
<i>Mitella nuda</i>	18.7		T	10%	1%																
<i>Ranunculus</i> sp.	6.2			T																	
<i>Scutellaria laterifolia</i>	18.7			T							5%				T						

Species	Total	Black Ash-White		Cedar-Halsam		Fir	Ash-Red Maple-Elm		Stand	Ash-Elm-Basswood			Stand	Elm-Maple			Stand
	Freq.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	(%)	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3
<i>Sium suave</i>	12.5												T				T
<i>Solidago ulmifolia</i>	25.0					T		1%			1%	T					
<i>Thalictrum dasycarpum</i>	6.2		1%														
<i>Viola blanda</i>	62.5		1%		2%	1%	1%	1%	T	1%	2%		T		T		

T --- Denotes "Trace" which indicates less than 1% coverage.

Figure 1 is a line graph showing the effect of temperature on the rate of photosynthesis in a plant. The x-axis represents Temperature in degrees Celsius (°C), ranging from 0 to 40. The y-axis represents the Rate of Photosynthesis in arbitrary units, ranging from 0 to 10. The curve starts at 0 at 0°C, rises to a peak of 10 at 25°C, and then declines to 0 at 40°C. A dashed line indicates the rate at 15°C is 5 units.

Temperature (°C)	Rate of Photosynthesis (arbitrary units)
0	0
5	2
10	4
15	5
20	8
25	10
30	8
35	4
40	0

2. Swamp Conifers of Black Spruce-Balsam Fir-Northern White Cedar Association

Dominant species in this type were the balsam fir, northern white cedar, tamarack, and black spruce. Red maple and yellow birch were the associate hardwoods. Four quadrats of this type were studied:

a. Tamarack stand

Location ----- Crawford County, Beaver Creek Township,
T25N, R3W, SE $\frac{1}{4}$, Section 29.

Soil type ----- Rifle peat.

Tamarack was the only tree species. The average age of the stand was approximately 30 years old, with the largest individual measured 9.6 inches D.B.H., and the smallest 1.3 inches D.B.H.. One important fact was that no tamarack reproduction has been observed in the quadrat.

There was a dense shrub growth of green alder (Alnus sinuata) and red osier dogwood (Cornus stolonifera). Some swamp birch (Betula pumila) and Labrador tea (Ledum groenlandicum) were also present. Sphagnum moss (Sphagnum sp.) was abundant with a coverage of approximate 40 percent.

Soils were very wet and spongy with most of the herbaceous plants grown on the hummucks. Plants in the milacre quadrats were:

Trees

Rare ----- Quercus rubra (1)

The second part of the document provides a detailed breakdown of the accounting process. It outlines the steps involved in recording transactions, from identifying the event to posting it to the appropriate ledger account. This section also covers the importance of double-checking entries to avoid errors and the need for regular reconciliation of accounts.

The third part of the document discusses the various methods used to calculate the cost of goods sold (COGS). It compares the first-in, first-out (FIFO) method with the last-in, first-out (LIFO) method, highlighting the differences in their impact on profit and tax liability. The document also mentions the weighted average method as a middle ground between the two.

The fourth part of the document focuses on the importance of proper documentation. It stresses that every transaction must be supported by a valid receipt or invoice. This not only helps in verifying the accuracy of the records but also provides a clear trail for auditing purposes. The document also discusses the importance of keeping records for a sufficient period of time to comply with legal requirements.

The fifth part of the document discusses the role of the accountant in the business. It outlines the various responsibilities of the accountant, including maintaining the books, preparing financial statements, and providing advice on tax and financial matters. It also emphasizes the importance of the accountant's independence and objectivity in their work.

Shrubs and VinesAbundant --- Rubus pubescensFrequent --- Betula pumila Prunus virginiana
Lonicera villosa var. solonisRare ----- Alnus sinuata Cornus stolonifera
Ledum groenlandicum Prunus avium
Spiraea latifoliaPteridophytesCommon ----- Dryopteris cristataSedges, Grasses, and HerbsAbundant --- Agrostis hyemalis Bromus ciliatus
Calamagrostis canadensis Carex intumescens
Galium aparine Maianthemum canadensis
Solidago uliginosa Solidago ulmifoliaFrequent --- Campanula aparinoidesRare ----- Coptis groenlandica Lycopus americanus
Mitella nuda

b. Balsam Fir-Tamarack stand

Location ----- Crawford County, Beaver Creek Township,
T25N, R3W, SW $\frac{1}{4}$, Section 35.Soil type ----- Newton loamy sand (approximately 8 inches
layer of organic soil on top).

This stand was composed mostly of smaller trees.

Balsam fir was the predominant species with the largest one, 8.4 inches D.B.H., about 40 years old. The largest of the five tamaracks was 9.7 inches D.B.H., only 25 years old. The only northern white cedar, 7.8 inches D.B.H., was 36 years of age. Although there were nine different species present in the quadrat, six of them were represented by a single tree.

The predominant shrub species was the speckled alder (Alnus rugosa). Fire cherry (Prunus pensylvanica) and choke cherry (Prunus virginiana) were also abundant. These formed a very dense growth.

Large number of plants were present in the four mil-acre quadrats. They were:

Trees

- Abundant --- Abies balsamea (27)
 Frequent --- Acer rubrum (15) Ulmus sp. (6)
 Rare ----- Betula lutea (11) Quercus rubra (2)
 Thuja occidentalis (2)

Shrubs and Vines

- Abundant --- Cornus alternifolia Ilex verticillata
 Prunus virginiana Rubus pubescens
 Frequent --- Alnus rugosa
 Rubus idaeus var. aculeatissimus
 Common ----- Cornus stolonifera Lonicera villosa var. solonis
 Nemopanthus micronata Ribes lacustre
 Rare ----- Ribes americanum

Pteridophytes

- Abundant --- Dryopteris cristata var. clintoniana
 Rare ----- Dryopteris spinulosa

Sedges, Grasses, and Herbs

- Abundant --- Agrostis hyemalis Bromus ciliatus
 Calamagrostis canadensis
 Carex intumescens Fragaria vesca
 Galium triflorum (4) Glyceria borealis
 Glyceria striata (6) Lycopus americanus
 Maianthemum canadensis Mulenbergia racemosa

Common -----	<u>Aster</u> sp.	<u>Geum aleppicum</u> var. <u>strictum</u>
	<u>Impatiens capensis</u>	<u>Lysimachia terrestris</u>
	<u>Mitella nuda</u>	<u>Ranunculus</u> sp.
	<u>Solidago ulmifolia</u>	<u>Viola blanda</u>
Rare -----	<u>Aralia nudicaulis</u>	<u>Coptis groenlandica</u>
	<u>Goodyear pubescens</u>	<u>Iris versicolor</u>
	<u>Scutellaria lateriflora</u>	<u>Solidago canadensis</u>
	<u>Solidago patula</u>	

c. Black Spruce-Balsam Fir stand

Location ----- Crawford County, Beaver Creek Township,
T25N, R4W, SE $\frac{1}{4}$, Section 34.

Soil type ----- Rifle peat.

This was a well stocked stand in which black spruce and balsam fir were dominants. Some northern white cedar, a few red maple and yellow birch completed the tree species of the stand. The largest tree was a northern white cedar, 15.8 inches D.B.H., and the largest black spruce was 9.6 inches D.B.H..

The stand was composed of 85 years old northern white cedar, 50 years old balsam fir, and 40 years old black spruce. The balsam fir had far more reproduction than the others. Some seedlings of black spruce were also present.

A few speckled alder were the only shrub species which located at an opening in the stand. Vegetation of the milacre quadrats were:

Trees

Abundant ---	<u>Abies balsamea</u> (40)	<u>Acer rubrum</u> (341)
	<u>Quercus rubra</u> (10)	
Rare -----	<u>Pinus Strobus</u> (1)	

Shrubs and VinesAbundant --- Vaccinium myrtilloidesFrequent --- Rubus pubescensCommon ----- Ilex verticillata Linnaea borealis var. americana
Mitchella repensRare ----- Gautheria procumbens Lonicera villosa var. solonis
Prunus virginiana Ribes triestePteridophytesFrequent --- Equisetum sylvaticumRare ----- Dryopteris cristata Dryopteris spinulosa
Dryopteris thelypterisSedges, Grasses, and HerbsAbundant --- Aralia nudicaulis Carex intumescens
Clintonia borealis Coptis groenlandica
Cornus canadensis Glyceria borealis
Glyceria striata Maianthemum canadensis
Pyrola secunda Trientalis borealisFrequent --- Aster sp. Habenaria obtusata
Viola blandaCommon ----- Mitella nuda Solidago uliginosaRare ----- Galium asprellum Geum aleppicum var. strictum

d. Northern White Cedar-Balsam Fir stand

Location ----- Roscommon County, Gerrish Township,

T24N, R3W, NW $\frac{1}{4}$, Section 2.

Soil type ----- Rifle peat.

This stand was densely stocked with northern white cedar and balsam fir as the dominant species, which associated with black spruce and yellow birch.

2. The second part of the document focuses on the implementation of internal controls to prevent fraud and ensure the accuracy of financial data. It outlines the key components of a robust internal control system, including segregation of duties, authorization procedures, and regular monitoring and evaluation.

3. The third part of the document addresses the challenges faced by organizations in managing their financial resources effectively. It discusses the importance of budgeting and forecasting, and the role of the accounting department in providing accurate and timely financial information to support decision-making.

4. The fourth part of the document explores the impact of technology on the accounting profession. It discusses the benefits of automation and the use of data analytics in financial reporting, and the need for accountants to stay updated on the latest technological advancements.

The largest tree was a 10 inches D.B.H. northern white cedar. The stand was uneven-aged, consisting of 65 years old northern white cedar, 50 years old balsam fir, and 40 years old black spruce. Both northern white cedar and balsam fir were well represented in different diameter classes and were well reproduced. Seven black spruce were tallied in the quadrat, all of them fell into size class 4 with no reproduction to be found. A few red maple and cherries were scattered in the stand to complete the composition of tree species.

A considerable number of speckled alder was the sole representative of shrub species.

Plants in the four milacre quadrats were:

Trees

Abundant --- Abies balsamea (47) Acer rubrum (35)
Rare ----- Quercus rubra (1)

Shrubs and Vines

Frequent --- Lonicera canadensis Rubus pubescens
Common ----- Linnaea borealis var. americana
 Rhus radicans
Rare ----- Acer spicatum Corylus cornuta
 Ilex verticallata Mitchella repens
 Ribes lacustre

Pteridophytes

Frequent --- Dryopteris thelypteris
Rare ----- Dryopteris spinulosa

Sedges, Grasses, and Herbs

Abundant ---	<u>Agrostis</u> <u>hyemalis</u>	<u>Aralia</u> <u>nudicaulis</u>
	<u>Carex</u> <u>intumescens</u>	<u>Clintonia</u> <u>borealis</u>
	<u>Galium</u> <u>triflorum</u>	<u>Glyceria</u> <u>borealis</u>
	<u>Mitella</u> <u>nuda</u>	
Frequent ---	<u>Coptis</u> <u>groenlandica</u>	<u>Pyrola</u> <u>secunda</u>
Common -----	<u>Cornus</u> <u>canadensis</u>	<u>Maianthemum</u> <u>canadensis</u>
	<u>Prunella</u> <u>vulgaris</u>	<u>Trientalis</u> <u>borealis</u>
	<u>Viola</u> <u>blanda</u>	

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Table 4. Summarization data of four 1/5 acre Swamp Conifers stands by size classes.

Species	SIZE												CLASSES												TOTALS												Importance Value
	2				3				4				5				Frequency				Density				Basal Area												
	Freq.	Density	Freq.	Density	Freq.	Density	Freq.	Density	Freq.	Density	Freq.	Density	T	Fq	Fr	Ts	D	Drs	Ft ²	Rel. Ft ² /A																	
Abies balsamea	3	75	42	73.7	3	75	301	60.0	3	75	94	24.5				3	75	13.6	437	109.2	45.9	21.3	26.6	26.6	86.1												
Acer rubrum	1	25	3	5.3	1	25	1	0.2	2	50	13	3.4	1	25	1	12.5	3	75	13.6	18	4.5	1.9	3.1	3.9	3.9	19.4											
Betula lutea					1	25	5	1.0	2	50	11	2.8	1	25	2	25.0	3	75	13.6	18	4.5	1.9	3.1	3.9	3.9	19.4											
Fraxinus nigra									1	25	1	0.3					1	25	4.6	1	1.2	0.1	0.1	0.1	0.1	4.8											
Larix laricina					2	50	45	9.0	2	50	100	26.0	2	50	2	25.0	2	50	9.1	147	36.8	15.5	19.0	23.7	23.7	48.3											
Picea mariana	1	25	2	3.5	1	25	20	4.0	3	75	41	10.7	1	25	1	12.5	3	75	13.6	64	16.0	6.7	9.7	12.1	12.1	32.4											
Pinus Strobus									1	25	1	0.3					1	25	4.6	1	1.2	0.1	0.1	0.1	0.1	4.8											
Prunus serotina	2	50	7	12.2	2	50	8	1.5									2	50	9.1	15	3.8	1.6	0.1	0.1	0.1	10.8											
Thuja occidentalis	1	25	3	5.3	2	50	122	24.3	3	75	122	31.7	2	50	2	25.0	3	75	13.6	249	62.2	26.2	23.3	29.1	29.1	68.9											
Ulmus americana									1	25	1	0.3					1	25	4.6	1	1.2	0.1	0.3	0.4	0.4	5.1											
	-	-	57	6.0	-	-	502	52.8	-	-	384	40.4	-	-	8	0.8	-550	100.0	951	----	100.0	80.1	100.0	100.0	300.0												

Table 5. Summarisation data of 1/10 acre quadrats by height classes of the Swamp Conifer stands.

Species	HEIGHT										CLASSES										TOTALS				No. of Stems per Acre
	6-15		Feet		15-25		Feet																		
	Freq.	Density	Freq.	Density	Freq.	Density	Freq.	Density	Tq	Fq	Frs	TS	D	Drs	Abundance	Ar	Agre								
	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#								
Acer spicatum	1	25	2	0.4										1	25	7.7	2	0.5	0.3	2.0	1.2	5			
Alnus rugosa	4	100	400	76.2	4	100	118	75.2	4	100	30.7	518	129.5	76.0	13.0					7.8	1295				
Alnus sinuata	1	25	70	13.3	1	25	20	12.7	1	25	7.7	90	22.5	13.2	90.0	54.2	225								
Amelanchier sp.	1	25	1	0.2										1	25	7.7	1	0.3	0.1	1.2	0.7	2			
Cornus stolonifera	2	50	7	1.3										2	50	15.4	7	1.8	1.0	3.6	2.2	18			
Prunus pensylvanica	1	25	11	2.1	2	50	4	2.5	2	50	15.4	15	3.7	2.2	7.4	4.4	37								
Prunus virginiana	1	25	33	6.3	1	25	15	9.6	1	25	7.7	48	12.0	7.1	48.0	28.8	120								
Sorbus americana	1	25	1	0.2										1	25	7.7	1	0.3	0.1	1.2	0.7	2			
	-	-	525	77.0	-	-	157	23.0	-	325	100.0	682	-	-	-	100.0	166.4	100.0	170.4						

Table 6. Sum

Species

Species
Ulex balsamea
Ulex rubrum
Ulex lutea
Ulex Strobilus
Ulex rubra
Ulex occidentalis
Ulex thomasi
Herbs & Vines
Ulex spicatum
Ulex rugosa
Ulex sinuata
Ulex pumila
Ulex alternifolius
Ulex stolonifer
Ulex cornuta
Ulex procumbens
Ulex verticillatus
Ulex groenlandicus
Ulex borealis
 var. *america*
Ulex canadensis
Ulex villosa var.
Ulex repens

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Species	Total Freq. (%)	Tamarack			Stand			Balsam Fir-Tamarack			ack	Stand	Black Spruce-Balsam Fir			Stand	N. White Cedar-Balsam Fir			Stand												
		1 0-1 1-3	2 0-1 1-3	3 0-1 1-3	4 0-1 1-3	5 0-1 1-3	6 0-1 1-3	7 0-1 1-3	8 0-1 1-3	9 0-1 1-3			10 0-1 1-3	11 0-1 1-3	12 0-1 1-3		13 0-1 1-3	14 0-1 1-3	15 0-1 1-3		16 0-1 1-3											
<i>Nemopanthus mucronata</i>	12.5					1	3			1	1																					
<i>Prunus avium</i>	6.2			2																												
<i>Prunus virginiana</i>	50.0	2	1	3		3	5	1	1	1		1			1																	
<i>Rhus radicans</i>	12.5																		3%		T											
<i>Ribes americanum</i>	6.2									1%																						
<i>Ribes lacustre</i>	18.7					1				1						1																
<i>Ribes trieste</i>	6.2														1																	
<i>Rubus ideaus</i> var. <i>aculeatissimus</i>	18.7						3%	5%		10%		5%																				
<i>Rubus pubescens</i>	87.5	15%	10%	20%	15%	10%	5%	10%	10%	15%	15%	5%	15%		T		40%	2%	30%		T	3%										
<i>Spiraea latifolia</i>	6.2				1																											
<i>Vaccinium myrtilloides</i>	25.0													25%	1%	1%		T		2%												
<u>Pteridophytes</u>																																
<i>Dryopteris cristata</i>	18.7		T		T													1%														
<i>Dryopteris cristata</i> var. <i>clintoniana</i>	25.0							1%	1%	3%		1%																				
<i>Dryopteris spinulosa</i>	18.7					T											1%			1%												
<i>Dryopteris thelypteris</i>	25.0														5%				2%		T	2%										
<i>Equisetum sylvaticum</i>	18.7														5%		T		T													
<u>Herbs</u>																																
<i>Aralia nudicaulis</i>	56.2									T				10%	5%	5%	10%	5%	5%	5%	3%	3%	5%	15%	5%	8%						
<i>Aster</i> sp.	31.2							T		T				T		T			1%													
<i>Aster junciformis</i>	18.7	T		T		T																										
<i>Clintonia borealis</i>	50.0													1%	2%	2%		T		3%		3%		3%		3%						
<i>Coptis groenlandica</i>	56.2			T						3%				2%	1%	3%		1%		5%		T				1%						
<i>Cornus canadensis</i>	37.5													T	1%	T		T		3%		T		T		1%						
<i>Fragaria vesca</i>	25.0													1%	3%	1%		T														
<i>Galium aparine</i>	25.0	10%	20%		15%	10%																										
<i>Galium asprellum</i>	6.2																															

Species	Total Freq. (%)	Tamarack			Stand			Balsam Fir-Tamarack			Stand			Black Spruce-Balsam Fir			Stand			N. White Cedar-Balsam Fir			Stand		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Galium triflorum	50.0						1%	T												3%	1%	T	T		
Geum aleppicum var. strictum	18.7																								
Goodyear pubescens	6.2						T																		
Habenaria obtusata	18.7																								
Impatiens capensis	12.5																								
Iris versicolor	6.2																								
Lycopus americanus	31.2					10%		3%	1%	25%	2%	15%	2%	2%											
Lysimachia terrestris	12.5																								
Maianthemum canadensis	100.0	1%	1%	2%	1%	T	T																		
Mitella nuda	56.2		1%					5%																	
Prunella vulgaris	12.5																								
Pyrola secunda	43.8																								
Ranunculus sp.	12.5						T																		
Scutellaria lateriflora	6.2																								
Solidago canadensis	6.2																								
Solidago patula	6.2																								
Solidago uliginosa	43.8	T	T	T	T	T																			
Solidago ulmifolia	37.5	T	2%	2%	2%	2%	2%	T	T	T	2%														
Trientalis borealis	50.0																								
Viola blanda	43.8																								
Sedges & Grasses																									
Bromus ciliatus	50.0																								
Calamagrostis canadensis	50.0																								
Agrostis hyemalis	75.0	20%	30%	35%	10%			15%	25%			50%	40%								7%	3%	2%	3%	
Carex intumescens	100.0																								
Glyceria borealis	75.0																								
Glyceria striata	50.0																								
Muhlenbergia racemosa	25.0																								

T --- Denotes "Trace" which indicates less than 1% coverage.

3. Lowland Aspen of Populus-Salix Association

Trembling aspen (Populus tremuloides) was the major species in the type, with Salix, Alnus, and Cornus as the dominant shrub species. Two stands were selected for quadrat study. On the region as a whole, this type does not occupy extensive area but occurs in small tracts here and there bordering marshes or brooksides.

a. Trembling Aspen-Long-beaked Willow stand

Location ----- Roscommon County, Lake Township,
T23N, R4W, SW $\frac{1}{4}$, Section 16.

Soil Type ----- Newton sand.

This was a poorly-stocked trembling aspen stand of approximately 30 years old. One birch was the only other tree species found in the quadrat.

Alnus rugosa and Salix bebbiana were the dominant shrubs. A few red osier dogwood were also present.

Plants in the four milacre quadrats were:

Trees

Abundant ---	<u>Betula lutea</u> (21)	<u>Acer rubrum</u> (1)
	<u>Quercus rubra</u> (1)	

Shrubs and Vines

Abundant ---	<u>Cornus stolonifera</u>	<u>Ilex verticillata</u>
	<u>Rubus pubescens</u>	
Frequent ---	<u>Alnus rugosa</u>	<u>Salix bebbiana</u>
Common -----	<u>Ribes lacustre</u>	
Rare -----	<u>Lonicera oblongifolia</u>	<u>Rhus radicans</u>
	<u>Rubus ideaus</u> var. <u>aculeatissimus</u>	
	<u>Vaccinium vacillans</u>	

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Pteridophytes

Common ----- Equisetum palustre Dryopteris spinulosa
 Rare ----- Onoclea sensibilis

Sedges, Grasses, and Herbs

Abundant --- Carex diandra Glyceria borealis
 Lysimachia terrestris Lycomus americanus

Frequent --- Campanula aparinoïdes Fragaria virginiana
 Pyrola rotundifolia Viola blanda

Common ----- Aster lateriflorus Galium sp.
 Mentha arvensis Pyrola secunda
 Solidago ulmifolia

Rare ----- Agrostis hyemalis
 Epilobium glandulosum var. adenocaulon
 Maianthemum canadensis Scutellaria epilobiifolia
 Smilacina trifolia Solidago caesia &

b. Trembling Aspen-Heartleaf Willow stand

Location ----- Roscommon County, Markey Township,

T23N, R3W, SE $\frac{1}{4}$, Section 1.

