EXPERIMENTS TESTING A SHOT HOLE TECHNIQUE

WITH SOIL AND GROWTH IN THE VEGETATIONAL COVER

REPORT NO. 5

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by

John P. Boone, Jr.

Student Research Assistant

Experiment Designated to Show the Relationship Between Soil and Changes in the Vegetational Cover

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Introduction

This experiment, which was inaugarated during the summer of 1938, is designed to answer more definitely some of the questions facing present day botanists, foresters, and soil scientists. Some of the more important problems we hope to secure information towards solving are listed as follows:

1. Can a typical forest community be recognized for certain soil types and how closely does the occurrence of the one agree with the extent of the other?

2. Can ground vegetation be used as a measure of site productivity and if so, with what degree of accuracy?

3. If natural succession is allowed to proceed without interference, at what rate will it take place?

4. Is the relation between the dominant and subordinate cover specific enough to make the herbaceous communities valuable as indicators of forest types?

5. Is it possible to predict the forest cover at desired intervals in the future?

6. If a subclimax community is more desirable economically, can it be maintained without too much difficulty? (4)

7. If the successional trends differ with different soil types, what soil site characteristics can the differences be attributed to?

8. In what ways does forest succession influence soil properties

and profile development? If the changes are beneficial, can they be encouraged silviculturally?

9. What changes take place in the forest floor and how do they affect runoff and natural forest regeneration?

10. In the light of what has been learned what soil site characteristics can be used in classifying forest sites?

If feasible the findings will be used in improving forest management.

Permanent plots established on seven of the more important non agricultural soil types occurring in the vicinity of Douglas and Burt Lakes, Cheboygan County, Michigan are serving as the basis for the study.

During the summer of 1938 areas suitable for study were selected and vevetation within the permane nt plots were mapped (1). The following summer soil profile descriptions were written for each of the seven soil types, and samples were taken from each horizon for physical and chemical analyses (2). The 1940 problem deals with description of ground plant occurrence in the vibinity of the permanent plots.

I am greatly indebted to my supervisors, Professors F.C.Gates and W.F. Ramsdell, who have directed by efforts and advised me concerning the organization of this report; in addition, Professor Ramsdell has read the manuscript and made many helpful suggestions. The report has also been reviewed by Pfofessor M. Senstius, his constructive criticism has led to several revisions of the original text. All of the more difficult plant species have been identified by Professor Gates. I owe a special debt of gratitude to Professor Ramsdell for giving me the opportunity to make this study. I am also under obligation to R. W. Varner, graduate research assistant, for his aid in the collect-

ion of field data.

Object of the 1940 Study

Since this phase of the experiment is the first step in our study of succession it is considered appropriate to review briefly some of the ecological principles involved in this study.

Practically every forest community contains a subordinate flora consisting of herbaceous and shrubby species. Some of these species with wide ranges of environmental toleration occur independtly and others thrive only under certain environmental conditions created by the dominant vegetation. Since plants are forced to compete with each other for moisture, nutrients. light, and growing space the more aggressive species continue to replace their weaker competitors until ultimately those species best adapted to the site remain in possession. Through each develop mental stage to the establishment of the climax forest association the dominants are accompanied by a characteristic ground flora. The ground cover at any one stage is composed of relic, characteristic, and invading species. Very frequently the climax forest is destroyed or the primayy sequence of successional stages is prevented by farming, fire, or logging operations and a new or secondary sequence of stages is initiated (6). In this experiment we are more concerned with these secondary successions.

Intensive study of the ground cover will be conducted by means of the permanent sample plots. In order to reduce the danger of drawing conclusions from relationships existing on such relatively small areas as the permanent plots a survey has been made of ground plant occurrence in the vicinity. This supplementary information will help to establish the ground cover make-up and its present stage of development

for each soil type. When resurveys are made at five year intervals as planned successional trends may be recorded in advance of their appearence in the plots.

The dominant cover and the apparently more important ground plants have been described in an attempt to give a qualitative description of the vegetation. In addition the plants encountered in the survey have been considered for soil indicator qualities.

Discussion

This experiment may be considered as one of the pioneer studies in the combined fields of forest ecology, soils, and land use classification. It is one of the few such studies whose purposes have been defined with the intention of carrying it through several generations.

A considerable amount of data must be obtained and many years may pass before many of the questions can be answered. Through information obtained from a review of literature and observations made in the field it is possible to throw some light on a few of the questions.

In the case of the seven soil types under observation it is possible to recognixe forest communities typical of each. Recognition is possible here because these soil types are quite distinctive and their topographic position has a direct influence on soil moisture. A count of the number of species recorded for each soil type shows a progressive increase in numbers from the driest soil, the Grayling Sand, to the wettest soil, the Rifle Peat. Where the Rifle Peat and Granby Sand soil types adjoin any of the better drained soil types the transition between plant communities is pronounced. Elsewhere the community transitions are not so noticable. Many of the species found here have very wide distributions and their habitat preferences vary with their range so our conclusions probably apply only to this locality.

The use of plants as site indicators has aroused considerable interest in this country but the results of several attempts at application of the theory have not equaled expectations. In this study it was possible to associate certain herbaceous species with general soil conditions, namely; peat soils, poorly drained sands, loamy sands and sandy loams, and light well drained sands. The value of indicators selected on the basis of this classification is reduced because the soil

conditions as defined can be recognized more easily by the presence of dominant tree species. In addition, any classification such as this may be considered incomplete as long as successional relationships are not considered.

Plants may serve as indicators of soil moisture, humus content, mineral content, and of any other combination of environmental factors. But before the plants can be used as reliable indicators the factor or combination of factors critical for them must be determined.

The value of ground plants as indicators of site productivity is ofparticular interest to foresters, but it must be remembered that the requirements of various tree species differ and the standard of site productivity therefore varies with the crop species.

The most comprehensive evaluation of site indicators in this country has been made by Kittredge in his study of the growth rate of aspen(5). He has found that as indicators of site class plant communities are more reliable that individuals, but soil profile characteristics show a better correlation with site index that plant communities.

Perhaps the most vigorous criticism of the indicator theory is that made by Coile (8). His arguments are well founded and in brief they are as follows. A classification of forest sites based upon ground vegetation is valueless when the vegetation is destroyed. Site classifications should be based on permanent site features, such as, soil and topography.

Coile believes that ground vegetation has a limited value as an indicator of tree growth because the trees have a more extensive root system which enables them to use the soil more completely(8). His reason may be questioned because a high percentage of the feeding rootsof trees are concentrated in the same upper horizons occupied by the roots of herbaceous plants.

Plants commonly associated with a given forest type do not represent the same environmental conditions when found in an aspen field as they do when living in the highly competitive forest environment.

Another problem which attracts great interest is the correlation between soil succession and plant succession. Investigators know that vegetation affects soil properties chiefly through the action of humus and water and nutrient seeking roots. Because of its favorable effect on soil moisture incorporated humus is of especial importance in the heavily drained sand soils. In such porous soils humus incorporation should take place readily and under protection from fire the soils should improve. Numerous fires in the past have undoubtedly resulted in soil deterioration.

The heavy concentration of feeding roots in the A_0, A_1, and A_2 horizons observed by many investigators testifies to the importance of the humus (9). It would be interesting to know if the root distribution in the soil profile changes during the course of forest and soil succession. For example, the Rifle Peat soil probably will not change materially, but I believe we can look forward to a heavier surface accumulation of humus on the Granby Sand.

Some Suggestions for Future Study

In a study such as this it would be excellent if all the factors and phases influencing it could be investigated also, but expense and time availible impose certain limitations.

