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THE UNIVERSITY OF WISCONSIN
GEOLOGICAL AND NATURAL HISTORY SURVEY
SOIL SURVEY DIVISION

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F. D. Hole, in charge, Soil Survey Division

Bulletin 85, Soil Series No. 60

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By Clarence J. Milfred, Gerald W. Olson, and Francis D. Hole; with chapters by F. P. Baxter and F. G. Goff; W. A. Creed and Forest Stearns

IN COOPERATION WITH
DEPARTMENT OF SOIL SCIENCE, COLLEGE OF AGRICULTURE,
AND
SOIL CONSERVATION SERVICE AND FOREST SERVICE, U.S.D.A.

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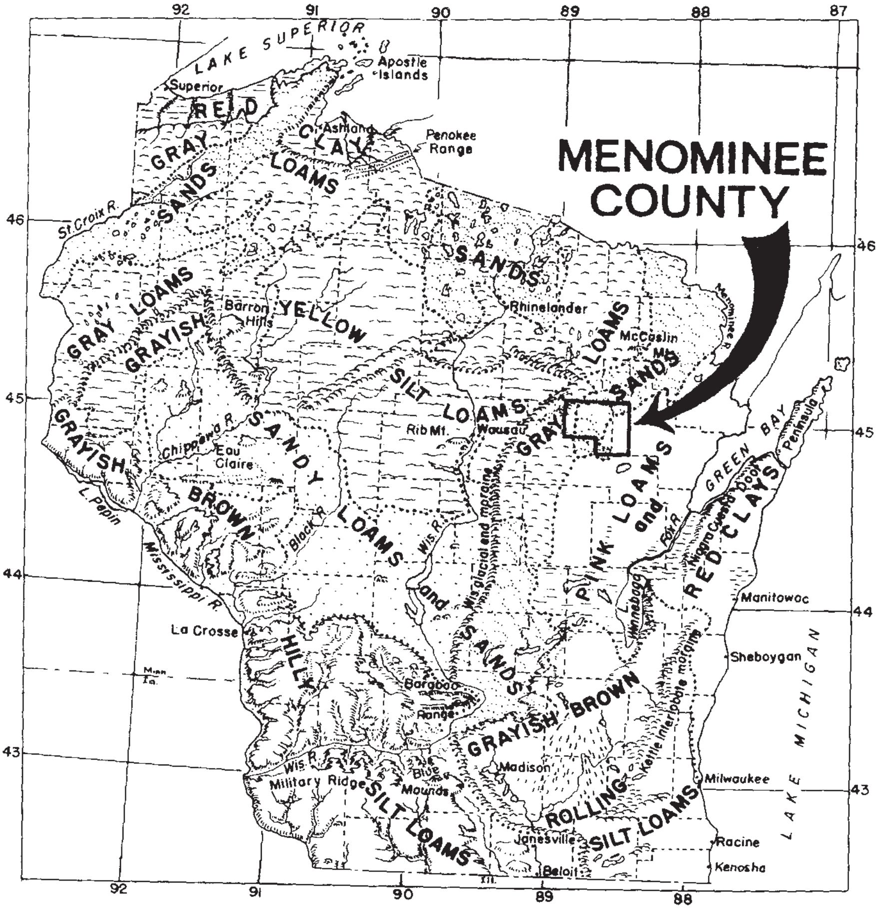

Figure 1. This generalized soil map of Wisconsin shows three general soil regions in Menominee County: (1) "gray loams" on the west, (2) "sands" in the central part, and (3) "pink loams" on the east. The colored soil map in the backcover pocket shows twenty-five kinds of soils in Menominee County. Each kind of soil has a characteristic profile (vertical cross-section), with definite horizons (soil layers) and a characteristic landscape. See Figure 2.

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Figure 2a. Forest dominated by white pine and red pine (unit 4, vegetation map) on Pence sandy loam, (units 17, 18, 19, 22, soil map).

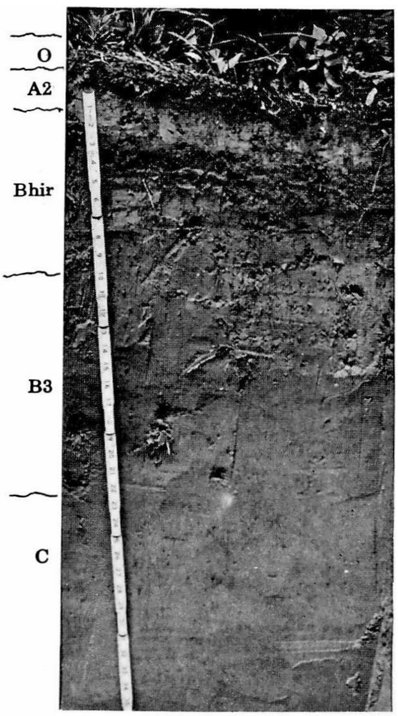

Figure 2b. Profile of Pence sandy loam showing the horizons: O, organic layer; pale A2 (0″-2″), sandy loam; dark brown humus-iron layer, Bhir (2″-10″), sandy loam; light brown B3 (10″-22″), sandy loam; yellowish brown C, sand. This soil is formed from loamy material over acid sand and gravel glacial outwash.

Soil Resources and Forest Ecology Of Menominee County, Wisconsin

C. J. Milfred, G. W. Olson and F. D. Hole; with chapters by F. P. Baxter, F. G. Goff, W. A. Creed, F. W. Stearns

ABSTRACT

Menominee County, located in northeastern Wisconsin, is the land formerly designated as the Menominee Indian Reservation (1854–1961). The county has an area of 234,000 acres and had a population of about 3,300 in 1961. It is remarkable for its large block of timber which has never been clear-cut, and which has increased in volume under a program of conservative selective cutting. Stands more than 100 feet tall of white and red pine, hemlock, and sugar maple trees are impressive. Unregulated hunting by the Menominees in the days of the reservation has kept the deer population to a low figure, which explains in part the excellent reproduction of the forest.

Land-surface altitudes range from about 625 to 1,425 feet. Except for scattered outcrops of granitic bedrock in the Wolf River Valley the Precambrian bedrock is buried beneath glacial deposits of Middle to Late Wisconsonian age. Glacial drumlins, standing about 50 feet high above outwash and till plains, are prominent in the landscape as viewed from a fire-tower or from an airplane. Peat bogs are extensive and there are more than 100 lakes.

The soils range from sands in the southeast to silt loams in the northwest. The county lies in a transition zone grading from coniferous forest lands on the north, southwestward toward deciduous forest and prairie lands. This is reflected in the character of the soils, which include weakly developed dark soils under prairie vegetation in open jack pine and Hill's oak forests, weakly developed forest soils under hardwood-coniferous forest, and strongly developed Podzol soils under hemlock forest. Most of the forest floor is characterized by pits and mounds ("cradle-knolls") made by blowdown of timber during violent storms over many centuries. The present composition of the forest in many parts of the county has been influenced by local forest fires of thirty or more years ago. The county presents unusual opportunities for study of forest and wildlife ecology, for recreation as well as for harvesting of wood products on a sustained yield basis.

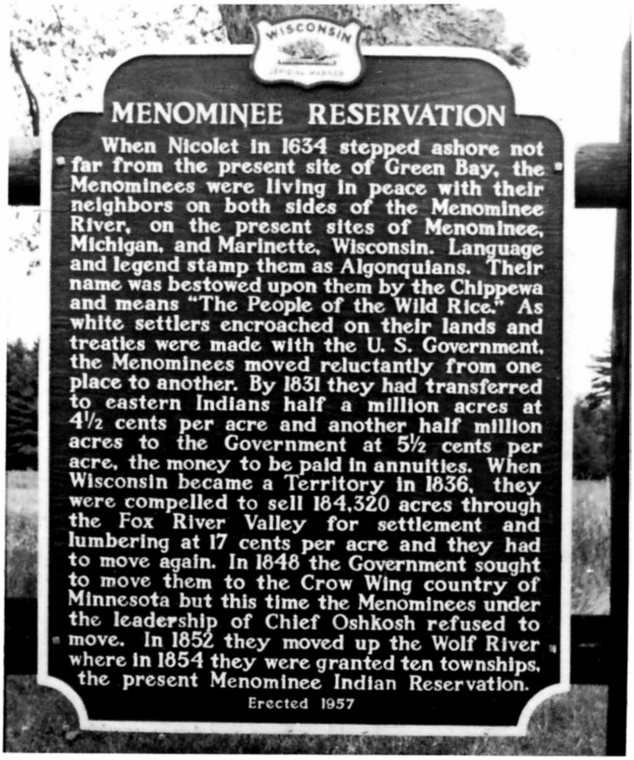

Figure 3. The plaque (above) located along Wisconsin State Highway 55 and 47 just south of the Menominee County line. The county sign (below) was erected here in 1961 when the reservation became Menominee County.

I. INTRODUCTION

Purpose and Scope of Investigation

The people of Wisconsin are becoming increasingly aware of the importance of natural resources in the development of the state from the economic, recreational, and aesthetic standpoints. Menominee County (Figure 1) is outstanding—not only in Wisconsin but, also, in the Lake States region—for its resources of soils, forest, wildlife, lakes, and streams. It stands as a demonstration of successful forest management for sustained yield of forest products, along with conservation of soil, fish and wildlife, and water resources, and preservation of natural beauty.

A study of the soils, glacial geology, plant communities, and wildlife was begun in 1961 by the Soil Survey Division of The University of Wisconsin Geological and Natural History Survey under the direction of George F. Hanson with the cooperation of the Department of Soil Science of the College of Agriculture, the U.S. Soil Conservation Service, the Wisconsin Conservation Department, the U.S. Forest Service, and the U.S. Bureau of Indian Affairs. Later the Menominee Enterprises, Inc. cooperated by facilitating entry into the most remote parts of the forest. This study was a part of a state-wide and nation-wide cooperative program of soil survey begun in 1899.

The investigation was under the immediate supervision of F. D. Hole, Professor of Soil Science, in charge of the Soil Survey Division of the Geological and Natural History Survey. The project was planned cooperatively with the following individuals: R. D. Sale, Geological and Natural History Survey Cartographer; Professor L. E. Engelbert, Chairman of The University of Wisconsin Department of Soil Science; Professors G. Cottam and O. L. Loucks of the Botany Department; A. J. Klingelhoets of the Soil Conservation Service; W. Wertz of the U.S. Forest Service; and J. B. Hale of the Wisconsin Conservation Department. The purpose of the project was to determine (1) the characteristics and potentialities, and the pattern of distribution, of the soils, (2) the nature and extent of the plant communities, (3) the character and distribution of glacial deposits, and (4) the relationships between soils, their parent materials, and plant and animal communities.

Reconnaissance surveys were made of the soils, geological formations, and vegetation; and use was made of existing maps and information. A soil map, a vegetative cover map, and a glacial geology map were prepared. Mapping was done on contact aerial photographs and U.S. Geological Survey planimetric maps. C. J. Milfred, G. W. Olson, and F. D. Hole did most of the soil mapping and description of soils. F. G. Goff and F. P. Baxter carried out intensive plant community and soil studies. Cartography was by R. D. Sale, R. Helgeland, P. T. Liu, and C. Monum. S. A. Wilde gave valuable assistance in the field and in the editorial process. T. T. Kozlowski kindly reviewed the sections on forestry. F. D. Hole served as editor.

Acknowledgments

Appreciation is expressed to Menominee Enterprises, Inc., to Mr. and Mrs. James Webster of Neopit, and to other citizens of the county for friendly cooperation. Carl Hackensen of Menominee Enterprises provided valuable information on forest ecology from his own experience in the county. Mr. George M. Chappa, Superintendent, White Lake Public School, kindly made office space available during the summer of 1964. P. Claeys, J. Bouma, E. J. Ciolkosz, and G. A. Nielsen, all of the Soil Survey Division, assisted in the survey. J. K. Ableiter, A. J. Klingelhoets, P. H. Carroll, H. V. Strelow, and R. J. Bartelme of the Soil Conservation Service, W. Wertz of the U.S. Forest Service, and G. B. Lee and M. T. Beatty of the Soil Survey Division all helped with soil correlation. F. Glenn Goff, James H. Zimmerman, and Paul H. Zedler prepared a list of flora with the help of Professor Hugh H. Iltis. Richard Gordon prepared a list of summer resident birds.

Acknowledgment for review of this report is made to George F. Hanson, Director of the Geological and Natural History Survey, to Professor Robert F. Black of the Department of Geology, to M. E. Ostrom, Assistant State Geologist, to Alice E. Smith of the Wisconsin State Historical Society, to A. J. Klingelhoets and Robert Fox of the Soil Conservation Service, and Mrs. Nancy Knight. Helping with cartography and preparation of illustrations were Catherine Horrall, David Kopitzke, and Philip Chapados.

Previous Reports

Whitson *et al* (1915) published a Reconnaissance Soil Survey of northeastern Wisconsin which covered the present Menominee County. Terman and Fine (1942) of the College of Agriculture at The University of Wisconsin prepared soil maps of about 6,000 acres of cleared land on the Menominee Indian Reservation as a basis for determining soil productivity for agricultural and silvicultural uses. Thwaites (1943) published an article on the glacial geology of the region, with maps and bulletin. Wilde *et al* (1949) presented much information on the relation of soils to silviculture which had been obtained from the forests of the Menominee Indian Reservation. Klingelhoets and Muckenhirn (1956) prepared a generalized soil map of the Menominee Indian Reservation.

Directions for using the colored generalized soil map in back cover pocket

To use the soil map in Menominee County, the reader orients himself with respect to roads, streams, numbered sections, and townships. For example, one can follow State Highway 47 northwest from Neopit to an intersection with a side road about seven miles distant, not far beyond Lake

Noseum. This is in the southwest corner of section number 28, in Township 30 North, Range 13 East (note in the margins of the map the symbols T. 30 N. and R. 13 E.). At the intersection a road leads to the right onto a body of soils numbered 5, which refers the reader to the legend at the bottom of the map where unit 5 is defined briefly as "Kennan and Iron River stony loams and sandy loams; Pence and Chetek sandy loams; and associated soils, hilly. Slopes 10 to 40 per cent." These soils are hilly, stony, and sandy. This is an example of a soil association. Twenty-five soil associations are shown on the soil map and are listed in Table 36. The soils of a given association are typically found grouped together in the landscape and grade into each other.

The soil keys in Table 3 and Figure 5 can be used along with the map to identify soils. By means of the soil map the user may locate himself on a soil body (Hole, *et al,* 1953). With a spade he can clear off a road bank or dig with a spade to a depth of about three feet to expose soil layers and horizons (Figure 20). By reading from left to right on a soil key, using his observations of the soil layers as a guide, he can find the proper name of the soil. The soil map tells where soils occur together at a given part of the county, and the soil key, together with soil description in Chapter IX, tells how to distinguish these soils. Silt loam, sandy loam, and other soil textures may be recognized by carefully rubbing soil between the fingers, as described in the glossary under the heading, field grading of soil texture.

Where to find detailed soil maps

This publication does not contain detailed soil maps of Menominee County, except for the sample shown in Figure 4, which covers Section 2, T. 30N., R. 15E. A number of detailed maps like the one in Figure 4c have been made by soil scientists of the Soil Conservation Service for scattered quarter sections of the county. These maps may be found at the S.C.S. office in Wausau. The slight degree of erosion indicated for most soil bodies in Figure 4c refers chiefly to local scalping of the soil in logging operations.

Figure 4a. An aerial photograph of section 2, T.30N., R.15E. This represents 1 square mile. The large stream is the Wolf River.

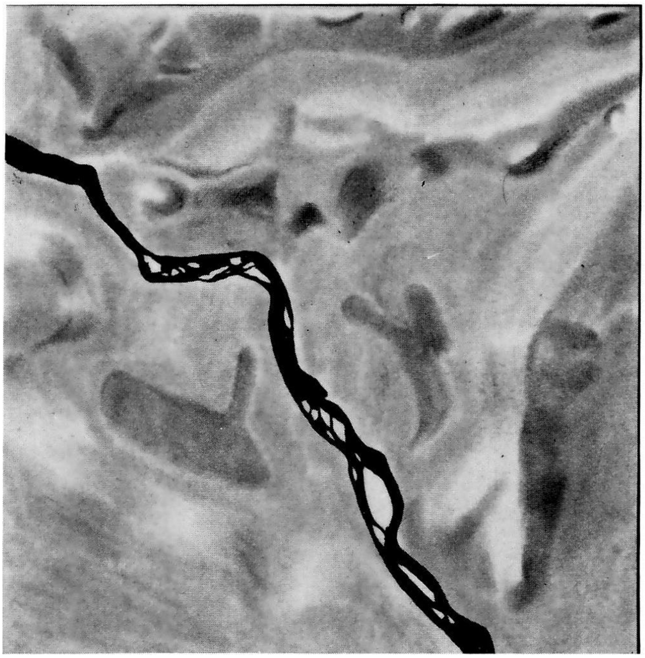

Figure 4b. A shaded landform map of the same section.

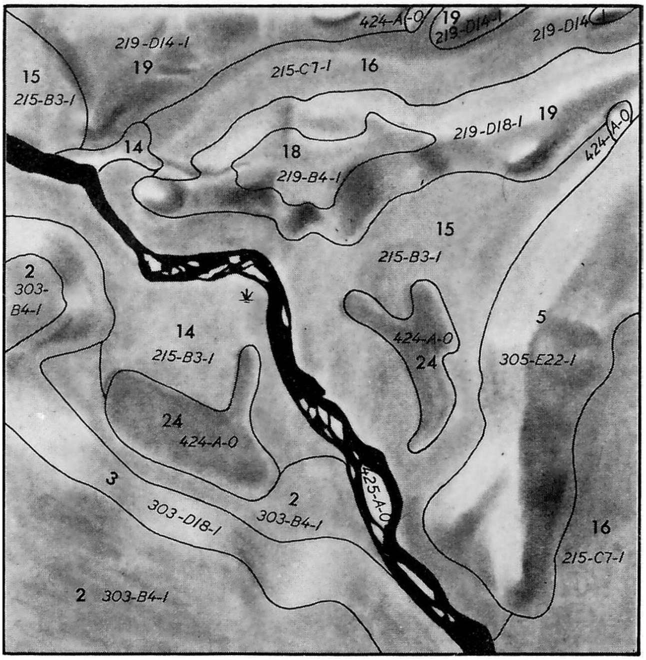

Figure 4c. A detailed soil map drawn on the land form map.

LEGEND, FIGURE 4c

Sample symbol: 303-B4-1 (soil-slope-erosion) = Norrie silt loam, undulating ("B" slope of 4%), slightly eroded.*

Symbols, Figure 4c	Corresponding symbols, colored soil map	Explanation
303-B4-1	2	As above
303-D18-1	3	Norrie silt loam, rolling (18% slope), slightly eroded.
305-E22-1	5	Kennan and Emmert stony loams, hilly (22% slopes), slightly eroded.
215-B3-1	14	Onamia loam(with wet spots), undulating (3% slope), slightly eroded.
215-B3-1	15	Like 14, but lacking wet spots.
215-C7-1	16	Onamia loam, gently rolling (7% slope), slightly eroded.
219-B4-1	18	Chetek sandy loam, undulating (4% slope), slightly eroded.
219-D14, 18-1	19	Chetek sandy loam, rolling (14% and 18% slopes), slightly eroded.
424-A-0	24	Peat (forested, level, uneroded) and associated alluvial soils.

(*Slight erosion refers to skidding trails, disturbance by logging)

GENERALIZED SOIL KEY FOR USE IN LANDSCAPES OF MENOMINEE COUNTY, WISCONSIN

(Note: A soil key for your locality can be prepared with the assistance of a soils specialist)

ALL SOILS IN THE LANDSCAPE

LAY OF THE LAND	SOIL PROFILE			SOIL NAME
Soils above bogs and streams and therefore not flooded with water nor wet permanently. Soils nearly level to hilly.	Sandy soils over loose sand with gravel.	Deep sand with or without loamy sand surface layer (<6" thick)	Very dark "A1" overlies brown (7.5YR 4/4) "B" horizon	OMEGA
			1" to 3" thick "A2" (5YR 5/2) overlies reddish brown (5YR 4/4) "B" horizon	VILAS
		Loamy fine sand surface soil overlies sand at 18" to 42" depths	1" to 3" thick "A2" overlies brown to reddish brown (7.5YR 4/4) "B"	CRIVITZ
	Loams and silt loams over loose sand with gravel.	Silt is 20" deep to 40" deep	Thin dark "A1" overlies 8"-12" thick grayish brown (10YR 4/3-6/3) "A2" over a dark brown (7.5YR-10YR 4/4) "B"	ANTIGO
			6" thick dark "A1" overlies 8"-10" mottled pale brown (10YR 6/3) "A2" over mottled brown (10YR 4/4) "B"	BRILL
			Gray (5YR 5/1) "A2" horizon is 1" to 3" thick over brown (7.5YR 5/4-4/4) "B" horizon	STAMBAUGH
		Loam is 24" to 42" deep	5"-8" thick light gray (10YR 6/2) "A2" overlies dark brown (7.5YR 4/4) "B"	ONAMIA
			3"-5" thick reddish gray (5YR 5/2) "A2" overlies reddish brown (5YR 4/4) "B"	PADUS
		Loam or sandy loam is 15" to 24" deep	4"-6" thick light brownish gray (10YR 5/3) "A2" overlies brown (7.5YR 4/4) "B"	CHETEK
			2"-4" thick brown (7.5YR 5/2) "A2" overlies brown (7. 5YR 4/4) "B"	PENCE
	Loams and silt loams over stony loamy or sandy material.	Silt is 18" to 42" deep over stony sandy loam or loam	4" thick black "A1" and 5"-10" thick pale "A2" overlies brown (7.5YR 4/4) "B"	NORRIE
			2"-3" gray (5YR 5/1) "A2" overlies dark brown (7.5YR 4/4) "B"	GOODMAN
		Silt is more than 20" deep over stony sandy loam	Dark "A1" and 5"-10" thick pale "A2" overlie dark brown (7.5YR 4/3) "B"	KENNAN
			3" thick reddish gray (5YR 5/2) "A2" overlies reddish brown (5YR 5/4) "B"	IRON RIVER
		Loams — Underlying reddish brown (5YR-7.5YR) substratum is calcareous at 36" to 72"	Substratum is loam till	UNDERHILL
			Substratum is sandy loam till	UNDERHILL sandy substratum variant
	Fine sandy loams and silt loams over substratum of fine sands, silts and some clays.	Substratum lies at a depth of more than 40"	surface soil is silt loam and fine sandy loam	ALBAN
			surface soil is fine sandy loam and loamy fine sand	CRIVITZ loam substratum variant
		Substratum lies at 18" to 42"		FENCE
	Gravelly, sandy soils			EMMERT
Soils on low ground where water stands after rains or where soils are permanently wet.	Sandy soils on loose sand		3"-7" thick gray (10YR 5/2) mottled "A2" overlies 7"-14" thick mottled "B"	AU GRES
			3"-7" thick dark "A1" and mottled "A3" overlie mottled grayish brown (10YR 5/2) "C"	ROSCOMMON
	Fine sandy loams and silt loams less than 18" thick over stratified fine sand, silt clay, calcareous at 30" to 60"		Black A1 about 1" thick overlies mottled "A2" and "B" horizons	BRIMLEY
			Nearly black "A1" is more than 6" thick over mottled "B" and "C"	BRUCE
	Organic soils of bogs; soil is deeper than 12" over sand, silt or loam			PEATS

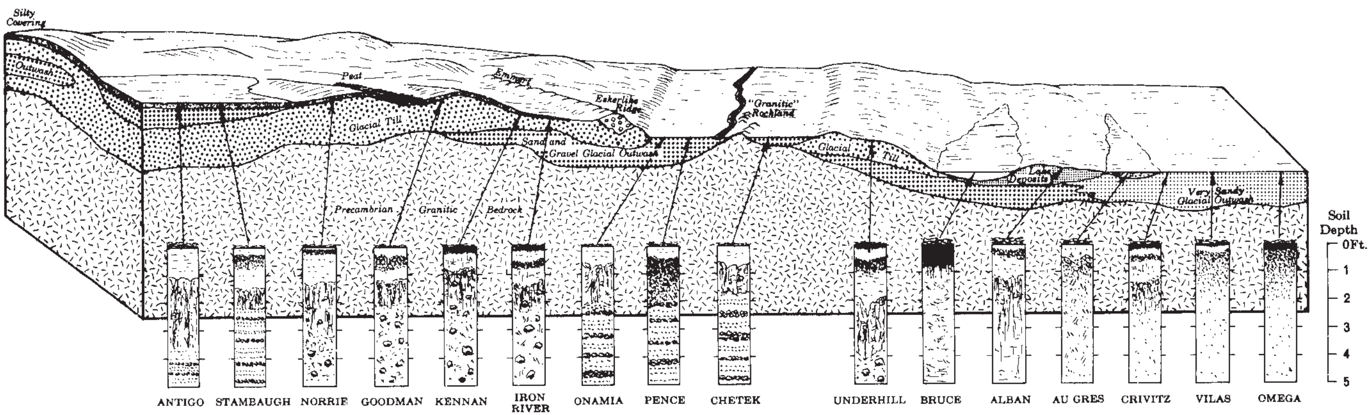

Figure 5

II. MENOMINEE COUNTY HISTORY AND RESOURCES

The Menominees, 1634-1854

The explorer Jean Nicolet, the first known European to visit the Menominee tribe in northeastern Wisconsin, was precursor of many French explorers and fur traders who called these Indians Folles-avoines. The term, meaning Wild-rice, had reference to the word Menominee itself which signified rice people. Wild rice was an important article of diet for the tribe.

In the years following Nicolet's 1634 visit (Table 1) to the site of Green Bay, the Menominee Indian Tribe of over 2,000 was subjected to an influx of other American Indians from as far away as New York State. At the same time Europeans were also encroaching in their territory. The French, British, and American flags were displayed in succession at forts at Green Bay.

A series of peace treaties between the U.S. Government and the Menominee Indian Tribe arranged for the transfer of millions of acres of what are now Wisconsin and Michigan from tribal possession to U.S. Government ownership. Later, 2,500 Menominees refused to leave Wisconsin Territory to emigrate to Crow Wing County, Minnesota, as stipulated in the Treaty of Lake Poygan in 1848.

The Menominee Indian Reservation, 1854-1961

In December, 1852, the 2,000 Menominees who would not renounce tribal affiliation for a fee were forcibly moved 70 miles north from Lake Poygan, Wisconsin, to reservation lands designated for them. The treaty of Keshena Falls established the Menominee Indian Reservation in 1854 (Figure 3), and by 1856 its borders were defined at the present locations of the boundaries of Menominee County, encompassing 234,000 acres. In 1887, when most American Indians were taking advantage of the General Allotment Act to divide tribal lands among individual members of the tribes, the Menominee Indians chose to keep their reservation intact as a tribal holding. The "rice people" became of necessity a people of the timber (Figure 6). In a series of Congressional Acts, the tribe was given permission by the U.S. Government to cut and sell logs to millers outside the Reservation (1875); later to cut logs and manufacture lumber for sale at mills (Figure 7) on the reservation itself (1906–1908). Mistakes made by federal superintendents from 1912 to 1916 in clear-cutting instead of selectively cutting Menominee forests, as stipulated by the LaFollette bill of 1908, led to a successful suit by the tribe against the U.S. Government. The suit lasted from 1935 to 1951, when an 8.5 million dollar judgment was determined against the Government (Chapman, 1957). Of this, each of the 3,270 registered Menominees received a payment of $1,500.

TABLE 1. A SELECTED ANNOTATED LIST OF DATES IMPORTANT IN THE HISTORY OF THE MENOMINEE INDIAN TRIBE AND OF MENOMINEE COUNTY, WISCONSIN

Date	Annotation
1634	Jean Nicolet, French explorer, visited the Menominee Indians in Wisconsin, as the first European to do so. He discovered Menominee villages at the mouth of the Menominee River and at La Baye (now Green Bay). The Menominee Tribe was the largest in the Algonquin nation, which also included the Potawatomi, Sac, Fox, and Ojibway (Chippewa) tribes. Soon after, Pierre Esprit Radisson and Medard Chousart came to the Butte de Morts-Green Bay region as Algonquin tribes were fleeing west under pressure from the Iroquois Indians.
1667	Nicholas Perrot, French fur trader, came to mediate between the Menominees and the Potawatomis, at odds over some intertribal killings. In the next year he took the first cargo of furs from La Baye.
1669	Claude Allouez, Jesuit, came as a missionary to the small remnant of Menominee Indians which had survived invasion from the eastern tribes.
1671	The French annexed the territory now included in Wisconsin. Allouez and Andre started a mission on the Fox River.
1673	Joliet and Marquette visited the Menominee Indians.
1678	Duluth and LaSalle visited the Menominee Indians. Of the estimated 20,000 Indians then in what is now Wisconsin, probably 2,000 were Menominees.
1716	A French fort was built at La Baye.
1761	French domination was ended. A British flag flew over La Baye. The British licensed French traders De Langlade and Grignon in the Fox River valley.
1795	Chief Oshkosh ("The Brave") was born.
1815	La Baye became Green Bay and representatives of the U.S. Government replaced those of the British Government there.
1817	The first peace treaty was made between the U.S. Government and the Menominee Indian Tribe, which occupied about eleven million acres in what is now Wisconsin and Upper Michigan.
1818	The Menominee territory was included in what was called the "Michigan Territory".
1821	Government interest in fur trading was terminated.
1827 to 1830	The Treaties of Butte des Morts between the U.S. Government and the Menominee Indian Tribe arranged for the sale of the half million acres of Menominee lands to eastern Indian tribes of New York at $4\frac{1}{2}$ cents per acre. Another equal extent of lands was sold by the Tribe to the Government at 5 cents per acre. Payment was to be in annuities.
1831	Catholic priests resumed missions among the Menominees near Lake Poygan.
1834	A small pox epidemic destroyed about one fourth of the Menominee Indian Tribe.
1836	The "Wisconsin Territory" was created. The Treaty of Cedars arranged for a sale to the U.S. Government of 4 million acres of Menominee lands at 17 cents per acre. The Menominees gave up lands north of the Fox River and east of the Wolf River.

1848 A Treaty at Lake Poygan arranged for the sale of 4.5 million acres of Menominee lands to the U.S. Government for $350,000 plus 6 million acres in Crow Wing County, Minnesota, to which the Menominees were asked to go. The 2,500 Menominee Indians refused to go to Minnesota.

1849 Only 300 descendants of mixed marriages between Menominees and European immigrants accepted payments from the U.S. Government and in return gave up tribal affiliation.

1852 The Menominees (about 2,000 in number) were forcibly moved in the month of December from Lake Poygan to reservation lands 70 miles to the North.

1854 The Treaty of Keshena Falls (10 Stat. 1064-1068) established the Menominee Indian Reservation. In 1856 the tribe sold to the U.S. Government two townships to be assigned to the Stockbridge and Munsee Indians. The Menominee Reservation then consisted of 10 townships of 233,902 acres. Chiefs Keshena and Oshkosh signed the Treaty. A federal Indian Agency was established in 1855.

1858 Chief Oskosh ("The Brave") died.

1863 A school was established in Keshena. President Lincoln signed an Act of Congress enabling construction in Wisconsin and Michigan of a road between old Ft. Howard (now Green Bay) through the Menominee Indian Reservation to Ft. Wilkins (near Marquette, Michigan). In this year about 400 acres of land were under cultivation on the Reservation.

1864 Chief Reginald Oshkosh was born. He was educated at the Carlisle Indian School in Pennsylvania.

1868 A "Pine Ring" of outsiders was accused by the Menominees of seeking to exploit Menominee timber and even of setting fires in the reservation to destroy pine stands.

1871 A Congressional Act (16 Stat. 410-411) provided for the sale of tribal lands with the consent of the Tribal Council. The Council did not give consent, however. The Secretary of Interior consented that the Menominees cut and sell saw logs to mills outside the reservation. Subsequent acts provided for improvement of the Wolf and Oconto Rivers in the reservation.

1880 A Franciscan mission was established in Keshena, and in the next year a central boarding school was opened at the same place. Other schools in the reservation were closed forthwith. Francis Otter and John Corn operated lodging houses along the "military road" in this decade.

1882 A Congressional Act (22 Stat. 30) permitted the Menominees to cut "dead and down" timber and sell logs.

1887 The General Allotment Act provided for allotment of Indian Reservation lands of the country to tribal members with their consent. The Menominee Tribe chose rather to hold the lands of their reservation in common as tribal lands.

1888 The U.S. Attorney General ordered the Menominees to cease cutting timber on the reservation, for the reason that the timber was Government property.

1890 A Congressional Act (26 Stat. 146) authorized cutting and sale by the Menominees, under supervision of Government superintendents, of as much as 20 million board feet on the reservation annually. The U.S. Government asked Chief Neopit (Oshkosh) to relinquish all titles as "there were to be Chiefs no more" and the Indians were to "be subject only to the U.S.A." In 1892 an Act authorized construction of a railroad through the reservation.

1905 A severe storm damaged about 40 million board feet of hardwood-hemlock west of Neopit along West Branch. An Act of 1906 authorized the Indians to log this timber and associated green timber, under supervision of Government experts, to saw lumber at mills on reservation and to sell same.

1908 The LaFollette bill authorized the Menominees to cut logs, manufacture timber under a selective cutting management system by which only physiologically fully matured and ripened green timber would be cut. Forestry Service specialists would mark the trees to be cut. A saw mill, kiln, planing mill and machine shop would be established on the reservation at Neopit and would employ Menominees under supervision of experts. The limit for annual cutting was set at 20 million board feet.

1910 A fire in the "Evergreen District" northeast of Neopit damaged pine, hemlock, and hardwood stands.

1912 A policy was begun by superintendents of clear-cutting the forest in contradiction to the stipulations of the LaFollette bill. Railroad spurs were built in the areas to be cut.

1915 A. R. Whitson, W. J. Geib, and other soil scientists completed a reconnaissance soil survey of Northeastern Wisconsin, including the Menominee Indian Reservation. This was published by The University of Wisconsin Geological and Natural History Survey as Bul. 47, Soil Series No. 12.

1924 The old "military road" became part of the state highway system. It is now Wisconsin State Highway 55.

1925 The mill at Neopit burned. It was replaced by a more adequate structure.

1926 A policy was reinstituted of selective cutting of timber on the Menominee Reservation. At first 75 per cent, then 30 per cent of merchantable timber was cut. Selective cutting was practiced even during salvage operations of two blow-downs in 1935-38.

1931 Several Congressional Acts including the "Indian Reorganization Act," authorized per capita distribution of Menominee Tribal funds, and strengthening of the Menominee Tribe as a more self-governing entity.

1935 A Congressional Act initiated hearings on claims of the Menominee Tribe against the U.S. Government for cutting other than dead and down timber and fully matured and ripened green timber.

1942 G. L. Terman and L. O. Fine of the College of Agriculture, The University of Wisconsin made soil maps of about 6,000 acres of cleared land on the reservation to determine soil productivity for agricultural use.

1951 The Menominee Indian Tribe won an 8.5 million dollar judgement against the U.S. Government for failure on the part of the Government officials to carry out provisions of the LaFollette Act. About 20,486 acres of pine-hardwood-hemlock forest had been clear-cut northeast of Neopit. A sum of $1,500 was paid to each of the 3,270 registered Menominees. Simultaneously the Treaty of 1854 was formally ended and the Government declared intention of termination of federal supervision of the Menominee Indians. In this year about 8,000 acres were under cultivation on the reservation.

1954 President Eisenhower signed the Menominee "Freedom Bill" (68 Stat. 250-252) providing for termination of federal control of the Menominee Indian Reservation.

1956 A. J. Klingelhoets prepared a generalized soil map of the Menominee Reservation.

1961 The Menominee Indian Reservation became Menominee County, Wisconsin. County offices were established at Keshena. Some county governmental functions for which trained personnel was not available among the Menominees were to be carried out by officials in nearby Shawano County. Menominee Enterprises, Incorporated, with headquarters at Neopit was established to manage productive economic enterprises in the county. For 30 years this Corporation was not to sell or mortgage forest lands, exclusive of homes, farms, resorts, without approval of the U.S. Government. Six hundred lots with lake frontage were made available for lease for 10 to 40 years. Each Menominee family could have 4 acres, but could sell these only on condition that the county would be given first chance to purchase.

In 1957 the tribe was faced with four alternatives for their reservation: (1) conversion to a national forest, (2) conversion to a state forest, (3) absorption into Shawano and Oconto Counties and allotment of parcels of land to members of the tribe, and (4) creation of a new county. The Menominee Tribe chose the fourth course of action. On July 3, 1959, Governor Nelson of Wisconsin signed a law making Menominee County the state's 72nd county (Figure 3), the first to be formed since 1901. The law took effect at midnight on April 30, 1961. Menominee County then had about 3,300 residents, including 2,720 enrolled as members of the tribe, whose total membership was 3,700. The Menominee Tribe was the first Indian tribe in the U.S. to be given possession of its lands.

Resources of Menominee County

Income of Menominee County is primarily from forest products and secondarily from recreational resources. Agriculture plays a minor role.

Ninety-three percent of the county is classified as forest land. This forest is the largest block of old-growth timber in the lake states. A 1960 forest inventory showed nearly 1,400,000,000 board feet of saw timber and more than 722,000 cords. Saw timber inventories included 525,000,000 board feet and 180,000 cords of hardwoods, 383,000,000 board feet and 119,000 cords of hemlock, 336,000,000 board feet and 85,000 cords of pine, 93,000,000 board feet and 240,000 cords of aspen (Figure 8), and 26,000,000 board feet and 98,000 cords of swamp conifer.

Under the program of selective cutting initiated by Senator LaFollette, the forest is considered capable of producing about 30,000,000 board feet annually. The current rate of cutting is on a 15-year cycle, with removal of one-fifteenth of the stand once each cycle. Annual growth of trees per

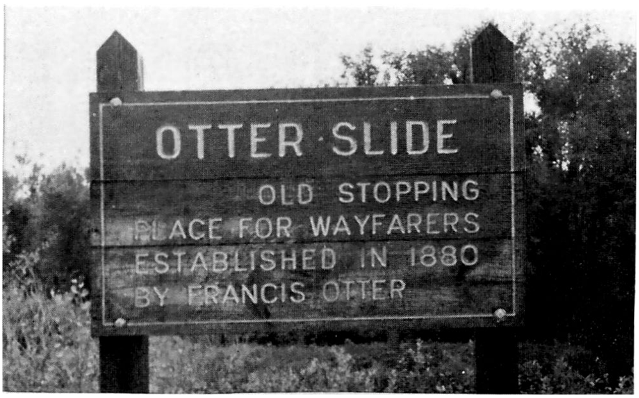

Figure 6. The upper picture shows a wigwam and a wooden canoe in the process of construction at the Dalles of the Wolf River. The lower pictures are of roadside markers commemorating activities of two Menominee Indians on the reservation along routes of travel during the last century.

Figure 7. A view of the lumber mill at Neopit.

acre is about 218 board feet in Menominee County as compared with about 100 board feet per acre for most of northern Wisconsin forest land. The county occupies less than 1 percent of the area of the state but produces about 10 percent of the saw logs of the state; this is despite the toll taken over the years by numerous forest fires and wind-storm damage (Table 1). Out of the approximately 600 employable males in the county in 1960, about 275 were employed in the sawmill of Menominee Enterprises, Inc. at Neopit, and about 125 in logging operations. These figures may be compared with 50 workers in governmental offices, chiefly at Keshena, and 50 workers in other undesignated jobs.

The potential recreational value of Menominee County is considerable. There are 300 miles of trout streams in the Wolf and Oconto River systems, about 130 lakes of which 15 are named (Andrews, *et al,* 1963). Most of the lakes are less than 20 acres in extent and are shallow. A mean of 60 percent of the lake shore length is bordered by soft black soils rich in organic matter, 35 percent by sand and gravel, and 1 percent by rock. Waterfowl are abundant in the lake district of southeastern Menominee County. The fauna include beaver, mink, muskrat, otter. The deer population is low as a result of years of unregulated hunting (see Chapter VIII) as well as limited extent of openings in the forest. The Menominee Enterprise, Inc., which holds title on behalf of the tribe to practically all the land of the county, is prepared to lease several hundred cottage sites near suitable lakes to people who will undertake appropriate development.

In 1960 about 20 families were engaged to some degree in agricultural enterprises as compared with 45 families in 1951 (Wisconsin Governor's Commission on Human Rights, 1952). Five dairy farmers were producing for the general market. A former pattern of subsistence farming, supplemented by winter logging operations with the aid of horses, was changed as work in the forest became mechanized and as the sawmill operations expanded. About 400 acres were considered cleared in 1861 as compared with some 8,000 acres in 1952. Some fields were subsequently abandoned to forest succession. By 1960 only about 4,000 acres were classed as cleared and available for agricultural development. A few farmers are seeking to secure use of more acres (Wisconsin Department of Resource Development, 1964). About 1,600 acres are now under plow.

The population of Menominee County grew from 1,782 in 1910 to 2,948 in 1950. It declined to 2,606 in 1960 but still consisted almost entirely of Menominees. The four settlements are Neopit (population 1,359) which is the location of Menominee Enterprises, Inc.; Keshena, the county seat; Zoar (in the N.E. corner of Section 10, T.29N., R,13E.); and South Branch (in the S.W. corner of Section 23, T.30N., R.16E.). A large proportion of residents are children under 15 years of age. The 15- to 25-year age group is also larger than in Wisconsin as a whole. Parents of many children were working outside the county when the census was taken in 1960.

Leadership by Catholic educators in schools of the county has been notable for a hundred years. There are at present four elementary schools operating in the county. High schools at Shawano, Shawano County, and Antigo, Langlade County, are also available to Menominee County children by bus service.

For the period 1962 to 1966 federal grants-in-aid for educational purposes were scheduled to total $660,000, to be granted in disminishing amounts from $200,000 in the first year to $44,000 in the last year. State aids in 1962 amounted to $82,991. In that year full value of real and personal property was $16,700,350 according to the Wisconsin Taxation Department. The Soo Line Railroad, State Highways 55 and 47, and a network of smaller roads transverse the county.

Living conditions have been reported to be substandard with respect to nutrition, housing, local recreational facilities, and opportunities for training and employment for young people. However, many Menominees have modern homes and are developing forward-looking programs for the higher education of their young people.

Figure 8. Pulpwood on a roadside.

III. CLASSIFICATION OF SOILS

Individual soils are pieces of the mosaic that we call the landscape. Similar bodies of soil are called by the same name. For example all bodies of Au Gres loamy sand look about the same in cross-section (Figure 5). Soil characteristics, such as number and arrangement of horizons, the color, texture, structure, consistence, and acidity of each, are briefly discussed in Chapter IX. Here, names of individual soils are given as they will appear in subsequent chapters, and these soils are grouped into a scientific soil classification.

Classification of soils is chiefly based on characteristics as seen in a vertical section through the soil body. This section is called the soil profile (Figure 20), and its layers are called soil horizons. During the course of thousands of years the soils have formed from deposits called soil parent materials.

Six Major Kinds of Soils

In Menominee County six major kinds of soils are found which may be briefly designated with the following names, including, in parentheses, terms derived from the new soil classification of the Soil Conservation Service (1960). Figure 18 illustrates several of these soils and relates them to types of forest vegetation.

(1) The Podzol (Spodosol) soil consists of a layer of organic matter on the forest floor overlying an ashy gray horizon and a coffee-brown subsoil horizon. The Vilas sand illustrates this kind of soil, and is found well developed under hemlock forest. It appears that, upon removal of the hemlock forest, the horizons of the Podzol soil become faded and blurred. The following soil number 2 may then be formed.

(2) The Hill's oak and Jack pine prairie soil (Spodic Psamment) consists of a thin dark sand layer over a coffee-brown subsoil. The Omega sand illustrates this kind of soil.

(3) The deciduous forest soil (Glossoboralf) is made up of a thin forest litter layer over a thin black surface soil over a pale loam which extends in narrow tongues down into a slightly clay-enriched subsoil. The Antigo silt loam is an example of this, and is found under maple-basswood-elm forest. The Onamia soil is another example.

(4) The combination Podzol-deciduous forest soil (Alfic Haplorthod) consists of a miniature Podzol soil in the upper part of a deciduous forest soil. The Iron River sandy loam illustrates this group, which is fairly common in Menominee County. It is found under hemlock-northern hardwood forest.

(5) The marsh-border wet mineral soil (Haplaquept) is made up of a thick black surface soil over a gray, rust-spotted subsoil. Bruce silt loam (Figure 21) is an example.

TABLE 2.
A CLASSIFICATION OF SOILS OF MENOMINEE COUNTY, WISCONSIN

AZONAL SOILS (ENTISOLS)[1]	
Lithosols (Lithic)	**Regosols**
Granitic Rockland	Emmert (Spodic Udipsamment)
ZONAL SOILS INTERGRADING TO AZONAL REGOSOLS (SPODOSOLS INTERGRADING TO ENTISOLS)	
Podzols intergrading to Regosols	**Prairie-Podzols intergrading to Regosols**
(Spodosols intergrading to Entisols)	(Mollic Spodosols intergrading to Entisols)
Crivitz Vilas	Omega
ZONAL SOILS	
Podzols	**Gray-Brown Podzolic soils grading to Gray-Wooded soils**
(Typic Haplorthods)	(Hapludalfs, Glossoboralfic Hapludalfs and Glossoboralfs)
Pence	Antigo
(Alfic Haplorthods)	Brill
Alban	Chetek
Crivitz	Kennan
Fence	Norrie
Goodman	Onamia
Iron River	Underhill
Padus	
Stambaugh	
ZONAL SOILS INTERGRADING TO INTRAZONAL HUMIC-GLEY SOILS (SPODOSOLS INTERGRADING TO AQUALFIC SOILS)	
Brimley	Au Gres
INTRAZONAL SOILS	
Humic-Gley soils	**Bog soils**
(Mollic Haplaquepts)	(Histosols)
Bruce	Peat: Adrian
(Typic Haplaquepts)	Greenwood
Roscommon	Linwood
	Spalding
	Tawas

[1]Two systems of soil classification used in this chapter are: (1) that of Baldwin, Kellogg and Thorp (1938) revised by Thorp and Smith (1949); (2) the new classification of the Soil Conservation Service, U.S.D.A. (1960). In the table the terms in parantheses come from the second classification.

(6) Peat (Histosol) is a soft, wet organic soil accumulated in depressions to form bogs. Adrian peat is illustrated in Figure 22.

Soil Keys

Terminology used in classifying soils according to texture (proportions of sand, silt, and clay) of various horizons, and degree of wetness or dryness is explained in the glossary. Figures 5 and 24 illustrate how some soils occur in the landscape. Information about the classification of soils of Menominee County is best summarized in the soil keys, Tables 2 and 3 and Figure 5.

Table 2 groups the soils of Menominee County on the basis of three main orders: azonal, zonal, and intrazonal. Azonal soils are relatively weakly developed soils. They include young soils and soils which have formed in unstable environments. The new soil classification calls most of them Entisols (recent soils). Zonal soils reflect the dominating influence of climate and vegetation. Examples are Podzols (Spodosols) and Gray-Brown Podzolic soils (Alfisols). Intrazonal soils differ from the zonal soils in exhibiting characteristics impressed by local conditions, such as an unusual degree of wetness. Humic-Gley soils (Normaquepts) are wet mineral soils and Bog-peat soils (Histosols) are wet organic soil. There are transitions between these orders, such as the intergrade between prairie-Podzol and Regosols (Mollic Spodosols intergrading to Entisols) illustrated by the soil type, Omega sand (Figure 18).

Table 3 is a detailed key to the soils of the county. In it the soils are arranged from the sandiest and stoniest (below and to the left) to the siltiest (above), with a column for organic soils (peats) on the right. The driest soils are on the left, and wettest soils on the right. This soil classification is based on soil profile descriptions (Chapter IX), which are a source of valuable information necessary for planning use and management of soils, and for studying their origins and potentialities.

The organic surface layers of the soils of Menominee County are briefly characterized in Chapter IX in connection with profile descriptions. Chapters VI and VII on the dynamics of vegetation and soils indicate the importance of these surficial horizons, which have been discussed previously by Wilde *et al* (1949).

Soils occur in the landscape in groupings called "soil associations" which are geologic and ecologic in origin. Twenty-five of these are shown on the soil map and are listed with acreages, including area of water, in Table 36. Chapter X discusses soil geography and lists 20 other soils besides those named in Table 3.

FOOTNOTES FOR TABLE 3

[1]In the table two sets of soil names are given, as for example: "Pence sandy loam, loam (Typic Haplorthod)." The first name designates the specific soil type. The name in parentheses is a more general term taken from the new soil classification of the Soil Conservation Service, U.S.D.A. (1960).

[2]Parent materials are inorganic and organic materials from which soils are forming. Where the soil formed from two layers or strata, these two materials are referred to as (1) surface materials and (2) substrata, respectively.

[3]Solum (A + B horizons) of well drained soils.

[4]Well drained soils are medium textured soils (silt loams, loams and fine sandy loams) which show little or no mottling in the A, B, or upper C horizons. Excessively drained soils show no mottling in the profile, and include deep gravels and sands, and medium textured soils overlying sand and gravel.

[5]Upland soils consist of well drained to poorly drained soils lying above bottomland or alluvial soils. In Menominee County, the distinction between outwash terrace and till uplands is not as clear as in some counties of southern Wisconsin, such as Dane County. Therefore, all soils are grouped as Upland soils in this table.

[6]Moderately well drained soils are those which under natural drainage conditions show distinct mottling in the C and lower B horizons.

[7]Somewhat poorly drained soils are those which under natural drainage conditions show distinct mottling in the C, B, and lower A horizons.

[8]Regosolic and lithosolic soils are very young soils over unconsolidated and consolidated geologic materials respectively. These soils have scarcely any B horizon.

[9]An Acid Brown Forest soil has fairly uniform color throughout, and nearly uniform content of clay from top to bottom of the solum, but exhibits structural differences between the A and B horizons.

[10]A Brown Podzolic soils has an A1 horizon resting directly on a Podzol B horizon, without intervening A2 horizon.

[11]A Podzol soil has a thick humus layer on the forest floor overlying a pale pinkish gray A2 horizon over a dark brown B horizon in which iron and/or organic matter have been deposited.

[12]A minimal Podzol is a weakly developed Podzol. In Menominee County this Podzol in sand has an A2 horizon 0.5 to 3.0 inches thick, a Bhir orterde (7.5-5YR 4/4 moist color) 5.0 to 7.0 inches thick.

[13]A Gray Wooded soil has a humus layer on the forest floor, overlying a pale gray A2 horizon which tongues down into a blocky prismatic B horizon, scattered units of which are completely enveloped in the lower A2. A Gray-Brown Podzolic soil has a humus layer over a mull layer (mixture of mineral soil and organic matter), and an underlying pale A2 horizon which does not tongue down noticeably into the blocky B horizon.

[14]A bisequal Podzol soil is a soil with a Podzol sequence of horizons (01, 02, A2, Bhir) over a Gray-Wooded or Gray-Brown Podzolic sequence (A'2x, B'2x).

[15]Low Humic-Gley soils have dark A horizons which are shallower than plow-depth (about 7 inches), overlying gray subsoil.

[16]Humic-Gley soils have black A horizons which are deeper than plow-depth, overlying gray subsoil.

[17]Bog soils are organic soils (peats and mucks) formed primarily from organic materials such as moss, sedges, reeds, trees and other bog vegetation.

[18]This soil was observed in Menominee County but no description was obtained in the course of the reconnaissance soil survey.

TABLE 3. TABULAR KEY TO THE SOILS[1] OF MENOMINEE COUNTY, WISCONSIN

Patent Material[2]				drier ←— Upland Soils[5] Arranged According to Natural Soil Drainage —→ wetter										
				Well to Excessively Drained[4]					Moderately Well-drained[6]		Somewhat poorly Drained[7]	Poorly Drained	Very Poorly Drained	
Surface Materials[2]		Substrata[2]												
Texture	Thickness	Charac-teristics	Thick-ness of Solum[3]	Regosolic[8] and Litho-solic[8] Soils (Entisols and Lithic Subgroups)	Acid Brown Forest[9] Brown Podzolic [10] and disturbed Podzol Soils (Entisols and Entic Subgroups)	Minimal Podzol[11, 12] (Haplorthods)	Gray Brown Podzolic[11, 13] Gray-Wooded Soils[13] Glossoboralfic Hapludalfs)	Minimal Podzol[12] Bisequal[14] (Alfic Haplorthods)	Gray-Brown[13] Podzolic Gray-Wooded (Typic Glossoboralf)	Minimal Podzol[12] Bisequal[14] (Typic Glossoboralf)	Minimal Podzol [12] Haplaquods and (Aqualfic Haplorthods)	Low Humic Gley[15] Soils (Typic Haplaquepts)	Humic Gley [16] Soils (Mollic Haplaquepts)	Bog[17] Soils (Histosols)
Silty or very fine sandy loam surface layer present	Less than 20" thick	Acid brown (7.5 YR-10 YR) stony sandy loam glacial till	24" to 36"	Granitic Rockland Entisols and Lithic subgroups			Kennan silt loam, loam, sandy loam (Glossoboralfic Hapludalf)	Iron River silt loam, loam, sandy loam (Alfic Haplorthod)	18	18	18			
	20" to 40"		24" to 48"				Norrie silt loam (Glossoboralfic Hapludalf)	Goodman silt loam (Alfic Haplorthod)	18	18	18			
		Acid Sand and gravel glacial outwash	24" to 48"				Antigo silt loam (Typic Glossoboralf)	Stambaugh silt loam (Alfic Haplorthod)	Brill silt loam (Typic Glossoboralf)		18			
Loam or sandy loam surface layer present (upper 6" may be silt)	15" to 24"	Acid sand and gravel glacial outwash	20" to 30"	Emmert gravelly sandy loam (Spodic Udipsamment)		Pence sandy loam, loam (Typic Haplorthod)	Chetek sandy loam, loam (Typic Hapludalf)				18			Peat (Adrian) (Greenwood) (Linwood) (Spalding) (Tawas)
	24" to 42"		30" to 48"				Onamia loam, sandy loam (Typic Hapludalf)	Padus loam, sandy loam (Alfic Haplorthod)			18			
	18" to 40"	Calcareous pink (5 YR) sandy loam to loam glacial till	30" to 50"					Underhill loam, sandy loam, (Typic Eutroboralf)		Underhill loam, sandy loam (Typic Glossoboralf)	18			
		Thin calcareous glacial till over outwash sand and gravel						Underhill (sandy substratum variant sandy loam, loam (Typic Eutroboralf)						
Very fine sandy loam or coarse silt loam surface layer present	40" to 60"	Neutral to calcareous pink (5 YR) glacio-lacustrine silts and sands	24" to 40"					Alban fine sandy loam, coarse silt loam (Typic Hapludalf)		18	18			
	18" to 24"	Acid pink (5 YR) glaciolacus-trine fine sand and silt	24" to 42"					Fence fine sandy loam coarse silt loam (Alfic Haplorthod)						
	Less than 18"	Pink (5 YR) stratified silt, very fine sand, clay glacio-lacustrine deposits, calcareous at 30" to 60"	24" to 40"								Brimley silt loam, very fine sandy loam loam (Aqualfic Haplorthod)		Bruce silt loam (Mollic Haplaquept)	Peat (Adrian) (Greenwood) (Linwood) (Spadling) (Tawas)
Very sandy material	15" to 30"	Deep acid fine to medium sand with some gravel	24" to 36"		Crivitz loamy sand, fine sandy loam (Entic Haplorthod)			Crivitz loamy sand, fine sandy loam (Alfic Haplorthod)						
	36" to 48"	Loam, silty clay loam			Crivitz (loamy sub-stratum variant) loamy sand, fine sandy loam (Entic Haplorthod)						18			
Deep (more than 5') acid reddish yellow (7.5 YR) glacial drift sand with some gravel			Less than 24"	Omega sand, loamy sand (Spodic Udipsamment)	Vilas loamy sand, sand (Entic Haplorthod)						Au Gres loamy sand, sand (Entic Haplaquod)			
Deep neutral to calcareous sand			12" to 18"									Roscommon loamy sand, sand (Typic Haplaquept)		

IV. INTERPRETIVE RATINGS OF SOILS FOR VARIOUS USES

Land use planning is primarily based on the characteristics and geographical distribution of soils. Tables are presented in this chapter which indicate limitations and productivity estimates for the soils.

Limitations for various uses

Table 4 indicates degrees of limitations, from slight to very severe, of the soil types for forestry (northern hardwoods and red pine), pasture, agricultural crops, industrial sites, sites for homes with on-lot sewage disposal, transportation routes, and recreational uses (camping and hiking). Table 5 presents similar information for the soil associations listed in the legend of the soil map. Such soil ratings can be helpful in avoiding mistakes in land use, such as the installation of septic tank sewage disposal systems on wet low-lying soils subject to seasonal flooding.

Timber Productivity

Table 6 gives estimates of annual growth or yield of hardwood forests and several coniferous trees in Menominee County. The data are based on recent studies (Wilde, *et al,* 1965) in northern Wisconsin.

Mature forest stands in Menominee County have the following approximate volumes: hard maple (*Acer saccharum*), 20,000 board feet (BF) per acre; hemlock (*Tsuga canadensis*) at age 250 years, 15,000 BF per acre; white pine (*Pinus strobus*) at 130 years, 40,000 BF per acre, and at 200 years, 120,000 BF per acre. These representative volumes compare with oak (*Quercus*) stands in southern Wisconsin at 12,000 BF per acre, and with the remarkable volume of 40,000 BF per acre of deciduous forest stands on the Clermont silt loam in southern Indiana. The emphasis on volume of wood in Table 6 does not take into account differences in sale price per board foot (or cord) of the different kinds of wood.

S. A. Wilde *et al* (1958, 1964) have outlined the principles of forest soil management elsewhere.

Agricultural productivity

Table 7 presents a general agricultural rating for each soil and estimates of productivity of the soils for a variety of crops, including hay. These estimates are based on observations in counties in the vicinity of Menominee County.

Soil tests made by the Department of Soil Science, College of Agriculture, (see Tables 32, 33, 37) show that soil reaction and contents of available nutrients such as phosphorous and potassium in the surface soil vary with

TABLE 4. SEVERITY[1] OF LIMITATIONS OF SOIL TYPES OF MENOMINEE COUNTY, WISCONSIN, FOR VARIOUS USES

Name of soil type (or land unit)	Soil Map Symbol[2]	Forestry		Pasture (Legume-Grass)	Agricultural cultivated crops	Industrial sites	Home sites[3] with septic tank system	Transportation routes[4]	Recreation[5]	
		Northern Hardwoods	Red Pine						Campsites	Hiking terrain
Alban fine sandy loam	6, 7, (8), 9, (10)	Moderate	Moderate	Slight	Moderate	Moderate	Slight	Slight	Slight	Slight
Antigo silt loam	11, 12, 13	Slight	Slight	Slight	Slight	Slight	Slight	Slight[s]	Slight	Slight
Au Gres loamy sand	(20, 21)	Very Severe	Severe	Moderate	Severe	Severe#	Very Severe#	Severe#	Very Severe#	Severe#
Brill silt loam	(11, 12, 13)	Slight	Severe	Slight	Slight	Very Severe#	Very Severe#	Severe#	Slight	Severe#
Brimley silt loam	(6, 7, 8, 9, 10)	Moderate	Very Severe	Slight	Moderate	Severe#	Very Severe#	Severe#	Severe#	Severe#
Bruce silt loam	(6, 7, 8, 9, 10)	Severe	Very Severe	Slight	Moderate	Very Severe#	Very Severe#	Severe#	Very Severe#	Severe#
Chetek loam	5, (6), 10, 14, 15, 16, 17, 18, 19, 22, 23	Moderate	Moderate	Moderate	Moderate	Slight	Slight	Slight	Slight	Slight
Crivitz loamy fine sand	10, 17, 18, 19, 20, 21, 22, (23)	Severe	Moderate	Moderate	Severe	Slight	Slight	Slight	Slight	Slight
Crivitz (loam sustratum variant) loamy fine sand	6, 7, (8), 9, (10)	Moderate	Slight	Moderate	Moderate	Slight	Moderate	Slight	Slight	Slight
Emmert stony, gravelly sandy loam	(5)	Severe	Severe	Moderate#	Very Severe#	Moderate[b]	Moderate[b]	Slight	Severe[b]	Slight[a]
Fence fine sandy loam	(8, 9, 10, 17)	Slight	Moderate	Slight	Slight	Slight	Slight	Slight	Slight	Slight
Goodman silt loam	1, 2, 3, 4	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight
Granitic rockland	23	Very Severe	Very Severe	Severe*	Very Severe*	Very Severe*	Very Severe*	Severe*	Severe*	Slight
Iron River loam	1, 2, 3, 4, 5, 23	Slight	Moderate	Slight	Moderate	Slight	Slight	Slight	Slight	Slight

TABLE 4. SEVERITY[1] OF LIMITATIONS OF SOIL TYPES OF MENOMINEE COUNTY, WISCONSIN, FOR VARIOUS USES (CONT'D)

Name of soil type (or land unit)	Soil Map Symbol[2]	Forestry		Pasture (Legume-Grass)	Agricultural cultivated crops	Industrial sites	Home sites[3] with septic tank system	Transportation routes[4]	Recreation[5]	
		Northern Hardwoods	Red Pine						Campsites	Hiking terrain
Kennan loam	1, 2, 3, 4, 5	Moderate	Slight	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
Norrie silt loam	1, 2, 3, 4	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight
Omega loamy sand	20, 21, (23)	Very Severe	Moderate	Moderate	Very Severe	Slight	Slight	Slight	Slight	Slight
Onamia loam	(5, 6, 10), 11, 12, 13, 14, 15, 16, 22, 23	Moderate	Slight	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
Padus loam	(5, 6), 11, 12, 13, 14, 15, 16, 22, 23	Moderate	Moderate	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
Peat	24, 25	Very Severe	Very Severe	Severe	Very Severe	Very Severe#	Very Severe#	Very Severe#	Very Severe#	Severe#
Pence sandy loam	5, (6), 10, 14, 15, 16, 17, 18, 19, 22, (23)	Moderate	Slight	Moderate	Severe	Slight	Slight	Slight	Slight	Slight
Roscommon loamy sand	(6, 7, 8, 9, 10)	Very Severe	Very Severe	Moderate	Severe	Very Severe#	Very Severe#	Severe#	Very Severe#	Severe#
Stambaugh silt loam	11, 12, 13	Slight	Slight	Slight	Slight	Slight	Slight	Slight[5]	Slight	Slight
Underhill loam	6, 7, 8, 9	Moderate	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight	Slight
Underhill (sand substratum variant) loam	10	Moderate	Moderate	Slight	Slight	Slight	Slight	Slight	Slight	Slight
Vilas loamy sand	17, (18, 19), 20, 21	Very Severe	Moderate	Moderate	Very Severe	Slight	Slight	Slight	Slight	Slight

1. Soil ratings for the various uses indicated are given in terms of four degrees of severity of limitations: slight, moderate, severe, and very severe. Kinds of limitations of soils include: stoniness, shallowness, impeded drainage, hilliness, and droughtiness.

2. Each map symbol number stands for a soil association in the legend of the soil map. In the second column on the left, a number without parentheses represents a soil association which specifically cites the soil names in the first column of the table. A number within parentheses represents a soil association which does not cite the soil in question, but which actually includes small areas of it.

3. "With septic tank system" means that a septic tank system is used requiring drainage of effluent into soil. Care should be taken to avoid contamination of lakes, streams, sources of well water.

4. See Tables 9 and 10 for more information on engineering aspects of soils.

5. Soil ratings for campsites are based on the assumption that level, well-drained soils are best. Soil ratings for hiking terrain are based on the assumption that rolling to hilly soils are best. In neither case is the proximity of a lake or river taken into consideration in making the soil ratings. Vary these soil ratings according to local topographic conditions.

\# Wet conditions in this soil unit are unfavorable for the use in question.

* Stoniness or shallowness to bedrock are unfavorable conditions which limit the use indicated with respect to this soil unit.

a Rolling to hilly topography is a favorable factor in this instance.

b Hilly topography is an unfavorable condition in this instance.

s Siltiness of the soil is unfavorable in this instance.

