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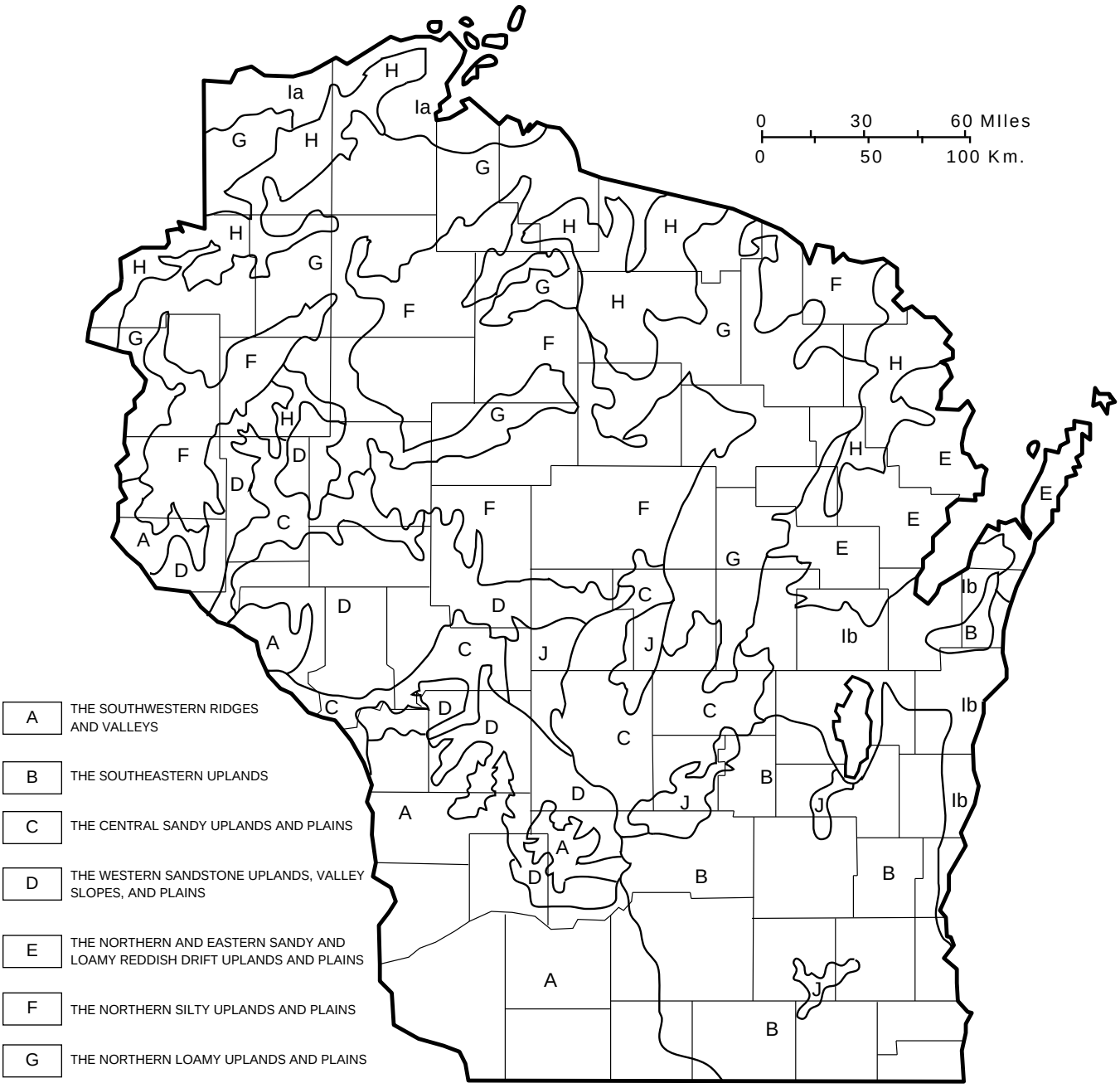
FOREST SOILS OF WISCONSIN

AN OVERVIEW

By James E. Johnson, James G. Bockheim and John M. Cain

FIGURE 1 SOIL REGIONS OF WISCONSIN



A THE SOUTHWESTERN RIDGES AND VALLEYS

B THE SOUTHEASTERN UPLANDS

C THE CENTRAL SANDY UPLANDS AND PLAINS

D THE WESTERN SANDSTONE UPLANDS, VALLEY SLOPES, AND PLAINS

E THE NORTHERN AND EASTERN SANDY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS

F THE NORTHERN SILTY UPLANDS AND PLAINS

G THE NORTHERN LOAMY UPLANDS AND PLAINS

H THE NORTHERN SANDY UPLANDS AND PLAINS

Ia THE NORTHERN CLAYEY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS

Ib THE EASTERN CLAYEY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS

J THE STREAM BOTTOMS AND MAJOR WETLANDS

Table of Contents

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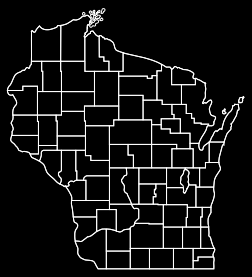


INTRODUCTION

Landowners can learn much about woodland management from professional foresters.

Wisconsin possesses a rich forest resource base. With nearly 14.8 million acres of commercial forest, the state ranks seventh nationally in forest acreage. Almost two-thirds of the commercial forest area has private, non-industrial ownership. The forest consists of a wide range of forest cover types, including northern hardwoods (29%), aspen - birch (26%), oak - hickory (19%), swamp conifers (9%), pines (8%), and bottomland hardwoods (8%).

The soils supporting this vast commercial forest are as variable as the cover types. Forest soils generally are defined as those which currently support forest growth or which developed under forest vegetation and have not changed appreciably due to other uses or vegetation.

A strong interaction exists between the soils and forest vegetation. To a large degree, soils influence the type and productivity of forest vegetation. For example, dry, infertile glacial outwash sands may support only jack pine and northern pin oak. These same species may be absent from a moist, medium- or fine-textured, nutrient-rich glacial till that grows good stands of sugar maple and basswood. In addition to influencing the type and productivity of forest vegetation, soils also affect numerous management practices such as logging, site preparation, and reforestation. Soil and site characteristics such as texture, drainage, infiltration, erodibility, and slope steepness all influence management practices. An informed land manager takes these characteristics into consideration when developing and implementing a management plan for a timber stand.

This bulletin discusses forest soils and forest management practices in each of Wisconsin's ten major soil regions, shown in Figure 1.[1] The soil regions are separated mainly on the basis of geology, landforms,

[1]For a more detailed discussion of the soils, climate, and landforms in each of these regions, see *Soils of Wisconsin*, by Francis D. Hole, available from the University of Wisconsin Press, Box 1379, Madison WI 53701.

soil parent materials, and location within the state. Soils within these regions have certain characteristics in common, but they also have substantial differences. Within a region, the soils can differ in depth, texture, natural drainage, slope, and fertility.

This bulletin serves as a supplement to detailed soil maps by describing general soil characteristics and patterns on the landscape within each region. It also briefly describes the major forest soils, provides some common forest management interpretations, and gives site index and yield estimates for the major tree species in each of the ten soil regions.

The site indexes were obtained primarily by the U.S. Department of Agriculture Soil Conservation Service. They were derived from more than 1,000 forest plots located throughout the state, as well as data from soil series in Michigan and Minnesota. The yield estimates were derived from normal yield tables showing volume per unit area as a function of stand age and site index. These tables assume fully stocked conditions and good management practices—no past grazing, removal of higher quality trees, etc. In estimating yield, we assumed a rotation age of 80 years for sawlogs and 40, 50 or 60 years for pulpwood, depending on forest type. Because many of the yield tables were prepared in the 1930s and 1940s, the yields provided are merely estimates subject to revision as new data are obtained. The management interpretations are based on many years of research and field observations.