In investigating the relation between forest succession and soil profile development we must get to the heart of the problem by isolating those influences which vegetation exerts upon soil. As mentioned before plants affect soil properties chiefly by the action of humus and water and nutrient seeking roots. Microclimate is probably a littl less important. Isolation or removal of vegetational influence might be accomplished by removal of vegetation from within areas 12'x12' square or larger and establishing permanent plots. If these surfaces are kept bare of plants and all kinds of litter are removed vegetational influence will be reduced. The roots of bordering plants should be severed by trenching around the plots every summer and if the crowns of neighboring trees are not allowed to extend over the plot vegetational influence will be sufficiently eliminated for practical purposes. At the conclusion of the experiment soil profiles from these plots could then be compared with normal profiles obtained nearby. The soil within the plots will probably retrograde but the comparisons will give concrete evidence of the influence of vegetation under local conditions. Since color differences are important in profile descriptions and they are difficult to describe accurately color photographs might be useful in recording color changes for publication.

I think a study of root distribution within the soil profile would be a good contribution to the study. It would help us to learn what soil properties are most favorable for plant growth and how certain species make their adjustments. Depth of humus incorporation, soil

moisture, and depth to water table, base exchange capacity, texture profile, silt content, and inherent fertility are some of the important factors (4).

If throughout the experiment the ground plant studies are confined to the immediate vicinity of the permanent plots there may be some question concerning the reliability of the conclusions as applied to the soil type. It may be wise to make ground plant studies from time to time in comparable communities on other parts of the soil type. This approach is advantageous because it eliminates the need for additional permanent plots and permits a better establishment of the typical forest cover. It should also reveal some of the successional trends.

If the successions originating from each of the different disturbances, such as, farming, fire, and logging, differ greatly they should also be worked out.

In addition it might be well to consider the advantages of recording species abundance as well as species frequency. Frequency studies are used as a measure of species dispersion (3). Such studies usually recognize only whether a species is present or not and the relative percentage of sample areas in which it occurs. The information obtained gives one some idea of the homogeneity of the community but it doesn't express ecological dominance satisfactorily. This will be understood when it is remembered that by this method one plant in a plot has just as much weight in frequency determinations as a 1000 individuals of the same species in a plot. I believe in the future we should record more information concerning the abundance or percent of coverage.

In making community and succession studies Gates report on the vegetation of this region should be consulted. (10). Professor Gates

descriptions are detailed but they haven't been linked with specific soil types.

Another report which should be read is that by Coile (4) on forest soil problems of Eastern United States. It includes a summary of all the more important forest soils literature as well as a comprehensive outline of specific forest soils problems.

Plot 1 Grayling Sand

Permanent Plot and Quadrat Comparisons

Permanent Plots	NW	SE	F.I.
Arctostaphylos uva-ursi	X	0	
Carex leucorum	X	X	
Epigaea repens	X	0	
Melampyrum kineare	X	0	
Prunus cuneata	X	0	
Pteris aquilina	X	0	
Quercus borealis	0	X	
Vaccinium pennsylvanicum	X	X	

Plants with High Frequencies Not Occurring in Permanent Plots

Species	F.I.
Cladonia rangiferina	96
Oryzopsis pungens	59
Myrica asplenifolia	42
Moss	29
Aster lindleyanus	29

Plot 2 Rubicon Sand

Permanent Plots	NW	SE	F.I.
Carex umbellata	0	X	
Diervilla lonicera	X	0	
Oryzopsis pungens	X	0	
Quercus borealis	0	X	
Pinus Strobus	0	X	
Pteris aquilina	X	X	
Rhus glabra borealis	0	X	
Vaccinium pennsylvanicum	X	0	

Plants with High Frequencies Not Occurring in Permanent Plots

Species	F.I.
Danthonia spicata	30
Convolvulus spithamaeus	20
Oryzopsis asperifolia	10

Symbol Legend

X = present in the plot
0 = not present in the plot

Plot 1 Grayling Sand

Supplementary Plant Occurrence Data

Based on 24 list quadrats of one square meter each. Quadrats spaced at ½ chain intervals, 12 on a line running west from the northwest corner of the plot and 12 on a line running east from the southeast corner. Field observations August 8, 1939.

Species	Occurrence in the 24 quadrats	Frequency on the basis of 100
Cladonia sp.	23	96
Vaccinium pennsylvanicum	23	96
Carex leucorum	22	92
Prunus cuneata	15	62
Oryzopsis pungens	14	58
Quercus borealis	13	54
Myrica asplenifolia	10	42
Pinus banksiana	10	42
Moss	7	29
Aster lindleyanus	7	29
Arctostaphylos uva-ursi	6	25
Melampyrum lineare	5	21
Pteris aquilina	4	17
Unknown grass	3	12
Comandra umbellata	3	12
Apocynum androsaemifolium	3	12
Hieracium paniculatum	2	8
Amelanchier canadensis	2	8
Helianthus occidentalis	2	8
Epigaea repens	2	8
Danthonia spicata	2	8
Prenanthes racemosa	1	4
Panicum xanthophysum	1	4
Populus grandidentata	1	4
Solidago juncea	1	4
Lactuca canadensis	1	4
Viola arenaria	1	4
Panicum depauperatum	1	4
Aster laevis	1	4

Plants nearby but not in any of the quadrats:

Acer rubrum
Prunus serotina
Hieracium venosum
Campanula rotundifolia

Plot 2 Rubicon Sand

Vegetation Description

The tree cover in the vicinity of the Rubicon Sand plot consists of a relatively open uneven aged stand in which the trees occur in more or less dense groups separated by large openings. Except for many scrub clumps of Quercus borealis and Acer rubrum the discontinuous canopy is dominated by Populus grandidentata. The other hardwoods, Betula papyrifera, Populus tremuloides, and Fagus grandfolia are not thriving and do not occur frequently enough to be of importance. The crowns of the widely dispersed Pinus resinosa project above the canopy formed by the aspens. Seed trees of Pinus Strobus are even more less infrequent. Scattered seedlings and saplings of Pinus resinosa have been successful in establishing themselves but they are not making rapid growth on this site. The sparse ground plant coverage is similar to that of other areas where fires have reduced the ground cover to a few of the more exerophytic species. Of the herbaceous species Pteris aquilina is the most conspicuous, but its smaller size and low density have resulted in a poor layer development. Another gregarious species, Vaccinium penn. is very common beneath the Pteris, but Diervilla lonicera is not quite as abundant. Many of the tree species, Quercus borealis, Betula papyrifera, Pinus resinosa, Populus tremuloides, Acer rubrum, and Amelanchier canadensis are represented by a few scattered seedlings. In the more extensive open areas, mosses and lichens Cladonias form large cushions. Reduced competition seems favorable for the development of grasses and sedges. Although no species is especially abundant, the stools of Danthonia spicata, Oryzopsis pungens, Carex umbellata, Oryzopsis asperifolia, Panicum meridionale, Carex leucorum, and Panicum tsugetorum, together from a conspicuous part of the ground cover. The

other plant species present, such as, Aster laevis, Hieracium aurantiacum, Gaultheria procumbens, Epigea repens, and Melampyrum lineare are typical of pinelands but here they have alimited occurrence.

Plot 2 Rubicon Sand

Supplementary Plant Occurrence Data

Based on 50 list quadrats of one square meter each. Quadrats were spaced at 2 meter intervals along lines running outward from the 0.1 A. plot. Thirteen were taken along a line running north from the NW corner, 12 along a line running east from the NE corner, 12 along a line running south from the SE corner, and 13 along a line running west from the SW corner.

