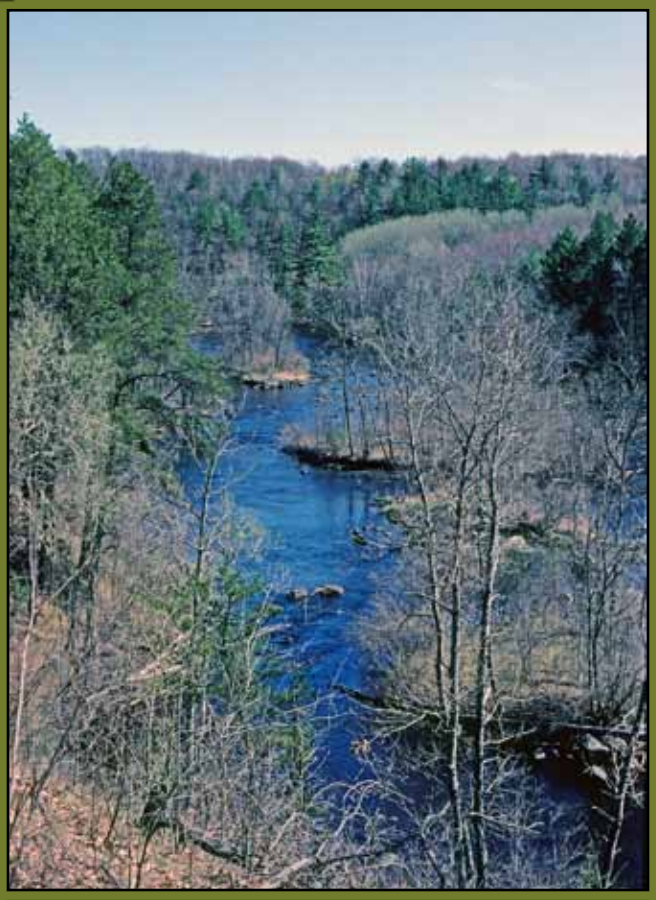
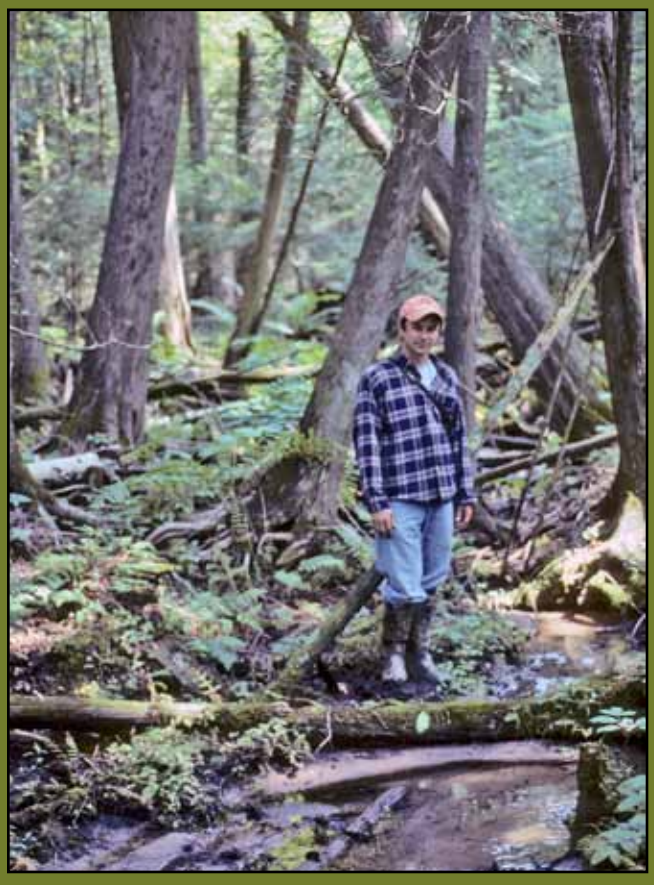
Chapter 13

Northeast Sands Ecological Landscape





Where to Find the Publication

The Ecological Landscapes of Wisconsin publication is available online, in CD format, and in limited quantities as a hard copy. Individual chapters are available for download in PDF format through the Wisconsin DNR website (http://dnr.wi.gov/, keyword "landscapes"). The introductory chapters (Part 1) and supporting materials (Part 3) should be downloaded along with individual ecological landscape chapters in Part 2 to aid in understanding and using the ecological landscape chapters. In addition to containing the full chapter of each ecological landscape, the website highlights key information such as the ecological landscape at a glance, Species of Greatest Conservation Need, natural community management opportunities, general management opportunities, and ecological landscape and Landtype Association maps (Appendix K of each ecological landscape chapter). These web pages are meant to be dynamic and were designed to work in close association with materials from the Wisconsin Wildlife Action Plan as well as with information on Wisconsin's natural communities from the Wisconsin Natural Heritage Inventory Program.

If you have a need for a CD or paper copy of this book, you may request one from Dreux Watermolen, Wisconsin Department of Natural Resources, P.O. Box 7921, Madison, WI 53707.

Photos (L to R): Bald Eagle, photo by Herbert Lange; gray wolf, photo by John and Karen Hollingsworth, U.S. Fish and Wildlife Service; Kirtland's Warbler, photo by Dean DiTomasso; Northern blue butterfly, photo by Mike Reese; nestling Red-shouldered Hawks, photo by Jim Woodford, Wisconsin DNR.

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Cover Photos

Top left: *Wisconsin Endangered northern blue butterfly inhabits bracken grasslands in northeastern Wisconsin. Photo by Mike Reese.*

Bottom left: *Mature forest dominated by northern white-cedar near the Peshtigo River in Marinette County. Spring runs and seepages are present, and this stand features a diverse understory. The individual depicted is former district ecologist Pat Robinson. Photo by Eric Epstein, Wisconsin DNR.*

Top right: *The steep-sided corridor of the Peshtigo River is flanked by an older dry-mesic conifer-hardwood forest of pine, spruce, fir, maple, and oak. Photo by Eric Epstein, Wisconsin DNR.*

Bottom right: *Rolling outwash sands support Bracken Grassland and Pine Barrens vegetation. Herb-dominated openings are interspersed with small scattered groves of jack pine. Spread Eagle Barrens, Florence County. Photo by Eric Epstein, Wisconsin DNR.*

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Christina Isenring, WDNR

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Size

The Northeast Sands Ecological Landscape encompasses 1,542 square miles (987,176 acres), representing 2.8% of Wisconsin's total area, making it the fifth smallest ecological landscape in the state.

Climate

The short growing season (122 days) is similar to other northern ecological landscapes and limits yield potential for row crop agriculture. January minimum temperatures average higher than other northern ecological landscapes. The average August maximum temperature (78.8°) is the third coolest of any other ecological landscape in the state.

Bedrock

Precambrian bedrock of volcanic and metamorphic origin, formed during the Lower Proterozoic (roughly 2,500 to 1,050 million years ago) almost completely underlies the Northeast Sands. The northern part of the ecological landscape is notable for its many waterfalls, almost all of which are associated with this ancient bedrock. Cambrian sandstone, with some dolomite and shale, underlies a small area along the eastern edge of the Northeast Sands. In some places, glacial deposits are thin enough that underlying bedrock directly affects vegetation and is sometimes exposed at the surface.

Geology and Landforms

The Green Bay Lobe covered this ecological landscape during the last part of the Wisconsin glaciation. As the Green Bay Lobe melted and retreated eastward, outwash was deposited over lower-lying surface features, so the ecological landscape now appears as a nearly level-to-rolling sandy outwash plain, pitted in places, with sandy heads-of-outwash and loamy moraines protruding through the outwash sediments. Heads-of-outwash, uncommon in most of Wisconsin, are a distinctive glacial feature here. A series of north-south trending morainal and head-of-outwash hills runs the length of the west side of the Northeast Sands. They are oriented in roughly parallel positions, marking the outer extent of Green Bay Lobe deposits in northeastern Wisconsin.

Soils

Most upland soils formed in acid outwash sand on outwash plains or outwash heads. The dominant soil is excessively drained and sandy with a loamy sand surface, rapid permeability, and very low available water capacity. More than half the land surface is made up of outwash sand and gravel. Glacial till deposits here have pH values that are neutral to calcareous, unlike the acid tills of most of northern Wisconsin, because dolomite was incorporated into the till as glaciers passed over the Niagara Escarpment.

Hydrology

Rivers and streams of the Northeast Sands Ecological Landscape include the Menominee, Peshtigo, Pike, Pine, Oconto, South Branch of the Oconto, and Wolf rivers. Scattered lakes are present, with local concentrations of small lakes in the far north, far south, and the northeast. Several large impoundments have been constructed, such as those on the Menominee and Peshtigo rivers. State Highway 64 bisects the Brazeau Swamp, one of Wisconsin's largest northern white-cedar swamps, disrupting its hydrology and altering composition and function. A large portion of this swamp was cleared and drained and is now a "muck farm" used to grow vegetables.

Current Land Cover

Forests cover almost 77% of this ecological landscape. Aspen is the most abundant cover type, and dry forests dominated by scrub-oak and jack pine are common. Plantation-grown pine, hemlock-hardwoods, and northern hardwoods are also among the important upland cover types. Common lowland communities include wet-mesic forests dominated by northern white-cedar, black spruce-tamarack swamps, and alder-dominated shrub swamps. Agriculture (only 7% of the area) is concentrated mostly in the southeastern and northernmost portions of the ecological landscape.

Socioeconomic Conditions

The counties included in this socioeconomic region are Florence, Marinette, Oconto, and Menominee counties.

Population
The population was 88,064, 1.5% of the state total, in 2010.