Additional information about soils not listed in this bulletin can be obtained by contacting the nearest Soil Conservation Service office. More extensive information is available from county soil survey reports which contain detailed soil maps (*Figure 2*). Forest management advice is available from the county Department of Natural Resources forester, industrial foresters, and consulting foresters.

The landscape of Wisconsin has changed dramatically in the last 200 years as cropland, pasture, roads, and cities replaced thousands of acres of forest and prairie. Records from explorers, surveyors, and early settlers provide a fairly accurate description of the presettlement vegetation. Most of the state was covered by forests, and the tree species growing in any area evolved over a long period of time as the best-adapted species. Figure 3 shows the major presettlement forest types in Wisconsin.

Different combinations of soils, climate, and topography resulted in different types of forests in different areas. To a large extent, the presettlement vegetation indicates the tree species that should be likely choices for present-day forest management, because they are best adapted to grow in that area.

There is a preliminary classification system relating common understory vegetation to forest type. The units are called vegetative habitat types and the system is now fairly well developed for the northern and central portions of the state. A habitat type is a recognizable plant association of overstory (trees) and understory vegetation that reflects site conditions such as climate, soils, and topography. Habitat types can be recognized by the presence and/or abundance of key plant species, and can be used to help in forest management planning. Several common habitat types have been identified for Soil Regions G and H shown in Figure 1.

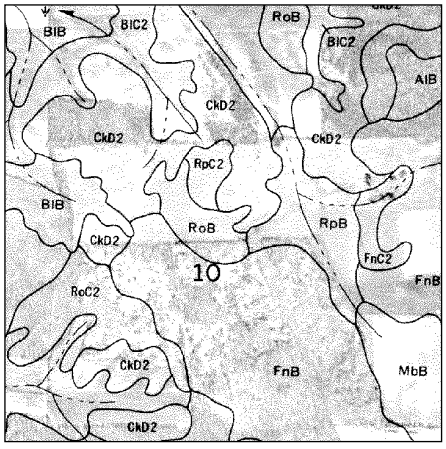


FIGURE 2 ▲

Detailed soil maps provide specific information on soil characteristics. The area depicted is one square mile (640 acres) with soil boundaries and soil symbols plotted on an aerial photograph background. Maps similar to this are a part of published soil surveys for 49 counties. They are also available in unpublished forms for many areas in the rest of the state. A status of soil surveys in Wisconsin is available from the Soil Conservation Service.

THE SOUTHWESTERN RIDGES AND VALLEYS

Location and Extent

The Southwestern Ridges and Valleys Soil Region covers about 11 percent of Wisconsin (3.7 million acres), and is mainly in the southern half of the Driftless Area. Although primarily an agricultural area, this region currently is 30 percent forested with another 25 percent of the region in cleared pasture.

Topography and Geology

The topography of the Southwestern Ridges and Valleys Soil Region is related to the underlying bedrock and the degree to which streams have dissected the landscape by cutting valleys. This region has the longest and steepest slopes of any region in the state. The underlying bedrock consists of level, bedded dolomite and sandstone. The dolomite is fairly hard and resistant to weathering and erosion, while the sandstone is soft and easily eroded. Where the dolomite has been removed, streams have been able to cut deep, wide valleys. Dolomite is the predominant bedrock occurring near the surface on ridge tops and upper side slopes and sandstone is the predominant rock exposed on the steep valley sides.

The soils in this region are formed partly from the underlying bedrock and partly from a windblown silty layer called loess, which was deposited over the region during and after the retreat of the glaciers. Because of this loess deposit, the surface layer is dominantly silt loam. Typical subsoils are silty clay loam, clay loam, or clay in areas of dolomite bedrock, and sandy loam, loamy sand, or sand in areas of sandstone bedrock (*Figure 4*).

This region is an interesting mixture of nearly level and gentle slopes, fertile soils on ridgetops and in valleys, and very steep land in between. Most of the gentler slopes are in cropland or pasture, and the steeper slopes are forested.

Forest Vegetation

In presettlement times, much of this region was oak - hickory forests, native prairies, and prairie-savannas. Since settlement and the subsequent ability to control wildfires, non-farmed portions of the region have succeeded to stands of white oak - red oak - hickory; sugar maple - basswood; and bur oak. The patterns of forest vegetation and timber productivity are closely related to slope position and aspect. The south and west aspects tend to be warmer and drier than the north and east aspects. Accordingly, oaks and hickories predominate on the south- and west-facing slopes; northern hardwoods may grow along with oaks and hickories on the north- and east-facing slopes.

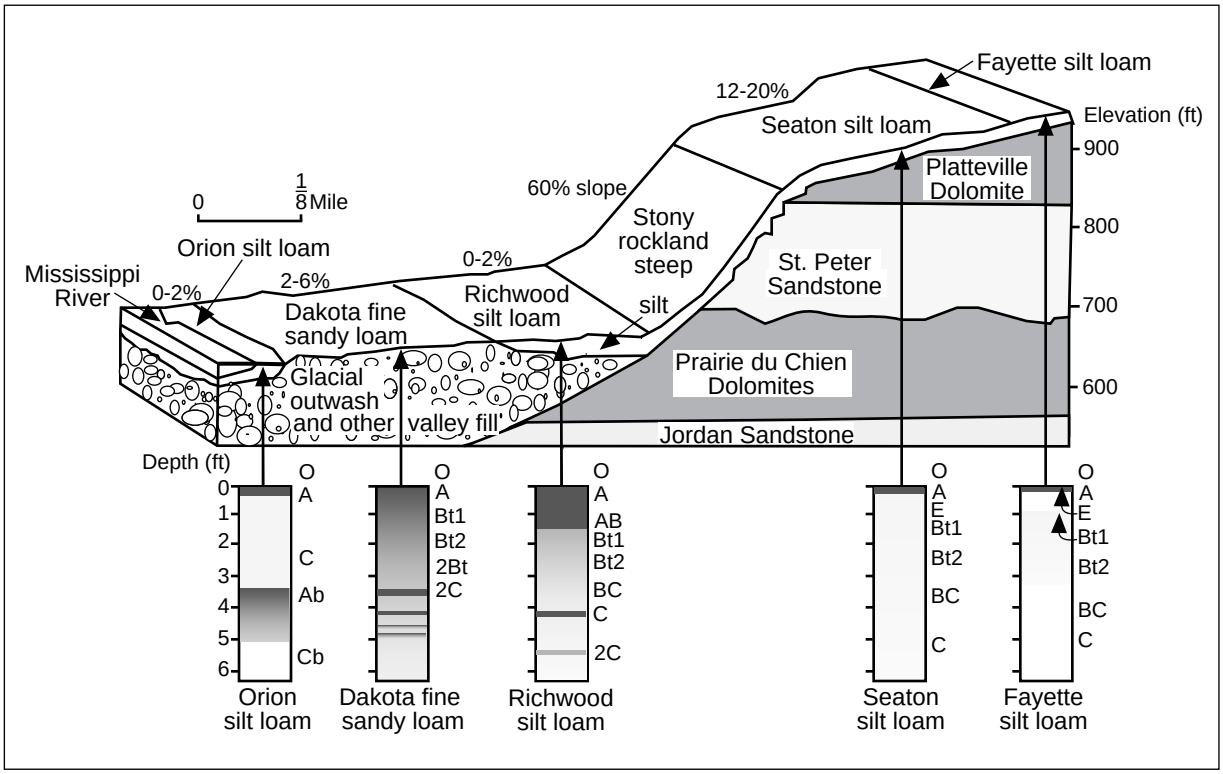
Forest Soils and Forest Management

The three most common forest soil series in this region are Dubuque, Fayette, and Palsgrove, which collectively occupy about 64 percent of the area (*Table 1*). These soils are derived from loess over dolomite, and are characterized by a silt loam surface layer. Common site indexes[2] for northern hardwoods and oaks on these soils range from 62 to 74 feet; however, planted white pine may easily be 20 feet higher. Final yield at rotation age ranges from 7.6 thousand board feet (MBF)/acre for the Palsgrove soil to 11.9 MBF/acre for the Fayette soils (*Table 1*). In addition to soil series, site factors such as slope position and aspect (orientation) influence forest productivity in the Southwestern Ridges and Valleys Soil Region.