Field observations July 22, 1940.

Ground plants

Species	Occurrence in the 50 quadrats	Frequency on the basis of 100
Pteris aquilina	50	100
Vaccinium pennsylvanicum	16	32
Danthonia spicata	15	30
Oryzopsis pungens	14	28
Carex umbellata	13	26
Diervilla lonicera	10	20
Convolvulus spithamaeus	10	20
Oryzopsis asperifolia	10	20
Aster laevis	4	8
Panicum meridionale	4	8
Populus tremuloides (seedling)	4	8
Quercus borealis (seedling)	4	8
Hieracium scabrum	3	6
Acer rubrum (seedling)	2	4
Amelanchier canadensis (seedling)	2	4
Betula papyrifera (seedling)	2	4
Carex leucorum	2	4
Gaultheria procumbens	2	4
Melampyrum lineare	2	4
Pinus resinosa (seedling)	2	4
Rhus glabra var. borealis (seedling)	2	4
Panicum tsugetorum	1	2
Moss and lichens	Average coverage 17%	

Trees and saplings

Populus grandidentata	7	14
Amelanchier canadensis	2	4
Populus tremuloides (sapling)	4	8
Acer rubrum	2	4
Populus tremuloides	2	4
Quercus borealis (sapling)	2	4
Betula papyrifera	1	2
Pinus resinosa (sapling)	1	2

*Trees less than 1 meters high and greater than 1 meter are classed as saplings.

Plot 3 Roselawn Sand

Vegetation Description

The vegetation in the vicinity of the permanent plot exhibits a transitional nature between that of the aspen, pine, and maple-beech associations. Large-tooth aspen, paper birch, and red and white pine, together form a mixed uneven-aged stand of varying density. The irregular spacing of trees of various ages and sizes has produced a discontinuous canopy favorable for many of the light loving species. The large tooth aspens (Populus grandidentata) with their widespread occurrence as trees and saplings characterize the stand. The crowns of the scattered red (Pinus resinosa) and white pine (P. Strobus) extend conspicuously above the general canopy level. A few Rhus glabra borealis saplings occur in the openings. In several places clumps of Cornus circinata form small thickets. Two of the shrubs, Cornus circinata, Viburnum acerifolium, and the understory species, Acer pennsylvanicum, which also occurs here, are characteristic of the maple-beech association. The presence of two saplings of Prunus serotina and Acer saccharum and occasional Rubus allegheniensis suggests that the soil type may be invaded by the hardwoods. Although the Pteris aquilina had a frequency of 100 in the quadrats it isn't abundant enough on the top of the hill to form a well developed layer; however, along the northeast slope it is more numerous and its leaves form a continuous canopy. The other subdominant, Diervilla lonicera, also has a wide distribution. Where the Pteris cover is not dense Vaccinium pennsylvanicum appears frequently. Over most of the ground surface the leaf litter is very thin. In the open areas several grass species are common and in a few places they are abundant, two of these, Oryzopsis asperifolia and O. punges, are typical pineland species. Teaberry (Gaultheria procumbens) is common

throughout the vicinity. Some of the common aspen associates are Melampyrum lineare, Aster laevis, and Solidago hispida. The maple-beech association is also represented by several scattered Smilacina racemosa and Pyrola secunda. Beneath the shade of the Pteris on the northeast slope Ploygala paucifolia is one of the few abundant species.

Plot 3 Roselawn Sand

Supplementary Plant Occurrence Note

Based on 50 list quadrats of one square meter each. Quadrats were taken at 2 meter intervals along lines extended from the corners of the O. I A. plot. Twelve quadrats were taken along a line running north from the NW corner, 12 along a line running east from the NE corner, 13 along a line running south from the SE corner, 13 along a line running west from the SW corner. Field observations July 18, 1940.

Ground plants

Species	Occurrence in the 50 quadrats	Frequency on a basis of 100
Diervilla lonicera	29	58
Pteris aquilina	25	50
Gaultheria procumbens	18	36
Oryzopsis asperifolia	12	24
Melampyrum lineare	11	22
Polygala Paucifolia	9	18
Aster laevis	7	14
Vaccinium pennsylvanicum	5	10
Oryzopsis pungens	3	6
Solidago hispida	3	6
Carex umbellata	2	4
Rubus alleghenienesis	1	2
Antennaria neodioica	1	2
Cornus circinata	1	2
Apocynum androsaemifolium	1	2
Betula papyrifolia(seedling)	1	2
Betula papyrifera (sprout)	1	2
Hieracium aurantiacum	1	2
Maianthemum canadense	1	2
Panicum meridionale	1	2
Pinus resinosa (seedling)	1	2
Rumex acetosella	1	2
Salix rostrata	1	2
Smilicina racemosa	1	2
Acer rubrum (seedling)		
Pyrola secunda	*	

Trees and saplings	7	14
	6	12
populus grandidentata	3	6
Populus grandidentata (sapling)	2	4
Quercus borealis (sapling)	1	2
Rhus glabra borealis	1	2

*Trees less than 3 meters high and greater than 1 meter are classed as saplings.

Plot 4 Emmet Loamy Sand

Vegetation Description

The vegetative cover in the vicinity of the plot is dominated by a relatively dense stand of aspen. The two dominant species, Populus grandidentata and Ptremuloides, average 2"--4" d.b.h. and occur in almost equal numbers. Codominance is shared with occasional groups of Acer saccharum, Fagus grandifolia, and Acer rubrum. These three species, together with Acer pennsylvanicum, also occur in the understory where they help to form a denser crown canopy. The occurrence of the few Prunus pennsylvanicas and Rhus glabras seems restricted to several openings in the stand. A luxuriant growth of Pteris aquilina forms a conspicuous layer varying greatly in density, canopy closure, and height. One of the most prominent features is the widespread abundance of Rubus alleghaniensis. Where the Pteris layer is dense the Rubus bushes are small but in the less shady places they are codominant with the Pteris aquilina. The ground surface is uniformly covered with a thin layer of leaf litter. The smaller ground plants are noticeably sparse with most of the species poorly represented. The one exception is Hieracium aurantiacum; its rosettes are abundantly and uniformly distributed throughout most of the area. Some of the other species have a more localized occurrence. In the places where a crown canopy hasn't been formed a few specimans of Anaphalis margaritacea, Solidago canadensis, Convolvulus spithamaeus, and Antennaria neodioica still remain. The invading hardwood association is represented by a scattering of Medeola virginiana, Lycopodium lucidulum, Pyrola secunda, P. elliptica, Streptopus roseu, and Trillium grandiflorum. Several of the other species, Smilacina racemosa, Trientalis americana, and Mitchella repens, are common on the heavier sand soils.

Plot 4 Emmet Loamy Sand

Supplementary Plant Occurrence Data

Based on 50 list quadrats of one square meter each. Quadrats were spaced at one meter intervals along lines extending outward from the corners of the 0.1 acre plot. Thirteen quadrats were taken along a line running north from the NW corner; 12 east from the NE corner; 13 along a line running N 45 W from the SW corner; and 12 along a line running S 45 W from the SE corner. Field observations August 1, 1940.