TABLE 5. SEVERITY[1] OF LIMITATIONS OF SOIL ASSOCIATIONS OF MENOMINEE COUNTY, WISCONSIN, FOR VARIOUS USES

Map Symbol[2]	Name of Soil Association	Ratings for								
		Forestry		Pasture (Legume-Grass)	Agricultural cultivated crops	Industrial sites	Home sites[3] with septic tank system	Trans-portation routes[4]	Recreation[5]	
		Northern Hardwoods	Red pine						Camping sites	Hiking terrain
1	Norrie and Goodman silt loams; etc. Slopes 0-10%	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate[s]	Slight	Slight
2	Norrie and Goodman silt loams; etc. Slopes 0-8%	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate[s]	Slight	Slight
3	Norrie and Goodman silt loams; etc. Slopes 8-20%	Slight	Moderate	Slight	Slight	Slight	Severe[b]	Moderate[s]	Moderate	Slight[a]
4	Kennan and Iron River loams; etc. Slopes 8-20%	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Slight	Moderate	Slight[a]
5	Kennan and Iron River stony loams; etc. Slopes 10-40%	Severe	Severe	Moderate	Very Severe	Moderate[b]	Severe[b]	Slight	Severe[b]	Slight[a]
6	Alban and Underhill loams; etc. Slopes 0-10%	Moderate	Moderate	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
7	Underhill and Alban loams, etc. Slopes 0-8%	Moderate	Moderate	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
8	Underhill loam, etc. Slopes 8-20%	Moderate	Moderate	Slight	Moderate	Slight	Moderate[b]	Slight	Moderate	Slight[a]
9	Alban and Crivitz (loam sub-stratum variant) loams Slopes 8-20%	Severe	Moderate	Moderate	Severe	Slight	Moderate[b]	Slight	Moderate	Slight[a]
10	Crivitz and Pence sandy loams, etc. Slopes 8-20%	Moderate	Slight	Moderate	Severe	Slight	Moderate[b]	Slight	Moderate	Slight[a]
11	Antigo and Stambaugh silt loams, etc. Slopes 0-10%	Slight	Slight	Slight	Slight	Slight	Silght	Slight[s]	Slight	Slight
12	Antigo and Stambaugh silt loams, etc. Slopes 0-8%	Slight	Slight	Slight	Slight	Slight	Slight	Slight[s]	Slight	Slight
13	Antigo and Stambaugh silt loams, etc. Slopes 8-20%	Slight	Slight	Slight	Slight	Slight	Moderate[b]	Slight[s]	Moderate	Slight[a]

TABLE 5. SEVERITY[1] OF LIMITATIONS OF SOIL ASSOCIATIONS OF MENOMINEE COUNTY, WISCONSIN, FOR VARIOUS USES (CONT'D)

Map Symbol[2]	Name of Soil Association	Ratings for								
		Forestry		Pasture (Legume-Grass)	Agricultural cultivated crops	Industrial sites	Home sites[3] with septic tank system	Trans-portation routes[4]	Recreation[5]	
		Northern Hardwoods	Red pine						Camping sites	Hiking terrain
14	Onamia and Padus loams etc. Slopes 0-10%	Moderate	Slight	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
15	Onamia and Padus loams etc. Slopes 0-8%	Moderate	Slight	Slight	Moderate	Slight	Slight	Slight	Slight	Slight
16	Onamia and Padus loams, etc. Slopes 8-20%	Moderate	Slight	Slight	Moderate	Slight	Moderate[b]	Slight	Moderate	Slight[a]
17	Pence and Chetek sandy loams, etc. Slopes 0-10%	Moderate	Moderate	Moderate	Severe	Slight	Slight	Slight	Slight	Slight
18	Pence and Chetek sandy loams, etc. Slopes 0-8%	Moderate	Moderate	Moderate	Severe	Slight	Slight	Slight	Slight	Slight
19	Pence and Chetek sandy loams, etc. Slopes 8-20%	Moderate	Moderate	Moderate	Severe	Slight	Moderate[b]	Slight	Moderate	Slight[a]
20	Omega and Vilas loamy sands, etc. Slopes 0-5%	Very Severe	Moderate	Moderate	Very Severe	Slight	Slight	Slight	Slight	Slight
21	Omega and Vilas loamy sands, etc. Slopes 8-20%	Very Severe	Moderate	Moderate	Very Severe	Slight	Moderate[b]	Slight	Moderate	Slight[a]
22	Pence and Chetek sandy loams, etc. Slopes 10-40%	Moderate	Moderate	Moderate	Severe	Moderate[b]	Moderate[b]	Slight	Severe[b]	Slight[a]
23	Granitic Rockland, etc. Slopes 0-40%	Very Severe	Very Severe	Very Severe	Very Severe	Severe*	Severe*	Severe*	Severe[b]*	Slight[a]
24	Peats etc. with forest cover. Slopes 0-3%	Very Severe	Very Severe	Very Severe	Very Severe	Very Severe#	Very Severe#	Severe#	Very Severe#	Severe#
25	Peats, etc. without forest cover, Slopes 0-3%	Very Severe	Very Severe	Very Severe	Very Severe	Very Severe#	Very Severe#	Severe#	Very Severe#	Severe#

1 Please refer to footnotes of Table 4.

TABLE 6. SOIL PRODUCTIVITY ESTIMATES FOR TREES IN MENOMINEE COUNTY, WISCONSIN[1]

Soil type name	Soil Map symbol[2]	Estimates of annual growth or yeild per acre						
		Aspen[3] (Cords[4])	Northern Hard-woods (Bd. Ft.[5])	Hemlock-Hard-woods (Bd. Ft.[5])	White Spruce (Cords[4])	Jack pine (Cords[4])	White pine (Bd. Ft.[5])	Red Pine (Bd. Ft.[5])
Alban fine sandy loam	6, 7, (8), 9, (10)	0.7-0.8	120-200	100-175	0.3	—	550-550	450-500
Antigo silt loam	11, 12, 13	0.6-0.7	200-250	160-220	0.3	—	300-600	475-575
Au Gres loamy sand	(20, 21)	0.9-1.0	—	60- 90	0.2	0.5	500-600	325-375
Brill silt loam	(11, 12, 13)	0.7-0.8	200-250	160-220	0.2	—	500-600	—
Brimley silt loam	(6, 7, 8, 9, 10)	0.5-0.6	180-220	165-200	0.2	—	450-550	—
Bruce silt loam	(6, 7, 8, 9, 10)	0.1-0.2	80-120	75-100	0.2	—	—	—
Chetek loam	{ 5, (6), 10, 14, 15, 16, 17, 18, 19, 22, 23 }	0.7-0.8	180-220	165-200	0.4	0.6	400-450	400-450
Crivitz loamy fine sand	17, 18, 19, 20, 21, 22, (23)	0.7-0.8	60-90	55-80	0.4	0.6	450-500	450-500
Crivitz (loam substratum variant) loamy fine sand	6, 7, (8), 9, (10)	0.8-0.9	180-220	165-200	0.5	0.7	500-550	475-550
Emmert stony, gravelly sandy loam	(5)	0.1-0.2	—	60- 90	0.2	0.5	375-425	400-450
Fence fine sandy loam	(8, 9, 10, 17)	0.9-1.0	200-250	160-220	0.3	—	500-575	450-500
Goodman silt loam	1, 2, 3, 4	0.9-1.0	225-275	200-250	0.2	—	475-550	450-500
Granitic rockland	23	0.1-0.2	60-90	55- 80	0.1	0.3	100-200	—
Iron River loam	1, 2, 3, 4, 5, 23	0.7-0.8	225-275	200-250	0.4	—	450-500	400-450
Kennan loam	1, 2, 3, 4, 5	0.7-0.8	160-190	150-175	0.4	0.6	500-575	475-550
Norrie silt loam	1, 2, 3, 4	0.8-0.9	200-250	160-220	0.4	—	500-600	450-500
Omega loamy sand	20, 21, (23)	—	—	—	0.1	0.5	400-450	400-450
Onamia loam	{ (5, 6, 10), 11, 12, 13, 14, 15, 16, 22, 23 }	0.5-0.6	180-220	155-200	0.4	0.5	500-575	500-575
Padus loam	{ (5, 6), 11, 12, 13, 14, 15, 16, 22, 23 }	0.7-0.8	160-190	150-180	0.5	—	450-500	450-500

TABLE 6. SOIL PRODUCTIVITY ESTIMATES FOR TREES IN MENOMINEE COUNTY, WISCONSIN[1] (CONTINUED)

Soil type name	Soil Map symbol[2]	Estimates of annual growth or yield per acre						
		Aspen[3] (Cords[4])	Northern Hard-woods (Bd. Ft.[5])	Hemlock-Hard-woods (Bd. Ft.[5])	White Spruce (Cords[4])	Jack pine (Cords[4])	White pine (Bd. Ft.[5])	Red pine (Bd. Ft.[5])
Peat	24, 25	—	—	—	0.1	—	—	—
Pence sandy loam	5, (6), 10, 14, 15, 16, 17, 18, 19, 22, (23)	0.7-0.8	135-165	125-150	0.5	0.8	500-575	500-575
Roscommon loamy sand	(6, 7, 8, 9, 10)	0.5-0.6	—	55- 80	0.2	—	200-300	—
Stambaugh silt loam	11, 12, 13	0.7-0.8	200-250	160-220	0.3	—	500-600	475-550
Underhill loam	6, 7, 8, 9	0.7-0.8	180-220	160-200	0.2	—	450-500	400-450
Underhill (sand substratum variant) loam	10	0.6-0.7	150-200	140-180	0.2	—	450-500	375-425
Vilas loamy sand	17, (18, 19), 20, 21	0.6-0.7	—	50- 75	0.2	0.6	400-450	400-450

1 Estimates adapted from tables in Special Circular 65, revised, 1965, "What Yields for Wisconsin Soils?", Extension Service, University of Wisconsin, Madison. Reference was also made to Wilde, S. A., *et al*, "Growth of Wisconsin Coniferous Plantations in Relation to Soils", Research Bull. 262, 1965, Agric. Exp. Sta., Madison, Wisconsin. Dashes in the table indicate that the timber type does not normally occur on the soil type shown.

2 Each map symbol number stands for a soil association listed in the legend of the soil map. In the second column from the left in this table a number within parentheses represents a soil association which does not cite the soil in question, but which actually includes small areas of it.

3 Growth of aspen is best where a subsoil barrier, such as bedrock or a compact soil layer, holds up a water table.

5 A cord of wood is a pile of wood measuring four feet by four feet by eight feet.

5 Yields in board feet are given according to Scribner rule: one board foot is one foot square and one inch thick.

TABLE 7. SOIL PRODUCTIVITY RATING[1] ESTIMATES FOR AGRICULTURE, MENOMINEE COUNTY, WISCONSIN

Soil Type Name	Soil Slope and Degree of Erosion[2]	Soil Map Symbol[3]	General Productivity Ratings[4] for Agriculture Crops	Crop Productivity Ratings[5]: Red Clover Hay[6] (tons)	Alfalfa Brome Hay[7] (tons)	Oats[8] (bu.)	Potatoes[9] (bu.)	Corn Silage[10] (tons)	Blue-grass Pasture[11]
Alban fine sandy loam	B-1	6, 7, (8), 9, (10)	3	2.00 (2.75)	2.0 (3.0)	40 (70)	100 (200)	7 (10)	1.00 (2.0)
Antigo silt loam	A-1	11, 12, 13	1	2.0 (3.00)	2.5 (3.5)	55 (80)	150 (300)	10 (13)	1.00 (1.5)
Au Gres loamy sand	A-1	(20, 21)	6	0.75 (1.00)	1.5 (2.5)	30 (55)	... (....)	6 (8)	... (....)
Brill silt loam	A-1	(11, 12, 13)	1	2.0 (3.25)	2.5 (3.5)	55 (80)	... (...)	10 (13)	1.50 (2.5)
Brimley silt loam	A-1	(6, 7, 8, 9, 10)	3	2.0 (3.0)	2.0 (3.5)	45 (70)	... (...)	7 (11)	1.50 (2.5)
Bruce silt loam	A-1	(6, 7, 8, 9, 10)	5	1.75 (3.0)	... (3.5)	40 (55)	... (...)	.. (....)	.... (...)
Chetek loam	B-1	5, (6), 10, 14, 15, 16, 17, 18, 19, 22, 23	5	1.0 (2.0)	1.5 (2.75)	35 (55)	100 (200)	7.5 (11)	0.75 (1.25)
Crivitz loamy fine sand	B-1	17, 18, 19, 20, 21, 22, (23)	7	0.75 (1.25)	1.0 (2.0)	30 (45)	95 (190)	6 (8)	0.25 (0.5)
Crivitz (loam substratum variant) loamy fine sand	B-1	6, 7, (8), 9, (10)	5	1.5 (1.8)	1.5 (2.5)	35 (60)	100 (215)	7 (9.5)	0.5 (1.0)
Emmert stony, gravelly sandy loam	C-1	(5)	9	.... (1.6)	... (2.0)	.. (35)	... (...)	.... (5)	0.25 (0.5)
Fence fine sandy loam	A-1	(8, 9, 10, 17)	2	2.00 (3.25)	2.5 (3.5)	50 (75)	100 (250)	8 (13)	1.05 (2.0)
Goodman silt loam	B-1	1, 2, 3, 4	2	1.75 (3.0)	2.5 (3.5)	50 (75)	140 (285)	8 (12)	1.25 (2.5)
Granitic Rockland	C-1	23	10	.... (....)	... (....)	.. (..)	... (...)	.... (....)	.... (....)
Iron River loam	C-1	1, 2, 3, 4, 5, 23	3	1.50 (2.75)	2.0 (3.5)	45 (70)	100 (200)	8 (12)	0.75 (1.5)
Kennan loam	C-1	1, 2, 3, 4, 5	3	2.00 (2.75)	2.0 (3.5)	45 (70)	100 (200)	8 (12.5)	0.75 (1.5)
Norrie silt loam	B-1	1, 2, 3, 4	1	2.75 (3.0)	2.5 (4.0)	55 (80)	140 (285)	10 (14)	1.0 (2.0)
Omega loamy sand	A-1	20, 21, (23)	9	.... (1.50)	1.0 (2.0)	20 (35)	... (175)	5 (7)	0.2 (0.5)
Onamia loam	B-1	(5, 6, 10), 11, 12, 13, 14, 15, 16, 22, 23	4	1.75 (2.75)	2.0 (3.0)	40 (60)	100 (230)	9 (12.5)	0.75 (1.5)

TABLE 7. SOIL PRODUCTIVITY RATING[1] ESTIMATES FOR AGRICULTURE, MENOMINEE COUNTY, WISCONSIN (CONT'D)

Soil Type Name	Soil Slope and Degree of Erosion[2]	Soil Map Symbol[3]	General Productivity Ratings[4] for Agriculture Crops	Crop Productivity Ratings[5]					
				Red Clover Hay[6] (tons)	Alfalfa Brome Hay[7] (tons)	Oats[8] (bu.)	Potatoes[9] (bu.)	Corn Silage[10] (tons)	Blue-grass Pasture[11]
Padus loam	B-1	(5, 6), 11, 12, 13, 14, 15, 16, 22, 23	4	1.75 (2.75)	2.0 (3.0)	40 (65)	125 (250)	8 (12)	1.0 (2.0)
Peat	A-1	24, 25	10	.... (....)	... (....)	.. (..)	... (...)	... (....)	.... (....)
Pence sandy loam	B-1	5, (6), 10, 14, 15, 16 17, 18, 19, 22, (23)	6	1.0 (1.75)	1.5 (2.5)	35 (50)	100 (200)	7 (10)	0.5 (1.0)
Roscommon loamy sand	A-1	(6, 7, 8, 9, 10)	8	1.0 (1.5)	... (2.0)	.. (45)	... (...)	... (10)	1.2 (2.4)
Stambaugh silt loam	A-1	11, 12, 13	2	1.75 (2.75)	2.0 (3.0)	50 (75)	125 (300)	8 (12)	1.25 (2.0)
Underhill loam	B-1	6, 7, 8, 9	2	2.0 (2.75)	2.0 (3.75)	50 (70)	130 (250)	8 (13)	0.75 (1.5)
Underhill (sand substratum variant) loam	B-1	10	3	1.75 (2.50)	2.0 (3.5)	45 (65)	100 (225)	8 (12)	0.75 (1.5)
Vilas loamy sand	A-1	17, (18, 19), 20, 21	9	.... (1.25)	1.0 (2.0)	25 (35)	... (175)	... (6)	0.2 (0.5)

[1]Ratings adapted from tables in special Circular 65, revised, 1965, "What Yields for Wisconsin Soils?", Extension Service, The University of Wisconsin, Madison.

[2]All estimates are for the dominant slope and erosion conditions associated with each soil type in farmland in counties adjacent to Menominee County. These dominant conditions are shown after the soil type name by symbols as follows: A = 0-2% slope, B = 2-6% slope, C = 6-12% slope; 1 = no apparent erosion, 2 = moderate erosion.

[3]Each soil map symbol number stands for a soil association listed in the legend of the soil map. In this column a number without parentheses represents a soil association which specifically cites the soil names listed in the first column of the table. A number within parentheses represents a soil association which does not cite the soil in question, but which actually includes small areas of it.

[4]Soils having the highest productivity for hay and oats in the county and adjacent counties are rated "1", on scale of 1 to 10. Ratings indicate estimated production of the soils under "high management", which for agricultural crops includes liming and fertilizing according to soil test, maintaining optimum conditions of drainage and tilth, proper planting of good seed of most productive crop varieties, controlling diseases and harmful weeds and insects. Dashes (—) indicate that the crop is usually not grown on the soil due to unfavorable conditions.

[5]Yields under high management (figures in parentheses) are for soils with adequate drainage. Figures without parentheses are for soils under common management in the region.

[6]Yield of first and second cuttings first year after adequate stands are established, absolute dry matter basis.

[7]Average annual yields of first and second year hay after adequate stands are established, absolute dry matter basis.

[8]These yields are for oats with legume-grass seeding. Higher yields may be obtained, but a poorer stand of legume-grass seeding usually results. A 32-lb. bushel is assumed.

[9]High level management yields for potatoes (in parentheses) can be approximately doubled with irrigation.

[10]Corn for grain usually does not mature in Menominee County because of the short frost-free season and low summer temperatures. In years with a favorable growing season, productivity ranges from about 40 bushels under common to 75 bushels under high managements on Stambaugh silt loam; and from about 30 bushels under common to 45 bushels under high managements on Omega sand. A 56-lb. bushel is assumed.

[11]Bluegrass pastures are usually found on steeper, stonier, droughtier or wetter soils than are cultivated crops. As indicated above, production of total dry matter is approximately doubled with proper fertilization. Grazing management determines how much dry matter is recovered. For this reason pasture yield is expressed in tons per acre per year, rather than in cow-days per acre.

TABLE 8. SOIL POTENTIALS[1] FOR WILDLIFE IN MENOMINEE COUNTY, WISCONSIN

Soil Map Symbol	Name of Soil Association	Ratings[2] For		
		Deer		Grouse
		Summer	Winter	
1	Norrie and Goodman silt loams, etc. Slopes 0—10%	Medium[3]	Poor[3]	Medium[3]
2	Norrie and Goodman silt loams, etc. Slopes Slopes 0—8%	Medium[3]	Poor[3]	Medium[3]
3	Norrie and Goodman silt loams, etc. Slopes 8—20%	Medium[3]	Poor[3]	Medium[3]
4	Kennan and Iron River silt loams, etc. Slopes 8—20%	Medium[3]	Poor[3]	Medium[3]
5	Emmert and Kennan stony loams, etc. Slopes 10—40%	Excellent	Good	Excellent
6	Alban and Underhill loams, etc. Slopes 0—10%	Medium[3]	Poor[3]	Medium[3]
7	Underhill and Alban loams, etc. Slopes 0—8%	Medium[3]	Poor[3]	Medium[3]
8	Underhill loam, etc. Slopes 8—20%	Medium[3]	Poor[3]	Medium[3]
9	Alban and Crivitz (loam substratum variant) loams, Slopes 8—20%	Good	Medium	Good
10	Crivitz and Pence sandy loams, etc. Slopes 8—20%	Good[3]	Medium[3]	Good[3]
11	Antigo and Stambaugh silt loams, etc. Slopes 0—10%	Good[3]	Medium[3]	Medium[3]
12	Antigo and Stambaugh silt loams, etc. Slopes 0—8%	Medium[3]	Poor[3]	Medium[3]
13	Antigo and Stambaugh silt loams, etc. Slopes 8—20%	Medium[3]	Poor[3]	Medium[3]
14	Onamia and Padus loams, etc. Slopes 0—10%	Good[3]	Medium[3]	Medium[3]
15	Onamia and Padus loams, etc. Slopes 0—8%	Good[3]	Medium[3]	Good[3]
16	Onamia and Padus loams, etc. Slopes 8—20%	Good[3]	Medium[3]	Good[3]
17	Pence and Chetek sandy loams, etc. Slopes 0—10%	Good[3]	Medium[3]	Medium[3]
18	Pence and Chetek sandy loams, etc. Slopes 0—8%	Medium[3]	Poor[3]	Medium[3]
19	Pence and Chetek sandy loams, etc. Slopes 8—20%	Medium[3]	Medium[3]	Medium[3]
20	Omega and Vilas loamy sands, etc. Slopes 0—5%	Medium	Medium	Good
21	Omega and Vilas loamy sands, etc. Slopes 8—20%	Good	Medium	Good
22	Pence and Chetek sandy loams, etc. Slopes 10—40%	Excellent	Good	Excellent
23	Granitic Rockland, etc. Slopes 0—40%	Medium	Poor	Poor
24	Peats, etc. with forest cover. Slopes 0—3%	Good	Good	Good
25	Peats, etc. without forest cover. Slope 0—3%	Good	Good	Good

[1]These ratings of potential productivity of soils for white-tailed deer and ruffed grouse are based on an adaptation of an approach to soil ratings for wildlife developed by W. Wertz, Soil Scientist, U. S. Forest Service, Milwaukee, Wisconsin. Ratings are given for both summer and winter range for white-tailed deer. A single rating is given for the entire year for ruffed grouse. Diversity of plant cover (required plant species are present in adequate density or volume), which is a favorable factor for deer and grouse, is a condition characteristic of borders between contrasting soils and on rolling infertile sands.

[2]Soil ratings are given in four steps: excellent, good, medium, poor.

[3]The soil unit is above average in productivity for vegetation, and therefore if the vegetative cover is managed for the benefit of wildlife (as by the creation of artificial openings in the forest), the rating of the soil for potential productivity of wildlife can be substantially raised above the level indicated in this table.

the forest stand. In cleared and cultivated fields soils are typically acid and low in contents of available nutrients unless adequate fertilization has been carried out. Liming is not always advised for potato fields but is recommended for soils used to produce other common crops of dairy farms.

Wildlife potentials

Table 8 gives estimates of relative productivities of the various soil associations for deer and grouse. Chapter VIII provides information on deer population and its relation to natural regeneration of the forest.

Most species of wildlife live on a wide range of soils, from peat bogs to dry sand and gravel ridges. The beaver is an exception in confining its activities to a narrow range of soils: those occurring beside streams and lakes. The factors limiting population of animals in Menominee County include: (1) successional stage of vegetation, (2) natural soil fertility, (3) frequency of occurrence of ecological tension zones such as those between wet and well-drained soils, and (4) hunting pressure.

In general, diversity of vegetative cover is favorable to wildlife. The borders of small peat bogs, for example, provide a wide variety of vegetative cover. Many logging trails in Menominee County run along soil boundaries, because natural topographic breaks are in many instances coincident with changes in soil. The trails help to create conditions favorable to diversity of vegetative cover. Soil associations which occur typically as intricate mosaics of contrasting soils provide many more miles of ecologic transitions belt per square mile than do associations found as extensive bodies of similar soils. An attempt has been made to express some of these relationships in Table 8.

Engineering characteristics

Table 9 is adapted from the *Soil Manual for Highway Engineers* (Wisconsin State Highway Commission, 1964) to indicate engineering characteristics of representative soils of Menominee County.

Load-carrying capacity is one of the characteristics of the soil and is expressed by the classification of the American Association of State Highway Officials (1961). Highways remain in good condition for relatively long periods of time on well-drained, permeable soils like Vilas sand and Omega sand. Roads deteriorate rapidly wherever they are improperly laid on imperfectly drained soils like Brimley silt loam. Bodies of naturally moist or wet soils can be quickly located by means of the soil map, in conjunction with the soil key (Figure 5). Road construction on these sites should be handled in such a way as to minimize the effects of instability inherent in these soils. It is recommended that a detailed soil map be made especially for engineering uses along any major highway right-of-way before road con-

TABLE 9A. HIGHWAY ENGINEERS' SOIL SERIES DATA AND RECOMMENDATION CHART[1]

Soil Series Name	Brief Engineering Description of Typical Soil Profile (with AASHO Classification)	Normal Depth to Water Table (ft.)	Design Group Index[2] Horizon B	Design Group Index[2] Horizon C	Design Group Index[2] Horizon Sub-stratum	Frost Index[2] Horizon B	Frost Index[2] Horizon C	Frost Index[2] Horizon Sub-stratum	Recommended Location of Grade Line with Respect to Natural Ground Line	Normal Depth to Bedrock (ft.)
		1	2			3			4	5
Alban	Stratified sand, silt and clay [A-4(8)]...............	Indefinite (b)	14	14	..	F-4	F-4	..	Anywhere	Deep
Antigo	Silt [A-6(11)] over sand and gravel [A-3]..........	Deep (c)	14	..	0	F-4	..	F-0	Anywhere	Deep
Au Gres	[A-4(5)]..	1—2	..	0	..	F-2	F-0	..	Fill 1'-2'	Deep
Brill	Silt [A-4(5)] over sand and gravel [A-3]............	3—4	14	..	0	F-4	..	F-4	Anywhere	Deep
Brimley	Stratified sand, silt and clay [A-4(8)]..............	2—3	14	14	..	F-4	F-4	..	Fill 1'-2'	Deep
Bruce	Stratified sand, silt and clay [A-4(8)]..............	1—2	14	14	..	F-4	F-4	..	Fill 2'-3'	Deep
Chetek	Deep gravel and sand [A-3].......................	Deep (c)	14	0	..	F-3	F-0	..	Anywhere	Deep
Crivitz	Sand with fines [A-4(1)] over sand [A-3]...........	Deep (c)	10	..	0	F-2	..	F-0	Anywhere	Deep
Crivitz (loam substratum variant)	Sand with fines [A-2-4(0)].......................	Deep (c)	10	..	2	F-3	..	F-2	Anywhere	Deep

TABLE 9A. HIGHWAY ENGINEERS' SOIL SERIES DATA AND RECOMMENDATION CHART[1] (CONTINUED)

Soil Series Name	Brief Engineering Description of Typical Soil Profile (with AASHO Classification)	Normal Depth to Water Table (ft.)	Design Group Index[2] Horizon			Frost Index[2] Horizon			Recommended Location of Grade Line with Respect to Natural Ground Line	Normal Depth to Bedrock (ft.)
			B	C	Sub-stratum	B	C	Sub-stratum		
		1	2			3			4	5
Emmert	Deep gravel and sand [A-2].	Deep	..	0	..	..	F-0	..	Anywhere	Deep
Fence	Stratified sand, silt and clay.	Indefinite (b)	14	14	..	F-4	F-4	..	Anywhere	Deep
Goodman	Silt [A-4(5)] over sand with fines [A-2-4(0)].	Deep	14	2	..	F-4	F-2	..	Anywhere	Deep (c)
Grantic Rockland	Rock outcrops and sand with fines [A-2-4(0)].	3—4	2	..	Rock	F-2	..	..	Fill or Blast	0-10
Iron River	Silt [A-4(8)] over sand with fines [A-2-4(0)].	Deep	10	2	..	F-3	F-2	..	Anywhere	Deep (c)
Kennan	Silt [A-4(8)] over sand with fines [A-2-4(0)].	Deep	12	2	..	F-3	F-2	..	Anywhere	Deep
Norrie	Silt [A-6(11)] over sand with fines.	Deep	12	..	2	F-4	..	F-2	Anywhere	Deep
Omega	Deep sand [A-2-4(0)].	Deep (c)	..	0	..	..	F-0	..	Anywhere	Deep
Onamia	Sand with fines [A-4(1)] over sand and gravel [A-3].	Deep (c)	14	0	..	F-3	F-0	..	Anywhere	Deep (c)
Padus	Sand with fines [A-4(1)] over sand and gravel [A-3].	Deep (c)	14	0	..	F-3	F-0	..	Anywhere	Deep (c)

TABLE 9A. HIGHWAY ENGINEERS' SOIL SERIES DATA AND RECOMMENDATION CHART[1] (CONTINUED)

Soil Series Name	Brief Engineering Description of Typical Soil Profile (with AASHO Classification)	Normal Depth to Water Table (ft.)	Design Group Index[2] Horizon B	Design Group Index[2] Horizon C	Design Group Index[2] Sub-stratum	Frost Index[2] Horizon B	Frost Index[2] Horizon C	Frost Index[2] Sub-stratum	Recommended Location of Grade Line with Respect to Natural Ground Line	Normal Depth to Bedrock (ft.)
		1	2			3			4	5
Peat	Peat and muck (mostly organic material)...........	0	..	20	..	..	F-4	..	Fill many feet	Deep (c)
Pence	Deep sand and gravel [A-3]......................	Deep (c)	4	0	..	F-2	F-0	..	Anywhere	Deep
Roscommon	Deep sand [A-2-4(0)]...........................	0—2	..	14	..	..	F-4	..	Fill 2'-3'	Deep
Stambaugh	Silt [A-4(8)] over sand and gravel [A-4(6)].........	Deep (c)	14	0	..	F-4	F-0	..	Anywhere	Deep
Underhill	Silty clay [A-6(7)] over sand and fines [A-4(2)].....	Deep	12	12	..	F-3	F-3	..	Anywhere	Deep
Vilas	Deep sand [A-7-6(17)]...........................	Deep (c)	0	0	..	F-0	F-0	..	Anywhere	Deep

1. Data adapted from State Highway Commission of Wisconsin, Soil Survey Manual, 1964, Madison, Wisconsin.
   Data are based on model conditions; variabilities are to be expected.
   (b) Indefinite: No true watertable. Possible seepage water below 3 feet.
   (c) Normally deep, but may be within 5 feet.
   (d) These answers apply only when the grade lies in cut sections.
   (e) Slopes over 10 feet in depth should be mulched.
   (f) Topsoil should be applied on slopes over 10 feet in depth with 3 to 1 slopes or flatter.
   (g) Topsoil or mulch is needed on the exposed underlying gravelly drift.
   (h) Mulch on all slopes steeper than 3 to 1. Topsoil or mulch should be used on 3 to 1 slopes or flatter where cut is 10 feet or more.
   (j) E.B.S. (excavation below subgrade) normally required.
   (k) E.B.S. may be required.
   (l) E.B.S. normally not required.
   (m) Underdrains normally required.
   (p) Underdrains may not be required.
   (q) Underdrains normally not required.

2. Frost indices range from F-0 (no frost potential) to F-4 (highest frost potential). Equivalent design group index ranges are: F-1 =0;F-2 =1-6; F-3 =6-15; F-4 =15-20.

3. Ratings for wind erosion hazard (E-1, slight, to E-3, severe) and water erozion hazard (E-1, slight to E-3, severe) relate to exposed surface of soil on unprotected raw slopes.

4. The hydrologic grouping arranges the soil series into four groups on the basis of the capacity of a soil to restrain runoff after the soil has been thoroughly wetted: Group A (high infiltration) to Group D (very slow infiltration).

5. T, F, S & M = Spread topsoil, fetilize, seed and mulch on slopes in order to control erosion.

TABLE 9B. HIGHWAY ENGINEERS' SOIL SERIES DATA AND RECOMMENDATION CHART[1]

Soil Series Name	Brief Engineering Description of Typical Soil Profile (with AASHO Classification)	Subgrade Improvement		Possible Source of			Percent Shrinkage	Erosion[3]		Hydrologic[4] Group	Recommended Protection of Slopes[5]
		Exc. Below Subgrade	Underdrains	Gravel	Sand	Top Soil		Wind	Water		
		6	7	8	9	10	11	12	13	14	15
Alban	Stratified sand, silt and clay [A-4(8)]	j	m	No	No	Fair	20–30	E-1	E-3	B	F & S (e)
Antigo	Silt [A-6(11)] over sand and gravel	k	q	Good	Good	Good	15–25	E-1	E-2	B	F & S (e)(f)
Au Gres	[A-4(5)]	1(d)	m(d)	No	Good	Poor	10–20	E-3	E-3	C	F & S
Brill	Silt [A-4(5)] over sand and gravel [A-3]	k	m(d)	Good	Good	Good	15–25	E-1	E-2	B	F & S (e)(f)
Brimley	Stratified sand, silt and clay [A-4(8)]	j(d)	m(d)	No	No	Fair	20–30	E-1	E-3	C	F & S
Bruce	Stratified sand, silt and clay [A4(8)]	j(d)	m(d)	No	No	Fair	20–30	E-1	E-3	C	F & S
Chetek	Deep gravel and sand [A-3]	l	q	Good	Good	Fair	10–20	E-1	E-2	B	T, F, S (e)
Crivitiz	Sand with fines [A-4(1)] over sand [A-3]	l	q	No	Good	Poor	10–20	E-2	E-2	B	T, F, S (e)
Crivitz (loam substratum variant)	Sand with fines [A-2-4(0)]	k	p	No	No	Poor	15–25	E-2	E-2	B	T, F, S, (e)

TABLE 9B. HIGHWAY ENGINEERS' SOIL SERIES DATA AND RECOMMENDATION CHART[1] (CONTINUED)

Soil Series Name	Brief Engineering Description of Typical Soil Profile (with AASHO Classification)	Subgrade Improvement		Possible Source of			Percent Shrink-age	Erosion[3]		Hydro-logic[4] Group	Recom-mended Protection of Slopes[5]
		Exc. Below Sub-grade	Under-drains	Grav-vel	Sand	Top Soil		Wind	Water		
		6	7	8	9	10	11	12	13	14	15
Emmert	Deep gravel and sand [A-2]	l	q	Good	Good	Poor	10–20	E-1	E-1	A	T, F, S & M
Fence	Stratified sand, silt and clay	j	m	No	No	Fair	20–30	E-1	E-3	B	F & S (e)
Goodman	Silt [A-4(5)] over sand with fines [A-2-4(0)]	k	p	No	Poor	Good	20–30	E-1	E-2	B	F & S (e)
Granitic Rockland	Rock outcrops and sand with fines [A-2-4(0)]	l	p	No	No	No	....	....	....	....	....
Iron River	Silt [A-4(8)] over sand with fines [A-2-4(0)]	k	p	No	Poor	Fair	15-25	E-1	E-2	B	F, S & M
Kennan	Silt [A-4(8)] over sand with fines [A-2-4(0)]	k	p	No	No	Good	15–25	E-1	E-2	B	F & S (g)
Norrie	Silt [A-6(11)] over sand with fines	k	p	No	No	Good	20–30	E-1	E-2	B	F & S (e)
Omega	Deep sand [A-2-4(0)]	l	q	Poor	Good	Poor	10–20	E-3	E-3	A	T, F, S & M
Onamia	Sand with fines [A-4(1)] over sand and gravel [A-3]	l	q	Good	Good	Fair	10–20	E-1	E-2	B	T, F & S (e)
Padus	Sand with fines [A-4(1)] over sand and gravel [A-3]	l	q	Good	Good	Fair	10–20	E-1	E-2	B	T, F & S (e)

TABLE 9B. HIGHWAY ENGINEERS' SOIL SERIES DATA AND RECOMMENDATION CHART[1] (CONTINUED)

Soil Series Name	Brief Engineering Description of Typical Soil Profile (with AASHO Classification)	Subgrade Improvement		Possible Source of			Percent Shrinkage	Erosion[3]		Hydrologic[4] Group	Recommended Protection of Slopes[5]
		Exc. Below Subgrade	Underdrains	Gravel	Sand	Top Soil		Wind	Water		
		6	7	8	9	10	11	12	13	14	15
Peat	Peat and muck (mostly organic material)...........	j	m	No	No	No	100–300	E-3	E-1	A	F & S
Pence	Deep sand and gravel [A-3]......................	l	q	Good	Good	Fair	10–20	E-1	E-2	B	F, S & M
Roscommon	Deep sand [A-2-4(0)]...........................	j(d)	m(d)	Fair	Fair	Poor	20–30	E-1	E-2	C	F & S
Stambaugh	Silt [A-4(8)] over sand and gravel [A-4(6)].........	l	q	Good	Good	Fair	15–25	E-1	E-2	B	F & S (e)(f)
Underhill	Silty clay [A-6(7)] over sand and fines [A-4(2)].....	k	p	No	No	Fair	20–30	E-1	E-2	B	F, S & M
Vilas	Deep sand [A-7-6(17)]..........................	l	q	No	Good	Poor	10–20	E-3	E-3	A	F, S & M

Footnotes: See below Table 9A.

TABLE 10. SEVERITY[1] OF LIMITATIONS OF SOILS OF MENOMINEE COUNTY, WISCONSIN, FOR POND AND FLOWAGE SITES

Soil Map Symbol[2]	Soil Type Name	Reservoir Area[3]	Embankment suitability[4]	
			Subsoil[5]	Substratum[5]
Alban fine sandy loam	6, 7, (8), 9, (10)	Moderate	Moderate	Severe
Antigo silt loam	11, 12, 13	Severe	Moderate	Very severe
Au Gres loamy sand	(20, 21)	Severe	Very severe	Very severe
Brill silt loam	(11, 12, 13)	Moderate	Moderate	Very severe
Brimley silt loam	(6, 7, 8, 9, 10)	Moderate	Moderate	Moderate
Bruce silt loam	(6, 7, 8, 9, 10)	Slight	Slight	Slight
Chetek loam	5, (6), 10, 14, 15, 16, 17, 18, 19, 22, 23	Moderate	Very severe	Very severe
Crivitz loamy fine sand	10, 17, 18, 19, 20, 21, 22, (23)	Very severe	Very severe	Very severe
Crivitz (loam substratum variant) loamy fine sand	6, 7, (8), 9, (10)	Severe	Very severe	Moderate
Emmert stony, gravelly sandy loam	(5)	Very severe	Very severe	Very severe
Fence fine sandy loam	(8, 9, 19, 17)	Moderate	Moderate	Severe
Goodman silt loam	1, 2, 3, 4	Moderate	Moderate	Severe
Granitic Rockland	23	Slight	Severe	Very severe
Iron River loam	1, 2, 3, 4, 5, 23	Moderate	Severe	Very severe
Kennan loam	1, 2, 3, 4, 5	Moderate	Severe	Severe
Norrie silt loam	1, 2, 3, 4	Moderate	Moderate	Severe
Omega loamy sand	20, 21, (23)	Very severe	Very severe	Very severe
Onamia loam	(5, 6, 10), 11, 12, 13, 14, 15, 16, 22, 23	Severe	Moderate	Very severe
Padus loam	(5, 6), 11, 12, 13, 14, 15, 16, 22, 23	Moderate	Moderate	Very severe
Peat	24, 25	Severe	Very severe	Very severe
Pence sandy loam	5, (6), 10, 14, 15, 16, 17, 18, 19, 22, (23)	Severe	Severe	Very severe
Roscommon loamy sand	(6, 7, 8, 9, 10)	Severe	Very severe	Very severe
Stambaugh silt loam	11, 12, 13	Moderate	Moderate	Very severe
Underhill loam	6, 7, 8, 9	Moderate	Moderate	Moderate
Underhill (sand substratum variant) loam	10	Severe	Moderate	Very severe
Vilas loamy sand	(17, 18, 19), 20, 21	Very severe	Very severe	Very severe

[1] Soil ratings for the various uses indicated are given in terms of four degrees of severity of limitations: slight, moderate. severe, and very severe. Kinds of limitations of soils include: stoniness, shallowness, impeded drainage, hilliness, and droughtiness.

[2] Each soil map symbol number stands for a soil association listed in the legend of the soil map of Menominee County. In the second column of this table a number without parentheses represents a soil association which specifically cites the soil names in the first column of the Table. A number within parentheses represents a soil association which does not cite the soil in question, but which actually includes small areas of it.

[3] It is seldom economical to impound water on the soils listed as having very severe limitation for this use. Ratings of limitations are for undisturbed soils and do not apply to mixed land fill or disturbed soils.

[4] Soils are rated as to their limitations for use in constructing low berms or embankments to impound water. This column considers characteristics and properties of soils that have been disturbed. For example, controlled compaction of embankments results in increased density and lower permeability.

[5] The terms "subsoil" and "substratum" refer to soil materials that have been removed from these horizons.

struction begins. The present soil map should be used only in preparation for a more detailed study of the soils and their condition at the site of each proposed structure.

Pond and flowage sites

Table 10 indicates degrees of limitations, from slight to very severe, of the soils for use as sites of ponds and flowages, and for use as material for constructing dams and embankments.

TABLE 11. DISTRIBUTION OF THE GLACIAL GEOLOGY MAP UNITS, MENOMINEE COUNTY

Map Symbol	Name of Glacial Geologic Unit	Distribution[1]: Percentage of Area of County	Distribution[1]: Acres
	GLACIAL TILL (LOCALLY SHALLOW OVER OUTWASH)		
1	Reddish brown till, undulating to rolling	3.4	8,050
2	Reddish brown till, rolling to hilly {Moraines (11.4%; Drumlins (0.2%)}	11.6	27,135
3	Brown till, mostly rolling {Moraines (8.2%); Drumlins (3.0%)}	11.2	26,217
	Glacial till, total	26.2	61,462
	WATER-LAID DEPOSITS		
4	Reddish brown sandy glacio-lacustrine sediments, rolling to hilly	7.1	16,558
5	Yellowish brown outwash sand, undulating to rolling	7.0	16,328
6	Yellowish brown outwash sand, rolling to hilly	3.0	7,130
7	Brown outwash, undulating to rolling	25.6	59,792
8	Brown outwash, rolling to hilly	28.4	66,460
9	Ice-contact deposits	1.0	2,300
	Water-laid deposits, total	72.1	168,568
	WATER		
	Water {Lakes (1.3%); Rivers (0.4%)}	1.7	4,030
	Water, total	1.7	4,030
	Totals	100.0	234,000

[1] See footnote to Table 36.

V. FACTORS OF SOIL FORMATION

The geology, climate, and biota of Menominee County have caused the soils to develop differently from those in southwestern Wisconsin and in extreme northeastern Wisconsin. In many instances variations between soils within the county may be traced to differences in parent material, topography, and vegetative cover (Jenny, 1941).

Geologic Formations

Bedrock. Menominee County lies within the southern extension of the Precambrian Canadian Shield. The known bedrock is identified on the Geologic Map of Wisconsin as Huronian-Laurentian age granite, gneiss, gabbro, and metamorphosed sedimentary rocks (Bean, 1949; Martin, 1932). Locations of major outcrops are indicated on the soil and glacial geology maps under the designation, Granitic Rockland.

Surficial Deposits. The unconsolidated glacial deposits contain materials derived both from local bedrock and from Precambrian and Paleozoic rocks outside the county. Evidence indicates that a glacier advanced across the county in a northwesterly direction about 15,000 years ago during the Cary or Woodfordian substage (Frye and Willman, 1960) of the Wisconsinan Stage of the Pleistocene glaciation. A neutral to calcareous reddish-brown till was deposited in the east and an acid brown till in the west. The eastern reddish drift was classified as Valders (Thwaites, 1943), although he drew its boundary differently in Menominee County from the more detailed line on the glacial geology map accompanying this bulletin. Precise relations between the two kinds of till in the county are not yet known, nor is the significance of their colors[1] established. All but four of the more than one hundred drumlins lie west of the boundary of the reddish-brown drift. No attempt was made in the present survey to distinguish outwash of one glacial stage from another.

Thwaites (1943) named three northeast-trending morainic systems which cross Menominee County. They are (1) the Elderon, (2) the Bowler, and (3) the Mountain systems. On the glacial geology map of the county prominent bodies of drift called ice-contact deposits show the extent of the Elderon morainic system trending southwest in the northwest corner of T.30N., R.13E.

[1]In eastern Menominee County glacial materials consist largely of heavy sandy loam to light loam, calcareous reddish brown (dark reddish brown, 2.5YR 3/4 Moist to reddish yellow, 7.5YR 6/6 Moist) till, calcareous reddish brown (5YR 5/3 Moist) glacio-lacustrine sediments, and light brown (reddish yellow, 7.5YR 6/6 Moist; to strong brown, 7.5YR 5/6 Moist) sandy glacial outwash. West of the limit of reddish brown glacial drift (see the glacial geology map) are sandy loam, acid, brown (dark brown, 10YR-7.5YR 4/3 to brown, 7.5YR 5/4 Moist) glacial till, and brown (grayish brown, 10YR 5/2 and yellowish brown 10YR 5/6, to dark brown, 7.5YR 4/4 Moist) outwash sand and gravel. It is likely that the red coloring material which is particularly evident in the glacial drift of eastern Menominee County had the same origin as that in reddish brown clayey soils of the Green Bay area, namely fine glacio-lacustrine sediments colored by iron oxides which have been incorporated into other phases of the glacial drift (Thwaites, 1943).

The Bowler moraines trend southwest from Sec. 1, T.30N., R.14E., to Sec. 1, T.29N., R.13E. There are some discontinuous recessional moraines east of the Bowler morainic system which are unnamed. The Mountain morainic system is represented on the glacial geology map by two bands of reddish-brown till extending northeast from T.28N., R.15E. to the northeast corner of the county.

Table 11 lists the glacial formations and gives their areal extents. The till is unsorted debris left by the glacier and in many places in the county was found to be shallow over stratified drift (Figure 24). Waterlaid deposits include outwash sand and gravel, laid down by rapidly flowing glacial melt waters, and glacio-lacustrine fine sands and silts deposited in relatively quiet waters. Gravelly, cobbly ridges (eskers and crevasse fillings) are considered to have been deposited by fast-flowing water between blocks of ice or in tunnels under the stagnant glacier.

The numerous pits in outwash, particularly in the eastern part of the county, represent former sites of buried blocks of glacial ice. Lakes and peat bogs occupy most of the pits today.

The glacier brought rocks from Canada, the northern peninsula of Michigan and northeastern Wisconsin and mixed them with local granitic material to constitute the moraines of the county. Thwaites (1943) reported percentages of Paleozoic dolomite plus chert pebbles in glacial outwash gravels of Menominee County ranging from 78 percent in the east, about 12 miles from dolomitic bedrock in Oconto County, to 42 percent at a point about 18 miles farther west. A low of 12 percent was reported from north central Menominee County in the drainageway of the Wolf River.

A foot or two of coarse wind-blown silt (loess) is a surficial deposit in western portions of the county. It has undergone leaching and some alteration in the process of soil formation.

Local alluvial deposits occur in the county but are not extensive.

Relief and Natural Drainage Pattern

Figure 9 shows a range in elevations of 625 feet. Thwaites (1943) likened the topography of the county to a gigantic staircase, whose treads are outwash plains and whose risers are moraines. The general elevations of the four "steps" are, in order from east to west, 800, 1100, 1350 and 1425 feet above sea level, respectively. Local relief is typically about 20 to 50 feet.

Figure 10 shows the general drainage pattern of the county. Depth of ground water ranges from a few feet near bodies of water to more than 30 feet on drumlins and other high hills. Natural soil drainage conditions vary correspondingly. Although the soils are leached of carbonates to a depth of at least three feet, percolating waters are supplied with solutes by the cycling forest litter and by weatherable silicate minerals in the soil profiles

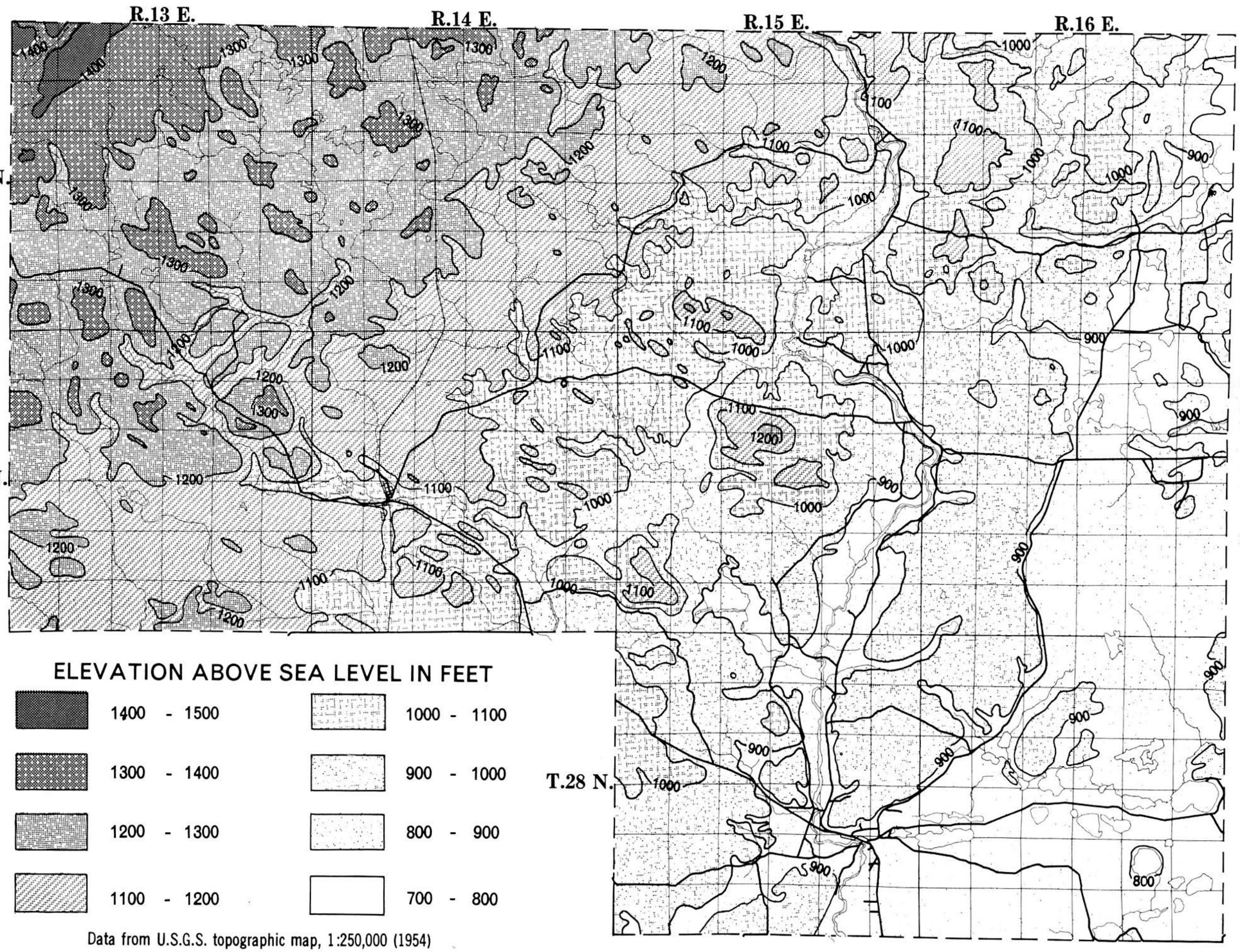

Figure 9. Topographic map.

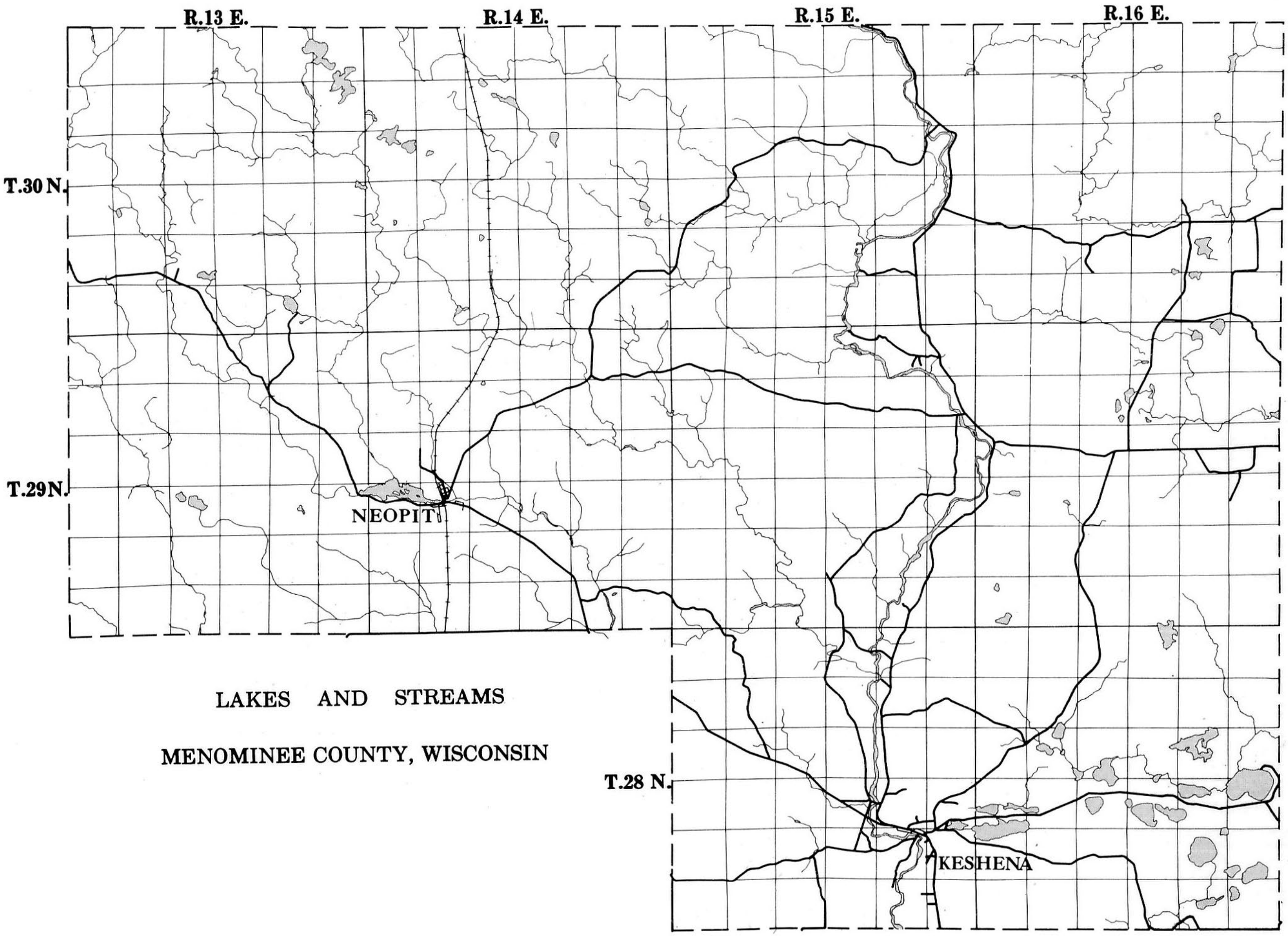

Figure 10. Drainage map.

and substrata. Erratic carbonate material in the glacial drift is another source of dissolved solids in ground water.

One hundred and sixteen lakes are shown on the colored soil map accompanying this report. Surface water flows south from Menominee County chiefly through the Wolf River system, and these tributaries: Red River, Mill Creek, West Branch of the Wolf River, Little Rabe Creek, Squaw Creek, Fish Creek, Dalles Creek, Little West Branch of the Wolf River, Evergreen River, and Deadman Creek. The South Branch of the Oconto River, and Pecora Creek drain eastward into Oconto County. The large acreage of bogs constitutes a reservoir of water and a notable accumulation of peat soils.

Northwest trends of topographic and drainage features (see the soil and glacial geology maps) relate chiefly to direction of glacial advance. Northeast topographic trends are apparently related to positions of the ice fronts during recession.

Climate

Menominee County has a humid, continental climate (Table 12). The county is near the northwestern limit of the humid climatic zone of eastern North America, about 175 miles northeast of the border of the sub-humid zone of the prairies, and about 325 miles south of the cool summer subarctic zone of forested lands of Canada. In terms of soil geography, the county is in a tension zone between the Podzols to the northeast and the Gray-Brown Podzolic soils to the southwest and south. The average thickness of snowfall and sleet is about 47 inches annually. Snow covers the landscape

Figure 11. Muskeg or sphagnum peat bog (Greenwood peat, unit 25, soil map).

TABLE 12. CLIMATIC DATA FOR SHAWANO[1], WISCONSIN, NEAR MENOMINEE COUNTY, WISCONSIN[2], (MEAN AND EXTREMES FOR PERIOD 1930-1959)

	Temperature (°F)								(Precipitation Totals (Inches)								Mean Number of Days					
	Means			Extremes								Snow, Sleet						Temperatures				
																		Max.		Min.		
Month	Daily Maximum	Daily Minimum	Monthly	Record Highest	Year	Record Lowest	Year	Mean Degree Days▲	Mean	Greatest Daily	Year	Mean	Maximum Monthly	Year	Greatest Daily	Year	Precip. .10 In. or More	90° and Above	32° and Below	32° and Below	0° and Below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		30	30	30	30	30	
Jan.	26.6	7.2	16.9	53	1944	—35	1935	1490	1.52	1.27	1946	12.2	27.5	1935	11.0	1940	5	0	21	31	10	Jan.
Feb.	29.6	8.6	19.1	61	1930	—33	1936	1290	1.35	1.75	1937	9.9	25.5	1953	9.0	1948	4	0	17	28	8	Feb.
Mar.	39.3	19.4	29.4	79	1946	—17	1943	1100	1.72	1.89	1950	8.7	22.0	1956	10.0	1956†	4	0	7	28	2	Mar.
Apr.	56.4	32.7	44.6	88	1952	5	1954	610	2.60	1.81	1953	2.0	7.0	1944	5.0	1940	5	0	*	17	0	Apr.
May	70.2	43.6	56.9	100	1934	21	1947	280	3.33	3.70	1942	0.4	4.0	1940	4.0	1940	6	*	0	4	0	May
June	79.7	54.0	66.9	101	1934	30	1945	80	3.93	2.45	1934	0	0		0		7	3	0	0	0	June
July	84.6	58.4	71.5	109	1936	39	1930	20	2.91	2.24	1956	0	0		0		6	7	0	0	0	July
Aug.	81.9	56.2	69.1	104	1955	32	1934	40	3.64	3.81	1940	0	0		0		6	5	0	*	0	Aug.
Sept.	72.7	48.1	60.4	100	1933	21	1947	190	3.11	2.25	1940	T	T	1945†	T	1945†	6	1	0	2	0	Sept.
Oct.	60.3	37.8	49.1	86	1953†	15	1930	490	2.20	2.40	1936	0.4	6.8	1933	6.0	1933	4	0	*	9	0	Oct.
Nov.	42.5	25.5	34.0	75	1933	— 9	1950	930	2.28	2.41	1949	4.3	16.0	1959	6.0	1956	5	0	6	23	*	Nov.
Dec.	29.9	13.6	21.8	57	1939	—25	1933	1340	1.51	1.71	1959	9.0	19.8	1938	7.0	1946†	4	0	18	30	6	Dec.
Year	56.1	33.8	45.0	109	July 1936	—35	Jan. 1935	7860	30.10	3.81	Aug. 1940	46.9	27.5	Jan. 1935	11.0	Jan. 1940	62	16	69	172	26	Year

1. Latitude 44°47'N, Longitude 88°37'W, Elevation (ground) 786 ft.
2. Prepared by Marvin W. Burley, Weather Bureau State Climatologist, Weather Bureau Office, Madison, Wisconsin

(a) Average length of record, years.
T Trace, an amount too small to measure.
▲ Base 65°F. (H. C. S. Thom, Monthly **Weather Review,** January 1954.)
† Also on earlier dates, months, or years.
* Less than one half.

about 110 days out of the year. The annual precipitation is approximately 30 inches. Of this about 18 inches are lost through evaporation and transpiration, leaving about 12 inches for ground water recharge and stream flow (U.S.D.A. Yearbook Agr., 1941).

The average frost-free season is about 126 days. Depressions such as bogs may have summer night frosts. Average winter frost penetration in open fields is about 40 inches, but under forest cover with thick undisturbed natural litter on the forest floor the soil may not freeze at all. The spring killing frost for common field crops comes on May 14, on the average (Hole and Lee, 1955) although 10 percent of the time it is as late as May 26. Corresponding dates for the first autumn frost are September 29 and September 18.

Organisms

Forest. The forest trees annually produce about a ton and a half of litter per acre. The destruction of this great mass of leaves, wood, seeds, bark, and related organic material lags one to seven years behind production, with the greatest lag under hemlock stands. Decomposition is accomplished chiefly by bacteria and other small organisms, including the fungi which in the summer give rise to numerous striking fruiting bodies on the forest floor. The importance of cycling of plant nutrients in soil and forest ecology is discussed in Chapter VI.

Large earthworms, particularly the "night crawler" (*Lumbricus terrestris*), are active in mixing leaf litter into mineral soil (Nielsen and Hole, 1964). We observed that they occurred in the county along highways and bodies of water to a distance of about 150 feet into the forest on either side, but were otherwise absent. Studies here and in southern Wisconsin indicate that *Lumbricus terrestris* was introduced into the state. It has been conjectured that this species was brought from Europe (possibly in soil used as ship ballast two centuries ago), and has been spreading from the east coast across

Figure 12. Cradle-knolls, formed by blow-down of trees, are numerous in the forests of Menominee County, but are most easily seen in recently cleared land, as in this pasture just outside the County.

the continent since. Fishermen have undoubtedly accelerated its northward migration in Wisconsin and its advance near streams and routes of travel. In well drained soils the "night crawler" forms a deeper black A1 horizon than was present before its coming. Large populations of *Lumbricus* during moist summers can strip the floor of a deciduous forest nearly bare of litter, and thus expose the soil to erosion.

Shallow pits and low mounds, called cradle-knolls (Figure 12) (Hole and Schmude, 1959; Gaikawad and Hole, 1961), have been formed over the centuries in forest soils of the county by blow-down of large trees during wind storms. The roots of a falling tree in each instance lifted up a mass of soil and pulled it to one side, forming a shallow pit and an adjacent low mound. Large tipped-up masses of soil and roots are found at very recent sites, but at most cradle-knolls no trace remains of the trees which produced the disturbance long ago. Cradle-knolls (Chapter VII) occupy about 20 percent of the area of the forest floor except on very sandy soils and on granitic rockland.

Man. Man has been responsible in a great many areas for disturbance of natural ecosystems (Bidwell and Hole, 1965), but in Menominee County he has maintained a harmony with nature which is unusual for the state of Wisconsin and, indeed, for the North-Central Region of the country. The plow and the bulldozer and associated erosion (Figure 13) have altered the soil in only limited areas in the county. Even though the tribe is having difficulties maintaining itself and in making the inevitable adjustments to the pressures of white man's culture, the Menominees have demonstrated that a people can live in a forest in such a way that the ecosystem largely supports them without its deterioration.

Fire

The presence of bits of charcoal in most surface soils of the county, and the fire-scars on trees and old stumps referred to in Chapter VI, are ample

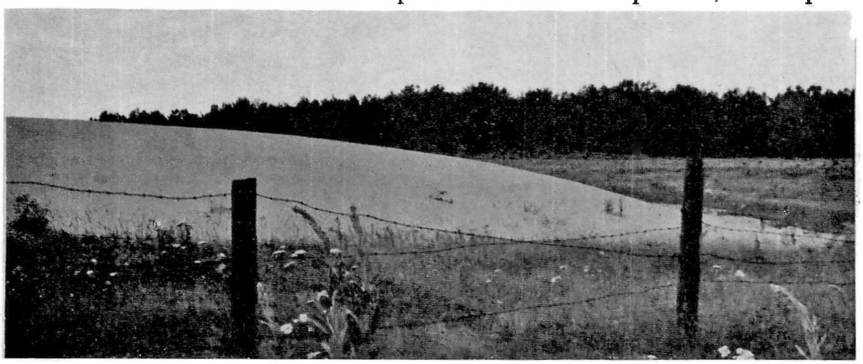

Figure 13. Sand dune on eroding Crivitz loamy sand in eastern Menominee County, Wisconsin, 1962.

evidence of local burns in decades and centuries past. Whether the fires were set by lightning or by people, they can be considered as natural catastrophes in the ecosystem. The effect of fire on the soil has been considerable, as has the modern control of fire, by altering the density and species composition of forest stands, as will be explained in the following two chapters.