[2]Site index is defined as the average height of dominant trees in a stand at an age of 50 years.

The highest-value product from forests in this region is veneer, and many stands contain trees capable of producing veneer logs. Hardwood stands should be managed to produce the highest-quality logs possible, with intermediate cuts producing firewood and low-quality sawlogs. Because of the steep slopes and erodible soils, logging roads should be carefully constructed, avoiding straight upslope-downslope sections. Following logging, roads should be seeded with a cover crop to reduce erosion.

Planted conifers in this region generally outproduce native hardwoods; however, markets for some softwood products (e.g., pulpwood) are somewhat limited. Both red pine and eastern white pine are recommended for planting; however, competing vegetation is generally heavy and must be controlled by hand cutting or herbicide application. Black walnut is a popular hardwood species to plant in this region; however, it should be planted only in sheltered areas on fertile, better-drained soils. Plantations with alternating rows of black walnut and eastern white pine have the advantages of producing a much greater fiber yield (due to the pine) and better form on the walnut trees, with the pines acting as "trainers."



▲ FIGURE 4.

Cross-section of a typical landscape in Soil Region A. Soils on different topographic positions can have very different characteristics.

THE SOUTHEASTERN UPLANDS

Location and Extent

The Southeastern Upland Soil Region covers about 13 percent of the state (4.2 million acres). Forest land in this region occupies only about 9 percent of the area and is largely restricted to farm woodlots. The Kettle Moraine area is the most extensively wooded. Farmland is the predominant land use in the region; however, increasing urbanization is resulting in a decrease in farm and forest land.

Topography and Geology

The Southeastern Uplands have nearly level, undulating, and rolling landforms, and soils derived from glacial drift. Although predominantly an upland region, lakes, marshes, and bogs are very common. Nearly 10 percent of the region is wet organic soil, and an additional 15 percent is wet mineral soil in lowlands. Calcareous drift covers the underlying bedrock and the drift is capped in many areas with a layer of windblown loess. This silty loess cap ranges from 0 to 5 feet thick.

Forest Vegetation

Prior to settlement, the southern and western portions of the Southeastern Uplands were covered with native prairies interspersed with oak - hickory forests. The level and gently sloping areas within the region have been farmed more or less continually since settlement; however, many steeper lands and shallower or less-productive soils have reverted to forest. The predominant timber types are sugar maple - basswood; white oak - red oak - hickory; bur oak on the upland sites; and elm - ash - soft maple on the wetter soils.

Forest Soils and Forest Management

The major forest soils of the Southeastern Uplands are the Casco, Fox, Hochheim, McHenry, Miami, and Theresa series (*Table 1*). These soils occupy about 42 percent of the region. Typically, they have a silt loam surface layer formed in loess with subsoils derived from calcareous glacial drift. These soils are typically deep without layers that restrict rooting (*Figure 5*). Site indexes for northern hardwoods and oaks commonly range from a high of 70 feet on the Theresa soil to 53 feet on the Casco soils. Casco soil has a substratum derived from sandy and gravelly outwash and is not as productive for hardwood species as other soils in this region.

The highest-value product from forests in the Southeastern Upland Soil Region is veneer. Many mixed oak and northern hardwood stands are currently producing veneer-quality timber. Sawlogs for hardwood lumber and fuel wood are also common products from the forest. On many sites, particularly the Casco soils, softwoods such as red and white pine can greatly outproduce the hardwoods. However, before investing in site conversion from hardwoods to softwoods, woodland managers should make sure that adequate pulpwood, pole or sawlog markets are available.

A common forest management problem in hardwood stands in this region is adequate regeneration following timber harvesting. Most foresters recommend that adequate established advance regeneration should be present before the overstory is removed. This regeneration, when added to

sprouts which originate from cut stumps, generally is sufficient to restock cutover lands. On some sites, it may be necessary to underplant desired seedlings prior to the final harvest. In general, problems with regeneration, particularly red and white oak, are more common on higher-quality sites such as the McHenry, Miami, and Theresa soils than on poorer-quality sites.

◀ FIGURE 5
Soils may vary greatly with depth. To estimate the quality of a soil for growing trees, one must consider the entire rooting zone. Rooting depth is limited by features such as bedrock, hardpan, layers of droughty sand, and water tables.

THE CENTRAL SANDY UPLANDS AND PLAINS

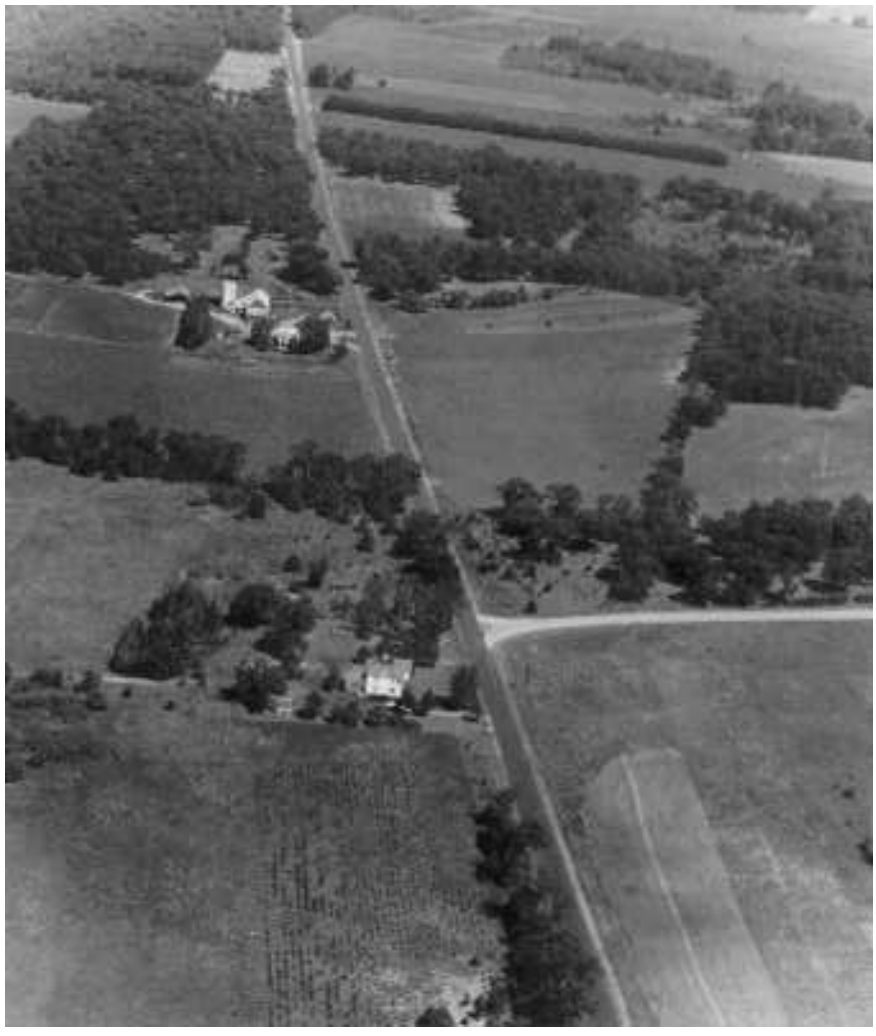
Location and Extent

The Central Sandy Uplands and Plains are located primarily in central Wisconsin and in scattered locations along streams in the western part of the state. This region occupies about 2.5 million acres, or seven percent of the state's land area. Typically called the "golden sands" because of high crop yields on irrigated soils, this region is known for abundant crops of potatoes and other vegetables, cranberries in the lowlands, and extensive pine forests, which are on the increase.