Species	Occurrence in the 50 quadrats	Frequency on a basis of 100
Ground plants		
Pteris aquilina	49	98
Rubus allegheniensis	48	96
Hieracium aurantiacum	22	44
Smilacina racemosa	10	20
Taraxacum officinale	9	18
Acer rubrum (seedling)	7	14
Convolvulus spithamaeus	6	12
Agrostis (capillonnee)	5	10
Hainantherum canadense	5	10
Trientalis americana	5	10
Mitchella repens	4	8
Betula papyrifera (seedling)	3	6
Trillium grandiflorum	3	6
Unknown monocot ? (seedling)	3	6
Apocynum androsaemifolium	2	4
Lactuca canadensis	2	4
Ploytrichum sp.	2	4
Populus grandidentata (seedling)	2	4
Pyrola secunda	2	4
Acer saccharum (seedling)	1	2
Anaphalis margaritacea	1	2
Carex (sp. unknown)	1	2
Carex (sp. unknown)	1	2
Carex (sp. unknown)	1	2
Carex umbellata	1	2
Danthonia spicata	1	2
Epilobium angustifolium	1	2
Fraxinus americana (seedling)	1	2
Lycopodium clavatum	1	2
Habenaria obtusata	1	2
Habenaria (sp. unknown)	1	2
Pyrola elliptica	1	2
Medeola virginiana	1	2
Prunus pennsylvanica (seedling)	1	2
Solidago canadensis	1	2
Trees and saplings*		
Populus grandidentata	11	22
Prunus pennsylvanica	7	14
Rhus glabra borealis (sapling)	3	6
Acer saccharum	1	2

*Trees less than 3 meters high and more than 1 meter high are classed as saplings.

Plot 4 Emmet Loamy Sand

Permanent Plot and Quadrat Survey Comparisons

Permanent Plots	NW	SE	F.I.
Hieracium aurantiacum	0	X	
Pteris aquilina	X	X	
Rubus allegheniensis	X	X	

Species with High Frequencies Not Occurring in the Permanent Plots

Smilacina racemosa	20
Taraxicum officionalis	18
Acer rubrum (seedling)	14
Convolvulus spithemaeus	12

Plot 3 Roselawn Sand

Permanent Plot and Quadrat Survey Comparisons

Permanent Plots	NW	SE	F.I.
Acer rubrum	0	X	
Antennaria canadensis	0	X	
Apocynum androsaemifolium	X	0	
Aster laevis	0	X	
Carex leucorum	X	0	
Carex umbellata	X	X	
Diervilla lonicera	X	X	
Erigeron canadensis	0	X	
Gaultheria procumbens	X	X	
Oryzopsis asperifolia	X	X	
Pinus resinosa	X	X	
Poa compressa	0	X	
Poa palustris	0	X	
Pteris aquilina	X	X	
Rhus glabra borealis	0	X	
Rubus allegheniensis	0	X	
Solidago hispida	0	X	

Species with High Frequencies Not Occurring in Permanent Plots

Melampyrum lineare	36
Polygala paucifolia	24
Vaccinium pennsylvanicum	18
Oryzopsis pungens	14

Plot 5 Saugatuck Sand

Vegetation Description

A poorly stocked stand, dominated by Populus tremuloides, forms the dominant cover. Of the two aspens present Populus grandidentata develops into the largest trees. Insect defoliation and considerable windfall among the Populus tremuloides has helped to produce a light, irregular crown canopy. Several other trees of this species are dying as the result of the attack of an insect which leaves a spiral scar around the hole. The Populus grandidentatas are apparently unaffected. Scattered groups of Betula papyrifera complete the stand. Saplings of Salix discolor are common while those of Abies balsamea, Prunus virginiana, and P. serotina are infrequent. Among the ground plants there are a large number of species present but many of them have only a localized occurrence. The most ubiquitous species are the subdominants, Pteris aquilina and Apocynum androsaemifolium; together, their tops form a conspicuous layer. Where the layer is denser there are fewer of the lower ground plants. On all sides of the plot except the northeast, Diervilla lonicera was a frequent codominant in the layer. Towards the southwest, near the edge of the swamp, Diervilla increased abruptly in size and abundance. The numerous openings in the Pteris layer permit many of the open field species to develop, especially, Solidago canadensis, Epilobium angustifolium, and Anaphalis margaritacea. Large down logs and aspen leaf litter form a good proportion of the ground floor. The hummocky character of most of the surrounding area helps to localize ground plant distribution. Some of these species with a limited occurrence are Clintonia borealis, Cornus canadensis, Medeola virginiana, Maianthemum canadense, Pyrola chlorantha, Fragaria virginiana, and Polytrichum sp. The presence of Equisetum sylvaticum near the swamp is probably due to the moister conditions. On the road which passes nearby the rosettes of Hieracium scabrum have formed a dense cover. Throughout the

Pteris and along the road several grass species are common; Danthonia spicata is the common open grass, but Poa pratensis and Phleum pratensis are probably escapes from an old abandoned field about three chains to the northeast. A considerable number of large white pine stumps in the vicinity suggests the suitability of the site for this species. One red pine seedling was noticed nearby, but since the nearest pine are along Douglas Lake about one-fourth mile southward seeding in may be slow.

Plot 5 Saugatuck Sand

Supplementary Plant Occurrence Data

Based on 45 list quadrats of one square meter each. Fifteen quadrats spaced at 2 meter intervals along a line running N 45 E from the SE corner of the plot, 15 at one meter intervals along a line running N 15 E from the NE corner, and 15 at one meter intervals along a line running south from the SW corner. Field observations July 9, 1940.

Ground plants

Species	Occurrence in the 45 quadrats	Frequency on the basis of 100
Pteris aquilina	40	89
Apocynum androsaemifolium	37	82
Solidago canadensis	31	69
Diervilla lonicera	17	38
Hieracium scabrum	10	22
Populus tremuloides (sprout)	9	20
Poa pratense	8	18
Danthonia spicata	6	13
Phleum pratense	6	13
Rubus alleghaniensis	6	13
Taraxacum vulgaris	5	11
Lactuca canadensis	4	9
Polytrichum sp	4	9
Epilobium angustifolium	4	9
Maianthemum canadense	4	9
Pyrola chlorantha	3	7
Anaphalis margaritacea	3	7
Salix discolor (sprout)	3	7
Rubus canadensis	3	7
Fragaria virginiana	2	4
Galium Claytoni	2	4
Unknown grass	2	4
Pyrola secunda	2	4
Populus tremuloides (seedling)	1	2
Salix rostrata	1	2
Solidago hispida	1	2
Acer rubrum (seedling)	1	2
Antennaria neodioica	1	2
Prunus pennsylvanica (seedling)	1	2
Hieracium paniculatum	1	2
Cornus canadensis	1	2
Poa sylvestris	1	2

Trees and saplings

Populus tremuloides	9	20
Salix discolor	3	7
Betula papyrifera	3	7
Populus tremuloides (dead tree)	2	4
Populus grandidentata	1	2
Prunus pennsylvanica	1	2
Prunus Pennsylvanica (dead tree)	1	2

Plot 5 Saugatuck Sand

Permanent Plot and Quadrat Survey Comparisons

Permanent Plots	NE	SW	F.I.
Apocynum androsaemifolium	X	X	82
Aster laevis	X	0	
Betula papyrifera (seedling)	0	X	
Danthonia spicata	X	X	13
Diervilla lonicera	X	0	38
Epigea repens	X	X	
Populus tremuloides	X	X	20
Pteris aquilina	X	X	89
Salix rostrata	0	X	2
Solidago canadensis	X	X	69
Solidago hispida	X	0	2

Species with High Frequencies Not Occurring in the Permanent Plots

Hieracium scabrum	22
Poa pratense	18
Phleum pratense	13
Rubus alleghoniensis	13

Plot 6 Granby Sand

Ground Plant "Constancy"