Soil type ----- Newton sand.

Trembling aspen was the only tree species found in this quadrat. This was a better stand than the first one with more trees and better growth. The largest one was 7.7 inches D.B.H., 35 years old.

The speckled alder and the heart-leaf willow (Salix eriocephala) were the dominant shrub species.

Components of the herbaceous layer were:

Trees

Rare ----- Populus tremuloides (1)

Shrubs and VinesFrequent --- Salix alba var. vitellinaCommon ----- Alnus rugosa Cornus stolonifera
Salix amygdaloidesRare ----- Asclepias incarnataPteridophytesRare ----- Dryopteris spinulosaSedges, Grasses, and HerbsAbundant --- Carex intumescens Lysimachia terrestris
Lycopus americanus Scutellaria epilobiifoliaFrequent --- Calamagrostis canadensis
Galium trifidumCommon ----- Azropyron repens Campanula aparinoides
Cicuta bulbifera Epilobium leptophyllum
Juncus canadensis Lysimachia thyrsiflora
Scirpus cyperinusRare ----- Aster junciformis Eupatorium perfoliatum
Fragaria virginiana Rumex verticillatus

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Table 7. Summarization data of two 1/5 acre Lowland Aspen stands by size classes.

Species	SIZE								CLASSES								TOTALS								Importance Value
	2		3		4		5																		
	Freq.	Density	Freq.	Density	Freq.	Density	Freq.	Density	Frequency				Density				Basal Area								
	#	F	#	Dr	#	F	#	Dr	#	F	#	Dr	#	F	#	Dr	T	Fq	Fr	TS	D	Drs	Ft ²	Rel. Ft ² /A	
Betula lutea					1	50	1	1.7			1	50	33.3	1	0.5	1.2	0.120	1.2	0.30						
Populus tremuloides			2	100	24	100	2	100	58	98.3			2	100	66.7	82	41.0	98.8	9.543	98.8	23.86				
			-	---	24	29.0	-	---	59	71.0			-	150	100.0	83	----	100.0	9.663	100.0	24.16				

Table 8. Summarization data of two 1/5 acre Lowland Aspen stands by height classes.

Species	HEIGHT								CLASSES								TOTALS								
	6-15				Feet				15-25				Feet												Abun-
	Freq.		Density		Freq.		Density		Frequency				Density												
	#	F	#	Dr	#	F	#	Dr	Tq	Fq	Frs	TS	D	Drs	dance	Ar	#/Acre								
Alnus rugosa	2	100	157	80.5	2	100	246	66.8	2	100	33.3	403	201.5	71.6	201.5	56.6	2015								
Cornus stolonifera	2	100	11	5.6	-	---	---	---	2	100	33.3	11	5.5	2.0	5.5	1.5	55								
Salix bebbiana	1	50	7	3.6	1	50	80	21.7	1	50	16.7	87	43.5	15.4	87.0	24.5	435								
Salix eriocephala	1	50	20	10.3	1	50	42	11.5	1	50	16.7	62	31.0	11.0	62.0	17.4	310								
	-	---	195	100.0	-	---	368	100.0	-	300	100.0	563	----	100.0	356.0	100.0	2815								

Table 9. Summary data of the vegetation in millacre quadrats of the Lowland Aspen Association by height classes. Plants were recorded in percentage of coverage or number of stems.

Species	Total Trembling Aspen-Long-beaked Willow Trembling Aspen-Heartleaf Willow									
	1		2		3		4		5	
	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)
<u>Trees</u>										
<i>Acer rubrum</i>	12.5	1								
<i>Betula lutea</i>	50.0	7	6	3	3	5				
<i>Populus tremuloides</i>	12.5								1	
<i>Quercus rubra</i>	12.5	1								
<u>Shrubs & Vines</u>										
<i>Alnus rugosa</i>	62.5		1	4	3	1	3	2	4	1
<i>Asclepias incarnata</i>	12.5									5
<i>Cornus stolonifera</i>	75.0	6	2	5	1	3	1	2		
<i>Ilex verticillata</i>	50.0	5	4	1	1	6				
<i>Lonicer a oblongifolia</i>	12.5		1							
<i>Rhus radicans</i>	12.5				5%					
<i>Ribes laeustre</i>	25.0				T	T	T			
<i>Rubus idaeus</i> var. <i>aculeatissimus</i>	12.5		2	1						
<i>Rubus pubescens</i>	50.0	5%	10%	3%	25%					
<i>Salix alba</i> var. <i>vitellina</i>	37.5						1	1	2	1



Species	Total Trembling Aspen-Long-beaked Willow				Trembling Aspen-Heartleaf Willow stand			
	Freq.				5 6 7 8			
	(%)	1 0-1 1-3	2 0-1 1-3	3 0-1 1-3	4 0-1 1-3	5 0-1 1-3	6 0-1 1-3	7 0-1 1-3
<i>Salix amygdaleoides</i>	25.0					1	1	3
<i>Salix bebbiana</i>	37.5		1	1	1			
<i>Vaccinium vacillans</i>	12.5		1%					
<u>Pteridophytes</u>								
<i>Dryopteris spinulosa</i>	37.5			1%	1%	T		
<i>Equisetum palustre</i>	25.0	1%			1%			
<i>Onoclea sensibilis</i>	12.5	3%						
<u>Sedges, Grasses & Herbs</u>								
<i>Agropyron repens</i>	25.0					5%		5%
<i>Agrostis hyemalis</i>	12.5		T	T				
<i>Calamagrostis canadensis</i>	37.5					10%	15%	15%
<i>Carex diandra</i>	50.0	2%	5%	T	5%	5%	25%	40%
<i>Carex intumescens</i>	50.0					30%	5%	
<i>Glyceria borealis</i>	50.0	3%	5%	3%	1%			
<i>Juncus canadensis</i>	25.0						15%	15%
<i>Scirpus cyperinus</i>	25.0						5%	1%
<i>Aster junciformis</i>	12.5							
<i>Aster lateriflorus</i>	25.0		1%	T	T			1%

Species	Total Trembling Aspen-Long-beaked Willow								Trembling Aspen-Heartleaf Willow stand								
	Freq.	1	2	3	4	5	6	7	8								
	(%)	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3		
Campanula aparineoides	62.5		T	T								T	T	T	T		
Cicuta bulbifera	25.0											T			T		
Epilobium glandulosum var. adenocaulen	12.5		1%														
Epilobium leptophyllum	25.0													1%	1%		
Eupatorium perfoliatum	12.5														T		
Fragaria virginiana	50.0	1%	5%	T								T					
Galium sp.	25.0	1%				T											
Galium trifidum	37.5											T	T				
Lysimachia terrestris	100.0	1%	T	1%	T							1%	T	2%	T		
Lysimachia thyrsiflora	25.0												1%		T		
Lycopus americanus	100.0	10%	3%	3%	2%	3%	T					1%	1%	2%	2%		
Maianthemum canadensis	12.5	1%															
Mentha arvensis	25.0			10%	2%	1%											
Pyrola rotundifolia	50.0	T	1%	T													
Pyrola secunda	25.0		1%														
Rumex verticillatus	12.5											1%					
Scutellaria epilobifolia	62.5	1%										T	T	2%	T		
Smilacina trifolia	12.5	T															



Species	Total	Trembling Aspen-Long-beaked Willow				Trembling Aspen-Heartleaf Willow stand			
	Freq.	1	2	3	4	5	6	7	8
	(%)	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3	0-1 1-3
<i>Solidago caesia</i>	12.5								
<i>Solidago ulmifolia</i>	25.0	T			T				
<i>Viola blanda</i>	37.5	T			T				

T --- Denotes "Trace" which indicates less than 1% coverage.

1

4. Swamp Shrubs of Salix-Cornus-Alnus Association

This type consisted a mixture of willow, dogwood, alder, swamp birch, etc., to form a dense thicket growth.

Only one stand was selected for quadrat study. It was bordering a tamarack swamp and along the stream. All plants were below 6 feet in height, therefore only milacre quadrats were being studied.

Location ----- Crawford County, Beaver Creek Township,
T25N, R3W, NW $\frac{1}{4}$, Section 33.

Soil type ----- Rifle peat.

Plants in the four milacre quadrats were:

Trees

Rare ----- Betula lutea (6)

Shrubs and Vines

Abundant ---	<u>Alnus rugosa</u>	<u>Betula pumila</u>
	<u>Cornus stolonifera</u>	<u>Lonicera villosa</u> var. <u>solonis</u>
	<u>Potentilla fruticosa</u>	<u>Rubus hispidus</u>
	<u>Salix petiolaris</u>	<u>Spiraea alba</u>

Frequent --- Aronia nigra

Common ----- Ribes trieste

Rare ----- Cornus alternifolia

Pteridophytes

Rare ----- Dryopteris cristata

Sedges, Grasses, and Herbs

Abundant ---	<u>Agropyron repens</u>	<u>Bromus purgens</u>
	<u>Muhlenbergia racemosa</u>	<u>Solidago canadensis</u>
Frequent ---	<u>Galium asprellum</u>	<u>Solidago uliginosa</u>
	<u>Solidago ulmifolia</u>	
Common -----	<u>Aster juncoformis</u>	
Rare -----	<u>Aster novae-angliae</u>	<u>Cirsium muticum</u>

Table 10. Summary data of the four milacre quadrats in the Swamp Shrubs stand by height classes. Plants were recorded in percentage of coverage or number of stems.

Species	Total Freq. (%)	HEIGHT CLASSES											
		1			2			3			4		
		0-1	1-3	3-6	0-1	1-3	3-6	0-1	1-3	3-6	0-1	1-3	3-6
(Trees)													
Betula lutea	25	6											
(Shrubs and Vines)													
Alnus rugosa	100		3	2		1	2		2	2		1	
Arenia nigra	75		5%	10%		1%			5%	5%			
Betula pumila	100		10%	15%		1%	15%		5%	10%		2%	10%
Cornus alternifolia	25								5%				
Cornus stolonifera	100		5%	10%		1%			5%			10%	
Lonicera villosa var. selenis	100		2%	3%		5%	20%		2%	10%		T	5%
Potentilla fruticosa	100		15%			25%			20%			15%	
Ribes lacustre	50	T				T							
Rubus hispidus	100		5%			5%			10%			3%	
Salix petiolaris	100		1%	1%	5%		1%	5%		1%		1%	3%
Spiraea alba	100			5%		5%	15%		10%	5%		5%	5%
(Sedges, Grasses & Herbs)													
Agropyron repens	100	-----	8%	-----	-----	5%	-----	-----	5%	-----	-----	10%	-----
Bromus purgens	100	-----	8%	-----	-----	5%	-----	-----	2%	-----	-----	10%	-----
Glyceria borealis	75				-----	5%	-----	-----	5%	-----	-----	5%	-----
Muhlenbergia racemosa	100	---	5%	----	-----	2%	-----	-----	8%	-----	---	10%	----
Aster juncinermis	50		T									T	
Aster novae-angliae	25											1%	
Cirsium muticum	25						1%						
Galium asprellum	75				2%			1%				1%	

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Species	Total Freq. (%)	CLASSES											
		HEIGHT						CLASSES					
		1		2		3		4		5		6	
		0-1	1-3	3-6	0-1	1-3	3-6	0-1	1-3	3-6	0-1	1-3	3-6
Solidago canadensis	100		T			T			T			T	
Solidago uliginosa	75					T			T			T	T
Solidago ulmifolia	75		T			T			2%	1%			
(Pteridophytes)													
Dryopteris cristata	25		T										

T --- Denotes "Trace" which indicates less than 1% coverage.

1. The first step in the process is to identify the problem or issue that needs to be addressed. This involves gathering information and understanding the context of the problem.

2. Once the problem is identified, the next step is to define the objectives and goals of the project. This helps to clarify what needs to be achieved and provides a clear direction for the team.

3. The third step is to develop a plan or strategy to address the problem. This involves breaking down the problem into smaller, manageable tasks and determining the resources needed to complete each task.

4. The fourth step is to implement the plan. This involves assigning tasks to team members, setting deadlines, and monitoring progress to ensure that the project is on track.

5. The final step is to evaluate the results of the project. This involves comparing the actual outcomes with the objectives and goals to determine the effectiveness of the project and identify areas for improvement.

5. The Marsh or Open-Meadow type

Davis (1906) has defined the "marsh" and "bog" as:

"The 'bog' is an area of wet, porous land, on which the soil is made up principally of decayed and decaying vegetable matter, so loosely consolidated, and containing so much water, that the surface shakes and trembles as one walks over it. The vegetation upon the surface is characteristically either some species of moss or sedge, or grass, or a combination of two or more of these with shrubs and even small trees.

A 'marsh' has a firm soil, it may be soft and very wet, even submerged, and the vegetation upon it is principally grass-like. Shrubs may occur but are not infrequently form thickets"

Three stands were selected for sample plots in this type. Two were bogs and one was the marsh. The bogs were found on Greenwood peat; and the marsh was on Newton sand.

a. Scirpus-Typha stand

Location ----- Roscommon County, Lake Township,

T23N, R4W, NE $\frac{1}{4}$, Section 21.

Soil type ----- Greenwood peat.

Dominant species of this stand were the grassy vegetation consisting of Scirpus cyperinus, several species of Carex, and Calamagrostis canadensis. Juncus canadensis, Eleocharis obtusa, Glyceria canadensis were also present with the former two found on very wet sites.

The water-table of the soil was very near the surface to form an almost permanent wet condition, as indicated by such partly submerged plants as : Scirpus cyperinus, Carex lasiocarpa, Eleocharis obtusa, Juncus canadensis, Typha

latifolia, Iris versicolor, Bidens cernua, Alisma triviale, and Sagittaria montevidensis. Davis (1906) has classified such type as the "Rush Swamp".

The secondary species were Typha latifolia, Iris versicolor, Sagittaria montevidensis, Cicuta bulbifera, Sium suave, Lysimachia terrestris, Bidens cernua, Hypericum boreale, Lycopus americanus, Rumex verticillatus, etc..

One species of willow (Salix sp.) was the only shrub present in the stand.

The occurring plants in the four milacre quadrats were:

Shrubs and Vines

Common ----- Salix sp.

Sedges, Grasses, and Herbs

Abundant ---	<u>Bidens cernua</u>	<u>Calamagrostis canadensis</u>
	<u>Carex lasiocarpa</u>	<u>Cicuta bulbifera</u>
	<u>Galium trifidum</u>	<u>Lysimachia terrestris</u>
	<u>Sagittaria montevidensis</u>	<u>Scirpus cyperinus</u>
	<u>Sium suave</u>	<u>Typha latifolia</u>
Frequent ---	<u>Carex crinita</u>	<u>Carex comosa</u>
	<u>Eleocharis obtusa</u>	<u>Glyceria canadensis</u>
	<u>Hypericum boreale</u>	<u>Iris versicolor</u>
	<u>Juncus canadensis</u>	<u>Lycopus americanus</u>
	<u>Rumex verticillatus</u>	
Rare -----	<u>Alisma triviale</u>	<u>Scutellaria epilobiifolia</u>

b. Calamagrostis-Scirpus stand

Location ----- Roscommon County, Lake Township,
T23N, R4W, SW $\frac{1}{4}$, Section 21.

Soil type ----- Greenwood peat.

This was an ecologically slight more advance stand than the previous one, as indicated by the increase of Calamagrostis canadensis, the presence of Agrostis hyemalis, Aster, Solidago, and the absence of such partly submerged species as Alisma, Sagittaria, Typha, Eleocharis, etc..

Willow (Salix discolor) remained to be the only occurring shrubs but was more frequent in presence and also increased in its coverage.

Vegetation in the four milacre quadrats were:

Shrubs and Vines

Frequent --- Salix discolor

Sedges, Grasses, and Herbs

Abundant ---	<u>Agrostis hyemalis</u>	<u>Calamagrostis canadensis</u>
	<u>Carex lasiocarpa</u>	<u>Cicuta bulbifera</u>
	<u>Lysimachia terrestris</u>	<u>Scirpus cyperinus</u>
	<u>Veronica scutellaria</u>	
Frequent ---	<u>Galium trifidum</u>	<u>Hypericum boreale</u>
	<u>Scutellaria epilobiifolia</u>	
	<u>Sium suave</u>	
Common -----	<u>Carex tenera</u>	<u>Epilobium leptophyllum</u>
	<u>Eupatorium perfoliatum</u>	<u>Lycopus americanus</u>
Rare -----	<u>Aster junciformis</u>	<u>Aster sp.</u>
	<u>Bidens cernua</u>	<u>Carex comosa</u>
	<u>Galium tinctorium</u>	<u>Solidago rugosa</u>
	<u>Solidago uliginosa</u>	<u>Rumex verticillatus</u>

1

c. Salix-Calamagrostis stand

Location ----- Roscommon County, Lake Township,

T23N, R4W, NW $\frac{1}{4}$, Section 21.

Soil type ----- Newton loamy sand.

This was a more advanced stage of the marsh type. Although the soil is somewhat different than the peat, but a relatively thick layer of organic soil on top of the wet sand makes it similar to the peat. Water-table was very near or at the surface during most part of the growing season. However it dropped to as deep as 24 inches in a dry period.

The increase of willows in number of species and in coverages indicated a drier condition than the preceeding two stands. This invasion of shrubs into the wet marsh area is slow and may last for a long period of time.

Salix petiolaris and Salix serissima were the dominant shrubs which formed dense bushes. The diameter of their spreading crown ranged from less than one foot to as large as six, seven feet or more. Most of the willows attained a height from 3 to 5 feet, a few also reached 6 feet or more. The following data shows the height and diameter of the crown of shrubs over 6 feet tall in a 1/10 acre quadrat:

<u>Species</u>	<u>Height (Ft.)</u>	<u>Diameter of Crown (Ft.)</u>
Salix petiolaris	7	6
	6	6.5
	5	7
Salix serissima	5.5	6

Vegetation in the four milacre quadrats were:

Trees

Common ----- Betula lutea (6)

Rare ----- Populus tremuloides (14)

Shrubs and Vines

Common ----- Salix alba var. vitellina
Salix serissima

Rare ----- Alnus rugosa Salix lucida
Salix petiolaris Spiraea alba
Rubus flagellaris

Sedges, Grasses, and Herbs

Abundant --- Agrostis hyemalis Aster junciformis
Calamagrostis canadensis Carex lasiocarpa
Carex tenera Iris versicolor
Lycopus americanus Lysimachia terrestris
Scirpus cyperinus

Frequent --- Cicuta bulbifera
Solidago uliginosa

Common ----- Eupatorium perfoliatum Galium trifidum
Hypericum boreale

Rare ----- Campanula aparinoides Solidago graminifolia
Solidago missouriensis

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[illegible]



Total Scirpus-Typha		Stand Calamagrostis-Scirpus		Stand Salix-Calamagrostis		Stand							
Freq.		1	2	3	4	5	6	7	8	9	10	11	12
Species	(%)	0-3	3-6	0-3	3-6	0-3	3-6	0-1	1-3	0-1	1-3	0-1	1-3
Solidago rugosa	8.3												
Solidago uliginosa	33.3												
Typha latifolia	33.3	3%	5%	1%	1%	T							
Veronica scutellaria	33.3												
<u>Sedges, Grasses & Rushes</u>													
Carex tenera	50.0												
Agrostis hyemalis	75.0												
Calamagrostis canadensis	100.0												
Carex lasiocarpa	100.0												
Scirpus cyperinus	100.0												
Carex comosa	41.7	60%	70%	55%	70%								
Carex crinita	33.3												
Eleocharis obtusa	33.3												
Juncus canadensis	33.3												
Glyceria canadensis	25.0												

T --- Denotes "Trace" which indicates less than 1% coverage.

1

1. The first part of the document is a list of names and dates, which appears to be a roster or a list of events. The names are written in a cursive script, and the dates are in a standard font. The list is organized into two columns, with names on the left and dates on the right.

2. The second part of the document is a series of handwritten notes or a letter. The text is written in a cursive script and is somewhat difficult to read due to the handwriting. It appears to be a personal communication, possibly a letter or a note.

3. The third part of the document is a series of handwritten notes or a letter. The text is written in a cursive script and is somewhat difficult to read due to the handwriting. It appears to be a personal communication, possibly a letter or a note.

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ECOLOGICAL FACTORS

Ecology is the study of organisms in relation to their environment. Therefore, in making an ecological study of forest succession, it is necessary to investigate the environment in addition to plant communities.

The site factors which are essential for the ecological description and characterization of associations are best considered under three groups: (1) Climatic or atmospheric factors, (2) Edaphic or soil factors, and (3) Biotic factors or the effects of the living environment.

These factors are responsible not only for the ecological characteristics of the present vegetation but also for successional changes of the plant communities.

A. Climatic factors

The climatic factors relate to atmospheric conditions and include all factors influencing plant life which are associated with the atmosphere. Four factors are being considered in this paper. They are: temperature, relative humidity, precipitation, and evaporation. Climatological data pertaining to the region are shown in Table 1.

1. Temperature

Meriam (1898) stated that air temperature is the most important factor in fixing the limits beyond which particular species and particular communities can not extend. Weaver and Clements (1958) have stated that "Temperature is like water in its action upon plants in that it has more or less to do with nearly every function, but as a working condition and not as a material."