Topography and Geology

The landforms in this region are generally level to gently rolling, with occasional sandstone outcrops or buttes. The underlying sandstone and Precambrian bedrock in the area is largely covered with thick, sandy, glacial outwash deposits and moraines. In the eastern part of the region, sandy glacial till is the primary soil parent material.

Throughout most of the Central Sandy Uplands and Plains, the water table is fairly close to the surface. The sand and



Aerial view of a typical landscape in Soil Region C, showing cropland, pasture, pine plantations, and oak woodlots.

gravel aquifer is a major source of water for irrigated agriculture. In non-irrigated areas, the soils are often subject to extreme drought.

Forest Vegetation

Although the native vegetation of this region was principally jack pine barrens, oak savannas and prairie, the forested areas now consist of natural stands of mixed oak and pine, northern hardwoods, aspen, and plantations of red and white pine. Extensive Christmas tree plantations have also been planted throughout the region. About 44 percent of the region is now in forest cover, and this amount is slowly increasing. Red pine is the predominant commercial forest species in the region, with red pine plantations occupying 85 percent of the forested area. Almost two-thirds of these stands are less than 30 years old. This young, developing pine resource will become a major source of pulpwood, poles, and sawlogs within the next 20 years.

Forest Soils and Forest Management

The major forest soils of the Central Sandy Uplands and Plains are the Dancy, Gotham, Guenther, Menahga, Plainfield, and Sparta series. These soils cover about 60 percent of the land area, represent a variety of conditions, and support different timber types. The Plainfield and Menahga soils are the typical, weakly developed soils derived from sandy outwash; they are commonly planted to red pine. The Gotham and Guenther soils are somewhat finer textured, with the lower portion of the Guenther soil developed from residual bedrock. Both the Guenther and wetter Dancy soils commonly support northern hardwoods and aspen. The Sparta soils in the western part of the region developed under prairie vegetation. They are sandy, droughty, and best suited to pine.

The common site indexes for these soils differ somewhat. The Plainfield, Menahga, Gotham, and Sparta soils have average pine site indexes of 55 to 82 feet. The Guenther soils are capable of growing northern red oak with a site index of 68 feet, and the Dancy soils have an average site index of 60 feet for northern hardwoods. Managed stands of red pine on the Plainfield and Menahga soils are capable of producing over 34 thousand board feet (MBF)/acre by rotation age (about 80 years) and the yield increases to 59 for red pine on the Gotham soils.

The major reforestation species on sandy soils in this region is red pine. Although jack pine usually matches red pine in height growth, red pine produces more total volume and higher-quality lumber, particularly after 30 years of age. Stand conversion from existing timber types to red pine involves clearcutting followed by mechanical and/or chemical site preparation, hand or machine planting of two- or three-year-old seedlings (usually at rates of about 1,000 seedlings/acre), and follow-up chemical release from competing vegetation.

Some landowners may prefer a lower-cost alternative of growing mixed oak and pine stands. These stands have the advantage of producing quality hardwood fuel wood and pine pulpwood, poles or sawlogs. In addition, the stands have a higher wildlife value than pure conifer stands. On the sandy soils in this region, oak trees seldom produce high-quality sawtimber.

Wind erosion is a common problem on agricultural fields, and windbreaks of pines, northern pin oak, and other species are necessary to reduce soil losses, damage to seedlings, and other harmful environmental impacts. Planting windbreaks is encouraged, as well as maintaining and regenerating mature windbreaks.

▲ *Sandy outwash soils such as the Plainfield in Waushara County are well suited for pine plantations.*

THE WESTERN SANDSTONE UPLANDS, VALLEY SLOPES, AND PLAINS

A combination of poor soils and management can result in woodlots with little value. This is an area in Soil Region D with shallow soils over limestone bedrock. These gravelly, droughty soils slow tree growth.

Location and Extent

The Western Sandstone Uplands, Valley Slopes, and Plains occupy about 3.3 million acres, or 9 percent of the state's land area. About one-third of this region is forested, with 40 percent of the region in cropland and 25 percent in pasture.

Topography and Geology

This soil region has hilly topography resulting from stream dissection of sandstone bedrock. A thin layer of glacial till covers some of the northern and northeastern portions of the region. In some areas, loess deposits provide a silt loam surface layer. Sandstone outcrops are common, as are low cliffs along stream courses. The Dells of the Wisconsin River form a spectacular example of stream-cut exposures of the sandstone bedrock.

Forest Vegetation

The native vegetation in this region included prairies, oak savannas, oak forests, and northern hardwood forests. Today, the major forest cover type is white oak - red oak - hickory; other common types include white oak, bur oak, sugar maple - basswood, white pine, red pine, and jack pine.

Forest Soils and Forest Management

The primary forest soils of the Western Sandstone Uplands, Valley Slopes, and Plains are the Boone, Gale, Hixton, Norden, and Northfield series. These soils account for about 65 percent of the land area in this region. The Gale, Hixton, Norden, and Northfield soils developed in loamy glacial drift or loess over sandstone bedrock. Site indexes range from 62 to 73 feet for northern red oak, with the exception of the Northfield and Boone soils which have a site index of 55 feet or less.

Reforestation species on these soils include red and white pine, and jack pine on the Boone soils. Expected final yields for red pine on the Gale, Hixton, and Norden soils range from about 8 to 12 thousand board feet (MBF)/acre, but are only 1 to 5 MBF/acre on the Northfield and Boone soils. The finer-textured soils are capable of supporting good stands of oak, and attention should be given to growing quality trees to sawlog sizes. After harvesting, regeneration to red oak and white oak is usually achieved from stump sprouts and advance-growth seedlings. A management option is growing mixed stands of pine and oak.

The Northern and Eastern Sandy and Loamy Reddish Drift Uplands and Plains

Location and Extent

The Northern and Eastern Sandy and Loamy Reddish Drift Uplands and Plains Soil Region is located in the east-central portion of Wisconsin, and is most prevalent in Door, Oconto, Marinette, and Outagamie counties. This region occupies about 5 percent of the land area of the state, and is about 60 percent forested.

Topography and Geology

This region has level to rolling topography formed largely from glacial till deposits. A pinkish, loamy till covers about three-fourths of the region, while the remainder is underlain by lacustrine, or glacial lake bed, deposits. In Door County, the glacial drift is shallow over limestone bedrock, and rock outcrops are common. The soils throughout this region generally are well drained, and range from thin, weakly developed profiles over bedrock, to deep, well-developed soils in lacustrine deposits.

Forest Vegetation

The native vegetation of this region included a wide variety of plant communities, such as swamp conifers, sedge meadows, oak savannas, pine barrens, pine forests, boreal forests, and southern mesic forests. Today, the major forest cover types are sugar maple - beech - yellow birch; sugar maple - basswood; northern red oak - basswood - white ash; aspen; and northern white-cedar. Aspen is a predominant timber type in the northern portions of the region (Oconto and Marinette counties), while northern white-cedar is the major type in Door County.

Forest Soils and Forest Management

The primary forest soils of the region are the Emmet, Onaway, Shawano, and Solona series. These soils are generally formed in sandy or loamy deposits over calcareous glacial till. The Solona soil is wetter, being typically somewhat poorly drained, while the Shawano soils are excessively drained and consist of weak development in sandy lacustrine deposits. The Onaway, Solona, and Emmet soils typically support hardwood forests, and are capable of growing good stands of sugar maple, northern red oak, and aspen. Average red oak site indexes on these soils range from 63 to 73 feet. The Shawano soil is best suited to growing pines, and the typically level lacustrine landforms are well suited for establishing plantations.