Permanent Plots	NE	SW	F.I.
Abies balsamea (seedling)	X	0	
Acer rubrum (seedling)	0	X	
Agropyron tenerum	0	X	
Alnus incana	X	X	
Antennaria canadensis	0	X	
Aster hirsuticaulis	X	X	
Aster lindleyanus	X	X	
Cares asa-grayi	X	0	
Carex leucorum	X	0	
Carex (stellutata)	0	X	
Carex trisperma	0	X	
Carex sp.	X	0	
Cinna latifolia	0	X	
Cirsium muticum	X	0	
Cornus baileyi	0	X	
Equisetum sylvaticum	X	0	
Fragaria virginiana	X	X	
Gallium triflorum	X	0	
Glyceria striata	X	0	
Habenaria borealis	0	X	
Maianthemum canadense	0	X	
Polytrichum sp.	X	0	

Plot 6 Granby Sand

Vegetation Description

The Granby Sand Plot is located in a stand of tall, slim, trembling aspens whose crowns form a relatively open canopy. Beneath them a few smaller aspen, several black ash, and occasional tall alder (Alnus incana) form a light tree understory. A few Abies balsamea saplings here and many more scattered throughout the vicinity suggest the future cover. Frequent clumps of alder and occasional Cornus stolonifera and C. alternifolia form a shrub layer of moderate density. An irregular ground surface littered with dead moss-covered saplings strongly influences ground plant distribution. In the depressions where the dead leaves accumulate there are comparatively few ground plants. In spite of these irregularities the site supports a luxuriant vegetation with a large number of species occurring abundantly and many others occurring occasionaly. Around the southern part of the plot most of the plants develop on the numerous hummocks of moss which skirt the depressions. Some of the more conspicuous of these species are Scirpus atrocinctus and Glyceria nervata. Numerous stools of Carex help to give the ground cover a patchy appearence. The Compositae family is well represented by several members of the Aster, Solidago, and Eupatorium genera. Two species, Rubus triflorus, and Fragaria virginiana, are able to maintain high frequencies by means of their stolon and rhizome habits of growth. The presence of several Iris versi-colors in some of the depressions is probably indicative of the poor soil drainage. Towards the north the sedge cover becomes almost continuous and shrubs occur more densely. Wood fern (Dryopteris spinulosum) is common but its scattered distribution makes it seem less so; Onoclea sensibilis, the sensitive fern, is more inclined to form infrequent patches. Two of the more frequent species, Viola pallens and Lycopus uniflorus, are too small to be conspicuous. In an area northwest of the plot, Rubus tri-

florus and Cornus canadensis are very abundant. The numerous remaining species do not seem outstanding enough for individual description.

Plot 6 Granby Sand

Supplementary Plant Occurrence Data

Based on 40 list quadrats of one square meter each. Quadrats were spaced at ½ meter intervals along lines extending outward from the corners of the O.1A. plot. Ten quadrats were taken along each of the following lines: north from the NW corner, east from the NE corner, south from the SE corner, and west from the SW corner. Field observations July 22, 1940.

Ground plants

Species	Occurrence in the 40 quadrats	Frequency on the basis of 100
Viola pallens	25	63
Rubus triflorus	24	60
Glyceria nervata	22	55
Fragaria virginiana	18	45
Lycopus sp.	14	35
Carex asa-grayi	11	28
Galium triflorum	11	28
Equisetum sylvaticum	9	23
Aster hirsuticaulis	9	23
Carex (stellata)	9	23
Ranunculus recurvatus	9	23
Aster nova-angliae	8	21
Carex leptalea	8	21
Carex rosea	7	18
Pyrola secunda	7	18
Solidago canadensis	7	18
Alnus incana (seedling)	6	15
Scirpus atrocinctus	6	15
Ribes triste	5	13
Aster laevis	4	10
Dryopteris spinulosum	4	10
Mainanthemum canadense	4	10
Rubus strigosus	4	10
Acer rubrum (seedling)	3	8
Aster paniculatus	3	8
Carex gracillima	3	8
Cornus canadensis	3	8
Ilex verticillata	3	8
Impatiens biflora	3	8
Carex (sp. unknown)	3	8
Brachyelitrum erectum	2	5
Carex trisperma	2	5
Aster strictocaulis	2	5
Abies balsamea (seedling)	2	5
Polygala paucifloro	2	5
Pteris aquilina	2	5
Salix discolor (seedling)	2	5
Taraxacum officinale	2	5
Amelanchier canadensis (seedling)	1	3
Anaphalis margaritacea	1	3
Betula papyrifera (seedling)	1	3

Plot 6 Granby Sand

Supplementary Plant Occurrence Data (cont.)

Species	Occurrence in the 40 quadrats	Frequency on the basis of 100
Carex (diandra)	1	3
Carex laxiflora blanda	1	3
Cornus alternifolia	1	3
Cornus stolonifera	1	3
Erigeron annuus	1	3
Eupatorium maculatum	1	3
Fraxinus nigra (seedling)	1	3
Krigia virginica	1	3
Lysimachia thyrsifolia	1	3
Populus tremuloides (seedling)	1	3
Prunella vulgaris	1	3
Pyrola asarifolia	1	3
Pyrola chlorantha	1	3
Pyrola elliptica	1	3
Pyrus malus	1	3
Solidago hispida	1	3
Solidago rugosa	1	3
Solidago (sp. unknown)	1	3
Rhamnus alnifolia	1	3
Vaccinium canadense	1	3
Viburnum (Opulus)	1	3
Mint (sp. unknown)	1	3
Unknown dicot (seedling)	1	3
Trees and saplings*		
Populus tremuloides	11	28
Alnus incana (sapling)	6	15
Alnus incana	3	8
Betula papyrifera	2	5
Fraxinus nigra	2	5
Populus balsamifera	2	5
Acer rubrum (sapling)	1	3
Acer rubrum	1	3
Amelanchier canadensis	1	3
Salix lucida (sapling)	1	3
Salic discolor (sapling)	1	3

*Trees less than 3 meters high and more that 1 meter high are classed as saplings.

Plot 6 Granby Sand

Permanent Plot and Quadrat Survey Comparisons

Permanent Plots	NE	SW	F.I.
Pyrola secunda	X	X	
Ribes triste	0	X	
Rubus triflorus	X	X	
Salix discolor	X	0	
Sphagnum sp.	X	0	
Solidago canadensis	0	X	
Taraxicum officionalis	X	0	
Viola pallens	X	0	

Species with High Frequencies Not Occurring in the Permanent Plots

Glyceria nervata	55
Lycopus sp.	35
Ranunculus recurvatus	23
Aster nova-angliae	20
Carex leptalea	20
Carex rosea	18
Scirpus atrocinctus	15

Plot 7 Rifle Peat

Constancy is a relationship used in estimating the homogeneity of plant communities. Since the vegetation surrounding Plot 7 represents several communities, each a little different from the others, a constancy comparison is not justified.