Observations indicate that the various tree species can live only at temperature of a certain range, which may be termed their critical temperatures. However, within a relatively small, climatically similar area, such as the region of this study, local variations in temperature are very little which can be disregarded in their direct effect on vegetational changes.

Yet, vegetation tends to moderate the temperature. This equalizing effect increases with number and height of the layers (Braun-Blanquet, 1932). Therefore temperature is being considered as an influential factor to the evaporation rates of different vegetation types in this study.

Average weekly maximum and minimum temperatures for the period from July 20 to October 4, 1952, as recorded from the Higgins Lake and Houghton Lake Weather Bureau Stations are shown in Table 12. Graphical presentation of the data is shown in Fig. 6.

Table 12. Weekly averages of temperature, relative humidity, and accumulated precipitation during the period from July 20 to October 4, 1952, compiled from data obtained at Weather Bureau Stations near the Higgins Lake area.

Week (Ended)	Temperature °F.				Ave- rage	R. H. % (Lupton)	Precipitation-Inches		
	Higgins Lake		Houghton Lake				Higgins Lake	Houghton Lake	Ave- rage
	Max.	Min.	Max.	Min.					
July 26	82.6	61.1	82.7	61.7	72.0	51.4	1.63	2.79	2.21
Aug. 2	76.8	51.6	77.0	54.3	64.9	59.1	0.19	0.12	0.16
9	75.1	51.1	76.3	53.7	64.0	65.3	2.24	2.27	2.25
16	78.4	53.1	78.4	55.3	66.3	58.7	0.12	0.06	0.09
23	73.8	48.8	75.4	53.0	62.8	51.4	0.42	0.04	0.23
30	83.0	51.8	84.7	53.7	68.3	62.1	0.00	0.00	0.00
Sept. 6	72.7	53.1	73.3	51.5	62.7	65.7	0.98	1.19	1.08
13	83.3	51.1	81.8	51.8	67.0	54.7	0.00	0.00	0.00
20	68.3	46.1	70.3	47.3	58.0	68.1	0.21	0.48	0.35
27	63.8	38.6	65.2	38.0	51.4	65.0	0.56	0.47	0.51
Oct. 4	62.4	39.8	65.8	40.0	52.0	57.0	0.26	0.23	0.24

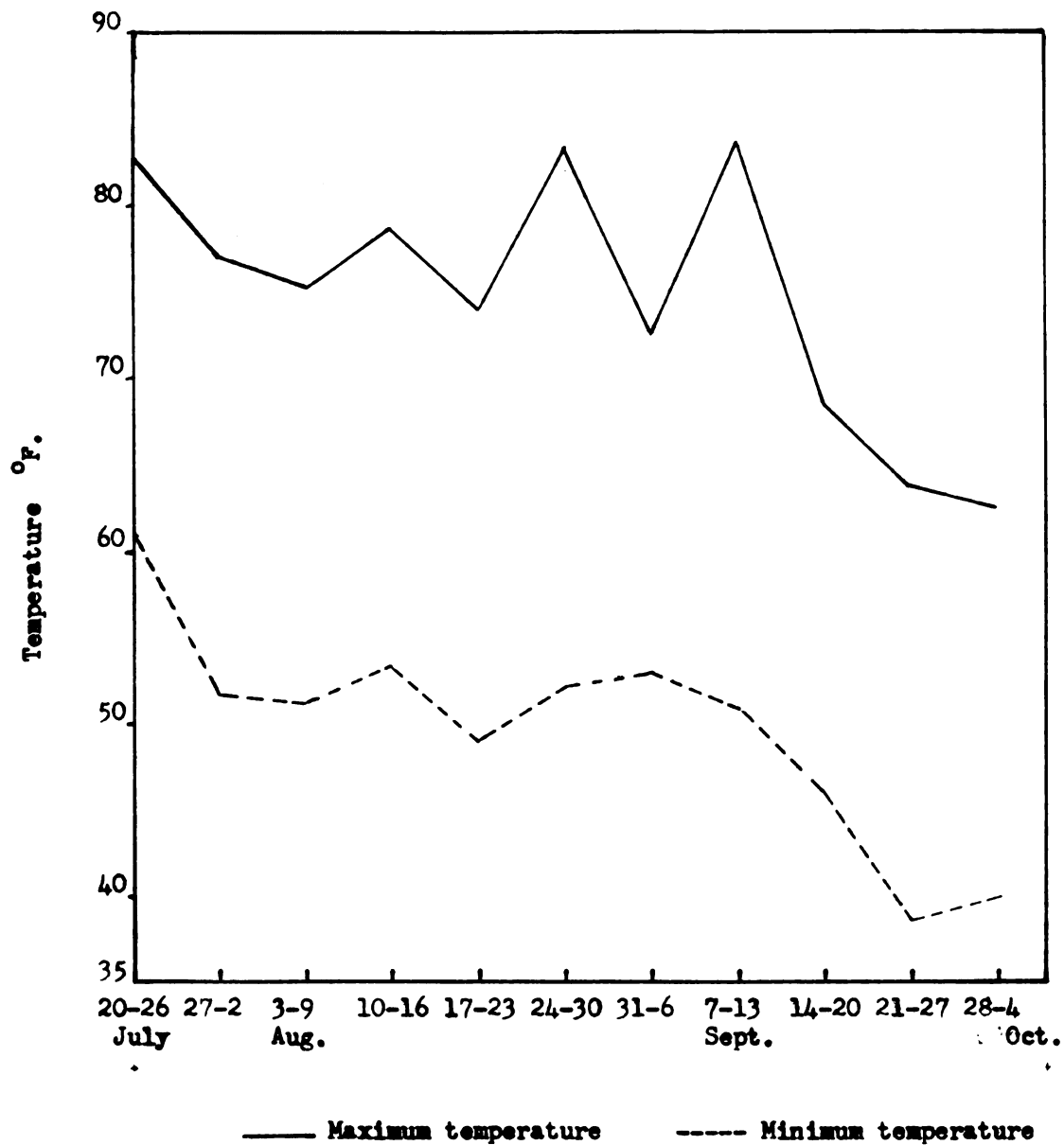


Fig. 6. Weekly data of maximum and minimum temperatures as recorded at the Higgins Lake and Houghton Lake Weather Stations during the period from July 20 to October 4, 1952.

Figure 1. The effect of the concentration of the H_2O_2 solution on the amount of the released H_2O from the H_2O_2 -loaded hydrogel. The amount of the released H_2O was measured by the weight difference of the hydrogel before and after the release. The concentration of the H_2O_2 solution was 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0 wt. %.

[illegible][illegible]

. 2. Relative humidity

The only available data of the relative humidity obtained from the Weather Bureau Stations near the Higgins Lake area was the one at Rose Lake (Lupton), Ogemaw County. Percentages of relative humidity were transformed from wet and dry bulb readings. Weekly averages of the period from July 20 to October 4, 1952 were derived from daily data and are shown in Table 12.

Humidity is affected by temperature, wind, altitude, exposure, cover, and soil moisture content (Weaver & Clements, 1938). High temperatures lower the relative humidity; wind has a powerful effect upon humidity in that dry winds lower the amount of air moisture and promote transpiration, whereas the moist winds exert an opposite influence; exposure affects humidity through the action of sun and wind; cover increases humidity by reducing the influence of both temperature and wind; and evaporation from the surface of moist soils increases humidity.

Generally speaking, forested regions have high humidities; while the humidity of open area or grassland is low. Lowlands are more humid; and tablelands and mountains usually less humid.

3. Precipitation

The water requirements of plants are chiefly met by the precipitation of the water vapor of the air in the form of rain, dew, or snow. The atmospheric precipitation is of particular importance in its effect on vegetation, owing to its relation to atmospheric humidity and soil moisture content. In general, fluctuations in soil moisture are directly traceable to variations in precipitation.

Toumey & Korstian (1948) stated that

"Variations in geographical distribution of precipitation influence markedly the distribution of forest. With the same amount of annual precipitation the character of a forest depends upon whether the rainfall is in the growing season or in the cold season; whether it is evenly distributed or confined to a few months of the year. In fact the distribution of precipitation throughout the year, especially when rainfall is not heavy, may determine whether a forest is present or a type of vegetation needing less water."

However, in this study, precipitation would not be an important factor in influencing the soil moisture because of the fact that the soils of the swampy lands are almost continuously wet throughout the year. The annual precipitation of about 30 inches in this region could not possibly be responsible alone; edaphic factors must also be considered.

Weekly precipitation data at the Higgins Lake and Houghton Lake Weather Stations during the period from July 20 to October 4, 1952 are shown in Table 12. Graphical presentation of the data is shown in Fig. 7.

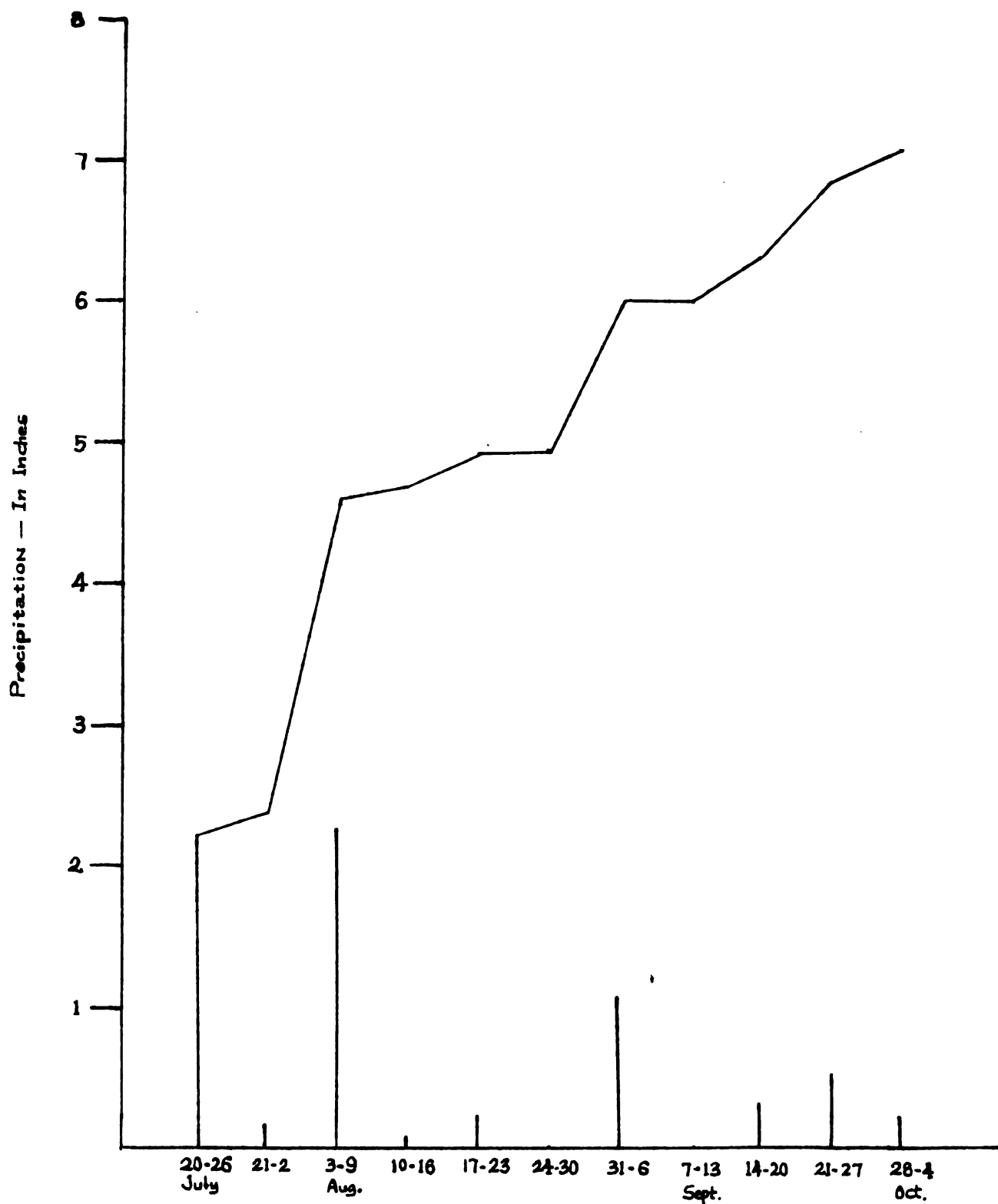
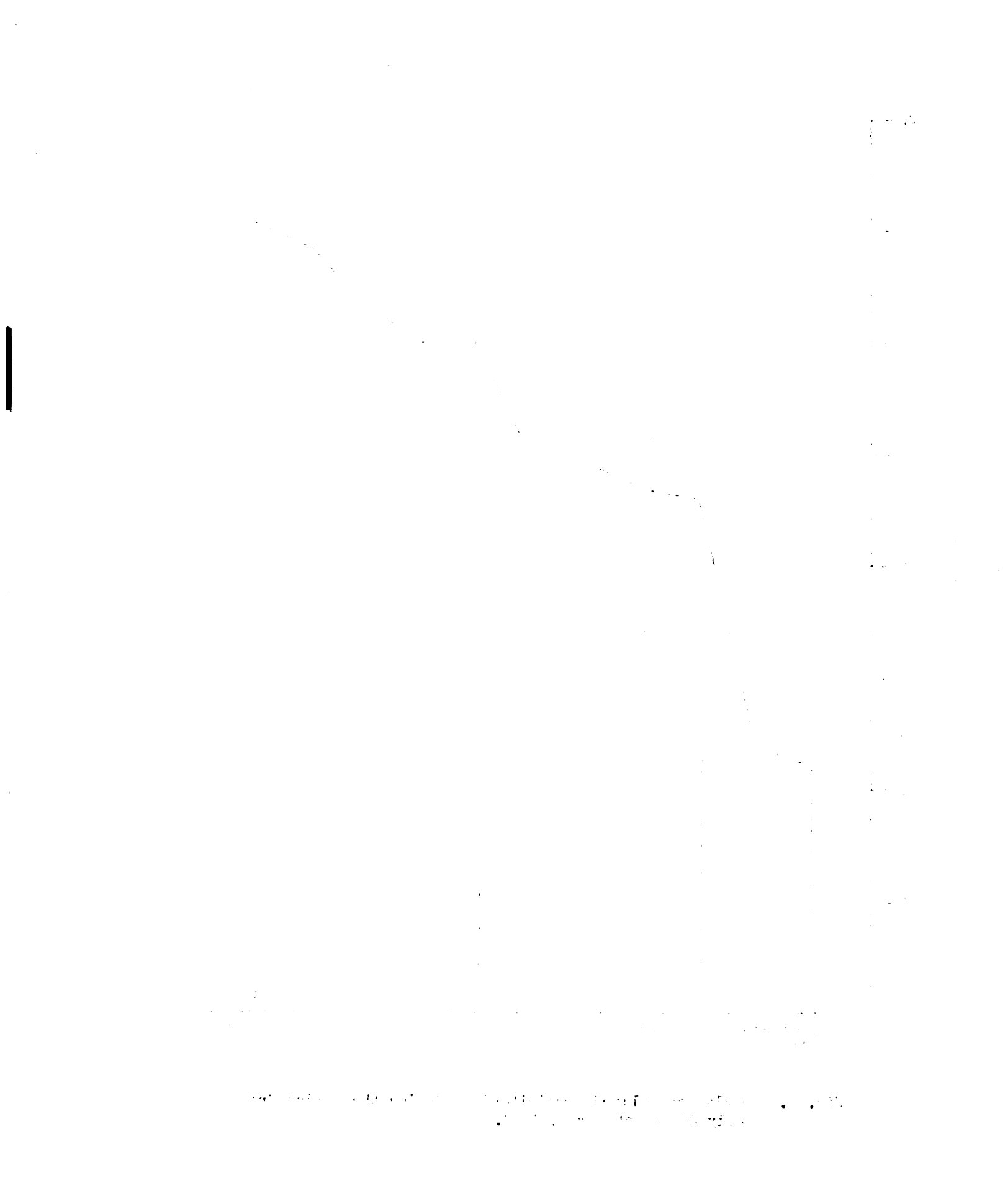


Fig. 7. Weekly accumulated precipitation during the period from July 20 to October 4, 1952.



4. Evaporation

Braun-Blanquet (1932) stated that "the evaporation rate is the combined effect of humidity, temperature, wind, atmospheric pressure, and radiant energy." Evaporation markedly determine the efficiency of rainfall, especially where the annual precipitation is less than 30 inches (Weaver and Clements, 1938).

Table 13. Evaporation rate as recorded by week at stations of 3 different vegetation layers during the period from July 20 to October 4, 1952.

<u>Date of Measurement</u>	<u>Evaporation</u>	<u>in C.C. of</u>	<u>Water</u>
	<u>Marsh Stand</u>	<u>Salix-Cornus-Alnus Stand</u>	<u>Thuja-Abies Stand</u>
July 26	65.5	49.3	43.1
Aug. 2	98.6	57.7	48.5
9	37.7	16.2	1.3
16	77.7	30.8	28.0
23	91.6	35.4	30.0
30	85.5	50.8	43.1
Sept. 6	54.7	32.3	27.8
13	93.3	61.6	44.7
20	74.3	40.0	35.4
27	55.3	28.5	17.7
Oct. 4	93.6	72.8	47.8

Livingston atmometers were used to determine the evaporation rate at three stands of different vegetation layers in this study. The three stands selected for the

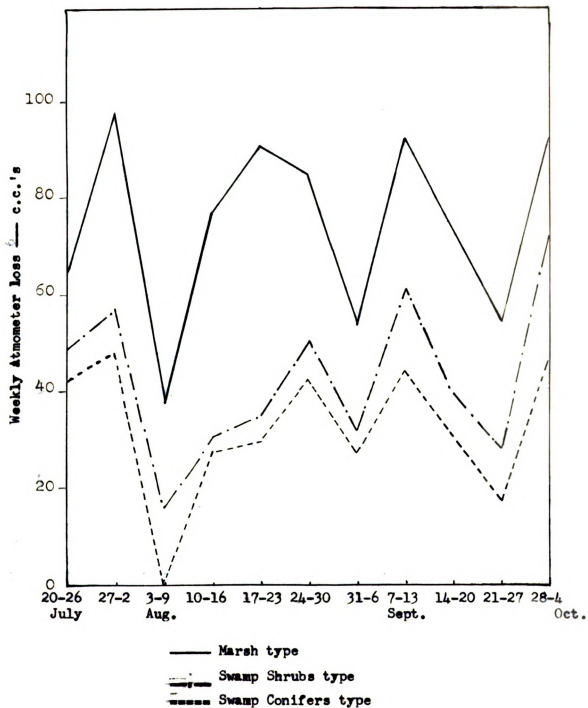


Fig. 8. Weekly evaporation in cubic centimeters in Marsh type, Swamp Shrubs type, and Swamp Conifers type for the period from July 20 to October 4, 1952.

experiment were: (1)The Marsh. (2)The Swamp Shrubs of Salix-Cornus-Alnus stand. (3)The Thuja-Abies stand of the Swamp Conifers.

Photographs of atmometer set up in the first two stands are shown in **Plate 1 and 2**. All atmometers were set up with bulbs about 18 inches above the ground surface.

Weekly readings were recorded during the period from July 20 to October 4, 1952, as shown in Table 13. Graphical presentation of the data is shown in Fig. 8.

Table 14. Analysis of variance of the evaporation data obtained from three different stands during the period from July 20 to October 4, 1952.

<u>Source of Variation</u>	<u>Degree of Freedom</u>	<u>Sum of Squares</u>	<u>Mean Square</u>	<u>F</u>
Total	32	19505.33	609.54	
Between stands	2	10584.32	5292.16	100.14**
Between weeks	10	7864.00	786.40	14.88**
Error	20	1057.01	52.85	

**Denotes significant at 1% level.

Statistical analysis in Table 14 shows highly significant differences between the evaporation rates of the three stands. The evaporation rate decreases from the Marsh to the Swamp Shrubs and to the Swamp Conifers. Although the forest vegetation may be the cause rather than effect of the lower evaporation, but the higher evaporation rate in the Marsh may still play an important role in retarding the establishment of forest cover on the area.



Plate 1. Set up of the Livingston atmometer in a Marsh stand. Inflorescences of Scirpus cyperinus can be seen on the upper part of the photograph. Bulb was approximately 18 inches above the ground.



Plate 2. Set up of the Livingston atmometer in a Swamp Shrubs stand. Bulb was approximately 18 inches above the ground.

Weekly averages of temperature and precipitation are plotted against the average evaporation rate of the three stands during the 11 week period from July 20 to October 4, 1952, in Fig. 9.

From the graph, we may observe that the evaporation rate serves as an indicator of temperature and precipitation, i.e., the higher the evaporation rate, the higher the temperature and the lower the precipitation will be; whereas the reverse will be true with the lower evaporation rates.

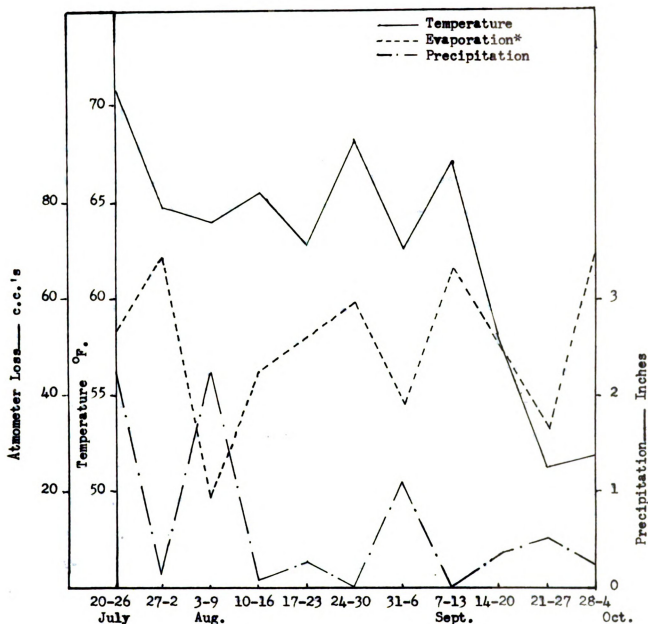


Fig. 9. Weekly evaporation (Average of three stands) in relation to temperature and precipitation for the period from July 20 to October 4, 1952.