Natural stands of northern hardwoods and aspen on the better-quality sites should be managed for the higher-value species such as sugar maple, basswood, yellow birch, and northern red oak. Although it is primarily a low-value pulpwood species, aspen also grows well on these sites and should be managed in pure, even-aged stands. Costs of converting these stands to faster-growing conifers would probably be excessive on these sites. The Shawano soil is well suited for conifer production, particularly red pine, and conversion from hardwoods to pine may be a viable management alternative. Markets for pulpwood and sawlogs are generally favorable in this region, improving the opportunity for the practice of forestry on small woodlots.

▲ *Good management can result in excellent quality red oak stands. Many soils in Regions B, E, F, and G are capable of supporting stands like this.*

The Northern Silty Uplands and Plains

Location and Extent

The Northern Silty Uplands and Plains Soil Region is widely scattered throughout northern Wisconsin, from Florence County in the east to St. Croix County in the west. This soil region covers nearly six million acres, or about 16 percent of the state's land area. The region is currently 53 percent forested, with other important land uses being pasture, hay production, grain and forage production, and some potato production.

Topography and Geology

The topography of this broad soil region is level to gently rolling, determined largely by the nature of the parent material, which includes stony glacial till, outwash, and lacustrine deposits. In some areas, weathered Precambrian and Cambrian bedrock is near the surface. A silty layer deposited by either wind or water covers most of this region. This "silty cap," two to three feet thick, results in fairly productive soils. For example, Antigo silt loam, the official "State Soil," is located primarily in the region's eastern portion. The Antigo soil is well known for its excellent crop-producing capabilities, including northern hardwoods.

Forest Vegetation

This soil region was initially vegetated with species from the northern mesic forest; typically, eastern hemlock, yellow birch, maple, and basswood. Today, the region supports some of the state's most productive northern hardwood stands. The dominant forest cover types are sugar maple - basswood; hemlock - yellow birch; northern red oak; and aspen. Red maple, the region's dominant species, is increasing in abundance, and now represents the largest amount of growing stock volume in Marathon and Taylor Counties.

Forest Soils and Forest Management

The Northern Silty Uplands and Plains include a variety of important soil series (*Table 1*). These soils occupy nearly 2.1 million acres, or about 37 percent of the region. Generally, these soils are formed in silty sediments over either glacial till or outwash. Drainage varies from well drained with the Antigo soil, to somewhat poorly drained with the Almena soil, to poorly drained with the Auburndale soils.

All of these soils represent typical northern hardwood sites, with site indexes ranging from 57 feet for red maple on the Auburndale soil to 69 feet for northern red oak on the Withee, Antigo, and Freer soils. Likewise, sawtimber production ranges from 4.1 thousand board feet (MBF)/acre on the Auburndale soil to 10.1 MBF/acre on the Withee, Antigo, and Freer soils.

Although hardwood timber stands on these soils could be clearcut and converted to conifers, the costs of conversion are generally quite high because of the large amount of competing vegetation, both from hardwood sprouts, seedlings, and invading brush species. In general, these sites should be managed for either northern hardwoods, northern red oak, or aspen. Suitable conifers for planting on most of these soils include white pine, red pine, white spruce, and black spruce. Spruces are better adapted to the wetter sites, pines to well-drained sites. Conifer volume growth on these soils may actually be two to three times that of the northern hardwoods; however, the conversion process may be very difficult.

Hardwoods may be managed for sawtimber production, with a small amount of veneer-quality logs produced. On these sites, rotation age, or the age at final harvest, is commonly 80 years or more. Wood harvested in intermediate cuttings such as thinnings is valuable for both fuel wood and

Northern hardwood stands such as this are common in Soil Regions E, F, G, and I.

pulpwood. Landowners may use either even-aged or uneven-aged systems for managing northern hardwood stands. With the even-aged system, the entire stand of trees is usually harvested after advance regeneration has become established (3-4 feet tall). With the uneven-aged system, regular partial cuttings are conducted at periodic intervals, such as five or ten years, and regeneration occurs following each cutting. Aspen is managed using the even-aged system of clearcutting.

THE NORTHERN LOAMY UPLANDS AND PLAINS

Location and Extent

Soil Region G, the Northern Loamy Uplands and Plains, covers more than 5.9 million acres, or nearly 17 percent of the state's land area. The region extends from eastern Marinette County to Burnett County. About 76 percent of this region is commercial forest, with most of the Chequamegon and Nicolet National Forests located on these soils. Other major land uses include dairy farming and potato production.

Topography and Geology

The topography of the Northern Loamy Uplands and Plains ranges from level on outwash or glacial till plains to hilly in glacial moraine areas. The distinguishing feature between this region and Soil Region F is the lack of a thick, silty surface layer. Although a gritty, silt loam surface is evident in some portions of the region, it is not more than ten inches thick. The region features thick glacial drift that is underlain by Precambrian bedrock. About 75 percent of the region has moderately-well to excessively drained soils, 15 percent of the region has organic soils, and the remaining 10 percent consists of poorly drained mineral soils.

Forest Vegetation

The native forest vegetation throughout this region consisted of northern mesic forests, pine forests, and swamp conifers in the lowlands. Today the predominant forest cover types are aspen; sugar maple - basswood; sugar maple - birch; hemlock - yellow birch; and sugar maple - beech - yellow birch (only in the eastern portion of the region). White spruce is an abundant species in western Oneida and Forest counties. Maple - birch is the most prevalent forest type in Ashland, Iron, Price, Sawyer, Florence, Forest, Langlade, Lincoln, Menominee, and Shawano counties.

Forest Soils and Forest Management

The forest soils of Region G are quite variable, with the following soil series dominant: Cable, Chetek, Cloquet, Gogebic, Iron River[3], Kennan, Padus, and Pence. Together these soils cover nearly 3.6 million acres, or 62 percent of the region. In general, these soils have formed in a thin layer of loamy or silty sediments over either glacial till or outwash. Fragipans, dense restricting layers, are common in the Iron River and Gogebic series. The Chetek, Pence, and Padus soils all have a subsoil consisting of sandy outwash material. Most of these soils are well drained, with the exception of Cable, which is very poorly drained.

In general, these soils are fairly productive. The silty and/or loamy surfaces have a high water- and nutrient-holding capacity, and are well suited to growing high-quality hardwoods such as yellow birch, sugar maple, northern red oak, white ash, and American basswood. Site indexes range from 56 feet for red maple on Cable soils to 75 feet for northern red oak on the Kennan soil (*Table 1*). On most of these soils, the aspen site index ranges from 67 to 76 feet. Final yields on the Kennan soils may reach 12 thousand board feet (MBF)/acre for northern hardwoods, while yields of 4 to 11 MBF/acre are more common for the other soils in the region. Soils such as the Pence are particularly well suited for conversion from hardwoods to conifers, primarily because of the coarse

[3]The Iron River name is no longer used; proposed new name is Wabeno.

texture, which creates a soil environment drier and less fertile than required for optimum hardwood growth. After conversion, the volume growth may increase by a factor of four. Although competing vegetation is a problem, these soils are particularly well suited to growing good crops of red pine. The Padus soil is especially productive for pine, but may be more difficult to convert because of competing vegetation problems.

Northern hardwoods currently occupying these sites should be managed using either even-aged or uneven-aged systems. In general, the uneven-aged system, where regeneration occurs following periodic, scheduled cuttings, favors sugar maple. Regeneration by other species such as hemlock, yellow birch, ash, basswood, and red oak is more competitive with the even-aged systems.

Experts have identified forest vegetative habitat types of this part of Wisconsin. Forest habitat types are distinct units of vegetation that are considered to be climax; that is, they will occupy the site indefinitely if they are not disturbed. The habitat type name incorporates both understory and overstory plant species which will eventually dominate the type, although they may not dominate at present. The types are identified using key indicator plant species and broad soil conditions such as drainage, texture, droughtiness and profile development. Major forest habitat types associated with the soils in this region are as follows:

Soil Series	*Habitat Type*
Iron River	*Acer-Viola-Osmorhiza*
Padus	*Acer-Tsuga-Dryopteris*
	Acer-Viola-Osmorhiza
	Tsuga-Maianthemum
Pence	*Tsuga-Maianthemum*

The Northern Sandy Uplands and Plains

Location and Extent

The Northern Sandy Uplands and Plains occupy three major areas in northern Wisconsin: Bayfield, Douglas, and Burnett counties in the west, Oneida and Vilas counties in the north-central, and Marinette and Florence Counties in the northeast. The region includes nearly 2.5 million acres, or 7 percent of the state's land area. The region is 75 percent forested, and is principally known for timber production and recreation. Some cropland and pastures are present, but limited in extent.