Plot 7 Rifle Peat

Vegetation Description

The Rifle Peat plot is located in a small area surrounded by a Thuja-Abies-Picea forest. About twenty-five years ago the vegetative cover on the plot was similar to that of the stands bordering it on the east and west but heavy selective logging has reduced it to a heterogeneous mixture of several plant associations. The dominant cover within the plot has been given a patchy appearance by the openings winding between groups of saplings and small trees of Thuja occidentalis, Picea mariana, and Abies balsamea. In the southern part of the plot, small saplings of these three species together with an occasional Larix laricina form a dense thicket. Among the lower plants Thuja seedlings are also very abundant. An influx of a large number of species has resulted in the development of a complex ground cover. Throughout most of the area a layer of Sphagnum is the principal ground plant substratum. The more abundant of the conspicuous species occurring on the Sphagnum are Smilacina trifolia, Linnaea borealis, and species of Carex. Four other common species, Clintonia borealis, Coptis trifolia, Epigaea repens, and Gaultheria procumbens, are ubiquitous, occurring also on dry pineland soils, Vaccinium pennsylvanicum and Diervilla lonicera occur less frequently. Both Epilobium angustifolium and Eriophorum virginicum, typical open bog species, occur occasionally. Scattered plants of Ledum groenlandicum add to the bog appearance. Both Typha latifolia and Cirsium muticum, which occur infrequently, are characteristic of this early developmental stage. In the course of secession we expect all the species to become less abundant and many of these more ephemeral species named will disappear entirely until the ground cover resembles that of the adjacent stands east and west of the plot. The ground cover of the adjacent area north of the plot is probably an intermediate stage in this succession.

Both of the communities adjoining the plot on the east and the west are somewhat similar in tree and ground cover structure. Dense stands of young Thuja occidentalis trees overtopped by a smaller number of Picea mariana and Abies balsamea relics have produced a one-layered crown canopy. A few Betula papyrifera and Acer rubrum and a Pinus Strobus occur as minor dominants. In the younger parts of the stands the fallen trees make walking difficult. The ground surface is made up of old and recently fallen tree trunks covered with peat and Thuja leaf litter. Where the litter accumulations are heaviest, they have produced a modified ground surface. After a long period of rain the water table rises to within several inches of the ground surface. Although practically all the ground plants are less abundant than in the more open situations the frequencies of several species, Linnaea borealis, Chiogenes hispidula, Mitella nuda, and Coptis trifolia, have not changed materially. On the drier litter and humus beneath the Thuja the seedlings of Abies balsamea have become much more frequent. The ground yew, Taxus canadensis, is one species which does well even in the densest shade. Where the ground surface is moister or the tree canopy is lighter, Sphagnum and other mosses form a part of the ground cover. Ground plants appear more numerously on these moist moss patches.

The vegetation along the south side more closely resembles that within the plot. Young Thuja occidentalis, Picea mariana, and Abies balsamea seedlings form dense groups. Two large dying Populus tremuloides suggest an open cover during the past. An extensive cover of Sphagnum cuspidatum is favored by the water table which appears almost at the ground surface. The occurrence of Petasites palmatus, Sanicula marilandica, and Smilacina trifolia seems to be linked with this soggy ground character. In the open marshy situations Cypripedium hirsutum, Cirsium muticum, and Typha latifolia are conspicuous.

In the adjacent area on the north the selective cutting typical of swamp forest pulpwood operations has produced a community different from the others. The tree cover consists of a dense, uneven-aged stand of Abies balsamea, Thuja occidentalis, and Picea mariana sapling. The shade formed by the irregular canopyiis not as heavy as that beneath the pure Thuja stands. Except where the drier cedar root hummocks rise above the general ground level a layer of Sphagnum accompanied by many other plants forms and extensive ground cover (80%). Many of the species common in other parts of the vicinity are also common here, Chiogenes hispidula, Coptis trifolia, Smilacina trifolia, Gaultheria procumbens, Linnaea borealis, and Mitella nuda. Several species common to maple-beech communities are also frequent here, Aralia nudicaulis, Pyrola secunda, Polygala paucifolia, and Trientalis americana. A few Pteris aquilina and Diervilla lonicera occur in the open. In some of the more shady places seedlings of Taxus canadensis are common. Along the paths and among the smaller conifers there are several Fraxinus nigra seedlings and saplings.

Plot 7 Rifle Peat

Supplementary Plant Occurrence Data (a)

Based on 10 list quadrats each one meter square. Quadrats were spaced at one meter intervals a long a line running north from the middle of the 0.1 acre plot. Field observations July 15, 1940.

Ground plants

Species	Occurrence in the 10 quadrats	Frequency on a basis of 100
Aralia nudicaulis	10	100
Coptis trifolia	9	90
Linnaea borealis	9	90
Chiogenes hispidula	8	80
Mitella nuda	8	80
Polygala paucifloro	8	80
Smilacina trifolia	8	80
Sphagnum sp.	8	80
Pyrola secunda	7	70
Trientalis americana	7	70
Epigea repens	6	60
Gaultheria procumbens	6	60
Betula papyrifera (seedling)	5	50
Carex leptalea	5	50
Drosera rotundifolia	5	50
Taxus canadensis	5	50
Abies balsamea (seedling)	4	40
Aster macrophyllus	4	40
Prunella vulgaris	4	40
Rubus triflorus	4	40
Thuja occidentalis (seedling)	4	40
Equisetum scirpoides	3	30
Aster lindleyanus	3	30
Carex trisperma	3	30
Diervilla lonicera	3	30
Amelanchier canadensis (seedling)	3	30
Picea mariana (seedling)	3	30
Vaccinium pennsylvanicum	3	30
Acer rubrum (seedling)	2	20
Carex (sp. unknown, leaf wide and thick)	2	20
Maianthemum canadense	2	20
Carex (brunnescens)	2	20
Streptopus amplexifolius	2	20
Salix discolor (seedling)	2	20
Viola pallens	2	20
Carex (rosea group)	1	10
Equisetum sylvaticum	1	10
Epilobium angustifolium	1	10
Fragaria virginiana	1	10

Plot 7 Rifle Peat

Supplementary Plant Occurrence Data (a), (cont.)

Species	Occurrence in the 10 quadrats	Frequency on a basis of 100
Fraxinus nigra (seedling)	1	10
Habenaria clavolata	1	10
Habenaria obtusata	1	10
Ledum groenlandicum	1	10
Melampyrum lineare	1	10
Mitchella repens	1	10
Petasites palmatus	1	10
Unknown seedling	1	10
Trees and saplings*		
Thuja occidentalis	4	40
Abies balsamea (sapling)	3	30
Abies balsamea	2	20
Picea mariana (sapling)	2	20
Thuja occidentalis (sapling)	2	20
Picea mariana	1	10

*Trees less than 3 meters high and more than 1 meter high are classed as saplings.

Plot 7 Rifle Pent

Supplementary Plant Occurrence Data (b)

Based on 20 list quadrats. One series of 10 quadrats were taken at one meter intervals along a line running east from the NE corner and another series of 10 along a line running west from the middle of the west side of the 0. 1 acre plot at ½ meter intervals.