* Denotes evaporation of the average of 3 stands.

The following is a list of names and their corresponding numbers, organized into two columns. The names are written in a cursive script, and the numbers are written in a simple, bold font.

The first column contains the names, and the second column contains the numbers. The list is organized into two columns, with names on the left and numbers on the right.

The second column contains the numbers, and the first column contains the names. The list is organized into two columns, with numbers on the left and names on the right.

B. Edaphic factors

A soil is the product of its environment. The most important factors in determining the character of the soil are the climate, living organisms, relief, time and parent material (Lutz and Chandler, 1947). The interrelationships between the vegetation, soil, and climate are inseparable. Although climate is most important in determining the range of a species, or broadly speaking, a formation; the condition of the soil is often responsible for limiting its occurrence. In other words, climate determines the climatic climax of a region. And soil condition within the climatic region will limit the vegetation either to be that of the true climax which occurs on the mesophytic, well-drained, upland soil; or the subclimax (physiographic climax as called by others) which occurs on either excessively wet or excessively dry soils. Therefore in the study of vegetation, soil is one of the most important factors to be taken into consideration.

The soils in the Higgins Lake area falls into the Podzol group (Soils and Man, USDA Yearbook 1938). Soils of three series were encountered in this study. Due to the excessive moisture contents and the high percentages of organic matter presented in the soils, only limited laboratory experiments were being carried out in the study of their physical and chemical properties.

A spade and an auger were used in the field to examine the soil profiles by way of digging. Soils of all the quadrats were investigated. As a result, seven soil samples belonging to five different soil types were encountered. They have been coded numerically as follows:

<u>Code No.</u>	<u>Soil Type</u>	<u>Cover Type</u>
1	Newton loamy sand	<u>Salix-Calamagrostis</u> stand
2	Greenwood peat	<u>Scirpus- Typha</u> stand
3	Rifle peat	<u>Salix-Cornus-Alnus</u> stand
4	Newton loamy sand	<u>Abies-Larix</u> stand
5	Rifle peat	<u>Thuja-Abies</u> stand
6	Bergland loam	<u>Fraxinus-Ulmus-Tilia</u> stand
7	Bergland clay loam	<u>Ulmus-Acer</u> stand

Soils of same type, such as 1 and 4, 3 and 5, taken as samples are due to the fact that different types of vegetation have been recorded.

Samples from depth of six inch intervals were taken for each soil. This demarcation has been set up arbitrarily because of the lack of zonation in the organic soils. In order to obtain a favorable comparison, mineral soils were also being divided in the same manner disregarding their natural depth of horizons.

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1. Soil profile description

a. Newton loamy sand

<u>Depth</u>	<u>pH</u>	<u>Soil Color</u>	<u>Soil Texture</u>
6"	4.96	Very dark brown	Sandy loam
12"	4.60	Dark grayish brown	Loamy sand
18"	3.70	Grayish or dingy white wet sand	sand
24" —	(Water-table)		
Cover Type ----- Marsh (<u>Salix-Calamagrostis</u> stand)			

Physiography --- Flat

b. Greenwood peat

<u>Depth</u>	<u>pH</u>	<u>Soil Color</u>	<u>Soil Texture</u>
6" —	4.55	Dark brown	Fibrous peat
12"	4.43	Brown	Fibrous peat
18"	4.27	Brown	Fibrous peat
Cover Type --- Marsh (<u>Scirpus-Typha</u> stand)			

Physiography --- Flat

c. Rifle peat

<u>Depth</u>	<u>pH</u>	<u>Soil Color</u>	<u>Soil Texture</u>
	6.21	Very dark brown	Woody peat
6"			
	6.09	Dark brown	Woody peat
12" — (Water-table)			
	5.78	Dark brown	Woody peat
18"			

Cover Type ----- Swamp Shrubs
 Physiography --- Flat

d. Newton loamy sand

<u>Depth</u>	<u>pH</u>	<u>Soil Color</u>	<u>Soil Texture</u>
	5.60	Very dark brown	Woody peat
6"			
8" — (Water-table)			
	6.32	Grayish brown	Wet sand
12"			
	6.35	Grayish brown	Wet sand
18"			

Cover Type ----- Swamp Conifer forest
 of Balsam Fir-Tamarack.
 Physiography --- Flat

e. Rifle peat

<u>Depth</u>	<u>pH</u>	<u>Soil Color</u>	<u>Soil Texture</u>
6"	6.15	Very dark brown	Woody peat
12"	6.08	Dark brown	Woody peat
18"	5.32	Dark brown	Woody peat

(Water-table) ———

Cover Type ----- Swamp Conifer forest of Balsam Fir-N. White Cedar.

Physiography --- Flat

f. Bergland loam

<u>Depth</u>	<u>pH</u>	<u>Soil Color</u>	<u>Soil Texture</u>
6"	5.32	Very dark brown	Loam
10"	5.54	Gray	Clay
12"	6.00	Gray with yellowish streaks	Loamy sand with clay pockets & gravels
18"			

(Water-table) - - - - -

Cover Tyne ----- Swamp Hardwoods of Ash-Elm-Basswood

Physiography --- Flat

g.Bergland clay loam

<u>Depth</u>	<u>p^H</u>	<u>Soil Color</u>	<u>Soil Texture</u>
	5.73	Very dark brown	Loam
6"			
	6.30	Gray	Clay
10" — (Water-Table)			
12"			
	6.50	Gray with yellowish stains	Clay
18"			
Cover Type ----- Swamp Hardwoods of Elm-Soft Maple			
Physiography --- Flat			

2. Soil volume weight

Lutz and Chandler (1947) have defined volume weight as "the ratio between the dry weight of a given volume of undisturbed soil and the weight of an equal volume of water." It is evident that the volume weight is greatly influenced by soil structure, therefore the determination should be based on the volume of soil in its natural field condition.

Soil samples of this study were collected in situ by means of the soil core sampler (Cylinder of 3" x 3" in dimension which gives a volume of 347 cm.). Soil cores of each horizon were collected in duplicate and placed in ice-cream containers in order to retain their natural condition.

In the laboratory, a disk of filter paper and cheese-cloth were fastened to one end of the cylinder with a rubber band. They were weighed and oven-dried at 105° C. for 24 hours and calculation was made on oven-dry basis.

Results of laboratory determination are shown in Table 15. Statistical analysis has been made which shows no significant difference between either different soils or different horizons of the soil (Table 16).

However, from the data, conclusions can be drawn:
(1) The volume weight increases with increasing depth below the surface; and (2) lower volume weight in soils of higher content of organic matter (also see Table 15). These are

essentially coincides with the statement made by Lutz and Chandler (P. 238, 1947).

Table 15. Volume weight of each of the three horizons of six soils.

Soil Type	Code No.	Horizon	Oven-dry Wt. in Grams	Volume Weight
Newton sand	1	0"-6"	56.5	0.163
		6"-12"	143.3	0.413
		12"-18"	549.4	1.583
Greenwood peat	2	0"-6"	63.4	0.183
		6"-12"	100.3	0.289
		12"-18"	105.8	0.305
Rifle peat	3	0"-6"	75.4	0.217
		6"-12"	114.3	0.329
		12"-18"	129.6	0.373
Newton sand	4	0"-6"	73.8	0.218
		6"-12"	568.5	1.638
		12"-18"	601.7	1.734
Rifle peat	5	0"-6"	55.8	0.160
		6"-12"	61.7	0.177
		12"-18"	65.1	0.187
Bergland loam	6	0"-6"	55.6	0.160
		6"-12"	78.1	0.225
		12"-18"	174.7	0.503

Table 16. Result of the statistical analysis of the soil volume weight data.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F
Total	17	49893.11	2934.89	
Between Soil Types	5	23183.78	4636.76	2.89
Between Soil Horizons	2	10720.44	5360.22	3.35
Error	10	15988.89	1598.89	

[illegible]

Figure 1 consists of four scatter plots arranged in a 2x2 grid. The top row shows the relationship between the number of children and the number of children who are not in school, with the y-axis labeled 'Number of children' and the x-axis labeled 'Number of children who are not in school'. The bottom row shows the relationship between the number of children and the number of children who are not in school, with the y-axis labeled 'Number of children who are not in school' and the x-axis labeled 'Number of children who are not in school'. The left column shows the relationship for the number of children, and the right column shows the relationship for the number of children who are not in school. The plots show a positive relationship between the number of children and the number of children who are not in school, with a steeper slope for the total number of children than for the number of children who are not in school.

[illegible]

3. Soil porosity

Most soil porosity measurements are based upon determinations of volume weight of the soil at some arbitrary moisture content (Baver, 1948). In this study, the total porosity is based on weight of soil at oven-dry, 105°C., whereas the separating moisture content between the capillary and non-capillary porosity is at the tension equivalent to 60 cm. of water (p^F 1.6).

a. Capillary, non-capillary, and total porosity

Eighteen samples in duplicate were collected in situ using core sampler. They were taken from each of the three horizons of six soils.

A disk of filter paper and cheesecloth were fastened to one end of the cylinder with a rubber band. Cylinders were then placed into a pan of water such that the water is level with the top of the soil and allowed to stand for 24 hours. After the cores were saturated, they were removed from the pan, let drain freely for one minute, weighed, placed on a tension table, allowed to drain for 24 hours, and weighed. Tension tables of four different tensions which have the equivalent to 10 cm., 20 cm., 40 cm., and 60 cm. of water were used. Data obtained from the tensions of 10 cm., 20 cm., and 40 cm. were used to calculate the percentages of pore space distribution. Cores were placed on the 10 cm. tension table first for 24 hours and weighed. The same procedure was

1. The first part of the document is a letter from the President of the United States to the Congress, dated January 3, 1863. It is a very important document, as it contains the President's message to Congress regarding the state of the Union and the progress of the war. The letter is written in a formal, official style, and is signed by Abraham Lincoln.

2. The second part of the document is a report from the Secretary of War, dated January 3, 1863. It provides a detailed account of the military operations and the state of the army during the year. The report is written in a formal, official style, and is signed by Edwin M. Stanton.

3. The third part of the document is a report from the Secretary of the Treasury, dated January 3, 1863. It provides a detailed account of the financial operations and the state of the treasury during the year. The report is written in a formal, official style, and is signed by Charles A. Smith.

4. The fourth part of the document is a report from the Secretary of the Interior, dated January 3, 1863. It provides a detailed account of the land and mineral operations and the state of the interior during the year. The report is written in a formal, official style, and is signed by Caleb B. Smith.

5. The fifth part of the document is a report from the Secretary of the Navy, dated January 3, 1863. It provides a detailed account of the naval operations and the state of the navy during the year. The report is written in a formal, official style, and is signed by Gideon Welles.

6. The sixth part of the document is a report from the Secretary of the War, dated January 3, 1863. It provides a detailed account of the military operations and the state of the army during the year. The report is written in a formal, official style, and is signed by Edwin M. Stanton.

7. The seventh part of the document is a report from the Secretary of the Treasury, dated January 3, 1863. It provides a detailed account of the financial operations and the state of the treasury during the year. The report is written in a formal, official style, and is signed by Charles A. Smith.

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10. The tenth part of the document is a report from the Secretary of the War, dated January 3, 1863. It provides a detailed account of the military operations and the state of the army during the year. The report is written in a formal, official style, and is signed by Edwin M. Stanton.

repeated for the remaining three tension tables. Cores were oven-dried after removed from the 60 cm. tension table.

Percentages of the non-capillary, capillary, and total porosity of the six soils are shown in Table 17.

Table 17. Percentages of soil porosity of each of the three horizons of six soils.

Soil Type	Code No.	Horizon	Percentage of Porosity		
			Non-capillary	Capillary	Total
Newton sand	1	0"-6"	37.70	53.66	91.36
		6"-12"	13.06	66.94	80.00
		12"-18"	13.78	31.55	45.33
Greenwood peat	2	0"-6"	36.29	56.48	92.77
		6"-12"	24.76	63.21	87.98
		12"-18"	17.67	67.11	84.78
Rifle peat	3	0"-6"	28.88	53.33	82.21
		6"-12"	15.39	67.46	82.85
		12"-18"	13.04	68.57	81.61
Newton sand	4	0"-6"	39.04	53.03	92.07
		6"-12"	16.69	21.26	37.95
		12"-18"	8.67	23.49	32.16
Rifle peat	5	0"-6"	31.57	59.65	91.22
		6"-12"	25.79	62.77	88.56
		12"-18"	16.92	72.01	88.93
Bergland loam	6	0"-6"	22.74	67.69	90.43
		6"-12"	19.42	74.87	94.29
		12"-18"	14.58	60.95	75.53

The data shows that the percentages of non-capillary porosity are lower than the capillary porosity in all the soils. This proves the fact that all the soils are poorly-drained, as Lutz and Chandler (1947) have stated that soils which possess a low non-capillary pore volume and high capillary pore volume will have high field capacity but the

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infiltration of water will be slow. The high percentages of the total porosity of all the soils are no doubt due to the high content of unincorporated organic matter which is very highly porous in nature.

Table 18. Analysis of variances for non-capillary, capillary, and total porosity of six soils.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F
Non-capillary porosity				
Total	17	1483.78	87.28	
Between Soil Types	5	137.78	27.56	1.14
Between Soil Horizons	2	1104.78	552.39	22.90**
Error	10	241.22	24.12	
Capillary porosity				
Total	17	4329.78	254.69	
Between Soil Types	5	2671.11	534.22	3.39*
Between Soil Horizons	2	87.11	43.55	0.27
Error	10	1571.56	157.16	
Total porosity				
Total	17	5773.78	339.63	
Between Soil Types	5	2221.11	444.22	2.07
Between Soil Horizons	2	1408.78	704.39	3.28
Error	10	2143.89	214.39	

**Denotes significant at 1% level

*Denotes significant at 5% level

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Results of statistical analysis are shown in Table 18. There are no significant differences between the total porosity of the six soils. For the capillary porosity, slight differences (significant at 5% level) exist between the six soils. Result of the t-Test proves that soils of code number 2,3,5,6 have higher percentages of capillary porosity than Newton sand type. The Newton soil has a sub-soil of wet sand which will certainly be less porous than the other peat or clayey soils.

As for the non-capillary porosity, there are no significant differences between the six soils. However, highly significant differences exist between the three horizons. Results of the t-Test show that the 0"-6" horizons have higher percentages of non-capillary porosity than the lower two horizons, whereas there is no difference between the 6"-12" and 12"-18" horizons. This is rather typical for most of the soils whose sub-soils are less aerated due to compactness. As in this study, the continuous wetness should account for the poor aeration which in turn explains the incomplete decomposition of the organic remains and causes the formation of peat

b. Pore space distribution

Percentages of pore space for the six soils by horizons were determined from the volume weight of the soil at moisture content of the saturated soil core drained for 24 hours under tension equivalent to 10 cm., 20 cm., 40 cm., 60 cm. of water, and oven-dry conditions. The percentages of pore space distribution serve to give a better picture of the pore space under different moisture content.

Results of laboratory determinations are shown in Table 19.

Table 19. Pore space distribution in percentages of the six soils by horizon.

Soil	Type	Code	No.	Horizon	Tension Equivalent to cm. of Water				
					10 cm.	20 cm.	40 cm.	60 cm.	Oven-dry
Newton sand		1		0"-6"	21.17	25.22	33.57	37.70	91.36
				6"-12"	8.69	9.30	11.38	13.06	80.00
				12"-18"	3.60	4.73	9.54	13.78	45.33
Greenwood peat		2		0"-6"	21.53	23.66	30.86	36.29	92.77
				6"-12"	15.30	16.71	21.01	24.76	87.98
				12"-18"	11.18	12.48	15.65	17.67	84.78
Rifle peat		3		0"-6"	22.74	24.09	27.00	28.88	82.21
				6"-12"	10.69	11.61	13.66	15.39	82.85
				12"-18"	9.10	9.91	11.73	13.04	81.61
Newton sand		4		0"-6"	28.02	31.55	36.73	39.04	92.07
				6"-12"	4.21	6.28	13.11	16.69	37.95
				12"-18"	3.17	3.40	6.59	8.76	32.16
Rifle peat		5		0"-6"	24.45	26.51	29.93	31.57	91.22
				6"-12"	19.31	21.32	24.29	25.79	88.56
				12"-18"	11.58	12.97	15.30	16.92	88.93
Bergland lean		6		0"-6"	15.01	16.51	19.45	22.74	90.43
				6"-12"	11.30	12.94	16.63	19.42	94.29
				12"-18"	10.29	11.21	13.11	14.58	75.53

2. The second part outlines the various methods and tools used to collect and analyze data. It mentions the use of surveys, interviews, and statistical software to ensure that the information gathered is reliable and valid.

3. The third part describes the process of identifying trends and patterns in the data. It highlights the need for careful analysis and interpretation to draw meaningful conclusions from the collected information.

4. The fourth part discusses the challenges and limitations of the research process. It acknowledges that there may be certain biases or constraints that could affect the results, and it provides strategies to mitigate these issues.

5. The fifth part concludes the document by summarizing the key findings and recommendations. It stresses the importance of ongoing monitoring and evaluation to ensure that the implemented measures are effective and sustainable.

6. The sixth part of the document provides a detailed overview of the data collection process. It describes the steps involved in designing the study, selecting the sample, and conducting the data collection activities. It also mentions the use of various data management systems to store and organize the collected data.

7. The seventh part discusses the analysis of the data. It mentions the use of statistical software to perform various tests and calculations. It also describes the process of interpreting the results and drawing conclusions based on the analysis.

8. The eighth part discusses the dissemination of the findings. It mentions the importance of sharing the results with the relevant stakeholders and the public. It also describes the various channels and methods used to disseminate the information, such as reports, presentations, and publications.

9. The ninth part discusses the impact of the research. It mentions the various ways in which the findings have been used to inform policy and practice. It also describes the ongoing efforts to monitor and evaluate the impact of the implemented measures.

10. The tenth part concludes the document by summarizing the key findings and recommendations. It stresses the importance of ongoing monitoring and evaluation to ensure that the implemented measures are effective and sustainable.

Statistical analysis, as shown in Table 20, indicates highly significant differences between the different soil types and between the different soil horizons. The following statements were drawn from results of the t-Test:

(1)The Greenwood peat and the Rifle peat (Code No. 5) have higher pore space percentages than the other four soils.

(2)The pore space decreases as depth of the soil increases.

Table 20. Analysis of variance from data of the pore space distribution of the six soils by horizons.

Sources of Variation	Degree of freedom	Sum of Squares	Mean Square	F
Total	71	5685.87	80.08	
Between Soil Types	5	429.45	85.89	21.00**
Between Diff. Tensions	3	740.37	246.79	60.34**
Error (a)	15	61.38	4.09	0.18
Between Soil Horizons	2	3514.58	1757.29	77.79**
Interaction Between T & H	6	36.42	6.07	0.27
Error (b)	40	903.67	22.59	

**Denoted significant at 1% level.

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4. Soil moisture

In many regions, the occurrence of forest types is controlled by the supply of water. Generally speaking, site quality improves with increasing amount of available soil moisture. However, there is a limit to the amount of soil moisture which is desirable. Lutz and Chandler (1947) pointed out if the soil water exceeds a certain limit, unfavorable conditions for plant growth result because of deficient aeration and related phenomena.

In this study, the swampy soils are wet throughout the year or at least for part or all of the growing season. This makes the accurate determination of soil moisture in situ difficult to accomplish, because most of the methods in use are not designed to measure soil moisture in very wet conditions.

Nevertheless, the "electrical resistance method" (Bouyoucos and Mick, 1940, 1948) was used to determine the moisture content of two soils. Both of them are Rifle peat, but the stands are of two different types: a Swamp Conifers, and a Swamp Shrubs of Salix-Cornus-Alnus Association. Soils of these two stands are comparatively drier than soils of the Marsh and Swamp Hardwoods which at the time of setting up the experiment were both under water-logged conditions.

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Nylon blocks were buried at 6 inches and 10 inches depth into the soil column. The lower depth of 10 inches was selected because the water-table in both the soils were at about 12 inches. Weekly measurements were taken by means of the Bouyoucos' Bridge during the period from July 26 to October 4, 1952. Soil temperatures were also measured at the same time in order to correct the resistance readings of the nylon blocks against the room temperature of 76°F. (Bouyoucos and Mick, 1948).

The soil moisture curves for the two soils, which have been calibrated in laboratory at room temperature of 76°F. are shown in Fig. 10. (Bouyoucos and Mick, 1940, 1948)

Table 21. Soil moisture data of Rifle peat soils in two different stand types, obtained during the period from July 26 to October 4, 1952.

Date (Week ending)	Soil Code		No. 3		Soil Code		No. 5	
	6 inches		10 inches		6 inches		10 inches	
	X	MC	X	MC	X	MC	X	MC
Aug. 2	1.9x10 ³	232	0.92x10 ³	252	2.1x10 ³	199	1.6x10 ³	205
9	4.6x10 ³	209	2.1x10 ³	229	2.9x10 ³	191	2.0x10 ³	200
16	2.9x10 ³	220	1.4x10 ³	240	1.7x10 ³	204	1.4x10 ³	208
23	2.0x10 ³	230	0.96x10 ³	251	1.5x10 ³	207	1.3x10 ³	210
30	4.2x10 ³	211	2.7x10 ³	222	5.4x10 ³	178	4.1x10 ³	183
Sept. 6	2.7x10 ³	222	1.2x10 ³	244	2.8x10 ³	192	2.1x10 ³	199
13	5.0x10 ³	207	1.8x10 ³	233	3.8x10 ³	185	3.0x10 ³	190
20	4.0x10 ³	213	2.4x10 ³	225	7.0x10 ³	172	5.0x10 ³	179
27	2.2x10 ³	228	0.92x10 ³	252	4.3x10 ³	182	4.0x10 ³	184
Oct. 4	2.8x10 ³	221	1.05x10 ³	248	5.0x10 ³	179	4.5x10 ³	181

X ----- Corrected resistance reading in ohms.