Topography and Geology

The Northern Sandy Uplands and Plains have varied topography, characterized by kettles, ridges, hills, and outwash plains. The region's sandy soils are developed in glacial drift, and, to a degree, resemble the sandy soils in Region C. However, the cooler climate and shorter growing season in the north have produced vegetative and soil differences between the two regions. Over most of the region, the sandy drift deposits are deep, varying little with depth. In some areas, bands of clay and/or silt occur in the substratum.

Forest Vegetation

The presettlement vegetation in this region included primarily pine barrens and pine forests. The pine barrens often consisted of a mix of jack pine, northern pin oak, and prairie grasses. The pine forests, most extensive in Vilas and Oneida Counties, were comprised of extensive stands of eastern white pine. Today, this region is still dominated by pine forests, with the major timber types being oak - pine, jack pine, red pine, eastern white pine, and aspen - birch. Black spruce, tamarack, balsam fir, and northern white-cedar are common in lowlands.

Forest Soils and Forest Management

The forest soils of Region H are generally very sandy, low in organic matter and fertility, and fairly droughty. The region's main soils include the Au Gres, Chetek, Omega, Pence, and Vilas series. These soils cover about 2.5 million acres, or 90 percent of the region (*Table 1*). All of these soils developed in sandy glacial outwash, and are generally well drained to excessively drained. The Au Gres series is an exception; it is a wet outwash soil that is usually somewhat poorly drained. These soils are best suited to pine production, and generally have a site index of 55 to 60 feet and produce about 32 thousand board feet (MBF)/acre of pine sawtimber in an 80-year rotation.

Forestry practices in the Northern Sandy Uplands and Plains generally involve pine management, either in natural stands or plantations. Although natural regeneration of jack and white pine can be achieved using standard even-aged management practices, red pine, the preferred species on most sites, is regenerated with hand or machine planting of seedlings following clearcutting. Seed crops of red pine are generally not sufficient to insure adequate natural regeneration. Plantation management in this region is similar to the Central Sandy Uplands and Plains. Common habitat types that occur on these soils include *Tsuga-Maianthemum-Vaccinium* and *Acer-Quercus-Vaccinium*.

THE NORTHERN CLAYEY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS

Location and Extent

The Northern Clayey and Loamy Reddish Drift Uplands and Plains is a sub-region of Soil Region I. This sub-region is located in the northern portions of Douglas, Bayfield, and Ashland counties, and comprises only about 857,000 acres, or 2 percent of Wisconsin's land surface. Approximately 35 percent of this region is in cropland, 20 percent in pasture, and 45 percent in forest.

Topography and Geology

The topography in Soil Region Ia is gently rolling to flat. The landscape consists largely of broad plains formed by the lowering of Lake Superior after the glaciers retreated. Soils are derived from the red silt and clay that settled to the bottom of the lake. These lacustrine deposits are high in carbonates, although in the process of soil development, the carbonates have leached out of the soil surface. Clay concentrations in these soils may range from 50 to 80 percent.

Forest Vegetation

In presettlement times, the soils of Region Ia primarily supported a boreal forest consisting of balsam fir and white spruce. Today, however, a variety of timber types are common throughout the region, including aspen; spruce - fir; sugar maple - basswood, red maple; and northern red oak - basswood - white ash. Red and white pine are also found in some areas.

Forest Soils and Forest Management

The major forest soils of Region Ia include the Hibbing, Ontonagon, Rudyard, Pickford, and Superior series. Collectively, these soils account for about 706,000 acres, or 82 percent of the region (*Table 1*). These soils are generally fine textured, ranging from loams and sandy loams in the Superior series to silty clays in the Ontonagon and Rudyard series. Drainage also varies from somewhat poorly drained (Rudyard) and poorly drained (Pickford) to well drained (Hibbing).

These soils obtained their red color from silts and clays that resulted from glacially pulverized Precambrian iron formations. The presence of high amounts of silt and clay imparts some unique properties to the soils of this region. Infiltration and permeability are slow, resulting in frequent standing water on the surface and increased runoff. Erosion problems can be quite severe on areas with bare soil. These soils are quite fertile, and tend to hold large amounts of moisture, which is favorable for tree growth.

Site indexes on these soils range from 45 feet for white spruce on the Rudyard soil to 72 feet for aspen on the Hibbing. The Hibbing soils are the most productive, with aspen yields of 48 cords/acre at rotation age (*Table 1*). In existing hardwood stands, the commercially valuable species should be maintained and encouraged for pulpwood and/or sawlog production. However, in poorly stocked areas or abandoned agricultural land, conversion to conifers may be a viable alternative. Species normally recommended for planting on these soils include white and black spruce, and, to a lesser degree, red and white pine. In some areas where deer browsing is not a problem, northern white-cedar may be a good conifer to plant. Pine and spruce site indexes as high as 70 feet have been recorded on the Superior soil, and final yields of 48 cords/acre are not uncommon.

Standing surface water caused by poor infiltration is a major problem affecting seedling survival and early growth. Lack of aeration frequently kills small seedlings, resulting in plantations with poor stocking. The practice of bedding or furrowing (with seedlings planted on top of the furrow slices) has greatly improved the survival rate and early growth of conifer seedlings in the region.

The Eastern Clayey and Loamy Reddish Drift Uplands and Plains

Location and Extent

The Eastern Clayey and Loamy Reddish Drift Uplands and Plains are found chiefly in eastern Wisconsin along the Lake Michigan shoreline and inland as far as Waupaca and Waushara counties. Minor portions of the region also exist in Adams, Marquette, and Sauk Counties. This region comprises over 1.7 million acres, or about 5 percent of the state's land area. About 60 percent of the acreage is in cropland, 15 percent in pasture, and the remaining 25 percent in forest and wetland.

Topography and Geology

The region's topography and geology are very similar to those of Region Ia. Overall, the landscape is level to gently rolling, and reflects the surface of the glacial Lake Michigan clay and silt deposits. The carbonate content of the soil and parent material in this region is higher than in Region Ia, due mainly to more extensive deposits of shale and dolomite bedrock derived from the Lake Michigan basin in the northeast. In many areas, the lacustrine deposits were laid down on top of a reddish-colored glacial drift known as the Valderan till, deposited about 11,800 years ago. The upland areas consist of soils such as the Kewaunee, which are formed from the Valderan till.

Forest Vegetation

The native vegetation throughout this region consisted primarily of northern and southern mesic forest species, including sugar maple, basswood, hemlock, and yellow birch. Today, stands of sugar maple - beech - yellow birch; northern red oak - basswood - white ash; aspen; and elm - ash - soft maple are common. For example, in Brown, Calumet, Manitowoc, and Winnebago Counties, stands of maple and birch cover nearly 70,000 acres, or about half of all the commercial timberland in the region. The second most prevalent timber type is elm - ash - soft maple, which covers an additional 41,000 acres.

Forest Soils and Forest Management

The three primary forest soils of this region include the Kewaunee, Manawa, and Oshkosh series. These soils occupy about 1.1 million acres, or 63 percent of the region. All these soils are fine textured, predominantly silty clay loams. The Manawa is somewhat poorly drained, the Oshkosh is moderately well drained, and the Kewaunee is well drained.