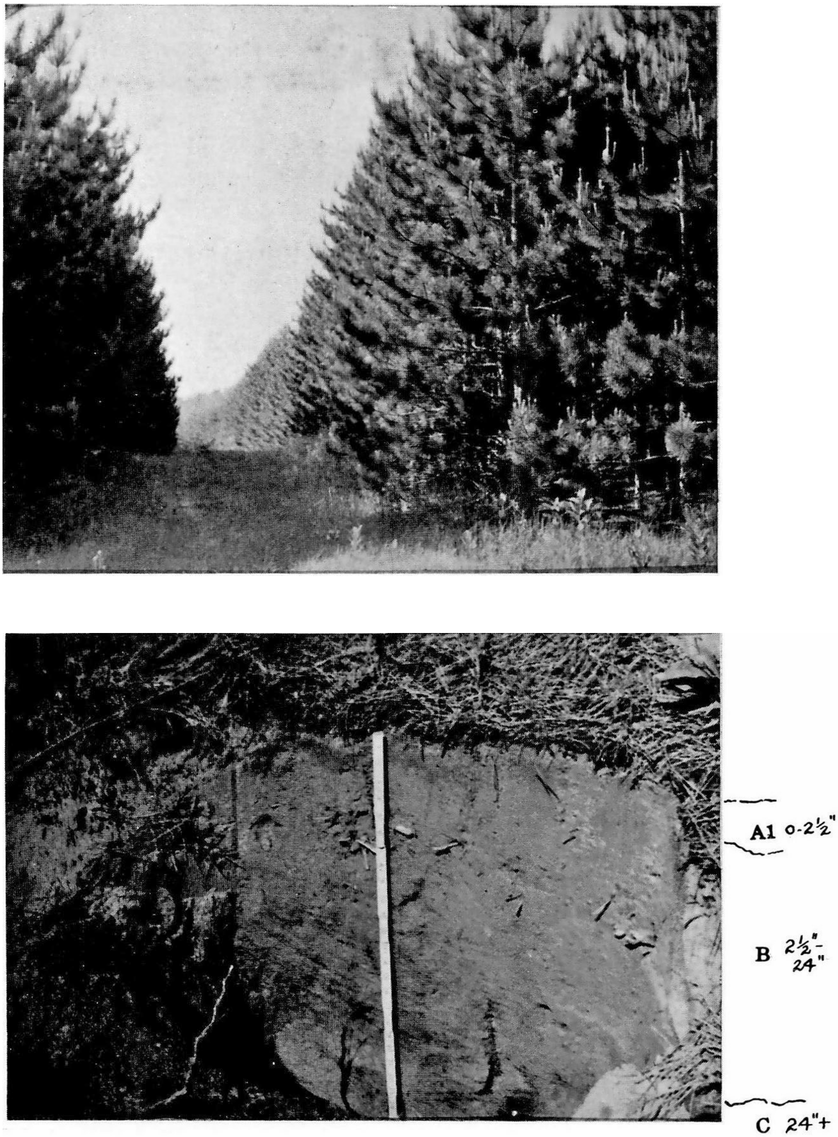

Figure 14. Red pine plantation (Unit 4P on the vegetative cover map) near the Keshena Ranger Station on Crivitz sandy loam (unit 18 on the soil map).

VI. UPLAND VEGETATION

F. Glenn Goff[1]

Menominee County is a unique island of diverse (Table 30) relatively undisturbed forest surrounded by an expanse of second growth aspen, red maple, white birch, and other pioneer species in the Great Lakes Region. The area thus offers an unusual opportunity for examination of relationships between native plant communities and the soils that support them. This chapter is a preliminary report on an intensive study of 50 upland forest stands. Study areas, one to two acres in extent, were selected to represent the major gradients in parent materials and history within the county. Each stand was examined with consideration of both the history and ecology of the site. From the characteristics of the existing vegetation and soils, as well as from stumps, cradle-knolls and a variety of other circumstantial evidence, forest conditions of a century or more ago can usually be reconstructed. The present population of seedlings, saplings, and small trees indicates the probable future of each stand. Observations on herb and shrub vegetation, which are useful in ecological interpretation, will be published elsewhere as part of a more comprehensive treatment. A list of the vascular plant species observed in the county is given in the appendix.

The following discussion summarizes observations under four general textural groupings of soils:

(a) Forests of the outwash sands (Soil map units 20, 21).

(b) Forests of the stratified loamy sands and sandy loams (Soil map units 17, 18, and 19).

(c) Forests of the loams and shallow silt loams (Soil map units 4, 8, 14, 15, 16).

(d) Forests of the deep silt loams (Soil map units 1, 2, 3, 11, 12, and 13).

Reference to the colored vegetative cover map will be useful to the reader. In each of the sections of this chapter the least disturbed forests will be treated last.

Forests of the outwash sands

On the nearly level outwash sand plain of southeastern Menominee County, the leading upland tree species are jack pine (*Pinus banksiana*) and Hill's oak (*Quercus ellipsoidalis*). On imperfectly drained or finer textured soils large-toothed (*Populus grandidentata*) and quaking aspen (*P. tremuloides*) become increasingly important. A variety of swamp conifers and hardwoods occupy poorly drained sites.

[1]National Science Foundation Fellow, Department of Botany, The University of Wisconsin.

Evidence of fire on the sand plain. Studies of fossil pollen elsewhere in northern Wisconsin indicate that spruce, fir, and other mesic species may have occupied the area sometime prior to the climatic warming that occurred about 4,000 years ago. Changing climatic conditions, together with recurrent fires, presumably transformed the vegetation of the outwash sand plain to a relatively open savanna. This vegetation has been maintained by recurrent burning as evidenced by the following: (1) fire-adapted tree species (jack pine, Hill's oak, etc.); (2) a rich complement of species characteristic of pairies of southwestern Wisconsin (big bluestem, *Andropogon gerardi;* little bluestem, *A. scoparius;* Indian grass, *Sorghastrum nutans;* Prairie bush clover, *Lespedeza capitata;* leadplant, *Amorpha canescens;* etc.); (3) large clones of aspen resulting from frequent post-fire resprouting; (4) old, fire-scarred white pine (*Pinus strobus*), red pine (*P. resinosa*), jack pine, and Hill's oak trees; (5) the open-grown form of old trees (6) proliferation of even-aged oak sprouts and jack pine upon cessation of burning about 1930; (7) abundance of charcoal fragments in the surface soil; and (8) historical accounts of repeated burning in recent times.

Compositional pattern of forests on the sand plain. The upland forests of the southeastern sand plain are dominated by two species, jack pine and Hill's oak. Although areas in which these species form an almost equally mixed overstory are not uncommon, a mosaic pattern of nearly pure stands of each is more typical. This pattern may simply reflect past burns, for there is no apparent correlation of soil and topography with the distribution of vegetation.

The response of these two species to fire differs markedly. A relatively light burn kills Hill's oak back to the ground. New sprouts arise from the root crown to produce a brushy clump of stems. The work of Buckman (1964) has shown that spring fires in particular favor such sprouting by broadleaved species. Hill's oak, white birch, and aspen appear to respond in this manner. Data for trees over four inches in diameter at four and one-half feet above ground (dbh) from a representative stand (stand 3, Table 31) show densities of 274 Hill's oak, 62 large-toothed aspen, and 2 jack pine per acre.

Jack pine displays a very different response to fire. This species retains its seeds for many years in tightly closed serotinal cones that are opened by the heat of a fire. The large volume of seed released may give rise to very high jack pine seedling densities following fire. Late summer fires are particularly favorable to regeneration of pine rather than oak because of the destruction of litter and elimination of competition by broad-leaved species. Stand 2 is an even-aged jack pine stand only a mile distant from the Hill's oak stand described above. Jack pine is represented in stand 2 by 446 tree-sized stems ($>4''$ dbh) out of a total tree density of 468.

Successional relationships. Successional relationships on sand plains are perhaps less clearly understood than in any other type of Wisconsin forest. The concept of an "edaphic climax" may apply in this forest. The edaphic climax can be composed of species which are commonly considered pioneers such as jack pine, Hill's oak, and aspen, provided they are able to perpetuate themselves generation after generation. On very poor soils, reduced canopy cover may allow the cyclic regeneration of these species.

The current pattern of regeneration in these stands, however, suggests that succession to more mesic vegetation may be occurring over much of the area. In the vicinity of old seed trees, red and white pine seedlings have become established in significant numbers. Combined seedling and sapling densities of white and red pine totaled over 335 stems per acre in stand 3.

In this survey, a concerted effort was made to find an example of more mesic vegetation than jack pine, Hill's oak, or aspen on a well drained site within the southeastern sand plain. It was reasoned that somewhere within the area, perhaps on the lee side of a lake, natural protection from fire might have been sufficient to allow more mesic vegetation to develop fully, but we were unable to find such a stand. Therefore, the question as to whether or not the white pine understory will continue to develop can be answered only by time.

Evidence of successional sequence from outside the sand plain. South of Neopit, stand 35 was sampled on soil (Vilas medium sand) of texture similar to that of soils in the southeastern sand plain. The topography in the vicinity is steep and rolling. Bedrock occurs at a depth of only about 5 to 20 feet. It is doubtful that this stand can be taken as representative of the future vegetation of the sand plain of southeastern Menominee County because of the extremely different site conditions with respect to slope, topography, age and origin of parent material, surrounding soils and vegetation, proximity of bedrock, and probable incidence of fire over the centuries. Stand 35 is considered here, only because it illustrates one of the more mesic forest types on record for a soil of this texture. Table 13 summarizes densities by species for size strata within the stand.

White pine forms the overstory. Hemlock (*Tsuga canadensis*) accounts for most of the density below 15 inches dbh. Sugar maple (*Acer saccharum*) is represented by a few tree-sized individuals and shows a characteristic peak density in the seedling classes. Of interest is the presence of a few aspen sprouts. This illustrates the peculiar ability of aspen to hang on as small, vegetatively reproducing sprouts for a very long time, which may account for its proliferation after fire.

It may be conjectured that Hill's oak and jack pine would come to occupy a body of Vilas sand like that at stand 35, if the site were subjected to the frequent burning described for the sand plain.

TABLE 13. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 35

Species	Diameter class midpoint[2]									
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″
Quaking aspen	8	0	0	0	0	0	0	C	0	0
White pine	0	0	0	12	12	4	12	4	10	4
Hemlock	400	72	26	52	32	18	6	0	0	0
Balsam fir	24	32	0	0	0	0	0	0	0	0
Sugar maple	472	0	8	6	2	4	0	0	0	0
Red maple	24	0	0	0	0	0	0	0	0	0
Basswood	56	0	0	0	0	2	0	0	0	0
Yellow birch	16	0	2	2	6	0	0	0	0	0
Other	0	0	0	4	4	6	0	0	0	0
Total	1048	104	36	76	56	34	18	4	10	4

See table 39 for definitions of diameter classes.

Forest succession on imperfectly and poorly drained sites. On swamp borders and in other areas where evidence of a water table occurs within the rooting zone, red maple (*Acer rubrum*), white pine, and low densities of hemlock and sugar maple may be found. Tentatively it would seem that the succession on such low-lying sites is capable of proceeding more rapidly to a terminal forest comprised of these species.

Management. From an ecological point of view, several management alternatives present themselves on the Omega sand plain of southeastern Menominee County. Jack pine is commercially valuable for pulpwood and many stands of this species are approaching merchantable size. The apparent trend in succession toward red and white pine suggests that a high value pine forest may eventually occupy the area. The few remaining red and white pine trees should be left uncut as a seed source.

In very dense stands of Hill's oak, summer burning may be used to tip the balance away from Hill's oak and toward pine.

The recreational potential of the sand-bottomed lakes of the sand plain provides a resource far more important than any anticipated yield of forest products. In the opinion of the writer, watershed maintenance and perpetuation of the aesthetic qualities of the landscape must be given priority over the more immediate goal of timber production.

Forests of the stratified loamy sands and sandy loams

On the slightly finer textured soils and more rolling topography outside the sand plain, a different series of forests are present. Here white pine reaches its maximum as do hemlock, yellow birch (*Betula lutea*), and quaking aspen. The major part of the presettlement pine forest must have occurred on these soils, judging by the high densities of white pine stumps encountered on the sandy drift.

Most areas of extensive white pine forest in northern Wisconsin are located, as they are in this county, on rolling stratified loamy sand and sandy loam soils near sand plains from which fires occasionally licked unto the uplands, thereby setting back succession and permitting a cover of aspen and white pine to persist. The presettlement white pine belt on these soils in Menominee County is located principally to the north and west of the sand plain.

Both quaking and large-toothed aspen are primary post-fire species on the sandy drift. Absence of aspen appears to coincide with a high density of white pine stumps and snags, as found on bracken grasslands to be discussed below. This may indicate that aspen was unable to persist in the pine forests which once occupied these sites. The soils of the sandy drift, unlike Omega sand, support a wide variety of forests in both intermediate and late stages of succession.

Forest succession after fire, as illustrated by three stands. A series of three stands (numbers 31, 50 and 4) on similar parent materials illustrates the normal seral relationships of several common species on the soils of the sandy drift (Figure 15).

In stand 31 (Table 14) a 35 year old aspen overstory of sprout origin is associated with a moderately dense pine understory. The 15 to 20 year age-gap between aspen and white pine in this stand appears to be characteristic in the county, although occasional stands occur in which these species are of nearly the same age. Black cherry (*Prunus serotina*), likewise of sprout origin, is associated with aspen in the overstory. The relatively high black cherry densities within the seedling class result from basal sprouts.

A white pine understory beneath aspen as illustrated here is common. Other species less commonly observed to invade aspen lands include red pine, white spruce (*Picea glauca*), balsam fir, red maple, and occasionally hemlock and sugar maple. Where these species are found as important com-

TABLE 14. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 31

Species	Diameter class midpoint			
	S	2″	5″	8″
Quaking aspen	60	304	296	24
White pine	20	552	0	0
Black cherry	220	32	32	0
Other	20	0	0	0
TOTAL	320	888	328	24

ponents of the understory, there is nearly always one or more mature trees in the immediate vicinity to provide a source of seed. Seed source, always a most important factor in determining the pattern of forest succession, is particularly crucial on these burned-over aspen lands of the central part of the county. In areas lacking a local seed source of other species, aspen may persist for some time. This it does by two or three generations of sprouts each of which breaks up to make way for the next. This process may eventually lead to actual degeneration of the forest to give place to extensive openings, unless management is applied periodically. Aspen sprouts with greatest vigor after cutting, windthrow or burning of a stand before it has reached full size.

By observing stands of varying composition on a similar substratum at sites further removed from disturbance, an insight can be gained into the probable general course of vegetational succession. Stand 50 includes white pine about 60 years of age and a few scattered remnant aspen trees. Table 15 summarizes the density values for several of the more important species within this stand. A few old, hollow, large-toothed aspen, and their more recent root sprouts, represent all that is left of a former overstory of aspen.

White pine shows a nearly normal distribution of density about the 11-inch size-class at which point it reaches a peak of 84 stems per acre. The presence of large pine stumps suggests that the forest was lightly cut for pine many years ago. The hemlock, yellow birch, basswood (*Tilia americana*), and red maple probably appeared as seedlings after the cut.

Sugar maple and beech (*Fagus grandifolia*) show a fairly regular increase in number with decreasing size. The very high density of sugar maple in the smallest stratum is characteristic of this species. It normally establishes a great many individuals but displays a high initial mortality rate. Hemlock,

TABLE 15. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 50

Species	Diameter class midpoint							
	S	2″	5″	8″	11″	14″	17″	20″
L. T. aspen	60	0	0	0	0	0	0	4
Black cherry	40	0	0	0	2	0	0	0
Red Maple	620	0	10	0	0	0	0	0
White pine	0	0	26	70	84	46	14	0
Hemlock	700	24	36	2	0	0	0	0
Sugar maple	5060	104	24	22	0	0	0	0
Yellow birch	140	0	18	12	2	0	0	0
Beech	300	24	8	2	0	0	0	0
Basswood	140	8	12	6	4	0	0	0
Other	80	8	6	12	6	2	0	0
Total	7140	168	140	144	98	48	14	4

on the other hand, etablishes fewer seedlings, but has a lower rate of mortality.

Table 16 summarizes the density values of stand 4. The stand contains several large white pine trees averaging about 350 years of age and a well developed hemlock-hardwood component. This is indeed a spectacular forest. Several of the white pine trees are over 140 feet in height with straight trunks extending upward 100 feet or more to the first branches. Mosses carpet much of the forest floor but otherwise herbaceous cover is generally sparse.

The successional stage represented by this stand is far in advance of that of stand 50. All of the white pine trees are in excess of 27 inches dbh. The largest stems of hemlock and yellow birch probably date to an original invasion of these species beneath a young white pine overstory. Both sugar maple and yellow birch are found to be rather sparse in the larger tree strata but are well represented as saplings. In contrast, hemlock is well represented throughout most tree strata. Although their seedling densities are considerably lower, both beech and basswood show a more regular increase within the smaller classes than does sugar maple. A major break in density of several species occurs at approximately 8 inches dbh. The presence of white birch of about this size elsewhere in the area suggests a surface fire 35-40 years ago. This contention is supported by fire scars on some of the white pine trunks.

Hemlock may become established in very high densities following surface fire beneath an intact overstory. In many places along the Shawano-Menominee County line where fire burned into the Menominee pine-hemlock stands from adjacent cut-over areas, a dense hemlock "fire-fringe" may be observed. Trees 1 to 6 inches dbh often exceed 1000 per acre in such areas. In stand 4

TABLE 16. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 4

Species	Diameter class midpoint										
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″	G
White pine	0	0	0	0	0	0	0	0	0	0	16
Hemlock	160	288	30	0	6	10	14	6	6	2	2
Sugar maple	3140	64	12	0	0	0	0	2	0	0	0
Red maple	620	0	0	0	0	0	0	0	0	0	0
Yellow birch	80	16	2	0	0	0	0	0	0	4	0
Basswood	40	8	4	6	4	0	0	0	0	0	0
Beech	820	80	16	2	6	6	0	0	0	0	0
White ash	380	0	2	0	0	0	0	0	0	0	0
Other	20	0	0	2	0	0	0	0	0	0	0
Total	5280	456	482	10	16	16	14	8	6	6	18

(Table 16) the high density of hemlock stems in the small tree and sapling classes suggests a similar phenomenon.

The major compositional gradient on sandy drifts following fire is summarized in Figure 15. Aspen is the initial invader in association with other post-fire species. After 10 to 20 years a white pine understory may develop that eventually replaces the immediate post-fire pioneers. This species remains as an overstory dominant for a very long time. Hemlock and shade tolerant hardwoods normally invade beneath the pine understory to form a more or less self-perpetuating forest in the absence of catastrophe.

Disturbance on a large scale is a natural characteristic of such a landscape. Although fire is not as frequent on this rolling sandy drift as on the outwash sand plains, it is nonetheless an important element in the ecology of these forests. The complement of species occurring within a landscape, including such important species as white pine and aspen, is largely dependent upon the frequency of occurrence of catastrophic disturbance. Prior to the advent of management by humans, windthrow and fire were the major natural catastrophic events responsible for reinitiating the successional cycle. Disease and insect infestation were probably important locally. The recent effects of cutting upon succession resemble those produced by windthrow. There is some evidence that light selective cutting may be more unnatural than cutting more heavily in a mosaic pattern.

Forest Succession after Cutting. The effect of clear-cutting without fire is shown by data from stand 44 (Table 17). Remaining stumps of hemlock and hardwoods and a few large white pine indicate an original composition similar to that of stand 4 (Table 16). Judging from the age of the yellow birch now present, the clear-cut occurred between 1900 and 1910. With

TABLE 17. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 44

Species	Diameter class midpoint						
	S	2″	5″	8″	11″	14″	17″
Hemlock	112	64	0	0	2	0	0
Sugar maple	1324	280	30	16	8	2	0
Red maple	92	0	0	0	0	0	0
Yellow birch	0	40	146	86	48	2	2
Basswood	8	0	2	10	6	0	0
Beech	1284	24	4	0	0	2	0
White ash	116	0	0	4	4	0	0
Other[1]	36	8	0	12	6	0	0
Total	2452	416	182	128	74	6	2

[1] Includes white ash which is most numerous in the seedling (S) and 8-inch and 11-inch size classes.

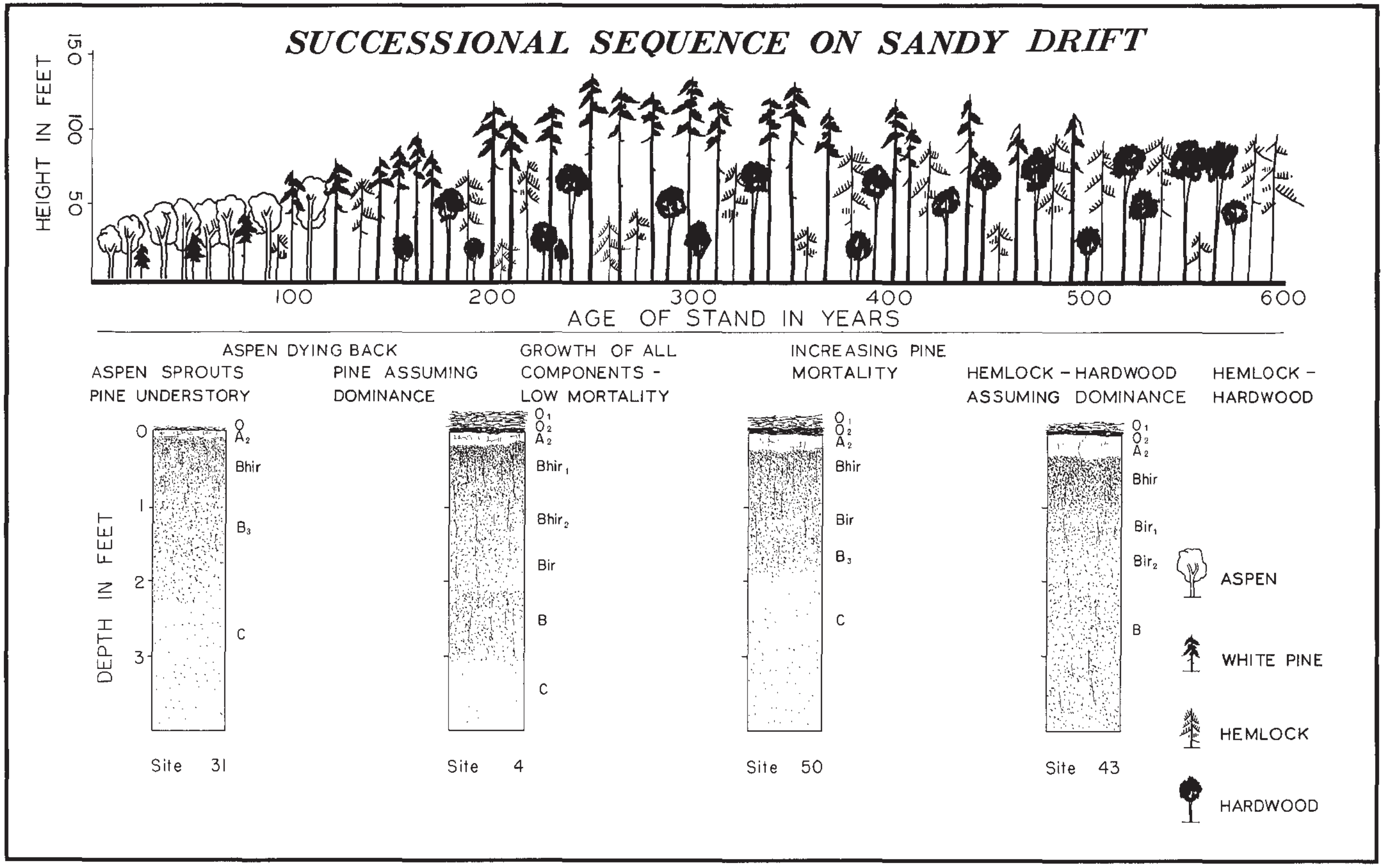

Figure 15. A concept of forest and soil succession on sandy drift in Menominee County.

removal of the overstory, yellow birch comes in rapidly to form a fairly solid stand on podzolized light-textured soil exposed and disturbed by logging operations. Sugar maple grows slower than yellow birch and is more tolerant as indicated by its increasing density in the smaller size classes.

White ash (*Fraxinus americana*) and basswood are fast growing species occurring most abundantly in the 8-inch stratum with sprouts in the seedling class. Hemlock and beech occur principally within the smallest strata and will probably become more important with passing time.

In several other stands (numbers 11, 8, and 49) similar trends are apparent. Clear-cutting of hemlock-hardwoods, at least in these instances, has produced a relatively pure hardwood overstory, often with yellow birch dominant and sugar maple co-dominant, beneath which hemlock and other tolerant species reproduce. The forest returns in one generation to a more or less stable hemlock-hardwood composition that is very similar to that of the terminal forest produced by the post-fire series (Figure 15), although the pathways of succession are very different. The proportion of yellow birch to sugar maple in the initial stand seems to depend upon the quality of the site, the availability of seed, and the degree of soil disturbance associated with cutting. Yellow birch is favored on sandy strongly podzolized soils that are greatly disturbed provided a seed source is immediately available.

Normally, yellow birch continues as an element of the terminal forest, reproducing on logs, cradle-knolls, and other sites of disturbance, but large pure stands of this species cannot be attributed to such a means of regeneration. Windthrow or cutting without fire appear most favorable to this species, although under certain circumstances light burning may aid its establishment.

Bracken-grasslands of forest openings. In topographically low areas in the rolling sandy drift country, open stumplands with a heavy groundcover of bracken fern and sedges occur. These bracken-grasslands (Curtis, 1959) support a very peculiar flora with a number of exotic species, nearly always including mullein (*Verbascum thapsus*) and butter-and-eggs (*Linaria vulgaris*). They differ remarkably from openings in the sand plain area which characteristically support many native prairie species and few exotics. Bracken grasslands are principally of recent origin and may be maintained at least in part by frost and other micro-climatic extremes.

Management. While hemlock is an important species from the wildlife standpoint, it is relatively undesirable in terms of timber production. The successful management of a forest must be based upon the concept of the forest as a highly integrated system. Each species interacts in varying degrees with every other species, plant and animal alike, and the entire biota in turn interacts with soil and climate. Thus, the elimination of one species in favor of another cannot be justified on the basis of immediate commercial value alone. With a view to the long-term recreational use of Menominee forest, hemlock may be one of the most valuable species.

The most profitable immediate management alternatives on these soils would be directed either toward aspen, white pine, or yellow birch. Perpetual aspen management demands periodic clear-cutting to encourage sprouting, and may in certain instances demand fire as well. For natural white pine regeneration, seed trees must be available in the immediate vicinity. Although more careful quantitative work should be directed toward this problem, a density of about one seed tree per two acres (20 trees per 40 acres) would probably be adequate. In this case, aspen should be left as a cover crop until the pine is 20 to 30 years old, although aspen thinning operations of less than 50 percent canopy reduction would be allowable.

Management for yellow birch in relatively pure stands appears most suited to light loam and sandy loam Podzols, contrary to the widely accepted view that this species requires heavy soils. Indications are that the species is fire intolerant yet requires a mineral seedbed and relatively open canopy conditions for establishment in nearly pure stands. Management for yellow birch demands a near clearcut of hemlock-hardwood with canopy reduction in excess of 80 percent, but leaving a yellow birch seed source. Supplemental scarification by bulldozer or disk would further improve yellow birch seeding.

With repeated fire, red oak, red maple, and white birch may encroach upon these soils with aspen. But red oak is more characteristic of somewhat finer textured soils.

Forests of the loams and shallow silt loams

Forests on these medium textured soils display a much greater diversity of species than those of the sandier soils. Following disturbance it is not uncommon to find 15 or more tree species per acre on the medium textured soils. Because many more species are involved, and because the pattern of history is in general more complex, successional trends are not as clear as on the lighter soils.

Forest succession after fire, as illustrated by two stands. Two young second-growth stands illustrate the nature of post-fire pioneer forests on these soils. Stand 23 (Table 18) is red oak-mixed hardwood on loam soil. The richness and diversity are immediately apparent from the number of species included in Table 18. Rotting trunks and fire-scarred older trees in the vicinity suggest that this area was covered by hemlock-hardwood forest prior to burning about 1910. Ages of the larger red oaks range from 41 to 51 years. The relatively large number of red oak trees in the 8-inch class could be accounted for by a second less severe burn in about 1930. Greater density of hardwood relative to pine in the understory illustrates how the successional balance is tipped away from white pine toward hemlock, red oak, and other second-growth hardwoods as one moves onto progressively

TABLE 18. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 23

Species	Diameter class midpoint						
	S	2″	5″	8″	11″	14″	17″
White pine	40	0	2	0	0	0	0
Hemlock	480	32	0	0	0	0	0
Balsam fir	500	8	0	0	0	0	0
Sugar maple	620	448	74	4	0	0	2
Red maple	1020	88	64	0	2	0	0
Yellow birch	60	0	18	0	0	0	0
Basswood	60	8	14	12	2	0	0
Red oak	640	16	36	34	44	6	0
Beech	240	288	32	0	0	0	0
White ash	1540	16	14	2	0	0	0
Black cherry	40	0	0	0	0	0	0
Ironwood	660	48	0	0	0	0	0
Quaking aspen	200	0	0	14	4	0	0
Large-toothed aspen	0	0	0	6	2	0	0
Other	0	0	0	2	0	0	0
Total	6120	952	272	90	54	6	2

TABLE 19. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 13

Species	Diameter class midpoint					
	S	2″	5″	8″	11″	14″
Hemlock	40	0	0	0	0	0
Balsam fir	20	0	0	0	0	0
Sugar maple	4760	344	52	36	10	2
Yellow birch	60	0	8	0	0	0
Basswood	20	8	74	88	18	0
American elm	80	112	82	42	16	2
Red elm	2200	8	22	8	2	0
Red oak	20	0	0	0	0	0
White oak	2200	8	4	10	8	0
Bitternut hickory	680	0	2	2	2	0
Ironwood	320	48	6	0	0	0
Quaking aspen	140	0	2	0	0	0
Other	0	0	0	2	2	0
Total	10540	528	252	188	58	4

finer textured soils. Hemlock is becoming established primarily on rotting logs and cradle-knolls where the litter is shallow. By means of layering, balsam fir has attained a higher density in the smallest size class. However, observations within the county indicated that this species rarely becomes an important overstory component on upland sites. Tight clumps of small individuals of sugar maple, red maple, basswood, white ash, and other hardwood species probably represent root crown sprouts following fire. Quaking aspen is present in the smallest size class as root sprouts.

Stand 13 (Table 19) illustrates a somewhat more mesic composition on a finer textured soil. This stand is younger than stand 23, the largest trees being about 40 years old. Seedlings are much more abundant in stand 13 than under the denser canopy of stand 23. Red oak is the leading dominant species in stand 23 but is present in stand 13 only as seedlings. Conversely, American elm is dominant in stand 13 but is lacking in stand 23. The differences between these stands are typical of the diversity of forest composition following fire on these soils.

Minor differences in soils, fire intensity, availability of seed source immediately after fire, and numerous other factors may combine to produce a great variety in post-fire vegetation.

Forest succession after cutting. Selective cutting on the loams and light silt loams increases the proportion of hardwoods to hemlock. On podzolized light loams, particularly where cutting has been heavy and the mineral soil has been exposed, yellow birch proliferates. On less podzolized heavier loams, with only selective cutting and little disturbance of the forest floor, sugar maple, beech, elm (*Ulmus americana*), and basswood become established.

Stands 9 (Table 20) and 11 (Table 21), located contiguously on the same ridge, illustrate conditions before and after cutting respectively. These stands do not fit well into any of the main site categories considered. Because of excessive exposure on the ridge and the strongly leached condition of the soil, they resemble in several ways the vegetation of lighter soils (such as stand 35). The leading species in stand 9 are hemlock and yellow birch. Under a thick mat of slowly decomposing needles and wood the mineral soil has become acid and low in nutrients and exchange capacity. Interception of rain by the dense canopy and the litter mat account in considerable part for the sparse understory of hardwoods and small plants. The hardwood species will probably never become important components of the overstory unless some form of disturbance such as burning or cutting occurs. The present conditions maintain a balance within the system as a whole that is more favorable to hemlock and yellow birch than to the more mesic and basophilic hardwood species. Hemlock regeneration becomes established in high density and the entire cycle tends to be perpetuated (Figure 16).

Judging by the state of decomposition of stumps, stand 11 was cut lightly for large white pine and hemlock around 1910 and heavily for hemlock in about 1935. The total tree density remaining after the cut was probably less than 70 trees per acre, representing a density reduction of about 60 percent. Since principally larger trees were cut, the reduction in basal area and volume may have been as much as 75 percent. Some large hemlock, sugar maple, and yellow birch trees were spared in the first cut. Small trees under 8 inches in diameter have come in since the second cut. Pin cherry (*Prunus pensylvanica*) which occurs here in unusual numbers is dying out rapidly and will probably not be a significant component in the mature stand. Survival of yellow birch beyond the seedling stage far outstrips that of the maples, and this species will eventually be the leading dominant. Hemlock seedlings, rooted on rotting logs and stumps and on cradle-knolls, can be expected along with the birch to assume an important place in this forest.

Influence of topography. Although red oak and other mesic second-growth hardwoods are more abundant on these medium textured soils than on those of lighter texture, aspen and white pine are often present and may become locally abundant. South of Neopit there is a large area of white pine and red oak that apparently dates to an extensive fire in about 1830. White pine and hemlock are found principally on sandier soils and in lower topographic positions throughout the area while the proportion of red oak and other hardwoods increases on the hill tops.

Data from stands (10 and 24) sampled in this area are presented for comparison in Tables 22 and 23. These stands are located on similar soils only about a mile apart and were apparently burned over at the same time. They are broadly representative of the upland vegetation of much of southwestern Menominee County.

Stand 10 (Table 22) has a very heavily stocked overstory of white pine. Hemlock and sugar maple are prominent in the medium and smaller classes. Stand 24 on higher topography one mile west of stand 10 shows a more

TABLE 20. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 9

Species	Diameter class midpoint									
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″
Hemlock	3720	144	28	20	30	32	28	10	4	2
White cedar	140	0	0	0	0	0	0	0	0	0
Balsam fir	20	8	4	2	0	0	0	0	0	0
Sugar maple	360	64	0	0	0	0	0	0	0	0
Red maple	20	0	2	0	0	0	0	0	0	0
Yellow birch	540	176	30	4	2	0	4	0	0	0
Total	4800	392	64	26	32	32	32	10	4	2

diverse composition. Red oak is dominant. Despite the relatively high climax adaptation value of red oak reported by Curtis (1959), this species occupies a position early in forest succession in the county. Sugar maple promises to be the dominant species in the future forest. Because of existing high mortality, balsam fir (*Abies balsamea*) and ironwood (*Ostrya virginiana*) probably will not be important although their present densities in the smaller classes are surprisingly high. Lower canopy density in stand 24 as compared with stand 10 is reflected in a higher density of seedlings in stand 24.

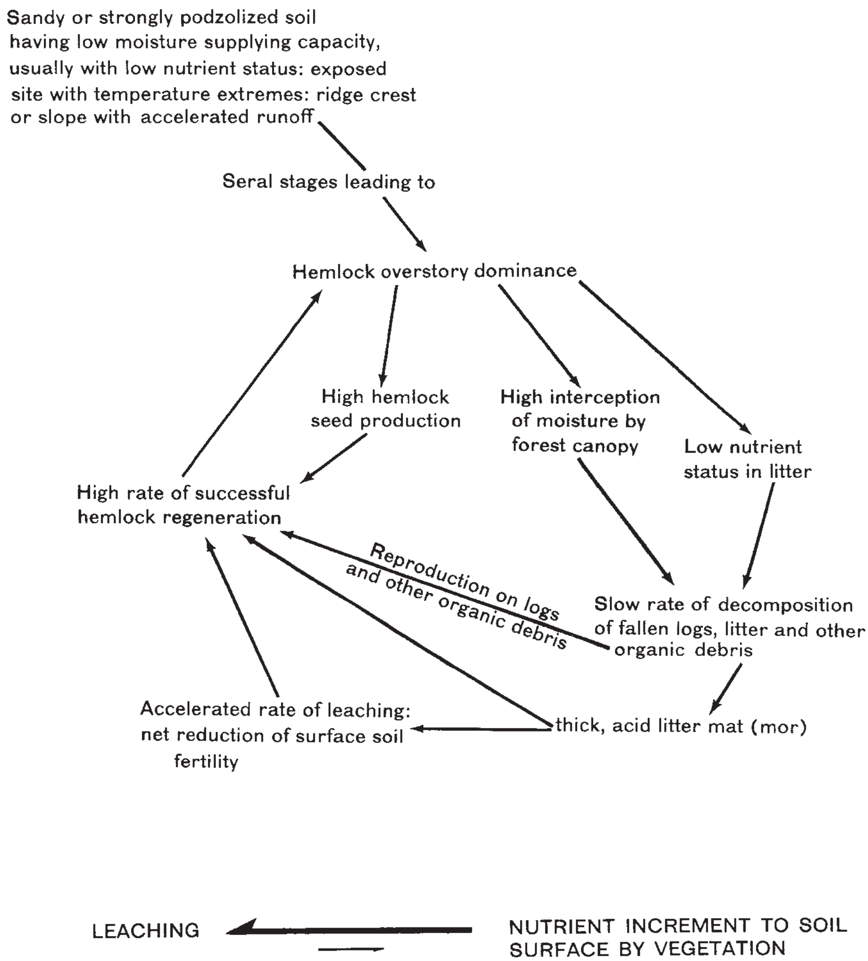

Figure 16. **Concepts of the dynamics of the hemlock forest ecosystem in Menominee County.**

Effect of texture on stands of similar composition. The effects of textural differences are not expressed alone in altered species composition. Some of the effects of texture on forests of similar composition are shown by a comparison of the seral position and structure of stand 10 (Table 22) with that of stand 35 (Table 13), previously considered in connection with vegetation on sands. These two stands are about four miles apart and are the same age. White pine is the overstory dominant in both but it averages much larger and supports higher densities on the finer textured soils at stand 10. Although hemlock is an important and apparently self-replacing component in both of these stands, sugar maple is far more successful in stand 10. Seedling density is reduced in stand 10 due to the extremely heavy stocking of the tree strata. Although composition *per se* is similar, biomass production over the 130-year span in which these forests have developed is

TABLE 21. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 11

Species	Diameter class midpoint							
	S	2″	5″	8″	11″	14″	17″	20″
Hemlock	120	0	4	14	8	6	4	14
Balsam fir	20	16	2	4	0	0	0	0
Sugar maple	1100	208	20	4	4	2	6	0
Red maple	20	24	14	0	0	0	0	0
Yellow birch	240	640	160	0	2	0	0	0
Black cherry	0	0	12	6	0	0	0	0
Pin cherry	0	32	102	0	0	0	0	0
Other	20	8	2	0	0	0	0	0
Total	1520	928	314	28	14	8	10	14

TABLE 22. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 10

Species	Diameter class midpoint										
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″	G
White pine	0	0	0	10	14	38	20	22	6	10	6
Hemlock	80	40	38	52	26	6	2	0	0	0	0
Sugar maple	240	8	22	10	10	6	4	0	0	0	0
Red maple	20	0	0	2	4	6	0	0	0	0	0
Basswood	20	0	0	0	0	0	0	0	0	0	0
Red oak	40	8	2	0	0	0	0	0	0	0	0
Other	60	8	0	2	0	0	0	0	0	0	0
Total	460	64	122	76	54	56	26	22	6	10	6

perhaps half again as high in stand 10. The future composition of both stands will likely be hemlock-hardwood; however, hemlock will probably be relatively much more important in stand 35.

Hemlock-hardwood forests. Mixed forests containing both hemlock and hardwoods appear to be the terminal forests on the loams and shallow silt loams. Stand 27 (Table 24) is a hemlock-hardwood forest in which a compositional equilibrium has become established with approximately an equal balance of composition throughout all structural classes of the stand.

Some of the largest hemlock trees in the county occur in the vicinity of this stand. One log, butted off at about 9 feet above ground, was determined to be 530 years. The annual rings on this stump showed three distinct zones of more rapid growth corresponding to the dates 1650, 1550, and 1450.

Hemlock and beech are represented by a steadily increasing density with decreasing size, a characteristic feature of species in equilibrium. The high density recorded for hemlock in the largest class results from the inclusion in this class of a larger diameter range. Only a few herb species are present and among these the most abundant ones are rather rare elsewhere in the county. Included are such plants as Indian cucumber (*Medeola virginiana*) and beech drops (*Epifagus virginiana*).

As in stand 9 (Table 20) autogenic processes seem to be important in perpetuation of the forest. The litter of both hemlock and beech is low in cations and decomposition is normally slow. In stand 27 (Table 24) a very thick litter mat has accumulated favoring the continual importance of hemlock and beech over more basophilic species such as sugar maple and basswood. Seedlings of these species occur principally along skidroads and in other areas where the litter has been disturbed.

In several of the hemlock-hardwood forests, hemlock is restricted almost exclusively to the overstory and appears not to be perpetuating itself within the stand. In every case these stands have a thinner litter layer with a greater ratio of thickness of humus layer to fermenting layer (H:F) and they support a rich herbaceous ground flora. Stand 20 (Table 25) is representative of hemlock-hardwood forests in which the compositional balance is shifting toward hardwood.

The largest trees in stand 20 are American elm, basswood, and sugar maple. In contrast to the situation in stand 27, hemlock is found here primarily in the larger tree classes with essentially no current reproduction. On the other hand, sugar maple displays a gradually increasing density with decreasing size and this species, in association with the other hardwoods, is apparently replacing hemlock. The herbaceous cover in this stand contrasts markedly with that of stand 27. Many species are present among which are several spring ephemerals.

The relation between surface organic soil horizons, particularly the litter layer, and tree species replacement patterns appears to a very intimate one

TABLE 23. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 24

Species	Diameter class point								
	S	2″	5″	8″	11″	14″	17″	20″	23″
White pine	20	0	0	0	2	0	0	0	0
Hemlock	40	40	24	0	2	0	2	0	0
Balsam fir	1180	136	8	8	0	0	0	0	0
Sugar maple	1560	128	30	0	14	2	0	0	0
Red maple	640	0	4	18	8	2	0	2	0
Basswood	60	8	0	12	0	0	0	0	0
Red oak	300	8	4	2	8	14	24	2	2
Beech	60	40	0	0	0	0	0	0	0
White ash	1500	0	0	2	0	0	0	0	0
Butternut	20	0	0	0	0	0	0	0	0
Bitternut-hickory	20	0	0	0	0	0	0	0	0
Ironwood	1100	176	4	0	0	0	0	0	0
Other	0	0	0	4	0	0	0	0	0
Total	6500	536	74	46	34	18	26	4	2

TABLE 24. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 27

Species	Diameter class midpoint										
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″	G
Hemlock	220	120	54	34	32	18	8	2	2	0	10
Sugar maple	360	40	0	4	4	6	6	4	4	0	2
Yellow birch	40	0	0	0	0	2	6	0	2	0	0
Basswood	20	0	0	0	0	0	0	0	0	0	0
Beech	1120	120	14	8	6	2	0	2	0	0	0
White ash	20	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0
Total	1780	280	68	46	42	28	20	8	8	0	12

TABLE 25. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 20

Species	Diameter class midpoint										
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″	G
Hemlock	0	0	2	0	4	6	6	2	8	6	0
Sugar maple	832	88	26	12	8	4	4	4	0	2	0
Yellow birch	64	8	10	8	0	0	0	C	0	0	2
Basswood	24	0	2	2	2	0	2	0	0	0	2
American elm	160	0	0	4	0	2	2	2	2	0	4
Ironwood	16	16	2	0	0	0	0	0	0	0	0
Other	48	8	0	0	2	0	0	0	0	0	0
Total	1144	120	42	26	16	8	14	8	10	8	8

indeed. The nutrient status of the mineral soil parent material likely conditions this balance by regulating to a degree, principally through moisture retaining and supplying capacity, the initial invasion of the site by pioneer species. The species present in turn determine the nature of the soil surface organic layers *via* their annual increment to the litter, and by degree of interception of atmospheric moisture. The thick F layer found in equilibrium hemlock-hardwood forests is due largely to very low cation content and consequent reduction in decomposition rate, but it is also conditioned by the extremely high rainfall interception of hemlock. Beneath the hemlock overstory ground-layer plants are subjected seasonally to veritable desert conditions.

Both the site deterioration and hence self-perpetuation properties of hemlock (Figure 16) and beech, and the site enrichment and hence self-perpetuation characteristics of basswood, sugar maple and American elm (described in the following section) illustrate the high degree of integration found within the natural forest ecosystem (Figure 17). Both are analogous to the positive feedback characteristics of certain thermodynamic systems. The mutual interdependence of vegetation and soils becomes clear in this context, for it is apparent that the expression of the self-perpetuating ability of a given species is largely site-dependent.

Forests of the deep silt loams

The siltiest soils in the county occur on the tops of drumlins northwest of Neopit (see soil and glacial geology maps). On these soils occur some of the most impressive examples of old growth maple-basswood forests in Wisconsin. Within such forests the canopy of the larger trees often extends to 100 or more feet above ground. The forests have an all-aged structure. The ground layer is characterized by spring ephemerals that impart to the stands a verdant lushness in May and early June.

Forest succession after fire. Maple-basswood forests on silt loams are not very susceptible to fire, in contrast to the forests on the droughty soils considered previously. Consequently, the combination of relatively fine textured soils and early post-fire vegetation is difficult to find within the general range of the maple-basswood forest. Some such areas were found in drumlin-outwash complexes where fires in forests on outwash sand had spread up into forests on silt loam drumlins.

For example, in the large aspen belt west of the Wolf River a few hills have silty soils not unlike those found on similar topography northwest of Neopit. Stand 15 (Table 26) is situated on an isolated drumlin that rises as an island out of a "sea" of sandy loam and loamy sand soils. On these sandy soils extensive forests of aspen with bracken fern and charred white pine stumps attest to the fact that this area has been repeatedly burned

TABLE 26. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 15

Species	Diameter class midpoint				
	S	2″	5″	8″	11″
Suagar maple	80	136	70	10	0
Basswood	420	328	106	12	0
Red oak	40	16	16	10	0
White ash	400	48	34	26	2
Butternut	20	0	14	4	0
Bitternut hickory	220	48	42	4	0
Quaking aspen	280	0	22	38	2
Large-toothed aspen	0	8	0	2	2
Total	1460	584	304	106	6

TABLE 27. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 19

Species	Diameter class midpoint										
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″	G
Hemlock	0	0	0	0	2	2	4	0	0	0	0
Balsam fir	120	24	0	0	0	0	0	0	0	0	0
Sugar maple	1820	216	48	18	18	4	4	6	6	0	0
Yellow birch	0	0	0	0	6	2	2	2	0	0	0
Basswood	0	0	0	2	4	2	2	12	2	2	4
American elm	420	8	0	0	0	2	2	4	0	0	0
Red elm	300	0	0	0	0	0	0	0	0	0	0
Red oak	20	0	0	0	0	0	0	0	0	0	2
White oak	160	8	0	0	0	0	2	2	2	0	0
Bitternut hickory	120	16	0	0	0	0	0	0	0	0	0
Ironwood	0	16	0	0	0	0	0	0	0	0	0
Total	2960	288	48	20	30	12	16	26	10	2	6

TABLE 28. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 22

Species	Diameter class midpoint							
	S	2″	5″	8″	11″	14″	17″	20″
Sugar maple	3912	120	44	54	16	14	6	2
Yellow birch	24	0	0	2	2	0	0	0
Basswood	16	0	0	4	2	2	2	0
American elm	760	0	4	12	8	8	6	4
Red elm	536	0	0	4	22	6	0	0
White ash	128	0	2	0	0	2	2	0
Bitternut hickory	448	0	0	6	10	2	0	0
Ironwood	56	24	0	0	0	0	0	0
Total	5880	144	50	82	60	34	16	6

over. Apparently fires originating on the outwash have burned over the more mesic drumlin on which stand 15 is located. The largest trees in this stand are about 40 years old, and most of them occur in clumps as a result of root crown sprouting after fire. There is an unusual mixture of xeric and mesic species. In the tree stratum sugar maple and quaking aspen are found together with a number of species of intermediate mesicness. In the ground-layer, bracken fern (*Pteridium aquilinum*) and other xeric herbs are associated side by side with mayapple (*Podophyllum peltatum*) and other mesic forest herbs. Most of the herbaceous species appear to be highly aggregated. In many respects the vegetation of this drumlin resembles that of the oak forest of southern Wisconsin. Not only are many of the herbs characteristic of southern oak forests, but large open grown oak trees, some repeatedly fire-scarred, that occur outside stand 15 are reminiscent of conditions farther south. Hemlock was not observed anywhere on this hill.

On one of the drumlin tops southwest of Neopit, red oak-mixed hardwood stand 19 was sampled (Table 27). The oldest trees in this stand are about 130 years of age as are most of the forests in this part of the county. Basswood shows a pronounced peak in the 20-inch size class as well as American elm and white ash. Numerous cradle-knolls of uniform relief and distinctness suggest that a rather extensive windthrow may have occurred before fire in about 1830. Apparently some hemlock and yellow birch became established on cradle-knolls under the post-fire canopy of oak, sugar maple, and basswood. Sugar maple gives every indication of eventually becoming the leading dominant in this stand.

Forest succession after cutting. Stand 22 (Table 28) illustrates the difference between heavy cutting and fire on these soils. This stand occurs on a drumlin top about six miles west of Neopit. The overstory trees are about 70 years old. No evidence of fire could be detected in the vicinity of the stand. Increasers after cutting include sugar maple, basswood, American elm, slippery elm (*Ulmus rubra*), white ash, and bitternut hickory (*Carya cordiformis*). Yellow birch shows a slight increase at the 10-inch level. Although sugar maple is the most constant increaser through all strata and shows promise of remaining the leading overstory dominant, cutting has apparently increased the importance of many other species. The most marked increase occurs in basswood, bitternut hickory, and both elm species. Young stems of slippery elm persist as understory sprouts for many years, only to be released from suppression upon the advent of cutting.

In another of the stands sampled (14) more than 60 percent of the trees forming the overstory showed some defect associated with previous cutting operations. Many of the damaged trees were of low value species, such as elm.

The terminal forests on silt loams. The all-aged structure of stand 7 (Table 29) contrasts with the even-aged post-disturbance stands following both cutting and fire. Stand 7 represents the terminal sugar maple-basswood-American elm forests occurring on the silt loam soils. The reduction of density of sugar maple trees around the 14-inch size class and the presence of hemlock, yellow birch, and white ash may reflect some disturbance. Recent evidence, however, suggests that such compositional patterns, with species alternating in importance through size classes, is a characteristic feature of most forests.

The equilibrium forest may be thought of as a highly integrated feedback system. Just as hemlock and beech tend to perpetuate themselves by site deterioration on sandy soils, so sugar maple, basswood, and elm on loams produce an environment on the forest floor that is conducive to their own regeneration (Figure 17).

The feedback mechanisms outlined in Figures 16 and 17 oppose one another in varying degrees over most of the landscape. On the finer textured soils the mechanisms outlined in Figure 17 operate almost exclusively. The maple-basswood forests present a very different aspect from that of the hemlock-hardwood forests in terms of tree size, tree vigor, litter and soil surface features, and ground-layer vegetation, even though the compositional index (Curtis, 1959) frequently places these types together under the designation of northern mesic forests. It is true that they are not clearly distinct. Intermediates may be found. Nonetheless, a useful separation may be made between the mesic hardwood forest, which occurs on silt loam soils and presents a richer ephemeral ground layer vegetation, and the hemlock-hardwood forest, supporting a groundlayer more characteristic of conifer forests, a thick acid mor litter, and generally occurring on coarser textured soils. Hemlock may occur as a seral species on deep, silt loam soils, but indications are that its duration as an overstory dominant on these soils is short.

TABLE 29. DENSITY OF TREES (NUMBER PER ACRE) BY SPECIES BY SIZE CLASSES IN FOREST STAND NUMBER 7

Species	Diameter class midpoint										
	S	2″	5″	8″	11″	14″	17″	20″	23″	26″	G
Hemlock	0	0	0	0	0	2	0	0	0	0	0
Sugar maple	1208	392	46	30	10	0	2	10	2	8	2
Yellow birch	0	8	0	0	0	2	0	0	0	0	2
Basswood	0	0	0	2	2	0	2	0	0	0	2
American elm	104	40	0	6	2	2	4	0	0	0	4
Red elm	88	0	0	0	0	0	0	0	0	0	0
White ash	144	8	0	0	0	2	0	0	0	0	0
Butternut	0	0	2	0	0	0	0	0	0	0	0
Bitternut hickory	8	8	0	0	0	0	0	0	0	0	0
Ironwood	8	40	6	0	0	0	0	0	0	0	0
Total	1560	496	54	38	14	8	8	10	8	8	10

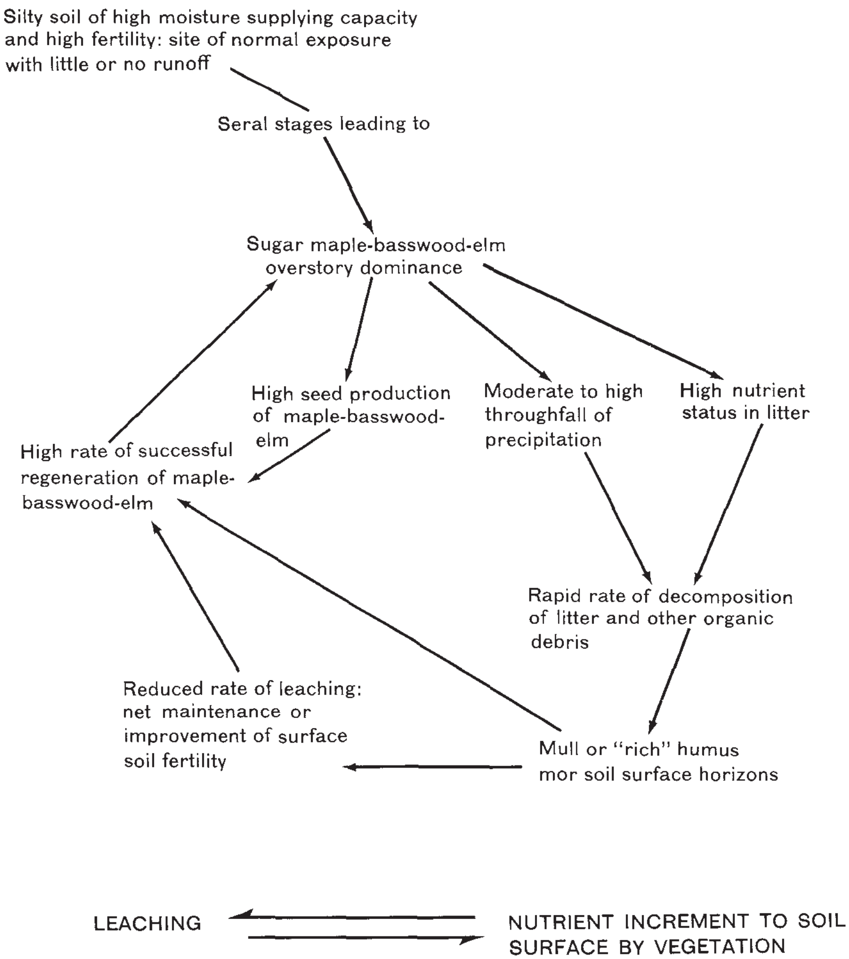

Figure 17. Diagram illustrating concepts of the dynamics of northern hardwood forest ecosystem in Menominee County.

TABLE 30. DISTRIBUTION OF THE VEGETATIVE COVER MAP UNITS, MENOMINEE COUNTY

Map Symbol	Name of Vegetative Unit	DISTRIBUTION[1] Percentage of Area of County	Acres
1	Hill' (scrub) oak (*Quercus ellipsoidalis*)	4.9	11,497
2	Jack pine (*Pinus banksiana*)	1.1	2,530
3	Aspen (*Populus tremuloides*; *P. grandidentata*) with associated hardwoods	24.3	57,263
4	Pine (*Pinus strobus*; *P. resinosa*)	10.3	24,147
4b	Pine plantation	0.2	460
5	Red oak (*Quercus borealis*)	0.7	1,609
6	Northern Hardwoods (*Acer saccharum; Tilia americana*; *Quercus borealis*)	14.3	33,575
7	Hemlock-Hardwoods (*Tsuga canadensis*; *Betula lutea*; *Acer saccharum*)	25.0	58,412
8	Hemlock-Hardwood-Swamp Conifer (*Tsuga canadensis*; *Acer rubrum*; *Larix laricina*)	2.2	5,059
9	Swamp Hardwoods (*Fraxinus nigra*; *Acer rubrum*)	2.5	5,749
10	Swamp conifers (*Thuja occidentalis*; *Larix laricina*; *Picea mariana*)	8.1	18,957
11	Lowland brush (*Salix discolor*; *Alnus rugosa*)	0.5	1,056
12	Nonforested lowland (*Calamagrostis canadensis*; *Chamaedaphne calyculata*; *Sphagnum spp.*)	1.3	2,989
13	Nonforested upland (*Carex* spp.; *Graminae*)	1.7	3,909
14	Field, cultivated or recently abandoned	0.7	1,609
15	Sites of current urban and industrial occupation	0.5	1,149
Total	All vegetative units (supported by organic and mineral soils)	98.3	229,970
Water		1.7	4,030
	Lakes	1.3	3,135
	Rivers and streams	0.4	895
Total	All vegetative units and water	100.0	234,000

[1] See Footnote to Table 36.

TABLE 31. LIST OF FOREST STANDS[1] IN MENOMINEE COUNTY, WISCONSIN, AT WHICH VEGETATION AND SOILS WERE STUDIED, WITH PERTINENT INFORMATION.

Stand number[1] and location	Map unit, vegetative cover map[2]	Soil described	Soil map unit
1 (SW, NW, Sec 27, T 28N, R 16E)	13. Grassy or sedgey opening (with jack pine), well drained nonforested upland	Omega medium sand on level outwash plain	20. Omega loamy sand, Crivitz sandy loam, 0—5% slopes
2 (SE, NE, Sec 28, T 28N, R 16E)	2. Jack pine	Omega medium sand on level outwash plain	20. Omega loamy sand, Crivitz sandy loam, 0—5% slopes
3 (NE, NW, Sec. 27, T 28N, R 16E)	1. Hill's oak	Omega medium sand on level outwash plain	21. Omega sand, Crivitz sandy loam, 5—16% slopes
4 (NW, NE, Sec. 16, T 30N, R 15E)	4. White and red pine	Crivitz loamy sand on rolling pitted outwash	19. Chetek, Pence sandy loams; Crivitz loamy sand, 8—20% slopes
5 (NE, NE, Sec. 15, T 30N, R 15E)	7. Hemlock-hardwoods	Kennan silt loam (with weak fragipan) on high high drumlin crest	5. Emmert, Kennan, Onamia stony loams, 10—40% slopes
6 (NE, NE, Sec. 15, T 30N, R 15E)	7. Hemlock-hardwoods	Kennan silt loam on a high drumlin crest	5. Emmert, Kennan, Onamia stony loams, 10—40% slopes
7 (SE, SW, Sec. 13, T 29N, R 13E)	6. Northern hardwoods	Onamia silt loam on a high drumlin crest	3. Norrie, Goodman silt loams; Kennan and Iron River loams, 8—20% slopes
8 (NW, SW, Sec. 36, T 29N, R 13E)	7. Hemlock-hardwoods	Kennan loam on an undulating morainic bench	12. Antigo, Stambaugh silt loams; Onamia, Padus loams, 0—10% slopes
9 (SW, NW, Sec. 13, T 30N, R 13E)	7. Hemlock-hardwoods	Padus sandy loam, with fragipan, on hilly ice-contact deposits	13. Antigo, Stambaugh silt loams; Onamia, Padus loams, 8—20% slopes
10 (SW, SW, Sec. 26, T 29N, R 14E)	4. Pine (white, red)	Chetek silt loam (with weak textural B) on level outwash plain	16. Onamia, Padus loams; Chetek, Pence sandy loams, 8—20% slopes
11 (NE, SE, Sec. 14, T 30N, R 13E)	7. Hemlock-hardwoods (yellow birch prominent after cutting of hemlock)	Padus loam, shallow, on hilly ice-contact deposits	13. Antigo, Stambaugh silt loams; Onamia, Padus loams, 8—20% slopes

TABLE 31. LIST OF FOREST STANDS[1] IN MENOMINEE COUNTY, WISCONSIN, AT WHICH VEGETATION AND SOILS WERE STUDIED, WITH PERTINENT INFORMATION. (CONTINUED)

Stand number[1] and location	Map unit, vegetative cover map[2]	Soil described	Soil map unit
12 (NW, SE, Sec. 16, T 29 N, R 13E)	6. Northern hardwoods	Kennan silt loam on a low drumlin rise	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
13 (SE, SE, Sec. 9, T 29 N, R 14E)	7. Hemlock-hardwoods	Kennan loam on rolling moraine	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
14 (NW, SE, Sec. 16, T 29 N, R 13E)	6. Northern hardwoods	Kennan silt loam (in 3-layer parent material) on low drumlin rise	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
15 (NE, NE, Sec. 16, T 29 N, R 15E)	3. Northern hardwoods and aspen	Kennan silt loam (with weak textural B) on high drumlin crest	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
16 (NW, SW, Sec. 36, T 29 N, R 13E)	4. Pine (white, red)	Padus silt loam on undulating morainic bench	13. Antigo, Stambaugh silt loams; Onamia, Padus loams, 8—20% slopes
17 (SE, SW, Sec. 8, T 29 N, R 13E)	6. Northern hardwoods	Onamia silt loam (with weak textural B) on low drumlin rise	5. Emmert, Kennan and Onamia stony loams, 10—40% slopes
18 (NW, SE, Sec. 24, T 29 N, R 13E)	6. Northern hardwoods	Onamia silt loam (with weak textural B) on high drumlin flank	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
19 (NE, SE, Sec. 24, T 29 N, R 13E)	6. Northern hardwoods	Kennan sandy loam (with weak textural B, and showing distortion of horizons by creep) on high drumlin flank	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
20 (SW, SW, Sec. 28, T 30 N, R 13E)	7. Hemlock hardwoods	Onamia silt loam	12. Antigo, Stambaugh silt loams; Onamia, Padus loams, 0—10% slopes
21 (NE, SW, Sec. 11, T 29 N, R 13E)	6. Northern hardwoods	Antigo silt loam (with textural B) on high drumlin crest	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
22 (NW, SE, Sec. 33, T 30 N, R 13E)	6. Northern hardwoods	Kennan silt loam on high drumlin crest	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes

TABLE 31. LIST OF FOREST STANDS[1] IN MENOMINEE COUNTY, WISCONSIN, AT WHICH VEGETATION AND SOILS WERE STUDIED, WITH PERTINENT INFORMATION. (CONTINUED)

Stand number[1] and location	Map unit, vegetative cover map[2]	Soil described	Soil map unit
23 (SW, SE, Sec. 7, T 28N, R 15E)	3. Red oak and mixed hardwood	Chetek loam (with weak fragipan) on hill crest on rolling drift (till over outwash)	19. Chetek, Pence sandy loams; Crivitz loamy sand, 8—20% slopes
24 (SW, NE, Sec. 27, T 29N, R 14E)	5. Red oak	Kennan sandy loam (with no fragipan) on rolling moraine, bouldery	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
25 (NE, NW, Sec. 15, T 29N, R 15E)	5. Red oak	Kennan silt loam (with no fragipan) on high drumlin flank	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
26 (SE, SE, Sec. 12, T 29N, R 15E)	1. Hill's oak	Omega medium sand (with coarse gravel at 5 ft.) on undulating outwash plain	19. Chetek, Pence sandy loams; Crivitz loamy sand, 8—20% slopes
27 (SW, SW, Sec. 12, T 30N, R 15E)	7. Hemlock-hardwoods	Onamia silt loam on hill crest, rolling outwash	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20%
28 (NW, SW, Sec. 24, T 30N, R 13E)	7. Hemlock-hardwoods	Iron River silt loam on hill crest, rolling moraine	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
29 (NW, NW, Sec. 6, T 29N, R 14E)	6. Northern hardwoods	Kennan silt loam on high drumlin crest	5. Emmert, Kennan, Onamia stony loams, 10—40% slopes
30 (Center, Sec. 9, T 29N, R 15E)	3. Aspen	Vilas loamy sand on undulating moraine, stony	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
31 (SW, NW, Sec. 10, T 29N, R 15E)	3. Aspen	Crivitz loamy sand on rolling outwash	19. Chetek, Pence sandy loams; Crivitz loamy sand, 8—20% slopes
32 (SE, SW, Sec. 31) T 30N, R 14E)	6. Northern hardwoods	Norrie silt loam (over sandy till) on low drumlin rise	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
33 (SW, SE, Sec. 13, T 29N, R 13E)	6. Northern hardwoods	Antigo silt loam (deep phase) on high drumlin flank	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes

TABLE 31. LIST OF FOREST STANDS[1] IN MENOMINEE COUNTY, WISCONSIN, AT WHICH VEGETATION AND SOILS WERE STUDIED, WITH PERTINENT INFORMATION. (CONTINUED)

Stand number[1] and location	Map unit, vegetative cover map[2]	Soil described	Soil map unit
34 (SE, NE, Sec. 13, T 29N, R 13E)	6. Northern hardwoods	Antigo silt loam on high drumlin flank	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
35 (SE, NW, Sec. 24, T 29N, R 13E)	7. Hemlock-white pine-hardwoods	Vilas medium sand on undulating stream terrace	16. Onamia, Padus, loams; Chetek, Pence sandy loams, 8—20% slopes
36 (NW, NW, Sec. 6, T 29N, R 15E)	13. Grassy or sedgey opening well drained, nonforested upland	Omega sand on undulating outwash between two eskers	16. Onamia, Padus loams; Chetek, Pence sandy loams, 8—20% slopes
37 (SE, NW, Sec. 4, T 29N, R 15E)	3. Aspen	Iron River loam on hilly moraine, stony	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
38 (NW, NE, Sec. 5, T 29N, R 15E)	3. Aspen	Vilas medium sand on level, stratified stream terrace	18. Chetek, Pence sandy loams; Crivitz loamy sand, 0—8% slopes
39 (SE, NW, Sec. 29, T 30N, R 15E)	3. Aspen	Vilas sandy loam on undulating outwash plain	15. Onamia, Padus, loams; Chetek, Pence sandy loams, 0—8% slopes
40 (SE, NW, Sec. 28, T 30N, R 15E)	13. Grassy or sedgey opening well drained, nonforested upland	Pence loam (on 3-layer parent material) on level outwash plain	16. Onamia, Padus, loams, Chetek, Pence sandy loams, 8—20% slopes
41 (SW, SE, Sec. 9, T 30N, R 15E)	8. Hemlock-hardwoods-swamp conifer	Vilas medium sand on rolling outwash	13. Antigo, Stambaugh silt loams; Onamia, Padus loams, 8—20% slopes
42 (NE cor. Sec. 13, T 29N, R 15E)	4. Pine (white, red)	Omega sand on undulating outwash plain	18. Chetek, Pence sandy loams; Crivitz loamy sand, 0—8% slopes
43 (SE, NE, Sec. 9, T 30N, R 15E)	8. Hemlock-hardwoods-swamp conifer	Crivitz loamy sand on undulated moraine with outwash substratum	16. Onamia, Padus loams; Chetek, Pence sandy loams, 8—20% slopes
44 SE, SE, Sec. 9, T 30N, R 15E)	8. Hemlock-hardwoods-swamp conifer	Crivitz loamy sand on rolling outwash with till substratum	14. Onamia, Padus loams; Chetek, Pence sandy loams, 0—10% slopes

TABLE 31. LIST OF FOREST STANDS[1] IN MENOMINEE COUNTY, WISCONSIN, AT WHICH VEGETATION AND SOILS WERE STUDIED, WITH PERTINENT INFORMATION. (CONTINUED)

Stand number[1] and location	Map unit, vegetative cover map[2]	Soil described	Soil map unit
45 (NE, SE, Sec. 8, T 28N, R 16E)	1. Hill's oak (with aspen)	Vilas medium sand on rolling outwash	8. Underhill loam and sandy loam, 8—20% slopes
46 (SW, NE, Sec. 28, T 28N, R 16E)	2. Jack pine (with aspen and Hill's oak)	Omega medium on undulating outwash plains	21. Omega loamy sand, Crivitz sandy loam, 5—16% slopes
47 (NW, SW, Sec. 1, T 28N, R 16E)	2. Jack pine	Omega medium sand on level outwash plain	20. Omega loamy sand, Crivitz sandy loam, 0—5% slopes
48 (SE, NW, Sec. 27, T 28N, R 16E)	3. Aspen	Omega medium sand (with very fine sandy substratum) on undulating outwash plain	21. Omega loamy sand, Crivitz sandy loam, 5—12% slopes
49 (NW, NE, Sec. 9, T 30N, R 15E)	7. Hemlock-hardwoods	Vilas medium sand (with till substratum) on level outwash plain	14. Onamia, Padus loams; Chetek, Pence sandy loams, 0—10% slopes
50 (NW, NE, Sec. 9 T 30N, R 15E)	7. Hemlock-hardwoods	Crivitz loamy sand (with till substratum) on level outwash plain	14. Onamia, Padus loams; Chetek, Pence sandy loams, 0—10% slopes
63 (NE, NE, Sec. 30, T 30N, R 16E)	3. Aspen	Underhill silt loam on low drumlin crest	8. Underhill loam and sandy loam, 8—20% slopes
119 (SE, NW, Sec. 16, T 30N, R 15E)	4. Pine (white, red)	Hiawatha sand (deep Vilas) on rolling outwash, bouldery	19. Chetek, Pence sandy loams; Crivitz loamy sand, 8—20% slopes
221 (SW, NW, Sec. 20, T 30N, R 14E)	7. Hemlock-hardwoods	Shallow Stambaugh silt loam on rolling moraine	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
303 (SE, NW, Sec. 13, T 30N, R 13E)	7. Hemlock-hardwoods	Shallow Stambaugh loam on rolling moraine with outwash substratum	13. Antigo, Stambaugh silt loams; Onamia, Padus loams, 8—20% slopes
392 (NW, SE, Sec. 8, T 29N, R 13E)	6. Northern hardwoods	Kennan silt loam on low drumlin flank	5. Emmert, Kennan, Onamia stony loams, 10—40% slopes

TABLE 31. LIST OF FOREST STANDS[1] IN MENOMINEE COUNTY, WISCONSIN, AT WHICH VEGETATION AND SOILS WERE STUDIED, WITH PERTINENT INFORMATION. (CONTINUED)

Stand number[1] and location	Map unit, vegetative cover map[2]	Soil described	Soil map unit
403 (SE, NW, Sec. 13, T 29N, R 13E)	6. Northern hardwoods	Norrie silt loam, with sand substratum, on high drumlin crest	3. Norrie, Goodman silt loams; Kennan, Iron River loams, 8—20% slopes
571 (SW, SW, Sec. 10, T 29N, R 15E)	3. Aspen	Goodman silt loam on high drumlin flank	4. Kennan, Iron River loams; Norrie, Goodman silt loams, 8—20% slopes
572 (NW, NE, Sec. 10, T 29N, R 15E)	3. Aspen	Padus sandy loam on undulating outwash plain	8. Underhill loam and sandy loam, 8—20% slopes
605 (NW, SW, Sec. 19, T 29N, R 15E)	4. Pine (white, red)	Pence sandy loam on undulating outwash plain	15. Onamia, Padus loams; Chetek, Pence sandy loams, 0—8% slopes
680 (NE, SW, Sec. 15, T 29N, R 16E)	2. Jack pine	Omega sand on level outwash plain	20. Omega loamy sand, Crivitz sandy loam, 0—5% slopes
763 (Center, Sec. 8, T 28N, R 16E)	3. Aspen	Alban sandy loam (with sandy substratum) on level outwash plain	7. Underhill, Alban loams and sandy loams, 0—8% slopes
778 (SW, SE, Sec. 14, T 28N, R 16E)	1. Hill's (scrub) oak	Omega sand on gently rolling outwash plain	21. Omega loamy sand, Crivitz sandy loam, 5—16% slopes

Footnotes to Table 31:

[1] See colored map, Vegetative Cover, Menominee County, Wisconsin.