MC ----- Moisture content in percent.

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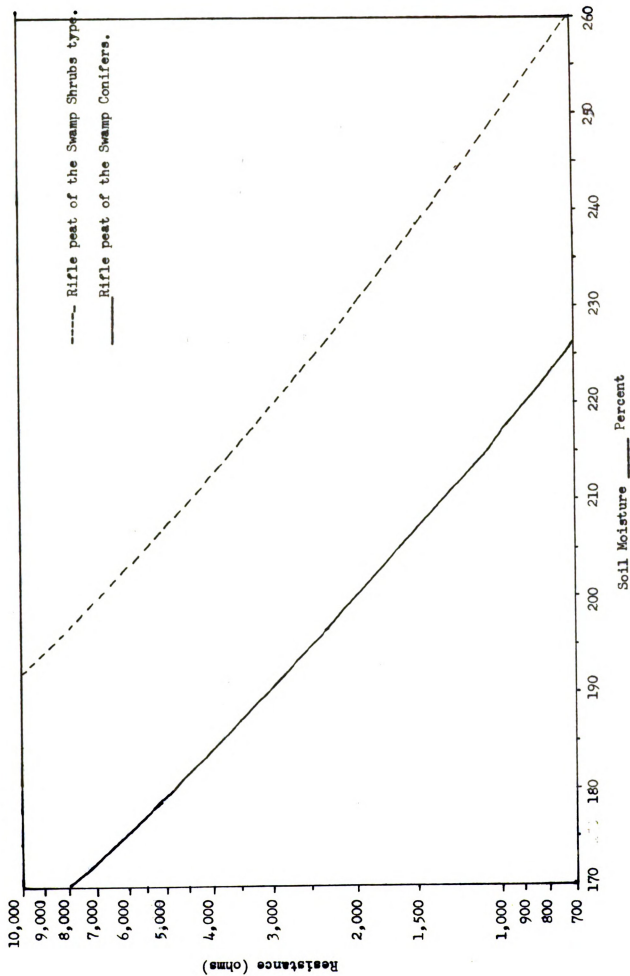


Fig. 10. Soil moisture curves for the two Rifle pest soils.

Weekly data of the moisture contents of the two soils are shown in Table 21. Graphical presentation is shown in Fig. 11.

Analysis of variance (Table 22) shows highly significant difference between the moisture contents of the two soils as well as between the two different horizons.

Table 22. Analysis of variance of the moisture contents of the two Rifle peat soils.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F
Total	39	21099.78	541.02	
Between Dates	9	3143.03	349.22	2.74
Between Soil Types	1	14478.03	14478.03	113.88**
Error (a)	9	1144.22	127.13	
Between Soil Horizons	1	1600.23	1600.23	193.26**
Interaction Between T & H	1	585.22	585.22	70.67**
Error (b)	18	149.05	8.28	

**Denotes significant at 1% level.

Further t-Test shows that the moisture content of the soils of the Swamp Shrub type (Code No. 3) is significantly higher (at 1% level) than the soils obtained from the Swamp Conifer forest stand (Code No. 5). Whereas in each soil the lower (10 inches) layer has a higher moisture than the upper (6 inches) layer.

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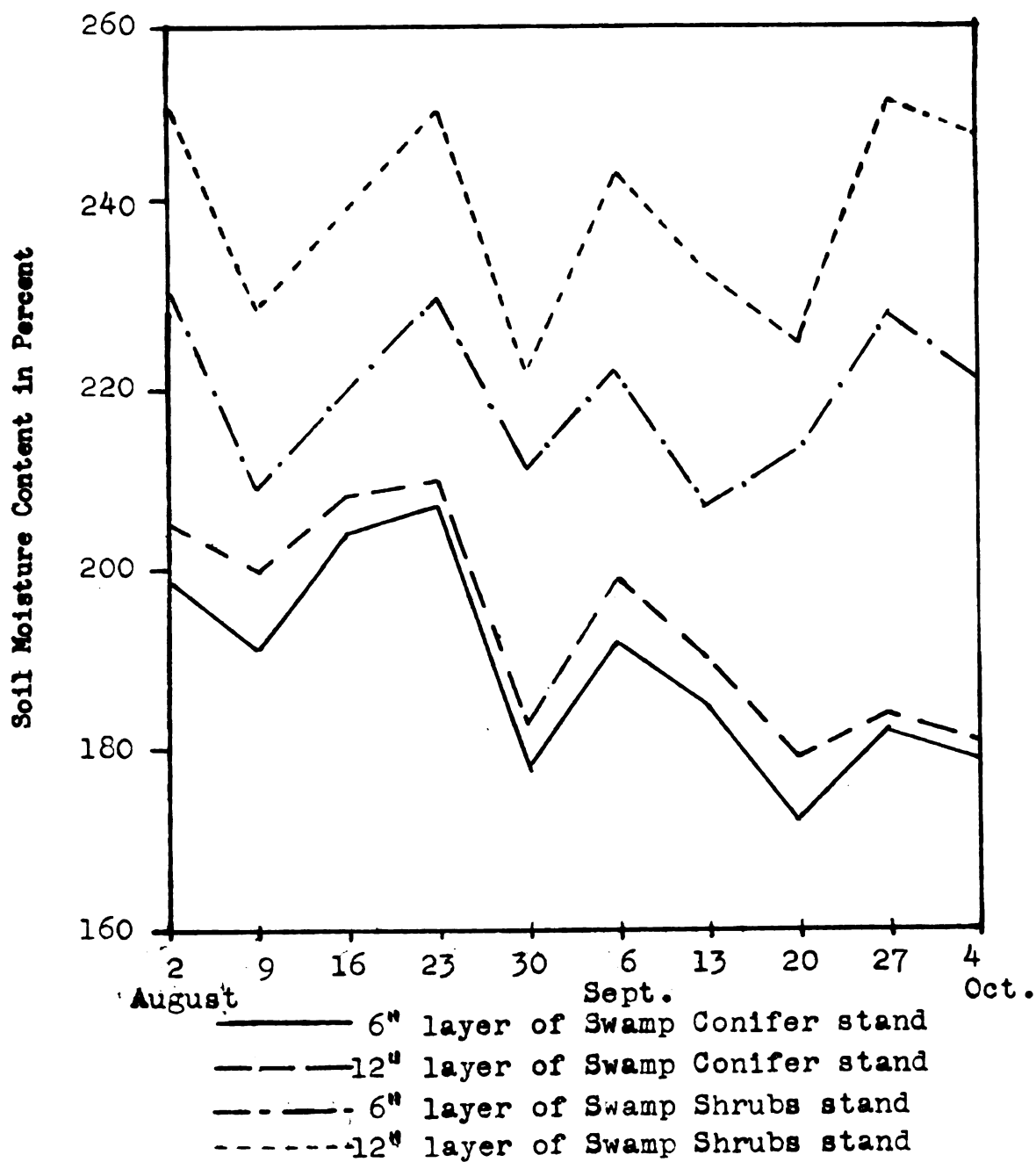


Fig. 11. Weekly data of soil moisture content in percent of the two Rifle peat soils by horizons.

Amount of interest received 1100



Amount of interest received 1100
Amount of interest received 1100

5. Soil temperature

Soil temperature is important because it affects the biological, chemical and physical processes in soils. Weaver and Clements (1939) have stated that color, texture, structure, water content, amount of humus, slope and aspect, and the presence or absence of vegetation cover are among the factors that directly affect soil temperature. According to them, water content is the most important because it has a specific heat about five times greater than the solid constituent of the soil. Therefore, the poorly-drained soils, under dense vegetation cover, of flat and low ground, are colder than sandy or leamy soils of the uplands.

Table 23. Soil temperatures of the two Rifle peat soils which measured once every week during the period from July 26 to October 4, 1952.

Date	Soil Temperature °F.	
	Code No. 3	Code No. 5
July 26	--	66
Aug. 2	61	61
9	60	61
16	60.5	60
23	57.5	55
30	60	62
Sept. 6	58	58
13	61.5	62
20	52	53
27	49.5	49
Oct. 4	47	46

In this study, soil temperatures have been measured in only two of the sample plots (shown in Table 23), as a supplementary procedure in measuring the moisture contents of the soils. No significant difference has been found between the two sampling areas, the Swamp Shrub stand and the Swamp Conifer forest.

6.Organic matter

The effect of organic matter or humus on forest vegetation has been discussed by Toumey and Kerstian (1948). They stated that the humus is a source of supply of both ash and non-ash nutrients. They also stated that the effect of organic matter will improve the physical properties of soil. For example, the incorporated humus improves the soil structure, increases water holding capacity, decreases the volume weight, increases the activities of soil organisms, and has a high exchange capacity; and the unincorporated organic matter will protect the soil from the compacting effect of heavy precipitation.

Decomposition of plant remains is much retarded in the poorly-drained soils due to the cool climate, excessive moisture, poor aeration, and unfavorable microbiological conditions. The litter of the swamp vegetation such as Picea, Larix, Vaccinium, Ledum, Carex, etc., is highly acid in reaction which upon accumulation is readily formed into peat.

Q. Now, you said that you were not sure whether the person was a man or a woman, is that correct?

A. Yes, I'm not sure whether it was a man or a woman, but I'm sure it was a person.

Q. Now, you said that you saw the person in the car, is that correct?

A. Yes, I saw the person in the car, and I saw the person in the car.

Q. Now, you said that you saw the person in the car, is that correct?

A. Yes, I saw the person in the car, and I saw the person in the car.

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Braun-Blanquet (1932) has segregated the humus substances into two qualitatively different groups: the neutral, mild, saturated; and the adsorptively unsaturated humus. He stated that "----- the interior surface of the unsaturated humus (of this, peat belongs to) is very great, involving a large water fixation; hence very acid humus soils are physically dry."

Twenty-one samples in duplicate from each of the three horizons of seven soils were used to determine their organic matter content by the Dry Combustion method.

To 2 grams of finely ground air-dry soil (0.5 or 1 gram for some of the soil whose organic matter is very high) were added 0.25 gram manganese dioxide and 5 grams 60 mesh carbon free alundum. They were mixed well and placed in alundum combustion boat and the boat was inserted directly into the hot silica tube of furnace, previously heated to operating temperature of about 950°C. The flow of oxygen was adjusted to about 100-200 c.c. per minute. Carbon dioxide evolved in combustion passed thru the purifying section of the train, and was absorbed in a previously weighed tube filled with ascarite. Grams of carbon dioxide evolved was calculated and then converted to percent of organic matter by using the converting factor 0.471.

Results from the laboratory determination are shown in Table 24.

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Table 24. Organic matter in percent of seven soils by horizon as determined from Dry Combustion method.

Soil Type	Code No.	Horizon	Organic Matter in Percent		
			Replications		Average
			I	II	
Newton sand	1	0"-6"	59.24	40.38	49.81
		6"-12"	16.49	18.90	17.69
		12"-18"	1.52	1.00	1.26
Greenwood peat	2	0"-6"	67.68	66.62	67.15
		6"-12"	78.08	71.98	75.03
		12"-18"	33.77	50.29	42.03
Rifle peat	3	0"-6"	51.91	48.75	50.33
		6"-12"	63.23	53.32	58.27
		12"-18"	41.40	44.37	42.88
Newton sand	4	0"-6"	47.82	48.55	48.19
		6"-12"	0.79	1.30	1.04
		12"-18"	0.99	0.79	0.89
Rifle peat	5	0"-6"	42.41	46.01	44.22
		6"-12"	45.40	42.91	44.15
		12"-18"	40.40	43.38	41.89
Bergland loam	6	0"-6"	46.12	30.47	38.30
		6"-12"	32.24	21.57	26.91
		12"-18"	1.33	1.82	1.58
Bergland clay loam	7	0"-6"	38.49	42.14	40.31
		6"-12"	3.72	3.37	3.55
		12"-18"	1.35	1.29	1.32

Statistical analysis which is shown in Table 25 shows that there are highly significant differences (at 1% level) between the organic matter of the different soil types, different soil horizons, and also the interaction of soil type and horizon.

1. The first step in the process of the investigation is the identification of the problem. This is done by the investigator who is responsible for the study. The problem is then defined in terms of the research objectives and the research questions.

2. The second step is the design of the study. This involves the selection of the research method, the selection of the sample, and the selection of the data collection instruments. The design of the study is then approved by the research ethics committee.

3. The third step is the data collection. This involves the collection of data from the sample. The data collection is then carried out by the investigator who is responsible for the study. The data collection is then approved by the research ethics committee.

4. The fourth step is the data analysis. This involves the analysis of the data collected. The data analysis is then carried out by the investigator who is responsible for the study. The data analysis is then approved by the research ethics committee.

5. The fifth step is the interpretation of the results. This involves the interpretation of the results of the data analysis. The interpretation of the results is then carried out by the investigator who is responsible for the study. The interpretation of the results is then approved by the research ethics committee.

6. The sixth step is the conclusion. This involves the conclusion of the study. The conclusion is then carried out by the investigator who is responsible for the study. The conclusion is then approved by the research ethics committee.

7. The seventh step is the dissemination of the results. This involves the dissemination of the results of the study. The dissemination of the results is then carried out by the investigator who is responsible for the study. The dissemination of the results is then approved by the research ethics committee.

8. The eighth step is the evaluation of the study. This involves the evaluation of the study. The evaluation of the study is then carried out by the investigator who is responsible for the study. The evaluation of the study is then approved by the research ethics committee.

9. The ninth step is the final report. This involves the final report of the study. The final report is then carried out by the investigator who is responsible for the study. The final report is then approved by the research ethics committee.

10. The tenth step is the final approval. This involves the final approval of the study. The final approval is then carried out by the investigator who is responsible for the study. The final approval is then approved by the research ethics committee.

11. The eleventh step is the final publication. This involves the final publication of the study. The final publication is then carried out by the investigator who is responsible for the study. The final publication is then approved by the research ethics committee.

12. The twelfth step is the final evaluation. This involves the final evaluation of the study. The final evaluation is then carried out by the investigator who is responsible for the study. The final evaluation is then approved by the research ethics committee.

Table 25. Analysis of variance from the data of organic matter of seven soils by horizons.

<u>Source of Variation</u>	<u>Degree of Freedom</u>	<u>Sum of Squares</u>	<u>Mean Square</u>	<u>F</u>
Total	41	22913.62	558.87	105.85
Between Soil Types	6	12168.12	2028.02	75.42**
Between Replications	1	27.52	27.52	1.02
Error (a)	6	161.31	26.89	
Between Soil Horizons	2	6135.05	3067.52	105.85**
Interaction Between T & H	12	4015.95	334.66	11.55**
Error (b)	14	405.67	28.98	

**Denotes significant at 1% level.

The following observations are drawn from the t-Test:

a. For different soil types ----- The Greenwood peat has the highest organic matter content, followed by the two Rifle peat types. Next comes the two Newton sand types and both the Bergland soils.

The high percentages of organic matter in all the peaty soils can well be expected as the result of vegetative accumulation in the peat. The greater amount of coarse woody materials in the Rifle peat should account for the lower organic matter content than found in Greenwood peat which is composed of mostly finer textured materials.

The lower organic matter content of the Newton and Bergland soils is due to the fact that they are mineral

soils whose substrata are low in organic matter, in spite of the high content of organic matter in the top layer of the two soils.

b. For types at same horizon

(1) 0"-6" Horizon ----- Greenwood peat has the highest organic matter, and the Bergland loam has the lowest. The rest of the soils are in between without differences.

(2) 6"-12" Horizon ----- Organic matter in soil code No. 2 3 5 6,1 4,7. The higher organic content in the first three soils is attributed to the characteristic of peat which is naturally high in organic matter. The decreases in organic content of these soils account for the fact of vegetational changes from Marsh to Swamp Shrubs and to Swamp Forest vegetations. The lower organic matter content of the Newton and Bergland soils is due to the mineral origin of the sub-soil. The differences between them are probably due to the variation in thickness of organic surface soils.

(3) 12"-18" Horizon ----- Results of the t-Test show that the three peat soils are higher in organic content than the Newton and Bergland soils. This coincides with the difference between the peat and mineral soils.

7. Soil reaction (p^H)

Most forest soils have an acid reaction. Acidity of the soil may affect tree growth. However, certain species particularly of the family Ericaceae, grew best on acid soil.

Under conditions of poor drainage, highly acid conditions are apt to develop. Weaver and Clements (1938) stated that "In soils of organic origin, basic salts are present in only small amount. The soil develops more or less marked acidity as the result of the accumulation of humus under conditions of poor aeration and sometimes by the setting free of acid from the mineral constituents of the soils."

The Beckman p^H meter was used in the determination of the soil acidity in this study. Twenty-one samples in duplicate were tested. For the organic soils, soil-water ratio of 1:10 by weight, and 5 grams air-dry soil samples were used. For the mineral soils, 10 grams of soil at soil-water suspensions of 1:5 by weight were employed for the determination. The higher soil-water ratio for the organic soils was necessary to make better contact between the soil and the glass electrode. The use of a small amount of organic soil for samples was made possible by their high percentages of organic content.

A series of soil samples were weighed up and to each sample the required amount of water was added. The soil suspensions were stirred for one minute, and the p^H determined. Laboratory results are shown in Table 26.

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Table 25. Soil reaction (pH values) of the seven soils by horizon.

Soil Type	Code No.	Horizon	Replications		Average
			I	II	
Newton sand	1	0"-6"	4.98	4.95	4.96
		6"-12"	4.65	4.55	4.60
		12"-18"	3.75	3.65	3.70
Greenwood peat	2	0"-6"	4.55	4.55	4.55
		6"-12"	4.48	4.38	4.43
		12"-18"	4.22	4.32	4.27
Rifle peat	3	0"-6"	6.20	6.22	6.21
		6"-12"	6.06	6.12	6.09
		12"-18"	5.78	5.78	5.78
Newton sand	4	0"-6"	5.65	5.56	5.60
		6"-12"	6.40	6.25	6.32
		12"-18"	6.45	6.25	6.35
Rifle peat	5	0"-6"	6.15	6.15	6.15
		6"-12"	6.02	6.15	6.08
		12"-18"	5.35	5.28	5.32
Bergland loam	6	0"-6"	5.75	5.70	5.73
		6"-12"	6.25	6.35	6.30
		12"-18"	6.40	6.60	6.50
Bergland clay loam	7	0"-6"	5.25	5.20	5.23
		6"-12"	5.52	5.55	5.54
		12"-18"	5.85	6.15	6.00

Statistical analysis has been carried out for five of the seven soils tested. The arbitrary horizons of 6 inches interval in this study are set up primarily for the organic soils (Azonal) which are undifferentiated in natural horizons.

In this experiment, if both the Bergland soils are thrown in for statistical analysis, erroneous results would

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be produced because of the different thickness in the corresponding horizons of these two structurally similar soils. Therefore, only one of the two is being analyzed. The same applies to the Newton soils.

Table 27. Analysis of variance for the soil reaction data of five soils by horizon.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F
Total	29	2200.97	75.90	
Between Replications	1	0.04	0.04	0.11
Between Soil Types	4	1848.14	462.04	1248.76**
Error (a)	4	1.46	0.37	
Between Soil Horizons	2	112.27	56.14	93.57**
Interaction Between T & H	8	233.06	28.51	47.52**
Error (b)	10	6.00	0.60	

**Denotes significant at 1% level.

Analysis of variance in Table 27 shows a highly significant difference between the five soil types as well as between horizons. The t-Test gives further results as follows:

a. For different soil types ----- The two soils of the Open-meadow type (Greenwood peat and Newton sand) were strongly acid in reaction, followed by the two Rifle peat soils. No difference was found between the former two soils, whereas the Rifle peat of the Swamp Conifer Forest stand was

slightly more acid than the soils of the Swamp Shrub type (significant at 5% level). The Bergland soil of the Swamp Hardwood stand was the least acid and almost neutral in reaction.

b. For different horizons ----- The 12"-18" horizon was significantly more acid (at 1% level) than the top two layers, while there was no difference between the latter two horizons.

This was true for the organic soils and was probably due to the excessive moisture present in the lower layer which in turn caused poorer aeration and less decomposition of plant remains.

As for the Bergland soil, the p^H value increased with increasing depth. This is typical to podzol soils as stated by Lutz and Chandler (1947):

"The H layer or the A horizon in podzols is commonly most acid and the maximum p^H values are commonly encountered in the lower part of the B horizon."

A composite summarization of all the edaphic characteristics for the seven soils by horizon is shown in Table 28.

Table 28. Composite summation of edaphic characteristics of seven soils by horizon.