Population Density
27 persons per square mile

Per Capita Income
$27,677

Important Economic Sectors
In 2007, important economic sectors included Government (16.5%), Manufacturing (non-wood) (16.1%), Tourism-related (11.8%), and Health Care and Social Services (9.6%) sectors. Forestry has the largest overall impact on the natural resources of the ecological landscape.

Public Ownership
Notable public lands in the Northeast Sands include the Chequamegon-Nicolet National Forest, Peshtigo River State Forest, Governor Tommy Thompson State Park, Peshtigo Brook State Wildlife Area, the Pine-Popple Wild Rivers, the Menominee River Natural Resources Area, and scattered state natural areas, including Dunbar Barrens and Spread Eagle Barrens. Lands owned and managed by Florence, Marinette, and Oconto counties comprise over two-thirds of the public acreage, mostly as county forests but including several small areas managed as county parks. A map showing public land ownership (county, state, and federal) and private lands enrolled in the forest tax programs in this ecological landscape can be found in Appendix 13.K.

Other Notable Ownerships
The eastern part of the Menominee Reservation is in the Northeast Sands. Several land trusts are situated here and have active projects in this part of Wisconsin.

Considerations for Planning and Management
Public lands are extensive, and there are significant tribal holdings in the southern part of the Northeast Sands. As in other parts of Wisconsin, high populations of white-tailed deer continue to have significant negative impacts on seedlings and saplings of important forest dominants such as northern white-cedar and eastern hemlock as well as on composition and structure of shrubs and herbs. Hydrologic modifications include large dams on several of the major rivers, including the Menominee, Peshtigo, and Pine. Shoreline development, especially along rivers and streams, is a significant concern and is likely to increase in the future. Several invasive species are established here, and others are likely to appear in the near future. There is currently a shortage of older forest and large forest patches; these issues could be addressed during the public lands planning process. Prescribed fire is a potentially important management tool at many locations in this ecological landscape. Jack pine, scrub oak, and aspen are all well represented, abundant, and important upland tree species to manage and maintain here.

Management Opportunities
Roughly 75% of the Northeast Sands is forested, playing an important role in the ecological landscape's high water quality, providing extensive forest habitat, supporting local economies, and offering varied management opportunities. Opportunities exist to maintain large habitat patches and improve connectivity between smaller forest patches; both of these would help avoid or minimize problems associated with fragmentation and patch isolation and should benefit area-sensitive species. Older forests are scarce here, as they are in most of the state, and working forests could include areas with extended rotations, the development of old-growth characteristics, and/or stands of "managed ***old-growth forest***."

Dry forest types are prevalent, but many other types are also significant. Much of the forested land here is now managed for aspen and plantation-grown pine, but there are good opportunities to maintain dry forests of other early successional species such as jack pine and scrub oak as well as older, mesic forests of American beech-eastern hemlock-sugar maple, dry-mesic forests of eastern white and red pines, and wet-mesic forests of northern white-cedar. Northern Wet-mesic Forests dominated by northern white-cedar are common here; these forests have high ecological value and support numerous rare or uncommon plants and animals, but they are susceptible to negative impacts from hydrological modifications and white-tailed deer browse pressure. Good opportunities to protect this important but fragile natural community occur on the Chequamegon-Nicolet National Forest, within several state wildlife areas, and on the Marinette and Oconto county forests.

Glade and adjacent dry forest composed of small northern pin oak. Photo by Andy Clark, Wisconsin DNR.

Barrens and bracken grassland communities, once much more common features here, represent important restoration and management opportunities, and active projects are underway at several locations. Some of these projects could be expanded and/or made more compatible with management of adjoining dry forests. Where possible, early successional forests could be managed in association with remnant barrens and bracken grasslands to increase connectivity between open areas that are now isolated, increasing effective habitat size, reducing undesirable edge impacts, and supporting additional open country animals.

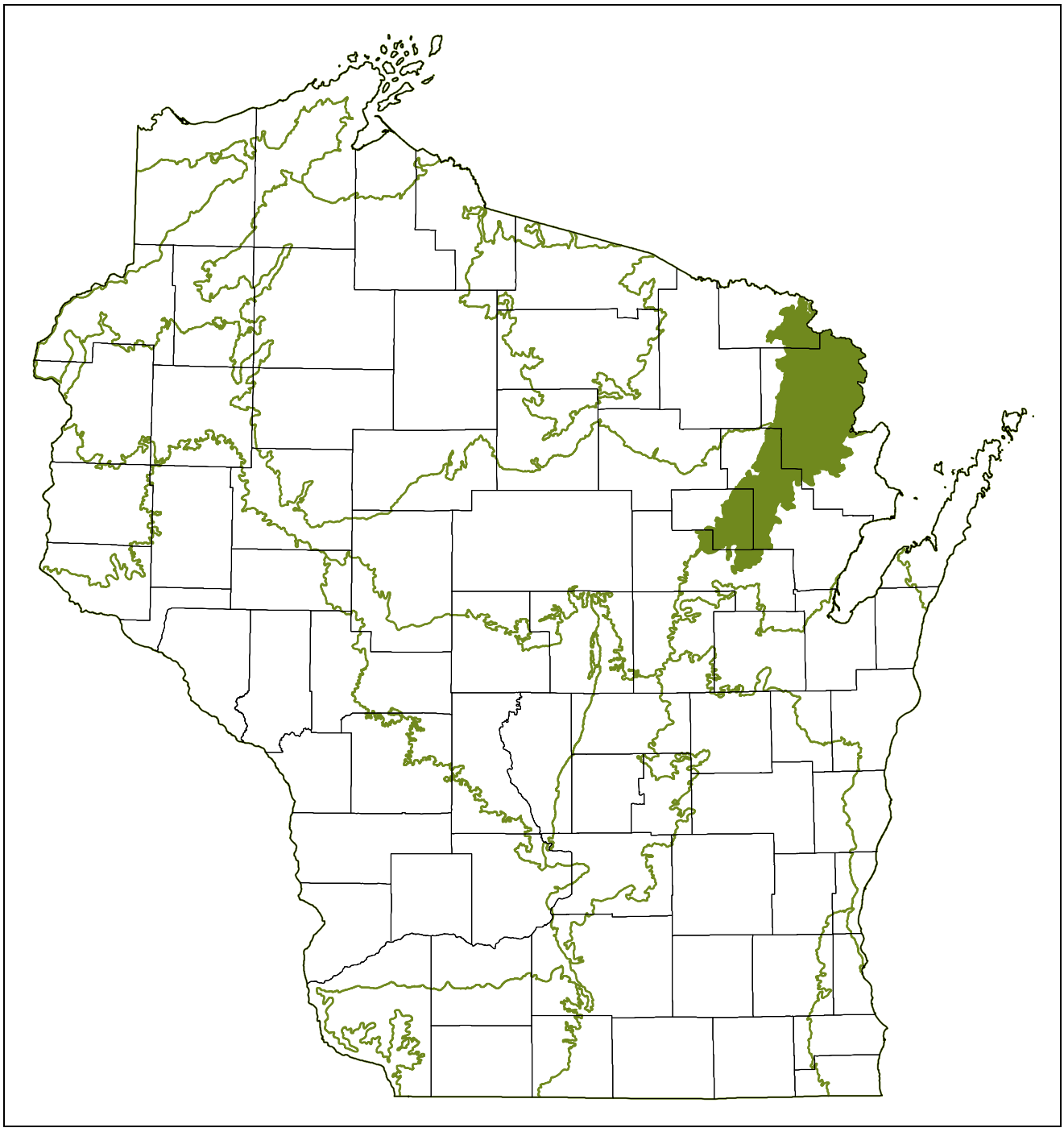
Several Northeast Sands streams offer opportunities to protect aquatic habitats of high biodiversity value. There are good opportunities to protect and maintain river and stream corridors, including those of the Menominee, Peshtigo, Oconto, Wolf, Pine, and Pike rivers and some of their tributaries. Some of the streams are bordered by bedrock outcroppings, stands of conifers, and/or relatively old forest, which support, or have the potential to support, species that are rare elsewhere in the ecological landscape and surrounding regions.

Bedrock features, such as cliffs, glades, and talus slopes, are well represented in some parts of the Northeast Sands, and these merit protection for their unusual biota as well as for the aesthetic and recreational interests they stimulate. Miscellaneous features of potentially high local and regional ecological value include undeveloped lakes and ponds, bogs, fens, sedge meadows, marshes, and alder swamps.

The extensive forests of the Northeast Sands are of great ecological and economic importance. Panoramic view from the top of one of the prominent bedrock features in this ecological landscape. Marinette County. Photo by Eunice Padley.

Bracken Grassland, managed with prescribed fire and timber harvest. Photo by Andy Clark, Wisconsin DNR.

Slow stretch of the Peshtigo River, flanked by a dry forest of pine, oak, and aspen. Photo by Eric Epstein, Wisconsin DNR.



Northeast Sands Ecological Landscape

Thomas Meyer, WDNR

Northeast Sands Ecological Landscape

Introduction

This is one of 23 chapters that make up the Wisconsin DNR's publication *The Ecological Landscapes of Wisconsin: An Assessment of Ecological Resources and a Guide to Planning Sustainable Management*. This book was developed by the Wisconsin DNR's Ecosystem Management Planning Team and identifies the best areas of the state to manage for natural communities, key habitats, aquatic features, native plants, and native animals from an ecological perspective. It also identifies and prioritizes Wisconsin's most ecologically important resources from a global perspective. In addition, the book highlights socioeconomic activities that are compatible with sustaining important ecological features in each of Wisconsin's 16 ecological landscapes.