[2] See Table 30.

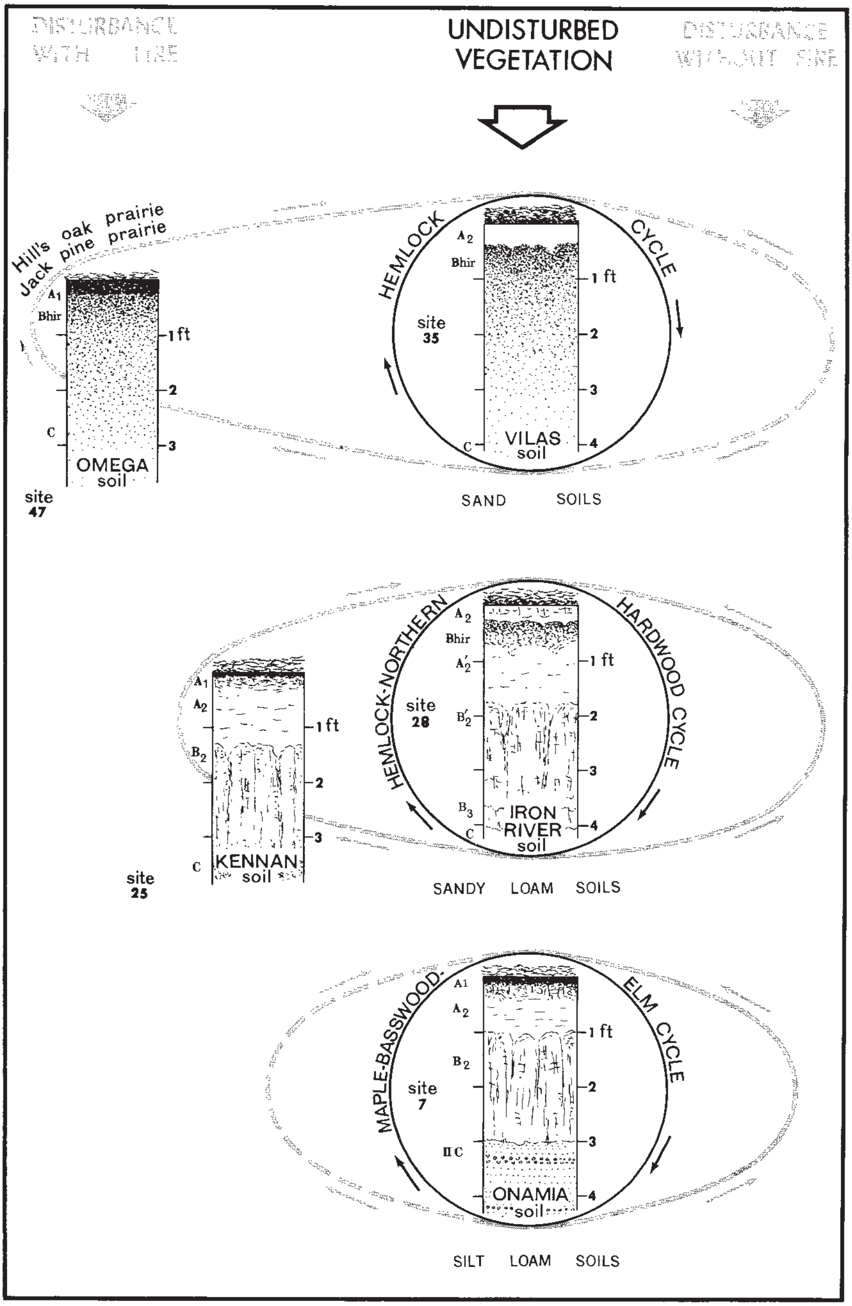

Figure 18. Diagram illustrating five important soil profiles of Menominee County and concepts of their relationships to vegetation at undisturbed and disturbed sites.

VII. GENESIS OF UPLAND SOILS

F. Paul Baxter[1]

This chapter is concerned with the first four of the six major kinds of soils described in Chapter III. They are the upland soils (see Figure 18) developed to a depth of two to four feet under distinct forest communities from unconsolidated deposits laid down by glacial ice, water, and wind. The wide distribution of these deposits in the county has been most important in soil formation, for where bare bedrock was exposed by scouring of glacial ice, running water and winds, scarcely any soil has formed. Ever since deposition, the original sand, silt and clay contents of the glacial drift have not only influenced the pattern of growth of vegetation but have set limits to soil development. Deep deposits of well sorted sand support only undemanding species of plants and develop only rather weak Podzol soils, whereas unsorted till and stratified drift with layers of varying textures support demanding species and develop more mature soil profiles, including those of bisequal soils.

Some Relationships Between Vegetative Cycles and Soils

Vegetative cycles in which undisturbed forests may perpetuate themselves are indicated in Figure 18 by three circles as follows; hemlock forest on sand, maple-basswood-elm forest on silty soils, and hemlock-hardwood forests on soils of intermediate loamy textures. Each circle represents an equilibrium of continual natural replacement of old trees by young ones of the same species. It is suggested that any forest on upland in Menominee County could be placed on the continum between these three kinds of forests, or between disturbed phases of them. Two forests of disturbance are indicated in Figure 18. Disturbance may be by logging operations, windthrow, or fire or combinations of these. Forests on sandy soils re-establish themselves with greater difficulty than forests on finer textured soils. Before fire control was instituted, the incidence of fire was greatest on sands, and reserves of moisture and plant nutrients are lowest in these soils.

The Soils Exhibit Combinations of Characteristics of Different Soil Groups

Soil profiles in the transition zone of Menominee County exhibit a variety of combinations of features of Podzol, Gray-Brown Podzolic, and melanized soils. It is important, therefore, to recognize these combinations and to consider the environments which produced them. Menominee County is not the locus of development of typical soil profiles of any major group of upland

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soils, because it is not in the heart of any single soil province. However, we can take advantage of the complex of soil profile characteristics to investigate the relative importance of various factors and processes in the genesis of the soil groups involved.

The various constituents in a typical soil profile (Figure 20) differ in their sensitivity to the environment. A suggested sequence of items of data and indices is presented in Tables 32 and 33 in an attempt to rate soils of the county in terms of degree of development. Values for soils illustrated in Figure 18 are given in Table 32. In each column of the tables scaled values are given in parentheses to show the relative placement of the soils with respect to the item designated at the top of the column.

Average thickness of the A1 horizon, which may be referred to as melanized soil, changes rapidly in response to variation in the amount of light that reaches the forest floor. The Omega soil, developed in a park-like forest-prairie ecosystem in southeastern Menominee County, has a 3-inch nearly black A1 horizon. Likewise some of the other forest soils have had enough cover of grasses, sedges and other small plants to develop a distinct A1 horizon.

Average thickness of the litter layer on the forest floor changes from month to month and from year to year as the composition of the plant community shifts, and as rate and amount of production and decomposition of litter vary. The mat of raw organic matter on the floor of a hemlock forest is relatively constant in thickness. In contrast, the litter in a hardwood forest thins in the course of the summer; bare soil may be exposed in places by late August, particularly where the large earthworm, *Lumbricus terrestris* is present.

Maximum change in soil reaction (pH) of the soil during soil genesis is a sensitive measure of response of the soil to the ecosystem. Presumably fresh glacial deposits had a reaction of about 7.0, which is the reaction of abraded fresh quartz and muscovite. In any case, the lowest pH in the A horizon is listed for each soil in Tables 32 and 33. The range is from 6.1 (hardwood stand 7, Table 32) to 3.2 (hemlock-hardwood stand 9, Table 33).

A sensitive measure of cycling of cations by the forest from the soil and geologic material into the upper six inches of mineral soil and associated organic layers is the content of exchangeable calcium (column 8). The range in pounds per acre is from 504 pounds in the Omega soil (stand 3, Table 33) to 3,430 pounds in the Kennan silt loam (stand 22, Table 33). Under hemlock forest the exchangeable calcium content of the upper solum is greatly depleted, as in stand 9 (Table 33).

Accumulation of organic matter in the B horizon of a Podzol, and of clay in the B horizon of a Gray-Brown Podzolic are measures of the development of these two kinds of soil, as will be discussed below.

TABLE 32. DATA, RATIOS AND INDICES, WITH SCALED VALUES[a] RELATED TO SOIL DEVELOPMENT OF FIVE REPRESENTATIVE SOILS OF MENOMINEE COUNTY, WISCONSIN

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
													Indices of Degree of Soil Development			
Soil Type	Forest Stand Number; Vegetation	Mean dbh [b] (in.)	Av. % Silt Plus % Clay, Mineral Soil 0"—72"	Av. Thickness of A1 (cm)	Av. Thickness of Litter [c] (cm.)	Lowest pH, Mineral A Horizon	Lbs. Exchangeable Ca, 0"—6" Soil [d]	Av. % Organic Matter Mineral Soil 0"—18"	Ratio, Max. % O.M. in A: Min. % O.M. in A [e]	Ratio, Max. % O.M. in Bhir: Min. % O.M. in A2 [f]	Moist Color of the Podzol Bhir [g]	Ratio Max. % Clay in Non-Podzol B: Min. % Clay in A [h]	Of Podzol Soil [i]	Of Gray Brown Podzolic Soils [j]	Of Melanized Soil [k]	Of Total Solum [l]
Omega Sand	47 Jack Pine and Prairie	7.6 (16)	1.3 (2)	7.5 (100)	4.4 (28)	4.8 (18)	829 (11)	1.38 (28)	1.0 (1)	... (1)	7.5 YR 4/4 (50)	... (1)	186	195	100	315
Vilas Sand	35 Hemlock, White Pine	13.7 (55)	0.6 (1)	0.0 (1)	10.6 (83)	4.9 (17)	630 (4)	1.14 (14)	1.0 (1)	2.33 (100)	5 YR. 4/3 (90)	... (1)	386	90	1	285
Kennan Silt loam	25 Red Oak	9.3 (27)	32.3 (76)	3.8 (51)	8.1 (61)	4.8 (18)	1446 (32)	1.39 (29)	14.8 (100)	... (1)	.... (1)	3.7 (43)	149	944	51	1106
Iron River Silt loam	28 Hemlock, Hardwoods	15.0 (64)	33.2 (78)	0.0 (1)	6.9 (50)	5.7 (5)	1376 (30)	2.4 (88)	1.0 (1)	1.32 (57)	5 YR 4/4 (80)	1.5 (13)	262	361	1	571
Onamina Silt loam	7 Maple, Basswood, Elm	15.8 (68)	36.6 (86)	1.9 (25)	6.4 (46)	6.1 (1)	3070 (88)	2.0 (65)	14.3 (96)	... (1)	.... (1)	3.1 (31)	61	819	25	941

Notes: See notes below Table 33.

TABLE 33. DATA, RATIOS, AND INDICES, WITH SCALED VALUES[a], RELATED TO SOIL DEVELOPMENT OF SOME SOILS OF MENOMINEE COUNTY, WISCONSIN

Omega Sand.........	3 Hill's Oak	6.2 (7)	1.2 (2)	7.5 (100)	6.3 (45)	4.3 (30)	504 (1)	1.4 (29)	1.0 (1)	... (1)	7.5 YR 4/4 (50)	... (1)	225	173	100	313
Omega Sand	2 Jack Pine	6.1 (6)	1.4 (2)	7.5 (100)	6.3 (45)	4.6 (21)	550 (2)	1.4 (29)	1.0 (1)	... (1)	7.5 YR 4/4 (50)	... (1)	215	183	100	317
Crivitz Loamy Sand	31 Aspen	5.1 (1)	2.3 (4)	0.0 (1)	6.9 (50)	4.6 (21)	782 (10)	0.9 (1)	1.0 (1)	0.5 (21)	5 YR 4/4 (80)	... (1)	262	92	1	228

TABLE 33. DATA, RATIOS, AND INDICES, WITH SCALED VALUES[a], RELATED TO SOIL DEVELOPMENT OF SOME SOILS OF MENOMINEE COUNTY, WISCONSIN (CONTINUED)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
													Indices of Degree of Soil Development			
Soil Type	Forest Stand Number; Vegetation	Mean dbh [b] (in.)	Av. % Silt Plus % Clay, Mineral Soil 0″—72″	Av. Thickness of A1 (cm)	Av. Thickness of Litter [c] (cm.)	Lowest pH, Mineral A Horizon	Lbs. Exchangeable Ca, 0″—6″ Soil [d]	Av. % Organic Matter Mineral Soil 0″—18″	Ratio, Max. % O.M. in A: Min. % O.M. in A [e]	Ratio, Max. % O.M. in Bhir: Min. % O.M. in A2 [f]	Moist Color of the Podzol Bhir [g]	Ratio, Max. % Clay in Non-Podzol B: Min. % Clay in A [h]	Of Podzol Soil [i]	Of Gray Brown Podzolic Soil [j]	Of Melanized Soil [k]	Of Total Solum [l]
Vilas Sand	41 Hemlock, Yellow Birch	12.2 (46)	3.6 (7)	0.0 (1)	5.6 (39)	3.8 (54)	658 (5)	1.3 (24)	1.0 (1)	0.9 (38)	5 YR 4/4 (80)	. . . (1)	306	54	1	215
Crivitz Loamy Sand	4 White and Red Pine	20.7 (100)	9.1 (20)	0.0 (1)	6.9 (50)	4.8 (18)	1298 (27)	1.4 (29)	1.0 (1)	1.3 (56)	7.5 YR 3/2 (70)	. . . (1)	267	112	1	266
Kennan Silt Loam	29 Maple, Elm, Basswood	9.7 (29)	9.8 (22)	0.0 (1)	10.0 (78)	4.8 (18)	1160 (22)	1.0 (6)	3.4 (17)	. . . (1)	. . . . (1)	1.9 (17)	176	377	1	488
Crivitz Loamy Sand	44 Hemlock, Hardwoods	8.2 (20)	12.2 (28)	0.0 (1)	7.1 (52)	4.6 (21)	911 (14)	1.0 (6)	1.0 (1)	1.1 (47)	5 YR 4/4 (80)	2.5 (24)	286	215	1	387
Chetek Silt Loam	10 Red and White Pine	13.7 (55)	16.1 (37)	6.3 (84)	4.9 (32)	5.5 (5)	881 (13)	1.3 (24)	2.0 (7)	0.5 (21)	10 YR 4/3 (1)	1.0 (7)	146	255	84	386
Crivitz Loamy Sand	43 Hemlock, Hardwoods	14.0 (57)	16.0 (37)	0.0 (1)	7.5 (56)	3.9 (48)	825 (11)	1.3 (24)	1.0 (1)	1.0 (43)	5 YR 3/4 (100)	5.0 (53)	336	1125	1	1331
Pandus Sandy Loam	9 Hemlock, Hardwoods	14.1 (58)	19.2 (44)	0.0 (1)	11.25 (89)	3.2 (100)	658 (5)	2.6 (100)	1.0 (1)	1.4 (60)	5 YR 3/4 (100)	4.0 (42)	444	701	1	968
Padus Silt Loam	16 White Pine, Maple	16.8 (75)	20.2 (47)	2.5 (33)	9.4 (72)	5.6 (6)	1138 (22)	2.0 (65)	5.2 (30)	0.8 (32)	7.5 YR 4/4 (50)	3.3 (34)	238	859	33	1033
Padus Loam	11 Hemlock, Hardwoods	9.9 (31)	20.7 (48)	0.0 (1)	7.2 (53)	4.2 (34)	840 (11)	2.2 (76)	1.0 (1)	1.0 (43)	5 YR 3/4 (100)	1.3 (10)	319	259	1	467

TABLE 33. DATA, RATIOS, AND INDICES, WITH SCALED VALUES[a], RELATED TO SOIL DEVELOPMENT OF SOME SOILS OF MENOMINEE COUNTY, WISCONSIN (CONTINUED)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
													Indices of Degree of Soil Development			
Soil Type	Forest Stand Number; vegetation	Mean dbh [b] (in.)	Av. % Silt Plus % Clay Mineral Soil 0"—72"	Av. Thickness of A1 (cm)	Av. Thickness of Litter [c] (cm.)	Lowest pH, Mineral A Horizon	Lbs. Exchangeable Ca, 0"—6" Soil [d]	Av. % Organic Matter Mineral Soil 0"—18"	Ratio, Max. % O.M. in A: Min. % O.M. in A [e]	Ratio, Max. % O.M. in Bhir: Min. % O.M. in A2 [f]	Moist Color of the Podzol Bhir [g]	Ratio, Max. % Clay in Non-Podzol B: Min. % Clay in A [h]	Of Podzol Soil [i]	Of Gray Brown Podzolic Soil [j]	Of Melanized Soil [k]	Of Total Solum [l]
Chetek Loam	23 Red Oak, Maple	8.0 (19)	21.1 (49)	0.0 (1)	6.8 (50)	4.5 (23)	877 (13)	1.0 (6)	9.0 (58)	... (1)	7.5 YR 5/4 (40)	2.0 (19)	201	624	1	774
Iron River Loam	37 Aspen (White Pine stumps)	5.8 (4)	21.8 (51)	0.0 (1)	6.3 (45)	4.7 (19)	706 (7)	1.3 (24)	1.0 (1)	1.0 (43)	7.5 YR 4/2 (60)	1.8 (16)	260	314	1	496
Kennan Silt Loam	22 Maple, Basswood, Elm	10.5 (35)	23.7 (55)	1.9 (25)	9.8 (76)	4.2 (34)	3430 (100)	1.6 (41)	2.5 (11)	... (1)	.... (1)	0.4 (1)	113	207	25	325
Kennan Loam	13 Maple, Basswood, Elm	7.4 (15)	25.4 (59)	0.0 (1)	6.3 (45)	5.3 (9)	2950 (84)	1.2 (18)	4.0 (22)	... (1)	... (1)	0.9 (6)	72	258	1	354
Onamia Silt Loam	27 Hemlock, Hardwoods	13.8 (56)	26.2 (61)	0.0 (1)	4.4 (28)	4.2 (34)	676 (6)	1.7 (45)	6.6 (41)	... (1)	.... (1)	2.5 (24)	158	594	1	735
Kennan Silt Loam	6 Maple, Hemlock	15.5 (67)	29.0 (68)	0.0 (1)	8.8 (67)	4.3 (30)	1257 (26)	1.0 (6)	4.5 (25)	... (1)	.... (1)	3.1 (31)	173	409	1	565
Onamia Silt Loam	20 Maple, Hemlock	15.2 (65)	30.4 (71)	4.4 (58)	1.2 (1)	4.5 (23)	1862 (46)	1.8 (53)	2.1 (8)	0.6 (26)	10 YR 4/3 (1)	1.9 (17)	105	444	58	583
Kennan Silt Loam	5 Basswood, Maple, Ash	9.0 (25)	30.3 (71)	0.0 (71)	12.5 (100)	4.9 (7)	3295 (95)	1.0 (6)	6.5 (40)	... (1)	.... (1)	2.2 (21)	114	385	1	514

TABLE 33. DATA, RATIOS, AND INDICES, WITH SCALED VALUES[a], RELATED TO SOIL DEVELOPMENT OF SOME SOILS OF MENOMINEE COUNTY, WISCONSIN (CONTINUED)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
													Indices of Degree of Soil Development			
Soil Type	Forest Stand Number; Vegetation	Mean dbh [b] (in.)	Av. % Silt Plus % Clay Mineral Soil 0″—72″	Av. Thickness of A1 (cm)	Av. Thickness of Litter [c] (cm.)	Lowest pH, Mineral A Horizon	Lbs. Exchangeable Ca, 0″—6″ Soil [d]	Av. % Organic Matter Mineral Soil 0″—18″	Ratio, Max. % O.M. in A: Min. % O.M. in A [e]	Ratio, Max. % O.M. in Bhir: Min. % O.M. in A2 [f]	Moist Color of the Podzol Bhir [g]	Ratio, Max. % Clay in Non-Podzol B: Min. % Clay in A [h]	Of Podzol Soil [i]	Of Gray Brown Podzolic Soil [j]	Of Melanized Soil [k]	Of Total Solum [l]
Kennan Sandy Loam	24 Red Oak	12.0 (44)	31.2 (73)	0.0 (1)	6.9 (50)	4.1 (38)	890 (13)	1.1 (12)	1.4 (3)	. . . (1)	. . . . (1)	2.4 (23)	177	470	1	632
Kennan Silt Loam	15 Maple. Elm. Baswood	6.3 (8)	33.5 (79)	0.0 (1)	8.4 (64)	5.1 (14)	1675 (40)	0.9 (1)	7.3 (46)	. . . (1)	. . . . (1)	3.2 (33)	140	495	1	645
Onamia Silt Loam	18 Hemlock, Basswood	16.6 (74)	38.4 (90)	1.3 (17)	5.6 (39)	5.0 (16)	2555 (70)	1.5 (35)	4.2 (23)	0.5 (21)	10 YR 4/4 (10)	1.2 (9)	116	374	17	526
Kennan Sandy Loam	19 Maple, Basswood, Hemlock	15.2 (65)	40.0 (94)	1.9 (25)	8.0 (60)	5.5 (7)	3235 (93)	2.1 (71)	4.0 (22)	0.8 (34)	7.5 YR 4/4 (50)	9.0 (100)	158	2033	25	2212
Norrie Silt Loam	32 Maple, Basswood, Elm	15.1 (64)	42.4 (100)	5.0 (67)	6.3 (45)	4.5 (23)	3400 (99)	1.4 (29)	11.0 (72)	. . . (1)	. . . . (1)	1.4 (12)	71	579	67	731

a Scaled valued (in parentheses) are from 1 to 100 and are assigned to the range of figures reported in any single column of Tables 32 and 33.
b dbh = diameter breast height of a tree. The scaled values in this column may be considered as indices of relative stability of the forest stand. The larger the scaled value, the older the stand.
c L, F, and H horizons of the forest soil.
d This includes the upper 6″ of mineral soil plus the associated organic layers.
e Ratio of the maximum percent of organic matter in the A horizon to the minimum percent of organic matter in the A horizon, mineral soil.
f Ratio of the maximum percent of organic matter in the Podzol Bhir horizon to the minimum percent of organic matter in the Podzol A2 horizon.
g The Munsell color (moist) with lowest value and highest chroma was chosen from the Podzol B horizons in each profile.
h Ratio of the maximum percent of clay (< .002 mm.) in the non-Podzol B horizon to the minimum percent of clay in the A horizon, mineral soil.
i Formula for calculating the index of development of the Podzol soil = Scaled value of column 6 + scaled value of column 7 + (100—scaled value of coulmn 8) + scaled value of column 11 + scaled value of column 12.
j Formula for calculating the index of development of the Gray-Brown Podzolic soil = scaled value of column 5 + (100—Scaled value of column 7) + scaled value of column 8 + scaled value of column 10 + (Scaled value of column 13 x maximum % clay in the Bt horizon). Note that a dash in column 13 indicates that the soil has no textural B (Bt).
k This is the scaled value of column 5. Melanized soil is mineral soil with incorporated dark organic matter.
l Formula for calculating total index of soil development = scaled value of column 4 + (index ÷ 2 of column 14) + index of column 15 + (scaled value ÷ 4 of column 16).

Observations on the Genesis of Podzol Soils

A relatively well developed Podzol soil in the county has a solum less than 27 inches thick and is recognized by the dark reddish brown color of the organic matter-enriched Bhir horizon (column 12, Tables 32 and 33) in contrast to the colors of the pale A2 horizon above it; and by the low pH and low content of exchangeable calcium in the A horizon (columns 7 and 8).

The Vilas soil (hemlock-white pine stand 35) is one of the best developed Podzol soils observed in this study, and the Onamia silt loam (northern hardwood stand 7) is the profile most free from Podzol characteristics.

This investigation indicates that in Menominee County a Podzol forms most readily in sandy geologic material. The hemlock forest favors the development of a Podzol soil profile by accumulating a mat of relatively decay-resistant forest litter from which organic compounds are carried down into the mineral soil, bleaching the sand of the A2 horizon and enriching the B horizon in organic matter and associated iron oxide and other colloids. This forest also severely restricts growth of ground cover plants and inhibits activity of earthworms and other animals capable of mixing the litter into the mineral soil. The forest floor of a hemlock forest appears to be rather inactive biologically, but supports striking fungal growths in moist seasons. By intercepting and absorbing much precipitation, this forest maintains a cycle of alternation between extremely dry conditions in the soil in the summer and wet conditions in other seasons, particularly during snow-melt and early rains in spring. The forest further impoverishes the already low plant nutrient content of the soil by storing considerable amounts in the tall trees.

Where hemlock is found on sandy loams, loams and silt loams, hardwood trees are also prominent and the resulting soil profile is a double one, as at hemlock-hardwood stand 28, located on a north-facing slope; a Podzol profile overlies a Gray-Brown Podzolic soil profile. At stand number 9 (Table 33) the predominance of hemlock has resulted in a striking Podzol profile in the upper part of loamy geologic material. The best developed Podzol soil profiles, indicated in Tables 32 and 33 by indices of 386 to 444 in column 14, are under hemlock or hemlock-hardwood stands with average dbh of ten to fourteen inches. For development of a definite Podzol profile the forest must have escaped disturbance, such as severe burning, for a century or more. Shallow Podzol profiles have developed on old mounds made by windthrow of trees.

Observations on the Genesis of Gray-Brown Podzolic Soils

Gray-Brown Podzolic soil profiles in the county are weakly developed as compared with profiles in southern Wisconsin, west central Ohio, and intervening areas. A Gray-Brown Podzolic soil is recognized in Menominee County by the thick pale A2 horizon which contrasts with the thin relatively dark layer of mineral soil at the surface (columns 5 and 10 in Tables 32 and 33); the clay-enriched B horizon (column 13); the accumulation in the surface soil of exchangeable calcium (column 8); and the relatively high pH in the upper A horizon (column 7). The Kennan sandy loam (hardwood stand 19, Table 33) and the Onamia silt loam (hardwood stand 7, Table 32) are two of the best developed Gray-Brown Podzolic soils observed in the county. The Vilas sand (hemlock stand 41, Table 33) is the soil most free of features characteristic of a Gray-Brown Podzolic soil.

This study suggests that in Menominee County the Gray-Brown Podzolic soil profile has its best development in the finer textured materials; the loams and silt loams. The forest floor of the hardwood forest is biologically active. The soil is enriched in plant nutrients by biocycling. The organic litter, high in available nutrients, particularly calcium, is relatively easily decomposed. A ground cover of spring ephemerals sedges and grasses develops. Percolating waters do not induce the bleaching of the mineral grains as in the A2 horizon of Podzol soils. Clay, but not organic matter, is concentrated in the B horizon. Of all the features of this forest soil the formation of the clay-enriched B horizon probably requires the longest time and is the most enduring.

Well developed Gray-Brown Podzolic soils were observed under hardwood stands with an average dbh of 10 to 15 inches. The stands have been undisturbed by fire or cutting for 40 to 100 years or more. The textural B horizon (Bt or B2) may represent development over thousands of years. In the formula for calculating the index of development of a Gray-Brown Podzolic soil (Tables 32 and 33), the formation of the B horizon is given emphasis. It seems impossible in a soil formed from stratified material to determine the degree to which this horizon inherits its clay content from geologic processes which predated soil formation.

Observations in the Genesis of Melanized Soils

Melanization (Wilde, 1958) is the process or processes of darkening of soil by incorporation of organic matter into it. The Omega soil exhibits maximum melanization among the soils studied. This is shown by the 3-inch, very dark A1 horizon which directly overlies a weakly developed Podzol Bhir horizon. Disturbance of the forest by fire, cutting or windthrow favors the growth of sedges, grasses and other plants and the concomittant darkening of the surface soil. Repeated burning of the sand plain in southeastern Menominee County in the past has favored the development of prairie vegetation and the dark colored surface horizon (A1) in the Hill's oak and jack pine forests. Some wind erosion followed fires, as indicated by sand seams observed in peat profiles in associated bogs. The numerous conical pits (glacial kettles) in the sand plain are sites of treeless frost pockets. Rodent and ant activities in mixing organic material into soil have been greater in Hill's oak and jack pine forests than elsewhere.

Estimates of the Relative Rates of Formation of the Three Kinds of Soils

The indices of total soil development presented in the tables (column 17) are calculated on the assumption that melanization is four times as rapid, and podzolization twice as rapid as the formation of a Gray-Brown Podzolic B2 horizon. It is impossible to say at present to what extent these estimates are accurate. But it seems evident that the differences in the speed with which these processes operate produce approximately these relationships. The relative fineness of the initial geologic materials is included in the estimates. Evidences of soil formation develop most easily in coarse materials and with greatest difficulty in finer materials. Vegetative growth in the upland soils, and consequent incorporation of organic matter (column 9, Tables 32 and 33), are generally greater the finer the texture of the mineral material. Sands by their very nature set limits to the degree of soil development as shown by indices (Tables 32 to 33, column 17) ranging from 215 to 315. These contrast with indices above 1,000 for some loams.

Observations on the Genesis of Fragipans

Between depths of 8 and 18 inches in two Gray-Brown Podzolic soils, the well-drained Norrie and the moderately well-drained Brill silt loams, Olson (1962) observed and sampled horizons which exhibited moderate cementation and brittleness when dry. A fragment of the dry soil was observed to resist deformation when pressed between the fingers, then to rupture suddenly. Examination of microscopic thin sections revealed that the soil consisted of sand, silt, and a very little clay closely packed together. These weakly developed fragipans are compact layers which are fragile. During the spring thaw the soil above the fragipan becomes saturated. Seepage at the surface of the fragipan, as has been observed in the sides of freshly dug soil pits, indicates that lateral flow of water occurs early in the season above this soil layer. These pans constitute moderate barriers to root growth, and some susceptibility of large trees to windthrow in storms is attributable to them. Possibly pans form as a result of freezing and thawing which causes loamy soil material to run together into a compact mass. The pans may be softened and loosened by mixing activities of animals, tree root growth, and percolating water. In places the A2 horizon above the fragipan appears to be in the process of extending downward with eventual distruction of the pan a possibility.

Observations on the Genesis of Cradle-Knolls

Apparently the requirements for the formation of cradle-knolls, so numerous in Menominee County soils, are these: (1) large trees with sound trunks, (2) trees with shallow rooting systems, and (3) a violent wind. The mounds

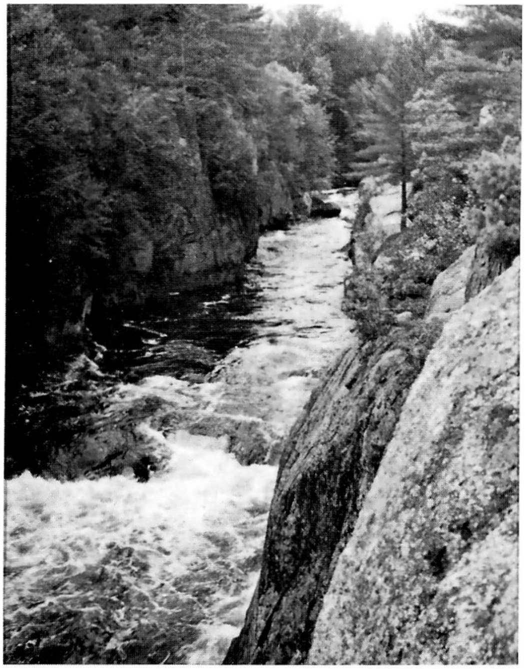

Figure 19. Vegetation at Wayka Falls (above) and Wolf River Dalles (below) supported by shallow soils and associated jointed crystalline bedrock in Granitic Rockland.

and hollows are found in sands, loams, and silts wherever the three conditions have been met.

During tree-fall, the tree roots pull or push out material to excavate a hollow, and at the same time deposit material nearby to form the accompanying mound. Nielsen (1963) counted 141 cradle-knolls per acre under mature hardwood-hemlock forest on silty soils and 4 per acre under jack pine on sandy soils in Menominee County. Most Hill's oak and jack pine trees on the sand plain are too deeply rooted or too infirm to be uprooted whole by wind. Hence cradle-knolls are rare on the Omega sand. Nielsen measured 250 cradle-knolls in silty soils and found that the average vertical distance between the bottom of the cradle and crest of the knoll was 1.3 feet, the horizontal distance was 4.0 feet and the average slope for a line drawn between the two points was 31 percent. Corresponding figures for cradle-knolls on sandy soils were 0.6 and 2.6 feet and 27 percent. Slopes of these small landforms may be as steep as 45° or 100 percent. These short, steep slopes are usually well protected by moss and leaf litter. New soils a few inches thick have formed on cradle-knolls. Orientation of the cradle-knolls indicated tree-fall caused by westerly winds. On slopes greater than 8 percent, tree-fall had been prefentially down-slope. Most of the trees which made the cradle-knolls have long since rotted completely away.

VIII. WILDLIFE RESOURCES

William Creed[1] and Forest Stearns[2]

Just as the vegetation of Menominee County approaches that of presettlement days in northern Wisconsin, so does the wildlife population closely approximate the natural condition found previous to major exploitation by white man. This is a unique situation in the lake states, where even in Isle Royale National Park the large moose herd has severely damaged the range. The animal population is varied as to species, but in most of the county the numbers of any one species are small.

In most of the north, lumbering and the fires that accompanied and followed cutting created large areas of brush and open land highly favorable to the build-up of a deer herd and to the development of high populations of snowshoe hare and other forest-edge species. Both lumbering and fire have influenced Menominee County, but primarily in localized areas. In these favorable habitats the increase in deer population was held in check by the Indian hunters.

The wildlife of the county is an important economic resource, furnishing both food and cash (in the form of venison and hides, respectively). Vastly more important in the long run, however, is the fact that the moderate populations of deer and hare have had little influence on forest regeneration and a good intermixture of tree species has been maintained.

Prior to termination of federal control in 1960, the Wisconsin Conservation Department undertook an investigation of deer-forest relationships on the then Menominee Indian Reservation. Since the economy of the reservation was dependent almost entirely upon its forest resources, the study was designated to establish bench marks for current deer populations and range conditions against which future management practices could be measured (Creed, 1960 and 1961).

Wildlife Populations

Present deer densities are low, compared to other Wisconsin counties. A pellet count (Thompson, 1955) conducted in 1960 showed an average overwinter population of 3.7 deer per square mile of range, or about 1,300 deer for the entire county. This is the lowest deer population that has been documented for any extensive forest area in the state, and is significantly lower than in the surrounding counties.

Aerial and ground surveys located 10 winter concentration areas, or "yards", totaling 2,663 acres. This amounts to only 1.2 percent of the county's 350 square miles of deer range, compared to about 10 percent of similar areas

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elsewhere. These aerial and ground checks confirmed the low deer population level indicated by the pellet-group-count survey.

More deer wintered in the east half than in the west half of the county. This unequal distribution did not appear to be influenced by a disproportionate distribution of winter cover. On the contrary, conifer types suitable for wintering deer are well distributed over the entire county. It it more likely that higher deer densities in the east half were influenced by (1) higher deer densities in outside areas closely adjacent to the east side of the county, and (2) the presence of better quality summer range adjacent to winter cover in the eastern portion.

The largest blocks of wild land adjacent to the county occur in the Nicolet National Forest, north of Shawano Lake, and northeast of Bowler. The major winter deer concentrations were located in areas adjacent to these three wild land tracts. We suggest that many deer wintering in the county move in from these outside areas. Indian Service personnel concurred with this viewpoint.

Ruffed grouse and snowshoe hare populations were also relatively low in 1960, according to the number of ruffed grouse roosts and presence of snowshoe hare pellets recorded on the deer-pellet survey plots. These results are compared with survey findings on nearby deer management units in Table 34.

As with deer, ruffed grouse densities also appeared to be higher in the eastern half of the county. For the most part, the eastern half offers the best wildlife habitat, primarily because these lands have a history of more severe disturbance, including both cutting and wild fires.

Although quantitative measurements of other species were not made, Menominee County also boasts the usual complement of forest wildlife found in northern Wisconsin, including black bear, beaver, otter, gray squirrel, coyote, red fox, and bobcat. Bear signs are frequently seen on logging roads and trails and bear seem to be prospering in the favorable intermixture of forest types found in the eastern half of the county. No studies have been made, but close observation indicates higher populations of bobcat than elsewhere in the state. These bobcat populations may be responsible for keeping small mammal populations, particularly snowshoe hares, in check.

Deer Range Studies

Measurements of woody plant composition, density, and utilization indicated the low deer population was having little effect on forest reproduction and other vegetation (Creed, 1960 and 1961).

Two separate range condition surveys were run. The first, in 1960, employed 2,000 milacre quadrats, located along 100 random compass lines through all cover types. The second, in 1961, was restricted to deer yards, and included measurements on 800 milacre plots located along 40 randomized transects (Tables 35).

The Menominee Indian Reservation was one of the areas sampled during Wisconsin's deer damage to forest reproduction survey in 1947 (DeBoer, 1947). In this survey, deer browsing on commercial tree reproduction was measured on five hundred and forty 1/50 acre plots distributed over the reservation. The 1947 survey showed 3.9 percent of the stems were browsed. While results of the 1960 survey cannot be expressed in terms of stems browsed, final tabulations showed 3.9 percent of the 1,075 plots with available browse indicated current browsing by deer. It appears reasonable to state that browsing was extremely light in 1947 and was similarly light in 1960.

The 1961 survey, restricted to winter deer yards, also indicated extremely light browsing pressure by deer; only 6 percent of the plots with available browse showed current deer use. In contrast to yards in most northern Wisconsin deer range, white cedar was extremely abundant, accounting for 50

TABLE 34. SPRING SURVEY RESULTS MENOMINEE COUNTY AND NEARBY DEER MANAGEMENT UNITS

Unit *	Year	Deer Density/ Square Mile * *	Ruffed Grouse Roosts/Acre	Snowshoe Hare Pellet Frequency on Plots
Menominee County	1960	3.7 ∓ 3.0	2.7	21
42	1960	21.1 ∓ 6.4	4.7	32
44A	1958	14.2 ∓ 4.4	4.8	55
	1959	12.1 ∓ 4.3	6.1	50
45	1959	17.9 ∓ 4.0	6.0	47
	1960	14.8 ∓ 4.7	3.4	34

*Unit 42 includes parts of Langlade and Lincoln Counties; Unit 44A, parts of Forest, Langlade, and Oconto Counties; Unit 45, parts of Forest, Marinette, and Oconto Counties.

* *Deer density estimates include 95 percent confidence limits and are uncorrected for deer removed through legal harvest.

TABLE 35. BROWSE COMPOSITION AND DENSITY IN DEER YARDS*

Item	Menominee Res. 1961	Unit 14 1959	Unit 39 1959	Unit 42 1960
No. milacres checked	800	280	360	260
Total browse stems/acre	2,746	2,341	2,271	2,058
%by preference rating * *				
1st choice	55	8	9	3
2nd choice	18	45	32	40
3rd choice	27	46	59	58

*Unit 14 includes parts of Ashland, Price, and Sawyer Counties; Unit 39, parts of Forest, Oneida, and Vilas Counties; Unit 42, parts of Langlade and Lincoln Counties.

* *Preference ratings according to Dahlberg and Guettinger (1956).

percent of the available stems. Plant composition was also more varied, with a total of 36 different woody browse species recorded. A comparison of species composition and density with some northern deer management units is shown in Table 35.

An extremely important consequence of low deer populations is that yellow birch regeneration persists successfully, even though past cutting practices have not especially favored this species. Other palatable species such as hemlock and basswood are also able to survive successfully, and stands of mixed species composition are being maintained. This is a healthy situation as far as forest management is concerned.

The presence of high-preference browse species in measurable quantities is indicative of the excellent and unique condition of the range and of the fact that it has never suffered the heavy browsing pressure found elsewhere in Wisconsin. Nowhere else in the hardwood areas of the state is Canada yew present in measurable amounts. Observations over the past 20 years indicate that deer have virtually exterminated the species in most counties. Likewise, few other areas show the profusion of white cedar and hemlock reproduction found in Menominee County. Less conspicuous species such as viburnums, dogwoods and mountain ash also prosper, and the success of yellow birch reproduction has already been noted.

Hunting by Indians

Prior to termination of federal control, deer hunting was relatively unrestricted on the reservation. While Indian Service personnel stated that hunting didn't begin until late summer, deer of any sex or age were taken by almost any means possible. Hunting with dogs was reportedly the most popular method, with shining from automobiles next in importance.

In 1960, a questionnaire was mailed to all Menominee households, requesting information on number of deer killed in 1959. Signatures were not required on the cards. Response to the questionnaire was poor, with only 90 of 531 cards (17 percent) returned. Hunters returning cards reported a total of 147 deer killed on the reservation in 1959. If all families killed deer at the rate shown by the 17 percent return, the total harvest would be about 860 deer. But experience with other mailed questionnaires has shown successful hunters are prone to report at a higher rate than unsuccessful hunters. Applying this principle to the Menominee questionnaire results, the total kill in 1959 probably amounted to 500 to 700 deer.

Very little information is available concerning hunting of other species. There is apparently substantial interest in hunting ruffed grouse in the fall, but very little interest in snowshoe hares. A small group of Indians hunt coyotes with dogs for sport, but otherwise predator hunting is insignificant.

Future

What is the future of the wildlife of the county? This depends on two factors, the range and the harvest. With continued planned and moderate management of the forests the range should not change greatly. Cutting should provide some areas with greater browse and berry production and the increasing road and trail network should support herbs and forbs favorable to grouse and bear as well as deer. Fire control and selective cutting in various forms can reduce the aspen acreage and prevent restablishment of pioneer species such as cherry, thus having some adverse effect on wildlife food supplies.

In any case, anticipated habitat changes of themselves should not cause any drastic upset in the present balance between game and forests.

The present condition of the range is adequate to provide the base for a build-up of deer populations if present state-wide game laws are applied to the county. In this event, a gradual increase from the present population of about 4 deer per square mile to 10 or 12 can be anticipated. When the population reaches that point, build-up will be more rapid, and it is doubtful that even liberal seasons will hold the herd in check.[1]

A rapid deer population increase should soon deplete the range of high preference browse species, including regeneration of valuable timber trees. Overpopulation may have serious effects on the scenic values of the county, since much of the conifer forest understory would be destroyed. Finally, a study and control area of inestimable values to foresters, game managers, and students of natural sciences would be lost forever. Eventually, deer populations should drop to levels the deteriorated range will support.

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[1] Since the writing of this report the pellet count survey was repeated in May, 1965. Results indicated 7.3 ± 3.1 deer per square mile, as compared to the mean estimate of 3.1 deer per square mile in 1960. This increasing deer herd is beginning to produce detrimental effects on vegetation, particularly evident in the development of browselines on cedar around the edges of swamp conifer yards.

IX. SOIL PROFILE DESCRIPTIONS

Introduction

Each soil listed in the legend (Table 36) of the colored soil map is defined in this chapter on the basis of horizons observed in the vertical cross-section called the soil profile (Figure 20). The soil profile descriptions were made in pits dug to a depth of 3 to 5 feet in representative soil bodies.

Individual soil profile descriptions have been arranged in alphabetical order. In most cases exact locations are given for sites at which descriptions were made in the field, although some descriptions have been based on observations made at several sites.

A soil profile description provides important information because our scientific classification of soils (Thorp and Smith, 1949; Baldwin, *et al,* 1938; Soil Survey Staff, 1951 and 1960) is based on these definite soil units. Great Soil Groups, such as Podzol (Spodosol) and Humic Gley (Haplaquoll) are technical terms used by soil scientists in classifying soils throughout the world. Some soils are briefly defined in the footnotes to Table 3. Technical terms used in the soil descriptions are defined briefly in the glossary. As more soil research is done in the laboratory and in the field, more complete descriptions and data become available.

An examination of the soil profile descriptions and Table 37 of analytical data reveals that the distinction between Podzol soils (Spodosols) and northern Gray-Brown Podzolic and Gray Wooded soils (Glossoboralfs) are far from clear in most soils profiles. The data give a correct picture of representative soils of the county and of the difficulty of assigning an individual soil profile, in many instances, to a single category in a national or world-wide classification of soils.

Individual Soil Profile Descriptions

ALBAN SERIES (Soil map units 6, 7, 8, 9, 10)

General Description. The Alban series includes well-drained, deep, medium textured, acid soils.

Detail Description. This series includes soils formed from more than 40 inches of acid very fine sands and silts overlying stratified coarse sands and silts of glacio-lacustrine origin. Natural drainage or aeration has been good. The original vegetation included northern hardwoods and some white and red pine. They are classified as weakly developed Gray Brown Podzolic soils (Typic Hapludalfs). However, because in Menominee County a weak Podzol sequum commonly occurs in the upper part of the profile these soils are Hapludalfs with spodic and glossoboralfic tendencies. Where present, the incipient Podzol B begins at a depth of 1 or 2 inches and continues downward about 8 inches with maximum contents of about 15% clay, 45% silt, and 0.5% organic matter. The clay contents in the weakly developed Gray-Brown Podzolic-like subsoil horizons are about 10% for the A'2x and 15% for the B'2x. Soil types include fine sandy loams, and silt loams. Slope gradients range from 3% to 20%.

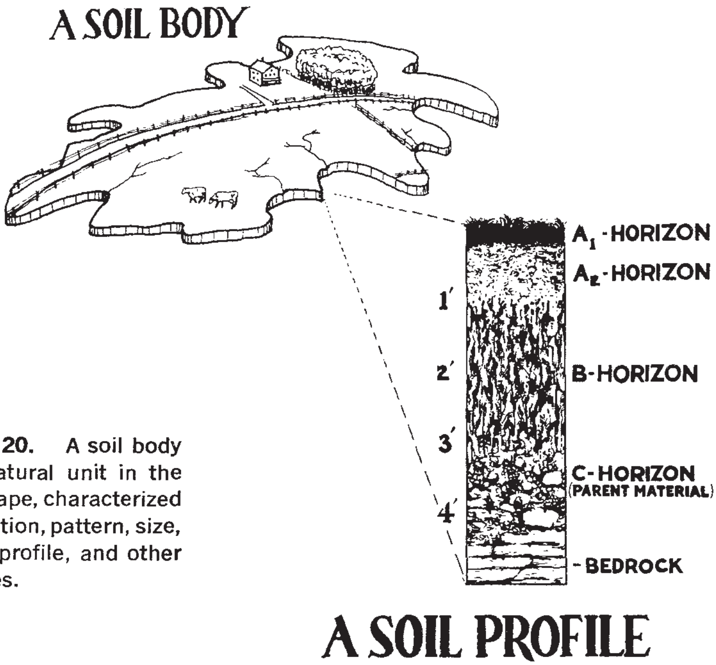

Figure 20. A soil body is a natural unit in the landscape, characterized by position, pattern, size, slope, profile, and other features.

Associated soils include Onamia, Chetek, Underhill, Fence, Padus, and Pence. The following profile was observed in the center of the S.E.¼, Sec. 17, T. 30N., R. 16E., on a 3% slope under a forest cover of white and red pine trees (about 100 feet tall), maple, oak, basswood, butternut, hickory, and ash. It is considered to be somewhat toward the sandy end of the textural range of this series.

Horizon	Depth, Inches	Description
01	2½-2	Dark reddish brown (5YR 3/2M) leaf mat; pH 6.0; abrupt, smooth boundary.
02	2-0	Black (5YR 2/1M) fibrous humus with some dark reddish brown (5YR 3/2M) woody humus; many roots; pH 5.0; abrupt, smooth boundary.
A2	0-1	Brown (7.5YR 4/2M) to dark grayish brown (10YR 4/2M) fine sandy loam to coarse silt loam: weak fine platy; vesicular; very friable to friable; discontinuous horizontally; many roots: pH 5.5; abrupt wavy boundary.
Bhir	1-9	Brown (7.5YR 5/2 above to 5/4M below) very fine sandy loam; weak thick to thin platy; vesicular; many roots; very friable; pH 5.7; clear, smooth boundary.
A'2x	9-13	Yellowish brown (10YR 5/4M) and gray (5YR 5/1M) coarse silt loam: moderate medium platy to moderate medium angular blocky: vesicular; firm and somewhat fragic; friable; some roots present; pH 6.0; abrupt, irregular boundary.
A'2x & B'2x	13-16	The A'2x horizon interfingers down between peds of the B'2x.

B'2x	16-24	Reddish brown (5YR 4/3M) silt loam; moderate medium to fine subangular blocky; brown (7.5YR 4/4M) and dark reddish gray (5YR 4/2M) cutans on ped surfaces; some roots present; firm and somewhat fragic: pH 6.0; gradual, smooth boundary.
C1	24-50	Reddish brown (5YR 5/4M) coarse silt loam; massive breaking to moderate medium angular blocky; firm: pH 5.7; (NOTE: At a depth of 115" reddish brown (5YR 5/3M) calcareous sandy loam was encountered.

Type Location: N.W.¼, N.E.¼, Sec. 34, T.26N., R.9E., Marathon County, Wisconsin.

Series Proposed: Marathon County, Wisconsin, 1960.

Source of Name: Township in northeastern Portage County, Wisconsin.

ANTIGO SERIES (Soil map units 11, 12, 13)

General Description. The Antigo series includes naturally well-drained, moderately deep to deep acid soils of medium texture underlain by sand and gravel.

Detailed Description. This series includes soils developed under conditions of good drainage or aeration from 20 to 40 inches of silty material overlying sand and gravel of glacio-fluvial origin containing igneous and metamorphic rock, but little or no limestone. The original vegetation was northern hardwoods with some hemlock. These soils are classified as Gray-Brown Podzolic, but show characteristics somewhat transitional to Podzol or Gray-Wooded in colors of A2 and upper B, and in tonguing of the A2 into the B (Typic Glossoboralf). The textural B horizon begins at a depth of about 14 inches and continues downward about a foot, with maximum contents of about 20% clay, 50% silt and 0.5% organic matter. Soil types include silt loams and very fine sandy loams. Slope gradients range from 1% to 20%. Associated soils include Stambaugh, Onamia, Padus, Pence, Emmert. The following soil profile was observed in the N.E.¼, S.W.¼, Sec. 11, T.29N., R.13E. on a 6% slope. Tree roots were seen to be most abundant in the A horizon.

Horizon	Depth, Inches	Description
011	5-3½	Leaf litter (from sugar maple, red oak, basswood, elm), light reddish brown (5YR 6/3M); abrupt smooth boundary.
012	3½-2	Reddish gray (5YR 5/2M) decomposing leaf litter; pH 5.5; abrupt smooth boundary.
02	2-0	Black humus.
A21	0-2	Dark grayish-brown (10YR-7.5YR 4/2M) silt loam; weak fine granular; very friable; pH 5.0: no earthworms observed; clear wavy boundary.
A22	2-5	Grayish brown (10YR 5/2M) silt loam; weak fine subangular blocky: friable; clear wavy boundary.
A23	5-11	Brown (10YR 4/3M) silt loam; weak to moderate fine subangular blocky; friable clear, wavy boundary.
A24	11-14	Dark brown (10YR-7.5YR 3/3-4/3M) silt loam; moderate fine subangular blocky; this horizon tongues downward as much as 5 inches into the B21, coating the surface of peds in that horizon; abrupt irregular, boundary.
B21	14-21	Dark brown (7.5YR 4/4M) heavy silt loam; moderate, medium angular blocky; firm; pH 5.1; clear wavy boundary.
IIB22	21-39	Dark brown (7.5YR 4/4M) sandy loam; moderate medium angular blocky: firm; pH 5.4; clear, wavy boundary.

IIB3	39-46	Dark brown (7.5YR 4/4M) loamy sand; very weak fine subangular blocky; friable; distinct, wavy boundary.
IIC	46-56	Dark brown (7.5YR 4/4M) sand; massive to very weak fine subangular blocky; loose to friable.

Type location: Near Antigo, Langlade County, Wisconsin.
Series Established: Langlade County, Wisconsin, 1947.
Source of Name: City of Antigo.

AU GRES SERIES (Soil Map Units 20, 21)

General Description. The Au Gres series includes somewhat poorly drained acid sands.

Detailed Description. This series includes somewhat poorly drained sandy soils developed from acid deposits of glacio-fluvial and -lacustrine origin. Original vegetation was white cedar, aspen, and northern hardwoods. These soils have been classified as Podzols (Entic Haplaquod) without ortstein. The Podzol B begins at a depth of about 5 inches and continues downward two feet with contents of about 5% clay, 10% silt, and 1% organic matter. The overlying horizon (A2) is pale and is faintly mottled. Soil types include sands and loamy fine sands. Slope gradients are less than 4%. This series differ from the Saugatuck by the lack of cementation in the Podzol B horizon. Associated soils include peats, Vilas and Crivitz series. The following soil profile was observed in the S.W. corner of the S.E.¼, Sec. 3, T.29N., R.14E., Menominee County, Wisconsin, on a 1% slope in a depressional position under forest cover of balsam fir, white cedar, basswood, yellow birch, aspen, and with some moss ground cover.

Horizon	Depth, Inches	Description
01	3½-3	Very dark gray (5YR 3/1M) to dark reddish brown (5YR 3/2M) leaf mat; pH 7.5; abrupt, smooth boundary.
02	3-0	Black (5YR 2/1M) fibrous peat; somewhat stratified, containing fragments of charcoal, and many live roots; pH 6.1; abrupt smooth boundary.
A2	0-5	Grayish-brown (10YR 5/2M) loamy sand, with a few faint yellowish brown (10YR 5/4M) mottles, and common, distinct grayish-brown (10YR 4/2M) mottles: very weak thick platy and very weak fine subangular blocky and single gain structures present; friable; some coarse roots present; pH 6.0; abrupt, smooth boundary.
Bhir	5-9	Dark reddish brown (5YR 3/4M) loamy sand with distinct common mottles of yellowish brown (10YR 5/4M); some pebbles present; very weak medium subangular block; very friable; some coarse roots present; pH 6.0; clear, smooth boundary.
Bir	9-28	Brown (5YR-7.5YR 4/4M) loamy sand mottled reddish yellow (7.5YR 6/6-5/4M): massive, breaking to very weak medium subangular blocky and single grain; friable to loose: roots present to a depth of 24 inches; pH 6.3; clear, smooth boundary.
C	28-40	Brown (7.5YR 4/4-5/4M) medium sand; single grain; loose; pH 6.5. Water table stood at 34 inches below the surface July 18, 1962.

Type location: Arenac County, Michigan.
Series proposed: Arenac County, Michigan.
Source of name: Town in Arenac County, Michigan.

BRILL SERIES (Soil map units 11, 12, 13)

General Description. The Brill series includes moderately well-drained, moderately deep to deep acid soils of medium texture underlain by sand and gravel.

Detailed Description. This series includes soils developed under conditions of moderately good drainage or aeration from 20 to 40 inches of silty material overlying sand and gravel of glacial-fluvial origin, containing much igneous and metamorphic rock material, but little or no limestone. The original vegetation was northern hardwood-hemlock forest. These soils are classified as Gray-Brown Podzolic, with possibly a slight trend toward Podzol (Paraquic Glossoboralf). The textural B horizon begins at a depth of about 15 inches and continues downward a little more than 2 feet, with maximum contents of about 20% clay, 60% silt, and 0.5% organic matter. Soil types include silt loams and very fine sandy loams. Slope gradients range from 1% to 5%. Associated soils include Stambaugh, Onamia, Padus, and Antigo. The following profile description was made in the S.W.¼, S.E.¼, Sec. 5, T.30N., R.13E., Menominee County, Wisconsin, under a forest cover of maple, birch, basswood, elm, hemlock. Large roots extend to 24 inches. A few stones were found in the profile.

Horizon	Depth, Inches	Description
011	1-1/8	Pale red (2.5YR 6/2M) leaf litter, mostly maple; pH 6.5; abrupt, smooth boundary.
012	1/8-0	Very dusky red (2.5YR 2/2M) decomposing leaf and twig litter; pH 6.5; abrupt, smooth boundary.
A1	0-6	Dark gray (10YR 4/1M) silt loam: strong, medium granular to subangular blocky; very friable; pH 5.7; clear smooth, boundary.
A3	6-8	Brown (10YR 5/3M) silt loam; moderate medium subangular blocky; somewhat firm; friable; pH 5.3; some spots and extensions of A1: clear, smooth boundary.
A'2	8-14	Pale brown (10YR 6/3M) silt loam: moderate, coarse platy breaking to moderate, medium angular blocky; vesicular; firm; fragic; pH 5.3; clear; smooth boundary.
A'2 & B11x	14-17	Light gray (10YR 7/2M) silt loam tonguing down into brown to dark brown (10YR 4/3M) silt loam which has strong, very coarse platy structure breaking to fine, angular blocky structure; vesicular; very firm; fragic; pH 5.4; clear, smooth boundary.
B12x	17-20	Dark brown to brown (10YR 4/3M) silt loam with few, faint fine very dark yellowish-brown (10YR 4/4M) mottles; moderate, coarse, platy breaking to fine, angular blocky; vesicular; friable; somewhat fragic; pH 5.3; clear, smooth boundary.
B13	20-28	Brown to dark brown (10YR 5/4-4/3M) silt loam with few faint fine very dark gray (10YR 3/1M) mottles; moderate, coarse platy breaking to angular blocky; slightly vesicular; firm to friable; pH 5.2; clear, smooth boundary.
B2g	28-36	Brownish yellow (10YR 6/6M) heavy silt loam with few faint fine very dark gray (10YR 3/1M) mottles, dark brown (10YR 3/3M) streaks and few dark reddish-gray (5YR 4/2M) clay skins; moderate, coarse platy breaking to angular blocky; slightly vesicular; firm to friable; pH 5.2; clear, smooth boundary.
IIB3	36-40	Dark reddish-brown (5YR 3/3M) sandy loam with light gray (10YR 7/2M) silt coatings on peds; moderate, medium platy breaking to subangular blocky; vesicular; friable; pH 5.1; abrupt, smooth boundary.
IIC	40-76	Reddish brown (5YR 4/4M) sandy loam above to grayish brown (10YR 5/2M) medium to coarse sand below; friable to loose; pH 5.2 above to 5.8 below; some ½-inch-thick bands occur.