These soils currently support hardwood stands of maple, ash, birch, oak, and aspen. Site indexes for the hardwoods commonly range from 60 to 65 feet, and final yields range from 27 to 34 cords per acre (5.6 to 7.8 MBF/acre) (*Table 1*). Forest management recommendations for the soils in Region Ib are basically similar to Region Ia. Conifers greatly outproduce the hardwoods on these soils, but successful plantations require careful site preparation and planting practices.

THE STREAM BOTTOMS AND MAJOR WETLANDS

Location and Extent

Soil Region J, the Stream Bottoms and Major Wetlands, is a region widely scattered throughout the state. Wetlands are abundant in Wood, Portage, Juneau, Adams and Jackson counties. However, areas of alluvial, organic, and wet mineral soils occur in most counties. This region occupies 2.8 million acres, or about 8 percent of the state's land area. Some areas have been drained for cropland, while others are used for hay and pasture. Many of Wisconsin's cranberry bogs are located on these soils.

Topography and Geology

These soils occur in lowlands, old lake basins, floodplains, and old glacial drainage ways throughout the state. Consequently, the topography is generally flat to gently sloping. The parent material is usually either alluvial material deposited in floodplains or organic accumulations. However, wet mineral soils influenced by a high perched or regional water table are also common. Wet lowland areas between glacial features such as drumlins, moraines, and kettle holes are also common landforms associated with Soil Region J.

Many of the soils in Region J have serious limitations for forestry caused by high water tables. Trees will be shallow rooted and only water-tolerant trees will grow well.

Forest Vegetation

The vegetation of this soil region is highly variable because of the vast differences in soil and climatic conditions. Many wetland areas are vegetated with sedge meadows and wetland species such as cattails and bulrushes. The forest vegetation, however, depends largely on the soil type and location in the state. For example, in southern Wisconsin, soils derived from alluvium support stands of elm - green and white ash - red maple; cottonwood; and river birch; while in the north, similar soils support elm - black ash - red maple; spruce - fir; and tamarack. Organic soils support a variety of trees, including black spruce, balsam fir, tamarack, northern white-cedar, and tag alder.

Forest Soils and Forest Management

There are presently over 30 alluvial soils in Wisconsin, and their forest productivity differs greatly depending upon such factors as drainage and frequency of flooding. In addition, another 30 to 35 organic soils are found statewide. Unfortunately, timber productivity for various soil series are not available for this region. However, the range in productivity between different species and sites may be enormous. On some southern Wisconsin bottomland sites, cottonwoods may have site indexes over 100 feet, while in northern bogs the black spruce site index may be only 20 feet. In general, these soils have serious limitations for forestry purposes due to low productivity, the absence of high-quality timber species, windthrow problems, and problems with equipment operation. However, with proper management, they do have some timber production potential and often good potential for wildlife.

Forest management practices on these sites should generally attempt to perpetuate the native species, as they are best adapted to cope with such factors as wet soils and shallow rooting depths. Where site indexes are high, good-quality hardwood sawtimber or veneer wood may be produced. On poor-quality sites, the final product will be pulpwood or fuel wood. There has been a major effort in the state to preserve wetlands, and proper forest management on these soils is one type of wetland preservation.

PRODUCTIVITY OF WISCONSIN SOILS BY REGION

TABLE 1

Soil series[1]	Species to favor[2]	Additional trees to plant[2]	Yield at Rotation Age[3] MBF/acre	Cords/acre
SOIL REGION A	FOREST SOILS OF THE SOUTHWESTERN RIDGES AND VALLEYS			
Palsgrove	OR(62)	PR, PW, SW	7.6	33
Dubuque	OR(66)*, AW(72)	PR, PW, SW	9.1	37
Fayette	OR(74)*, MH(68)	PR, PW, AW, SW	11.9	45
Bertrand	OR(70)*, AW, OW	PR, PW, SW	10.5	41
Billett	OR(64)	PR, PW	8.3	35
Chaseburg	OR(65)*, BA, MH	PR, PW, AW, SW	8.7	36
Dunbarton	OR(58)*, MH(56)	PJ, PW	6.2	29
LaFarge	MH(70)*, OR(66), AW(80)	PR, PW, SW	7.3	54
New Glarus	OR(58)	PR, PW, AW, SW	6.2	29
Seaton	OW(78)*, OR(68)	PR, PW, AW, SW	13.3	49
Valton	OR(67)*, OW(56)	PW(62), PR, AW, SW	9.4	38
SOIL REGION B	FOREST SOILS OF THE SOUTHEASTERN UPLANDS			
Theresa	OR(70)*, MH(64)	PR, PW, AW, SW	10.5	41
Miami	OW(62)*, OR(57), AW(70), MH(55)	PR, PW, SW	7.6	33
Hochheim	MH(57)*, AW(57), OR(55)	PR, PW	4.1	36
Fox	MH(64)*, OB(80), OR(58), AW(83)	PR, PW, SW	5.8	46
Casco	OR(53)*, OH(43), OB(66)	PR(52), PW	4.4	24
McHenry	OR(67)*, AW(84)	PR, PW, SW	9.4	38
Boyer	OR(62)*, OW(55), PW(45)	PR	7.6	33
Lamartine	MH(60)*, AW(63)	PR, PW, OR, SW	4.8	40
Lapeer	OB(50)	PR, PW	3.4	21
Morley	OR(60)*, OW(59)	PW, SW	6.9	31
St. Charles	OR(64)*, MH(60)	PW, PR, AW, SW	8.3	35
SOIL REGION C	FOREST SOILS OF THE CENTRAL SANDY UPLANDS AND PLAINS			
Plainfield	PR(61)*, PJ(49), OB(68), OH(48), PW(49)		34.2	50
Menahga	PR(62)*, PJ(64), A(69), OH(57), F(68), PW(55)		35.4	52
Gotham	PR(82)*, PW(63), OB(68), OH(54)	PJ(55)	59.4	84
Guenther	OR(68)*, MR(65), MH(61), AW(60)	PR, PW(53), PJ	9.8	39
Dancy	MR(60)	SW	4.8	40
Sparta	PJ(55)*, OH(55)	PR		28

[1] Soils in boldface are most common in a region and are referred to in the text.

[2] Species symbol followed by site index (base age of 50 years) in parentheses.

[3] Yields based on data contained in Table 2 for asterisked species only or single species listed under "species to favor"

MBF = thousand board feet.

Species symbols:

A - aspen	F - balsam fir	PJ - jack pine
AB - black ash	MH - hard (sugar) maple	PR - red pine
AW - white ash	MR - red maple	PW - white pine
BA - basswood	OB - bur oak	SB - black spruce
BW - white birch	OH - Hill's (northern pin) oak	SW - white spruce
BY - yellow birch	OR - northern red oak	T - tamarack
C - northern white cedar	OW - white oak	