The book is divided into three parts. Part 1, "Introductory Material," includes seven chapters describing the basic principles of ecosystem and landscape-scale management and how to use them in land and water management planning; statewide assessments of seven major natural community groups in the state; a comparison of the ecological and socioeconomic characteristics among the ecological landscapes; a discussion of the changes and trends in Wisconsin ecosystems over time; identification of major current and emerging issues; and identification of the most significant ecological opportunities and the best places to manage important natural resources in the state. Part 1 also contains a chapter describing the natural communities, aquatic features, and selected habitats of Wisconsin. Part 2, "Ecological Landscape Analyses," of which this chapter is part, provides a detailed assessment of the ecological and socioeconomic conditions for each of the 16 individual ecological landscapes. These chapters identify important considerations when planning management actions in a given ecological landscape and suggest management opportunities that are compatible with the ecology of the ecological landscape. Part 3, "Supporting Materials," includes appendices, a glossary, literature cited, recommended readings, and acknowledgments that apply to the entire book.

This publication is meant as a tool for applying the principles of ecosystem management (see Chapter 1, "Principles of Ecosystem and Landscape-scale Management"). We hope it will help users better understand the ecology of the different regions of the state and help identify management that will sustain all of Wisconsin's species and natural communities while meeting the expectations, needs, and desires of our public and private partners. The book should provide valuable tools for planning at different ***scales***, including master planning for Wisconsin DNR-managed lands, as well as assist in project selection and prioritization.

Many sources of data were used to assess the ecological and socioeconomic conditions within each ecological landscape. Appendix C, "Data Sources Used in the Book" (in Part 3, "Supporting Materials"), describes the methodologies used as well as the relative strengths and limitations of each data source for our analyses. Information is summarized by ecological landscape except for socioeconomic data. Most economic and demographic data are available only on a political unit basis, generally with counties as the smallest unit, so socioeconomic information is presented using county aggregations that approximate ecological landscapes unless specifically noted otherwise.

Rare, declining, or vulnerable species and natural community types are often highlighted in these chapters and are given particular attention when Wisconsin does or could contribute significantly to maintaining their regional or global abundance. These species are often associated with relatively intact natural communities and aquatic features, but they are sometimes associated with cultural features such as old fields, abandoned mines, or dredge spoil islands. Ecological landscapes where these species or community types are either most abundant or where they might be most successfully restored are noted. In some cases, specific sites or properties within an ecological landscape are also identified.

Although rare species are often discussed throughout the book, "keeping common species common" is also an important

Terms highlighted in green are found in the glossary in Part 3 of the book, "Supporting Materials." Naming conventions are described in Part 1 in the Introduction to the book. Data used and limitation of the data can be found in Appendix C, "Data Sources Used in the Book," in Part 3.

consideration for land and water managers, especially when Wisconsin supports a large proportion of a species' regional or global population or if a species is socially important. Our hope is that this publication will assist with the regional, statewide, and landscape-level management planning needed to ensure that most, if not all, native species, important habitats, and community types will be sustained over time.

Consideration of different scales is an important part of ecosystem management. The 16 ecological landscape chapters present management opportunities within a context of ecological functions, natural community types, specific habitats, important ecological processes, localized environmental settings, or even specific populations. We encourage managers and planners to include these along with broader landscape-scale considerations to help ensure that all natural community types, ***critical habitats***, and aquatic features, as well as the fauna and flora that use and depend upon them, are sustained collectively across the state, region, and globe. (See Chapter 1, "Principles of Ecosystem and Landscape-scale Management," for more information.)

Locations are important to consider since it is not possible to manage for all species or community types within any given ecological landscape. Some ecological landscapes are better suited to manage for particular community types and groups of species than others or may afford management opportunities that cannot be effectively replicated elsewhere. This publication presents management opportunities for all 16 ecological landscapes that are, collectively, designed to sustain as many species and community types as possible within the state, with an emphasis on those especially well represented in Wisconsin.

This document provides useful information for making management and planning decisions from a landscape-scale and long-term perspective. In addition, it offers suggestions for choosing which resources might be especially appropriate to maintain, emphasize, or restore within each ecological landscape. The next step is to use this information to develop landscape-scale plans for areas of the state (e.g., ecological landscapes) using a statewide and regional perspective that can be implemented by field resource managers and others. These landscape-scale plans could be developed by Wisconsin DNR staff in cooperation with other agencies and nongovernmental organizations (NGOs) that share common management goals. Chapter 1, "Principles of Ecosystem and Landscape-scale Management," in Part 1 of the book contains a section entitled "Property-level Approach to Ecosystem Management" that suggests how to apply this information to an individual property.

How to Use This Chapter

The organization of ecological landscape chapters is designed to allow readers quick access to specific topics. You will find some information repeated in more than one section, since our intent is for each section to stand alone, allowing the reader to quickly find information without having to read the chapter from cover to cover. The text is divided into the following major sections, each with numerous subsections:

- Environment and Ecology
- Management Opportunities for Important Ecological Features
- Socioeconomic Characteristics

The "Environment and Ecology" and "Socioeconomic Characteristics" sections describe the past and present resources found in the ecological landscape and how they have been used. The "Management Opportunities for Important Ecological Features" section emphasizes the ecological significance of features occurring in the ecological landscape from local, regional, and global perspectives as well as management opportunities, needs, and actions to ensure that these resources are enhanced or sustained. A statewide treatment of integrated ecological and socioeconomic opportunities can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management."

Summary sections provide quick access to important information for select topics. "Northeast Sands Ecological Landscape at a Glance" provides important statistics about and characteristics of the ecological landscape as well as management opportunities and considerations for planning or managing resources. "General Description and Overview" gives a brief narrative summary of the resources in an ecological landscape. Detailed discussions for each of these topics follow in the text. Boxed text provides quick access to important information for certain topics ("Significant Flora," "Significant Fauna," and "Management Opportunities").

Coordination with Other Land and Water Management Plans

Coordinating objectives from different plans and consolidating monetary and human resources from different programs, where appropriate and feasible, should provide the most efficient, informed, and effective management in each ecological landscape. Several land and water management plans dovetail well with *The Ecological Landscapes of Wisconsin*, including the Wisconsin Wildlife Action Plan; the Fish, Wildlife, and Habitat Management Plan; the Wisconsin Bird Conservation Initiative's (WBCI) All-Bird Conservation Plan and Important Bird Areas program; and the *Wisconsin Land Legacy Report*. Each of these addresses natural resources and provides management objectives using ecological landscapes as a framework. Wisconsin DNR ***basin*** plans focus on the aquatic resources of water basins and watersheds but also include land management recommendations referencing ecological landscapes. Each of these plans was prepared for different reasons and has a unique focus, but they overlap in many areas. The ecological management opportunities provided herein are consistent with the objectives provided in many

of these plans. A more thorough discussion of coordinating land and water management plans is provided in Chapter 1, "Principles of Ecosystem and Landscape-scale Management," in Part 1 of the book.

General Description and Overview

The Northeast Sands Ecological Landscape occupies a narrow, crescent-shaped area in northeastern Wisconsin. Much of this ecological landscape formed in sandy glacial outwash landforms, ground moraines, and end moraines. Precambrian outcroppings of basalt, rhyolite, or granite are scattered across the Northeast Sands, forming steep knolls and ridges, cliffs, short canyons, and waterfalls.

Historically, extensive oak/jack pine barrens, bracken grasslands, and jack pine (*Pinus banksiana*) forests were found on the outwash sands of this ecological landscape. Moraines supported forests of hardwoods, red pine (*Pinus resinosa*), and eastern white pine (*Pinus strobus*). ***Pitted outwash*** plains often contained numerous depressions, which contained wetlands and ***kettle lakes***. Most of this ecological landscape is still forested, with aspen (*Populus* spp.) and northern hardwoods the predominant ***cover types***. Jack pine remains common on the drier outwash plains, along with northern pin oak (*Quercus ellipsoidalis*). There are several significant examples of jack pine/oak barrens communities. A small percentage of the Northeast Sands contains conifer swamps of black spruce (*Picea mariana*) and tamarack (*Larix laricina*) or northern white-cedar (*Thuja occidentalis*) and limited areas of lowland hardwood forest. The Brazeau Swamp Conservation Opportunity Area, much of which is managed by Oconto and Marinette counties, includes one of the largest northern white-cedar swamps in Wisconsin.

The Northeast Sands contains several important river systems as well as extensive wetlands. The Menominee is the largest river, located on the Michigan-Wisconsin border and forming the northeastern boundary of the ecological landscape. The Pike and the Pine were the first Wisconsin rivers to be designated as state wild rivers, in 1965, under the then-new Wisconsin Wild Rivers Act. A 24-mile stretch of the Wolf River, from the Langlade/Menominee County line downstream to Keshena Falls, was designated a national wild and scenic river in 1968. The upper Peshtigo River runs through the center of the Northeast Sands and includes two large impoundments, Caldron Falls Flowage and High Falls Reservoir. Water quality in free-flowing rivers and streams is generally good across this ecological landscape, due to the combination of extensive forest cover and lack of significant industrial, agricultural, and residential development. This is underscored by the fact that 221 individual rivers and streams and one impoundment are designated as either ***Outstanding Resource Waters*** (ORW) or ***Exceptional Resource Waters*** (ERW). Extensive wetlands, including the expansive open wetlands of the Peshtigo Brook State Wildlife Area, occur here.

The total land area of the Northeast Sands Ecological Landscape is approximately 987,000 acres, of which 77% is classified as ***timberland***. About a third of the ecological landscape is publicly owned, and over two-thirds of this acreage is managed by the counties. Menominee County in the southern portion of the Northeast Sands is also heavily forested and is managed by the Menominee Indian tribe.

The economy of the Northeast Sands counties is largely dependent on the forest industry. The forest products and processing industries contribute 24% to total industrial output. Compared with other ecological landscape county approximations, the Northeast Sands counties are not heavily agricultural or recreational. The Northeast Sands counties have below-average percentages of acreage in farmland (only 18%) and acreage per farm and rank below the state average in milk and corn production per acre. (Farmland includes all land under farm ownership, such as cropland, pastureland, and woodland.)