Type location:	Barron County, Wisconsin.
Series Established:	Langlade County, Wisconsin, 1941.
Source of name:	Village in Barron County, Wisconsin.

BRIMLEY SERIES (Soil map units 6, 7, 8, 9, 10)

General Description. The Brimley series includes deep, somewhat poorly drained soils of medium texture which are limey at depths of 30 to 60 inches.

Detailed Description. This series includes soils formed under somewhat poorly drained conditions of drainage and aeration from less than 18 inches of silts over stratified silts, fine sands and clays which are calcareous or dolomitic at depths of 30 to 60 inches. The original vegetation included northern hardwoods, balsam fir, and white cedar. The soils are classified as Podzols (Aqualfic Haplorthod). The subsoil (B horizon) begins at a depth of about 6 inches and continues downward about a foot with contents of about 10% clay, 45% silt, and 1% organic matter. Below this is a lower brown subsoil (B′tg) with about 17% clay, and 30% silt. Above the B′ is a pale silt loam horizon (A2) containing about 15% clay, 60% silt, and 1.5% organic matter. Slope gradients are 1 to 3%. Soil types include silt loam and fine sandy loam. Associated soils include Alban, Crivitz, Underhill, Onamia, Cheteck. The following profile was observed in the center of Sec. 21, T.30N., R.16E., Menominee County, Wisconsin, on a 1% slope in a depression.

Horizon	Depth, Inches	Description
01	3½-3	Brown (10YR 5/3M) leaf litter (from hemlock, maple and yellow birch); pH 6.0; abrupt, smooth boundary.
02	3-0	Very dark gray (5YR 3/1M) humus with many fine roots; pH 5.0; fine to very fine soft granular; abrupt, smooth boundary.
A1	0-½	Black (5YR 2/1-3/1M) silt loam: moderate medium granular; very friable; earthworms present; many roots; pH 5.0; abrupt, wavy boundary.
A2 & Bhir	½-6	Brown (7.5YR 4/2M) silt loam A2 horizon tonguing into dark brown (7.5YR 3/2M) and dark yellowish brown (10YR 4/4M) loamy B, faintly and commonly mottled brown (7.5YR 5/2M) and reddish brown (5YR 4/3M); moderate fine subangular blocky above to weak coarse platy and weak medium angular blocky below; many roots, some earthworm channels filled with A1 material are present; slightly vesicular; friable; pH 6.5; clear smooth boundary.
IIBhir	6-11	Faintly mottled brown (7.5YR 4/2M) dark brown (7.5YR 4/4M) and grayish brown (10 YR 5/2M) loam; massive breaking to weak, coarse angular blocky and weak thick platy structure; friable; pH 7.0; abrupt, irregular boundary.
IIBir	11-21	Grayish brown (10YR 5/2M) heavy fine sandy loam, with faint common mottles of brown (10YR 5/3M and distinct mottles of dark brown (7.5YR 4/4M); thin coatings of dark gray (5YR 4/1M) occur in patches; massive in place, breaking to angular fragments: friable; few roots; abrupt, wavy boundary; pH 8.0.
IIC1	21-48	Reddish gray (5YR 5/2M) medium loamy sand, above, to reddish brown (5YR 5/3M) heavy handy loam, below; massive; friable; pH 8.0.
IIC2	48-60	Reddish brown (5YR 5/3M) light loam; massive; friable; calcareous.

Type location:	W. Center S.W.¼, Sec. 2, T.46N., R.1E., Chippewa County, Mich.
Series Established:	Chippewa County, Michigan, 1927.
Source of name:	Town in Chippewa County, Michigan.

BRUCE SERIES (Soil map units 6, 7, 8, 9, 10)

General Description. The Bruce series (Figure 21) includes wet, deep medium-textured lowlying soils which are limey at depths of 2 to 8 feet.

Detailed Description. This series includes soils formed under naturally very poor conditions of drainage and aeration from less than 2 feet of silts over stratified silts, fine sands and clays, which are calcareous or dolomitic at 2 to 8 feet. The original vegetation included northern hardwoods with cedar, balsam fir, and hemlock. These soils are classified as Humic-Gley soils (Mollic Haplaquept). The subsoil B begins at a depth of about 10 inches and continues downward nearly a foot with maximum contents of about 20% clay, 35% silt, and 0.2% organic matter. Above the subsoil is a dark silt loam horizon (A1) with about 20% clay, 60% silt, and 15% organic matter. Slope gradients are less than 2%. Soil types include fine sandy loam and silt loam. Associated soils are Brimley, Alban, Crivitz, Underhill. The following profile was observed in the center of Sec. 21, T.30N., R.16E., Menominee County, Wisconsin, on a level soil body in a depressional position, under forest cover of yellow birch, hard maple, hemlock, and beech with ferns and grass.

Horizon	Depth, Inches	Description
01	1½-1	Dark reddish brown (5YR 3/3M) leaves; pH 6.5; abrupt, smooth boundary.
02	1-0	Dark reddish brown (5YR 2/2M) humus; pH 6.0: abrupt, smooth boundary.
A11	0-3	Black (5YR 2/1M) silt loam; weak medium granular; very friable; pH 7.8; abrupt, smooth boundary.

Figure 21. The soil profile (left) is of a poorly drained marsh border soil called Humic-Gley (Aquoll). There are two major horizons: the thick black A1 (0 to 10 inches) and the bluish-gray Bg horizon (10 to 17 inches). The landscape shows a treeless bog bordered by Humic-Gley soil (unit 25 on the soil map).

A12	3-10	Black (5YR 2/1M) above to dark gray (10YR 4/1M) below, silt loam, with a few faint fine mottles of olive brown (2.5Y 4/4M) and grayish brown (2.5Y 5/2M); moderate medium subangular blocky; friable: earthworms present; pH 8.0; abrupt, smooth boundary.
IIBg	10-17	Light brownish gray (2.5Y 6/2M) to grayish brown (2.5Y 5/2M), heavy sandy loam with many distinct mottles of medium gray (2.5Y 6/1M) and light yellowish brown (10YR 6/4M); weak coarse prismatic; friable; pH 8.0; abrupt, irregular boundary.
IIC1g	17-48	Brown to dark brown (7.5YR 4/4M) sandy loam with distinct, common mottles of olive yellow (2.5Y 6/6M) and light brownish gray (2.5Y 6/2M); massive; very friable; pH 8.0; diffuse, smooth boundary.
IIC2g	48-60	Brown (7.5YR 4/4M) sandy loam with faint common mottles of olive yellow (2.5Y 6/6M) and light brownish gray (2.5Y 6/2M); very friable: massive; moderately calcareous.

Type location: S.E. 10 acres of S.W.¼, S.W.¼, Sec. 2, T.46N., R.1E., Chippewa County, Michigan.

Series Established: Chippewa County, Michigan, 1927.

Source of name: Township in Chippewa County, Michigan.

CHETEK SERIES (Soil map units 5, 6, 10, 14, 15, 16, 17, 18, 19, 22, 23)

General Description. The Chetek series includes droughtly shallow to moderately deep acid sandy loams and loams over acid sand and gravel.

Detailed Description. This series includes droughtly soils formed from 15 to 24 inches of loam to sandy loam material, with or without included gravel, over acid glacio-fluvial sand and gravel. Upper layers are silty locally. Original vegetation included northern hardwoods with white and red pine, hemlock, and balsam fir. These soils are classified as Gray-Brown Podzolic (Typic Hapludalf), with a tendency toward Podzol in Menominee County. The subsoil (B) begins at a depth of about a foot and continues downward a little more than a foot, with maximum contents of about 20% clay, 45% silt, and 0.5% organic matter. Associated soils are Pence, Padus, Onamia, Crivitz, Omega, Alban, Underhill, Kennan. Slopes range from 1% to 40%. Soil types are loams, sandy loams, and rarely silt loam. The following soil profile description represents the conditions in Menominee County.

Horizon	Depth, Inches	Description
01	2-1	Brown leaf mat: pH 6.5; abrupt, smooth boundary.
02	1-0	Very dark gray (5YR 3/1M) humus; fibrous; many roots; pH 5.0; abrupt, smooth boundary.
A2	0-5	Light brownish gray (10YR 6/2M) loam; weak medium platy to weak fine subangular blocky; pH 5.2; abrupt, wavy boundary.
A2 & B1	5-15	Brown (10YR 5/3M) loam with some infiltration of light brownish gray (10YR 6/2M) between peds; weak fine to medium subangular blocky; friable; pH 5.2; abrupt, smooth boundary.
B21	15-22	Brown (7.5YR 4/4M) heavy loam above to stony loam below; moderate medium subangular blocky; firm to friable; pH 5.5; abrupt, smooth boundary.
IIC	22-36	Yellowish brown (10YR 5/6M) stratified sand and gravel; loose; pH 5.5.

Type location: Barron County, Wisconsin.

Series Established: Langlade County, Wisconsin, 1947.

Source of name: Name of village, Barron County, Wisconsin.

CRIVITZ SERIES (Soil map units 7, 8, 9, 10, 17, 18, 19, 20, 21, 22)

General Description. The Crivitz (Figure 14) series includes deep, droughty, acid loamy sands of glacial uplands.

Detailed Description. This series includes fine sands, loamy fine sands, and light sandy loams formed under conditions of good to excessive natural drainage and aeration from acid glacio-fluvial and -lacustrine deposits. The parent material appears to have consisted originally of 15 to 30 inches of loamy fine sand overlying sand which may contain some gravel. The original vegetation included hardwoods, aspen, and some Hill's oak and jack pine. These soils are classified as weak Podzols (Entic Haplorthods). The subsoil (Bir) begins at a depth of about 4 inches and continues downward about two feet with maximum contents of about 7% clay, 10% silt, and 1% organic matter. Near the example given below, a faint sequum of A'2 and textural B horizons appeared in the lower part of the solum. Above the Bir horizon is a pale layer (A2); and a thin dark surface horizon (A1) may be present. Slope gradients range from 1% to 15%. Soil types included loamy sands and fine sandy loam. Associated soils include Onamia, Chetek, Pence, Omega, Underhill, Alban. The following soil profile was observed in the N.W.1/4, S.E.1/4, Sec. 8, T.28N., R.16E., Menominee County, Wisconsin, under cover of oak, aspen, and pine on an undulating outwash plain at a site having a 3% slope. Drainage was good, and the water table lay at a considerable, unknown depth. Aspect was to the south. There was no evidence of erosion.

Horizon	Depth, Inches	Description
01	2-1	Dark brown (7.5YR 4/2M) leaf mat; pH 5.5; abrupt, smooth boundary.
02	1-0	Dark reddish brown (5YR 2/2M) humus; pH 5.0; abrupt, smooth boundary.
A1	0-3	Very dark brown (10YR 2/2M) loamy fine sand with light gray (10YR 7/1,) quartz grains visible; weak fine granular; very friable; pH 4.8; abrupt, wavy boundary.
A2	3-4	Dark grayish brown (10YR-7.5YR 4/2M) loamy fine sand, with light gray (10YR 7/1M) quartz grains prominent; weak fine granular; very friable; pH 4.9: clear, wavy boundary.
Bir21	4-8	Dark brown (7.5YR 4/4M) loamy fine sand; weak fine subangular blocky to granular: very friable; pH 5.0; clear, wavy boundary.
Bir22	8-18	Brown to strong brown (7.5YR 5/4-5/6M) loamy fine sand; weak, medium subangular blocky; pH 5.0; clear, wavy boundary.
B'2	18-24	Strong brown (7.5YR 4/5M) heavy loamy fine sand; weak medium subangular blocky: friable; pH 5.8; gradual, wavy boundary.
B'3	24-33	Strong brown (7.5YR 5/6M) loamy fine sand; weak medium subangular blocky; very friable; pH 5.8; gradual, wavy boundary.
C1	33-40	Dark brown (7.5YR 4/4M) loamy sand; single grain; loose; pH 6.0; gradual, smooth boundary.
C2	40-50	Strong brown (7.5YR 5/6M) to yellowish red (7.5YR 6/6M) medium sand; single grain; loose; pH 5.8.

Type location: West 1/4 corner, Sec. 21, T.32N., R.20E., Marinette County, Wis.

Series proposed: Marinette County, Wisconsin, 1955.

Source of name: Small village in Marinette County, Wisconsin.

Crivitz, Loam Substratum variant. These soils differ from the usual Crivitz soils by the presence of a substratum of finer texture at a depth of three to four feet. They are associated with Underhill, Onaway, Alban soils. The following profile was observed in the N.E.1/4, N.W.1/4, Sec. 36, T.28N., R.15E., Menominee County, Wisconsin, on a 2% slope under a forest cover of white pine, yellow birch.

Horizon	Depth, Inches	Description
01	2-1½	Dark brown (7.5YR 4/2M) leaf mat; pH 5.5: abrupt, smooth boundary.
02	1-½-0	Dark reddish brown (5YR 2/2M) humus, pH 5.0; abrupt, smooth boundary.
A1	0-2	Black (5YR 2/1M) above, to very dark grayish brown (10YR 3/2M) below, loamy fine sand; moderate very fine to medium granular; friable; somewhat fragic below; many roots present; H 5.5; abrupt, wavy boundary.
A2	2-4	Dark brown (7.5YR 4/2-4/4M) loamy fine sand; massive to medium platy; somewhat fragic; many roots present; pH 6.0; abrupt, wavy boundary.
Bir1	4-9	Strong brown (7.5YR 5/6M) light fine to medium loamy sand; very weak medium angular to subangular blocky: loose to friable; many roots present; pH 6.0; clear, smooth boundary.
Bir2	9-15	Strong brown (7.5YR 5/6-5/8M) light fine to medium loamy sand; weak medium angular to subangular blocky; loose to friable; many roots; pH 6.0; clear, smooth boundary.
Bir3	15-20	Strong brown (7.5YR-5YR 5/8M) light fine to medium loamy sand; weak medium subangular blocky; some peds are somewhat fragic; roots rather numerous: pH 6.0; clear, smooth boundary.
Bir4	30-32	Yellowish red (5YR 5/6-5/8M) above to strong brown (7.5YR 5/8M) below, light sandy loam above to loamy medium sand below: somewhat fragic above to friable below; weak to moderate medium to coarse subangular blocky; roots present; pH 5.8; clear, smooth boundary.
C1	32-45	Reddish yellow to light yellowish brown (7.5YR-10YR 6/6M) loamy medium sand; very weak medium to coarse subangular blocky structure to loose; some yellowish red (5YR 5/8M) mottling; pH 6.0; clear, smooth boundary.
IIC2	45-62	Reddish brown (2.5YR 4/4-5/4M) loam to light silty clay loam; moderate medium coarse subangular blocky to very thick platy; yellowish red to red (5YR 5/8 to 2.5YR 4/6M) coatings on peds are patchy; friable: pH 6.0.

EMMERT SERIES (Soil map units 5, 22)

General Description. The Emmert series includes droughty stony, cobbly soils of ridges and steep hills of coarse glacial drift.

Detailed Description. This series includes stony, cobbly soils weakly developed in coarse acid glacial drift. The original vegetation included pine, hemlock, and northern hardwoods. These soils are classified as Regosols and weak Podzols (Spodic Udipsamment), and contain 20% to 80% stones and cobbles and gravel by volume. Slope gradients range from 10% to 40%. Soil types include loamy sands and sandy loams. Associated soils are Vilas, Pence, Omega, Crivitz, Iron River.

Horizon	Depth, Inches	Description
01	2-1	Leaf and needle litter.
02	1-0	Black (5YR 2/1M) humus.
A1	0-3	Black (10YR 2/1M) stony gravelly sandy loam; moderate to weak medium granular; friable between coarse fragments; pH 5.0; clear, wavy boundary.

A2	3-5	Brown (10YR 4/3-4/2M) stony, gravelly sandy loam; single grain; loose; pH 6.0: clear, wavy boundary.
Bhir	5-10	Dark brown (7.5YR 4/4M) stony, gravelly sandy loam to loamy sand; single grain: loose, pH 6.2; clear, wavy boundary.
C	10-20	Dark yellowish-brown (10YR 4/4M) stony cobbly sand and gravel; pH 6.0.

Type location: Mille Lacs County, Minnesota.
Series proposed: Mille Lacs County, Minnesota, 1927.
Source of name: Emmert Tower in St. Louis County, Minnesota.

FENCE SERIES (Soil map units 8, 9, 10, 17)

General Description. The Fence series includes naturally well-drained, deep acid medium-textured soils.

Detailed Description. This series includes soils formed from 18 to 42 inches in the normal phase and from 42 to 66 inches in the deep phase, of very fine sand and coarse silt overlying acid very fine sand, fine sand, sand and silt of glacio-lacustrine origin. Natural drainage and aeration have been good. The original vegetation included northern hardwoods and hemlock. These are bisequal soils (Alfic Haplorthod) with a Podzol solum overlying a Gray-Wooded or Gray-Brown Podzolic-like solum; both somewhat weakly developed. The Podzol B begins at a depth of about 2 inches and continues downward about 8 inches with maximum contents of about 18% clay, 45% silt, and 1% organic matter. Above this is a pale layer (A2) containing about 10% clay, 40% silt, and 3% organic matter. The clay contents of the lower sequum are about 10% for the A′2 and 20% for the B′2. Slope gradients are usually less than 4%. Soil types include silt loams and fine sandy loams. Associated soils include Alban, Crivitz, Underhill, Onamia, Chetek, and Pence. The following profile was observed in the center of Sec. 21, T.30N., R.16E., Menominee County, Wisconsin, on 3% convex slope under a forest cover of hemlock, beech and yellow birch. This particular profile is considered to be toward the coarse end of the textural range for this series.

Horizon	Depth, Inches	Description
011	4-3	Needle and leaf mat; pH 6.0; abrupt, smooth boundary.
012	3-0	Humus and decomposing twigs and leaves; roots numerous; pH 5.0; abrupt, smooth boundary.
A2	0-2	Brown (7.5YR 4/2M) fine sandy loam; very weak thick platy to very weak medium subangular blocky; friable to loose: roots numerous; pH 5.0; clear, smooth boundary.
Bhir1	2-5	Dark brown (7.5YR 4/2-4/4M) fine sandy loam; moderate medium platy to moderate fine subangular blocky; friable to loose; pH 5.5; roots present; clear, smooth boundary.
Bhir2	5-8	Brown (7.5YR 5/4M) loam; moderate fine subangular blocky, breaking to fine granular; friable; pH 5.5; roots present; clear; smooth boundary.
Bhir3	8-16	Brown (7.5YR 4/4M) loam; moderate medium subangular blocky to weak medium platy; friable; numerous roots; pH 4.8; abrupt, irregular boundary.
A′2	16-21	Brown (7.5YR 5/2-5/4M) sandy loam; moderate medium to coarse angular blocky; moderately vesicular; very friable; pH 4.9; abrupt, irregular boundary.
A′2 & B′2	21-25	The A′2 interfingers between the peds of the B′2.

B'2	25-39	Reddish brown (5YR 4/3M) loam; moderately coarse to medium angular blocky; some sandy coating of light brown (7.5YR 6/4M) and some clay skins of dark reddish brown (5YR 3/3M); very friable; pH 6.0; large roots penetrate to about 24 inches; clear, smooth boundary.
C1	39-55	Reddish brown (5YR 4/4M) medium sandy loam to loam; massive in place, breaking to moderate coarse angular blocky; very friable; pH 6.7; clear, smooth boundary.
C2	55-84	Reddish brown (5YR 4/3M) loamy medium and coarse sand; massive; very friable to loose; pH 7.5; abrupt, wavy boundary.
IIR	84+	Bedrock. (Note: 300 feet away from this profile crystalline bedrock was observed in outcrop at the surface.)

Type location: N.W.¼, N.W.¼, Sec. 26, T.40N., R.15E.
Series proposed: Florence County, Wisconsin, 1958.
Source of name: Village in Florence County, Wisconsin.

GOODMAN SERIES (Soil map units 1, 2, 3, 4)

General Description. The Goodman series includes naturally well-drained, moderately deep acid soils of medium texture overlying stony loam substratum.

Detailed Description. These soils developed under conditions of good drainage and aeration from 2 to 3½ feet of silty material overlying acid brown sandy loam to loam glacial till. The original vegetation was northern hardwood and hemlock forest. These soils are classified as minimal to medial Podzols developed in the deep A horizon of a texturally differentiated profile (Alfic Haplorthods). The subsoil (Bhir) begins at a depth of about 4 inches and continues downward about 7 inches with maximum contents of about 12% clay, 55% silt, and 2% organic matter. Above this B horizon is a paler silty horizon (A2) containing about the same amounts of silt and clay, but perhaps less organic matter than the B. Below the Podzol B is another paler horizon (A'2x) which is a very weak fragipan and contains about 10% clay, 50% silt, and 0.5% organic matter. This material extends into cracks between peds of the underlying horizon (B'2x). Slope gradients range from 2 to 20%. Soil types include fine sandy loam and silt loam. Associated soils include Norrie, Iron River, Kennan. The soil profile description given below illustrates the condition in Menominee County.

Horizon	Depth, Inches	Description
011	3-1	Leaf litter.
012	1-0	Reddish gray (5YR 5/2M) somewhat decomposed leaf litter; pH 5.5; abrupt, smooth boundary.
A2	0-3	Gray (5YR 5/1M) silt loam; very weak thin platy: many fibrous roots; friable: pH 5.0; abrupt, smooth boundary.
Bhir	3-7	Yellowish red (5YR 5/6M) silt loam; very weak medium and fine subangular blocky; friable; many fine roots; pH 5.0; clear, smooth lower boundary.
Bir	7-10	Brown (7.5YR 4/4M) silt loam; weak medium subangular blocky: friable; pH 5.0; clear, smooth boundary.
A'2x	10-15	Grayish brown (10YR 5/2M) silt loam; weak medium subangular blocky above to weak thin platy below; somewhat fragic; pH 5.0; abrupt, smooth boundary.
I, II, B'2x	15-26	Brown (7.5YR 5/4M) to dark brown (7.5YR 4/4M) stony heavy silt loam; strong medium angular blocky; pinkish gray (7.5YR 6/2M) bleached silt coatings on ped faces to a depth of about 20 inches fragic; pH 5.0; clear, smooth boundary.

IIC	26-50	Brown (7.5YR 5/4M) gravelly stony sandy loam; weak medium subangular blocky; friable; pH 5.8.

Type location:	N.E.¼, N.W.¼, Sec. 26, T.37N., R.19E., Marinette County, Wis.
Series proposed:	Marinette County, Wisconsin, 1954.
Source of name:	Village in Marinette County, Wisconsin.

GRANITIC ROCKLAND (Soil map unit No. 23)

General Description. This miscellaneous land unit includes outcrops of granite-like bedrock and associated patches of soil (Figure 19) ranging in depth from less than an inch to more than 10 feet.

Detailed Description. This is not a soil, but is a miscellaneous land type consisting largely of glacially-smoothed rock outcrops of metamorphic and igneous Precambrian rocks associated with Onamia, Padus, Cheteck, Pence loams and sandy loams, Crivitz and Omega loamy sands. Granitic Rockland is located chiefly along the Wolf River and some of its tributaries in central and northeastern parts of the county. A sequence of conditions is displayed: bare rock freshly exposed by exfoliation; somewhat disintegrated bare rock; lichens-encrusted rock; thin soil (Hole *et al,* 1962) about 3 inches thick consisting of rock debris and residues from moss, grass, and small shrubs; trees, such as white pine, growing in fillings of soil in enlarged joints and cracks in the bedrock; soils developed from glacial drift and aeolian deposits shallow (less than 3 feet thick) over bedrock; soils developed from thicker deposits lying between bedrock masses.

IRON RIVER SERIES (Soil map units 1, 2, 3, 4)

General Description. The Iron River series includes deep, naturally well-drained, acid somewhat stony medium textured soils of rolling glacial uplands.

Detailed Description. This series includes well-drained soils formed under northern hardwood, white and red pine, and balsam fir forest vegetation on undulating to rolling acid sandy glacial till, which may have a silty covering as much as 2 feet thick. These soils are classified as medial Podzols with a weakly developed lower sequum (Alfic Haplorthod). The subsoil (Bhir) begins at a depth of about 4 inches and continues downward nearly a foot with maximum contents of about 10% clay, 50% silt, and 3% organic matter. All or part of this horizon is developed in glacial till or admixtures of till and aeolian silty material, and is more strongly developed in loam and sandy loam material than in silt loam. Above this horizon is a bleached layer (A2) with a somewhat lower content of organic matter. Below the Podzol solum is a weakly developed Gray-Brown Podzolic-like sequum consisting of a pale, platy horizon (A'2x) over a weak textural B horizon (B'2x). Slope gradients are from 2 to 20%. Soil types include silt loam, loam, sandy loams. The following soil profile was observed in the N.W.¼, N.W.¼, Sec. 27, T.30N., R.14E. on a 3% convex slope of eastern aspect, under a cover of maple, yellow birch, basswood, grass and small shrubs.

Horizon	Depth, Inches	Description
01	2-1	Dark reddish brown (5YR 3/2M) maple leaf and twig litter; abrupt, smooth boundary.
02	1-0	Very dark gray (10YR 3/1M) humus.
A1	0-2	Black (10YR 2/1M) silt loam; many fine roots; very friable; pH 4.5; abrupt, smooth boundary.
A2	2-5	Reddish gray (5YR 5/2M) silt loam: coarse moderate platy to moderate, medium angular blocky; friable; pH 5.3; abrupt, smooth boundary.

Bhir	5-7	Reddish brown (5YR 5/4M) silt loam; weak to moderate medium platy to weak medium angular blocky: friable; pH 5.4; abrupt, smooth boundary.
Bir	7-10	Brown (7.5YR 5/4M) silt loam containing some gravel; moderate medium subangular to angular blocky; pH 5.5; abrupt, smooth boundary.
A'2x	10-16	Pale brown (10YR 6/3/M) silt loam containing some gravel; moderate, medium angular blocky; firm, fragic; vesicular; pH 5.5; abrupt, irregular boundary.
B'2x	16-21	Brown (7.5YR 5/4M) gravelly silt loam: moderate medium angular blocky; firm: fragic; vesicular; pH 5.3; abrupt, smooth boundary.
IIB3	21-27	Reddish brown (5YR 4/3M) stony heavy loamy sand; massive; very weak medium subangular blocky; very friable; pH 5.4; abrupt, smooth boundary.
IIC1	27-50	Reddish brown (5YR 4/3M) gravelly loamy sand; massive; very friable; pH 5.5; abrupt, smooth boundary.
IIIC2	50-84	Dark brown to brown (10YR-7.5YR 4/3M) stony loamy sand; massive: very friable; pH 5.8.

Type location: S.W. corner, Sec.28, T.36N., R.13E., Forest County, Wis.

Series established: Town of Iron River, Iron County, Michigan, 1930.

Source of name: Town of Iron River, Iron County, Michigan.

KENNAN SERIES (Soil map units 1, 2, 3, 4, 5)

General Description. The Kennan series includes deep, naturally well-drained, stony medium-textured soils of rolling glacial uplands.

Detailed Description. This series includes well drained soils formed under forest vegetation on undulating to rolling acid, sandy glacial till with silt covering locally as much as 20 inches thick. The original vegetation included northern hardwoods with some hemlock and pine. These soils are classified as weakly developed Gray-Brown Podzolic soils (Typic Hapludalfs) with some tonguing of the A2 horizon down into the B in places (Glossoboralfic Hapludalfs). Colors approaching those of a Podzol sequum appear in the upper solum of some profiles. The subsoil (B2) horizon begins at about 10 inches and continues downward about 1½ feet with maximum contents of 15% clay, 40% silt and 0.2% organic matter. All of this horizon is formed from glacial till. Above this horizon is a paler layer (A2). Sandy loam, loam and silt loam types are found. Associated soils include Iron River, Goodman, Norrie. Slopes range from 2 to 40%. The following profile was observed in the center of Sec. 11, T.29N., R.13E., under a forest of hard maple, oak, basswood, balsam fir, with grasses and herbs as ground cover. The slope was 4%.

Horizon	Depth, Inches	Description
01	½-0	Brown (7.5YR 4/2-4/4M) leaf litter; pH 7.0; abrupt, smooth boundary.
A1	0-3½	Very dark gray (5YR 3/1M) loam with some cobbles; weak coarse to medium granular; roots numerous: very friable; pH 4.6; abrupt, smooth boundary.
A2	3½-9	Dark grayish brown (10YR 4/2M) loam with some cobbles; moderate medium to coarse angular blocky: friable; pH 5.0; clear, smooth boundary.

B21	9-15	Dark brown (7.5YR 4/2-4/3M) loam with some cobbles; 10% by volume of pebbles about 1 inch in diameter; grayish brown (10YR 5/2-6/3M) coatings on peds; weak, medium angular blocky; vesicular: friable; pH 4.5; clear, smooth boundary.
B22	15-20	Dark brown (10YR 4/3M) sandy loam with some cobbles; about 15% gravel by volume; weak; medium angular blocky; very friable; pH 5.7; abrupt, smooth boundary.
B3	20-26	Brown (7.5YR 4/4M) coarse gravelly sandy loam with some cobbles; 30% gravel by volume; moderate medium subangular blocky; some dark reddish brown (5YR 3/4M) clay skins are present; friable to loose; pH 5.8; abrupt, smooth boundary.
C	26-62	Brown (7.5YR 5/4M) gravelly sandy loam with some cobbles; 50% gravel by volume; weak, medium subangular blocky; very friable; pH 5.8.

Type location: N.W.¼, N.W.¼, Sec. 25, T.28N., R.9E., Marathon County, Wis.

Series established: Langlade County, Wisconsin, 1947.

Source of name: Village in Price County, Wisconsin.

NORRIE SERIES (Soil map units 1, 2, 3, 4)

General Description. The Norrie series includes naturally well-drained, moderately deep to deep acid soils of medium texture overlying stony sandy loam substratum.

Detailed Description. These soils developed under conditions of good drainage and aeration from 20 to 40 inches of silty material overlying acid, brown sandy loam glacial till which contains igneous and metamorphic rock material but little or no limestone. The original vegetation was northern hardwood forest with some hemlock and balsam fir. These soils are classified as Gray-Brown Podzolic, but show characteristics transitional to Podzol or Gray-Wooded in colors of A2 and upper B, and in tonguing of the A2 into the B (Glossoboralfic Hapludalf). The textural B horizons begins at a depth of 12 to 18 inches and continues downward about 2 feet with maximum contents of about 30% clay, 65% silt, and 0.8% organic matter. The upper portion, if not all of the B horizon is developed in silty material. There is one soil type, the silt loam. Slope gradients range from 2 to 20%. Associated soils include Goodman, Kennan, and Iron River. The following soil profile was observed in Sec. 18, T.29N., R.13E., Menominee County, Wisconsin, on 2% slope under a forest cover of maple, basswood and elm trees.

Horizon	Depth, Inches	Description
011	1-¼	Pink (7.5YR 8/4M) leaf litter, predominantly maple; abrupt, smooth boundary.
012	¼-0	Very dark brown (10YR 2/2M) decomposing leaf litter; pH 7.0; abrupt, smooth boundary.
A1	0-4	Black (10YR 2/1M) silt loam with white quartz grains apparent; very weak medium subangular blocky breaking to very weak, very fine granular; very friable; pH 5.7; many fine roots present; clear, smooth boundary.
A21	4-6	Grayish brown (10YR 5/2M) silt loam; weak medium to fine granular; very friable; pH 4.8; clear, wavy boundary.
A22	6-12	Light brownish gray (10YR 6/2M) silt loam; weak, coarse platy; vesicular; very friable; pH 5.0; clear, smooth boundary.
A22 & B1	12-19	Pinkish gray (7.5YR 6/2M) silt loam with moderate coarse platy structure, and somewhat fragic consistence, tonguing down between peds of the B1 horizon which consists of a dark brown (7.5YR 4/4M) silt loam with 15% by volume of gravel, and with a fine

		angular block structure, slightly fragic consistence; pH 5.1; clear, smooth boundary.
B2	19-37	Brown (7.5YR 4/3M) heavy silt loam with 15% by volume of gravel; moderate coarse to medium irregular platy breaking to weak fine subangular blocky; somewhat vesicular; firm; pH 5.0; clear, smooth boundary.
IIB3	37-41	Brown (7.5YR 4/4M) loam: weak, coarse subangular blocky; firm; pH 5.0; clear, smooth boundary.
IIC	41-50	Brown (7.5YR 4/4M) sandy loam to loamy sand with stones; weak coarse subangular blocky; slightly firm; pH 5.0.

Type location: N.W.¼, S.W.¼, Sec. 26, T.30N., R.11E., Langlade County, Wis.

Series proposed: Marathon County, Wisconsin, 1955.

Source of name: Small village, Marathon County, Wisconsin.

OMEGA SERIES (Soil mp units 20, 21, 23)

General Description. The Omega series includes very droughty, deep acid sands.

Detailed Description. This series includes droughty soils developed from acid glaciofluvial sands, both level and rolling. Original cover was largely jack pine and Hill's oak with prairie vegetation between the trees. These soils have been classified as sandy Regosols (Spodic Udipsamments) intergrading to minimal Podzols. Regosols have no B horizon; minimal Podzols do. The subsoil (Bhir) is stained brown and begins at a depth of about 3 inches and continues downward a little more than a foot with maximum contents of about 4% clay, 10% silt, and 0.5% organic matter. Above this horizon are darker sandy layers (A1 or mixed A1, A2, and A3 with about the same contents of clay and silt, but with as much as 10% organic matter near the surface. A weakly developed pale horizon (A2) may appear just above the Bir horizon. Soil types are sand and loamy fine sand. Associated soils are Vilas, Crivitz, Chetek, Pence, Onamia, Padus. Slopes range from 1 to 40%. The following soil profile description was observed in a jack pine grassland in the N.E.¼, S.W.¼, Sec. 2, T.28N., R.16E.

Horizon	Depth, Inches	Description
011	1½-½	Dark brown (10YR 4/3M) leaf and grass litter; pH 6.0.
012	½-0	Dark brown leaf and grass litter, somewhat decomposed; pH 5.5; abrupt, wavy boundary.
A1	0-3	Very dark brown (10YR 2/2M) loamy sand sprinkled with light gray (10YR 7/2M) quartz grains; weak medium granular to fine subangular blocky; very friable; many fibrous roots; pH 4.7; clear, wavy boundary.
Bhir	3-10	Brown (7.5YR 4/4M) loamy sand; weak medium granular to subangular blocky; very friable; many roots; pH 5.7; gradual wavy boundary.
Bir	10-21	Strong brown (7.5YR 5/6M) sand; weak medium and fine subangular blocky to granular; very friable; many roots; pH 5.5; gradual wavy boundary.
B3	21-27	Reddish yellow (7.5YR 6/6M) sand; very weak fine subangular blocky to granular; very friable; some roots present; pH 6.0; gradual wavy boundary.
C1	27-39	Light brown (7.5YR 6/5M) sand; single grain; loose; pH 6.5; diffuse wavy boundary.
C2	39-45	Pink (7.5YR 7/4-6/4M) sand; single grain; loose; pH 6.5.

Type location: Cloquet Forest Exper. Station, Carleton County, Minnesota.

Series established:	Iron County, Michigan, 1930.
Source of name:	Village, St.Louis County, Minnesota.

ONAMIA SERIES (Soil map units 5, 6, 10, 11, 12, 13, 14, 15, 16, 22, 23)

General Description. The Onamia series includes moderately deep, naturally well-drained acid loams and sandy loams over deep sand and gravel.

Detailed Description. This series includes well-drained soils developed from 24 to 42 inches of loam to sandy loam material over acid sand and gravel of glacial outwash. The original vegetation included northern hardwoods with some hemlock and white and red pines. These soils are classified as Gray-Brown Podzolic soils with slight development of tonguing of the A2 down into the B (Typic Hapludalf). The subsoil (B2) horizon begins at a depth of about a foot and continues downward a little more than a foot, with maximum contents of about 20% clay, 45% silt, and 0.5% organic matter. Associated soils are Padus, Chetek, Pence, Underhill, Alban, Crivitz, Kennan, Emmert. Slopes range from 1 to 40%. Soil types are loam and sandy loam, and, less commonly, silt loam. The following profile was observed in the N.W.¼, N.E.¼ Sec. 1, T.29N., R.13E. on a 2% east-facing slope under a forest cover of elm, maple, basswood and aspen.

Horizon	Depth, Inches	Description
01	3-1½	Dark reddish brown (5YR 3/2M) leaf mat; pH 6.5; abrupt, smooth boundary.
02	1½-0	Very dark gray (5YR 3/1M) humus; fibrous; many roots; pH 5.0; abrupt, smooth boundary.
A2	0-5	Light brownish gray (10YR 6/2M) to brown (10YR 5/3M) loam; weak medium platy to weak fine subangular blocky; friable; pH 5.2; abrupt, wavy boundary.
A2 & B1	5-14	Brown (10YR 5/3M) loam with some coatings of light brownish gray (10YR 6/2M) material on ped surfaces; weak fine to medium subangular blocky; friable; pH 5.2; abrupt, smooth boundary.
B21	14-24	Brown (7.5YR 4/4M) to dark yellowish brown (10YR 4/4M) heavy loam; moderate medium subangular blocky; firm to friable; pH 5.5: abrupt, wavy boundary.
B22	24-28	Brown (7.5YR 4/4M) stony loam; weak coarse platy to moderate medium subangular to angular blocky: firm to friable; pH 5.5; abrupt, wavy boundary.
IIC	28-36	Yellowish brown (10YR 5/6M) to brown (7.5YR 4/4M) stratified sand and gravel; loose; pH 5.5.

Type location:	S.E.¼, S.E.¼, Sec. 29, T.44N., R.84W., Crow Wing County, Minnesota.
Series established:	Mille Lacs County, Minnesota, 1927.
Source of name:	Town, Mille Lacs County, Minnesota.

PADUS SERIES (Soil map units 5, 6, 11, 12, 13, 14, 15, 16, 22, 23)

General Description. The Padus series includes naturally well-drained moderately deep acid loams and sandy loams over deep sand and gravel.

Detailed Description. This series includes naturally well drained soils developed from 24 to 42 inches of loam to sandy loam material over acid sand and gravel outwash. The original vegetation included northern hardwoods with some hemlock and balsam fir. These soils are classified as medial Podzols with bisequa, that is with a Gray-Brown Podzolic-like solum under the Podzol solum (Alfic Haplorthods). The subsoil

(Bhir) begins at a depth of about 4 inches and continues downward about a foot, with maximum contents of about 12% clay, 45% silt, and 2% organic matter. Above this horizon is a pale layer (A2) with a somewhat lower organic matter content. Below the Podzol solum a brown vesicular layer (A′2x) and underlying reddish brown horizon (B′2x) comprise the Gray-Brown Podzolic-like solum. The B′2x horizon may contain as much as 18% clay, 45% silt, and 0.3% organic matter. Slope gradients range from 1 to 40%. Soil types include loam and sandy loams. Associated soils include Pence, Stambaugh, Onamia, Chetek, Crivitz, Kennan. The following soil profile was observed in the center of Sec. 6, T.30N., R.14E., Menominee County, Wisconsin, under a forest cover of maple, elm, spruce. Roots extended to the upper surface of the fragipan (x horizon).

Horizon	Depth, Inches	Description
01	2-1	Pinkish gray (7.5YR 6/2M) leaf and needle litter; pH 6.0; abrupt, smooth boundary.
02	1-0	Very dusky red (2.5YR 2/2M) decomposing organic matter; many small roots; pH 6.5; abrupt, smooth boundary.
A2	0-5	Reddish gray (5YR 5/2M) sandy loam; very weak, medium granular blocky; very friable: pH 5.0; abrupt, smooth boundary.
Bhir	5-13	Reddish brown (5YR 4/4M) sandy loam; weak, medium angular blocky; friable; pH 5.1; abrupt, smooth boundary.
Bir	13-18	Brown (7.5YR 4/4M) sandy loam; very weak fine angular blocky; friable; pH 5.1; abrupt, smooth boundary.
A′2x	18-25	Brown (7.5YR 5/3M) loamy sand to sandy loam: strong medium angular blocky; slightly vesicular; firm, shattering under pressure (fragic); pH 5.0; abrupt, smooth boundary.
B′2x	25-32	Reddish brown (5YR 4/3M) sandy loam with some tongues of A′2x extending into the upper part of the horizon; strong, medium angular blocky structure, with some dark red (2.5YR 3/6M) cutans on ped surfaces in lower part of the horizon; very firm; fragic; pH 5.2; abrupt, smooth boundary.
IIC	32-100	Yellowish red (5YR 4/6 M) above to brown (7.5YR 5/4M) below loamy sand with 10 to 15% gravel by volume: weak, coarse angular blocky structure above to loose below; pH 5.5 above to 6.0 below; abrupt, smooth boundary.

Type location: S.W.¼, Sec. 17, T.28N., R.13E., Shawano County, Wisconsin.
Series proposed: Forest County, Wisconsin, 1960.
Source of name: Railroad Station, Forest County, Wisconsin.

PEAT (Soil map units 24, 25)

General Description. The term peat is a general one for organic soils more than about one foot thick which contain recognizable plant fragments, and which accumulate under very poor drainage and aeration conditions.

Detailed Description. Peat soils contain more than 30% organic matter, and usually 70% to 90% organic matter containing abundant recognizable plant fragments. These soils are classified as Bog soils (Histosols). Five soil series are illustrated by soil profile descriptions given below, and are characterized briefly as follows: (1) The Adrian series includes fibrous peats and mucks 18 to 42 inches deep over sand, developed under a cover of sedges, reeds, and grasses. Acidity is not extreme. (2) The Greenwood series includes mossy, fibrous and woody peats which are quite acid and more than 5 feet deep, developed under sphagnum moss, leatherleaf, and scattered alder and spruce trees. (3) The Linwood series includes soils similar in character and vegetation to the Tawas, but overlying loam instead of sand. (4) The Spalding series (Figure 11) includes quite acid mixed fibrous and woody peats which are more than 5 feet deep, developed under spruce, tamarack, tag alder, leatherleaf, and sphagnum. (5) The Tawas series includes mixed fibrous and woody peats 18 to 42 inches deep over sand, developed in bogs under a cover of white cedar, and associated swamp conifers and hardwoods, with ground cover of sedges and ferns. These soils are not extremely acid. Classification of peats involves a consideration of the nature and sequence of the various organic layers, deposited by a succession of locally rather complicated plant communities (Hole and Schmude, 1959).

Adrian peat. The following profile description of Adrian peat (Figure 22) was observed in the N.E.¼, N.W.¼, N.W.¼, Sec. 14, T.28N., R.16E., Menominee County, Wisconsin, in a sedge bog.

Horizon	Depth, Inches	Description
1	1-½	Pale olive to brown sphagnum moss layer (5Y 6/3M to 10YR 4/3M) ; pH 6.0; abrupt, smooth boundary.
2	½-0	Dark brown (5YR-7.5YR 3/2M) matted, platy coarse sedge litter; pH 5.0; abrupt, smooth boundary.
3	0-3	Dark reddish brown to black (5YR 2/1M) very coarse fibrous peat, bound with sedge roots; pH 5.0; abrupt, smooth boundary.
4	3-11	Dark reddish brown (5YR 3/2M) moderately coarse fibrous peat with vertical roots; moderate coarse platy: pH 5.0; abrupt, smooth boundary.
5	11-14	Dark reddish brown (5YR 2/2M) muck with streaks of clear quartz grains and some fragments of sedge remains; massive to weak platy: vertical sedge roots present; pH 5.0; abrupt, smooth boundary.
6	14-15	Black (5YR 2/1M) muck with many gray quartz grains (5YR 6/1M) presumably aeolian from near-by sandy soils; massive to weak platy; pH 5.0; abrupt, smooth boundary.
7	15-27	Black (5YR 2/1M) muck with a few scattered quartz grains; vertical roots and fragments of sedge present; massive breaking to weak medium platy and weak medium subangular blocky; pH 5.0; abrupt, smooth boundary.
IIC1	27-30	Brown (7.5YR 4/3M) medium sand; vertical sedge roots present; pH 5.0: clear, smooth boundary.
IIC2	30-48	Very dark gray (7.5YR 3/1M) above to dark grayish brown (7.5YR 3/2M) below medium sand, with spots and streaks of black organic matter; pH 6.0.

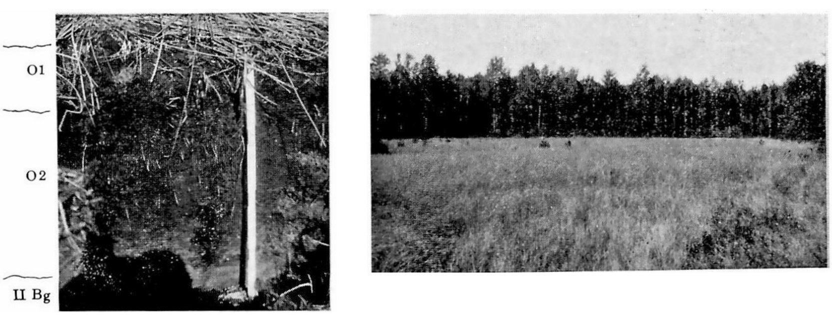

Figure 22. This is a profile and landscape of Adrian peat, acid variant, under sedge vegetation (unit 25 on the soil map).

Type location:	Arenac County Michigan.
Series proposed:	Arenac County Michigan.
Source of name:	City in Lenawee County, Michigan.

Greenwood peat. The following profile description of Greenwood peat (Figure 11) was observed in the N.E.¼, N.W.¼, Sec. 14, T.28N., R.16E.

Horizon	Depth, Inches	Description
1	0-10	Sphagnum moss pillow half burying leatherleaf plants; some sedges present; pH 4.4; abrupt, smooth boundary.
2	10-11	Dark reddish brown (5YR 2/2M) coarse fibrous moss and matted peat interlaced with tough roots of leatherleaf and fibrous roots of sedge; pH 4.4; abrupt, smooth boundary.
3	11-15	Dark brown (7.5YR 4/3M) coarse fibrous and mossy peat, bound with roots; pH 4.5; abrupt, smooth boundary: some streaks of quartz sand present, presumably aeolian from near-by sandy soils.
4	15-31	Very dark brown (10YR-7.5YR 2/2M) finely fibrous peat with numerous vertical sedge roots; pH 4.5; abrupt, smooth boundary.
5	31-44	Dark reddish brown (5YR 3/2M) finely fibrous mucky peat with fragments of decomposing sedge: massive; pH 4.5; abrupt, smooth boundary.
6	44-71	Very dark brown (10YR-7.5YR 2/2M) finely fibrous peat with remains of sedge; massive; pH 4.5 above to 5.5 below. A boring made to a depth of 10 feet was still in organic material.

Type location:	N.E.¼, S.W.¼, Sec. 5, T.37N., R.3W., Cheboygan County, Mich.
Series established:	Ogemaw County, Mich., 1923.
Source of name:	Railroad siding, Ogemaw County, Michigan.

Linwood peat. The following profile description of the Linwood peat was observed in the N.W. corner of Sec. 29, T.30N., R.14E.

Horizon	Depth, Inches	Description
	3-2	Live green moss.
1	2-1	Dark reddish gray (10R 3/1-3/2M) and dusky red (10R 3/3M) decomposing moss; many roots present: pH 5.0; abrupt, smooth boundary.
2	1-0	Reddish black (10R 2/1M) decomposing moss with weak red (10R 4/3M) decomposed wood; many roots present; pH 5.0; abrupt, smooth boundary.
3	0-6	Black (5YR 2/1M) mucky peat; soft; breaks into weak coarse angular blocks; no apparent stratification; roots present; pH 5.5; clear, smooth boundary.
4	6-12	Black (5YR 2/1M) mucky peat; roots present; more coherent and sticky than overlying horizon; pH 6.0; clear; smooth boundary.
5	12-24	Reddish black (10R 2/1M) and black (10YR 2/1M) to reddish brown (2.5YR 5/4M) mucky peat with wood fragments; massive; pH 5.8; clear, smooth boundary.
6	24-30	Very dusky red (2.5YR 2/2M) fibrous mucky peat, pH 6.5; clear, smooth boundary.
7	30-36	Very dusky red (2.5YR 2/2M) peaty muck with some fine woody fragments; massive: pH 6.5; abrupt, smooth boundary.
IIC	36-42	Grayish-brown (10YR 5/2M) loam; massive to single grain; pH 7.0.

Type location.	Arenac County, Michigan.

Series established:	Sanilac County, Michigan, 1955.
Source of name:	Town in Bay County, Michigan.

Spalding peat. The following profile description of the Spalding peat was observed in the N.E.¼, S.E.¼, Sec. 7, T.30N., R.16E.

Horizon	Depth, Inches	Description
1	3-0	Brown (10YR 5/3M) dead sphagnum moss; pH 5.0; many roots; abrupt, wavy boundary.
2	0-6	Dark reddish brown (5YR 3/2M) very coarse fibrous peat; many roots; pH 5.0; clear, wavy boundary.
3	6-24	Dark reddish brown (5YR 2/2M) mucky fibrous peat; pH 5.0; clear, smooth boundary.
4	24-36	Dark reddish brown (5YR 2/2M) mucky fibrous peat: pH 5.0; abrupt, smooth boundary.
5	36-42	Very dusky red (2.5YR 2/2M) with brown (7.5YR 5/4M) fragments; mucky fibrous peat; pH 4.5; abrupt, smooth boundary.
6	42-48	Very dark brown (7.5YR 2/2M) fibrous peat with pockets of reddish brown (5YR 4/3M) woody peat; pH 5.0; abrupt, smooth boundary.
7	48-54	Black (5YR 2/1M) muck; pH 6.0; abrupt, smooth boundary.
8	54-60	Very dark gray (10YR 3/1M) silty muck; pH 6.0; abrupt, smooth boundary.
IIC	60-84	Light olive brown (5Y 6/2M) above to grayish brown (10YR 5/2-5/1M) below silt loam to very fine sandy loam; pH 6.5 above to 8.0 at 72 inches.

Type location:	Chippewa County, Michigan.
Series established:	Chippewa County, Michigan 1927.
Source of name:	Village in Chippewa County, Michigan.

Tawas mucky peat. The following profile of Tawas mucky peat was observed in a cedar bog in the S.E. corner of Sec. 34, T.29N., R.14E., Menominee County, Wisconsin on a 1% slope.

Horizon	Depth, Inches	Description
1	½-0	Reddish brown (5YR 4/3M) to dark reddish brown (5YR 3/2-2/2M) needle litter; pH 4.5 to 8.0; abrupt, smooth boundary.
2	0-4	Very dusky red (2.5YR 2/2M) fibrous mucky peat, very full of roots; somewhat layered in the upper part; pH 5.0 to 8.0; clear, smooth boundary.
3	4-6	Black (5YR 2/1M) mucky peat; fibrous; many roots present; many fragments of charcoal present; fragments of light reddish brown (5YR 6/3M) rotting wood present; pH 8.0; clear, smooth boundary.
4	6-11	Very dark gray (5YR 3/1M) peaty muck; soft; weak, thick to very thick platy and weak very coarse to medium blacky; pH 8.0; clear, smooth boundary.
5	11-22	Dark reddish brown (5YR 3/2M) mucky peat; massive, breaks to weak medium prismatic and weak very coarse to medium blocky; weak thick platy and weak fine granular; pH 8.0; clear, smooth boundary.
6	22-36	Black (5YR 2/1M) peaty muck; breaks to weak medium angular blocky and weak medium granular; soft; wood fragments about ½ inch long are numerous at the bottom; pH 8.0; abrupt, smooth boundary.

IIC	36-42	Light gray to gray (5YR 6/1M) medium to fine sand; massive; pH 8.0.
Type location:		N.E.¼, N.E.¼, Sec. 7, T.19N., R.6E., Arenac County, Michigan.
Series established:		Sanilac County, Michigan, 1955.
Source of name:		Town in Iosco County, Michigan.

PENCE SERIES (Soil map units 5, 6, 10, 14, 15, 16, 17, 18, 19, 22, 23)

General Description. The Pence series (Figure 2) includes naturally well-drained shallow to moderately deep acid loam and sandy loam material over deep sand and gravel.

Detailed Description. This series includes naturally well-drained, somewhat droughty soils formed from 15 to 24 inches of loam to sandy loam material, with or without gravel, over acid glacio-fluvial sand which usually contains 15% or less of gravel by volume. Upper layers are silty locally. Original vegetation included northern hardwoods with hemlock, balsam fir, white and red pine. These soils are classified as medial Podzols (Typic Haplorthods). The subsoil (Bhir) begins at a depth of about 3 inches and continues downward for about 2 feet with maximum contents of about 10% clay, 40% silt, and 1.5% organic matter. The lower part of the B horizon may be weakly fragic. Above the B horizon is a shallow, somewhat paler layer (A2). Slope gradients range from 1 to 40%. Soil types include loam and sandy loams. Small bodies of Pence loamy sands and silt loams occur in the county. Associated soils include Chetek, Padus, Stambaugh, Antigo, Crivitz, Omega, Onamia. The following soil profile was observed under a hemlock-hardwood stand in the S.E. corner of Sec. 34, T.29N., R.14E. on a 3% slope.

Horizon	Depth, Inches	Description
01	2-1	Very dark gray (5YR 3/1M) leaf mat; pH 5.5-6.5; abrupt, smooth boundary.
02	1-0	Black (5YR 2/1M) humus; fibrous; many roots present; pH 5.3; abrupt, smooth boundary.
A2	0-3	Brown (7.5YR 5/2-4/2M) sandy loam; weak medium granular; many roots present; very friable to loose; pH 5.0; abrupt, smooth boundary.
Bhir	3-11	Brown (7.5YR 4/4M) heavy sandy loam; 10% by volume of gravel in the lower part of this horizon; weak medium to fine subangular blocky; many roots present; very friable; pH 5.0; clear, smooth boundary.
I & II Bir	11-22	Brown (7.5YR 4/4M) sandy loam to loamy sand; nearly 20% gravel by volume; single grain to very weak medium angular blocky; slightly fragic in spots; very friable to loose; pH 5.6; abrupt, smooth boundary.
IIB3	22-27	Reddish brown (5YR 4/4M) loamy coarse sand and (40% gravel by volume); single grain; loose; pH 5.0; abrupt, smooth boundary.
IIC	27-36	Brown (7.5YR 5/4M) sand and gravel with some reddish brown (5YR 5/5M) horizontal bands; very weak medium subangular blocky structure; very friable to loose; pH 6.0; clear, smooth boundary.
Type location:		S.E.¼, S.E.¼, Sec. 31, T.40N., R.1W., Price County, Wisconsin.
Series established:		Bayfield County, Wisconsin, 1958.
Source of name:		Village in Iron County, Wisconsin.

ROSCOMMON SERIES (Soil map units 6, 7, 8, 9, 10)

General Description. The Roscommon series includes wet sands which are neutral or even limey in the substratum.

Detailed Description. This series includes soil formed under conditions of poor drainage from sands and coarse sandy loams of neutral to calcareous glacial drift. Some fine gravel may be present in the substratum. The original vegetation included tag alder, tamarack, gray dogwood, willow, and sedges. These soils are classified as Low Humic-Gley soils (Typic Haplaquept). The subsoil (A3 and Cg horizons) begins at a depth of about 5 inches and contains a maximum of about 10% clay and 10% silt. The overlying dark horizon (A1) contains about 15% organic matter, and muck layer (02) containing more than 30% organic matter overlies that. Upper horizons are typically acid, but may be neutral as a result of drainage from surrounding slopes. Slope gradients are usually less than 2%. Soil types include loamy fine sand, fine sand, and sand. Light sandy loams occur inextensively. Associated soils include Crivitz, Underhill, Alban. The following soil profile was observed in September, 1962, in the S.W.¼, S.W.¼, Sec. 4, T.28N., R.16E., on a 1% slope at the edge of a peat bog. The water table stood at a depth of 3 feet.

Horizon	Depth, Inches	Description
01	6½-6	Mat of hardwood leaves, twigs, petioles.
02	6-0	Black (10YR 2/0M) muck with many light gray (10YR 7/1M) bleached sand grains; moderate fine granular; very friable; pH 6.5; abrupt, wavy boundary.
A11	0-5	Very dark gray (10YR 3/1M) loamy sand with light gray (10YR 7/1M) sand grains; weak coarse subangular blocky to weak medium granular; very friable; pH 7.5; clear, wavy boundary.
A12	5-11	Dark gray (10YR 4/1M) mottled dark grayish brown (2.5Y 4/2M) medium sand; single grain; loose; pH 7.5; clear, wavy boundary.
C1g	11-17	Grayish brown (10YR 5/2M) medium sand with a few weak fine yellowish brown (10YR 5/6M) mottles; single grain; loose; pH 7.5; gradual, wavy boundary.
C2g	17-36	Grayish brown (10YR 5/2M) medium sand; mottled with brown (10YR 5/3M) and very pale brown (10YR 7/4M); single grain; loose; pH 7.5.

Type location: Arenac County, Michigan.
Series established: Sanilac County, Michigan.
Source of name: Arenac County, Michigan.

STAMBAUGH SERIES (Soil map units 11, 12, 13)

General Description. The Stambaugh series includes naturally well-drained moderately deep acid soils of medium texture underlain by sand and gravel.

Detailed Description. This series includes soils developed under conditions of good natural drainage and aeration from 24 to 42 inches of silty material overlying acid sand and gravel of glacio-fluvial origin. In places a till-like layer 6 to 24 inches thick occurs between the silty solum and the underlying sand and gravel. The original vegetation included northern hardwood with hemlock, balsam fir, and some white pine. The soils are classified as medial Podzols overlying Gray-Brown Podzolic-like profiles. These two sola constitute a bisequum (Alfic Haplorthod). The Podzol B horizon begins at a depth of about 3 inches and continues downward 6 to 12 inches with maximum contents of about 15% clay, 60% silt, and 3% organic matter. Overlying it is a pale horizon (A2) containing somewhat less organic matter. Under the Podzol solum is a pale horizon (A′2x) containing about 10% clay, 60% silt, and 0.5% organic matter. Under this is a weakly developed textural B horizon (B′2x) containing about 18% clay, 55% silt, and 0.2% organic matter. Slope gradients range from 1 to 20%. The only soil type is the silt loam. Associated soils include Antigo, Onamia, Padus. The following soil profile was observed in the N.E.¼, S.W.¼, Sec. 21, T.30N., R.13E. on a nearly level outwash terrace.

Horizon	Depth, Inches	Description
011	2-1	Light reddish brown (5YR 6/3M) leaf litter from maple and hemlock trees; pH 5.5; abrupt, smooth boundary.
012	1-0	Reddish gray (5YR 5/2M) partially decomposed leaf litter; pH 5.3; abrupt, smooth boundary.
A2	0-3	Gray (5YR 5/1M) silt loam with very weak thin platy structure; many fine fibrous roots; friable; pH 5.0; abrupt, smooth boundary.
Bhir	3-7	Yellowish red (5YR 4/6M) silt loam with very weak medium and fine subangular blocky structure; fraible; many fine roots; pH 5.0; clear, smooth lower boundary.
Bir	7-9	Brown (7.5YR 5/4M) silt loam with weak medium subangular blocky structure; friable; very slightly vesicular; many medium and fine roots; pH 5.0; clear, smooth boundary.
I, II, A′2x	9-16	Grayish brown (10YR 5/2M) silt loam with less than 7% by volume of stones (less than 3 inches in diameter); weak medium subangular blocky above to weak thin platy below; fragic; pH 5.0; abrupt, smooth boundary.
I, II, B′2x	16-25	Brown (7.5YR 5/4M) to dark brown (7.5YR 4/4M) heavy silt loam with nearly 20% by volume of stones (less than 3 inches in diameter); strong medium angular blocky, breaking to strong fine subangular blocky structure; grayish-brown (10YR 5/2M) bleached silt coatings occur on ped faces to a depth of 19 inches; fragic; pH 5.0; clear, smooth boundary.
IIC1	25-55	Brown (7.5YR 5/4M) gravelly sand with a few weak red (10R 4/4M) bands; 30% gravel by volume; single grain; loose; pH 5.0 above to 5.8 below.
IIC2	55-80	Brown (7.5YR 5/4M) medium sand; single grain; loose; 20% gravel by volume; pH 6.0; abrupt, smooth boundary.
IIC3	80-90	Light brown (7.5YR 6/5M) medium to fine sand; single grain; loose; 18% gravel by volume; pH 6.5.

Type location: Marquette County, Michigan.
Series established: Iron County, Michigan, 1930.
Source of name: Town, Iron County, Michigan.

UNDERHILL SERIES (Soil map units 6, 7, 8, 9)

General Description. The Underhill series (Figure 23) includes deeply leached medium textured soils developed under good natural drainage in reddish-brown loam glacial till.

Detailed Description. This series includes naturally well-drained soils formed under forest cover on dolomitic reddish brown sandy loam to loam glacial till. A silt covering less than a foot thick may be present. The original vegetation included northern hardwoods, with hemlock, balsam fir, and some white and red pine. These soils are classified as weak Podzols overlying a weakly developed Gray-Wooded-like solum (Typic Eutroboralf). The Podzol B horizon begins at a depth of about 6 inches and continues downward about 10 inches with maximum contents of about 20% clay, 40% silt, and 2% organic matter. Above this is a paler horizon (A2). Below this Podzol sequum

(A2-Bhir-Bir) is a vesicular horizon (A′2x) overlying a weakly developed textural horizon (B′2) with maximum contents of about 30% clay, 40% silt, and 0.5% organic matter. The glacial till is dolomitic at a depth of 40 to 50 inches. Slope gradients range from 1 to 20%. Soil types include sandy loams, loam, silt loam. Alban soils are associated. The following soil profile was observed in the center of the N.E.¼, Sec. 27, T.29N., R.15E., on a 12% slope with northern aspect.

Horizon	Depth, Inches	Description
01	¼-0	Leaf and twig mat of debris from hemlock and northern hardwoods.
A1	0-1	Dark gray to dark grayish brown (10YR 4/1-4/2M) loam; weak fine granular; friable; many fine roots present; pH 5.1; clear, smooth boundary.
A2	1-6	Brown to dark brown (10YR 4/3M) rubbing to dark grayish brown (10YR 4/2M) sandy loam; moderate, medium granular to weak fine subangular blocky; friable; many fine roots present; a few earthworms present; pH 5.3; clear, smooth boundary.
Bhir	6-12	Brown to dark brown (7.5YR 4/3-4/4M) sandy loam; weak, fine subangular blocky; friable; many roots present; pH 5.4; abrupt, smooth boundary.
Birx	12-16	Brown to dark brown (7.5YR 4/4M) sandy loam; moderate, medium subangular blocky; friable; somewhat fragic; fewer roots present than above; pH 5.6; clear, smooth boundary.
A′2x	16-21	Reddish brown to dark brown (5YR-7.5YR 4/3M), rubbing to dark brown (7.5YR 4/3M) sandy loam; moderate medium angular blocky; friable; somewhat fragic; an occasional root noted; pH 5.7; clear to diffuse, smooth boundary.
A′2x & B′21x	21-39	Brown to dark brown (7.5YR 4/4M) friable sandy loam tonguing into and surrounding dark reddish brown (2.5YR 3/4M) loam which is friable when moist, but slightly sticky when wet moderate coarse to medium angular blocky; friable; occasional roots; pH 6.0; abrupt, smooth boundary.

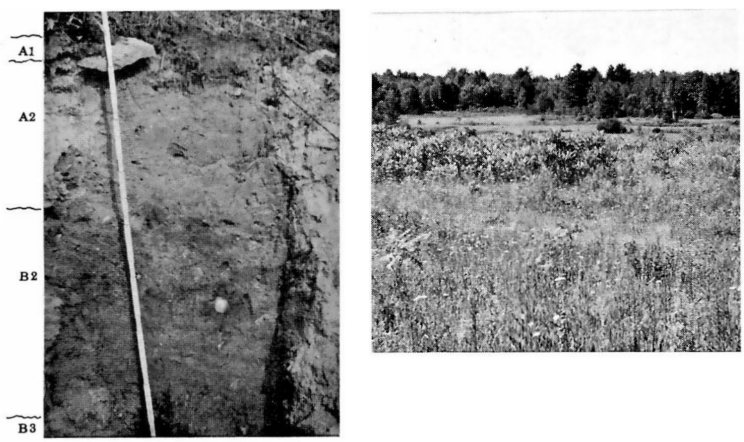

Figure 23. Underhill sandy loam soil profile (left) showing 2 feet of light brown sandy loam soil over reddish brown loam subsoil. The landscape shows an abandoned clearing in forest on this soil (unit 7 on the soil map).