Field observations: July 15, and August 1, 1940

Species	Ground plants Occurrence in the 20 quadrats W	E		Frequency on a basis of 100
Abies balsamea (seedling)	10	9	19	95
Mitella nuda	10	5	15	75
Chiogenes hispidula	8	5	13	65
Linnea borealis	9	3	12	60
Pyrola secunda	5	5	10	50
Acer rubrum (seedling)	2	6	8	40
Maianthemum canadense	3	5	8	40
Coptis trifolia	6	1	7	35
Mosses and lichens on logs		7	7	35
Polygala paucifiora	4	3	7	35
Viola pallens	6	1	7	35
Habenaria obtusata	3	3	6	30
Aralia nudicaulis	5		5	25
Carex trisperma		5	5	25
Smilacina trifolia	3	1	4	20
Thuja occidentalis (seedling)	3	1	4	20
Trientalis americana	2	2	4	20
Aster macrophyllus	3		3	15
Betula papyrifera (seedling)	3		3	15
Carex leptalea	3		3	15
Epigea repens		3	3	15
Galium triflorum	3		3	15
Lonicera canadensis	3		3	15
Rubus triflorus	3		3	15
Sphagnum sp.		3	3	15
Streptopus amplexifolius		3	3	15
Aster lindleyanus		2	2	10
Clintonia borealis	1	1	2	10
Equisetums scirpoides	1	1	2	10
Gaultheria procumbens		2	2	10
Petasites palmatus	2		2	10
Acer spicatum (seedling)	1		1	5
Betula papyrifera (sprout)	1	1	1	5
Botrychium virginiana	1		1	5
Carex tenella	1		1	5
Carex (sp. unknown)	1		1	5
Carex (sp. unknown)	1		1	5
Carex (sp. unknown)	1		1	5
Corallorhiza trifida	1		1	5
Ilex verticillata			1	

Plot 7 Rifle Peak

Supplementary Plant Occurrence Data (b) (cont.)

Species	Occurrence in the 20 quadrats W	E		Frequency on a basis of 100
Pyrola chlorantha	1		1	5
Ribes lacustre	1		1	5
Sambucus racemosa	1		1	5
Taxus canadensis	1		1	5
Trillium grandiflorum		1	1	5
Vaccinium canadense	1		1	5
Vaccinium pennsylvanicum	1		1	5
Trees and saplings*				
Thuja occidentalis	2	6	8	40
Thuja occidentalis (sapling)		3	3	15
Picea mariana		2	2	10
Abies balsamea		1	1	5
Abies balsamea (sapling)	1		1	5
Betula papyrifera		1	1	5

*Trees less than 3 meters and more than 1 meter high are classed as saplings.

Plot 7 Rifle Peat

Supplementary Plant Occurrence Data (c)

Based on 10 list quadrats. Quadrats were taken at 1 meter intervals along a line running south from the middle of the 0.1 acre plot.
Field observations: July 15, 1940.

Ground plants

Species	Occurrence in the 10 quadrats	Frequency on a basis of 100
Linnaea borealis	10	100
Petasites palmatus	9	90
Smilacina trifolia	9	90
Carex trisperma	8	80
Equisetum scirpoides	8	80
Pyrola secunda	8	80
Aster lindleyanus	7	70
Clintonia borealis	7	70
Coptis trifolia	7	70
Sanicula marilandica	7	70
Abies balsamea (seedling)	6	60
Aralia nudicaulis	6	60
Chiogenes hispidula	6	60
Gaultheria procumbens	6	60
Kalmia angustifolia	6	60
Rubus triflorus	6	60
Sphagnum sp.	6	60
Epigaea repens	5	50
Thuja occidentalis (seedling)	5	50
Cornus canadensis	4	40
Polygala pauciflora	4	40
Prunella vulgaris	4	40
Trientalis americana	4	40
Cirsium muticum	3	30
Diervilla lonicera	3	30
Drosera rotundifolia	3	30
Maianthemum canadense	3	30
Streptopus amplexifolius	3	30
Acer rubrum (seedling)	2	20
Aster macrophyllus	2	20
Carex leptalea	2	20
Equisetum sylvaticum	2	20
Eriophorum sp.	2	20
Galium triflorum	2	20
Picea mariana (seedling)	2	20
Salix discolor (seedling)	2	20
Viola pallens	2	20
Actaea rubra	1	10
Circaea alpina	1	10
Glyceria nervata	1	10
Epilobium angustifolium	1	10

Plot 7 Rifle Peat

Supplementary Plant Occurrence Data (c.)

Ground Plants (cont.)

Species	Occurrence in the 10 quadrats	Frequency on a basis of 100
Habenaria hyperborea	1	10
Habenaria obtusata	1	10
Ledum groenlandicum	1	10
Triosteum officionalis	1	10
Taxus canadensis	1	10
Vaccinium canadensis	1	10

Trees and Saplings*

Abies balsamea (sapling)	4	40
Picea mariana (sapling)	4	40
Thuja occidentalis (sapling)	2	20
Fraxinus nigra (sapling)	1	10
Larix laricina (sapling)	1	10
Populus tremuloides	1	10
Salix discolor (sapling)	1	10

*Trees less than 3 meters and more than 1 meter tall are classed as saplings.

Number of Species Recorded in Plots and Quadrats

Soil Types	No. of Individual Species
Greyling Sand	16
Rubicon Sand	24
Roselawn Sand	29
Emmet Loamy Sand	31
Saugatuck Sand	34
Granby Sand	56
Rifle Peat	68

Herbaceous and Shrubby Plant Species with Soil Indicator Possibilities

Through this study and classwork in ecology an acquaintance has been made with some herbaceous and shrub species that appear to be either limited to or comparatively abundant in certain soil groups. Their presence may be due to one of a number of different soil condition combinations or the character of the dominant cover. A soil classification such as this which is based on the general nature of the soil profile conforms with the local forest types but it is too general to be of value in recognizing soil quality within these groups. Since the root systems of so many herbaceous plants usually occupy only the humus layer and the A horizon it might be possible to find more specific soil indicators by subdividing these soil groups further. The permanent plots are established on soil types which are classified on the textural quality of the A horizon. In this study not enough data were obtained to justify proposing indicators for soil types, i.e., if there are any. Supplementary classifications on the basis of humus layer may be of aid. Until verified these findings should be considered only as a starting point for future study.

Exclusive species: species completely or almost completely confined to one soil group.

Preferential species: species present on several soil types more or less abundantly but predominantly on one soil group.

Light well drained sand soils

Exclusive species
- Arctostaphylos uva-ursi
- Cladonia sp.
- Cypripedium acaule?
- Myrica asplenifolia
- Prunus cuneata
- Prunus pumila
- Ammophila sp.

Preferential species
- Aralia hispida
- Carex loucorum
- Carex umbellata
- Convolvulus spithamaeus
- Comandra umbellata
- Epipactis decipiens
- Gaylussacia baccata
- Hieracium paniculatum
- Juniperus communis
- Lycopodium tristachyum
- Melampyrum lineare
- Oryzopsis asperifolia
- Oryzopsis Pungens
- Vaccinium pennsylvanicum?

Loamy sand and sandy loam soils

Exclusive species
- Acer pennsylvanicum
- Allium tricoccum
- Aquilegia canadensis
- Arisaema triphyllum?
- Carex arctata
- Caulophyllum thalictroides
- Circea lutetiana
- Cornus circinata
- Geranium Robertianum
- Hepatica acutiloba
- Hepatica triloba

Preferential species
- Actaea alba
- Adiantum pedatum
- Aster macrophyllus
- Chimaphila umbellata?
- Dirca palustris
- Hieracium scabrum
- Lonicera canadensis
- Medeola virginiana
- Mitchella repens
- Osmorrhiza Claytoni
- Rubus alleghaniensis

Loamy sand and sandy loam soils (cont'd)

Exclusive species	Preferential species
Lycopodium annotinum	Sambucus racemosa
Lycopodium lucidulum	Smilacina racemosa
Hystrix patula	Trientalis americana
Polygonatum biflorum	
Streptopus rosea	
Trillium grandiflorum?	
Viburnum acerifolium	