TABLE 1 PRODUCTIVITY OF WISCONSIN SOILS BY REGION

Soil series[1]	Species to favor[2]	Additional trees to plant[2]	Yield at Rotation Age[3] MBF/acre	Cords/acre
SOIL REGION C *continued*				
Brems	PR(65)*, OR(64), PJ(55), OH(56)		39.0	56
Coloma	PW(56)*, OH(49)	PR(54), PJ(52)	50	
Meridian	OR(68)	PW, PR, PJ	9.8	39
Richford	PW(61)*, OR(61), OH(52)	PR(49), PJ	59.6	
Tarr	PW(60)	PJ(54), PR(48)	57.7	
Wyocena	OR(51)*, OH(53)	PR, PJ	3.7	22
SOIL REGION D FOREST SOILS OF THE WESTERN SANDSTONE UPLANDS, VALLEY SLOPES AND PLAINS				
Norden	OR(62)	PR, PW	7.6	33
Hixton	A(78)*, OR(63)	PR, PW	11.4	60
Gale	OR(73)	PR, PW	11.5	44
Northfield	OR(55)*, OW(54), OB(50)	PJ, PW	5.2	26
Boone	OH(44)*, OB(40)	PW(48), PJ(41), PR	1.2	15
Elk Mound	OR(58)*, OH(49), OB(42)	PW, PJ	6.2	29
Urne	OR(62)*, MR(84)	PW, PR	7.6	33
SOIL REGION E FOREST SOILS OF THE NORTHERN AND EASTERN SANDY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS				
Onaway	OR(65)*, MH(65), BA(66), AW(70)	PR, PW, SW	8.7	36
Solona	OR(67)*, MH(68), AW(70)	SW, PW	9.4	38
Emmet	OR(73)*, MH(65), A(79), AW(66)	PR, PW	11.3	44
Shawano	OR(63)*, MH(63), BA(65)	PW(64), PJ(59), PR(54)	8.0	34
Hortonville	OR(67)*, MH(67)	PW(63), PR	9.4	38
Poygan	OW(66)	AB	9.1	37
SOIL REGION F FOREST SOILS OF THE NORTHERN SILTY UPLANDS AND PLAINS				
Auburndale	MR(57)	SW, F(54), SB	4.1	36
Withee	OR(69)*, MH(64), AW(72), BA(69)	PW, SW	10.1	40
Freeon	OR(65)*, MH(62), A(80), AW(66)	PR, PW(52), SW	8.7	36
Antigo	OR(69)*, MH(66)	PW(57), PR(53), SW	10.1	40
Freer	OR(69)*, A(77), PJ(60)	PW(55), SW	10.1	40
Almena	MH(66)*, MR(64), AW(76), BA(68)	SW(65), PW(60), F(50)	6.3	49
Santiago	OR(63)*, MH(61), A(78)	PR, PW, SW	8.0	34
Cushing	A(76)*, OR(58), MH(60)	PR(61), PW, SW	10.8	57
Goodman	OR(67)*, MH(68), BA(68)	PW, PR, SW	9.4	38
Marshfield	OR(60)*, MR(66), A(66)	(not normally planted)	6.9	31
Otterholt	OR(72)*, MH(61), BA(63)	PW, PR, SW	11.2	43
SOIL REGION G FOREST SOILS OF THE NORTHERN LOAMY UPLANDS AND PLAINS				
Wabeno	MH(62)*, BA(69), A(69), BY(61)	PR, PW, F(50), SW	5.3	43
Pence	OR(69)*, MH(59), BA(63), PJ(61)	PR(59), PW(57), SW	10.1	40
Gogebic	A(70)*, MH(58), BA(67), BY(63)	PR, PW, SW	9.0	48
Chetek	PJ(57)*, OH(56)	PR, PW		31
Cloquet	OR(70)*, A(67), SW(57)	PR(56), PW(50)	10.5	41
Kennan	OR(75)*, MH(68), BA(64)	PW(62), PR, SW	12.3	46
Cable	MR(56)*, AW(60), AB(48), F(46)	(not normally planted)	3.8	34
Padus	OR(70)*, A(75), MH(67), PJ(75)	PW(61), PR(57), SW	10.5	41
Amery	A(76)*, OR(65)	PW(60), PR(54), SW	10.8	57
Elderon	OR(60)*, MH(59), BY(62)	PR, PW	6.9	31

TABLE 1

Soil series[1]	Species to favor[2]	Additional trees to plant[2]	Yield at Rotation Age[3] MBF/acre	Cords/acre
SOIL REGION H	**FOREST SOILS OF THE NORTHERN SANDY UPLANDS AND PLAINS**			
Omega	PR(60)*, PW(56), PJ(56)		33.0	48
Vilas	PR(57)*, PJ(62), PW(56)		29.4	43
Pence	OR(69)*, MH(59), BA(63), PJ(61)	PR(59), PW(57), SW	10.1	40
AuGres	A(72)*, PR(59), PW(55), F(55), PJ(53)		9.6	51
Chetek	PJ(57)*, OH(56)	PR, PW		31
Champion	MH(59)*, BA(62), BY(62)	PW, PR, SW(43)	4.6	38
Croswell	OR(70)*, A(70)	PR(57), PW(57), PJ(55)	10.5	41
Grayling	PR(50)*, PJ(47), OR(44)		21.0	32
Kalkaska	A(80)*, MH(63), MR(63)	PR, PJ(63), PW(55)	12.0	63
Manitowish	MH(58)	F(67), PW, PR	4.3	37
Rousseau	OR(71)*, A(67), MH(58)	PJ(61), PR(55), PW(53)	10.8	42
Sayner	PJ(65)*, OR(63), PW(57)	PR(59)		44
SOIL REGION IA	**FOREST SOILS OF THE NORTHERN CLAYEY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS**			
Hibbing	A(72)*, PR(59), PJ(60), F(51)	SW, PW	9.6	51
Ontonagon	A(57)*, SW(43)	PW(42), F(40)	5.1	27
Rudyard	SW(45)*, F(45)			24
Pickford	SW(39)	(not normally planted)		21
Superior	MH(51)*, BA(49)	PW, PR, SW	2.6	27
SOIL REGION IB	**FOREST SOILS OF THE EASTERN CLAYEY AND LOAMY REDDISH DRIFT UPLANDS AND PLAINS**			
Kewaunee	OR(62)*, MH(58), AW(73)	SW, PW(42)	7.6	33
Manawa	OR(60)*, MH(57), AW(64)	SW	6.9	31
Oshkosh	OR(57)	PW, SW	5.9	28
SOIL REGION J	**FOREST SOILS OF THE STREAM BOTTOMS AND MAJOR WETLANDS**			
Carbondale	F(51)*, AB(53), AW(77), SW(34)	(not normally planted)		26
Houghton	MR(82)*, T(50), PW(41)	(not normally planted)		
Palms	T(61), AW(74)	(not normally planted)		
Pella	C(33)	(not normally planted)		
Roscommon	A(78)*, PW(50), SB(49)	(not normally planted)	11.4	60

[1] Soils in boldface are most common in a region and are referred to in the text.

[2] Species symbol followed by site index (base age of 50 years) in parentheses.

[3] Yields based on data contained in Table 2 for asterisked species only or single species listed under "species to favor"

MBF = thousand board feet.

Species symbols:

A - aspen	F - balsam fir	PJ - jack pine
AB - black ash	MH - hard (sugar) maple	PR - red pine
AW - white ash	MR - red maple	PW - white pine
BA - basswood	OB - bur oak	SB - black spruce
BW - white birch	OH - Hill's (northern pin) oak	SW - white spruce
BY - yellow birch	OR - northern red oak	T - tamarack
C - northern white cedar	OW - white oak	

TABLE 2 YIELDS AT SPECIFIED AGES FOR TREE SPECIES IN WISCONSIN IN RELATION TO SITE INDEX[1] (*Assumes fully stocked stands under good management.)*

Species/Forest Type[2]	Units	Age (yr)	*Site Index* 30	40	45	50	55	60	65	70	75	Comment	Ref. No.
Upland oaks (OB, OH, OR, OW)	MBF/a cords/a	80 80					5.4 26		8.2 36		12.5 46	Int. ¼ rule; No thinning	a
Northern hardwoods (AW, BA, BW, BY, MH, MR)	MBF/a cords/a	80 80			1.2 18		3.5 33		6.1 47			Scribner rule	b
Aspen (A)	MBF/a cords/a	50 50				3 16		6 33		9 47		Scribner rule	c
Red pine (PR)	MBF/a cords/a	80 50			15 23		27 41		39 56				d
Jack pine (PJ)	cords/a	40			12		25	36					d
White pine (PW)	MBF/a	80				32		55		74			d
Spruce-fir (F, SB, SW)	cords/a	60	16	24		27		29					e

[1] Site index is the average height of dominant trees in a stand at an age of 50 years.

[2] Species symbols given in Table 1.

MBF/a = thousand board feet per acre

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G3452 FOREST SOILS OF WISCONSIN: AN OVERVIEW I-01-93-1.5M-450-S