IIB'22	39-48	Dark reddish brown (2.5YR 3/4M) loam to sandy clay loam; moderate medium subangular blocky; sticky and plastic when wet; a few roots observed; pH 7.0; about 25% by volume limestone pebbles; abrupt, smooth boundary.
IIC1	48-66	Dark reddish brown (2.5YR 3/4M) loam glacial till, calcareous; pH 8.0.

Type location: Oconto County, Wisconsin.

Series proposed: Oconto County, Wisconsin, 1958.

Source of name: Village, Oconto County, Wisconsin.

Underhill, sandy substratum variant. These soils differ from the usual Underhill soils by being underlain by sand and gravel at 40 to 60 inches. The following example was observed in the S.E.¼, S.E.¼, Sec. 1, T.29N., R.16E., Menominee County, Wisconsin, September, 1962, under mixed coniferous-decidous forest cover. The parent material was sandy glacial drift of a moraine. The slope was 8%. Natural drainage was good. Aspect was north. Root distribution was to a depth of about 42 inches. Permeability was moderately rapid.

Horizon	Depth, Inches	Description
01	½-0	Mat of hardwood leaves and petioles.
A1	0-3	Black (10YR 2/1M) fine sandy loam moderate medium granular; very friable; pH 5.3; abrupt, wavy boundary.
Bir1	3-10	Dark brown (7.5YR 4/4-3/2M) fine sandy loam; weak, medium subangular blocky; very friable; pH 5.8; clear, wavy boundary.
Bir2	10-16	Dark brown (7.5YR 4/4M) sandy loam; medium subangular blocky; very friable; pH 5.8; abrupt; wavy boundary.
A'2x & B21x	16-25	Strong brown (7.5YR 5/6M) coherent medium sand with a few flecks to thin bands of dark brown (7.5YR 4/4M); weak, medium subangular blocky; pH 5.8; clear wavy boundary.
B'22x	25-32	Reddish brown (5YR 4/4M) coarse sandy loam with a few organic stains of very dark grayish brown (10YR 3/2M); moderate coarse platy to medium subangular block; friable; pH 5.0; clear, wavy boundary.
B'23	32-41	Brown to reddish brown (7.5YR-5YR 4/3M) sandy loam to sandy clay loam with thin, discontinuous clay films on peds; moderate, medium, subangular blocky; slightly plastic; pH 7.0; abrupt, wavy boundary.
IIC1	41-50	Reddish yellow (7.5YR 6/6M) medium and coarse sand with some gravel; a thin layer of calcareous gravel was present in the top of this horizon; single grain; loose, the gravel was calcareous; the sand was acid.

VILAS SERIES (Soil map units 17, 18, 19, 20, 21)

Brief Description. The Vilas series includes deep acid sands with a soft, brown subsoil at a depth of about 6 inches.

Detailed Description. This series includes very droughty soils developed from deep acid sands of glacial and glacio-fluvial origin. Original vegetation included jack pine, red and white pine, with hemlock and northern hardwoods. These soils are classified as minimal Podzols (Entic Haplorthod). When the upper horizon is disturbed, as by animals or fire with subsequent wind erosion, the Vilas soil is not easily distinguished from the Omega. The subsoil (Bhir) begins at a depth of about 3 inches and continues downward about a foot with maximum contents of about 5% clay, 5% silt, and 1% organic matter. Above the B horizon is a bleached layer (A2). A somewhat coherent layer may occur between the B horizon and the C. Slope gradients range from 1 to 20%. Soil types include sand, fine sand, loamy fine sand. Associated soils are Omega, Crivitz. Pence, Onamia, Cheteck, Padus. The following soil profile was observed in the N.E.¼, N.W.¼, S.E.¼, Sec. 9, T.29N., R. 15E., on a convex 3% slope.

Horizon	Depth, Inches	Description
01	1-1½	Brown (10YR 4/3M) leaf and grass litter; pH 5.0; abrupt, smooth boundary.
02	½-0	Brown (7.5YR 4/2M) humus; many fine roots; pH 6.5; abrupt, smooth boundary.
A1	0-1	Black (5YR 2/1M) with light gray (5YR 7/1M) quartz grains, loamy sand; single grain; loose; many fine roots; pH 5.0; abrupt, smooth boundary.
A2	1-3	Reddish gray (5YR 5/2M) loamy sand; loose; single grain; roots present; pH 4.5; abrupt, smooth boundary.
Bhir	3-12	Reddish brown to brown (5YR-7.5YR 4/4M) loamy sand; single grain to very weak fine subangular blocky; loose; pH 5.0; clear, smooth boundary.
Bir	12-20	Brown to strong brown (7.5YR 5/4-5/6M) coherent sand; single grain to very weak coarse to medium subangular blocky; loose; pH 5.7; gradual, smooth boundary.
C	20-30	Strong brown (7.5YR 5/6M) medium sand; single grain to very weak coarse to medium subangular blocky; loose; pH 6.0; clear, smooth boundary.

Type location: Sec. 26, T.48N., R.7W., Bayfield County, Wisconsin.

Series established: Iron County, Michigan, 1930.

Source of name: Vilas County, Wisconsin.

X. SOIL GEOGRAPHY

Introduction

The soil types of Menominee County which have been described in detail on preceding pages occur as soil bodies in the landscape. The land surface of the county is a mosaic of soil bodies which exhibit distinct geographic patterns (Figure 24) (Hole, 1953), and are grouped into units called soil associations or soil communities. In Figure 4c, for example, the Kennan and Emmert stony loams (305) constitute one unit of the landscape and peat soils (424) another unit, distinct from the Onamia loam (215) and Chetek sandy loam (219). Twenty-five soil associations are shown on the soil map. This chapter briefly describes these natural geographic groupings. The soil names used that have not been mentioned previously are briefly defined in the glossary.

A soil association consists of soil bodies representing usually less than a half-dozen soil types. The term association indicates that the soils occur together in the landscape. The less commonly used term, soil community, indicates that the combination of soils in a given portion of the landscape has unique dynamic characteristics with respect to the manner in which it responds to precipitation and solar radiation, the kinds of plants and animals it will support and the quantity of products it will yield. The soil types in each soil association are listed in order of decreasing areal extent within the association.

A brief description of the 25 geographic and cartographic (map) units follows. These units (Table 36) are numbered according to the legend of the colored soil map. Abbreviations used to indicate general classification of the soils are: GBP (Gray-Brown Podzolic or Alfisol); P (Podzol or Spodosol); P & GBP (both Podzol and Gray-Brown Podzolic, constituting a double soil profile); R (Regosol or Entisol); BP (Brown Podzolic or Inceptisol); HG (Humic Gley or Haplaquept); O (Organic soil or Histosol).

Description of cartographic units

SOILS OF THE GLACIAL TILL UPLANDS

Five soil associations (cartographic units 1 through 5) are included in this group. The major soils in associations 1 through 4 are formed either in a thin silt deposit over glacial till or entirely in till. These associations are found west of the boundary between the brown and reddish-brown tills (see map, Glacial Geology of Menominee County). The soils in association 5 are formed in ice-contact deposits, which consist of a complex mixture of till and outwash.

The total area occupied by these five soil associations is 36,959 acres, 15.8% of the area of the county.

Soils Formed From Silty to Loamy Material Over-Lying Acid, Brown Sandy Loam Glacial Drift, Largely Till

Four soil associations (cartographic units 1, 2, 3, and 4) are included in this group. These associations are found in the portion of the county covered by a thin layer of silt. The silt cap is as much as 3 feet thick in places in western townships. It gradually thins to the eastward and is seldom found east of the Wolf River.

Norrie and Goodman, the major soils in associations 1, 2, and 3 (Figure 25), are formed in more than 24 inches of silt over till. Kennan and Iron River, the major soils in association 4, are formed in less than 24 inches of silt over till, some of them entirely in till. The major soils in association 1 are well drained, but this unit also includes moderately well to poorly drained soils. Poorly drained soils are not extensive in associations 2 and 3, which are separated on the basis of topography.

1. *Norrie and Goodman silt loams; Kennan and Iron River loams and sandy loams; associated moderately well to poorly drained soils; undulating to gently rolling. Slopes 0 to 10%.*

Major soils—Norrie (GBP) and Goodman (P & GBP) silt loams; Kennan (GBP) and Iron River (P & GBP) loams and sandy loams. *Minor soils*—Spirit (P), Auburndale (HG), and Adolph (HG) loams; Monico (P) and Cable (HG) loams; peats. *Inclusions*—Antigo (GBP), Stambaugh (P & GBP), and Fence (P) silt loams and their poorly drained associates. *Distribution*—Mainly in the extreme western portion of the county (Figure 25). *Area*—1,539 acres, 0.7% of the county.

Description—The soils occur on undulating to gently rolling portions of till plains and drumlins. The well drained soils are found on upland slopes. The poorly drained associates are in nearly level interdrumlin depressions, along drainageways and bordering bogs. The association is of minor extent.

The Norrie (GBP) and Goodman (P & GBP) soils have solums two to four feet thick. The bisequal profile of the Goodman soil may be thought of as a medial Podzol

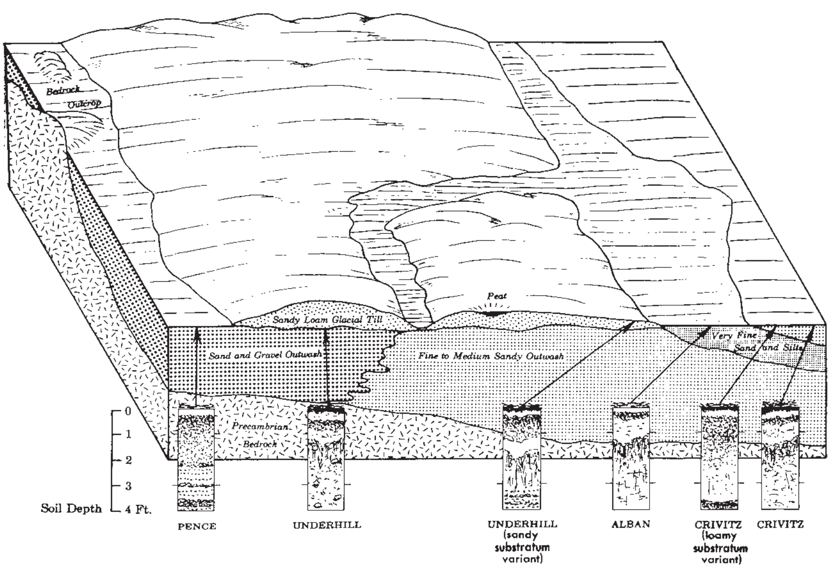

Figure 24. Block diagram showing general relationships of some soils to the landscape in eastern Menominee County.

TABLE 36. DISTRIBUTION OF SOIL ASSOCIATIONS (SOIL MAP UNITS), MENOMINEE COUNTY, WISCONSIN

Soil Map Symbols	Major Soil Groupings	Soil Associations (Soil Map Units)	Distribution[1]	
			Percentage of Area of County	Acres
I	SOILS OF THE GLACIAL UPLANDS		15.8	36,959
IA	**Soils formed from silty to loamy material overlying acid brown sandy loam glacial drift, largely till.**		14.5	33,441
1		Norrie and Goodman silt loams; Kennan and Iron River loams and sandy loams; associated moderately well to poorly drained soils, undulating to gently rolling. Slopes 0—10%	0.7	1,539
2		Norrie and Goodman silt loams, Kennan and Iron River loams and sandy loams; associated soils, undulating. Slopes 0—8%	1.3	3,078
3		Norrie and Goodman silt loams; Kennan and Iron River loams and sandy loams, associated soils, rolling to hilly. Slopes 8—20%	5.3	12,213
4		Kennan and Iron River loams; Norrie and Goodman silt loams, associated soils; rolling to hilly. Slopes 8—20%	7.2	16,611
IB	**Soils formed from ice-contact glacial drift.**		1.3	3,518

TABLE 36. DISTRIBUTION OF SOIL ASSOCIATIONS (SOIL MAP UNITS), MENOMINEE COUNTY, WISCONSIN (CONT'D)

Soil Map Symbols	Major Soil Groupings	Soil Associations (Soil Map Units)	Distribution[1]	
			Percentage of Area of County	Acres
5		Kennan and Iron River stony loams and sandy loams; Pence and Chetek sandy loams; Emmert stony sandy loam; associated soils, hilly. Slopes 10—40%	1.3	3,518
II	SOILS OF MIXED GLACIAL DRIFT DEPOSITS		18.4	43,117
IIA	**Soils formed from loamy and sandy coverings over reddish-brown neutral to calcareous glacial drift including till, glaciolacustrine and outwash materials.**		18.4	43,117
		Alban fine sandy loam; Underhill loam and sandy loam; Crivitz (loamy substratum variant) loamy sand and fine sandy loam; associated moderately well to poorly drained soils, undulating to gently rolling. Slopes 0—10%	1.3	3,078
7		Underhill loam and sandy loam; Alban and Crivitz (loamy substratum variant) fine sandy loams, associated soils, undulating. Slopes 0—8%	2.3	5,497
8		Underhill loam and sandy loam; associated soils, rolling to hilly. Slopes 8—20%	8.2	19,030

TABLE 36. DISTRIBUTION OF SOIL ASSOCIATIONS (SOIL MAP UNITS), MENOMINEE COUNTY, WISCONSIN (CONT'D)

Soil Map Symbols	Major Soil Groupings	Soil Associations (Soil Map Units)	Distribution[1]	
			Percentage of Area of County	Acres
9		Alban and Crivitz (loamy substratum variant) fine sandy loam; Underhill loam and sandy loam; associated soils, rolling to hilly. Slopes 8—20%	5.0	11,774
10		Crivitz loamy sand and fine sandy loam; Pence and Chetek sandy loams; Underhill (sandy substratum variant) loam and sandy loam; associated soils, rolling to hilly. Slopes 8—20%	1.6	3,738
III	SOILS OF GLACIO-FLUVIAL UPLANDS		51.6	120,653
IIIA	**Soils formed from silty and loamy materials overlying glacial outwash and inwash sand and gravel**		32.1	75,118
11		Antigo and Stambaugh silt loams, Onamia and Padus loams; associated moderately well to poorly drained soils; undulating to gently rolling. Slopes 0—10%..	2.8	6,596
12		Antigo and Stambaugh silt loams; Onamia and Padus loams; associated soils, undulating. Slopes 0—8%	3.3	7,696
13		Antigo and Stambaugh silt loams; Onamia and Padus loams; associated soils, rolling to hilly. Slopes 8—20%	8.8	20,568

TABLE 36. DISTRIBUTION OF SOIL ASSOCIATIONS (SOIL MAP UNITS), MENOMINEE COUNTY, WISCONSIN (CONT'D)

Soil Map Symbols	Major Soil Groupings	Soil Associations (Soil Map Units)	Distribution[1]	
			Percentage of Area of County	Acres
14		Onamia and Padus loams; Pence and Chetek sandy loams; associated moderately well to poorly drained soils, undulating to gently rolling. Slopes 0—10%	2.8	6,596
15		Onamia and Padus loams; Pence and Chetek loams and sandy loams; associated soils, undulating. Slopes 0—8%	4.2	9,795
16		Onamia and Padus loams; Pence and Chetek loams and sandy loams; associated soils, rolling to hilly. Slopes 8—20%	10.2	23,867
IIIB	**Soils formed from sandy loam and loamy sand materials overlying glacial outwash and inwash sand and gravel**		19.5	45,535
17		Pence and Chetek sandy loams; Crivitz loamy sand and fine sandy loam; Omega and Vilas loamy sands and sands; associated moderately well to poorly drained soils, nearly level to gently rolling. Slopes 0—10%	2.8	6,596
18		Pence and Chetek sandy loams; Crivitz loamy sand and fine sandy loam; associated soils, undulating. Slopes 0—8%	2.9	6,816

TABLE 36. DISTRIBUTION OF SOIL ASSOCIATIONS (SOIL MAP UNITS), MENOMINEE COUNTY, WISCONSIN (CONT'D)

Soil Map Symbols	Major Soil Groupings	Soil Associations (Soil Map Units)	Distribution[1]	
			Percentage of Area of County	Acres
19		Pence and Chetek sandy loams; Crivitz loamy sand and fine sandy loam; associated soils, rolling to hilly. Slopes 8—20%	5.6	13,093
20		Omega and Vilas loamy sands and sands; Crivitz loamy sand and fine sandy loam; associated soils, nearly level to gently undulating. Slopes 0—5%	4.4	10,015
21		Omega and Vilas loamy sands and sands; Crivitz loamy sand and fine sandy loam; associated soils, undulating to rolling to hilly. Slopes 5—16%	2.5	5,937
22		Pence and Chetek sandy loams; Onamia and Padus loams; Crivitz loamy sand and fine sandy loam; associated soils, hilly. Slopes 10—40%	1.3	3,078
IV	GRANITIC ROCKLAND AND ASSOCIATED SOILS		1.3	3,078
23		Granitic Rockland; Onamia and Padus loams; Kennan and Iron River loams and sandy loams; Pence and Chetek sandy loams; peats, nearly level to hilly. Slopes 0—40%	1.3	3,078

TABLE 36. DISTRIBUTION OF SOIL ASSOCIATIONS (SOIL MAP UNITS), MENOMINEE COUNTY, WISCONSIN (CONT'D)

Soil Map Symbols	Major Soil Groupings	Soil Associations (Soil Map Units)	Distribution[1]	
			Percentage of Area of County	Acres
V	SOILS FORMED LARGELY FROM ORGANIC MATERIAL		11.2	26,163
24		Peats and associated soils, with forest cover, nearly level to sloping. Slopes 0—3%	9.9	23,085
25		Peats and associated soils, without forest cover, nearly level to sloping. Slopes 0—3%	1.3	3,078
	All soils		98.3	229,970
	Water		1.7	4,030
	Lakes		1.3	3,135
	Rivers		0.4	895
	Total: All soils and bodies of water		100.0	234,000

[1] Percentages and acreages are based on weights of various parts of the soil map as determined with an analytical balance.

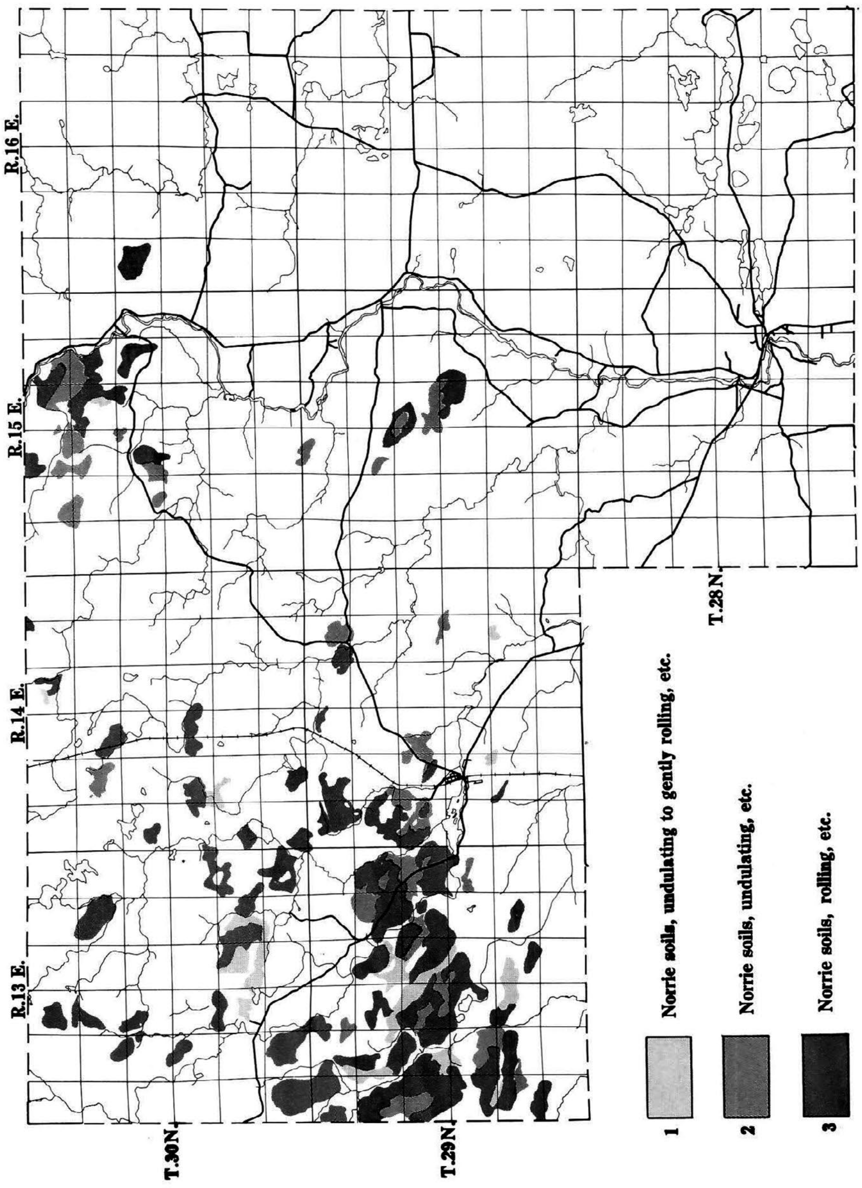

Figure 25. Geographic extent of units 1, 2, and 3, of the soil map.

formed in the upper portion of a minimal Gray-Brown Podzolic solum. The catenal associates of the Norrie series include the poorly drained Auburndale and the very poorly drained Adolph. The catenal associates of the Goodman series include the somewhat poorly drained Spirit, the poorly drained Auburndale, and the very poorly drained Adolph.

The Kennan (GBP) and Iron River (P & GBP) soils developed in glacial till or in a silt cap less than a foot thick over till. Catenal associates of the Kennan series are the poorly drained Cable and the very poorly drained Adolph soils. Catenal associates of the Iron River series include the somewhat poorly drained Monico and the poorly drained Cable soils.

Moist conditions favor the development of Podzol characteristics and, therefore, it is not surprising that bisequal profiles are more abundant in the more moist catenal associates than in the well drained upland soils.

Areas of shallow peat are found associated with the poorly drained soils. Where outwash deposits are included in the delineations, bodies of Antigo, Stambaugh, and Fence soils may be found in the association.

2. *Norrie and Goodman silt loams; Kennan and Iron River loams and sandy loams; associated soils; undulating. Slopes 0 to 8%.*

Major soils—Norrie (GBP) and Goodman (P & GBP) silt loams; Kennan (GBP) and Iron River (P) loams and sandy loams. *Minor soils*—Antigo (GBP), Stambaugh (P & GBP), and Fence (P) silt loams. *Inclusions*—Underhill (P & GBP) loam and sandy loam; Onamia (GBP) and Padus (P & GBP) loams; peats. *Distribution*—Scattered throughout the western half of the county (Figure 25). *Area*—3,078 acres, 1.3% of the county.

Description—This association differs from the preceding one in having less extensive imperfectly to poorly drained components. The Norrie and Goodman soils are dominant in the western part of the unit and occur in equal proportions with Kennan and Iron River soils in the eastern part of the association.

On outwash associated with the till, bodies of Antigo, Stambaugh and Fence soils are found in association with Norrie and Goodman; Onamia and Padus soils, associated with Kennan and Iron River.

Some deposits of reddish-brown sandy loam till are included in the association along the major till boundary shown on the colored geologic map. Underhill soils occur on the reddish-brown till.

Small bodies of peat are present in the association.

3. *Norrie and Goodman silt loams; Kennan and Iron River loams and associated soils; rolling to hilly. Slopes 8 to 20%.*

Major soils—Norrie (GBP) and Goodman (P & GBP) silt loams; Kennan (GBP) and Iron River (P & GBP) loams and sandy loams. *Minor soils*—Antigo (GBP), Stambaugh (P & GBP), and Fence (P) silt loams; Fence (P) and Chetek (GBP) sandy loams. *Distribution*—Scattered throughout the area of the acid brown till (Figure 25). *Area*—12,213 acres, 5.3% of the county.

Description—These rolling to hilly soils constitute a fairly extensive unit, particularly in the southwestern township of the county. The distribution of soils reflects the effect of topographic position on thickness of the silt mantle in which they are formed. Norrie and Goodman soils occur on the rolling topography and are dominant in the western range of the unit. The Kennan and Iron River soils occur on the hilly topography and are more extensive in the eastern part of the unit where the silt mantle is thinnest.

Underhill soils are found in the association in the zone where the acid brown and calcareous reddish-brown tills merge. On outwash materials lying between drumlins and along drainageways, Antigo, Stambaugh and Fence soils occur associated with Norrie and Goodman soils; Onamia and Padus loams, and Pence and Chetek sandy loams occur associated with Kennan and Iron River soils.

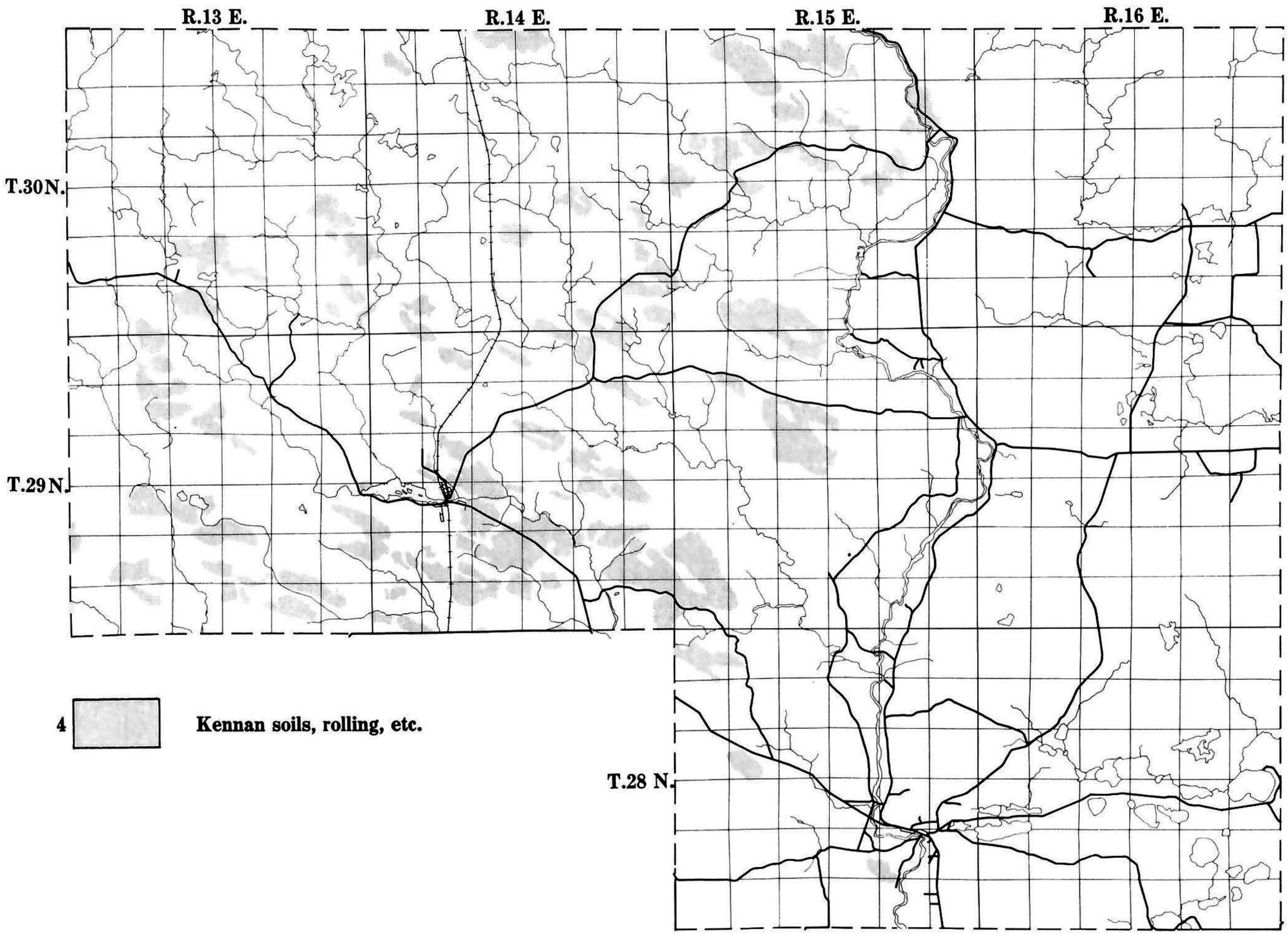

Figure 26. Geographic extent of unit 4, of the soil map.

4. *Kennan and Iron River loams; Norrie and Goodman silt loams; associated soils; rolling to hilly. Slopes 8 to 20%.*

Major soils—Kennan (GBP) and Iron River (P & GBP) loams and sandy loams; Norrie (GBP) and Goodman (P & GBP) silt loams. *Minor soils*—Underhill (P & GBP) loam and sandy loam; Onamia (GBP) and Padus (P & GBP) loams; Pence (P) and Chetek (GBP) sandy loams. *Inclusions*—Antigo (GBP), Stambaugh (P & GBP) and Fence (P) silt loams. *Distribution*—Scattered throughout the area of acid brown till, but concentrated in the eastern part (Figure 26). *Area*—16,611 acres, 7.2% of the county.

Description—The soils in this association are found on rolling to hilly portions of the acid brown till, where the silt mantle is generally less than 24 inches thick.

The Kennan and Iron River soils normally have solums 2 to 3 feet thick that are formed partly in till where a silt cap is present and entirely in till where the silty layer is absent. Soils of the Kennan series are classified as weakly developed Gray-Brown Podzolic with some Podzol characteristics. When profiles have well developed Podzol characteristics the Iron River soils are recognized. Soils of the Iron River series are classified as medial Podzols that may be bisequal with a weakly developed lower Gray-Brown Podzolic sequum. Podzol characteristics are generally better developed in coarse textured materials. Consequently, in Menominee County, the Iron River soils are usually better developed Podzols than the Goodman soils.

Association 4, the most extensive of the units on acid brown till, occurs chiefly in the eastern part of the geographic range of the association. Kennan and Iron River soils are found on the hilly slopes in the west and the entire slope range in the eastern part of the association. Norrie and Goodman soils are found on the rolling slopes in the west and are confined to areas where silt has accumulated in the east.

Underhill soils are found in this unit as discussed under association 2. Onamia, Padus, Pence, and Chetek soils occur with Kennan and Iron River soils; Antigo, Stambaugh, and Fence soils occur with Norrie and Goodman soils.

SOILS FORMED FROM ICE-CONTACT GLACIAL DRIFT

A single soil association (cartographic unit 5) occurs in this group.

5. *Kennan and Iron River stony loams and sandy loams; Pence and Chetek sandy loams; associated soils; hilly. Slopes 10 to 40%.*

Major soils—Kennan (GBP) and Iron River (P & GBP) stony loams and sandy loams; Pence (P) and Chetek (GBP) sandy loams; Emmert (R) stony loam and sandy loam. *Minor soils*—Onamia (GBP) and Padus (P & GBP) loams. *Inclusions*—Antigo (GBP), Stambaugh (P & GBP), and Fence (P & GBP) silt loams; Omega (R) and Vilas (P) loamy sands and sands; peas. *Distribution*—Scattered throughout the area of acid brown till (Figure 27). *Area*—3,518 acres, 1.3% of the county.

Description—The soils in this association are found on hilly to steep moraines, and crevasse fillings which form linear hills oriented northeast, perpendicular to the direction of glacial ice movement. Soils on eskers are included in the association which is scattered throughout the central and western portions of the county.

The Kennan and Iron River soils have been described for association 4. Soils of the Pence and Chetek series are formed in 15 to 24 inches of sandy loam material over outwash sand gravel, as described for association 17. The Onamia and Padus soils are associated with the Pence and Chetek soils in areas with loam surface textures and better developed profiles.

Soils in the Emmert series are formed in less than 12 inches of gravelly loam or sandy loam over coarse textured materials found in eskers or crevasse fills. They are droughty soils with solums less than 18 inches thick that are classified as Regosols and weak Podzols.

The morainic deposits in this association may have inclusions of silts and very fine

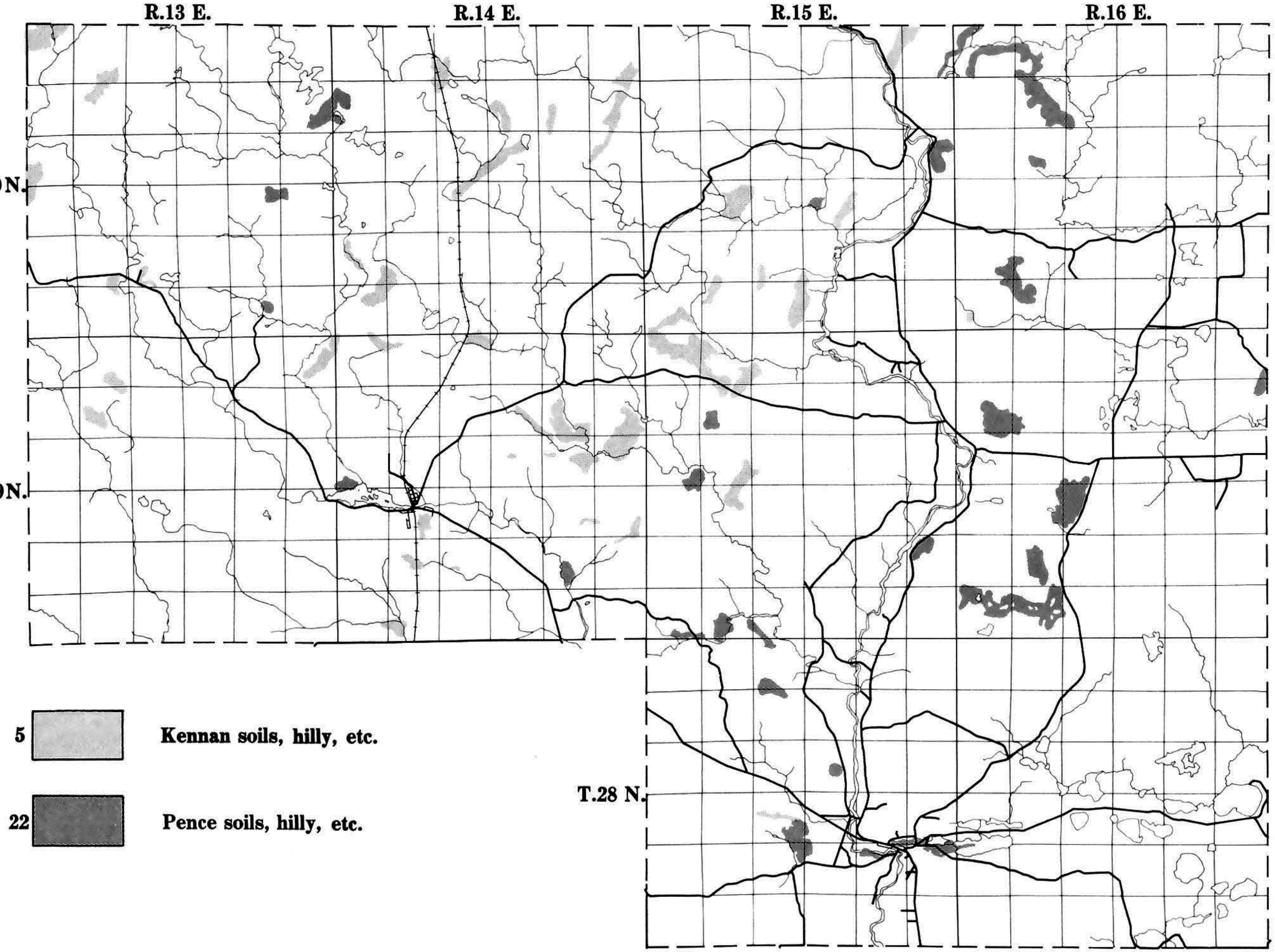

Figure 27. Geographic extent of units 5, and 22, of the soil map.

sands on which are found the Antigo, Stambaugh, and Fence soils. Omega and Vilas soils are found on sands. Small bodies of peats are present, particularly in glacial pits.

SOILS OF MIXED GLACIAL DRIFT DEPOSITS

The five soil associations (cartographic units 6 through 10) included in this group are found east of the boundary between the brown and reddish-brown tills. The parent materials of these five soil associations are stratigraphically related, but display a variety of textures and modes of deposition. The ice sheet which deposited the reddish-brown till must have been relatively thin and inactive, judging by the scarcity of drumlins in this portion of the county. Most of the till was deposited as a veneer 3 to 25 feet thick over pitted glacial outwash. A loamy covering 1 to 2 feet thick usually overlies the reddish-brown till which favors the development of bisequal soil profiles. Locally the reddish brown till has been reworked by water and grades into reddish-brown glacio-lacustrine fine sands and silt, overlain by 1 to 5 feet of medium to fine sand.

Soil associations 6 and 7 are nearly level to gently rolling and include soils formed in the entire range of materials discussed above. Association 6 includes a significant acreage of moderately well to poorly drained soils. Soil association 7 is well drained for the most part.

Soil associations 8, 9, and 10 are rolling to hilly. The major soils in association 8 are formed in calcareous reddish-brown sandy loam till. The major soils in association 9 are formed in slightly acid to weakly calcareous glacio-lacustrine deposits. The soils in association 10 are formed in a complex mixture of glacio-fluvial materials.

The total area occupied by these five soil associations is 43,117 acres or 18.4% of the county.

Soils Formed From Loamy and Sandy Coverings over Neutral to Calcareous Reddish-Brown Glacial Drift Including Till, Glacio-Lacustrine, and Glacio-Fluvial Materials.

6. *Alban fine sandy loam; Underhill loam and sandy loam; Crivitz (loamy substratum variant) loamy sand and fine sandy loam; associated moderately well to poorly drained soils; undulating to gently rolling. Slopes 0 to 10%.*

Major soils—Alban (GBP) fine sandy loam and coarse silt loam; Underhill (P & GBP) sandy loam and loam; Crivitz (P), (loamy substratum variant) loamy sand and fine sandy loam. *Minor soils*—Plover (GBP) and Manitou (HG) fine sandy loam and coarse silt loam; Brimley (P) and Bruce (HG) fine sandy loam and coarse silt loams; Solona (P) and Angelica (HG) sandy loams and loams; Crivitz (P) loamy sand and fine sandy loam; peats. *Inclusions*—Onamia (GBP) and Padus (P & GBP) loams; Pence (P) and Chetek (GBP) sand loams; Omega (R) and Vilas (P) loamy sands and sands. *Distribution*—Scattered throughout the eastern half of the county (Figure 28). *Area*—3,078 acres, 1,3% of the county.

Description—This inextensive association occurs on nearly level to gently rolling reddish-brown till and glacio-lacustrine deposits in the eastern half of the county. It is closely associated with areas of soil associations 7, 8, and 9. The well drained soils are found on the uplands and rolling portion of the landscape while the catenal associates occur in undrained depressions, along drainageways, and around edges of large bogs.

Soils in the Alban series are classified as weakly developed Gray-Brown Podzolics with some Podzol characteristics. The slightly acid to weakly calcareous materials in which they have developed range from lacustrine silts to very fine sands, to reddish-brown glacio-fluvial material. The Crivitz (loamy substratum variant) soil, described for association 9, was mapped where the solum developed in a covering of medium to fine sand over glacio-lacustrine deposits. The catenal associates of the Alban series include the somewhat poorly drained Plover, and the poorly drained Manitou. The somewhat poorly drained Brimley and poorly drained Bruce soils occur on finer materials in association with the Alban soils. The Brimley soils are Podzols and the Bruce

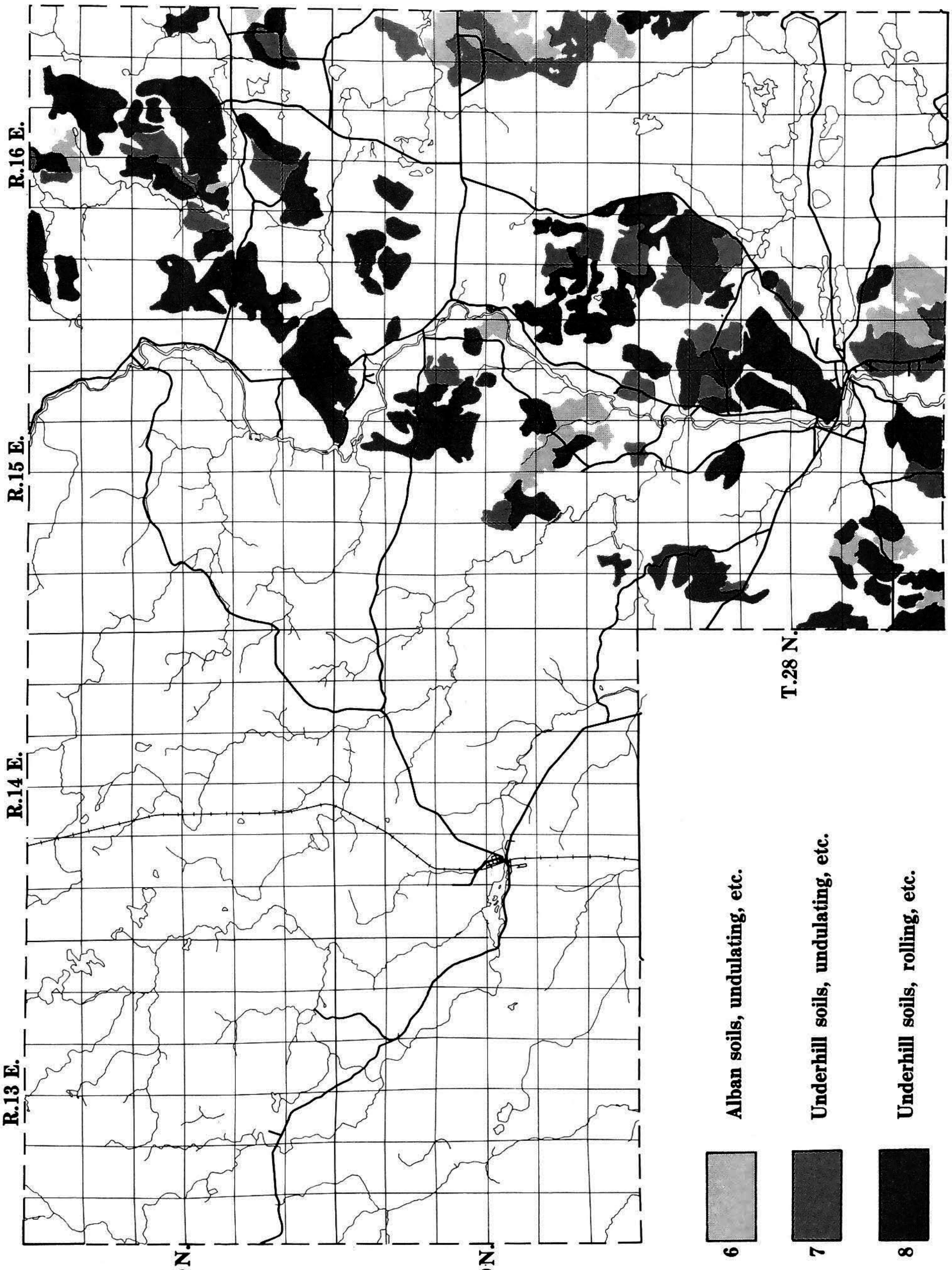

Figure 28. Geographic extent of units 6, 7, and 8, of the soil map.

soils are the associated Humic Gleys. They are formed in stratified very fine sands and silts which are calcareous at depths of 3 to 5 feet.

The Underhill soils are formed in calcareous reddish-brown sandy loam till as described for association 8. Somewhat poorly drained Solona and poorly drained Angelica soils also are present.

Small bodies of peat are included among the very poorly drained soils. Where bodies of outwash sand and gravel occur near the surface, Onamia, Padus, Pence, and Chetek soils are found in western and northern parts of the association, and Crivitz, Omega, and Vilas soils in the south and east.

7. *Underhill loam and sandy loam; Alban and Crivitz (loam substratum variant) fine sandy loams; associated soils; undulating. Slopes 0 to 8%.*

Major soils—Underhill (P & GBP) loam and sandy loam; Alban (GBP) fine sandy loam and coarse silt loam; Crivitz (P) (Loamy substratum variant) loamy sand and fine sandy loam. *Minor soils*—Underhill (P & GBP) (sandy substratum variant) loam and sandy loam; Crivitz (P) loamy sand and fine sandy loam. *Inclusions*—Onamia (GBP) and Padus (P & GBP); Pence (P) and Chetek (GBP) sandy loams; Omega (R) and Vilas (P) loamy sands and sands; peat. *Distribution*—Scattered throughout the area of the reddish-brown mixed glacial drift deposits (Figure 28). *Area*—5,497 acres, 2.3% of the county.

Description—This association, mainly well drained, occurs on the nearly level to undulating portions of the reddish-brown mixed glacial deposits, in association with soils of associations 8 and 9.

The Underhill soils formed in 12 to 24 inches of loamy material over weakly calcareous sandy loam till. The sandy substratum phase of this series occurs where till is less than 5 feet thick over outwash sand and gravel. The Alban soils are formed in stratified glacio-lacustrine materials. Where these are covered by 3 to 5 feet of sands, the Crivitz (loamy substratum variant) soil has been mapped. Where the sand covering is deeper than 5 feet, typical Crivitz soils occur.

Onamia, Padus, Pence, and Chetek soils occur on inclusions of outwash sand and gravel in the west and north part of the range of the association. Omega and Vilas are formed in outwash sands in the south and east part of the range of the association. Omega and Vilas are formed in outwash sands in the south and east part of the range. Small bodies of peat with associated poorly drained mineral soils are numerous.

8. *Underhill loam and sandy loam; associated soils; rolling to hilly. Slopes 8 to 20%.*

Major soils—Underhill (P) sandy loams and loams; *Minor soils*—Alban (GBP) fine sandy loam and coarse silt loam; Underhill (P) (sandy substratum variant), Kennan (GBP) and Iron River (P) loams and sandy loams; Crivitz (P) (loamy substratum variant) loamy sand and fine sandy loam. *Inclusions*—Pence (P) and Chetek (GBP) sandy loams; Onamia (GBP and Padus (P) loams; peats. *Distribution*—In the eastern half of the county (Figure 28). *Area*—19,030 acres, 8.2% of the county.

Description—This is the most extensive of the five associations in the area of reddish-brown mixed glacial drift. The soils included here are found chiefly on rolling and hilly moraines of reddish-brown sandy loam till, trending northeast across the six eastern townships.

Underhill soils formed in 12 to 24 inches of loamy materials over calcareous sandy loam to loam till. Solums average 30 to 48 inches deep, but extend to 60 inches in some places. They are classified as bisequal soils in which a weak to medial Podzol sequum overlies a Gray-Brown Podzolic or Gray-Wooded lower sequum. In areas where the till is less than 6 feet thick over outwash but with some C horizon in the till, the sandy substratum variant is mapped. Alban and Crivitz (loamy substratum variant) soils occur in some depressions.

Inclusions of Kennan and Iron River soils occur in the zone where the reddish-brown and brown tills merge. Also included are Pence, Chetek, Onamia and Padus soils to the west and north, and Crivitz, Omega and Vilas soils to the south and east, all formed on outwash.

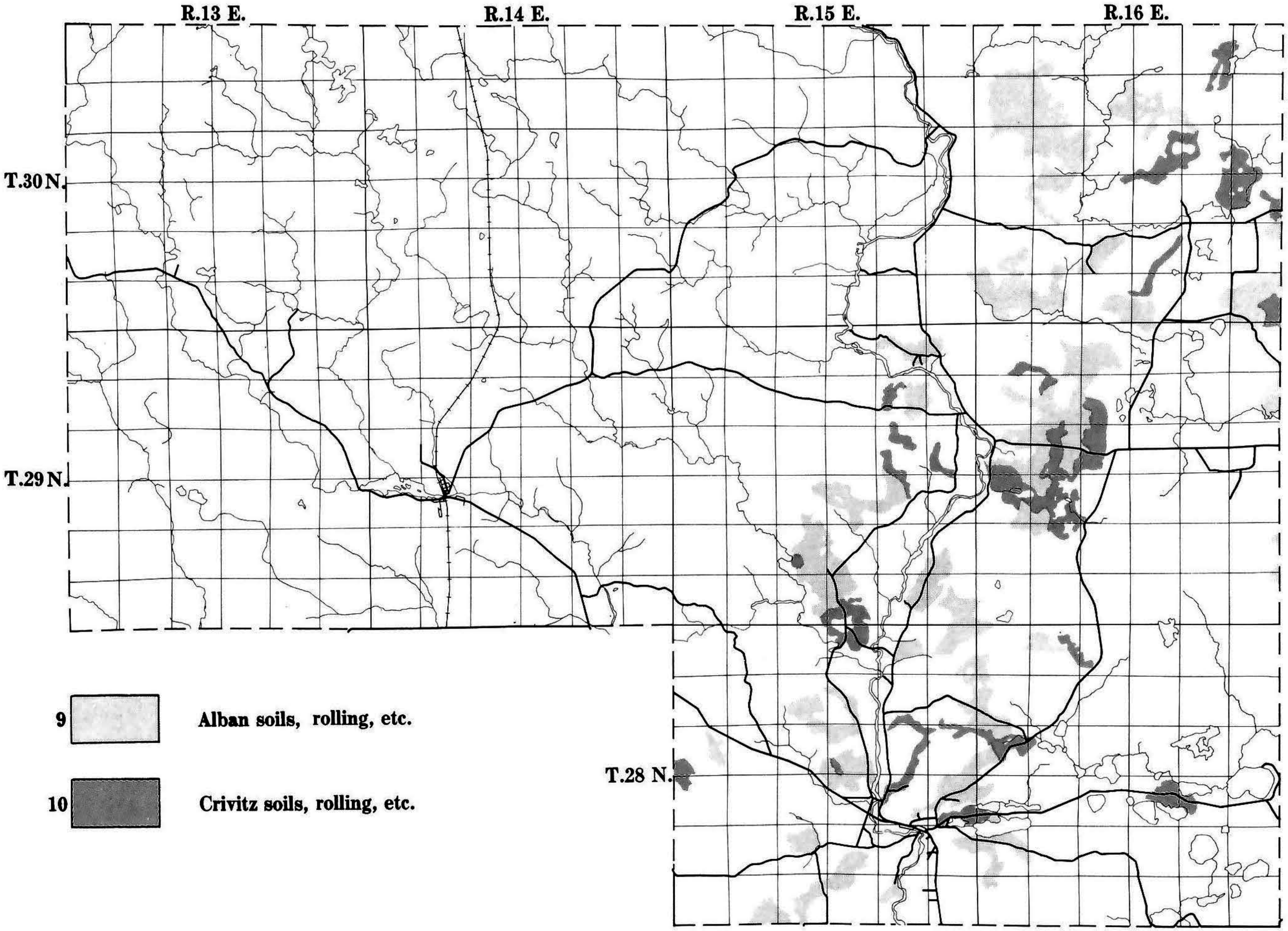

Figure 29. Geographic extent of units 9 and 10, of the soil map.

9. *Alban fine sandy loam and coarse silt loam; Crivitz (loamy substratum variant) loamy sand and fine sand loam; Underhill loam and sandy loam; associated soils; rolling to hilly. Slopes 8 to 20%.*

Major soils—Alban (GBP) fine sandy loam and coarse silt loam; Crivitz (P) (loamy substratum variant) loamy sand and fine sandy loam; Underhill (P & GBP) loam and sandy loam. *Minor soils*—Underhill (P & GBP) (sandy substratum variant) loam and sandy loam; Crivitz (P) loamy sand and fine sandy loam; Omega (R) and Vilas (P) loamy sands and sands; Onamia (GBP) and Padus (P & GBP) loams; Pence (P) and Chetek (GBP) sandy loams. *Inclusions*—Peats. *Distribution*—In the eastern half of the county (Figure 29). *Area*—11,774 acres, 5.0% of the county.

Description—The soils in this association are found on rolling to hilly slightly acid to weakly calcareous glacio-lacustrine deposits. The association occurs bordering the northeast-trending moraines of association 8.

The Alban soils formed in more than 40 inches of lacustrine fine sands and silts, as described for association 6. Where a sand cap 3 to 5 feet thick occurs, the Crivitz (loamy substratum variant) soil is mapped. This soil has a solum 24 to 36 inches thick and has profile characteristics similar to those of the Crivitz soils, described for association 10. Bodies of Omega and Vilas soils occur on deep deposits of medium and coarse sands.

Also included are Underhill and Underhill (sandy substratum variant) soils on till, Onamia, Padus, Pence, and Chetek soils on outwash, and peat in kettles and other depressions.

10. *Crivitz loamy sand and fine sandy loam; Pence and Chetek sandy loams; Underhill (sandy substratum variant) loam and sandy loam, rolling to hilly. Slopes 8 to 20%.*

Major soils—Crivitz (P) loamy sand and fine sandy loam; Pence (P) and Chetek (GBP) sandy loams; Underhill (P & GBP) (sandy substratum variant) loam and sandy loam. *Minor soils*—Crivitz (P) (loamy substratum variant) loamy sand and fine sandy loam; Alban (GBP) fine sandy loam and coarse silt loam; Onamia (GBP) and Padus (P & GBP) loams; Omega (R) and Vilas (P) loamy sands and sands. *Inclusions*—Underhill (P & GBP) loam and sandy loam; peat. *Distribution*—Scattered through the eastern half of the county (Figure 29). *Area*—3,738 acres, 1.6% of the county.

Description—The soils of this association, formed mainly in rolling to hilly glacio-fluvial deposits, occur in glacial drainageways leading through moraines to the glacio-lacustrine basins (association 9).

The Crivitz soils, formed in deep loamy sands, are classified as weak Podzols. They may have bisequal profiles. Solums are usually 24 to 36 inches deep. The Omega and Vilas soils are found when profiles are less well developed and solums are less than 24 inches deep. Pence and Chetek soils are found associated with Crivitz where the outwash becomes somewhat coarser and contains some gravel, as described for association 17. Where the sand is underlain by glacio-lacustrine materials, Crivitz (loamy substratum variant) and Alban soils are recognized. The glacio-lacustrine material grades into till locally. Most of the till in this association is less than 5 feet thick. Consequently the Underhill (sandy substratum variant) is the major till-derived soil. Bodies of Onamia and Padus are found mostly in the north and west portions of the range of this association. Peat occurs in kettles.

SOILS OF THE GLACIO-FLUVIAL UPLANDS

The soils of the twelve associations (cartographic units 11 through 22) included here are largely derived from extensive outwash and inwash materials deposited by glacial melt waters. The total area occupied by these twelve soil associations is 120,653 acres, 51.6% of the county.

Soils Formed From Silty and Loamy Materials Overlying Outwash and Inwash Sand and Gravel Glacial Drift

The six soil associations included here (cartographic units 11 through 16) can be divided into two groups: (1) soils developed in silt loam coverings over outwash sand and gravel (associations 11, 12 and 13) in western townships (Figure 30), and (2). more extensive soils (associations 14, 15 and 16) developed in loams and sandy loams over outwash sand and gravel (Figure 31).

11. *Antigo and Stambaugh silt loams; Onamia and Padus loams; associated moderately well to poorly drained soils, undulating to gently rolling. Slopes 0 to 10%.*

Major soils—Antigo (GBP) and Stambaugh (P & GBP) silt loams; Onamia (GBP) and Padus (P & GBP) loams and sandy loams. *Minor soils*—Fence (P & GBP), Brill (GBP), Poskin (GBP), Fifield (P), and Rib (HG) silt loams; Scott Lake (GBP), Halder (GBP), Worchester (P), Minocqua (HG), and Warman (HG) loams; peats. *Inclusions*—Pence (P) and Chetek (GBP) sandy loams. *Distribution*—Chiefly in the western one-third of the county (Figure 30). *Area*—6,596 acres, 2.8% of the county.

Description—This undulating to gently rolling association includes well to poorly drained soils of outwash plains and terraces in the western one-third of the county.

The Antigo and Stambaugh soils have developed in 20 to 40 inches of silt over outwash sand and gravel and have solums 30 to 42 inches thick. The Fence soils are formed in more than 40 inches of silt over stratified silts and fine sands. The Antigo soils are Gray-Brown Podzolic soils with some tendencies toward the Podzol. The associated Stambaugh and Fence soils are bisequal. Catenal associates of the Antigo soils include the moderately well drained Brill, the somewhat poorly drained Poskin, and the poorly drained Rib. Catenal associates of Stambaugh are the somewhat poorly drained Fifield and the poorly drained Rib. The Fifield is more common than the Poskin, presumably because moist conditions favor the development of Podzol soils. The Onamia and Padus soils have developed in 24 to 42 inches of loamy material over outwash, as described for association 14. Catenal associates of Onamia are the moderately well drained Scott Lake, somewhat poorly drained Halder and poorly drained Warman. In the Padus catena are the somewhat poorly drained Worchester and the poorly drained Minocqua.

Shallow peat bodies are present. Pence and Chetek soils occur as inclusions with Onamia and Padus soils.

12. *Antigo and Stambaugh silt loam; Onamia and Padus loams; associated soils, undulating. Slopes 0 to 8%.*

Major soils—Antigo (GBP) and Stambaugh (P & GBP) silt loams; Onamia (GBP) and Padus (P & GBP) loams and sandy loams. *Minor soils*—Pence (P) and Chetek (GBP) sandy loams; Fence (P & GBP) silt loams. *Inclusions*—Norrie (GBP) and Goodman (P & GBP) silt loams; Kennan (GBP) and Iron River (P & GBP) loams and sandy loams; peats. *Distribution*—Chiefly in the western half of the county (Figure 30). *Area*—7,696 acres, 3.3% of the county.

Description—The soils in this association are found on well drained, nearly level to undulating outwash plains and terraces. Well drained silty soils seem to resist development of Podzol characteristics and bisequal profiles are not as numerous as in association 11. Antigo and Stambaugh are the dominant soils in the western range of the association; Onamia and Padus, in the east. Fence is found associated with Antigo and Stambaugh soils; Pence and Chetek with Onamia and Padus soils.

Peat and poorly drained mineral soils occur in depressions. Norrie, Goodman, Kennan and Iron River soils are found on till.

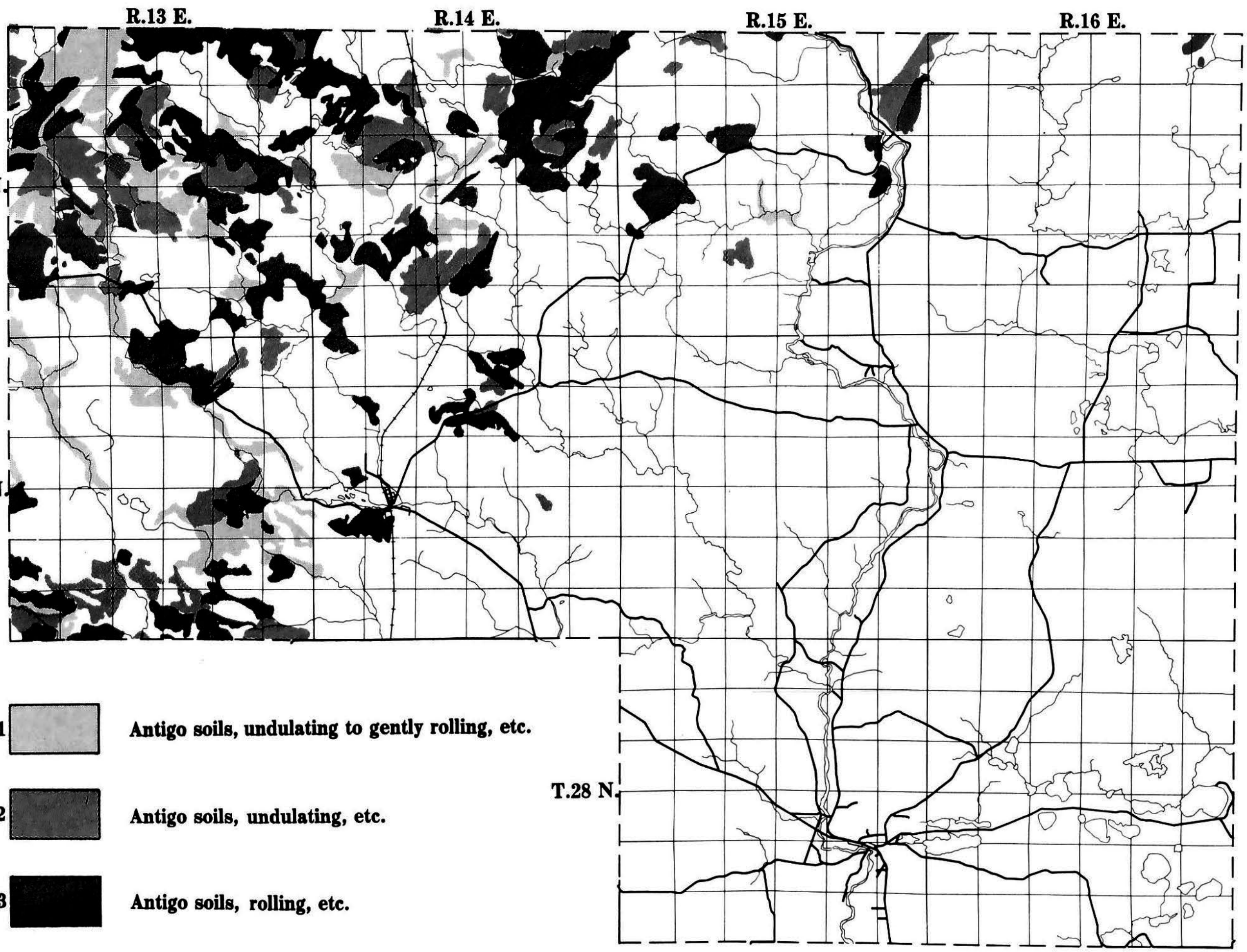

Figure 30. Geographic extent of units 11, 12, and 13, of the soil map.

13. *Antigo and Stambaugh silt loams; Onamia and Padus loams; associated soils, rolling to hilly. Slopes 8 to 20%.*

Major soils—Antigo (GBP) and Stambaugh (P & GBP) silt loams; Onamia (GBP) and Padus (P & GBP) loams and sandy loams. *Minor soils*—Pence (P) and Chetek (GBP) sandy loams; Emmert (R) loams and sandy loams. *Inclusions*—Norrie (GBP) and Goodman (P & GBP) silt loams; Kennan (GBP) and Iron River (P & GBP) loams and sandy loams. *Distribution*—Chiefly in the four western townships (Figure 30). *Area*—20,568 acres, 8.8% of the county.

Description—This association, the largest of the three which include soils formed in silty deposits over outwash sand and gravel, is found mainly in the four western townships. It occurs on rolling and hilly kame complexes, terrace escarpments, ice-contact deposits, and outwash.

Profile characteristics of the Antigo and Stambaugh soils are described in association 11. The Onamia and Padus soils are formed in 24 to 42 inches of loam deposits over outwash sand and gravel and have profile characteristics as described in association 14. The Antigo and Stambaugh soils are found on all slopes in the west but are confined to the rolling portions of the landscape in the eastern part of the range. Pence and Chetek soils are associated with Onamia and Padus soils.

On included bodies of till, Norrie and Goodman, Kennan and Iron River soils occur. Small bodies of peat occupy undrained pits.

14. *Onamia and Padus loams; Pence and Chetek sandy loams; associated moderately well to poorly drained soils; undulating to gently rolling. Slopes 0 to 10%.*

Major soils—Onamia (GBP) and Padus (P & GBP) loams and sandy loams; Pence (P) and Chetek (GBP) sandy loams. *Minor soils*—Scott Lake (GBP), Halder (GBP), Worchester (P), Minocqua (HG), and Warman (HG) loams; Crown (GBP), Channing (P), and Minocqua (HG) sandy loams. *Inclusions*—Antigo (GBP) and Stambaugh (P & GBP) silt loams; Crivitz (P) loamy sand and fine sandy loam; Omega (R) and Vilas (P) loamy sands and sands. *Distribution*—Scattered throughout the western two-thirds of the county (Figure 31). *Area*—6,596 acres, 2.8% of the county.

Description—The soils in this association are found on well to poorly drained portions of gently rolling to nearly level outwash plains and terraces.

Onamia and Padus soils, already described above, have surface textures ranging from loam to sandy loam and, where a thin silt cap occurs, to silt loam. Solum depths range from 30 to 48 inches, Onamia soils grade locally into the bisequal Padus soils. Catenal associates of Onamia include the modertely well drained Scott Lake, the somewhat poorly drained Halder, and the poorly drained Warman soils. Catenal associates of Padus include the somewhat poorly drained Worchester and the poorly drained Minocqua soils.