Poorly drained sand soils

Exclusive species	Preferential species
Aster nova-angliae	Cornus stolonifera
Aster strictiscaulis	Equisetum sylvaticum
Carex asa-grayi	Fragaria virginiana
Brachyelytrum erectum	Galium triflorum
Carex gracillima	Impatiens biflora
Cinna latifolia	Lobelia cardinalis
Cornus alternifolia?	Rubus triflorus
Erigeron annuus	Solidago hispida?
Eupatorium maculatum	Alnus incana
Glyceria nervata	Eupatorium perfoliatum
Ranunculus recurvatus	Eupatorium purpureum
Rubus strigosus	
Scirpus atrocinctus	

Peat soils

Exclusive species	Preferential species
Chiogenes hispidula	Epilobium adenocaulon
Cypripedium hirsutum	Equisetum scirpoides
Cypripedium parviflorum	Fragaria vesca
Drosera rotundifolia	Ilex verticillata
Equisetum scirpoides	Habenaria hyperborea
Eriophorum sp.	Habenaria blephariglottis
Dryopteris Thelypteris?	Linnaea borealis
Ledum groenlandicum	Mitella nuda
Oneclea sensibilis	Nemopanthus mucronata
Osmunda regalis	Spiraea salicifolia
Petasites palmatus	Taxus canadensis
Phegopteris Dryopteris	Viola pallens
Pyrola asarifolia	Lobelia siphilitica
Sanicula marilandica	
Smilacina trifolia	
Streptopus amplexifolius	
Sphagnum sp.	

Summary and Conclusions

This is the report of one phase of the experiment designed to show the relationship between soil and changes in the vegetational cover in the vicinity of Douglas and Burt Lakes, Cheboygan County, Michigan, studied during the summer of 1940.

During the summer a survey was made of the ground plants occurring in the vicinity of the Experimental plots which were established on the following soil types viz, Rubicon Sand, Roselawn Sand, Emmet Loamy Sand, Saugatuck Sand, Granby Sand, and Rifle Peat plots.

Vegetation descriptions were made of the above named plots and their immediate vicinity.

Several ways of strenthening the bases for conclusions have been suggested. One of these is a method of determining the influence of vegetation on soil development by comparing profiles developed in the presence of and the absence of vegetational cover.

The survey of ground plant occurrence in the neighborhood of the seven permanent plots illustrates very well the influence which site factors, chiefly soil moisture, have on plant distribution. From the Grayling Sand to the Rifle Peat plot there is a continuous increase in the number of species present.

A more intimate knowledge of the habits of the different ground plants will be necessary before any species can be credited with indicate qualities.

The ground cover should be more definitely established by sampling other similar communities within the soil type.

In order to give future student assistants a better idea of the scope of this experiment a list of references concerning related studies has been prepared.

LITERATURE CITED

1. DUNCAN, D.P. and VARNER, R.W. Experiment designed to show the relationship between soil and changes in the vegetational cover. 1938 Phase: Experiment inaugaration--permanent plot establishment and vegetation mapping.

2. SYLVESTER, WALTER R. Experiment designed to show the relationship between soil and changes in the vegetational cover. 1939. Phase: Soil profile descriptions.

3. BRAUN--BLANQUET, J. Plant Sociology. Translated, revised, and edited by George D. Fuller and Henry S. Conard. McGraw--Hill Book Company, New York. 1932.

4. COILE, THEODORE S. A Problem Analysis for Forest Soils with Special Reference to Eastern United States. 1940. Division of Forest Management Research, U. S. Forest Service

5. KITTREDGE, JOSEPH, JR. The interrelationships of habitats, growth rate, and associated vegetation in the aspen community of Minnesota and Wisconsin. Ecol. Mong. 8:153-246. 1938.

6. WEAVER, J.E. and CLEMENTS, F.E. Plant Ecology, 2nd edition 1938 P. 106-114. McGraw--Hill Book Company, New York

7. ROMELL, L.G. and HEIBERG, S.O. Types of humus layer in the forests of northeastern United States. Ecology 12: 567-608. 1931.

8. COILE, THEODORE S. Forest classification: Classification of forest sites with special reference to ground vegetation.
Tour Forestry 36: 1062-1066, 1938.

9. LUTZ, H.J. et al. The influence of soil profile horizons on root distribution of white pine. Yale Univ. School of Forestry Bul.44 75 pp. 1937.

10. GATES, F.C. The vegetation of the region in the vicinity of Douglas Lake, Cheboygan County, Michigan.
Papers Mich. Acad. Sci. 1911.

LITERATURE CONCERNING RELATED STUDIES

ALWAY, F.J., and P.R. McMILLEN. Interrelationships of soil and forest cover on Star Island, Minnesota. Soil Science 36: 281-294. 1933.

ALWAY, F.J., J. KITTREDGE, and W.J. METHLEY. Composition of the forest floor layers under different forest types on the same soil type. Soil Science 36: 387-398. 1933.

FISHER, R.T. Soil changes and silviculture on the Harvard forest. Ecology 9: 6-11. 1928.

GATES, F.C. Aspen association in northern lower Michigan. Botanical Gazette 90: 233-259. 1930.

GATES, F.C. Vegetation of the region in the vicinity of Douglas Lake Cheboygan County, Michigan. Mich. Acad. Sci. Rep't. 14: 46-106. 1912.

GRIFFITH, B.G., R.W.HARTWELL, and T.E. SHAW. The evolution of soils as affected by the old field white pine-mixed hardwood succession in Central New England. Harvard Forest, Bul. 15. 1930.

HEIMBURGER, CARL C. Forest-type studies in the Adirondack region. Cornell Univ. Agr. Expt. Sta. Memoir 165. 1934.

HICOCK, H.W., M.F. MORGAN, H.J.LUTZ, HENRY BULL, and H.A.LUNT. The relation of forest composition and rate of growth to certain soil character. Conn. Agr. Expt. Sta., Bul. 350. 1931.

KITTREDGE, JOSEPH, JR. The interrelationships of habitat, growth rate, and associated vegetationin the aspen community of Minnesota and Wisconsin. Ecological Monograph 8: 153-243.

LUNT, HERBERT A. Profile characteristics of New England forest soils. Conn. Agr. Expt. Sta., Bul. 342. 1932.

MacKINNEY, A.L. Effects of forest litter on soil temperature and soil freezing in autumn and winter. Ecology, 10: 312-321. 1929.

McINTYRE, GEORGE S. Theory and practice of forest typing with special reference to the hardwood and hemlock associations of Northern Michigan. Mich. Acad. of Sci., Arts, and Let., Papers 15: 239-261. 1931.

MELIN, E. Biological decomposition of some types of litter from North American forests. Ecology 11: 72-101. 1930.

STALLARD, HARVEY. Secondary succession in the climax forest formations of northern Minnesota. Ecology 10: 476-547. 1929.

STANLEY, ORAN B. Indicator significance of lesser vegetation in the Yale Forest near Keene, New Hampshire. Ecology 19: 1938.

STICKEL, P. W. Physical characteristics and silvicultural importance of

podsol soils. Ecology 9: 176-187. 1928.

WESTVELD, R.H. The relationship of certain soil characteristics to forest growth and composition in the Northern Hardwood Forest of Northern Michigan. Mich. Agr. Expt. Sta., Tech. Bul. 135.

WILDE, S. A. Classification of gley soils for the purpose of forest management and reforestation. Ecology 21: 1940.

WILDE, S.A. and H. F. SCHOLZ. Subdivision of the Upper Peninsula Experiment Station on the Basis of soils and Vegetation. Soil Science 38: 383-400. 1934.

YOUNG, VERNON A. Plant distribution as influenced by soil heterogeneity in the Cranberry Lake region of the Adirondack Mountains. Ecology 15: 154-196. 1934.