Soil	Type	Code No.	Horizon	Volume Weight	Porosity in Percent			Organic Matter, pH	
					Non-Ca- pillary	Capil- lary	Total	percent	
Newton sand		1	0"-6"	0.163	37.70	53.66	91.36	49.81	4.96
			6"-12"	0.413	13.06	66.94	80.00	17.69	4.60
			12"-18"	1.583	13.78	31.55	45.33	1.26	3.70
Greenwood peat		2	0"-6"	0.183	36.29	56.48	92.77	67.15	4.55
			6"-12"	0.289	24.76	63.21	87.98	75.03	4.43
			12"-18"	0.305	17.67	67.11	84.78	42.03	4.27
Rifle peat		3	0"-6"	0.217	28.88	53.33	82.21	50.33	6.21
			6"-12"	0.329	15.39	67.46	82.85	58.27	6.09
			12"-18"	0.373	13.04	68.57	81.61	42.88	5.78
Newton sand		4	0"-6"	0.218	39.04	53.03	92.07	48.19	5.60
			6"-12"	1.638	16.69	21.26	37.95	1.04	6.32
			12"-18"	1.734	8.67	23.49	32.16	0.89	6.35
Rifle peat		5	0"-6"	0.160	31.57	59.65	91.22	44.22	6.15
			6"-12"	0.177	25.79	62.77	88.56	44.15	6.08
			12"-18"	0.187	16.92	72.01	88.93	41.89	5.32
Bergland loam		6	0"-6"	0.160	22.74	67.69	90.43	38.30	5.73
			6"-12"	0.225	19.42	74.87	94.29	26.91	6.30
			12"-18"	0.503	14.58	60.95	75.53	1.58	6.50
Bergland clay loam		7	0"-6"	-----	-----	-----	-----	40.31	5.23
			6"-12"	-----	-----	-----	-----	3.55	5.54
			12"-18"	-----	-----	-----	-----	1.32	6.00

C. Biotic factors

In this paper, biotic factors are considered under three groups: (1) Insects and diseases, (2) Animals, and (3) Men. No attempts have been made toward detailed studies of these factors because they were not believed to significantly influence forest succession on the poorly-drained soils of this region. Only those observed to be relatively important were covered.

1. Insects and diseases

Generally speaking, most of the insects and diseases have species preferences or at least do not injure all species equally. This may be due to the composition and age-pattern of the forest. Therefore swamp forests which are mixed in composition and uneven-aged in most cases probably will not be subjected to great insect damage.

Some of the insects and diseases have had their epidemic periods. However, unusual damages were not reported in this region. Some of the common ones have been observed but were not to be considered destructive, at least from the ecological standpoint. Important ones encountered in the field were:

a. Insects

(1) Spruce budworm (*Choristoneura fumiferana* Clem.)

The spruce budworm is native to North America. Destructions caused by this pest to the spruce and fir have

been great according to Brown, MacAloney, and Dowden (USDA Yearbook, 1949). Outbreaks of this insect has been recorded in Maine in 1910, in Minnesota in 1913, and more recently in Canada in 1935 and 1944. No report of unusual abundance of the budworm has been received from the Lake States. However, light defoliations caused by this insect has been noted in the Higgins Lake region.

Upon the study of the biology and feeding habit of the spruce budworm, white and black spruce appeared to suffer less from attack than red spruce and balsam fir. And because spruce is far more valuable for lumber and pulp than balsam fir, it has been cut more heavily and its proportion in the forests has thus been reduced. Balsam fir is far more aggressive than spruce in seeding-in after logging operation, fire, or wind damage. Man's activity and the spruce budworm, therefore have often contributed to a gradual conversion from a forest containing a high percentage of spruce to one in which balsam fir predominates and which is far more favorable for the spruce budworm.

Three silvicultural practices can be done to increase the resistance of the forest to spruce budworm attack: (a) To clear cut mature and over-mature balsam fir stands, (b) To operate balsam fir stand on a short rotation, and (c) To try to increase the proportion of spruce in the stand.

(2) Larch sawfly (*Lygaeonematus erichsonii*)

The larch sawfly is the most important sawfly to attack conifers. From time to time, it appears in destructive numbers, defoliating extensive areas of tamarack, and it may also attack some other trees and shrubs.

Westveld (1949) and others have stated that the tamarack type was almost completely destroyed by this insect many years ago. In this area, some of the tamaracks in the Swamp Conifer Forests are the victims of this pest.

According to Doane (1936): "Little can be done toward controlling this insect in the swamp areas. ----- Importation of one of the European parasites has been evidently proved successive in Manitoba (Watson, 1931)."

b. Diseases

The important diseases pertaining to the swamp forests can be grouped into decay (or rots) and cankers. Fungi are the causal agents for both groups. In addition to the loss of merchantable timber, trees weakened by the rots or cankers are much more easily broken off and therefore these diseases indirectly disturb the original stand characteristic and composition.

The common diseases either being observed or believed to be present in the swamp forest of this region are listed by their causal agents and the host species:

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<u>Organism</u>	<u>Damage caused by organism and host species</u>
<i>Armillaria melea</i>	Occasionally cause rot in black spruce, yellow birch, and American elm.
<i>Formes igniarius</i>	Most important in aspen, also attacks yellow birch, to cause white heart rot.
<i>Formes pini</i>	Cause red ring rot in tamarack and black spruce.
<i>Polyporus balsameus</i>	Cause brown butt rot in balsam fir, northern white cedar, and hemlock.
<i>Polyporus schweinitzii</i>	Cause red brown butt rot in black spruce.
<i>Peria subacida</i>	Attacks balsam fir especially.
<i>Stereum sanguinolentum</i>	Cause red heart rot in balsam fir and spruce.
<i>Hypoxylon pruinatum</i>	Common and sometimes fatal in aspen.
<i>Nectria</i> sp.	Common in yellow birch, occasional in red maple, basswood, and American elm.

2. Animals

In general, the forests provide food and cover for wildlife. When there is a reasonable balance between the wildlife population and food supply from the forests, there will be no damage to the forests. However, repeated browsing by over-populated wildlife definitely damages reproduction. Swift (1949) reported that reproduction used most heavily as food by deer was that of maple, oak, northern white cedar, basswood, ash, birch, elm, etc., with prevalence in that order. Of these, northern white cedar, ash, elm, and maple are the important components of the swamp forests.

• The first step in the process of creating a new product is to identify a market need. This can be done through market research, which involves gathering information about the target market and its needs.

• Once a market need has been identified, the next step is to develop a concept for the new product. This involves brainstorming ideas and selecting the most promising one.

• The third step is to create a prototype of the product. This can be done using a variety of methods, including 3D printing, computer-aided design (CAD), and traditional manufacturing techniques.

• Once a prototype has been created, the next step is to test the product. This involves conducting experiments to determine the product's performance and to identify any potential problems.

• The final step in the process is to launch the product into the market. This involves creating a marketing plan and implementing it to promote the product and generate sales.

• The process of creating a new product is a complex one that requires a lot of time and resources. However, it is also a very rewarding process that can lead to the creation of a successful new product.

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3. Men

The effect of man's destruction upon vegetation is visible everywhere. The most important associates of man in the destruction of vegetation are "fire" and "cutting". Although fire occasionally may be caused by lightning by far the greatest number are man caused.

In the early lumbering period, general cutting practice was clear-cutting. Actual evidence supports the fact that in certain sections of the state fires destroyed more merchantable timber than was cut during that period. However, the swamps have not been subjected to burning nearly so often as the uplands. This may attribute to the fact that the swamps are usually wet with less chance for fire to occur. This does not mean there are no fires in the swamps. As we can see during the dry season, the water-table in a coniferous swamp may drop to a low level and this plus the fact that the litter of the swamp stands become readily flammable, may result in fire doing great damage.

Clear-cutting was the common practice in early lumbering period. This will eventually result in a shrubby growth on the site before the reproduction of the original species can re-establish; and this may not be accomplished for a considerable long period of time.

Unfavorable cutting sometimes may alter the stand composition, as for example, when selective logging is employed to remove valuable large black spruce from a coniferous swamp. This will result in the stand being dominated by inferior species such as balsam fir and culled northern white cedar. Eventually the unsuitable cutting operation will disturb the natural sequence of succession either progressively or retrogressively.

Secondary succession begins when the original stands are burned or otherwise denudated through some other agents such as destructive cutting, epidemic insect or disease damages etc.. Generally speaking, on lightly burned areas, original species such as black spruce or balsam fir of the Swamp Conifers may easily be reestablished in a short time because of favorable regeneration characteristics. On severely burned areas succession may initiate from the sedge-grass stage, the swamp shrub growth of Salix-Cornus-Alnus association, or the Lowland Aspen type. In either case, the subclimax type of Swamp Conifers or the Swamp Hardwoods will replace the temporary types depending upon the original composition and the nature of the soils. On shallow peat with mineral substratum, Swamp Hardwoods will have better chance in succession; whereas on bog or peat soils, Swamp Conifers probably will succeed. Repeated fire generally favors the continuance of Aspen type (Gates, 1930).

FOREST SUCCESSION

Cooper (1913) has divided succession into a series of two types, the xerarch and hydrarch. Hydrarch succession initiates from hydrophytic habitats such as lakes and ponds and becomes more and more mesophytic in its successive stages. This, the hydrarch succession, is the type to be discussed in this study.

Five vegetation types were found on the poorly-drained soils in the Higgins Lake area. They were the Marsh, the Swamp Shrubs, the Swamp Conifers, the Swamp Hardwoods, and the Low-land Aspen. A diagram showing successional relationships between the different vegetation types is shown in Fig. 12. Trends of succession are based on the characteristics of the soils and the occurring vegetation. No attempts were made to study the succession prior to the Marsh type.

A. The Marsh (or Open-Meadow type)

Marshes were found on two types of soils, the boggy Greenwood peat and the swampy Newton loamy sand. These two soils have the common characteristics of being strongly acid in reaction; but they do differ in moisture and organic contents.

The Greenwood peat is comparatively wetter than the Newton loamy sand because the former has a lower volume weight

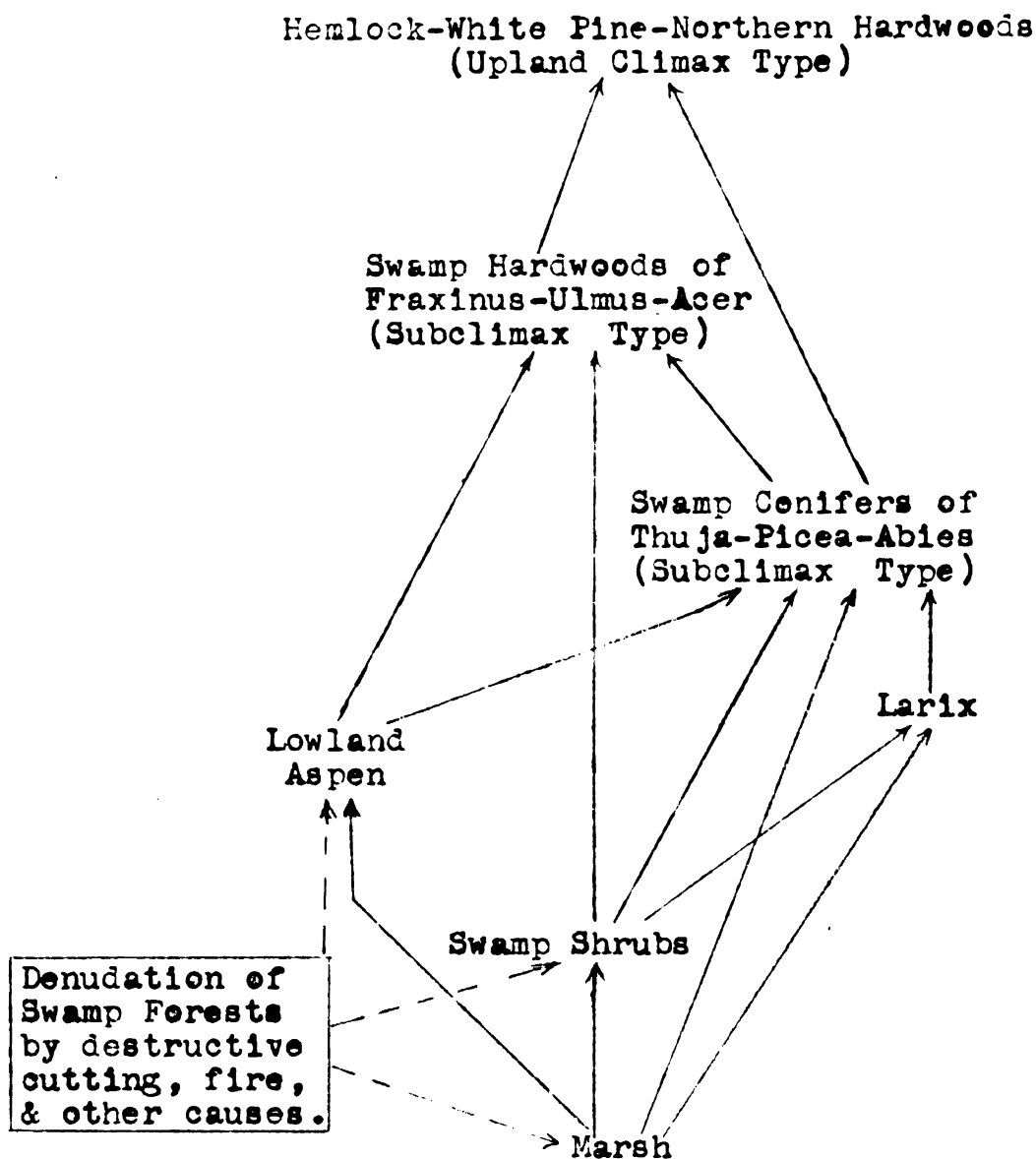


Fig. 12. Diagram showing successional relationships exhibited between the associations of poorly drained soils in the Higgins Lake area. An arrowhead indicates the direction of succession.

and higher capillary porosity, which indicates a higher water holding capacity. This wetter condition can also be verified by the fact that the water-table in the Greenwood peat is very near to the surface as compared to the lower water-table, at about twenty-four inches, in the Newton soil during the drier season.

The organic content of the Greenwood peat is considerably higher than that of the Newton sand. This should be as expected due to the difference between organic and mineral soils. The shallower organic layer on top of the wet sand of the Newton soil indicates its better-drained condition than the Greenwood peat which has a deep peat soil column.

The difference in vegetation components is another indication that the vegetation on the Newton soil belongs to a later stage. The plants found on the Greenwood peat are more hydrophytic such as Saxittaria, Alisma, Juncus, Eleocharis, Typha, and the abundance of Sium suave and Cicuta bulbifera. On the Newton soil there is a more luxuriant growth of Salix and the presence of such shrubs as Alnus, Spiraea, and Rubus.

Continuous filling-in onto the Marsh site by the mat forming plants such as sedges, rushes, grasses, cat-tails, etc., will result in one of two possibly successional stages:

1.The Swamp Shrubs, or the Swamp Conifers will succeed on the poorly-drained boggy sites.

2.The Lowland Aspen may succeed on relatively better drained sites as a temporary type and later give way to the Swamp Hardwoods or the Swamp Conifers.

B.The Swamp Shrub type

As the sedge mat gradually invades the poorly-drained peat, shrubby species will invade the Marsh to form a shrub stand which is principally composed of species of Salix, Alnus, and Cornus.

Plants such as Aronia nigra, Potentilla fruticosa, Betula pumila, Spiraea alba, and Rubus hispidus etc., are the indicators of the bog sites. Consequently, the Swamp Conifers of Picea-Abies, or Larix, or a mixture of these species will succeed this type in a longer or shorter period of time.

However, the Swamp Shrubs may also give way to the Swamp Hardwoods of Fraxinus-Ulmus-Acer community on the better drained sites, or on soils of mineral origin.

1

C.Swamp Coniferous Forest

The principal tree species of this type are Thuja occidentalis, Picea mariana, Abies balsamea, and Larix laricina. The Thuja, Picea, and Larix may occur in almost pure stands, on the other hand, they may occur in mixtures of any proportions.

This type may directly replace the Marsh vegetation whenever it is able to become established. However, it is more apt to succeed the Swamp Shrub type.

Larix is a rapid growing, short lived, deciduous coniferous species. It usually invades the open, burned over boggy sites as a pioneer species due to its shade intolerant character. Generally the Larix forms a pure stand, and an abundant growth of shrubs usually is found in the stand because they are less densely shaded. In succession, this type will be followed by other tree associations which are able to shade it. The usual ones are the Picea mariana on very wet sites, or the Thuja-Picea-Abies type on comparatively drier sites.

The black spruce (Picea mariana) is the most common tree species to follow the Swamp Shrubs or the Larix in succession due to its ability to withstand shade, excessive soil moisture, and soil acidity. It usually associates with balsam fir and northern white cedar and later as the stand advances will be replaced by the northern white cedar (Gates, 1942).

The Swamp Coniferous forest, especially the Thuja, when left undisturbed and fully developed, will attain a very dense growth so that almost no ground vegetation grows in its shade. However, in openings, a great number of plants of different genera do occur.

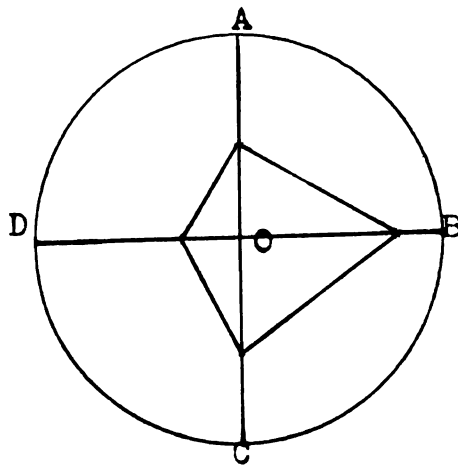
Thuja is a subclimax type in the region, considering the Hemlock-White Pine-Northern Hardwoods being the climax type on the well-drained, mesophytic, uplands. Without pronounced changes in drainage, Thuja would probably maintain its composition for some time to come. As Gates (1942) has stated the Thuja association is the subclimax type in boggy areas. He pointed out that the ultimate outcome would be the upland vegetation if the addition of soil material or a lowering of water-table converts the site to that of the upland.

Zasada (1952) in study the reproduction on cut over swamplands in the upper peninsula of Michigan, has come up with the conclusion that "----- the important species in the peat swamp was black spruce, but after logging reproduction of black spruce is poor. Reproduction on the muck soils contains much less northern white cedar than the original stand. On the wet mineral soils, the stocking of conifers is decidedly lower than the original forest. ----- Hardwood invasion is common on all swamp soils. -----"

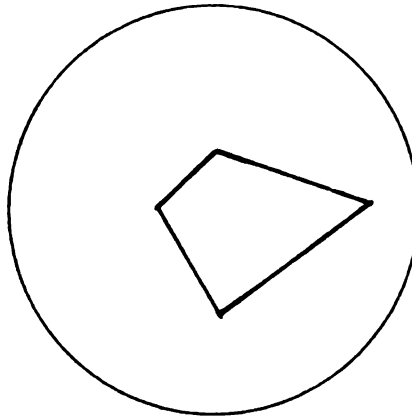
Westveld (1948) stated that the black spruce and northern white cedar are suffering from competition of hardwoods when the latter do appear in the composition because of the fast growth of the hardwoods in the early stage which more or less suppresses the reproduction of the conifers.

These lead me to believe that, on the Swamp Conifer sites, as time goes on, the Swamp Hardwoods, probably the Fraxinus-Ulmus-Acer community, will eventually replace the original conifers before reaching the mesophytic climax type of the upland.

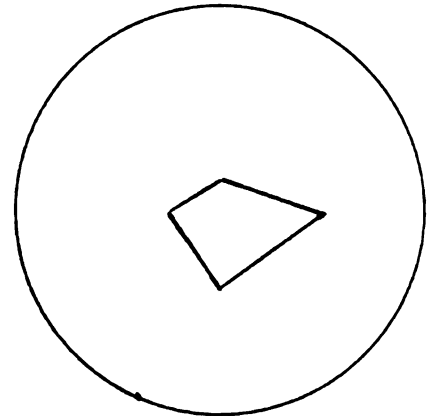
Results from the vegetation analysis of the Swamp Conifers (Table 4) show that the balsam fir is the predominating species, followed by the northern white cedar, tamarack, black spruce, red maple, and yellow birch in that order. Phytographs of these dominant species are shown in Fig. 13.



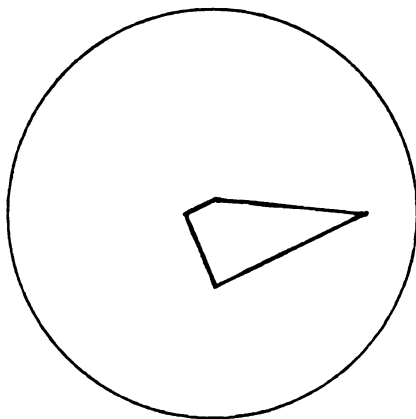
Balsam Fir



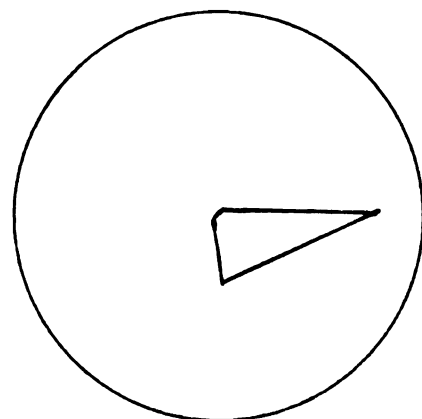
N. White Cedar



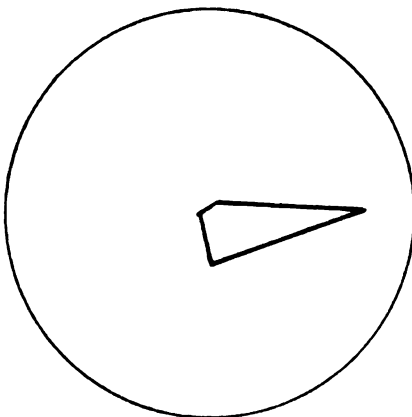
Tamarack



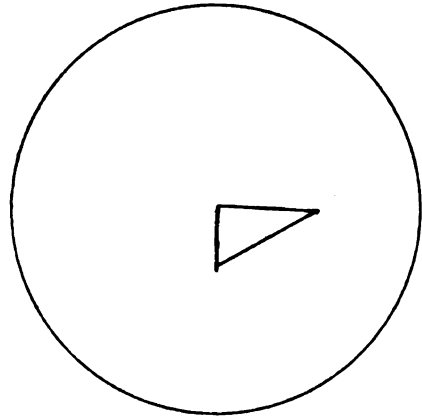
Black Spruce



Red Maple



Yellow Birch



Black Cherry

OA --- Percentage of relative density
 OB --- Percentage of total frequency
 OC --- Percentage of Size Class distribution
 OD --- Percentage of relative basal area

Fig. 13 Phytographs of the important species of the Swamp Coniferous Forest type.