Pence and Chetek soils, formed in 15 to 24 inches of sandy loam deposits over outwash sand and gravel, have solums 20 to 30 inches deep, as described for association 17. Catenal associates of Pence include the somewhat poorly drained Channing and the poorly drained Minocqua. The only recognized catenal associate of Chetek is the moderately well to somewhat poorly drained Crown.

Areas of shallow peat may be included with some of the poor drained soils in this association.

Inclusions of Antigo and Stambaugh are found associated with Onamia and Padus in the western range of the association, while Crivitz, Vilas, and Omega are associated with Pence and Chetek in the eastern part of the range.

15. *Onamia and Padus loams; Pence and Chetek sandy loams; associated soils; undulating. Slopes 0 to 8%.*

Major soils—Onamia (GBP) and Padus (P & GBP) loams and sandy loams; Pence (P) and Chetek (GBP) sandy loams. *Minor soils*—Antigo (GBP) and Stambaugh (P & GBP) silt loams; Crivitz (P) loamy sand and fine sandy loam; Omega (R) and Vilas (P) loamy sands and sands. *Inclusions*—Peats. *Distribution*—Scattered through-

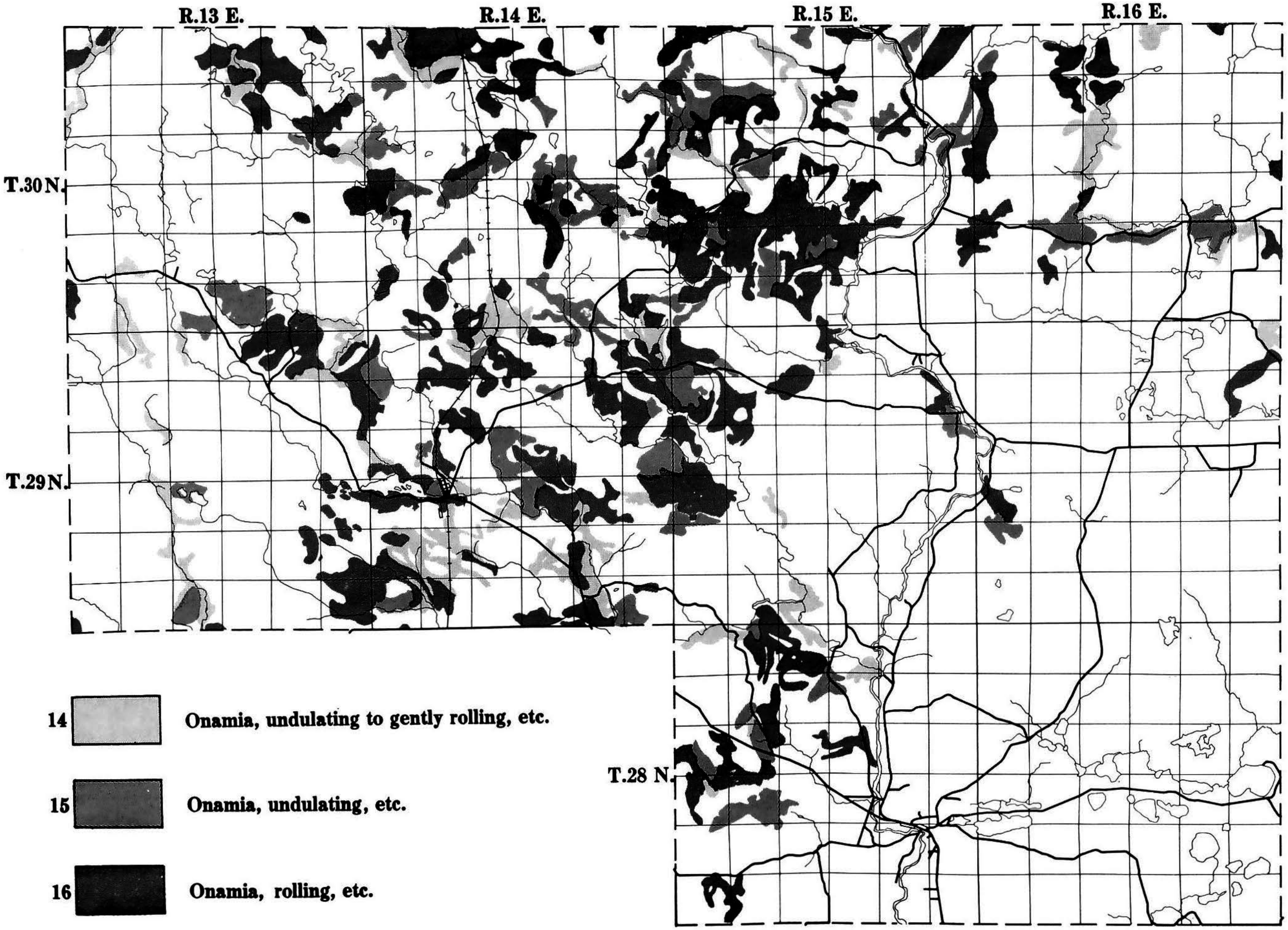

Figure 31. Geographic extent of units 14, 15, and 16, of the soil map.

out the western two-thirds of the county. (Figure 31). *Area*—9,795 acres, 4.2% of the county.

Description—This association differs from number 14 chiefly in lacking significant extents of poorly drained soils.

16. *Onamia and Padus loams; Pence and Chetek sandy loams; associated soils; rolling to hilly. Slopes 8 to 20%.*

Major soils—Onamia (GBP) and Padus (P & GBP) loams and sandy loams; Pence (P) and Chetek (GBP) sandy loams. *Minor soils*—Crivitz (P) loamy sand and fine sandy loam; Omega (R) and Vilas (P) loamy sands and sands; Antigo (GBP) and Stambaugh (P & GBP) silt loams. *Inclusions*—Emmert (R), Kennan (GBP), and Iron River (P & GBP) loams and sandy loams; peats. *Distribution*—Scattered throughout the western two-thirds of the county (Figure 31). *Area*—23,867 acres, 10.2% of the county.

Description—This extensive association occurs in the western half of the county on rolling and hilly pitted outwash, kame complexes, and morainic and ice-contact deposits.

Onamia and Padus soils, described for association 14, are concentrated in the central and western portions of the geographic range of the association. Stambaugh and Antigo soils occur where a 24-inch silt cap is present. Kennan and Iron River soils occur on inclusions of till.

Pence and Chetek soils, described for association 17, have formed in coarser materials and occur in the central and eastern part of the range of the association. Kennan and Iron River soils (on till), Crivitz, Omega, and Vilas (on sands) are also included. Small bodies of peat occupy depressions.

Soils Formed From Sandy Loam to Loamy Sand Materials Overlying Glacial Outwash and Inwash Sand and Gravel.

Six soil associations (cartographic units 17 through 22) are included here. One or more of the major soils in each association has textures as coarse as sandy loam or loamy sand. These associations, which occur east of the area of silty covering, occupy about 45,545 acres, 19.5% of the county.

The dominant surface textures of the major soils in associations 18 and 19 are sandy loam and loamy sand; in association 20 and 21, are loamy sand and sand. Association 17 includes soils of this textural range and is differentiated by inclusions of moderately well and poorly drained soils. Association 22 consists of soils on hilly outwash.

17. *Pence and Chetek sandy loams; Crivitz loamy sand to fine sandy loam; Omega and Vilas loamy sands and sands; associated moderately well to poorly drained soils; undulating to gently rolling. Slopes 0 to 10%.*

Major soils—Pence (P) and Chetek (GBP) sandy loams; Crivitz (P) loamy sand and fine sandy loam; Omega (R) and Vilas (P) loamy sands and sands. *Minor soils*—Crown (GBP), Channing (P), and Mirocqua (HG) sandy loams; Au Gres (P) and Roscommon (HG) loamy sands and sands; peats. *Inclusions*—Crivitz (P) (loamy substratum variant) loam and fine sandy loam; Alban (GBP) fine sandy to coarse silt loam. *Distribution*—Scattered throughout the eastern half of the county (Figure 32). *Area*—6,596 acres, 2.8% of the county.

Description—The soils in this association occur on well to poorly drained gently rolling to nearly level outwash plains, mainly in the eastern half of the county.

Podzol characteristics seem to develop most readily in coarse materials and consequently Pence soils are more common than Chetek soils here. These two soils grade locally into Padus and Onamia soils. Catenal associates of Pence are somewhat poorly drained Channing and poorly drained Minocqua; and of Chetek is the somewhat poorly drained Crown. Also included are Omega and Vilas soils (see association 20) and the somewhat poorly drained Au Gres sand.

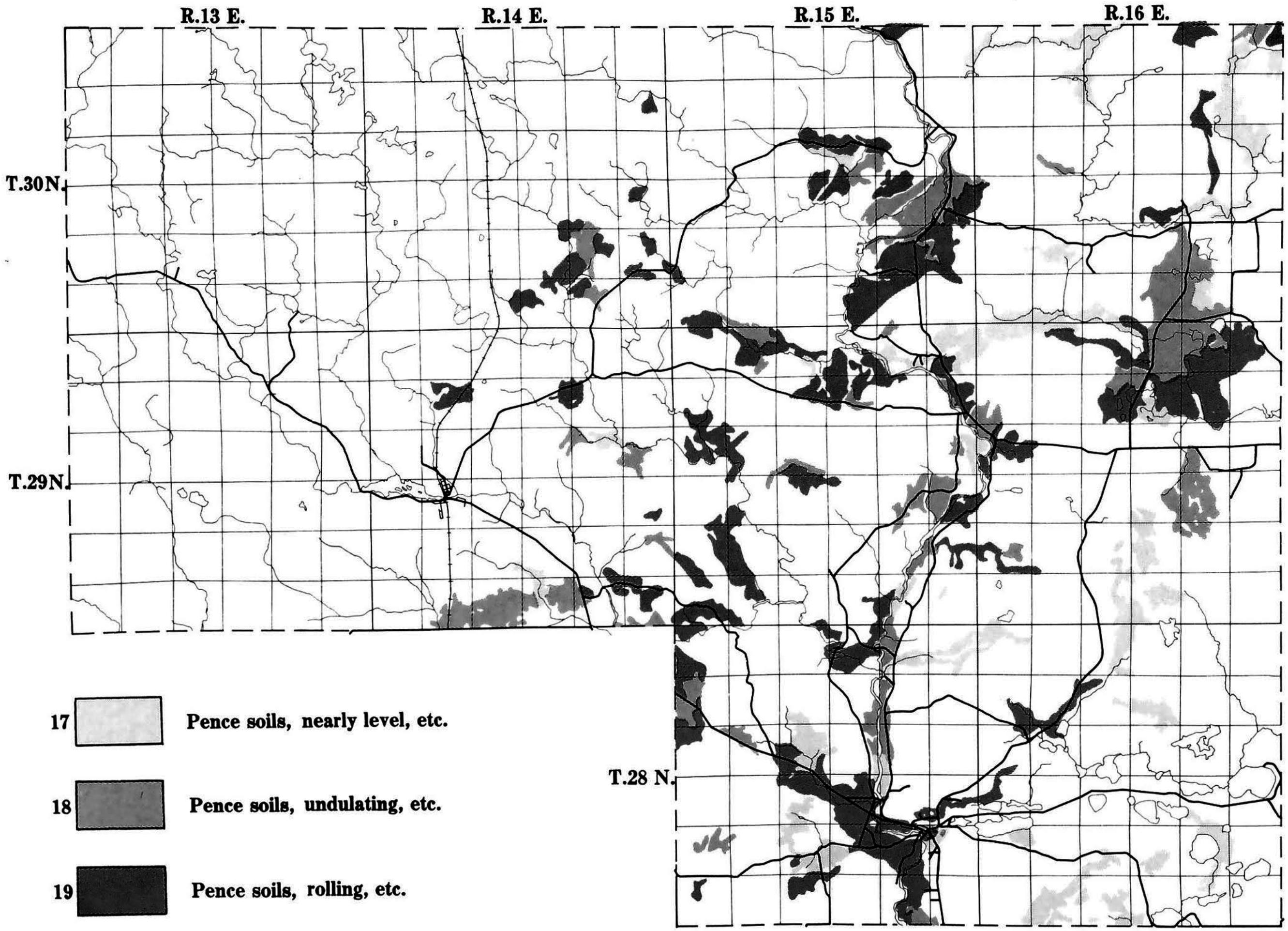

Figure 32. Geographic extent of units 17, 18, and 19, of the soil map.

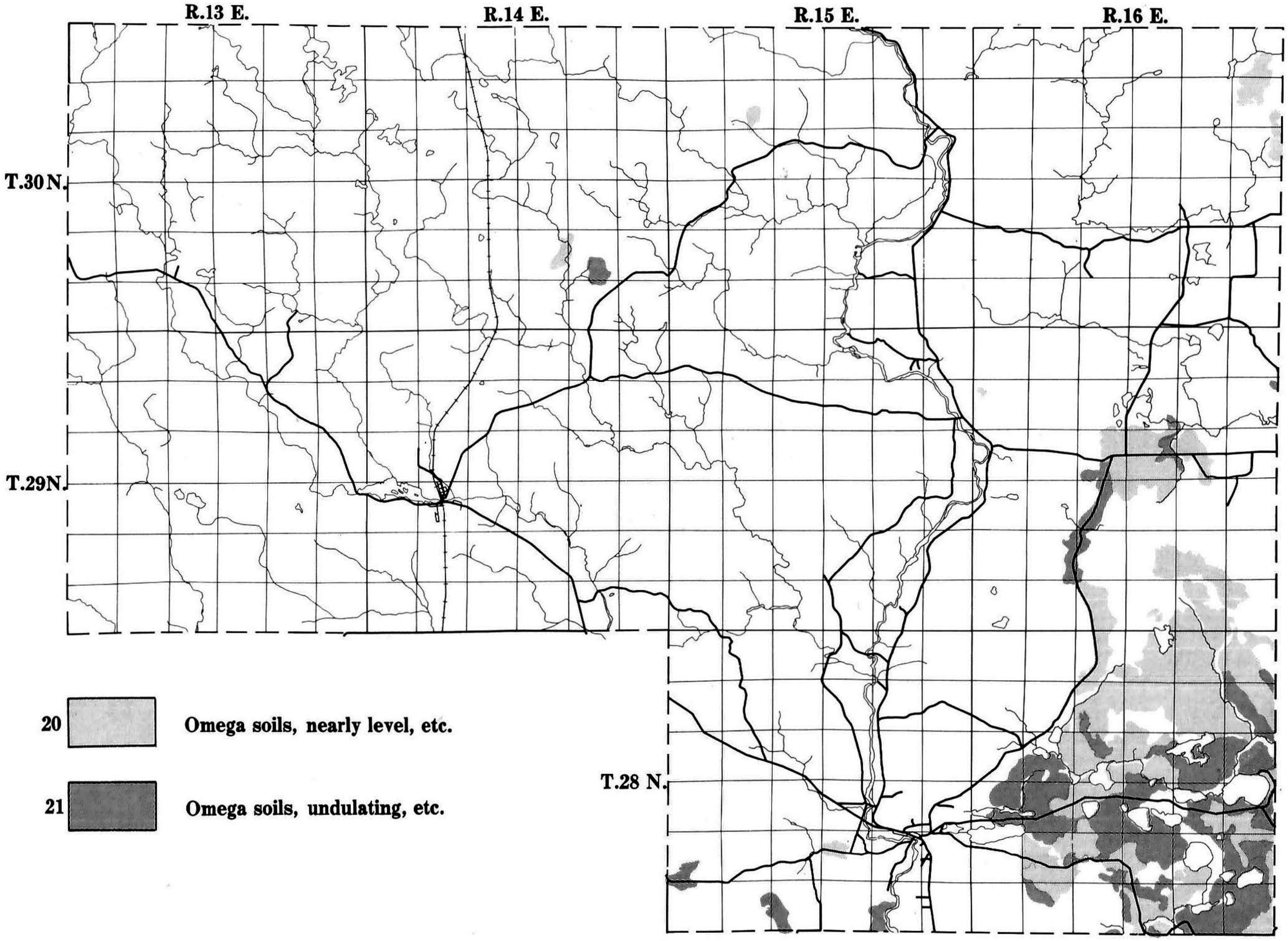

Figure 33. Geographic extent of units 20 and 21, of the soil map.

The soils in the Crivitz series are somewhat excessively drained and are formed in acid outwash and glacio-lacustrine sands. They are classified as weak Podzols with a 24- to 36-inch solum and may exhibit slight bisequal development. There are no recognized catenal associated of Crivitz, but in some areas the poorly drained Roscommon, which is formed in neutral to calcareous glacial drift, is found associated with Crivitz and Crivitz (loamy substratum variant).

Bodies of shallow peat are often included with the poorly drained soils in this association.

Pence and Chetek, and their catenal associates, along with inclusions of Onamia and Padus soils,, are found in the western and northern portions of the association. Crivitz soils, along with inclusions of its loamy substratum variant and Alban soils, are found closely associated with reddish-brown glacial drift. Omega and Vilas soils occur in the southeastern portion of the association.

18. *Pence and Chetek sandy loams; Crivitz loamy sand and fine sandy loam; associated soils; undulating. Slopes 0 to 8%.*

Major soils—Pence (P) and Chetek (GBP) sandy loams; Crivitz (P) loamy sands and fine sandy loams. *Minor soils*—Omega (R) and Vilas (P) loamy sands and sands. *Inclusions*—Onamia (GBP) and Padus (P & GBP) loams and sandy loams. *Distribution*—Scattered throughout the eastern half of the county (Figure 32). *Area*—6,816 acres, 2.9% of the county.

Description—This association consists of well drained soils on nearly level to undulating outwash sand and gravel deposits.

The Pence and Chetek soils, described in association 17, occur on nearly level outwash plains and terraces, as along the Wolf River. Onamia and Padus soils occur in the north and west portions of the range of this association.

Crivitz, Omega, and Vilas soils occur in the southeastern part of the association.

19. *Pence and Chetek sandy loams; Crivitz loamy sand and fine sandy loam; associated soils rolling to hilly. Slopes 8 to 20%.*

Major soils—Pence (P) and Chetek (GBP) sandy loams; Crivitz (P) loamy sand and fine sandy loams. *Minor soils*—Omega (R and Vilas (P) loamy sands and sands; Onamia (GBP) and Padus (P & GBP) loams and sandy loams. *Inclusions*—Peats. *Distribution*—Scattered throughout the eastern two-thirds of the county (Figure 32). *Area*—13,093 acres, 5.6% of the county.

Description—This extensive soil association, including soils formed in sandy loam to loamy sand materials over outwash deposits, is scattered throughout the eastern two-thirds of the county on rolling to hilly pitted outwash, kame complexes and terrace escarpments.

Pence and Chetek soils, already described for association 17, are found on hilly topography in the western and central portions of the range of the association, along with Onamia and Padus soils.

Crivitz soils occur on rolling and hilly slopes bordering the reddish-brown glacial drift. Omega and Vilas soils are included in southern and eastern portions of the association.

Small bodies of peat occupy kettle holes in pitted outwash.

20. *Omega and Vilas loamy sands and sands; Crivitz loamy sand and fine sandy loam; nearly level to gently undulating. Slopes 0 to 5%.*

Major soils—Omega (R) and Vilas (P) loamy sands and sands; Crivitz (P) loamy sand and fine sandy loam. *Minor soils*—Pence (P) and Chetek (GBP) sandy loams. *Inclusions*—Crivitz (P) (loamy substratum variant) loamy sand and fine sandy loam; Au Gres (P) loamy sand and sand; peat. *Distribution*—Chiefly in the southeastern corner of the county (Figure 33). *Area*—10,015 acres, 4.4% of the county.

Description—The soils in this association are formed in extensive nearly level to gently undulating deposits of sandy outwash in the southeastern corner of the county. Omega and Vilas are droughty soils which are formed in deep acid outwash sands

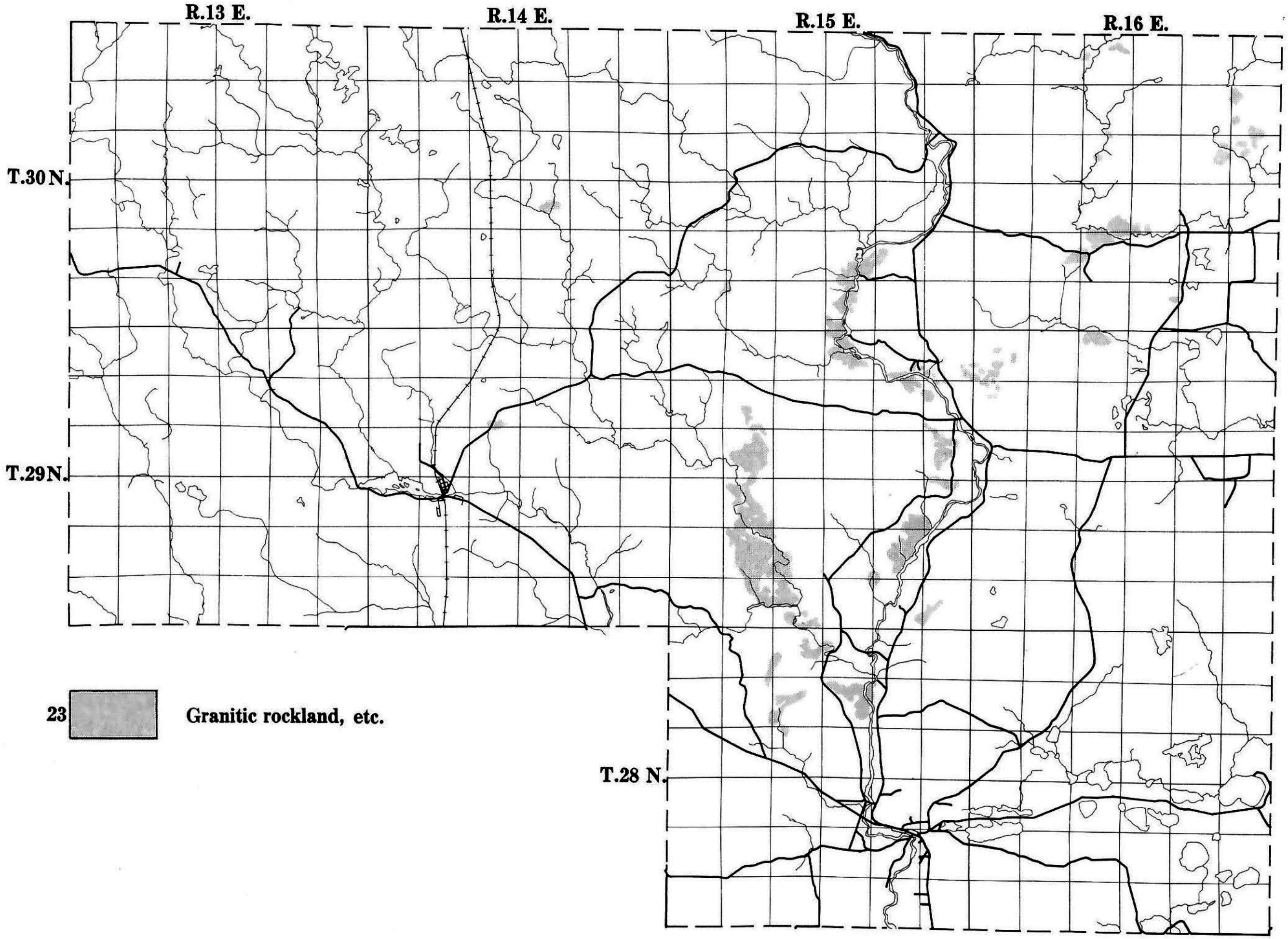

Figure 34. Geographic extent of Granitic Rockland and bedrock outcrops, of the soil map.

and have solums less than 24 inches deep. The soils in the Omega series are excessively drained and are classified as Regosols grading to minimal Podzols. Vilas soils are recognized where Podzol characteristics are distinct. Scattered areas of Omega and Vilas soils in the west and north part of the range of the association are associated with Pence and Chetek soils.

Crivitz soils, including the loamy substratum variant have developed in finer sands bordering the area of reddish-brown glacial drift.

Inclusions of Au Gres sand and peat occur in small depressions.

21. *Omega and Vilas loamy sands and sands; Crivitz loamy sand and fine sandy loam; associated soils undulating to rolling and hilly. Slopes 5 to 16%.*

Major soils—Omega (R) and Vilas (P) loamy sands and sands; Crivitz (P) loamy sand and fine sandy loam; *Minor soils*—Pence (P) and Chetek (GBP) sandy loams. *Inclusions*—Crivitz (P) (loamy substratum variant) loamy sand and fine sandy loam; Au Gres (P), loamy sand and sand; peat. *Distribution*—Chiefly in the southeastern corner of the county (Figure 33). *Area*—5,937 acres, 2.5% of the county.

Description—The soils in this association are found on the undulating to rolling portions of the sandy outwash deposits in the southeastern corner of the county.

Omega and Vilas are the most abundant soils in this association. Crivitz soils, formed in finer sands, occur along with inclusions of Pence and Chetek bordering the reddish-brown glacial drift. Au Gres sand and peat occur in pits.

22. *Pence and Chetek sandy loams; Onamia and Padus loams; Crivitz loamy sands and fine sandy loams; hilly. Slopes 10 to 40%.*

Major soils—Pence (P) and Chetek (GBP) sandy loams; Onamia (GBP) and Padus (P & GBP) loams and sandy loams; Crivitz (P) loamy sand and fine sandy loam. *Minor soils*—Alban (GBP) fine sandy loam and coarse silt loam; Crivitz (P) (loamy substratum variant) loamy sand and fine sandy loam; Omega (R) and Vilas (P) loamy sand and sands. *Inclusions*—Underhill (P & GBP) (sandy substratum variant) sandy loam; Kennan (GBP) and Iron River (P) loams and sandy loams; Underhill (P & GBP) sandy loam. *Distribution*—Scattered areas throughout the county (Figure 27). *Area*—3,078 acres, 1.3% of the county.

Description—The soils in this association are formed in hilly pitted outwash, kame complexes, and associated steep moraines.

Pence and Chetek soils occur in central and western portions of the range of this association, along with Onamia and Padus, Kennan and Iron River soils. Crivitz soils are found on steeply sloping outwash bordering the reddish-brown glacial drift. Bodies of Underhill soils occur near the tops of the slopes; Alban and Crivitz (loamy substratum variant) soils occur downslope. Pence, Chetek and Crivitz soils are associated with Omega and Vilas soils in the southern part of this association.

GRANITIC ROCKLAND AND ASSOCIATED SOILS

This unit, which is most extensive along the Wolf River and its tributaries, consists of a single soil association (cartographic unit 23) made up of bedrock outcrops and a number of shallow soils over bedrock. The total area is 3,078 acres, 1.3% of the county.

23. *Granitic Rockland; Onamia, Padus, Kennan, and Iron River loams and sandy loams; Pence and Chetek sandy loams; peats; nearly level to hilly. Slopes 0 to 40%.*

Major soils—Onamia (GBP) and Padus (P & GBP) loams and sandy loams; Kennan (GBP) and Iron River (P & GBP) loams and sandy loams; Pence (P) and Chetek (GBP) sandy loams. *Minor soils*—Peats and associated poorly drained soils; Omega (R) and Vilas (P) loamy sands and sands. *Inclusions*—None. *Distribution*—Mainly in the vicinity of the Wolf River and tributaries, and to the northeast (Figure 34).

Description—The proportionate extent of Precambrian bedrock outcrops in this unit is from 30% to 60%. Associated soils are formed in a variety of thin glacial deposits.

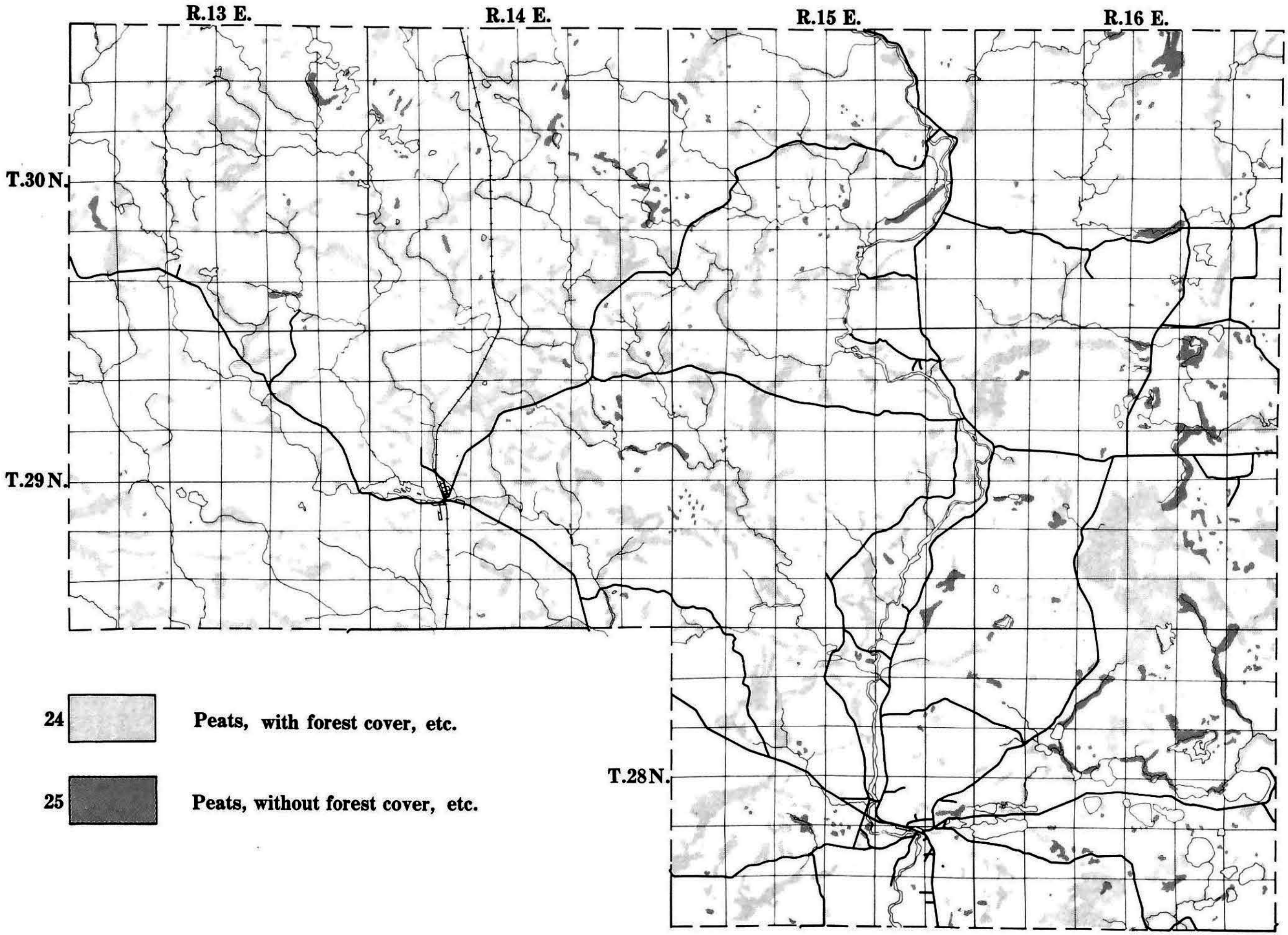

Figure 35. Geographic extent of units 24 and 25 of the soil map.

A gently rolling portion of this association, with numerous inclusions of peat, occurs in sections 17, 20, 28, 29, 32 and 33 of T.29N. and R.15E. This appears to occupy an old river bed or glacial drainageway.

SOILS LARGELY FORMED FROM ORGANIC MATERIALS

Organic deposits are formed under moist, anaerobic conditions such that organic matter accumulates more rapidly than it decomposes. Organic materials which contain relatively unaltered plant remains are called peat. However, if decomposition is so advanced that it is impossible to recognize distinct plant parts with the naked eye, the organic material is called muck. Peat is the dominant constituent of organic deposits in Menominee county. Muck is found where conditions have favored oxidation and decomposition of peat.

The Bog soils (Histosols) in Menominee county have been grouped into two associations (cartographic units 24 and 25) on the basis of presence or absence of forest vegetation. Each of these two associations includes a variety of organic soils. Properties important in their classification include composition of the organic materials, degree of decomposition, reaction (pH), and depth to the underlying mineral deposits.

Association 24 includes organic deposits with forest cover. Major tree species of these forested bogs (Curtis, 1959) include tamarack *(Larix laricina)*, black spruce *(Picea mariana)*, white cedar *(Thuja occidentalis)*, balsam fir *(Abies balsamea)*, along with hemlock *(Tsuga canadensis)*, yellow birch *(Betula lutea)*, black ash *(Fraxinus nigra)*, and American elm *(Ulmus americana)*. Ground cover consists of mosses *(Sphagnum* sp. and *Hypnum* sp.*)* and ericaceous bog shrubs.

Association 25 consists of bogs without forest cover. The vegetation consists of such shrubs as Labrador tea *(Ledum groenlandicum)*, leatherleaf *(Chamaedaphne calyculata)*, bog laurel *(Kalmia polifolia)*, bog rosemary *(Andromeda glaucophylla)*, blueberries *(Vaccinium* sp.*)*, and alder *(Alnus rugosa)*; herbaceous plants such as pitcher-plant *(Sarracenia purpurea)*, sundew *(Drosera rotundifolia)*, several species of orchids (family *Orchidaceae)*, and sedges (family *Cyperaceae)*; and mosses *(Sphagnum* sp. and *(Hypnum* sp.*)*.

These two associations are found scattered throughout the county. The total area is 26,163 acres, 11.2% of the county.

24. *Peats and associated soils, nearly level to sloping, with forest cover.*

Major soils—Linwood, Spalding, and Tawas peats. *Inclusions*—Poorly drained mineral soils and bedrock outcrops. *Distribution*—Scattered throughout the county (Figure 35). *Area*—23,085 acres, 9.9% of the county.

Description—This association includes all organic soils with forest cover.

Linwood peats are formed in 18 to 42 inches of very strongly to slightly acid woody peat and muck over loamy glacial drift. Spalding peats are the deep associates of Linwood and are formed in similar organic materials more than 42 inches thick.

Tawas peats are formed in medium acid to neutral woody peat and muck 18 to 42 inches thick over sandy drift. Carbondale peats are formed in organic materials similar to Tawas, but are more than 42 inches thick.

25. *Peats and associated soils nearly level to sloping, without forest cover.*

Major soils—Greenwood and Adrian peats. *Inclusions*—Associated poorly drained mineral soils and bedrock outcrops. *Distribution*—Scattered throughout the county (Figure 35). *Area*—3,078 acres, 1.3% of the county.

Description—This association is most extensive in the southeastern township of the county.

Greenwood peats are formed in extremely acid to very strongly acid moss and sedge peat deposits more than 42 inches deep. Dawson peats, the shallow associates of Greenwood, are formed in 18 to 42 inches of similar organic materials.

Adrian peats are formed in medium acid to neutral moss and sedge peat deposits 18 to 42 inches deep over sands. Palms peat is similar to Adrian, but is underlain by loamy materials. The deep associate of these soils, Houghton peat, is formed in more than 42 inches of similar organic materials.

APPENDIX

Flora[1]

Key to symbols

B = wetland and bog plants
F = fern and fern-like plants, including Lycopods and horsetails
G = Grasses and grass-like plants, including sedges and rushes
H = All other herbs (besides those designated by other symbols)
L = Lilies and lily-like plants
S = Shrubs
T = Trees
W = Weeds of disturbed ground

Species List of Latin names, followed by common names.

T *Abies balsamea.* Balsam fir
T *Acer negundo.* Box elder
T *Acer rubrum.* Red maple
T *Acer saccharinum.* Silver maple
T *Acer saccharum.* Sugar maple
S *Acer spicatum.* Mountain maple
HW *Achillea millefolium.* Yarrow
LB *Acorus calamus.* Sweetflag
H *Actaea alba.* White baneberry
H *Actaea rubra.* Red baneberry
F *Adiantum pedatum.* Maidenhair fern
H *Adlumia fungosa.* Climbing fumitory
H *Agrimonia gryposepela.* Agrimony
H *Agrimonia pubescens.* Hairy agrimony
GW *Agropyron repens.* Quackgrass
G *Agropyron trachycaulum.* Slender wheatgrass
GW *Agrostis alba.* Redtop
G *Agrostis perennans.* Upland bentgrass
G *Agrostis hyemalis.* Hairgrass
LB *Alisma plantago-aquatica.* Water plantain
L *Allium triccocum.* Wild leek
SB *Alnus rugosa.* Speckled alder
HW *Amaranthus retroflexus.* Redroot
HW *Ambrosia artemisiifolia.* Lesser ragweed
HW *Ambrosia trifida.* Greater ragweed
S *Amorpha canescens.* Leadplant
H *Amphicarpa bracteata.* Hog peanut
SB *Andromeda glaucophylla.* Bog rosemary
G *Andropogon gerardi.* Big bluestem
G *Andropogon scoparius.* Little bluestem
H *Anemone canadensis.* Canada anemone
H *Anemone cylindrica.* Thimbleweed
H *Anemone quinquefolia.* Wood anemone
H *Anemone virginica.* Thimbleweed
H *Anemonella thalictroides.* Rue anemone
H *Antennaria neglecta.* Small-leafed pussytoes
H *Antennaria plantaginifolia.* Large-leafed pussytoes
HW *Anthemis cotula.* Dogfennel
H *Apocynum androsaemifolium.* Dogbane
H *Apocynum cannabium.* Indian hemp
H *Aquilegia canadensis.* Columbine
H *Arabis canadensis.* Sicklepod
H *Arabis laevigata.* Rock cress
H *Aralia hispida.* Bristly sarsaparilla
H *Aralia nudicaulis.* Wild sarsaparilla
H *Aralia racemosa.* Spikenard
HW *Arctium minus.* Burdock
S *Arctostaphylos uva-ursi.* Bearberry
L *Arisaema triphyllum.* Jack-in-the pulpit
S *Aronia melanocarpa.* Chokeberry
H *Artemisia caudata.* Wormwood
H *Asarum canadense.* Wild ginger
H *Asclepias exaltata.* Poke milkweed

[1]A preliminary checklist of vascular plants of Menominee County, Wisconsin, by F. Glenn Goff, James H. Zimmerman, and Paul H. Zedler, summer, 1964. Specimens are on file at The University of Wisconsin Herbarium, Madison. Nomenclature is according to Gleason (1958).

H *Asclepias incarnata.* Swamp milkweed
H *Asclepias ovalifolia.* Milkweed
H *Asclepias syriaca.* Common milkweed
H *Asclepias tuberosa.* Butterflyweed
L *Asparagus officinalis.* Asparagus
H *Aster azureus.* Azure aster
H *Aster cordifolius.* Blue wood aster
H *Aster laevis.* Smooth aster
H *Aster lateriflorus.* Calico aster
H *Aster macrophyllus.* Bigleaf aster
H *Aster ptarmicoides.* White upland aster
HB *Aster puniceus.* Red-stem swamp aster
H *Aster sagittifolius.* Arrow-leaf aster
HB *Aster simplex.* White marsh aster
F *Athyrium filix-femina.* Lady fern
F *Athyrium thelypteroides.* Silvery spleenwort
HW *Berteroa incana.* Hoary alyssum
T *Betula lutea.* Yellow birch
T *Betula papyrifera.* White birch
SB *Betula pumila.* Swamp birch
HB *Bidens cernua.* Sticktight
H *Bidens frondosa.* Beggar-ticks
HB *Boehmeria cylindrica.* False nettle
F *Botrychium dissectum.* Dissected grape fern
F *Botrychium virginiaum.* Grape fern
G *Brachyeletrum erectum.*
HB *Brasenia schreberi.* Water-shield
HW *Brassica kaber.* Charlock
G *Bromus kalmii.* Wild chess
G *Bromus sp.* Brome grass

GB *Calamagrostis canadensis.* Bluejoint
LB *Calla palustris.* Water arum
HB *Caltha palustris.* Marsh marigold
HB *Campanula aparinoides.* Marsh bluebell
H *Campanula rotundifolia.* Bluebell
HW *Capsella bursa-pastoris.* Shepherd's purse
G *Carex albursina.* Sedge
G *Carex arctata.* Sedge
G *Carex brevior.* Sedge
GB *Carex bromoides.* Sedge
GB *Carex brunnescens.* Sedge
GB *Carex canescens.* Sedge
G *Carex cephaloidea.* Sedge
G *Carex communis.* Sedge
G *Carex convoluta.* Sedge
G *Carex crawfordii.* Sedge
GB *Carex cristatella.* Sedge
G *Carex deflexa.* Sedge
G *Carex deweyana.* Sedge
G *Carex flava var. fertilis.* Sedge
G *Carex foenea.* Sedge
G *Carex gracillima.* Sedge
G *Carex hirtifolia.* Sedge
G *Carex intumescens.* Sedge
GB *Carex lasiocarpa.* Wiregrass sedge
G *Carex leptonervia.* Sedge
GB *Carex limosa.* Sedge
G *Carex lupulina.* Sedge
G *Carex muhlenbergii.* Sedge
GB *Carex oligosperma.* Wiregrass sedge
GB *Carex pauciflora.* Sedge
G *Carex peckii.* Sedge
G *Carex pedunculata.* Sedge
G *Carex pensylvanica.* Sedge
G *Carex plantaginea.* Sedge
G *Carex projecta.* Sedge
G *Carex retrorsa.* Sedge
G *Carex sprengelii.* Sedge
GB *Carex stipata.* Sedge
GB *Carex stricta.* Tussock sedge
GB *Carex trisperma.* Sedge
GB *Carex tuckermani.* Sedge
G *Carex umbellata.* Sedge
G *Carex viridula.* Sedge
G *Carex woodii.* Sedge
T *Carpinus caroliniana.* Musclewood
T *Carya cordiformis.* Bitternut hickory
H *Castilleja coccinea.* Indian paintbrush
H *Caulophyllum thalictroides.* Blue cohosh
S *Ceanothus americanus.* New Jersey tea
S *Ceanothus ovatus.* Inland Jersey tea
S *Celastrus scandens.* Bittersweet
HW *Cerastium vulgatum.* Mouse-eared chickenweed
HB *Ceratophyllum demersum.* Coontail
SB *Chamaedaphne calyculata.* Leatherleaf
HB *Chelone glabra.* Turtlehead
HW *Chenopodium album.* Lamb's quarters
HW *Chenopodium hybridum.* Mapleleafed goosefoot
H *Chimaphila umbellata.* Pipsissewa
H *Chrysanthemum leucanthemum.* Ox-eye daisy
FB *Chrysosplenium americanum.* Water carpet
HB *Cicuta bulbifera.* Water hemlock
HB *Cicuta maculata.* Spotted cowbane
G *Cinna arundinacea.* Stout woodreed
G *Cinna latifolia.* Drooping woodreed

H *Circaea alpina.* Northern enchanter's nightshade
H *Circaea quadrisulcata.* Enchanter's nightshade
HW *Cirsium arvense.* Canada thistle
H *Cirsium discolor.* Prairie thistle
H *Cirsium muticum.* Swamp thistle
HW *Cirsium vulgare.* Bull thistle
H *Claytonia caroliniana.* Carolina spring beauty
H *Claytonia virginiana.* Spring beauty
S *Clematis virginiana.* Virgin's bower
L *Clintonia borealis.* Bluebead lily
H *Comandra richardsiana.* Bastard toadflax
S *Comptonia peregrina.* Sweet fern
H *Conopholis americana.* Squaw root
HW *Convolvulus arvense.* Field bindweed
H *Convolvulus sepium.* Hedge bindweed
H *Convolvulus spithamaeus.* Low bindweed
H *Coptis trifolia.* Goldthread
L *Corallorhiza maculata.* Spotted coral-root
L *Corallorhiza striata.* Spriped coral-root
S *Cornus alternifolia.* Alternate-leaved dogwood
H *Cornus canadensis.* Bunchberry
S *Cornus obliqua.* Silky dogwood
S *Cornus racemosa.* Grey dogwood
S *Cornus rugosa.* Round-leafed dogwood
SB *Cornus stolonifera.* Red osier dogwood
H *Corydalis sempervirens.* Corydalis
S *Corylus americana.* American hazel
S *Corylus cornuta.* Beaked hazel
T *Crataegus spp.* Hawthorn
H *Cryptotaenia canadensis.* Honewort
HB *Cuscuta sp.* Dodder
G *Cyperus filiculmis.* Umbrella sedge
G *Cyperus schweinitzii.* Umbrella sedge
GB *Cyperus strigosus.* Umbrella sedge
GB *Cyperus rivularis.* Umbrella sedge
L *Cypripedium acaule.* Stemless lady's slipper
L *Cypripedium pubescens.* Yellow lady's slipper
F *Cystopteris bulbifera.* Bladder fern

GW *Dactylis glomerata.* Orchard grass
G *Danthonia spicata.* Poverty grass
H *Dentaria diphylla.* Toothwort
H *Desmodium canadense.* Canada tick trefoil
H *Desmodium glutinosum.* Woodland tick trefoil
H *Desmodium nudiflorum.* Naked tick trefoil
H *Dicentra canadensis.* Squirrel corn
H *Dicentra cucullaria.* Dutchman's breeches
S *Diervilla lonicera.* Bush honeysuckle
GW *Digitaria sanguinalis.* Crab grass
H *Dioscorea villosa.* Wild yam
S *Dirca palustris.* Leatherwood
H *Drosera intermedia.* Sundew
H *Drosera rotundifolia.* Round-leaf sundew
F *Dryopteris cristata.* Crested wood fern
F *Dryopteris disjuncta.* Oak fern
F *Dryopteris goldiana.* Goldie's fern
F *Dryopteris hexagonoptera.* Broad beech fern
F *Dryopteris phegopteris.* Long beech fern
F *Dryopteris spinulosa.* Spinulose shield fern
FB *Dryopteris thelypteris.* Marsh fern
GB *Dulichum arundinaceum.* Three-way sedge

GW *Echinochloa crusgalli.* Barnyard grass
HB *Echinocystis lobata.* Wild cucumber
GB *Eleocharis intermedia.* Spike rush
GB *Eleocharis palustris.* Spike rush
LB *Elodea canadensis.* Waterweed
GW *Elymus canadensis.* Wild rye
G *Elymus virginicus.* Virginia wild rye
H *Epifagus virginiana.* Beech drops
H *Epigaea repens.* Trailing arbutus
H *Epilobium angustifolium.* Fireweed
HB *Epilobium coloratum.* Willow herb
HB *Epilobium strictum.* Willow herb
H *Equisetum arvense.* Horsetail
HB *Equisetum fluviatile.* Horsetail
F *Equisetum hyemale.* Scouring rush
F *Equisetum sylvaticum.* Horsetail
GW *Eragrostis capillaris.* Lace grass
G *Eragrostis spectabilis.* Tumble-grass
H *Erechtites hieracifolia.* Pilewort
H *Erigeron annuus.* Fleabane
H *Erigeron philadelphacus.* Fleabane
HW *Erigeron strigosus.* Fleabane
GB *Eriocaulon septangulare.* Pipewort
GB *Eriophorum spissum.* Cottongrass
GB *Eriophorum virginicum.* Cottongrass

HW *Erysimum cheiranthoides.* Wormseed mustard
L *Erythronium americanum.* Trout lily
HB *Eupatorium maculatum.* Joe-Pye-weed
HB *Eupatorium perfoliatum.* Thoroughwort
H *Eupatorium rugosum.* White snake root
H *Euphorbia corollata.* Flowering spurge
H *Euphorbia supina.* Milk-purslane

T *Fagus grandifolia.* Beech
G *Festuca obtusa.* Fescue
G *Festuca rubra.* Red fescue
H *Fragaria virginica.* Wild strawberry
T *Fraxinus americana.* White ash
TB *Fraxinus nigra.* Black ash

GW *Galeopsis tetrahit.* Hemp-nettle
HW *Galinsoga parviflora.* Kew-weed
H *Galium aparine.* Cleavers
HB *Galium asprellum.* Rough bedstraw
H *Galium boreale.* Northern bedstraw
H *Galium circaezans.* Wild licorice
HB *Galium tinctorium.* Bedstraw
HB *Galium trifidum.* Three cleft bedstraw
H *Galium triflorum.* Sweet scented bedstraw
H *Gaultheria hispidula.* Maidenhair berry
H *Gaultheria procumbens.* Wintergreen
S *Gaylussacia baccata.* Huckleberry
HB *Gentiana andrewsii.* Bottled gentian
HB *Gentiana crinita.* Fringed gentian
H *Geranium maculatum.* Wild geranium
H *Gerardia tenuifolia.* Slender leafed Gerardia
H *Geum canadense.* White avens
HB *Geum strictum.* Yellow avens
HW *Glecoma hederacea.* Creeping charley
GB *Glyceria canadensis.* Manna grass
GB *Glyceria grandis.* Reed meadow grass
GB *Glyceria striata.* Manna grass
H *Gnaphalium obtusifolium.* Cudweed
H *Gnaphalium uliginosum.* Low cudweed
L *Goodyera pubescens.* Rattlesnake plaintain
L *Goodyera repens.* Dwarf rattlesnake plantain

L *Habenaria psycodes.* Small purple fringed orchis
H *Hackelia virginiana.* Beggar's lice
S *Hamamelis virginiana.* Witch hazel
H *Hedeoma hispida.* Mock penny
H *Helenium autumnale.* Sneeze weed
H *Helianthemum bicknellii.* Frostweed
H *Helianthus giganteus.* Giant sunflower
H *Helianthus occidentalis.* Two-leaved sunflower
H *Helianthus strumosus.* Rough-leaved sunflower
L *Hemerocallis fulva.* Day lily
G *Hemicarpha micrantha.* Sedge
H *Hepatica acutiloba.* Hepatica
H *Hepatica americana.* Northern hepatica
H *Heracleum lanatum.* Cow parsnip
H *Heuchera richardsonii.* Alum-root
H *Hieracium sp.* Hawkweed
H *Hieracium aurantiacum.* Devil's paint brush
H *Hieracium canadense.* Canada hawkweed
G *Hordeum jubatum.* Squirrel-tail grass
H *Houstonia longifolia.* Bluets
S *Hudsonia tomentosa.* False heather
HB *Hydrocotyle americanum.* Water pennywort
H *Hydrophyllum virginicum.* Virginia water leaf
H *Hypericum Kalmianum.* Kalm's St. John's wort
H *Hypericum perforatum.* St. John's wort
HB *Hypericum pyramidatum.* Giant St. John's wort
G *Hystrix patula.* Bottle-brush grass

S *Ilex verticillata.* Winterberry
H *Impatiens biflora.* Spotted touch-me-not
H *Impatiens pallida.* Pale touch-me-not
LB *Iris versicolor.* Blue flag

T *Juglans cinerea.* Butternut
G *Juncus effusus.* Soft rush
G *Juncus tenuis.* Slender rush
G *Juncus sp.* Rush
S *Juniperus communis.* Common juniper
T *Juniperus virginiana.* Red cedar

SB *Kalmia polifolia.* Bog laurel
G *Koeleria cristata.* June grass
H *Krigia biflora.* Dwarf dandelion

H *Lactuca biennis.* Wild lettuce
H *Lactuca canadensis.* Canada wild lettuce
TB *Larix laricina.* Tamarack
H *Lathyrus ochroleucus.* Wild pea
H *Lathyrus palustris.* Swamp pea
H *Lathyrus venosus.* Veiny wild pea
H *Lechea intermedia.* Pinweed
SB *Ledum groenlandicum.* Labrador tea
GB *Leersia oryzoides.* Rice cutgrass
H *Lespedeza capitata.* Prairie bush clover
H *Liatris aspera.* Blazing star
H *Liatris cylindracea.* Blazing star
L *Lilium michiganese.* Turk's cap lily
H *Linaria canadensis.* Old field toad-flax
H *Linaria vulgaris.* Butter and eggs
H *Linnaea borealis.* Twin flower
H *Linum sulcatum.* Furrowed flax
H *Lithospermum canescens.* Hoary puccoon
H *Lithospermum croceum.* Yellow puccoon
H *Lobelia inflata.* Indian tobacco
HB *Lobelia Kalmii.* Kalm's Lobelia
HB *Lobelia siphilitica.* Blue Lobelia
S *Lonicera canadensis.* American fly honeysuckle
S *Lonicera dioica.* Smooth honey-suckle
S *Lonicera tatarica.* Tartarian honey-suckle
S *Lonicera villosa.* Mountain fly honeysuckle
H *Lupinus perennis.* Lupine
G *Luzula acuminata.* Wood rush
HW *Lychnis alba.* White cockle
F *Lycopodium annotinum.* Stiff club-moss
F *Lycopodium clavatum.* Wolf's claws
FB *Lycopodium inundatum.* Bog club-moss
F *Lycopodium lucidulum.* Shining clubmoss
F *Lycopodium obscurum.* Ground pine
HB *Lycopus americanus.* American water horehound
HB *Lycopus uniflorus.* Water hore-hound
H *Lysimachia quadrifolia.* Whorled loosestrife
HB *Lysimachia terrestris.* Swamp candles
HB *Lysimachia thyrsiflora.* Tufted loose-strife

L *Maianthemum canadense.* Canada mayflower
HW *Matricaria matricarioides.* Pineapple weed
H *Medeola virginiana.* Cucumber root
HW *Medicago lupulina.* Black medic
H *Melampyrum lineare.* Cow wheat
H *Melilotus alba.* Sweet clover, white
H *Melilotus officinalis.* Sweet clover, yellow
H *Menispermum canadensis.* Moonseed
HB *Mentha arvenis.* Wild mint
HB *Menyanthes trifolia.* Buckbean
G *Milium effusum.* Millet grass
HB *Mimulus ringens.* Monkey flower
H *Mirabilis nyctaginea.* Wild four o'clock
H *Mitchella repens.* Partridge berry
H *Mitella diphylla.* Bishop's cap
H *Mitella nuda.* Miterwort
HW *Mollugo verticillata.* Mollugo
H *Monarda fistulosa.* Wild bergamot
H *Moneses uniflora.* One-flowered wintergreen
G *Muhlenbergia sp.* Muhly grass
S *Myrica gale.* Sweet gale
HB *Myriophyllum heterophyllum.* Water milfoil

LB *Najas flexius.* Water naiad
SB *Nemopanthus mucronatus.* Moun-tain holly
HB *Nuphar variegatum.* Spatter dock
HB *Nymphea odorata.* White water lily

H *Oenothera biennis.* Evening prim-rose
H *Oenothera parviflora.* Small flowered evening primrose
G *Oryzopsis asperifolia.* Woodland ricegrass
G *Oryzopsis pungens.* Tufted rice-grass
G *Oryzopsis racemosa.* Large ricegrass
H *Osmorhiza Claytoni.* Sweet cicely
H *Osmorhiza longistylis.* Anise-root
FB *Osmunda cinnamomea.* Cinnamon fern
F *Osmunda Claytoniana.* Interrupted fern
FB *Osmunda regalis.* Royal fern
T *Ostyra virginiana.* Ironwood
H *Oxalis montana.* Common wood sorrel
HW *Oxalis stricta.* Wood sorrel

H *Panax quinquefolium.* Ginseng
H *Panax trifolium.* Dwarf ginseng
G *Panicum capillare.* Old witch grass
GW *Panicum virgatum.* Prairie switch grass

S *Parthenocissus vitacea.* Woodbine
HW *Pastinaca sativa.* Wild parsnip
H *Pedicularis canadensis.* Wood betony
HB *Pedicularis lanceolata.* Marsh lousewort
HB *Penthorum sedoides.* Ditch stonecrop
GW *Phleum pratense.* Timothy
H *Phlox divaricata.* Woodland phlox
H *Phlox pilosa..* Prairie phlox
H *Phyrma leptostachya.* Lopseed
H *Physalis virginiana.* Ground cherry
S *Physocarpus opulifolius.* Ninebark
HB *Physostegia virginiana.* False dragonhead
T *Picea glauca.* White spruce
TB *Picea mariana.* Black spruce
T *Picea pungens.* Colorado blue spruce
H *Pilea pumila.* Clearweed
T *Pinus banksiana.* Jack pine
T *Pinus mugo.* Mugo pine
T *Pinus resinosa.* Red pine
T *Pinus strobus.* White pine
T *Pinus sylvestris.* Scotch pine
HW *Plantago major.* Broad-leaved plantain
HW *Plantago rugelii.* Rugel's plantain
G *Poa alsodes.* Woodland bluegrass
GW *Poa annua.* Annual bluegrass
GW *Poa compressa.* Canada bluegrass
GB *Poa palustris.* Fowl-meadow grass
GW *Poa pratensis.* Kentucky bluegrass
H *Podophyllum peltatum.* Mayapple
H *Polygala pauciflora.* Gay-wings
H *Polygala polygama.* Milkwort
H *Polygonatum biflorum.* Solomon's seal
H *Polygonatum canaliculatum.* Large Solomon's seal
H *Polygonella articulatea.* Jointweed
H *Polygonum cilinode.* Climbing buckwheat
HB *Polygonum hydropiper.* Water pepper
HB *Polygonum lapathifolium.* Dock-leaved smartweed
HB *Polygonum pensylvanicum.* Pennsylvania smartweed
HB *Polygonum saggitatum.* Arrow-leaved tearthumb
HB *Polygonum sp.* Smartweed
F *Polypodium virginianum.* Rock polybody
LB *Pontederia cordata.* Pickerelweed
T *Populus alba.* Silver poplar
T *Populus balsamifera.* Balm-of-Gilead
T *Populus deltoides.* Cottonwood
T *Populus grandidentata.* Large-toothed aspen
T *Populus tremuloides.* Trembling aspen
HB *Portulaca oleracea.* Purslane
LB *Potamogeton sp.* Pondweed
HB *Potentilla argentea.* Silver cinquefoil
H *Potentilla arguta.* Tall cinquefoil
H *Potentilla norvegica.* Cinquefoil
HB *Potentilla palustris.* Bog cinquefoil
H *Potentilla simplex.* Old field cinquefoil
H *Prenanthes alba.* White lettuce
H *Prunella laciniata.* Lance-leafed selfheal
H *Prunella vulgaris.* Selfheal
T *Prunus pensylvanica.* Pin cherry
S *Prunus pumila.* Sand cherry
T *Prunus serotina.* Black cherry
T *Prunus virginiana.* Choke cherry
GB *Psilocarya scirpoides.* Bald rush
F *Pteretis nodulosa.* Ostrich fern
F *Pteridium aquilinum.* Bracken fern
HG *Pyrola elliptica.* Shinleaf
H *Pyrola rotundifolia.* Round-leafed wintergreen
H *Pyrola secunda.* One-sided wintergreen
HH *Pyrola virens.* Green pyrola

T *Quercus alba.* White oak
T *Quercus bicolor.* Swamp white oak
T *Quercus borealis.* Northern red oak
T *Quercus ellipsoidalis.* Hill's oak
T *Quercus macrocarpa.* Bur oak

H *Ranunculus abortivus.* Small-flowered buttercup
H *Ranunculus acris.* Buttercup
HB *Ranunculus pensylvanicus.* Bristly crowfoot
H *Ranunculus recurvatus.* Woodland buttercup
H *Ratibida pinnata.* Yellow coneflower
S *Rhamnus alnifolius.* Buckthorn
S *Rhus radicans.* Poison ivy
S *Rhus typhina.* Staghorn sumac
GB *Rhynchospora alba.* Beak rush
S *Ribes cynosbati.* Prickly gooseberry
S *Ribes glandulosum.* Skunk currant
S *Ribes lacustre.* Swamp currant
S *Ribes nigrum.* Black currant
T *Robinia pseudoacacia.* Black locust
S *Rosa carolina.* Prairie wild rose
S *Rosa palustris.* Swamp wild rose
S *Rubus canadensis.* Canada blackberry

S *Rubus occidentalis.* Black raspberry
S *Rubus pubescens.* Dwarf raspberry
S *Rubus sp.* Dewberry
S *Rubus strigosus.* Red raspberry
H *Rudbeckia hirta.* Black-eyed susan
H *Rudbeckia laciniata.* Cleft-leaved black-eyed susan
H *Rumex acetosella.* Sheep sorrel
H *Rumex altissiumus.* Pale dock
H *Rumex crispus.* Curly dock

LB *Sagittaria latifolia.* Arrowhead
LB *Sagittaria rigida.* Arrowhead
T *Salix babylonica.* Weeping willow
SB *Salix discolor.*. Pussy willow
S *Salix humilis.* Prairie willow
S *Salix interior.* Sand bar willow
S *Salix lucida.* Shining willow
T *Salix nigra.* Black willow
SB *Salix pedicellaris.* Bog willow
S *Salix petiolaris.* Slender willow
S *Salix pyrifolia.* Balsam willow
S *Sambucus canadensis.* Elderberry
S *Sambucus pubens.* Red elderberry
H *Sanguinaria canadensis.* Bloodroot
H *Sanicula gregaria.* Black snakeroot
H *Sanicula marilandica.* Black snakeroot
HW *Saponaria officinalis.* Bouncing Bet
HB *Sarracenia purpurea.* Pitcher plant
LB *Scheuchzeria palustris.*
G *Schizachne purpurascens.* False melic grass
GB *Scirpus americanus.* Sword grass
GB *Scirpus atrovirens.* Bulrush
GB *Scirpus debilis.* Bulrush
H *Scrophularia lanceolata.* Figwort
HB *Scutellaria epilobiifolia.* Common skullcap
HB *Scutellaria lateriflora.* Skullcap
F *Selaginella rupestris.* Rock spikemoss
H *Senecio pauperculus.* Ragwort
GW *Setaria lutescens.* Yellow foxtail
HW *Silene Cucubalus.* Bladder campion
H *Silphium perfoliatum.* Cup-plant
HW *Sisymbrium officinale.* Tumble mustard
L *Sisyrinchium sp.* Blue-eyed grass
HB *Sium suave.* Water parsnip
L *Smilacina racemosa.* False Solomon's seal
L *Smilacina stellata.* Starry false Solomon's seal
LB *Smilacina trifolia.* Three-leaved false Solomon's seal
S *Smilax herbacea.* Carrion flower
S *Smilax hispida.* Bristly greenbriar
H *Solanum carolinense.* Horse nettle
S *Solanum dulcamara.* Bitter nightshade
HW *Solanum nigrum.* Black nightshade
H *Solidago altissima.* Common goldenrod
H *Solidago canadensis.* Canada goldenrod
H *Solidago flexicaulis.* Zig-zag goldenrod
H *Solidago gigantea.* Giant goldenrod
H *Solidago gramnifolia.* Narrow-leaf goldenrod
H *Solidago juncea.* Early goldenrod
H *Solidago nemoralis.* Old field goldenrod
H *Solidago speciosa.* Showy goldenrod
T *Sorbus americana.* Mountain ash
G *Sorghastrum nutans.* Indian grass
GB *Sparganium eurycarpum.* Bur reed
G *Spartina pectinata.* Cordgrass
H *Specularia perfoliata.* Venus' looking glass
SB *Spiraea alba.* Meadowsweet
SB *Spiraea tomentosa.* Steeple bush
L *Spiranthes gracilis.* Lady's tresses
GW *Sporobolus neglectus.* Dropseed
H *Stachys sp.* Hedge nettle
HW *Stellaria media.* Chickweed
G *Stipa spartea.* Needle and thread grass
L *Streptopus roseus.* Twisted stalk
S *Symphoricarpos albus.* Snowberry
S *Syringa vulgaris.* Lilac

HW *Tanacetum vulgare.* Tansy
HW *Taraxacum officinale.* Dandelion
T *Taxus canadensis.* Canada yew
HB *Thalictrum dasycarpum.* Tall meadow rue
H *Thalictrum dioicum.* Woodland meadow rue
T *Thuja occidentalis.* White cedar
T *Tilia americana.* Basswood
HW *Tragopogon sp.* Goat's beard
HB *Triadenum virginicum.* Marsh St. John's wort
H *Trientalis borealis.* Star flower
HW *Trifolium hybridum.* Alsike clover
HW *Trifolium pratense.* Red clover
HW *Trifolium procumbens.* Low hop clover
HW *Trifolium repens.* White clover
L *Trillium cernuum.* Modding trilium
L *Trillium grandiflorum.* Large flowered trilium

H *Triosteum aurantiacum.* Horse gentian
T *Tsuga canadensis.* Hemlock

T *Ulmus americana.* American elm
T *Ulmus pumila.* Chinese elm
T *Ulmus rubra.* Slippery elm
HB *Urtica procera.* Nettle
HB *Utricularia resupinata.* Bladderwort
L *Uvularia grandiflora.* Large flowered bellwort
L *Uvularia sessilifolia.* Wild oats

S *Vaccinium angustifolium.* Blueberry
SB *Vaccinium macrocarpon.* Cranberry
S *Vaccinium myrtilloides.* Downy blueberry
LB *Vallisneria americana.* Eelgrass
HW *Verbascum blattaria.* Moth mullein
HW *Verbascum thapsus.* Mullein
H *Verbena hastata.* Blue vervain
HW *Verbena urticifolia.* White vervain
HW *Veronica serpyllifolia.* Thyme-leafed speedwell
H *Veronicastrum virginicum.* Culver's root
S *Viburnum acerifolium.* Maple-leafed viburnum
S *Viburnum dentatum.* Arrow wood
S *Viburnum lentago.* Nannyberry
H *Vicia caroliniana.* Wood vetch
H *Viola canadensis.* White violet.
H *Viola pensylvanica.* Yellow violet
H *Viola incognita.* Small white violet
H *Viola renifolia.* Kidney-leafed violet
H *Viola pallens.* Pale violet
H *Viola selkirkii.* Selkirk's violet
H *Viola adunca.* Dog violet
H *Viola pedata.* Birdfoot violet
H *Viola sororia.* Woodland blue violet
H *Viola cucullata.* Swamp blue violet
H *Viola lanceolata.* Lance-leafed violet
H *Vitis riparia.* River grape

H *Waldseteinia fragarioides.* False strawberry

S *Xanthoxylum americanum.* Prickly ash

GB *Zizania aquatica.* Wild rice

TABLE 37a. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTRY

Horizon	Depth (inches)	pH[2]	B.D.[3]	Particle Size Distribution Analysis[4]									Texture[5]	Pore space[6] (%)	Oven-dry roots/ ft²x1″ (g.)	%C[7]	%N[7]
				C (%)	fsi (%)	msi (%)	csi (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)					
Brill Silt Loam (SW¼, SE¼, SE¼, Sec. 5, T. 30N., R. 13E.)																	
011 & 012	1–0	6.0	....	..	..	..	..	..	..	..	..	..	......	....	......	....	1.35
A1	0–6	5.4	......	11	10	45	18	9	3	3	1	0	sil	....	26.4	6.8	0.23
A2	6–8	5.1	1.1	16	12	32	25	11	2	2	0	0	sil	57	25.0	7.3	0.13
A2x	8–14	5.1	1.5	11	11	33	30	12	1	1	1	0	sil	43	2.4	1.0	0.05
B11x	14–17	5.1	1.6	18	9	31	27	12	1	1	1	0	sil	38	0.8	0.3	0.03
B12x	17–20	4.8	1.6	24	8	27	30	9	1	1	0	0	sil	38	0.5	0.4	0.03
B13	20–28	4.8	1.7	26	6	25	25	11	3	3	1	0	sil	35	0.4	0.5	0.03
B2	28–36	4.7	1.6	20	5	22	16	15	8	10	4	Tr	l	31	....	0.2	0.02
IIB3	36–40	4.7	1.8	12	4	15	15	16	12	16	9	1	sl	32	....	0.5	0.02
IIC1	40–43	4.7	1.8	10	2	11	10	15	17	21	13	1	sl	30	....	0.2	0.02
IIC2	43–45	5.1	1.8	4	Tr	1	1	7	27	38	21	1	s	32	....	0.4	0.01
IIC3	45–46	5.1	1.8	3	0	0	0	2	29	60	6	Tr	s	34	....	1.0	0.02
IIC4	46–55	5.2	1.7	0	0	0	0	4	34	58	4	Tr	s	36	....	0.1	0.01
Norrie Silt Loam (NE¼, NW¼, NW¼, Sec. 18, T. 29N., R. 13E.)																	
012	¼–0	6.1	....	..	..	..	..	..	..	..	..	..	....	....	....	....	1.83
A1	0–4	5.3	....	12	2	25	29	6	8	12	4	2	sil	..	13.0	....	0.57
A21	4–6	5.0	1.4	15	8	30	15	10	7	10	3	2	sil	48	3.9	2.8	0.14
A22	6–12	4.9	1.3	10	8	34	19	10	6	6	5	2	sil	51	1.0	1.5	0.06
A22	12–14	5.0	1.6	10	7	30	23	2	5	7	6	10	sil	29	Tr	1.2	0.03

TABLE 37a. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTRY (CONTINUED)

Horizon	Depth (inches)	pH[2]	B.D.[3]	Particle Size Distribution Analysis[4]									Texture[5]	Pore space[6] (%)	Oven-dry roots/ ft²x1" (g.)	%C[7]	%N[7]
				C (%)	fsi (%)	msi (%)	csi (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)					
Norrie Silt Loam (NE¼, NW¼, NW¼, Sec. 18, T. 29N., R. 13E.)																	
B1	14–19	4.8	1.7	19	7	21	29	9	5	5	4	1	sil	37	0.5	0.5	0.02
B2	19–37	4.6	1.6	21	7	22	26	10	4	6	3	1	sil	38	....	0.3	0.02
IIB3	37–41	4.8	1.8	12	2	7	8	14	19	32	5	1	sl	31	....	0.1	0.02
IIC1	41–50	4.9	1.7	9	1	4	2	14	28	32	7	3	ls	34	....	0.3	0.01
IIIC2	50–69	6.0	1.8	7	1	1	1	8	25	38	14	5	s	32	....	0.1	0.01
IIIC3	69–93	7.7	1.5	7	1	1	1	9	25	37	13	6	s	43	....	0.1	0.01

1. Analyses were made by G. W. Olson (1962).
2. pH by Coleman pH Electrometer — Model 18A.
3. Bulk density: averages of determinations on 4 peds, paraffin-coated, per horizon.
4. Abbreviations of U.S.D.A. separates are: c = clay; fsi = fine silt; msi = medium silt; csi = coarse silt; vfs = very fine sand; fs = fine sand; ms = medium sand; cs = coarse sand; vcs = very coarse sand. The hydrometer method of Day (1956) was used.
5. Abbreviations are: sil = silt loam; sl = sandy loam; ls = loamy sand; s = sand.
6. Pore space percentages was calculated from B.D. values by the formula:

$$\% \text{ vol. p.s.} = \frac{\text{B.D.}}{\text{Sp.G.}} \text{x } 100. \qquad \text{Sp. G.} = 2.65 \text{ g./cc.}$$

7. % carbon by method of Walkley and Black (1934).
8. % organic and ammonium nitrogen by Kjeldahl method (Jackson, 1958).