Total acreage in lakes and rivers is relatively low, but these waters have important recreational as well as ecological value. Although there are relatively few state parks, forests, recreation areas, or fishery and wildlife areas, a significant portion of the Chequamegon-Nicolet National Forest is located within this ecological landscape. Relatively little of the forested or agricultural land is sold or diverted to other uses. The Northeast Sands counties have a fairly low per capita water usage, with industrial needs accounting for over 50% of total water use. The Northeast Sands counties are sparsely populated, and their population is older than that of the state as a whole. They have fewer African Americans than any other ecological landscape county approximation, but the percentage of American Indians is second highest in the state. The area has the state's second lowest per capita income, the highest rate of unemployment, and the second highest rate of adult poverty. Government and manufacturing sectors provide the most jobs in the Northeast Sands county approximation (16.5% and 16.1%, respectively).

Environment and Ecology

Physical Environment

Size

The Northeast Sands Ecological Landscape encompasses 1,542 square miles (987,176 acres), representing 2.8% of the total area of the state, making it Wisconsin's fifth smallest ecological landscape.

Climate

Climate data were analyzed from six weather stations within the Northeast Sands: Breakwater, Wausaukee, Breed, Brule Island, Crivitz High Falls, and Shawano (WSCO 2011). This ecological landscape has a continental climate, with cold winters and warm summers. Overall, the climate is similar to the other ecological landscapes in northern Wisconsin

(Northwest Lowlands, Northwest Sands, Superior Coastal Plain, North Central Forest, Northern Highland, and Northern Lake Michigan Coastal). Wisconsin's northern ecological landscapes generally tend to have shorter growing seasons, cooler summers, and colder winters than the ecological landscapes farther south. Climate data among the weather stations within the Northeast Sands are similar with the exception that Brule Island (the most northerly weather station) has 12 fewer growing degree days, and Shawano (the most southerly weather station) has 11 more growing degree days than the mean growing degree days for this ecological landscape.

The average growing season length here is 122 days (base 32°F), the same as other northern ecological landscapes, and it ranges from 110 to 133 days. The annual average temperature in the Northeast Sands is 41.6°F, essentially the same as the average for other northern ecological landscapes (41.2°F). The minimum January temperature averages 1.5°F, compared to the -1.2°F for the other northern ecological landscapes. The average August maximum temperature is 78.8°F, the third coolest of any ecological landscape but similar to other northern ecological landscapes (79.3°F).

Annual precipitation averages 31.8 inches, ranging from 29.8 to 32.5 inches. These values are slightly below average for the state (32.4 inches) but are consistent with the other northern ecological landscapes (31.6 inches). Average annual snowfall is 57.5 inches, which is similar to the amount of snowfall in northern ecological landscapes (excluding the Superior Coastal Plain which has greater snowfall due to lake effect snow). There is not a great deal of variation in the amount of snowfall reported from different stations within the Northeast Sands Ecological Landscape; it ranges from 50.8 to 61.9 inches.

Although there is adequate rainfall to support agricultural row crops such as corn, the sandy soils and short growing season limit row crop agriculture. The climate is most favorable for supporting forests, which cover about 75% of the ecological landscape.

Bedrock Geology

The Northeast Sands Ecological Landscape is almost completely underlain by Precambrian bedrock of volcanic and metamorphic origin, formed during the Lower Proterozoic (roughly 2,500 to 1,050 million years ago). Bedrock in the southern part of the area is the granitic Wolf River Batholith, while the northern portion is of Penokean origin, composed primarily of rhyolite, basalt, and granite. The northern part of the ecological landscape is notable for its many waterfalls, almost all of which are associated with this ancient bedrock. Cambrian sandstone, with some dolomite and shale, underlies a small area along the eastern edge of the ecological landscape. In some places, glacial deposits are thin enough that bedrock characteristics directly affect vegetation, and bedrock has influenced glacial geology and landforms. Bedrock exposures are very common in this ecological landscape, especially in the northern part and along rivers and streams. The bedrock surface lies within a depth of 100 feet over most of the area, but the thickness of glacial sediment can vary considerably across the ecological landscape, with bedrock depths ranging from 0 to more than 300 feet. The thickest glacial sediments occur in the southeast part of the ecological landscape.

The difficulty of characterizing Precambrian bedrock has been described by Schultz (2004) who noted that this rock has the most complex history of any in Wisconsin. The Precambrian Shield is more than 1 billion years old and has been subject to considerable metamorphism, erosion, and mixing during its existence. It is made up of many different kinds of rocks, and they do not occur in the systematic layers that are often seen in the underlying Paleozoic limestones and sandstones. Also, there are almost no Precambrian-age fossils to help identify a sequence of geologic events. Because of these factors, there is much that is unknown about the bedrock beneath this ecological landscape.

The oldest bedrock in the area, which generally underlies the northern half of the ecological landscape, was formed during the Penokean mountain building period about 1,860 million years ago (Dott and Attig 2004). This bedrock is metamorphosed volcanic rock that has been extensively folded, faulted, and eroded. It is mainly rhyolite, with some basalt, andesite, gneiss, and granite (Greenberg and Brown 1984, Olson 1984). An exposure of the ancient granite can be viewed at Twelve Foot Falls County Park in Marinette County. Attig and Ham (1999) noted the locations of hills formed of volcanic bedrock in central Oconto County, including Butler Rock (in the southwest part of Sec 5, T31N, R18E) and hills southwest of Crooked Lake (in the northern part of Sec. 22, T32N, R17E), and Lorenz (2005) reported outcrops along Parkway Road near High Falls Reservoir. Many rock outcrops are also mapped in southeast Florence County (Aurora Township) (Hole et al. 1962).

Part of the far northern tip of the ecological landscape, in Florence and Marinette counties, is underlain by slate, greywacke, and iron formation (Greenberg and Brown 1984). The sedimentary rocks are likely to have accumulated along the margin of ancient continents before the continental collision that occurred during the Penokean mountain building period (LaBerge 1994). They were metamorphosed along with the volcanics and are folded and steeply inclined in places due to faulting (Hole et al. 1962). An easily accessible exposure of these metamorphosed rocks is located at Long Slide Falls in northern Marinette County (Dott and Attig 2004, p. 102). The iron-bearing rock formation extends into Upper Michigan and is known as the Menominee Range. Iron was mined in the Florence area in open-pit and underground mines from around 1880 until 1937, with additional small operations occurring from 1952 until 1960 (Schultz 2004).

Granites that formed at around 1,750 million years ago have intruded the metamorphosed volcanics at a number of places in the northern part of the ecological landscape, including Dave's Falls on the Pike River, and at quarries near Amberg (Greenberg and Brown 1984, Dott and Attig 2004, p.

288). The approximate locations of these Lower Proterozoic granite intrusions are shown on the map "Bedrock Geology of Wisconsin" in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials."

The Wolf River Batholith is an important geologic feature that underlies approximately the southern half of the ecological landscape, in Menominee, Oconto, and Shawano counties. It is formed of Precambrian rock produced by volcanic activity at about 1,485 million years ago (Greenberg et al. 1986). The volcanic event occurred over a wide area, including Missouri, Colorado, and Arizona, but its cause is unknown (Dott and Attig 2004). The batholith formed when granitic magma from deep in the Earth's crust intruded toward the surface and cooled and crystallized at the relatively shallow depth of 1 to 2 miles (La Berge 1994). Wolf River rocks are dominantly granites and syenite, with smaller amounts of anorthosite and gabbro; they underlie about 3,600 square miles in Wisconsin. Outcrops of the reddish, coarse-grained granite are common along the Wolf and the Oconto rivers in Menominee County (Milfred et al. 1967).

Thunder Mountain, in Marinette County, is part of a notable quartzite outcrop associated with the McCaslin Syncline. Like the syncline of the Baraboo Hills, the rocks are folded downward in the center and rise up at the edges to form outcrops. The tip of the syncline's southern arm outcrops at Thunder Mountain. McCaslin Mountain is on the northern arm of the syncline, an outcrop about 4 miles long in the North Central Forest Ecological Landscape. The center of the syncline was intruded by rhyolite and granitic rocks of the Wolf River Batholith, burying the quartzite. The quartzite of the McCaslin Syncline is gray to reddish with quartz crystal inclusions, formed about 1,760 million years ago at about the same time as quartzite at the Blue Hills and Baraboo Hills (Dott and Attig 2004). The formations all have a similar appearance, with reddish-to-purple colors and obvious ripple-marked strata indicative of marine deposition. Another quartzite deposit of this age occurs at the Mountain Lookout Tower near the village of Mountain in Oconto County (Greenberg and Brown 1984).

Landforms and Surficial Geology

The Northeast Sands Ecological Landscape was covered by the Green Bay Lobe during the last part of the Wisconsin glaciation, which took place approximately 26,000 to 10,000 years ago. The oldest landforms in the Northeast Sands date from around 16,000 years ago, when the Green Bay Lobe built the moraines at the west side of the ecological landscape. Although the area was undoubtedly glaciated prior to that time, older deposits were removed or reworked into the currently existing glacial landforms by the Green Bay Lobe. The ice sheet flowed mainly in a westerly direction in this area, depositing a loamy reddish-brown till and forming moraines and ***heads-of-outwash*** oriented in a north-south direction. As the Green Bay Lobe melted and retreated eastward, outwash was deposited over lower-lying surface features, so the ecological landscape now appears as a nearly level-to-rolling sandy outwash plain, pitted in parts, with sandy heads-of-outwash and loamy moraines protruding through the outwash sediment. ***Proglacial*** stream sediments also formed outwash terraces and fans. The geology of this area is complex, including nearly every type of glacial landform, and there is no detailed surficial geology map that covers the entire ecological landscape. The Wisconsin Geological and Natural History Survey is working toward obtaining data to produce a detailed regional map, but meanwhile, information about this area comes from multiple sources and is not complete.