D. Swamp Hardwoods of Fraxinus-Ulmus-Acer association

The Swamp Hardwoods in this region occurs commonly on these swamp areas that are occupied by soils which have a better decomposed, relatively shallow, peaty organic layer on a mineral substratum. These soils are better-aerated and less acid than those of the bog sites. The stands contain species of both the swamp conifers and the upland hardwoods, generally with the hardwood species dominating.

Table 29. Data of relative frequency, relative density, and relative basal area of the dominant components of the Swamp Hardwoods.**

Species	Rel.Freq.	Rel.Den.	Rel. B.A.	I.V.*
Black and Green Ash	21.0	44.7	27.0	92.7
Red and Silver Maple	13.2	11.9	33.3	58.4
American & Slippery Elm	18.4	9.7	28.6	56.7
Northern White Cedar	7.9	16.0	10.3	34.2
Balsam Fir	7.9	8.2	3.2	19.3
Yellow & Sweet Birch	7.9	2.5	2.8	13.2
Basswood	5.4	3.3	2.7	11.4
Hemlock	2.6	0.5	0.4	3.5

**Produced from Table 2.

*Designates Importance Value which is the sum of relative frequency, relative density, and relative basal area.

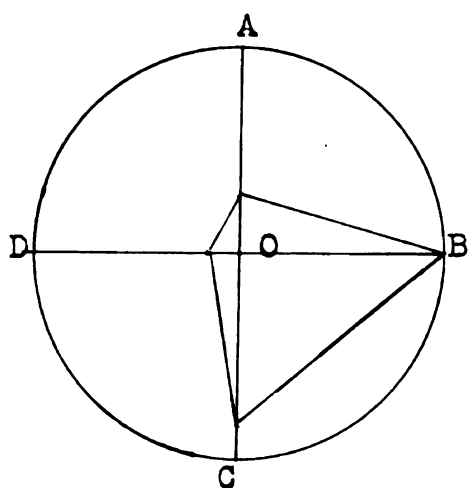
Table 29 shows the result of a vegetation analysis of the Swamp Hardwoods. The ashes (Black and green) are

predominating, followed by the maples (red and silver), the elms (American and slippery), northern white cedar, balsam fir, the birches (yellow and sweet), basswood, and hemlock in that order. Phytographs of these dominant species are shown in Fig. 14.

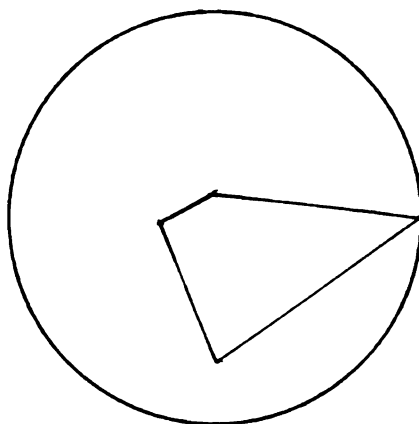
From the standpoint of soil development, the Swamp Hardwood is more apt to be an advanced type that succeeds the Lowland Aspen or the Swamp Shrubs of the relatively better-drained mineral soils of the river and stream banks. In many cases, the Swamp Hardwoods are found on depressions or flat areas bordering the swamps and bogs and connected on the other side to the uplands. Therefore, geographically, it occurs on sites which are intermediate between the swamps and the uplands. Whereas from the standpoint of the vegetation itself, the Swamp Hardwood type is composed of both the swamp coniferous species and the upland hardwood species which shows a true transition between the Swamp Conifers and the Hardwood Upland.

Gates (1942) pointed out that "Whenever boggy or wet ground has been cut over or burned over there is a possibility of the development of the lowland forest association of Fraxinus nigra and Acer rubrum. Only those of Thuja occidentalis are expected to result in succession, unless the area is being changed from a lowland to upland. In the latter case the upland hardwood species more frequently invade and attain dominance."

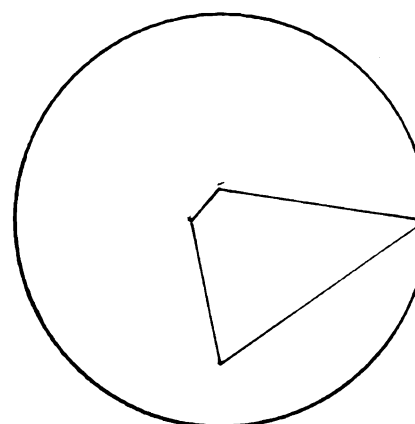
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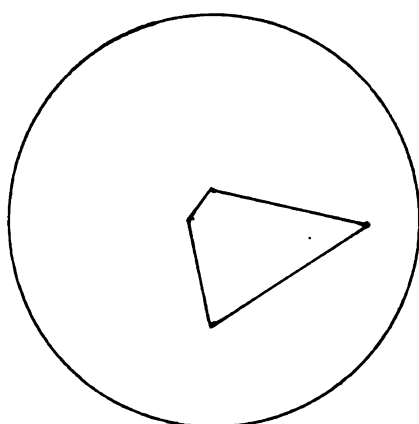
Black Ash



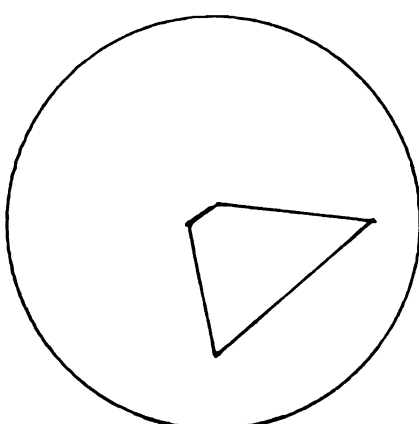
Red Maple



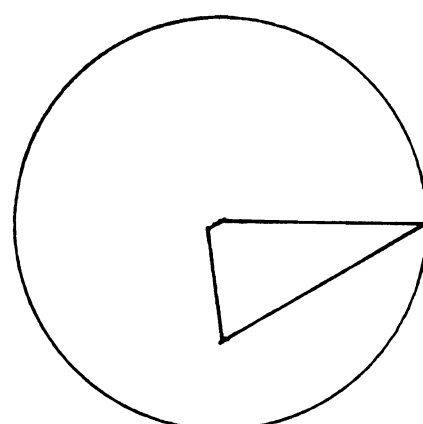
Green Ash



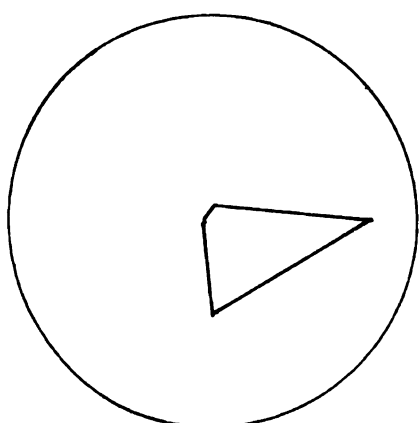
N. White Cedar



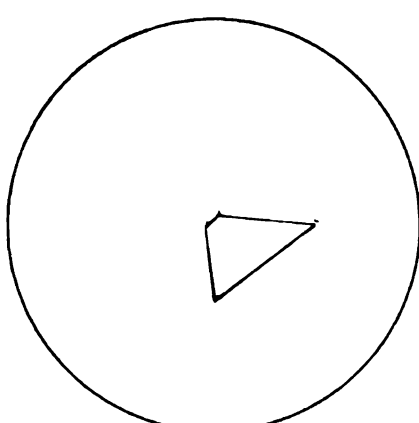
Slippery Elm



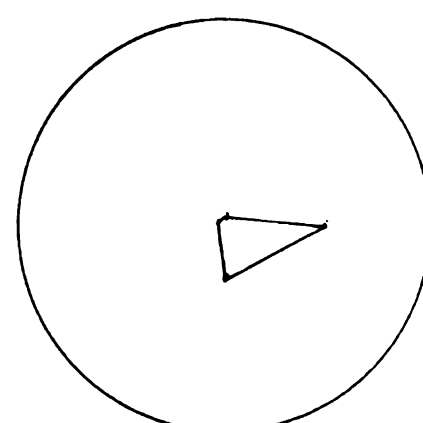
American Elm



Balsam Fir



Basswood



Yellow Birch

OA --- Percentage of relative density
 OB --- Percentage of total frequency
 OC --- Percentage of Size Class distribution
 OD --- Percentage of relative basal area

Fig. 14 Phytographs of the important species of the Swamp Hardwoods type.

Braun (1950) has discussed the Swamp Hardwoods as the river swamp community occurring on the wet but better drained habitat, and stated that on better-drained sites, a few additional hardwood species may enter into the present Elm-Ash-Maple communities, suggesting its replacement under good drainage conditions by mesophytic hardwood forest.

It is probable that the Swamp Hardwood type will succeed the Lowland Aspen or the Swamp Shrubs of Salix-Cornus-Alnus type on better-drained mineral soils of the swamps (Gates, 1942). And it may also invade the Swamp Conifers of Thuja-Abies-Picea stand when the drainage improves and soil reaction is not too acid.

The Swamp Hardwoods type is a subclimax on the poorly drained sites of the region. Without pronounced changes in climate and drainage, this type will perpetuate and remain for a relatively long period of time before the upland hardwoods can be established.

E. The Lowland Aspen type

This type is characterized by the dominance of Populus tremuloides, the trembling aspen. Inception of this type can be of two possibilities:

1. It succeeds the Marsh on the relatively better-drained soils, as a temporary type. After a relatively short period of time it will give way to either the Swamp Conifers or the Swamp Hardwoods.

2. It is established as a temporary fire type after an area of swamp forests, most commonly the Swamp Conifers, is burned over. Gates (1942) stated that an Aspen association developing on an area following one or two fires usually gives place to a higher genetic association in a comparatively short time. While further fires favor the continuance of the Aspen association. He pointed out the Thuja association may enter immediately and replace the Aspen association in twelve to twenty years, or a mixture of spruce-balsam fir will succeed in an even shorter time. The Swamp Hardwoods of Ash-Elm community may also replace the aspen sometimes.

Usually the original type previously occupying the site will replace the aspen in secondary succession.

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SILVICULTURAL CONSIDERATIONS

Five types of vegetation were recognized on the poorly-drained soils in the area: The Swamp Hardwoods, the Swamp Conifers, the Lowland Aspen, the Swamp Shrubs, and the Marsh. Silvicultural treatments are here considered only for the former three types.

Since both the Swamp Hardwoods and the Swamp Conifers are the physiographic, subclimax type, they are able to perpetuate easily if they be left undisturbed and without profound changes in environment. However, men are interested in growing and harvesting the desirable species for use, suitable silvicultural treatments must be adapted in order to do so.

A. Swamp Hardwood type

The Swamp Hardwoods type is being recognized as the most advanced forest type on the poorly-drained soils in the region. The major species of the type were the American and slippery elm, red or silver maple, black and green ash, with some associated species of basswood, northern white cedar, yellow birch, among others. Due to the excessive moisture of the soil, these species were not as well developed as those on the upland sites. At the present time, most of the stands were uneven-aged, mature, and well stocked with advance growth of red maple, ash and elm.

In the past, logging was carried out on a selective basis to remove merchantable and desirable species. Due to the fact that this type occurs mostly in small tracts bordering larger, conifer swamps, intensive silviculture will probably not pay.

Westveld (1949) suggested clear cutting followed by improvement cutting or thinning for this type. It was based on the easiness of the establishment of reproduction. More recently, Eyre and Zilligitt (1953) proposed partial cuttings for Northern Hardwoods in the Lake States which I believe can well be applied to the Swamp Hardwood type. However, due to the shallow root systems of some of the species, resulting from excessive soil moisture, only light partial cuttings should be employed.

B. Swamp Conifers type

The Swamp Coniferous stands occurred both as even- and uneven-aged in the area. Due to the generally high density of the even-aged trees, there was a wide variation in the size of individual trees, giving an uneven-aged appearance.

The principal species of this type were the black spruce, balsam fir, and northern white cedar. Black spruce and balsam fir are chiefly used for pulpwood, and the northern white cedar is mainly used for poles, posts and shingles. The associated species of tamarack and hardwoods have little commercial value..

Lebarron (1948) suggested clear cutting in strips, the removal of 50 to 75 feet strip along the leeward side of the stand at 1 to 3-year intervals, for the even-aged, thrifty, black spruce stands. As for the defective, over-matured stands, clear cutting was suggested. He stated that reproduction is usually adequate, and it can be improved by slash disposal as piling to expose more soil surface, and by prevention of logging damage to advance reproduction.

C.Lowland Aspen type

This is a temporary, or fire type on the poorly-drained sites. In this area, the stands were even-aged and mostly under-stocked.

Eventually either the Swamp Conifers or the Swamp Hardwoods will replace this type depending on the available seed trees near by or the advanced reproduction already on the site.

The Aspen usually lasts for a single generation because it is very intolerant and easily susceptible to diseases. Therefore, on stands having advanced growth, clear cutting is probably the only method to regenerate this type. Whereas on stands lacking desirable advanced reproduction, conversion of the stand to that of desirable species by clear cutting and planting was suggested by Westveld (1949).

SUMMARY

The Higgins Lake area is located in the northern central part of the lower peninsula of Michigan. Ecologically, it is within the Hemlock-White Pine-Northern Hardwoods Formation as defined by Nichols (1935), Braun (1950), among others.

General description and history of the area is reviewed. Climate, geology, soils, and cover types of the area are also discussed.

Five types of vegetation were recorded on the poorly-drained soils in the area. They were: (1)The Marsh or Open-meadow type, (2)the Swamp Shrubs of the Salix-Cornus-Alnus Association, (3)the Lowland Aspen of Populus-Salix Association, (4)the Swamp Coniferous forest, and (5)the Swamp Hardwood forest. Vegetation inventory was carried out in the summer of 1952. Quadrats of three sizes were used for the vegetation study, i.e., 1/5 acre quadrat for tree vegetation; 1/10 acre quadrat for shrub vegetation; and 1/1000 or milacre quadrat for vegetation below 6 feet tall, the herbaceous layer.

Ecological factors were considered in three groups: (1)Climatic, (2)Edaphic, and (3)Biotic. Among the climatic factors discussed, temperature, relative humidity, precipitation, and evaporation, evaporation is believed to show the combined effect of the other three. Data of evaporation rates in three different vegetation type were obtained by using Livingston atmometers. Results show that the evaporation

rate decreases from Marsh to Swamp Shrubs and to Swamp forest. This indicates that although the forest cover may be the cause of the lower evaporation, but the higher evaporation rate in the Marsh may still be an important factor in retarding the establishment of forest cover on that area.

Soils of all the quadrats were investigated in the field, seven soil samples belong to three soil series were encountered and were taken into laboratory. They belonged to five soil types: the Newton sand, Bergland loam, Bergland clay loam, Rifle peat, and Greenwood peat. On each of the two samples of the Newton sand and the Rifle peat, different types of vegetation were found. Samples of each soil by horizon were collected to determine their characteristics. The following properties were determined in laboratory experiments: (1) Soil volume weight, (2) Soil porosity, (3) Organic matter content of the soil, and (4) Soil reaction. Soil temperature and soil moisture were determined in the field. Statistical analyses were used to analyze all the laboratory data which give the following results:

1. No differences between the volume weight of the soils.
2. No differences between the total porosity of the soils.
3. The Newton sand had a lower capillary porosity than the other soils.
4. Soil moisture content is believed to be very high in the Marsh type which has a water-table near the surface. The

available data from the field determinations for the two vegetation types show that the moisture content in the Swamp Shrubs type was higher than in the Swamp Conifer type. This leads to the belief that soil moisture content decreases from the Marsh to the Swamp Shrubs and to the Swamp Forest.

5. Soil temperature was relatively constant between the Swamp Shrubs type and the Swamp Coniferous forest.
6. The peaty soils had higher organic matter contents than the mineral soils, with the Greenwood peat of the Marsh type having the highest percentage.
7. Soils of the Marsh type were strongly acid in reaction, followed by the two Rifle peat soils of the Swamp Shrubs type and the Swamp Coniferous forest. The Bergland soil of the Swamp Hardwood type was the least acid and almost neutral in reaction.

Biotic factors are discussed under three groups: (1) Insects and diseases, (2) Animals, and (3) Men. Biotic factors are not believed to be of great significance to influence the forest succession on the poorly-drained soils in this area. The most important one is probably the fire which will induce secondary succession.

Diagram of forest succession on the poorly-drained soils in this area is shown in Fig. 14. The principal trend of succession is believed to be that from Marsh to Swamp Shrubs type to Swamp Conifers to Swamp Hardwoods and finally

after a relative long period of time to the upland, mesophytic, climax type of the Hemlock-White Pine-Northern Hardwoods. The Lowland Aspen type is believed to be the fire or temporary type after the original forest has been burned-over or otherwise denuded. The Larix type is believed to be a temporary type prior to the Swamp Conifers. The Swamp Hardwoods, the Swamp Conifers of Thuja-Abies-Picea, and the Marsh type are all to be the subclimax type to the region.

Silvicultural treatments are considered for the three forest types, the Swamp Hardwoods, the Swamp Conifers, and the Lowland Aspen type. Light partial cutting is believed to be a good measure for the Swamp Hardwood type. Clear cutting in strips is suggested for the Swamp Conifer type. Clear cutting is probably the only method for the Lowland Aspen type.

APPENDIX A

List of common names of plants used with scientific equivalents

- Alder, green ---- Alnus sinuate (Reg.) Rydb.
 Alder, speckled ---- Alnus rugosa (Du Roi) Spreng.
 Ash, black ---- Fraxinus nigra Marsh.
 Ash, green ---- Fraxinus pennsylvanica Marsh.
 Aspen, trembling ---- Populus tremuloides Michx.
 Basswood ---- Tilia americana L.
 Birch, swamp ---- Betula pumila L.
 Birch, sweet ---- Betula lenta L.
 Birch, yellow ---- Betula lutea Michx, f.
 Bluejoint ---- Calamagrostis canadensis (Michx.) Nutt.
 Cat-tail ---- Typha latifolia L.
 Cedar, northern white ---- Thuja occidentalis L.
 Cherry, black ---- Prunus serotina Ehrh.
 Cherry, choke ---- Prunus virginiana L.
 Cherry, fire ---- Prunus pensylvanica L. f.
 Dogwood, red osier ---- Cornus stolonifera Michx.
 Elm, American ---- Ulmus americana L.
 Elm, rock ---- Ulmus thomasii Sarg.
 Elm, slippery ---- Ulmus rubra Muhl.
 Fern, royal ---- Osmunda regalis L.
 Fir, balsam ---- Abies balsamea (L.) Mill.
 Hemlock ---- Tsuga canadensis (L.) Carr.
 Hornbeam, American ---- Carpinus caroliniana Walt.

Maple, red ---- Acer rubrum L.
Maple, silver ---- Acer saccharinum L.
Oak, northern red ---- Quercus rubra L.
Pine, eastern white ---- Pinus Strobus L.
Spruce, black ---- Picea mariana (Mill.) BSP.
Tamarack ---- Larix laricina (Du Roi) K. Koch
Tea, Labrador ---- Ledum groenlandicum Oeder.
Willow, heart-leaf ---- Salix eriocephala Michx.
Willow, long-beaked ---- Salix bebbiana Sarg.

APPENDIX B

List of plants encountered in making the vegetation study in the Higgins Lake area.

TREES

1. Abies balsanea (L.) Mill.
 2. Acer rubrum L.
 3. Acer saccharinum L.
 4. Betula lenta L.
 - **5. Betula lutea Michx. f.
 6. Carpinus caroliniana Walt.
 7. Fraxinus nigra Marsh.
 - *8. Fraxinus pennsylvanica Marsh.
 9. Larix laricina (Du Roi) K. Koch
 10. Picea mariana (Mill.) BSP.
 11. Pinus Strobus L.
 12. Populus tremuloides Michx.
 13. Prunus serotina Ehrh.
 - *14. Quercus rubra L.
 15. Thuja occidentalis L.
 16. Tilia americana L.
 17. Tsuga canadensis (L.) Carr.
 18. Ulmus americana L.
 19. Ulmus thomasi Sarg.
 20. Ulmus rubra Muhl.
- **Betula alleghaniensis Britton in "Check List of Native and Naturalized Trees of the United States (Including Alaska)"
*After the "Check List" (U.S.D.A.F.S. Handbook No.41,1953)

2. The second part outlines the specific procedures for handling sensitive information. It states that all data must be stored securely and accessed only by authorized personnel. This section also covers the protocols for data retention and disposal, ensuring that information is not kept longer than necessary and is properly destroyed when no longer needed.

3. The third part addresses the issue of communication and collaboration. It encourages open communication between all parties involved and highlights the importance of regular meetings and updates. This section also discusses the use of technology to facilitate communication and the importance of clear, concise reporting.

4. The fourth part focuses on the overall management and oversight of the project. It discusses the role of the management team in setting goals, monitoring progress, and making decisions. It also covers the importance of regular reporting and the need for flexibility in the face of changing circumstances.

5. The fifth part discusses the importance of risk management. It identifies potential risks and outlines strategies to mitigate them. This section also covers the importance of having a contingency plan in place and the need for regular risk assessments.

6. The sixth part discusses the importance of stakeholder engagement. It identifies the key stakeholders and outlines strategies to engage them effectively. This section also covers the importance of clear communication and the need for regular updates.

7. The seventh part discusses the importance of documentation. It outlines the types of documents that should be created and maintained, and the importance of keeping them up-to-date. This section also covers the importance of having a clear system for organizing and storing documents.