TABLE 37b. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY

Horizon	Depth (Inches)	C.E.C.[2] (m.e./100 g.)	Exchangeable Cations[3] Ca	Mg	K	Na	Base Sat. (%)	"Free"[4] Fe (%)	Available Nutrients N[5]	P[6]	P[7] (Bray)	K[8] (Wet)	K[9] (Dry)
									(Lbs./Acre per 6" Layer of Soil)				
					Brill Silt Loam (SW¼, SE¼ SE¼ Sec. 5, T. 30N., R. 13E.)								
011 & 012	1–0	....	....	....	....	....	....	....	175	52	....	145	150
A1	0–6	20.3	6.1	1.4	0.32	0.14	39	1.4	325	9	32	60	95
A2	6–8	11.1	1.8	0.4	0.18	0.13	23	1.6	175	3	20	24	70
A2x	8–14	7.0	1.1	0.2	0.10	0.12	21	1.4	150	1	22	25	105
B11x	14–17	9.2	3.4	0.9	0.15	0.13	49	1.6	50	Tr	14	21	135
B12x	17–20	13.0	5.4	1.6	0.20	0.16	62	2.0	100	Tr	12	18	150
B13	20–28	13.5	5.8	1.7	0.2	0.16	58	2.0	75	Tr	15	15	110
B2	28–36	11.1	4.1	1.5	0.20	0.16	54	1.8	75	5	24	12	80
IIB3	36–40	7.3	2.3	0.8	0.17	0.15	45	1.2	25	48	38	15	85
IIC1	40–43	8.7	2.9	1.1	0.10	0.16	49	1.2	25	70	30	6	50
IIC2	43–45	3.7	0.8	0.4	0.03	0.04	35	0.7	25	47	24	23	45
IIC3	45–46	5.6	1.3	0.5	0.06	0.05	35	0.9	25	5	26	7	20
IIC4	46–55	2.6	0.7	0.1	0.02	0.03	30	0.5	25	50	16	..	..
					Norrie Silt Loam (NE¼ NW¼ NW¼ Sec. 18, T. 29N., R. 13E.)								
012	¼–0	....	....	....	....	....	....	....	250	31	24	334	230
A1	0–4	38.0	18.1	2.3	0.32	0.08	53	0.7	325	58	89	136	155
A21	4–6	11.2	3.0	0.6	0.15	0.14	35	1.1	225	58	89	32	65
A22	6–12	6.5	1.0	0.3	0.08	0.16	23	1.0	100	59	92	40	70
A22	12–14	4.7	1.0	0.3	0.08	0.12	28	0.9	75	25	40	85	125

TABLE 37b. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY (CONTINUED)

Horizon	Depth (Inches)	C.E.C.[2] (m.e./ 100 g.	Exchangeable Cations[3]				Base Sat. (%)	"Free"[4] Fe (%)	Available Nutrients				
			Ca	Mg	K	Na			N[5]	P[6]	P[7] (Bray)	K[8] (Wet)	K[9] (Dry)
									(Lbs./Acre per 6" Layer of Soil)				
Norrie Silt Loam (NE¼ NW¼ NW¼ Sec. 18, T. 29N., R. 13E.)													
B1	14-19	8.6	2.0	0.7	0.17	0.14	35	1.3	75	18	32	61	145
B2	19-37	12.0	3.4	1.4	0.22	0.16	43	1.5	50	97	52	43	90
IIB3	37-41	4.6	1.9	0.8	0.11	0.12	64	1.0	50	160	46	46	80
IIC1	41 50	4.0	1.6	0.7	0.08	0.12	62	0.8	25	165	31	62	90
IIIC2	50-69	3.3	1.9	1.1	0.08	0.13	97	0.5	25	198	13	72	100
IIIC3	69-93	4.8	3.2	2.7	0.08	0.10	128	0.3	25	250	10	. .	60

1. Analyses by G. W. Olson except for available N which was determined by H. H. Hull, R. B. Corey, and coworkers.
2. Cation exchange capacity determined by magnesium saturation, sodium displacement of magnesium, and measurement of Mg ion by EDTA titration.
3. Exchangeable cations (m.e.) determined by extraction with NH_4OAc and measurement of solution cation content on a Beckman Model DU Flame Photometer.
4. Reductant — soluble iron content determined with an Evelyn Photoelectric Colorimeter by methods outlined by Jackson (1956).
5. Determined colorimetrically with Nessler's reagent.
6. Determined colorimetrically as phosphovanadomolybdate complex, after extraction with 0.3 **N** HC1.
7. Determined colorimetrically as phosphomolybdate + $SnC1_2$, after extraction with 0.03 **N** NH_4F and 0.025 **N** HC1.
8. Determined with a Perkin-Elmer Model 52C Flame Photometer on soil extract remaining after P determinations. Soil samples at field moisture content were used.
9. As in footnote number 8, except that soil samples were air-dried before analysis.

TABLE 37c. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY

Horizon	Depth (inches)	pH[2]	Particle Size Distribution Analysis[3]							Texture[4]	C.E.C.[5]	Exchangeable Cations[6] (m.e./100 g.)				Base[7] Sat. (%)	C[8] (%)	N[9] (%)	"Free"[10] Fe (%)
			c (%)	si (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)			Ca	Mg	K	Na				
Iron River Silt Loam (SE¼, NW¼ Sec. 27, T. 30N., R. 14E.)																			
A1	0–2	. .	25	53	6	6	8	2	Tr	sil	45	23.7	5.77	1.11	0.50	70	9.1	1.13	0.7
A2	2–5	5.3	15	46	10	9	16	4	Tr	l	7	2.7	0.76	0.13	0.02	55	1.0	0.10	0.9
Bhir	5–10	5.4	8	55	14	8	12	3	Tr	sil	8	2.7	0.82	0.09	0.07	44	1.0	0.08	1.1
A'2x	10–16	5.5	8	61	12	7	10	2	Tr	sil	5	0.4	0.16	0.05	0.01	10	0.5	0.05	0.9
B'2x	16–21	5.3	10	43	14	12	16	4	1	l	6	0.9	0.67	0.08	0.04	40	0.3	0.03	1.2
IIB3 IIC1	21–27 27–50	5.4 5.5	8	5	3	6	38	30	10	s	2	1.4	0.97	0.12	0.02	123	0.1	0.01	0.7
Iron River Silt Loam (Center, Sec. 12, T. 30N., R. 13E.)																			
A2	0–5	5.0	10	56	8	4	11	9	2	sil	6	0.7	0.25	0.08	0.10	17	0.80	0.08	0.9
Bhir	5–10	5.2	14	49	11	4	12	9	1	l	7	0.1	0.11	0.07	0.08	5	0.89	0.07	1.2
Bir	10–15	5.3	8	59	13	5	13	9	1	sil	6	0.1	0.08	0.10	0.09	6	0.61	0.05	1.0
B'21x	15–18	5.4	15	43	8	5	15	12	2	l	7	0.1	0.17	0.06	0.02	5	0.30	0.02	1.2
IIB'22x	18–21	5.4	20	21	7	5	24	21	2	l	10	1.2	1.14	0.16	0.03	25	0.16	0.02	1.4
IIC1	21–34	5.2	10	4	1	2	36	43	4	ls	5	1.2	1.05	0.16	0.02	47	0.07	0.01	0.7
IIC2	34–50	5.4	8	0	1	1	44	43	3	s	. .	.	. .	. .	. .	. .	. .	. .	. .
IIC3	50–60	5.5	7	Tr	2	1	34	48	6	s	. .	. .	. .	. .	. .	. .	. .	.	. .

TABLE 37c. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY (CONTINUED)

Horizon	Depth (inches)	pH[2]	Particle Size Distribution Analysis[3]							Texture[4]	C.E.C.[5]	Exchangeable Cations[6] (m.e./100 g.)				Base[7] Sat. (%)	C[8] (%)	N[9] (%)	"Free"[10] Fe (%)
			c (%)	si (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)			Ca	Mg	K	Na				
Kennan Loam (Center, Sec. 11, T. 29N., R. 13E)																			
A1	0–3½	5.8 5.0	6	29	14	24	24	3	Tr	sl	9	4.6	1.01	0.19	5.89	68	2.31	0.10	0.5
A2	3½–9	5.1	8	27	14	26	22	3	Tr	sl	4	1.1	0.58	0.16	1.86	44	0.56	0.03	0.6
B21	9–15	5.2	6	27	14	28	22	3	Tr	sl	2	0.3	0.12	0.08	0.08	10	0.26	0.02	0.5
B22	15–20	5.2	6	17	14	33	25	4	1	sl	1	0.3	0.17	0.05	0.05	17	0.08	0.01	0.5
B3	20–26	5.7	6	18	16	36	20	3	1	sl	2	1.0	0.49	0.08	0.08	93	0.05	0.01	0.5
IIC1	26–25	6.2	8	12	15	31	25	7	2	ls	3	1.6	0.72	0.09	0.09	93	0.05	0.01	0.7
IIC2	35–62	6.2	13	39	23	18	6	1	Tr	l	12	3.6	1.40	0.13	0.13	44	0.07	0.01	0.9
Padus Loam (SE¼ Sec. 12, T. 30N., R. 14E.)																			
A1 & A2	0–5	5.9	12	40	9	8	23	7	1	l	9	13.7	1.32	0.28	0.08	80	3.3	0.32	0.8
Bhir	5–8	5.7	12	42	15	7	18	5	1	l	10	4.4	0.66	0.08	0.09	51	1.0	0.07	1.2
Bir	8–13	5.7	10	39	16	9	20	5	1	l	7	1.7	0.40	0.06	0.06	31	0.7	0.03	0.9
A'2x	13–16	5.6	8	42	15	6	22	6	1	l	..	0.9	0.36	0.07	0.07	..	0.2	0.02	0.7
B'21x	16–26	5.5	13	32	13	11	23	6	2	sl	5	2.0	0.90	0.08	0.06	56	0.2	0.01	1.0
B'22x	26–35	5.5	10	35	15	11	23	5	1	sl	6	1.8	1.08	0.07	0.07	54	0.1	0.01	0.9
IIC1	35–40	5.4	5	13	10	19	39	12	2	ls	3	0.9	0.60	0.05	0.05	53	0.1	0.01	0.6
IIC2	40–45	5.1	8	27	14	13	28	8	2	sl	..	..	..	..	..	..	..	..	..
IIC3	45–48	5.3	5	26	20	21	23	5	1	sl	..	..	..	..	..	..	..	..	..
IIC4	48–62	5.4	5	20	23	23	21	6	2	ls	..	..	..	..	..	..	..	..	..
IIC5	62–70	5.9	2	1	1	17	56	22	1	s	..	..	..	..	..	..	..	..	..

TABLE 37c. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY (CONTINUED)

Horizon	Depth (inches)	pH[2]	Particle Size Distribution Analysis[3] c (%)	si (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)	Texture[4]	C.E.C.[5]	Exchangeable Cations[6] (m.e./100 g.) Ca	Mg	K	Na	Base[7] Sat. (%)	C[8] (%)	N[9] (%)	Free Fe[10] (%)
Padus Sandy Loam (Center Sec. 6, T. 30N., R. 14E.)																			
A2	0–5	5.0	8	35	16	15	21	4	1	sl	5	0.9	0.49	0.05	0.04	30	0.8	0.07	0.8
Bhir	5–13	5.1	10	24	17	16	27	5	1	sl	8	0.7	0.41	0.08	0.03	15	1.0	0.05	1.1
Bir	13–18	5.1	10	11	25	23	25	5	1	sl	5	0.5	0.31	0.06	0.06	17	0.6	0.05	0.7
A'2x	18–25	5.0	10	22	16	19	26	6	1	sl	5	0.3	0.13	0.05	0.02	11	0.1	0.02	0.7
B'2x	25–32	5.2	10	15	13	20	33	8	1	sl	5	0.9	0.34	0.05	0.07	28	0.1	0.01	0.7
IIC	32–42	5.5	5	0	4	11	55	22	3	s	3	0.5	0.21	0.07	0.00	24	0.1	0.01	0.5
Padus Loam (SE¼ Sec. 19, T. 30N., R. 14E)																			
A2	0–5½	5.0	12	48	12	6	16	6	Tr	l	9	4.0	0.90	0.14	0.07	56	0.8	0.13	1.2
Bir1	5½–7½	5.1	10	50	12	6	15	5	2	l	8	2.8	0.82	0.08	0.07	45	0.8	0.07	1.4
Bir2	7½–11	5.2	8	52	11	8	16	5	1	sil	5	1.5	0.58	0.05	0.11	4	0.5	0.04	1.0
A'2x	11–15	5.4	8	47	11	8	18	7	1	l	4	1.3	0.65	0.05	0.07	54	..	0.01	0.8
B'2x	15–20	5.4	15	33	9	9	22	10	2	l	8	4.0	1.40	0.12	0.08	73	0.2	0.01	1.2
B'3	20–29	5.3	15	20	7	7	28	19	4	sl	9	4.4	1.61	0.18	0.07	69	0.2	0.02	1.1
IIC1	29–40	5.2	8	4	4	6	40	33	5	s	5	2.3	1.15	0.09	0.04	75	0.1	0.01	0.8
IIC2	40–63	5.0	12	1	2	6	34	33	12	ls	..	..	..	..	..	..	..	..	..
IIC3	63–113	6.0	2	0	0	4	58	32	4	s	..	..	..	..	..	..	..	..	..

TABLE 37c. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY (CONTINUED)

Horizon	Depth (inches)	pH[2]	Particle Size Distribution Analysis[3]							Texture[4]	C.E.C.[5]	Exchangeable Cations[6] (m.e./100 g.)				Base[7] Sat. (%)	C[8] (%)	N[9] (%)	Free[10] Fe (%)
			c (%)	si (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)			Ca	Mg	K	Na				
Pence Loam (SW¼ SW¼ NW¼ Sec. 29, T. 30N., R. 14E.)																			
A1	0–2	5.5	..	..	..	..	..	..	..	..	38	23.7	0.99	0.05	0.03	67	10.5	1.26	0.7
A2	2–4	5.0	15	49	10	9	14	3	Tr	l	11	1.9	0.66	0.11	0.01	24	1.4	0.12	1.0
Bhir	4–11	5.1	8	53	10	8	17	4	Tr	sil	10	2.0	0.58	0.08	0.05	27	1.0	0.08	1.1
B2x	11–14	5.3	10	38	9	13	25	5	Tr	l	5	2.0	0.66	0.06	0.01	51	0.3	0.02	1.0
B3	14–19	5.4	12	18	8	13	35	11	3	sl	5	3.3	0.86	0.10	0.01	91	0.2	0.01	1.1
C1	19–42	5.0	5	1	10	26	47	9	2	s	3	1.3	0.44	0.04	0.01	60	0.1	0.01	0.5
C2	42–72	5.4	2	2	12	26	49	7	2	s	..	..	..	..	..	..	..	..	..
Stambaugh Silt Loam (SE¼, SE¼ NE¼ Sec. 21, T. 30N., R. 13E)																			
A2	0–3	4.5	10	52	11	7	14	5	1	sil	10	0.1	0.17	0.06	0.06	19	1.5	0.10	1.2
Bhir	3–7	4.7	15	53	8	5	11	6	2	sil	10	1.1	0.44	0.08	0.06	18	1.2	0.11	0.7
Bir	7–9	5.0	13	56	7	4	12	6	2	sil	9	0.1	0.17	0.04	0.14	4	1.1	0.07	0.7
A'2x	9–16	5.0	10	63	10	4	9	3	1	sil	5	0.3	0.26	0.05	0.09	14	0.4	0.02	0.8
B'2x	16–25	5.1	20	50	10	5	10	4	1	sil	10	3.1	2.02	0.17	0.07	55	0.2	0.01	1.4
IIC1	25–35	5.5	5	0	4	36	51	4	Tr	s	3	0.7	0.72	0.05	0.02	53	0.1	0.01	0.5
IIC2	35–55	6.0	5	0	1	8	40	37	9	s	..	..	..	..	..	..	..	..	..
IIC3	55–80	6.0	5	0	0	7	37	43	8	s	..	..	..	..	..	..	..	..	..
IIC4	80–90	6.5	3	0	Tr	19	61	16	1	s	..	..	..	..	..	..	..	..	..

TABLE 37c. ANALYTICAL DATA[1] FOR SOME SOILS OF MENOMINEE COUNTY (CONTINUED)

Horizon	Depth (inches)	pH[2]	Particle Size Distribution Analysis[3]							Texture[4]	C.E.C.[5]	Exchangeable Cations[6] (m.e./100 g.)				Base[7] Sat. (%)	C[8] (%)	N[9] (%)	Free[10] Fe (%)
			c (%)	si (%)	vfs (%)	fs (%)	ms (%)	cs (%)	vcs (%)			Ca	Mg	K	Na				
								Underhill Loam (NE¼ Sec. 27, T. 29N., R. 15E)											
A1	0–1	5.1	7	32	25	19	15	2	Tr	sl	10	2.7	0.99	0.25	0.07	40	2.5	0.13	0.7
A2	1–6	5.3	8	38	15	20	17	2	Tr	sl	4	0.2	0.21	0.64	0.10	28	1.1	0.05	0.8
Bhir	6–12	5.4	9	37	16	18	16	3	1	sl	5	0.5	0.17	0.05	0.06	17	0.8	0.05	1.0
Birx	12–16	5.6	7	32	19	22	16	3	1	sl	4	0.9	2.80	0.04	0.06	100	0.4	0.03	0.7
A'2x	16–21	5.7	8	24	18	26	19	4	1	sl	3	1.0	0.44	0.03	0.10	25	0.1	0.01	0.7
A'2x & B'21x	21–39	6.0	13	21	18	26	17	4	1	sl	5	3.1	1.40	0.12	0.04	89	0.1	0.01	1.0
IIB'22	39–48	7.0	19	15	15	26	18	5	3	sl	7	6.2	3.52	0.13	0.08	148	0.1	0.01	0.7
IIC1	48–66	8.0	10	27	15	25	17	5	1	sl	5	5.5	3.46	0.10	0.03	171	0.1	0.01	0.6

1. Particle size distribution analyses by J. E. Langton. Other analyses by J. E. Langton and F. W. Madison.
2. Field test by Hellige-Troug quick-test.
3. See footnote number 4, Table 37a.
4. See footnote number 5, Table 37a.
5. See footnote number 2, Table 37b.
6. See footnote number 3, Table 37b.
7. Base saturation % calculated on basis of c.e.c. and sum of exchangeable cations. Hence analytical errors cause base saturation percentages in excess of 100% to appear in the table.
8. See footnote number 7, Table 37a.
9. See footnote number 8, Table 37a.
10. See footnote number 4, Table 37b.

Summer-Resident Birds

Richard Gordon[1]

This summary (Table 38) is restricted to those species present during the summer and presumed to breed, although few nests have actually been located. It is based primarily on 20 days afield by the writer during the warm seasons between 1958 and 1964, by foot and by canoe. Additional data have been contributed by F. Glenn Goff, Fr. Reinhold Link, Tom Soulen, and James Zimmerman. But special thanks are reserved for my friends from Menominee County, notably Don Pecore and Larry Waukau. They have had the kindness to lead me to some of their finest wetlands, but the reticence never to push me in.

Within the county exists a remarkable diversity of interfingering habitats. Sufficiently large and varied communities of conifers hold a regular population of such generally erratic boreal species as Red Crossbill and Evening Grosbeak. The southeast sand plain flora attracts prairie forms such as Dickcissel, and aspen parkland species like Clay-colored Sparrow. Natural forest regeneration and undisturbed ground flora, in the absence of the excessive deer populations found elsewhere in northern Wisconsin, have allowed birds with specific niche requirements to persist here. Thus Hooded Mergansers rear their young on secluded woodland ponds; Black-throated Blue Warblers nest were fallen leafy branches are allowed to remain under mature hardwoods; and Golden-winged Warblers inhabit the edges of natural woodland openings, as well as their typical haunts in open Tamarack swamps. Along tne seage fringe of a conifer-bordered pond, baby Lincoln's Sparrows have been observed being fed by both parents.

NOTES FOR TABLE 38

[1]**Habitat**

F — Forest
H — Hardwood Forest
C — Coniferous Forest
I — Inhabitated Area
E — Edge, including small openings and Aspen thickets
O — Larger openings, including grassland and fields
A — Air (the sky)
b — Bog
m — Marsh
l — Lake, Lake Edge, and Pond
s — Stream and Stream Edge

Note: Lowland communities are in lower case; uplands in upper case. Brushy habitats are underlined.

[2]**Abundance**

C — Common
F — Fairly Common
U — Uncommon
O — Occasional

Note: Differences in abundance between columns II and III indicate either scarcity of the general habitat (see vegetation map), or selectivity of niche within the general habitat.

[1]Student, Department of Zoology, The University of Wisconsin, Madison.

TABLE 38. CHART OF BIRD OCCURRENCE

Species	I General Habitat[1]	II Abundance in Preferred Habitats[2]	III Abundance in County as a Whole[2]
C. Loon	l	C	U
P. B. Grebe	lm	F	U
G. B. Heron	sm	C	F
Green Heron	m	U	O
Am. Bittern	m	F	U
Ducks			
Mallard	lm	F	U
B. W. Teal	lm	U	U
Shoveler	lm	U	O
Wood	lf	C	U
Ring-Necked	lf	U	O
Hooded Merganser	lf	F	U
Common Merganser	ls	U	U
Hawks			
Sharp-Shinned	F	U	U
Cooper's	F	U	U
Red-Tailed	OE	F	U
Red-Shouldered	F	F	F
Broad-Winged	F	F	F
Bald Eagle	ls	U	O
Marsh Hawk	om	F	U
Osprey	ls	F	U
Sparrow	EO	C	U
Grouse and Pheasant			
Ruffed	FE	C	C
Sharp-Tailed	O	O	O
R.N. Pheasant	O	U	O
C. Gallinule	m	U	O
Coot	m	U	O
Killdeer	ol	C	U
Woodcock	f	U	U
Common Snipe	fm	U	U
Upland Sandpiper	O	U	O
Spotted Sandpiper	ls	C	O
Black Tern	ml	C	U
Rock Dove	I	F	U
Mourning Dove	OE	F	U
Y. B. Cuckoo	H	U	U
B. B. Cuckoo	H	F	F
Screech Owl	OE	U	U

TABLE 38. CHART OF BIRD OCCURENCE (CONT'D)

Species	General Habitat[1]	Abundance in Preferred Habitats[2]	Abundance in County as a Whole[2]
Gr. Horned Owl	F	F	F
Barred Owl	F	C	C
Whippoorwill	F	C	C
Nighthawk	OI	F	U
Chimney Swift	AI	C	C
R. T. Hummingbird	E	F	F
Kingfisher	sI	C	F
Woodpeckers			
Flicker	F	C	C
Pileated	F	U	U
Red-Bellied	F	O	O
Red-Headed	EO	U	U
Sapsucker	F	C	C
Hairy	F	F	F
Downy	F	F	F
B. B. 3-Toed	bC	U	O
Flycatchers			
E. Kingbird	Es	C	F
Gr. Crested	H	C	C
Phoebe	Se	F	F
Yellow-Bellied	cb	O	O
Traill's	se	U	U
Least	Fb	C	C
E. Wood Pewee	F	C	C
Olive-Sided	b	U	O
Horned Lark	O	U	O
Swallows			
Tree	AF	C	C
Bank	A	F	U
Rough-Winged	A	F	F
Barn	As	C	F
Cliff	A	U	U
Purple Martin	AI	F	U
Canada Jay	bC	O	O
Blue Jay	F	C	C
Raven	F	U	U
Crow	OE	C	C
B. C. Chickadee	F	C	C
W. B. Nuthatch	F	C	F
R. B. Nuthatch	C	F	U

TABLE 38. CHART OF BIRD OCCURENCE (CONT'D)

Species	General Habitat[1]	Abundance in Preferred Habitats[2]	Abundance in County as a Whole[2]
Brown Creeper	C	C	U
House Wren	EI	C	U
Winter Wren	c	F	U
L. B. Marsh Wren	m	F	U
S. B. Marsh Wren	mo	U	O
Catbird	E	F	U
Brown Thrasher	E	C	F
Thrushes			
Robin	EI	C	C
Wood	F	C	C
Hermit	FE	F	U
Swainson's	C	C	U
Veery	F	F	F
E. Bluebird	O	F	U
G. C. Kinglet	bc	U	O
Cedar Waxwing	s	C	F
Starling	I	C	U
Vireos			
Yellow-Throated	H	U	U
Solitary	cE	U	O
Red-Eyed	F	C	C
Warbling	Es	U	U
Warblers			
Black & White	F	F	F
Golden-Winged	cE	F	U
Nashville	Ee	C	F
Parula	Cc	F	U
Yellow	O	U	O
Magnolia	b	O	O
Black-Thr. Blue	H	O	O
Myrtle	Cc	U	U
Black-Thr. Green	C	C	C
Blackburnian	C	C	F
Chestnut-Sided	EH	C	F
Pine	C	U	O
Palm	b	U	O
Oven-Bird	F	C	C
N. Waterthrush	c	F	U
Mourning	FE	F	U
Yellow-Throat	m	C	F

TABLE 38. CHART OF BIRD OCCURENCE (CONT'D)

Species	General Habitat[1]	Abundance in Preferred Habitats[5]	Abundance in County as a Whole[3]
Canada	sc	U	U
Am. Redstart	FE	F	F
House Sparrow	I	C	U
Bobolink	Oo	U	O
E. Meadowlark	O	C	U
W. Meadowlark	O	F	U
Redwing	mb	C	C
Baltimore Oriole	OE	F	U
Brewer's Blackbird	o	U	O
Bronzed Grackle	EO	C	F
Cowbird	Os	F	U
Scarlet Tanager	F	C	C
Cardinal	IE	O	O
R. B. Grosbeak	F	C	C
Indigo Bunting	EO	C	F
Dickcissel	O	U	O
Eve. Grosbeak	Es	U	O
Purple Finch	CI	C	F
Pine Siskin	Cc	O	O
Am. Goldfinch	EO	C	F
Red Crossbill	C	O	O
White-W. Crossbill	C	F	U
R. S. Towhee	E	F	U
Sparrows			
Savannah	OE	U	U
Grasshopper	O	U	O
Vesper	OE	F	U
S. C. Junco	b	U	O
Chipping	E	C	C
Clay-Colored	OE	U	O
Field	O	F	U
White-Throated	b	F	U
Lincoln's	bs	U	O
Swamp	hm	F	U
Song	EO	C	F

SEE NOTES ON PAGE 182

Methods Used in the Field Investigation of Vegetation and Soils

Fifty upland stands were selected for sampling during the summer of 1964. These stands were chosen so as to represent two major gradients affecting vegetation and soil genesis within the area; namely, (1) nature of the substratum material and (2) length of time since the most recent massive disturbance. Twelve strata were constructed representing four classes of parent materials and three age classes of the dominant trees. Within each of these strata lands were selected so as to provide a variety of compositional variation. Stands were 1 to 2 acres in size, and relatively internally uniform with respect to parent material, topography, slope, aspect, vegetational composition, and forest structure. Figure 36 shows the limits of an imaginary stand and plots within it.

Each stand was circumscribed by a flagged line. A small scale map was prepared on graph paper and coordinates of the mapped area were numbered. A table of random digits was used to select five sampling points with the criteria that these points could not be closer together than 37 feet (i.e. ½ the radius of the tree plots overlapping) and could not fall within 37 feet of the stand boundary. When these criteria were not met, an alternative point was selected. After the five random sampling points were placed on the grid map these points were located by pacing with compass in hand from a designated origin and marked with a stake. At each of the points the following sample was taken:

Vegetation: Lines along the four cardinal directions served to divide each circular plot for woody species into four pie shaped quadrants. The species name was recorded and basal area was measured for all trees over 4.5 inches dbh within each 1/40 acre pie shaped quadrant. Density and frequency values for each species were calculated directly from the basal area tally forms (Table 39).

Samplings between 0.5 and 4.5 inches dbh were tallied by 1 inch dbh classes in 1/160 acre quadrants about the same center point as trees (Table 39).

Seedlings less than 0.5 inches dbh but greater than 6 inches in height were tallied in two ¼ inch classes measured at 6 inches above ground with one transitional seedling class comprised of stems larger than ½ inch at 6 inches above ground but less than ⅛ inch dbh (Table 39). A variable plot radius was used to tally seedlings depending upon their density in the area. Plots of 1/1000, 1/500, 1/100, and 1/40 acre (corresponding to quadrants of 1/4000, 1/2000,1 /400, and 1/160 acre) were used. The criterion for selection of plot size was an average tally on the order of 5 to 10 stems per quadrant. A notched masonite template was used to tally seedlings and saplings.

Herb frequency and density of seedlings below 6 inches in height were recorded within square meter quadrats located 18.5 feet from the plot center in each of the cardinal compass directions.

In addition to the plot data, numerous tree ages were obtained within most of the stands, a total species list was taken, and general observation on growth form of the trees, abundance of cradle knolls and other phenomena of ecological significance were noted. Items of circumstantial evidence relating to an interpretation of stand history such as presence of charcoal, stumps, trees growing on top of cradle knolls, etc., were systematically noted and a preliminary reconstruction of the history of each stand was made in the field.

Soils: Surface soil nutrient samples were taken at each point. Twelve to 15 cores of soil were collected so as to represent the microtopographic conditions within the center 25 per cent of the 1/10 acre tree plot. Each sample consisted of 6 inches of mineral soil in addition to the overlying organic layers. These samples were consolidated and mixed for each of the five points.

At each point three descriptions were made of the litter and surface mineral horizons to a depth of 1 foot. The position of each of these micropits was determined at random about the sampling plot center. The percentage contributed by each of the major components to the undecomposed leaf litter was estimated. Four litter classes were recognized on the basis of degree of decomposition and the thickness of each noted.

Color, structure and texture were noted for the mineral horizons to 1 foot depth.

At a representative site within each stand one major soil pit was excavated and detailed profile description was made. Samples were collected from each horizon for laboratory analysis.

TABLE 39. EXPLANATION OF TREE DIAMETER CLASS DIVISIONS USED IN CHAPTER VI.

Diameter classes of trees[1]	Explanation
S	Seedling[2] > 6″ in height and < 0.5″ in diameter breast height (dbh)[3]
2″	0.5″ — 3.5″[4] dbh
5″	3.5″ — 6.5″ dbh
8″	6.5″ — 9.5″ dbh
11″	9.5″ — 12.5″ dbh
14″	12.5″ — 15.5″ dbh
17″	15.5″ — 18.5″ dbh
20″	18.5″ — 21.5″ dbh
23″	21.5″ — 24.5″ dbh
26″	24.5″ — 27.5″ dbh
G	27.5″ <

1. These classes are used in Tables 13 through 29.
2. The term "seedling" is used here to denote a size category and therefore includes sprouts.
3. It is of course understood that most seedlings do not even reach breast height.
4. Interpret this to mean 0.5″ to 3.49″ inclusive.

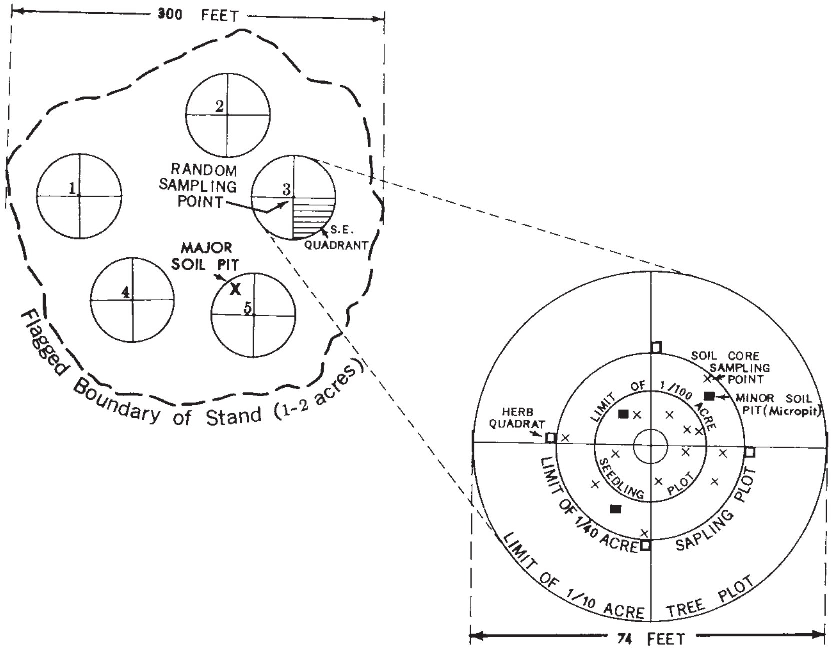

Figure 36. Diagram of a stand and the plots and points established in it for purposes of sampling vegetation and soils.

Glossary

(Soil terms; soil series not described in Chapter IX; ecological terms)

A horizon—The surface horizon of an undisturbed mineral soil. It is usually subdivided into several subhorizons. The A1 is dark colored and high in content of organic matter; the A2 is usually light colored and leached; the A3 is transitional to the B horizon. Some soils have all of these subdivisions, others do not.

Adolph series—Poorly drained (Humic Gley) soils with a nearly black A1 horizon six inches to a foot thick. This is a wet member of the Goodman and Norrie catenas, developed in 18 to 50 inches of silt over acid sandy loam glacial till. Horizons: 0, A1, Cg. (Typic Haplaquoll; fine loamy, mixed, frigid family).

Aggregate, soil—A cluster of soil particles. Synonym for ped.

Aggregated, organisms—Clustered.

All-aged—Denotes a forest in which many different ages and sizes of trees are present.

Alluvium—Soil material deposited by streams.

Amasa series—Naturally well drained shallow acid Podzol soil (Typic Haplorthod) developed from less than 18 inches of silty or very fine sandy material overlying outwash sand and gravel. This soil is shallower than Stambaugh.

Amplitude—The width of a curve which represents the behavior of a species of plant plotted against a compositional gradient. It is a measure of the range of conditions which are tolerated by a species.

Angelica series—Poorly drained (low Humic Gley) soil formed from more than 30 inches of loamy material overlying dolomitic sandy loam glacial till. This is a member of the Underhill catena. Horizons: 0, A1, Cg. (Mollic Haplaquepts; fine loamy, mixed, frigid family.)

Aspect—The direction toward which a slope faces.

Association, soil—A group of soils which may or may not resemble each other, but which are geographically associated together in a particular pattern.

Auburndale series—Poorly drained (Humic Gley) soils with a nearly black A1 horizon less than a foot thick. This is a wet member of the Otterholt catena, developed in 36 to 50 inches of silts over acid, reddish sandy loam glacial till. Horizons: 0, A1, Cg. (Typic Ochraqualfs; fine loamy to fine silty, mixed, acid, frigid family.)

Autogenic—Self-generated. Autogenic processes within a forest are controlled by the forest itself.

B horizon—A master horizon or layer in a soil profile usually found below the A horizon. It is usually characterized by stronger colors (usually brown) than those in horizons above or below, by an accumulation of iron, clay, or organic matter, and by a blocky structure. It is usually subdivided into several subhorizons.

Bh—A dark brown horizon high in content of organic matter.

Bir—A brown B horizon high in content of iron.

Bt—A B horizon having an accumulation of clay. This is sometimes called the B2 horizon.

Bx or Bm—Pale fragipan, which is a dense subsoil layer with a slightly higher content of clay than the Ax horizon.

Basophilous plant—A plant requiring considerable calcium and magnesium for proper growth. Such plants usually produce litter which is rich in calcium and magnesium.

Biomass—The total weight of the living plant mass including stored food.

Biota—The sum total of all organisms found within the area considered.

Bisequal (soil)—A soil having two sequa, one above the other. For example, a Podzol A2 and Bhir sequum over a Gray-Brown Podzolic A2 and Bt sequum constitute a bisequal soil.

Bog (soil)—An organic soil.

Bog (peat)—A peat deposit, usually consisting of moss peat, upon which plants are growing. Bogs are generally found in enclosed depressions.

Brown Podzolic (soil)—See footnote number 10, Table 3.

C horizon—A layer of relatively unweathered material similar to the material from which at least a part of the soil above it was formed. Soil parent material.

Cable series—Poorly drained (Low Humic Gley) acid soils with nearly black A1 horizon less than five inches thick. This is a wet member of the Iron River and Kennan catenas. Horizons: 0, A1, Cg. (Typic Haplaquepts, fine loamy, mixed, acid, frigid family.)

Calcareous (soil)—Soil containing free lime which effervesces when diluted (1:10) HCl is applied.

Catena—A group of soils developed from similar parent material but differing in morphology because of differences in natural drainage conditions.

Channing series—Somewhat poorly drained Podzol soils formed from 12 to 24 inches of loamy material over acid glacial outwash sand and gravel. This is a member of the Pence catena. Horizons: 0, A2, Bhir, C. (Aquic Haplorthods; coarse loamy over sandy, mixed, frigid family.)

Clay—The smallest mineral grains, less than 0.002 mm in diameter.

Clay (texture)—Soil that contains 40% or more clay, less than 45% sand, and less than 40% silt.

Clay loam—Soil consisting of 27 to 40% clay and 20 to 45% sand.

Clone—A group of individual plants that either are or at one time were interconnected to one another by a comon root system.

Codominant—The second most dominant species in the stand or plant community.

Colluvium—Deposit of soil accumulated at the base of a slope under the influence of gravity. Slope wash.

Color of soil—Soil color designations given in parentheses in this bulletin are from the scientific Munsell Color Chart (Munsell Co., Baltimore, Md., Pendleton and Nickerson, 1951) in terms of (1) hue, such as 10YR; (2) value (white or black); and (3) chroma (intensity of color). 10YR 4/4 is a designation for dark yellowish brown (Soil Survey Staff, 1951). The letter M signifies that the color is for moist soil.

Complex, soil—Several soils, so closely intermingled that they cannot be shown separately on a map at the scale being used.

Complement, area species—The complete set of species of plants occupying a given area.

Composition—The assemblage of plant species found within an area, each appropriately weighted according to its abundance and/or size. We speak of tree composition of an area; and of groundlayer composition.

Compositional equilibrium—Steady state. The condition under which a forest of a given composition is perpetuated generation after generation.

Consistence, soil—The resistance of soil to separation or deformation. Soil consistence varies with moisture content. It is described in terms such as loose, friable, firm, hard, sticky.

Cradle-knoll—A shallow pit, 6 to 30 inches deep and several feet across, and adjacent mound, 12 to 36 inches high and several feet across, created by tipping of a tree in a wind-storm. The root mass of the falling tree pulled soil up from the pit site (cradle) and dumped it in the form of the mound (knoll).

Crown series—Moderately well to somewhat poorly drained Gray-Brown Podzolic soil associated with Chetek soils, formed from 12 to 24 inches of loamy material over acid glacial outwash sand and gravel. Horizons: 0, A1, A2, Bt, C. (Aquic Hapludalfs; coarse loamy, mixed, mesic (family.)

Cycle—A regularly recurring series of events or phenomena.

D horizon—A layer or stratum below the C horizon, or the B horizon if no C is present, which is unlike the C or the material from which the B horizon has been formed.

dbh—Diameter breast-height. The diameter of a tree at 4.5 feet above ground.

Density—The number of plant individuals per unit area.

Density distribution—The density of plant stems in a stand, according to their sizes and/or species.

Disturbance—An environmental or man-induced catastrophe affecting at least several acres, such as cutting of timber, burning, blow-down of trees by strong wind.

Dominant—A plant species that is of great importance in a community through size, number, or other characteristics which enable it to receive the brunt of external environmental forces and modify them before they affect the lesser members of the community.

Drainage, soil—Natural soil drainage refers to the speed with which water is removed from the soil surface and through the soil itself. Seven classes have been recognized: excessive, somewhat excessive, well, moderately well, imperfect, poor, and very poor. Artificial drainage refers to removal of water by ditching, tiling, and construction of surface water ways and terraces.

Drift—Glacial deposits, both ice-laid and water-laid.

Drumlin—An oval or cigar-shaped hill of glacial drift (usually till), ordinarily with its long axis parallel to the movement of ice which formed it.

Edaphic climax—In this report it refers to a forest made up of species, that are usually considered pioneers, which, due to local soil and hydrologic conditions, is able to perpetuate itself.

Eluvial (horizon)—A horizon that has lost bases, iron, clay, etc. by processes of soil formation. A2 horizons are eluvial.

Ephemeral plants—Existing in an above ground state for only a brief period. Spring flowers in deciduous forests of the north temperate regions are ephemeral.

Exchangeable cations—Available plant nutrients in the form of cations (such as ions of calcium, magnesium, potassium) in soils, determined in me/100 gm with a flame photometer on leachate.

Exotic—An introduced species of plant, not native to the area.

Fence series—Podzol soils formed from 3 feet or more of lacustrine acid silts and fine sands, and with a slight accumulation of clay in the subsoil (Bt horizon). Horizons: 0, A2, Bhir, A2, Bt, C. (Alfic Haplorthods; fine loamy, mixed, frigid family.)

Field grading of soil texture—For more than 50 years soil surveyors have routinely done field grading of soil texture by rubbing soil between the fingers. With experience, a person can judge by the feel of the soil about how much sand, silt and clay are present. According to the proportions of material of these 3 sizes, textural class names are given to soil from different horizons and different profiles. These textural terms and their definitions are best summarized in a chart known as the textural triangle (Soil Survey Staff, 1951). Some people find it helpful to have a copy of this triangle with them in the field. However, an attempt is made here to describe briefly how the different textural classes of soil feel. These classes are defined elsewhere in the glossary. Some phrases are taken from C. F. Shaw (Soil Survey Staff, 1951). It is a good idea to accompany a professional soil surveyor from time to time in order to compare field grading judgments. Textures intermediate between those listed below can be recognized by relative amounts of gritty, soft, and sticky material in them.

Stones, cobbles and gravel. These coarse fragments, all with diameters greater than 2 mm (1/12th inch) are of course not rubbed between the fingers. They can be recognized by eye and measured with a rule. Fragments of gravel size are less than 3 inches in diameter, cobbles are between 3 and 10 inches in diameter, and stones (or boulders) are larger than that.

Sand. Sand feels gritty and harsh. Individual grains can be seen and felt. Squeezed in the hand when dry, sand will fall apart upon release. Squeezed when moist, sand forms a very fragile cast.

Sandy loam. This class feels quite gritty but also somewhat loamy. Individual sand grains can be seen and felt. There is enough silt and clay to soften the feel of this soil. Squeezed when dry, the soil forms a very fragile cast. Squeezed when moist, the soil form a somewhat more stable cast.

Loam. This feels somewhat gritty, somewhat smooth, and possibly a little sticky and plastic. Sometimes the observer decides to call the soil a loam chiefly because it is not sandy enough to be a sandy loam, silty enough to be a silt loam, nor clayey enough to be a clay loam. Squeezed dry, it forms a fragile cast. Squeezed moist, it forms a stable cast.

Silt loam. In a dry state, lumps and clods prove to be very fragile. When rubbed, this soil feels soft like flour and forms a fairly stable cast when squeezed. In a moist state this soil feels smooth and mellow. The moist cast is stable. Moist soil will not form a polished ribbon when rubbed between the thumb and finger, but will appear as a somewhat rough and noncoherent coating on the thumb.

Clay loam. The dry soil is hard and lumpy. Moist soil is plastic; forms a very stable cast when squeezed; and, when rubbed between the thumb and finger, forms a thin, somewhat fragile ribbon, with a somewhat polished surface. The moist soil can be kneaded in the hand into a compact mass which does not readily crumble.

Clay. The soil is very hard and lumpy, when dry. Moist soil is very plastic and sticky; it forms a cast which is stable; elongated casts may sag under their own weight; when rubbed between the thumb and finger, the soil forms a long flexible ribbon which has a good polish on the surface.

Fifield series—Somewhat poorly drained Podzol soils formed from 18 to 40 inches of silts over acid glacial outwash sands and gravels. Slight accumulation of clay in the subsoil has produced a B horizon. This is a member of the Stambaugh catena. Horizons: 0, A2, Bhir, A2, Bt, Cg. (Aqualfic Haplorthods; fine loamy, mixed, frigid family.)

Forest Type—A kind of forest. The term is not used in this bulletin in the technical sense in which foresters use it.

Fragic—As applied to a fragment of soil, this term is used in this bulletin to denote the property of noticeable resistance of the fragment to deformation when under pressure between the fingers, and subsequent sudden rupture of the fragment. Fragipans exhibit this fragic property. Many other soil horizons show the property, but too weakly to permit classification of those horizons as fragipans.

Fragipan—Brittle, dense, loamy, reversibly cemented subsoil horizon which is resistant to root growth and water movement, is friable when wet, and hard when dry.

G or g—A soil horizon that is gleyed.

Glacial drift—See *Drift*

Glacial till—Unsorted glacial drift transported and deposited by ice.

Glacio-fluvial deposits—Sediments deposited by glacial streams. These deposits are usually sandy or gravelly and are typically stratified.

Glacio-lacustrine deposits—Sediments deposited in glacial lakes. These include fine sands, silts and clays. They may be stratified or varved.

Gleyed (soil)—Soil material which is olive gray or bluish gray in color. Gleyed horizons are usually found below a dark colored surface layer in poorly drained soils.

Gray-Brown Podzolic—The kind of soil which usually developed under forest vegetation in southern Wisconsin. These soils have light colored subsurface horizons, brown illuvial (clayey) subsoils, and are generally acid.

Gray Wooded—See footnote Number 13, Table 3.

Groundlayer—The herbaceous vegetation and associated seedlings in a forest.

Halder series—Somewhat poorly drained Gray-Brown Podzolic soils associated with Onamia soils formed from 24 to 40 inches of loamy material over acid glacial outwash sand and gravel. Horizons: 0, A1, A2, Bt, Cg. (Aquic Hapludalfs; fine loamy over sandy, mixed, frigid family.)

Horizon, soil—A layer of soil more or less parallel to the land surface and having characteristics produced by processes of soil formation.

Humic Gley—A naturally poorly drained soil having a thick, dark colored surface horizon and a gray (gleyed) subsoil.

Humus—The organic layer of a forest soil consisting of well decomposed organic matter, the origin of which cannot be determined by observation of the material with the naked eye.

Illuvial horizon—Horizon that has received material (bases, clay, etc.) from an eluvial horizon. B horizons of Gray-Brown Podzolic and Podzol soils are illuvial.

Importance value—A measure of the significance of a species in a stand or plant community expressed as the total of its values for relative density, relative frequency, and relative basal area.

Intergrade—A soil that does not clearly belong to any great soil group but has some characteristics of several groups.

Layering—The process by which the lowermost branches of a tree droop to the ground and take root.

Leaching—Removal of material from soil in solution by percolating water. For example, the removal of lime from the upper part of a soil is a leaching process.

Lithosol—A shallow soil consisting of a dark colored surface soil underlain by bedrock.

Litter layer—The mat of dead, decomposing organic material above the mineral soil.

Loam (texture)—Soil that contains 7 to 27% clay, 28 to 59% silt, and less than 52% sand.

Loamy sand—Soil that contains at the upper limit 85 to 90% sand, and the percentage of silt plus 1½ times the percentage of clay is less than 15. At the lower limit it contains not less than 70 to 85% sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

Manitou series—Poorly drained (Low Humic Gley) soil of the Alban catena. The nearly black A1 horizon is less than 6 inches thick. Horizons: 0, A1, Cg. (Mollic Haplaquepts; fine loamy, mixed, frigid family.)

Marl—An earthy deposit consisting of calcium carbonate (lime), silt and clay. It is found in lake bottoms or below peat.

Marsh—A wet area supporting sedge, grass and reed vegetation.

Mesic—A term used for upland vegetation of fertile, well-drained sites or for the sites themselves.

Minocqua series—Poorly drained (Low Humic Gley) soils associated with Padus soils, formed from less than 18 inches of silts over loam and acid glacial outwash sand and gravel. Horizons: 0, A1, Cg. (Mollic Haplaquept; fine loamy over sandy skeletal, mixed, frigid family.)

Monico series—Somewhat poorly drained Podzol soils developed in less than 24 inches of silt overlying acid sandy loam glacial till. Horizons: 0, A2, Bhir, Cg. (Aquic Haplorthods; fine loamy, mixed, frigid family.)

Mor—A type of forest humus in which the humus (H) layer is prominent. There is little or no mixing of this organic layer with the underlying mineral soil.

Morphology, soil—This refers to the physical constitution of the soil, including such characteristics as the color, texture, structure, and consistency of the various horizons, their thickness and arrangement in the soil profile.

Mottled—Somewhat spotted appearance, as in the case of soil which shows splotches of rust and gray colors. Mottling in most of the soils in

Wisconsin indicates that natural drainage is restricted, or that the water table rises to or near the surface periodically.

Muck—Organic soil material that is partially decomposed. Muck is usually dark in color.

Mull—A mixture of humus and mineral soil which is intimate. The A1 soil horizon.

O horizon—An organic soil horizon, that is a soil horizon containing more than about 25% by weight of organic matter, oven dry. Sandy soil horizons are termed organic if the organic matter content exceeds 20%; clayey horizons, if it exceeds 30%.

Organic Soil—Soil formed from organic materials. Peat and muck are organic soils and are classified in the Bog great soil group.

Orterde—Soft brown layer in the B horizon of a Podzol soil.

Ortstein—An indurated layer in the B horizon of a Podzol soil, cemented by illuviated sesquioxides, mostly iron oxides, as well as organic matter.

Outwash—Sorted sand and gravel deposited by glacial melt waters flowing out from the glacier.

Overstory—Trees of the upper canopy. Technically, trees more than 4.5 inches dbh.

Parent material—The material from which a soil formed, such as sandy loam glacial till, deep sand, woody peat.

Particle size distribution (of soil)—This is a synonym for *texture* and refers to the per cent by weight of clay and silt (determined by hydrometer method of Day, 1957, in this study), and sands (determined with sieves) in dry material.

Peat—Organic soil material that is relatively undecomposed. This material may be broken (disintegrated), but plant parts can still be recognized. When peat undergoes decomposition it becomes muck.

Ped (soil)—A soil aggregate. A ped may be blocky, platy, prismatic, granular in shape.

pH—A notation used to designate the acidity or alkalinity of a soil. A pH of 7.0 indicates neutrality. Lower values indicate acidity and higher values, alkalinity.

Phase, soil—A subdivision of a soil unit based on features significant to man's use of a soil. For example: sloping phase, stony phase.

Plover series—Somewhat poorly drained soil transitional from Gray-Brown Podzolic to Podzol, developed in 2 to 3 feet of loamy or sandy material overlying lacustrine silts and fine sands. This is a member of the Alban catena. Horizons: O, A1, A2, Bhir, A2, Bt, Cg. (Aquic Hapludalfs; fine loamy, fixed, frigid family.)

Post-cut, Post-fire—Descriptive terms applied to vegetation which characteristically becomes established following cutting or burning of timber stands.

Profile, soil—A vertical section through a soil, exposing all of its horizons, including the parent material.

Pyric—Fire induced.

Reductant-soluble Fe—This refers to free iron in soil. Free iron is determined by reducing and complexing the iron in a neutral system (Jackson, 1956, 1958).

Regeneration—The natural establishment of new plant individuals.

Regosol—A shallow soil consisting of an A horizon over unweathered, unconsolidated parent material.

Release—The sudden increase in growth rate and vigor of remaining stems brought about by removal of competing vegetation.

Rib series—Poorly drained (Low Humic Gley) soil associated with Antigo soils, formed from 18 to 36 inches of silts over acid glacial outwash sand and gravel. Horizons: O, A1, Cg. (Mollic Haplaquepts; fine loamy over sandy, skeletal, mixed, frigid family.)

Sand—Mineral grains having diameters ranging between 2 and 0.05 mm.

Sand (texture)—Soil consisting of 85% or more of sand. The percentage of silt plus 1½ times the percentage of clay shall not exceed 15. Coarse sand, sand, fine sand, and very fine sandy subclasses are recognized.

Sandy clay loam—Soil that consists of 20 to 35% clay, less than 28% silt, and 45% or more of sand.

Sandy loam—Soil consisting of either 20% clay or less; and the percentage of silt plus twice the percentage of clay exceeds 30; and 52% or more of sand: or less than 7% clay, less than 50% silt, and between 43 and 52% of sand.

Scott Lake series—Moderately well drained Gray-Brown Podzolic soils formed from 18 to 40 inches of loamy material over acid glacial outwash sand and gravel. This is a member of the Onamia catena. Horizons: O, A1, A2, Bt, C. (Typic Hapludalfs; fine loamy over sandy skeletal, mixed, frigid family.)

Selective cut—A timber cutting operation in which trees of one or a few species or conditions are selectively removed.

Sequum—A sequence of an eluvial horizon and its related illuvial horizon.

Seral—Denoting one stage in a plant succession from early post-disturbance (pioneer) vegetation to climax vegetation.

Serotinal cone—A seed-bearing cone as in jack pine which does not open to liberate the seeds except when greatly heated as by a forest fire.

Silt—Mineral grains ranging in size from 0.05 to 0.002 mm in diameter. Soil material containing more than 80% silt and less than 12% clay is included in the silt class.

Silty clay—Soil that contains 40% or more of clay and 40% or more of silt.

Silty clay loam—Soil consisting of 27 to 40% of clay and less than 20% sand.

Silt loam—Soil consisting of 50% or more of silt and 12 to 27% of clay; or 50 to 80% of silt and less than 12% of clay.

Site—A place or location. Not used in this bulletin in the special sense employed by foresters.

Sol Brun Acide—A group of soils formed under forest vegetation from moderately acid parent materials in the podzolic soil region. These soils exhibit little or no eluviation and illuviation of oxides and clay. Some formation of clay may have occurred.

Solona series—Somewhat poorly drained Podzol-Gray-Brown Podzolic transitional soil formed from more than 30 inches of loamy material over dolomitic sandy loam to loam glacial till. This is a member of the Underhill catena. Horizons: O, A1, A2, Bhir, A2, Bt, C. (Aquollic Hapludalf; fine loamy, mixed, frigid family.)

Solum, soil—The soil solum is the A and B horizons taken together. The C horizon is not included.

Spirit series—Somewhat poorly drained Podzol soils developed in 24 to 40 inches of silt overlying acid sandy loam glacial till. Slight accumulation of clay in the subsoil has produced a weak B horizon. The solum (A + B) is 24 to 40 inches thick. This is a member of the Goodman catena. Horizons: O, A2, Bhir, A2, Bt, Cg. (Aqualfic Haplorthods; fine, silty, mixed, frigid family.)

Sprout ring—A tight ring of tree stems interconnected by a common root system and having arisen as sprouts from a root crown following removal by cutting or fire of 1 or more former stems.

Stand—A particular example of a plant community. A unit area in which the plant population is sampled. In this study stands were between 1 and 2 acres in extent.

Stock (in a forest)—The standing timber.

Stratum—A size interval designation used more generally than size class. The sapling stratum includes all stems 0.5 to 4.5 inches dbh. The tree stratum may include all trees larger than 4.5 inches dbh.

Structure, soil—This refers to the aggregation of primary soil particles into compound particles such as granules, blocks, prisms, or plates.

Succession—The process by which one plant community replaces another one through time.

Swamp—A wet area supporting woody vegetation, usually tamarack.

Texture, soil—This refers to the relative proportions of the various size groups of individual soil grains. See *Field grading of soil texture.*

Till—See Glacial till.

Tolerance—The ability of a tree to successfully develop as an understory component.

Understory—Small trees, the crowns of which have not yet reached an upper canopy position. Trees of the overstory characteristically have a lower mortality rate than trees of the understory. In this study, the diameter of 4.5 inches dbh was used as the upper size limit for understory trees.

Variant, soil—A soil of limited or unknown extent but having characteristics unique enough to set it apart from a related series. The term variant is usually used temporarily until the soil can be studied further. *Phase* is sometimes used in the same sense.

Worchester series—Somewhat poorly drained Podzol soils formed from less than 18 inches of silt over acid glacial loams over glacial outwash sand and gravel. Slight accumulation of clay in the subsoil has formed a B horizon. This is a member of the Padus catena. Horizons: O, A2, Bhir, A2, Bt, C. (Aquic Haplorthods; coarse loamy, mixed, frigid family.)

Xeric—Dry. A xeric site is one in which the water supply for plant growth is relatively limited.

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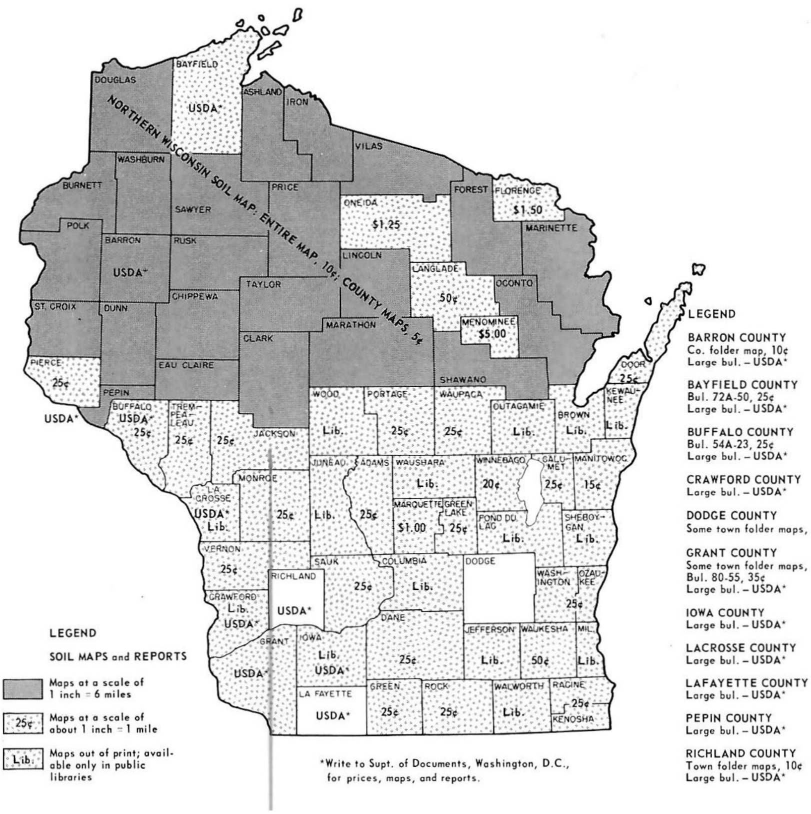

Figure 37. Index maps to soil survey publications as of 1967. Requisitions and payments for publications of the Soil Survey Division of the Wisconsin Geological and Natural History Survey are handled by the division at 203 Soils Building, The University of Wisconsin, Madison, Wisconsin 53706.

New detailed soil maps of Kenosha, Milwaukee, Racine, Walworth, Washington, Waukesha, and Ozaukee Counties can be obtained from the Southeastern Wisconsin Regional Planning Commission, Waukesha, Wisconsin.

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