Heads-of-outwash are a distinctive glacial feature, uncommon in Wisconsin but relatively abundant here. These hilly areas were formed at recessional positions of the Green Bay Lobe when ice was melting and thinning rapidly. Large amounts of sand and gravel, with inclusions of till or loamy debris-flow sediment, were deposited atop the thin edge of the ice sheet, and when the ice melted, a hummocky "head-of-outwash" ridge remained (Attig and Ham 1999). See Figure 13.1 for a diagram of formation of heads-of-outwash.

The ecological landscape also has loamy end moraines that were not completely buried by outwash materials. Moraines formed when the glacial ice was at a standstill and melting occurred at about the same rate as advance, allowing the glacier to remain in one place long enough to deposit a ridge of sediment (Figure 13.1). Moraines have a hummocky topography because ***supraglacial till*** (material on top of the ice sheet) was deposited unevenly in crevasses and depressions along the melting ice margin and also because overlying sediment collapsed when buried stagnant ice melted. Hills that initially appear to be moraines are often partly made up of head-of-outwash landforms. It can be difficult to tell whether a landform is a morainal ridge or a head-of-outwash feature, because they have similar surface shapes and are frequently intermingled. A range of hills in this ecological landscape may be moraine in parts and heads-of-outwash in others. Vegetation will usually reflect these differences because heads-of-outwash are built primarily of sand and gravel, while moraines are typically a reddish sandy loam till.

A series of north-south trending morainal and head-of-outwash hills runs the length of the west side of this ecological landscape. They are oriented in roughly parallel positions, marking the outer extent of Green Bay Lobe deposits in northeastern Wisconsin. Moraines in the northwest are typically known collectively as the Athelstane moraines, the westernmost of which lies along the edge of the ecological landscape. The inner Athelstane moraine, a shorter morainal and head-of-outwash segment, lies to the east. During glaciation, the two moraines trapped water between them, with the outflow blocked by ice dams, to form Glacial Lake Dunbar (Lorenz 2005). The Dunbar Barrens ***State Natural Area*** is located on the former glacial lakebed. To the south of the Athelstane moraines, features of the same till material are known as the Mountain moraines (again including head-of-outwash segments). There may be some confusion about

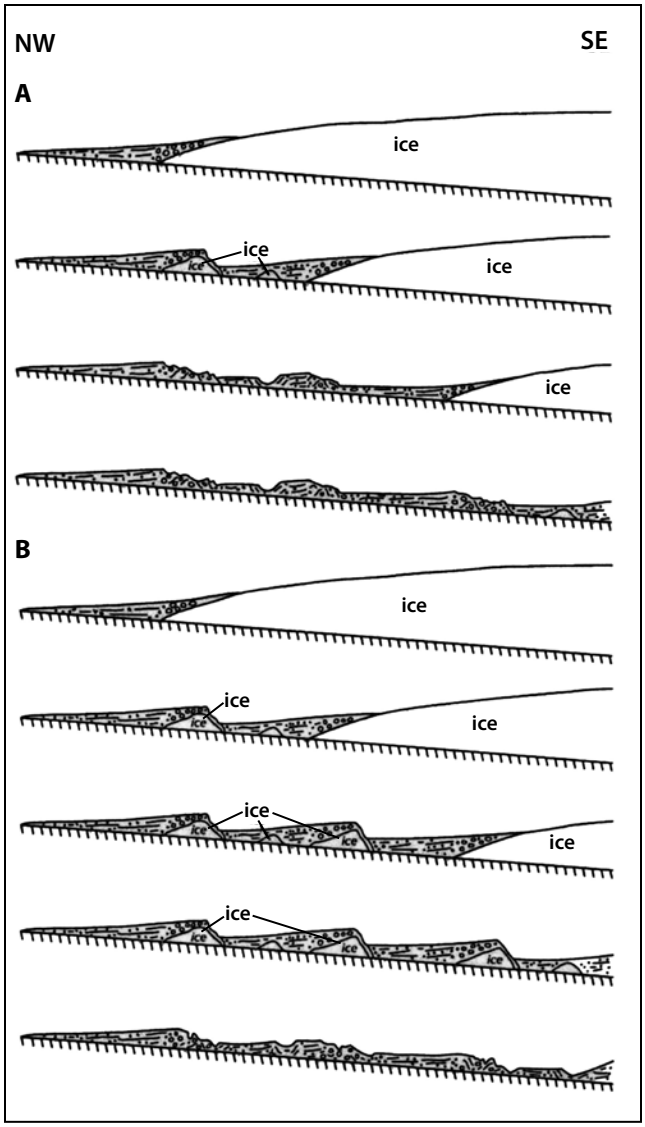


Figure 13.1. *Two possible sequences of events in the development of outwash heads during the wasting of the Green Bay Lobe into the Green Bay Lowland. In A and B, the Green Bay Lobe is shown depositing outwash between the ice margin and the west side of the lowland. In A, buried ice melts as the Green Bay Lobe wastes back. In B, buried ice persists until the lobe has receded from the area; the buried ice later melts and the rock debris overlying it collapses. Figure reproduced from Attig and Ham (1999) and reprinted by permission of the Wisconsin Geological and Natural History Survey.*

these naming conventions, as the earliest geology map by F. T. Thwaites called all of the moraines along the western edge of the ecological landscape the Mountain moraine (McCartney 1983). The Marinette County Beech Forest State Natural Area lies within the outer Athelstane moraine a few miles north of Caldron Falls Reservoir. Other moraines occur in the eastern part of the ecological landscape, but these ranges of hills lack commonly used place names (see the Landtype Associations map in Appendix 13.K at the end of this chapter for locations of some of these moraines).

Tunnel channels that have cut through morainal ridges are some of the many interesting glacial features of the area. The channels are formed by streams and rivers running beneath an ice sheet, probably under hydraulic pressure. A tunnel channel that cuts through a ridge east of High Falls Reservoir can be viewed from the vantage point of Thunder Mountain (J.W. Attig, University of Wisconsin-Madison, personal communication). The former channel is now occupied by Joy and Kiss lakes.

Glacial till deposits here have pH values that are neutral to calcareous, unlike the acid tills of most of northern Wisconsin, because dolomite was incorporated into the till as glaciers passed over the ***Niagara Escarpment***. Till deposits include the Silver Cliff Member of the Kewaunee Formation, which formed the Mountain moraine in northwestern Marinette County at about 15,900 years ago (Attig and Batten 2004, Hooyer 2007). This deposit continues in a south-southwesterly direction through north central Oconto County (Attig and Ham 1999) and also through the east-central part of Menominee County (Milfred et al. 1967). The Middle Inlet Member of the Kewaunee Formation advanced at about 13,600 years ago, building the inner Athelstane moraine and other moraines in the northern part of the ecological landscape (Attig and Batten 2004, Hooyer 2007). Both the Silver Cliff and the Middle Inlet Members are made up of reddish-brown, sandy, dolomitic till and debris-flow sediments; however, the Silver Cliff Member is more deeply leached of carbonates than the younger till, and this is how the two are distinguished (McCartney and Mickelson 1982, McCartney 1983). The silty, dolomitic Kirby Lake Member of the Kewaunee Formation was deposited at around 14,200 to 15,600 years ago, but this till mostly occurs farther south, in the Central Lake Michigan Coastal and Southeast Glacial Plains ecological landscapes (Attig and Batten 2004, Hooyer 2007, Hooyer and Mode 2007). Here, the Kirby Lake till is thin and patchy and was mostly buried by the Middle Inlet Member (McCartney and Mickelson 1982, McCartney 1983).

Till plains, or ground moraines, were also deposited by the Green Bay Lobe but are scarcely in evidence here because they were covered by outwash as the ice melted away to the east. Only in the northeast section of the ecological landscape are significant areas of ground moraine exposed, associated with the Amberg and Aurora moraines. These areas were glaciated later and received less outwash to cover the till surface.

More than half the land surface in the ecological landscape is made up of outwash sand and gravel. Topography of the outwash is dominantly "collapsed," formed when stranded blocks of glacial ice melted and overlying outwash material collapsed into the depressions. Hole et al. (1962) mapped pitting throughout the portion of the ecological landscape in Florence County in sandy outwash deposits over glacial sediment. Attig and Batten (2004) and Attig and Ham (1999) indicated collapsed topography in most of the outwash mapped near the Peshtigo River State Forest and in northern Oconto County. A map by Milfred et al.

(1967) shows extensive pitting in both outwash and remnant moraines in southeast Menominee County. Water tables are high in parts of the ecological landscape because glacial till underlies outwash sediments and slows infiltration. The high water table has allowed kettle lakes and wetlands to develop in the collapsed outwash, but lakes are less common here than in other outwash-dominated areas of northern Wisconsin. This is because the outwash plains tend to slope downward toward the west, while the more easterly portions are generally thicker and lie above the water table (J.W. Attig, University of Wisconsin-Madison, personal communication).