8. The eighth part discusses the importance of training and development. It outlines the need for ongoing training and development for all staff, and the importance of having a clear system for identifying and addressing training needs.

9. The ninth part discusses the importance of evaluation and feedback. It outlines the need for regular evaluation of the project and the importance of having a clear system for collecting and analyzing feedback.

10. The tenth part discusses the importance of compliance. It outlines the need for ensuring that all activities comply with relevant laws and regulations, and the importance of having a clear system for monitoring and reporting compliance.

SHRUBS AND VINES

1. Acer spicatum Lam.
- *2. Alnus sinuata (Reg.) Rydb.
3. Alnus rugosa (Du Roi) Spreng.
4. Amelanchier arborea (Michx. f.) Fern.
5. Amelanchier intermedia Spach
6. Amelanchier sp.
- *7. Aronia nigra Britt.
8. Asclepias incarnata L.
9. Betula pumila L.
10. Clematis virginiana L.
11. Cornus alternifolia L. f.
12. Cornus stolonifera Michx.
13. Corylus cornuta Marsh.
14. Gautheria procumbens L.
15. Ilex verticillata (L.) Gray
16. Ledum groenlandicum Oeder.
17. Linnaea borealis var. americana (Forbes) Rehd.
18. Lonicera canadensis Bartr.
19. Lonicera oblongifolia (Goldie) Hook.
20. Lonicera villosa var. solonis (Eat.) Fern.
21. Mitchella repens L.
22. Nemopanthus mucronata (L.) Trel.
23. Parthenocissus inserta (Kerner) K. Fritsch.
24. Potentilla fruticosa L.
25. Prunus avium L.

*After "Check List".

1. The first step in the process of the scientific method is to ask a question.
2. The second step is to do background research.
3. The third step is to form a hypothesis.
4. The fourth step is to test the hypothesis by conducting an experiment.
5. The fifth step is to analyze the data and draw a conclusion.
6. The sixth step is to communicate the results of the experiment.
7. The seventh step is to repeat the experiment to verify the results.
8. The eighth step is to publish the results of the experiment.
9. The ninth step is to have the results of the experiment reviewed by other scientists.
10. The tenth step is to use the results of the experiment to develop a theory.
11. The eleventh step is to use the theory to make predictions.
12. The twelfth step is to test the predictions.
13. The thirteenth step is to refine the theory based on the results of the test.
14. The fourteenth step is to use the refined theory to make new predictions.
15. The fifteenth step is to test the new predictions.
16. The sixteenth step is to refine the theory again based on the results of the test.
17. The seventeenth step is to use the refined theory to make new predictions.
18. The eighteenth step is to test the new predictions.
19. The nineteenth step is to refine the theory again based on the results of the test.
20. The twentieth step is to use the refined theory to make new predictions.
21. The twenty-first step is to test the new predictions.
22. The twenty-second step is to refine the theory again based on the results of the test.
23. The twenty-third step is to use the refined theory to make new predictions.
24. The twenty-fourth step is to test the new predictions.
25. The twenty-fifth step is to refine the theory again based on the results of the test.
26. The twenty-sixth step is to use the refined theory to make new predictions.
27. The twenty-seventh step is to test the new predictions.
28. The twenty-eighth step is to refine the theory again based on the results of the test.
29. The twenty-ninth step is to use the refined theory to make new predictions.
30. The thirtieth step is to test the new predictions.
31. The thirty-first step is to refine the theory again based on the results of the test.
32. The thirty-second step is to use the refined theory to make new predictions.
33. The thirty-third step is to test the new predictions.
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35. The thirty-fifth step is to use the refined theory to make new predictions.
36. The thirty-sixth step is to test the new predictions.
37. The thirty-seventh step is to refine the theory again based on the results of the test.
38. The thirty-eighth step is to use the refined theory to make new predictions.
39. The thirty-ninth step is to test the new predictions.
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42. The forty-second step is to test the new predictions.
43. The forty-third step is to refine the theory again based on the results of the test.
44. The forty-fourth step is to use the refined theory to make new predictions.
45. The forty-fifth step is to test the new predictions.
46. The forty-sixth step is to refine the theory again based on the results of the test.
47. The forty-seventh step is to use the refined theory to make new predictions.
48. The forty-eighth step is to test the new predictions.
49. The forty-ninth step is to refine the theory again based on the results of the test.
50. The fiftieth step is to use the refined theory to make new predictions.
51. The fifty-first step is to test the new predictions.
52. The fifty-second step is to refine the theory again based on the results of the test.
53. The fifty-third step is to use the refined theory to make new predictions.
54. The fifty-fourth step is to test the new predictions.
55. The fifty-fifth step is to refine the theory again based on the results of the test.
56. The fifty-sixth step is to use the refined theory to make new predictions.
57. The fifty-seventh step is to test the new predictions.
58. The fifty-eighth step is to refine the theory again based on the results of the test.
59. The fifty-ninth step is to use the refined theory to make new predictions.
60. The sixtieth step is to test the new predictions.
61. The sixty-first step is to refine the theory again based on the results of the test.
62. The sixty-second step is to use the refined theory to make new predictions.
63. The sixty-third step is to test the new predictions.
64. The sixty-fourth step is to refine the theory again based on the results of the test.
65. The sixty-fifth step is to use the refined theory to make new predictions.
66. The sixty-sixth step is to test the new predictions.
67. The sixty-seventh step is to refine the theory again based on the results of the test.
68. The sixty-eighth step is to use the refined theory to make new predictions.
69. The sixty-ninth step is to test the new predictions.
70. The seventieth step is to refine the theory again based on the results of the test.
71. The seventy-first step is to use the refined theory to make new predictions.
72. The seventy-second step is to test the new predictions.
73. The seventy-third step is to refine the theory again based on the results of the test.
74. The seventy-fourth step is to use the refined theory to make new predictions.
75. The seventy-fifth step is to test the new predictions.
76. The seventy-sixth step is to refine the theory again based on the results of the test.
77. The seventy-seventh step is to use the refined theory to make new predictions.
78. The seventy-eighth step is to test the new predictions.
79. The seventy-ninth step is to refine the theory again based on the results of the test.
80. The eightieth step is to use the refined theory to make new predictions.
81. The eighty-first step is to test the new predictions.
82. The eighty-second step is to refine the theory again based on the results of the test.
83. The eighty-third step is to use the refined theory to make new predictions.
84. The eighty-fourth step is to test the new predictions.
85. The eighty-fifth step is to refine the theory again based on the results of the test.
86. The eighty-sixth step is to use the refined theory to make new predictions.
87. The eighty-seventh step is to test the new predictions.
88. The eighty-eighth step is to refine the theory again based on the results of the test.
89. The eighty-ninth step is to use the refined theory to make new predictions.
90. The ninetieth step is to test the new predictions.
91. The ninety-first step is to refine the theory again based on the results of the test.
92. The ninety-second step is to use the refined theory to make new predictions.
93. The ninety-third step is to test the new predictions.
94. The ninety-fourth step is to refine the theory again based on the results of the test.
95. The ninety-fifth step is to use the refined theory to make new predictions.
96. The ninety-sixth step is to test the new predictions.
97. The ninety-seventh step is to refine the theory again based on the results of the test.
98. The ninety-eighth step is to use the refined theory to make new predictions.
99. The ninety-ninth step is to test the new predictions.
100. The hundredth step is to refine the theory again based on the results of the test.

- 26.Prunus pensylvanica L. f.
- 27.Prunus virginiana L.
- 28.Rhus radicans L.
- 29.Ribes americana Mill.
- 30.Ribes lacustre (Pers.) Foir.
- 31.Ribes trieste Pall.
- 32.Rubus flagellaris Willd.
- 33.Rubus hispidus L.
- 34.Rubus ideaus L.
- 35.Rubus ideaus var. aculeatissimus Regel & Tiling
- 36.Rubus pubescens Raf.
- 37.Salix alba var. vitellina (L.) Stokes
- 38.Salix amygdaloides Anderss.
- 39.Salix bebbiana Sarg.
- 40.Salix discolor Muhl.
- *41.Salix eriocephala Michx.
- 42.Salix lucida Muhl.
- *43.Salix petiolaris J.E.Sm.
- 44.Salix serissima (Bailey) Fern.
- 45.Salix sp.
- 46.Smilax tamnoides var. hispida (Muhl.) Fern.
- *47.Sorbus americana Marsh.
- 48.Spiraea alba Du Roi
- 49.Spiraea latifolia (Ait.) Borkh.
- 50.Vaccinium myrtilloides Michx.
- 51.Vaccinium vacillans Torr.

*After "Check List".

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PTERIDOPHYTES

1. Botrychium dissectum Spreng.
2. Cystopteris bulbifera (L.) Bernh.
3. Dryopteris cristata (L.) Gray
4. Dryopteris cristata var. clintoniana (D.C.Eat.) Underw.
5. Dryopteris spinulosa (O.F. Muell.) Watt.
6. Dryopteris thelypteris (L.) Gray
7. Equisetum palustre L.
8. Equisetum sylvaticum L.
9. Onoclea sensibilis L.
10. Osmunda regalis L.

SEDGES, GRASSES, AND HERBS

1. Azopyron repens (L.) Beauv.
2. Azrostis hyemalis (Walt.) Beauv.
3. Bromus ciliatus L.
4. Bromus purgans L.
5. Calamagrostis canadensis (Michx.) Nutt.
6. Carex comosa Boott.
7. Carex crinita Lam.
8. Carex diandra Schrank
9. Carex intumescens Rudge
10. Carex lasiocarpa Ehrh.
11. Carex tenera Dew.
12. Carex trisperma Dew.
13. Eleocharis obtusa (Willd.) Schultes
14. Glyceria borealis (Nash) Ratchelder
15. Glyceria canadensis (Michx.) Trin.
16. Glyceria pallida (Torr.) Trin.
17. Glyceria striata (Lam.) Hitchc.
18. Juncus canadensis J. Gay
19. Muhlenbergia racemosa (Michx.) BSP.
20. Scirpus cyperinus (L.) Kunth
21. Alisma triviale Furch.
22. Aralia nudicaulis L.
23. Aster junciformis Rydb.
24. Aster lateriflorus (L.) Britt.

- 25.Aster novae-angliae L.
- 26.Aster puniceus L.
- 27.Aster sp.
- 28.Bidens cernua L.
- 29.Bidens frondosa L.
- 30.Campanula aparinoides Pursh.
- 31.Cicuta bulbifera L.
- 32.Circium muticum Michx.
- 33.Clintonia borealis (Ait.) Raf.
- 34.Cortis groenlandica (Oeder) Fern.
- 35.Cornus canadensis L.
- 36.Epilobium glandulosum var. adenocaulon (Haussk.) Fern.
- 37.Epilobium leptophyllum Raf.
- 38.Eupatorium perfoliatum L.
- 39.Eupatorium purpureum L.
- 40.Fragaria vesca L.
- 41.Fragaria virginiana Duchesne.
- 42.Fragaria virginiana var. illinoensis Gray
- 43.Galium aparine L.
- 44.Galium asprellum Michx.
- 45.Galium obtusum Bigel.
- 46.Galium tinctorium L.
- 47.Galium triflorum Michx.
- 48.Galium trifidum L.
- 49.Galium sp.

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- 50.Geum aleppicum var. strictum (Ait.) Fern.
51.Goodyear pubescens (Willd.) R. Br.
52.Habenaria obtusata (Pursh.) Richards.
53.Hypericum boreale (Britt.) Bickn.
54.Impatiens capensis Meerb.
55.Impatiens pallida Nutt.
56.Iris versicolor L.
57.Lemna minor L.
58.Lemna trisulca L.
59.Lycopus americanus Muhl.
60.Lycopus rubellus Moench.
61.Lysimachia nummularia L.
62.Lysimachia terrestris (L.) ESP.
63.Lysimachia thyrsiflora L.
64.Maianthemum canadensis Desf.
65.Mentha arvensis L.
66.Mitella nuda L.
67.Prunella vulgaris L.
68.Pyrola rotundifolia (L.) Desf.
69.Pyrola secunda L.
70.Ranunculus sp.
71.Rumex verticillatus L.
*72.Sagittaria montevidensis Cham. & Schlecht.
73.Scutellaria epilobiifolia A. Hamilton
74.Scutellaria lateriflora L.

*After Gleason, H.A. 1952. New Britton & Brown Illustrated
Flora. The New York Botanical Garden.
Lophotocarpus calycinus in Gray's Manual of Botany.

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- 75. Sium suave Walt.
- 76. Smilacina trifolia (L.) Desf.
- 77. Solidago caesia L.
- 78. Solidago canadensis L.
- 79. Solidago graminifolia (L.) Salisb.
- 80. Solidago missouriensis Nutt.
- 81. Solidago patula Muhl.
- 82. Solidago rugosa Ait.
- 83. Solidago ulmifolia Muhl.
- 84. Solidago uliginosa Nutt.
- 85. Spirodela polyrhiza (L.) Schleid.
- 86. Thalictrum dasycarpum Fisch. & Lall.
- 87. Trientalis borealis Raf.
- 88. Typha latifolia L.
- 89. Veronica scutellaria L.
- 90. Viola blanda Willd.

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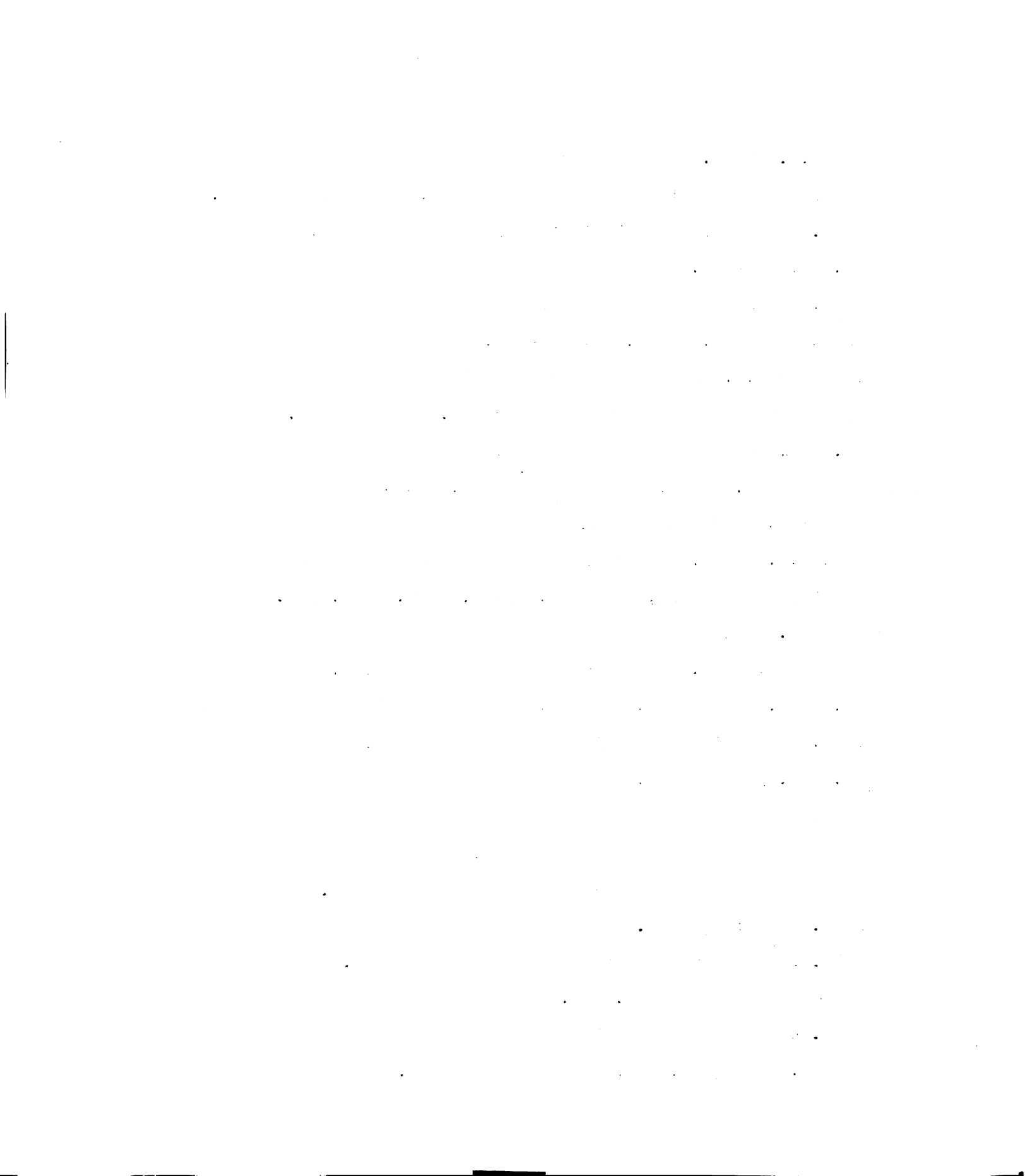
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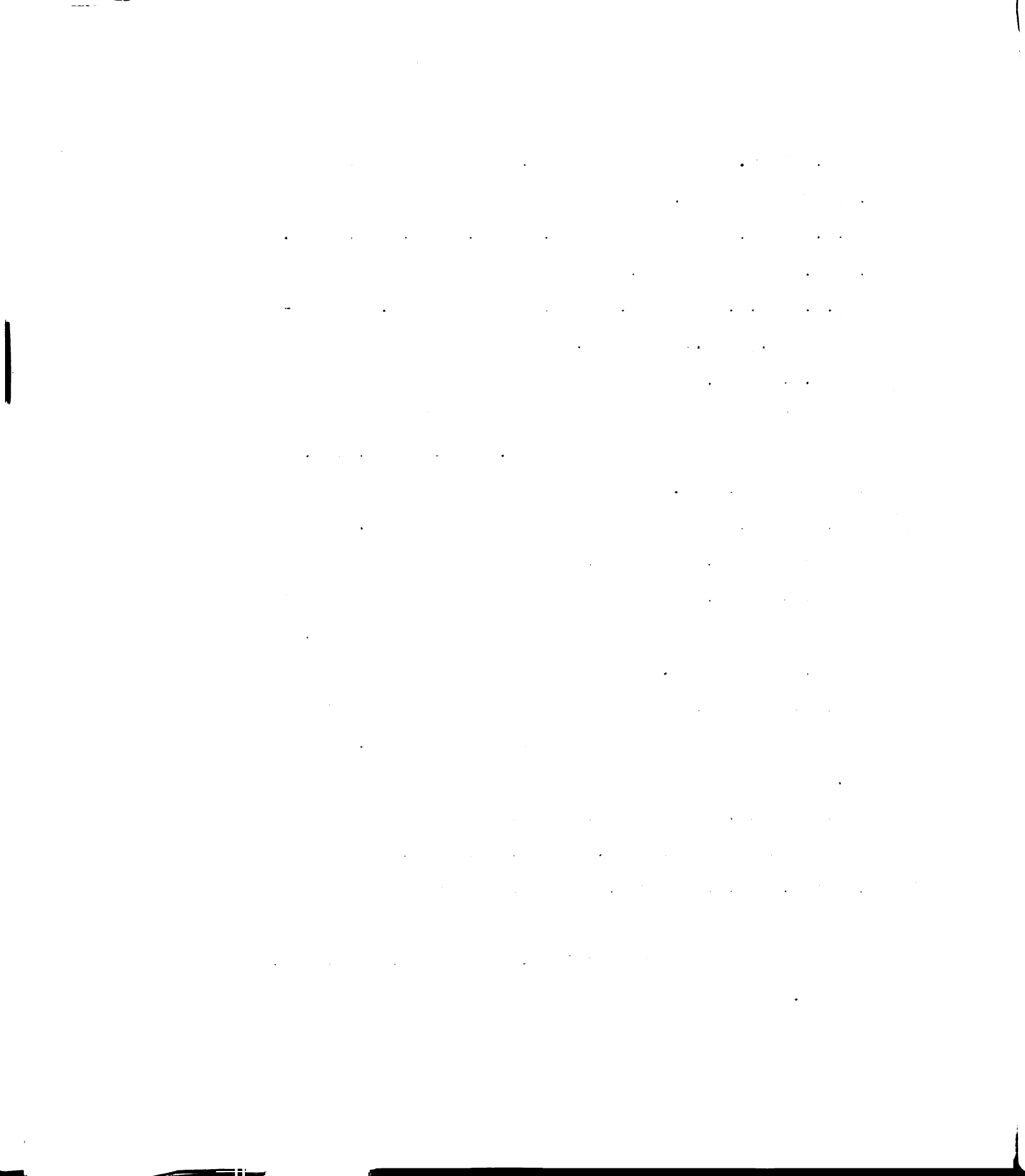
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Plate 3. A Scirpus-Typha stand of the Marsh type. The dominance of cat-tails (Typha latifolia) is indicated by their numerous flowering stems in the fore-ground. An Aspen (Populus tremuloides) stand is in the back ground. In between, willows (Salix sp.) are grown in low bushes to give a patchy appearance.



Plate 4. A Salix-Calamagrostis stand of the Marsh type. An Aspen (Populus tremuloides) stand is in the back ground.



Plate 5. Soil profile of the Newton loamy sand in a Salix-Calamagrostis stand of the Marsh type during the dry season in October. The water-table was down to a depth of approximately 2 feet. The organic peat layer reached down to about $1\frac{1}{2}$ feet.



Plate 6. A typical view of the Swamp Coniferous Forest.



Plate 7. External appearance of the Elm-Soft Maple stand of the Swamp Hardwoods type.



Plate 8. Ground vegetation of the Elm-Soft Maple stand of the Swamp Hardwoods type showing seedlings of maple, elm, and ash. Carex intumescens can be seen in the fore-ground with the inflorescences shown in center of the picture.



Plate 9. Soil profile of the Bergland loam in the Ash-Red Maple-Elm stand of the Swamp Hardwoods type. Water-table was at approximately 10 inches.

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