Lake deposits originating from Glacial Lake Oshkosh make up about 8% of the ecological landscape. Lacustrine silts and clays were deposited along the southeast edge of the ecological landscape, where the glacial lake abutted the ice sheet that formed the Middle Inlet Member of the Kewaunee Formation in the Northern Lake Michigan Coastal Ecological Landscape (Hooyer 2007, Hooyer and Mode 2007). Glacial Lake Oshkosh varied in size depending on the location of the ice sheet; at its maximum, it covered around 1.4 million acres, but most of its extent was farther south in the Central Lake Michigan Coastal and Southeast Glacial Plains ecological landscapes. The lake existed during times when ice of the Green Bay Lobe stood in the Fox River lowland between present-day Lake Winnebago and the city of Green Bay. Surface water draining northward through the lowland became ponded in front of the ice sheet until finding other outlets, either through the ancestral Wisconsin River or eastward to the Lake Michigan basin. The ice sheet re-advanced at least two times after it had fully receded from Wisconsin, so there were three stages of Glacial Lake Oshkosh during ice retreat. The lake was at its largest extent during the first stage at about 18,500 years ago; subsequent, lower stages occurred at around 16,000 and 13,500 years ago (Hooyer 2007). It left behind a nearly level lake plain formed by settling of fine-grained offshore sediment as well as beach terraces and ridges created by wave and ice action along former shorelines. As the lake dried, winds blowing unimpeded across the lake plain deposited aeolian sands and formed dunes in some locations, such as the one at the far southern tip of the ecological landscape near Shawano Lake (Hooyer and Mode 2007).

Some sandy lake sediments were deposited in localized glacial lakes, such as Glacial Lake Dunbar. Deposits of windblown sand with stabilized dunes also occur outside the former Glacial Lake Oshkosh. One such area is about 7 miles west of Crivitz (Attig and Batten 2004). There are areas with active sand dunes scattered throughout the dune formations, and stable dunes can be remobilized by surface disturbances and fire.

Notable examples of barrens communities are located on sandy sites in this ecological landscape. These include Spread Eagle Barrens State Natural Area on a collapsed outwash surface near Florence and Dunbar Barrens State Natural Area, northwest of the village of Dunbar, on a sandy plain formed under a glacial lake.

Eskers are a glacial feature formed by rock and gravel that settles out of streams running beneath an ice sheet. Two eskers are located near Keshena, one about a mile west of town, and the other about 3 miles to the east, near Sand Lake. An unusual fan of eskers occurs around 2 miles north of Wausaukee, extending east of Highway 141 for several miles. Eskers are mapped near Halls Creek and at several other locations in southeast Florence County (Hole et al. 1962).

Relatively few drumlins are found in this ecological landscape. For example, only 0.2% of the area of eastern Menominee County, the portion within the Northeast Sands Ecological Landscape, is drumlins. In the portion of the county that lies in the North Central Forest Ecological Landscape, drumlins make up 3% of the area (Milfred et al. 1967).

Postglacial erosion by streams, followed by redeposition of the sediment, led to the development of floodplains and terraces along rivers. The silty aeolian loess that was deposited over most of the state following glaciation is lacking here, and is less than 6 inches thick in most of the ecological landscape (Hole 1976).

The Northeast Sands Ecological Landscape has the same boundaries as the Athelstane Sandy Outwash and Moraines Subsection (212Tc) (Cleland et al. 1997). A map showing the Landtype Associations (WLTA Project Team 2002) in this ecological landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 13.K at the end of this chapter.

Topography and Elevation

Elevation ranges from 640 to 1,536 feet (195 to 468 meters) in the Northeast Sands Ecological Landscape. Topography is nearly level to undulating on outwash plains, undulating to hilly in collapsed outwash, and undulating to steep in moraines and heads-of-outwash. Slopes can be especially steep in outcrops of Precambrian bedrock. Thunder Mountain, a prominent bedrock hill at the western edge of Marinette County, has an elevation of 1,375 feet.

Soils

Most upland soils formed in acid outwash sand on outwash plains or outwash heads. The dominant soil is excessively drained and sandy with a loamy sand surface, rapid permeability, and very low available water capacity. Soil drainage classes range from excessively drained to somewhat poorly drained, and soils generally have loamy sand to sandy loam surface textures, rapid to very rapid permeability, and low to very low available water capacity. Moraines have soils formed in brown to reddish-brown noncalcareous to calcareous loamy sand, sandy loam, and loamy till. They range from well drained to somewhat poorly drained and generally have sandy loam to loamy sand textures, moderate to moderately slow permeability, and moderate to high available water capacity. Igneous and metamorphic bedrock exposures are common in the northern part of the ecological landscape. Most lowland soils are very poorly drained acid peat or nonacid muck.

Hydrology

Basins

The heavily forested Northeast Sands Ecological Landscape overlies two of Wisconsin's major water basins. Ninety percent of this ecological landscape is within the Green Bay Basin (occupying roughly the middle 30% of that basin), and the remaining 10% is in the Wolf River Basin immediately north of Shawano, (occupying the east-central 5% of that basin). Within these basins there are 20 watersheds that lie entirely or partially within this ecological landscape (see Appendix 13.A).

Inland Lakes

According to the Wisconsin DNR's 24K Hydrography Geodatabase, this ecological landscape contains 326 named lakes totaling 20,162 acres and 1,055 unnamed lakes (mostly small lakes) totaling 1,746 acres (WDNR 2012). The Menominee, Pike, Peshtigo, and Oconto River watersheds all contain numerous named lakes, especially in the vicinity of their headwaters. A number of these lakes contain populations of common game and forage fish and attract vacation home owners, anglers, and other recreationalists. Of all the lakes here, 494 are 50 acres or less in size and have been designated by the Wisconsin DNR water management programs as priority ***navigable*** waterway (PNW) lakes. These lakes have potentially high conservation value, based on some combination of their intact hydrology, lack of development, good water quality, undeveloped shorelines, important associated natural communities (these may be both wetland and upland communities), the presence of rare or otherwise noteworthy species, vulnerability to development impacts, or some other factor.

At the request of concerned lake associations, two lakes in this ecological landscape have been examined by Wisconsin DNR specialists for areas of ***Critical Habitat Designation*** (NR 1.06, Wis. Adm. Code), and other habitat features that have been mapped for protection, public rights maintenance, and resource management purposes. Shawano Lake (6,063 acres) has 18 critical habitat sites (see *Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters*, Ball and LaLiberte 2004), primarily aquatic plant beds and wetlands, which are vital to maintaining biological diversity in this lake. While it is heavily developed and has some water quality impairment, it is home to several rare fish species (see the "Fauna" section below for details). An exotic trematode (fluke) infestation in Shawano Lake killed 11,000 American Coots (*Fulica americana*) in 1997. American Coots and other aquatic birds have been killed annually since that time, and there is concern that this infestation could spread to other waters. There are also 11 sensitive area sites mapped in Lake Noquebay in Marinette County. When incorporated into lake management plan elements that limit aquatic plant removals and motorized boat use, these critical area designations offer protection for areas of diverse aquatic plants, sedge meadows, spawning gravels, and important wetlands for fish spawning and water quality.

Stands of northern sedge meadow and marsh fringe the margins of Jones Lake, Marinette County. Photo by Andy Clark, Wisconsin DNR.

Other named lakes in the Northeast Sands with good water quality and significant habitat values include Waupee, Bear Paw, Nelligan, Ledge, Bell, Gilkey, Gilas, White Potato, and Crooked lakes in Oconto County; Big, Koon, Upper Red, Lower Red, Loon, and Island lakes in Shawano County; Wonder, Fryingpan, Frieda, Mountain, Woods, Harwell, Lehman, Town Corner, Spring, West and East Twin, Noquebay, and Lindquist lakes in Marinette County; Sand, Hord, Emily, North, Middle, Long, and Hall's lakes in Florence County; and Berry, Moshawquit, Fredenberg, LaBelle, Watosa, LaMotte, Sand, Pine, and Bass lakes in Menominee County. Nearly all of these lakes have good water quality and habitat values. These lakes exhibit varying amounts of shoreline development (from none to moderate to more developed), but increased residential construction, other changes in land use, loss of shoreline and littoral zone habitats, and introduction of invasive species are always potential threats to lake health and biodiversity.

Populations of invasive, nonnative species are known to be problems at certain sites. For example, Chute Pond, Loon Lake, Shawano Lake, and Peshtigo Lake (Legend Lake Chain) are impacted by growths of curly-leaf pond weed (*Potamogeton crispus*). Eurasian water-milfoil (*Myriophyllum spicatum*) has been documented in 27 lakes, and nine lakes have infestations of the exotic, highly invasive, rusty crayfish (*Orconectes rusticus*) (Wisconsin DNR unpublished data).

Impoundments

One hundred and two dams on Northeast Sands streams have created 12,192 acres of impoundments, large and small (WDNR 2012). These hold 98,647 acre-feet of water. Most impoundments here are used for generating hydroelectricity, mostly in small amounts. Sediment build-up behind the dams, as well as the physical barriers created by the dams themselves, negatively impact stream habitats. Twenty-five dams have been removed for a variety of ecological, public

safety, or economic reasons. However, a number of dams are viewed, at least locally, as important for maintaining fish and wildlife habitat.

The Peshtigo River is dammed at several sites in this ecological landscape, forming Caldron Falls Flowage (1,018 acres), High Falls Flowage (1,498 acres), Johnson Falls Flowage (158 acres), and Sandstone Flowage (153 acres). While these flowages pose barriers to the free movement of fish and other aquatic life, they do not apparently have a significant negative water quality impact on free-flowing stream ***reaches*** below the dam spillways. The lentic habitat these impoundments provide does account for some of the aquatic invertebrate diversity in the Peshtigo River as a whole, but the trade-off between the number or abundance of riverine species that may have been present before the dams were built and the number of species and individuals that currently exist is unknown.

There are a total of 10 impoundments on the Menominee River, and many of them are in this ecological landscape. White Rapids Flowage is 447 acres and is managed as a ***run-of-the-river*** impoundment by Wisconsin Electric Energies. It holds healthy, naturally reproducing populations of walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), and panfish and is especially popular for its smallmouth bass (Donofrio 2006).

Twin Falls Flowage (926 acres) is also on the Menominee River and has an infestation of Eurasian water milfoil. Immediately downstream, Kingsford Flowage (491 acres) is an impoundment at the confluence of the Pine River (Donofrio 2009) with the Menominee River.

Pine River Flowage is 127 acres, and just below the dam is the heavily used whitewater segment of the Pine River. Legend Lake is a 1,230-acre impoundment on a small tributary of the Wolf River in Menominee County. It is the only impoundment in this ecological landscape that has been reviewed by Wisconsin DNR staff for critical habitat areas, and it has nine sites identified as having high habitat values worthy of protection for the benefit of biological diversity. Legend Lake does support an isolated population of lake sturgeon (*Acipenser fulvescens*).

Water quality is generally good in these impoundments, which support game and pan fish populations that attract many anglers (see the "Fauna" section for details). However, many of these impoundments now contain populations of nonnative invasive species such as Eurasian water milfoil and rusty crayfish.

Rivers and Streams

While small in size, the Northeast Sands Ecological Landscape contains long stretches of some of Wisconsin's most biologically diverse and popular recreational rivers and streams. There are medium-sized streams and large rivers with diverse habitats and rare aquatic species as well as small, coldwater streams with populations of native brook trout (*Salvelinus fontinalis*). Stream beds here tend to range from bedrock in the western portion of the ecological landscape (generally in the headwaters areas) to more sand-dominated substrates in the east. This high substrate diversity accounts to a significant degree for much of the aquatic biodiversity here (W.A. Smith, Wisconsin DNR, personal communication).

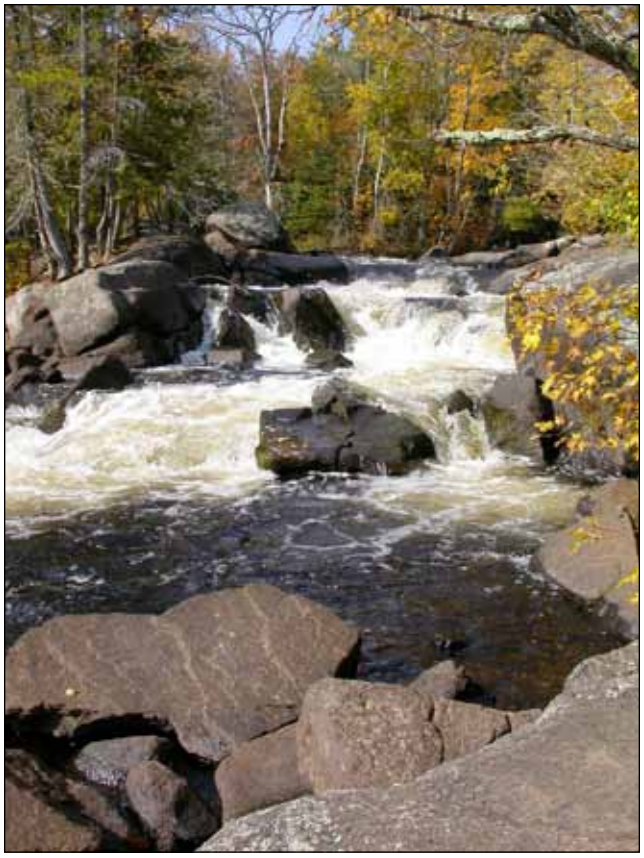
Menominee River, rapids, streamside bedrock outcroppings. Menominee River State Recreation Area, Marinette County. Photo by Jeff Prey, Wisconsin DNR.

The largest river flowing through this ecological landscape is the Menominee, which forms about 40 miles of the Michigan-Wisconsin border. Three designated wild rivers run through the Northeast Sands; the Wolf River is a national wild and scenic river and the Pine and Pike rivers are designated as state wild rivers. These and portions of the Peshtigo and Oconto rivers attract and are used by many canoeists, kayakers, and anglers.

Erosion, sediment build-up, water diversion ditches, and dams impact some stream habitats, although a number of the latter are viewed as locally important to fish and wildlife habitat for certain species. Exotic species found here, such as Eurasian water milfoil, rusty crayfish, and zebra mussel(*Dreissena polymorpha*), harm water quality, disrupt the food web, and create economic problems. Exotic plant species in some waters disrupt the function of native aquatic plants.

The Northeast Sands Ecological Landscape is famous among trout anglers for its many high quality coldwater streams. Primary among these are the North Branch of the Pike River, Wausaukee River, First South Branch of the Oconto River, a portion of the South Branch of the Oconto River, North Fork of the Thunder River, the Middle Inlet (to Lake Noquebay), and Spike Horn, KC, Lannon Tongue, Smith, Waupee, Hay, North Branch Beaver, Holmes, and Wausaukee creeks. Most of these rivers and streams support healthy populations of native brook trout and assemblages of coldwater invertebrates. Their headwaters are generally forested, and their flow is primarily from springs and other cold groundwater discharges.

Coolwater streams flow through this ecological landscape in some of the areas lacking cold spring and groundwater water sources. These include the upper reaches of streams



Waterfall on high-gradient coldwater stream in heavily forested portion of Marinette County. Photo by Drew Feldkirchner, Wisconsin DNR.

This fast-flowing stretch of the Peshtigo River is bordered by an extensive mixed upland forest of hardwoods and conifers. Photo by Eric Epstein, Wisconsin DNR.

above their confluence with sources of cold spring flows. Among these are the South Branch of the Oconto River, Pecore Creek, and many small tributaries to both the South Branch of the Pike River and the Pemebonwon River. These streams generally have healthy populations of ***nongame*** fish species and some rare invertebrates.

Warmwater rivers in the Northeast Sands that contribute significantly to the support of aquatic biodiversity include the Wolf, Peshtigo, Pine, Pike, and Menominee rivers. Even though the Menominee is dammed in several places, its forested free-flowing sections exhibit characteristics of a wild river, and much of its course is through a mix of electric utility-owned and commercial forestland with limited development. Despite its good habitat quality and diversity, only two rare aquatic invertebrates have been documented on the Menominee River. Some biologists believe that contaminants introduced via past mining discharges into its major tributary, the Brule River, may be one of the reasons why more rare or otherwise sensitive species have not been found here (W.A. Smith, Wisconsin DNR, personal communication).

The middle portion of the Peshtigo River is located in the Northeast Sands. This segment of the Peshtigo is the most biologically diverse in the Northeast Sands for stream invertebrates and is one of the top rivers in Wisconsin for aquatic invertebrate diversity (W.A. Smith, Wisconsin DNR, personal communication). Much of its in-stream habitat is undisturbed, and water quality is protected by a largely forested watershed and the absence of forest products industry discharges, other industrial developments, or other land uses associated with diminished water quality.

Only 5% of the Wolf River Basin is in this ecological landscape, but this small area includes about 20 free-flowing miles of the Wolf River, most of which is in Menominee County. This reach of the Wolf River is heavily forested and flows over a series of low waterfalls with names like Shotgun Eddy, the Oxbow, and Gilmore's Mistake, which provide important aquatic habitats, scenic beauty, and watersport adventure.

The Wolf River exhibits at least three critical characteristics of the Midwest region's large rivers that promote species abundance and diversity: good water quality, seasonally normative and unregulated flow, and high substrate diversity. Substrate diversity is especially notable in the Wolf River where it varies from rocky, to sand/gravel, to shifting sand, to mostly clay and silt. In the Northeast Sands, the Wolf is one of the most important rivers for aquatic macroinvertebrate assemblage abundance and diversity (see "Fauna" below for details). Also, in the spring of 2012, lake sturgeon were introduced to the Wolf River between the Shawano Dam and Keshena Falls.

The Pine River is a very popular recreational stream for canoeing and angling. Most of the Pine in this ecological landscape is downstream from the Pine Hydro project impoundment. The hydro project is currently being managed in a "run of the river" mode. This mode of operation results in the dam having less effect on river level fluctuations. This entire stretch of river is a warmwater fishery, with northern pike, bass, and walleye prominent. Except in the driest years, the lower stretch of the Pine River can be used for canoeing during the entire season. The Pine River provides quality habitat for eleven rare invertebrate species, mainly mayflies (Ephemeroptera) and caddisflies (Trichoptera). The Pike River is another medium-sized river with good water quality and habitat that is home to rare dragonflies (Odonata) and is popular with canoeists, kayakers, and anglers.

The Oconto River in this ecological landscape benefits from land cover that is primarily forest and wetland, maintaining clean groundwater and surface water. Nearly all streams are rated good to excellent regarding the "fish and aquatic life" water quality condition. A large portion of streams here are designated ORW or ERW waters and have undisturbed aquatic habitat features. The Oconto supports at least one rare invertebrate species and features healthy and diverse populations of common game fish.

There are many miles of warmwater streams that do not support trout or major concentrations of game fish. Instead, these streams often provide good populations of nongame fish and may serve as habitat for diverse assemblages of aquatic invertebrates. These, in turn, support mammals and birds associated with stream environments.

Warmwater streams in this ecological landscape include Newton Creek, Little River, Jones Creek, Deer Creek, Pickerel, Richardson, Dalton, Bundy, House, and Springer creeks as well as Peshtigo Brook, Christies Brook, Woods Lake Outlet, and Shawano Lake outlet.

Springs

One hundred and ten documented springs and spring ponds supply the numerous high quality coldwater streams with reliable sources of clean, cold, oxygenated water (Macholl 2007). Not all these springs are in the headwaters of streams. Several streams begin as coolwater streams with marginal coldwater habitat and become coldwater communities miles downstream, due to the input of cold spring water.

Wetlands

According to the Wisconsin Wetland Inventory (WDNR 2010b), the Northeast Sands Ecological Landscape contains almost 198,000 acres of wetland, or approximately 20% of the ecological landscape's total area. The Northeast Sands contains the 6th highest percentage of wetlands (20%) and ranks 11th in the number of wetland acres compared to other ecological landscapes. Forested wetlands cover more than 157,000 acres, and shrub/scrub wetlands comprise over 30,000 acres of wetlands.

The Brazeau Swamp-Waupee Lake-Peshtigo Brook area is the largest wetland complex in the Northeast Sands and, at roughly 30,000 acres, is one of the state's largest wetlands (Figure 13.2). The major wetland communities include northern white-cedar-dominated wet-mesic conifer swamp, black ash-dominated (*Fraxinus nigra*) lowland hardwood forest, shrub swamp, and northern sedge meadow. Though some parts of this wetland have experienced severe hydrological disruption (especially by State Highway 64), conversion to cropland, heavy past logging, and excessive white-tailed deer

Undeveloped Waupee Lake is near the western edge of a vast wetland complex that includes northern white-cedar swamp, alder thicket, northern fen, and marsh communities. Photo by Eric Epstein, Wisconsin DNR.

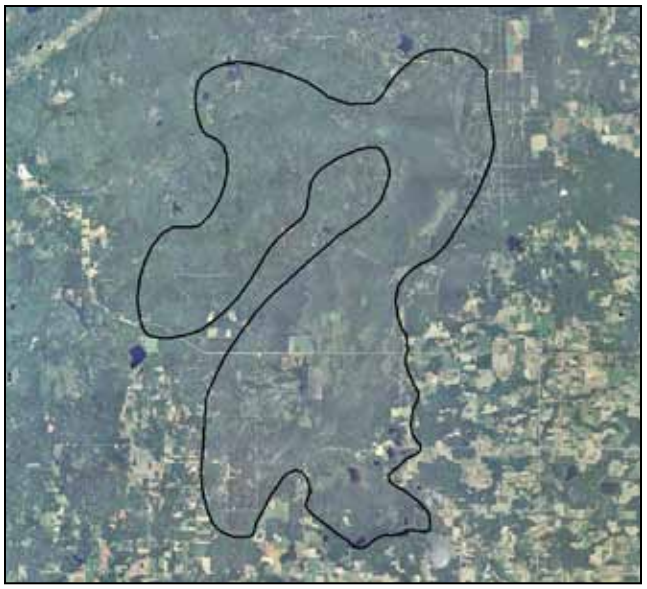


Figure 13.2. *Brazeau Swamp-Waupee Lake-Peshtigo Brook complex, the largest contiguous wetland in the Northeast Sands Ecological Landscape (outlined area). The rectangles near the photo's center depict a muck farm, and the straight line running east-west across the wetlands and through the cultivated area is State Highway 64. Construction of this road disrupted the movement of groundwater from north to south and had major impacts to wetland vegetation. Courtesy of the National Agricultural Imagery Program.*

(*Odocoileus virginianus*) browse, there are examples of high quality sedge meadow and shrub swamp embedded within an extensive lowland forest of variable quality, composed of both conifers and hardwoods. Canopy associates of the dominant northern white-cedar and black ash trees include tamarack, black spruce, balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), white birch (*Betula papyrifera*), yellow birch (*Betula alleghaniensis*), and eastern hemlock (*Tsuga canadensis*). Much of this area is publicly owned, as parts of the Oconto and Marinette county forests, Chequamegon-Nicolet National Forest, and the Peshtigo Brook State Wildlife Area. Three state natural areas have been designated on state and federal lands within the Brazeau Swamp-Waupee Lake-Peshtigo Brook complex. The margins of Waupee Lake, a State Natural Area on federal lands in the hydrologically intact western edge of this wetland, support an unusually high number of rare, calcium-loving plant species. This is due, in part, to the calcareous groundwater inputs that feed this wetland complex. The other two state natural areas in this complex are Peshtigo Brook Meadow and Woods (featuring an undisturbed northern sedge meadow) and Nelligan Lake (with an extensive conifer swamp).

Lake Lackawanna and Cedars State Natural Area is just west of Caldron Falls Flowage. The lake supports floating-leaved and submergent aquatic macrophyte vegetation and is surrounded by a narrow border of sedge meadow, hardwood swamp, and northern white-cedar swamp. Along the lake's outlet stream is a shrub swamp (Alder Thicket) composed of varying amounts of speckled alder (*Alnus incana*), red-osier dogwood (*Cornus stolonifera*), sweet gale (*Myrica gale*), and willows (*Salix* spp.).

This ecological landscape features extensive conifer swamps, mostly dominated by tamarack and northern white-cedar. There are also a few small, undisturbed, more acidic black spruce swamps. Good quality wetlands are especially abundant in the southeast portion of the Lower North Branch Oconto River watershed, the southern half of the South Branch Oconto River watershed, and all across the Pike River and Pemebonwon/Middle Menominee River watersheds. Lake Noquebay, which is partially impounded by a dam on the west end of the lake, is the only documented wild rice (*Zizania* spp.) lake in the Northeast Sands Ecological Landscape.

Mature Northern Wet-mesic Forest dominated by northern white cedar and supporting an understory of mosses, sedges, goldthread, bunchberry, and others. Photo by Andy Clark, Wisconsin DNR.

Water Quality

Water quality in free-flowing rivers and streams is generally good across the Northeast Sands, due to the combination of substantial forest cover and lack of extensive industrial, agricultural, and residential development. Failing septic systems do pose a potential water quality threat on some streams. General watershed water quality summaries are included in Appendix 13.A.

Outstanding Resource Waters (ORW) and Exceptional Resource Waters (ERW) are surface waters that have good water quality, support valuable fisheries and wildlife habitat, provide outstanding recreational opportunities, and are not significantly impacted by human activities. Waters with ORW or ERW status warrant protection from the effects of pollution. Both of these designations have regulatory restrictions, with ORWs being the most restricted. These designations are intended to meet federal Clean Water Act obligations and prevent any loss of water quality or degradation of the aquatic habitats in these waters. They are also used to inform and guide land use change proposals and some human activities near these waters.

There are 221 rivers and streams and one impoundment with either ORW or ERW designations. ORW streams include the Pike, Pine, Peshtigo, Wausaukee, North Fork Thunder, South Branch Oconto, South Branch Pike, and Little Popple rivers as well as Lund, Lanon Tongue, Miscauno, Philips, Glen, KC, Cedarville, Eagle, Meadow Brook, and many other creeks. Oshkosh, Minnow, Big Eddy, Waupee, Bonita, Pine, Wiscobee, Mountain, and Handsaw creeks and the Red River comprise a small sampling of the many ERW streams in the Northeast Sands. A complete list of ORW and ERW in this ecological landscape can be found on the Wisconsin DNR website (WDNR 2013c).

Spies, Cedar, and Bear Paw lakes, along with Railroad and North ponds, are the ORW lakes here. Caldron Falls reservoir is also an ORW, the only impoundment with this designation in this ecological landscape. Seven lakes and one impoundment are designated as ERWs, including Wiscobee Lake and Waupee Flowage.

Waters designated as impaired on the ***U.S. Environmental Protection Agency (EPA) 303(d) list*** exhibit various water quality problems including ***polychlorinated biphenyls*** (PCBs) in fish, sediments contaminated with industrial metals, mercury from atmospheric deposition, bacteria from farm and urban runoff, and habitat degradation. A plan is required

by EPA on how 303(d) designated waters will be improved by the Wisconsin DNR. This designation is used as the basis for obtaining federal funding, planning aquatic management work, and meeting federal water quality regulations.

Several lakes and impoundments are impaired by atmospheric mercury deposition and are included on the state list of 303(d) impaired waters. These waters are Sand, Gilas, Noquebay, and Shawano lakes as well as Caldron Falls and High Falls reservoirs. Fish in these waters are subject to fish consumption health advisories due to high levels of mercury in fish tissue. Caldron Falls Reservoir is an ORW due to the low concentrations of nutrients and other conventional water pollutants, but it is also a 303(d) impaired water, due solely to the presence of mercury in its sediments. The complete list of 303(d) impaired waters and criteria can be viewed at the Wisconsin DNR's' impaired waters web page (WDNR 2013d).

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

Several sources were used to characterize the ***historical vegetation*** of the Northeast Sands. We relied heavily on data from the federal General Land Office's public land survey (PLS), conducted in Wisconsin between 1832 and 1866 (Schulte and Mladenoff 2001). PLS data are useful for providing estimates of forest composition and tree species dominance for large areas (Manies and Mladenoff 2000). Finley's map (Finley 1976) of historical land cover based on his interpretation of PLS data was also consulted. Additional inferences about vegetative cover were sometimes drawn from information on land capability (soils and topography), climate, disturbance regimes, the activities of native peoples, and various descriptive narratives. More information about these data sources is available in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

According to Finley's map and data interpretation (Finley 1976), the Northeast Sands Ecological Landscape of the mid-1800s contained a range of plant communities from dry (barrens and dry forests) to very wet (swamp conifer), each type occupying less than one-third of the ecological landscape. There were extensive areas of northern hardwood forest (30% of the area); of these, roughly two-thirds included eastern hemlock and eastern white pine and almost one-third included American beech (*Fagus grandifolia*) as a dominant or co-dominant. Jack pine-***scrub oak*** forest and barrens covered 29.3% of the area, largely in the northern half of this ecological landscape where sandy soils predominate. Forested coniferous wetlands also occupied a significant portion (20.4%) of the Northeast Sands and were scattered throughout the ecological landscape with the largest contiguous wetland block occupying much of the current Brazeau Swamp Conservation Opportunity Area. Figure 13.3 illustrates the major cover types as interpreted by Finley (1976); also see "Vegetation of Wisconsin in the Mid-1800s" in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials."

Mid-1800s public land survey information has been converted to a database format and relative importance values (RIV) for tree species calculated based on the average of tree species density and ***basal area*** (He et al. 2000). Relative importance value (RIV) does not indicate the percentage of land cover of a species or group of species; rather it gives an indication of the importance of an individual species or group of species in a given forested land area. This analysis indicates that, collectively, the pine species (*Pinus* spp.) (45.6% of the RIV) were the most dominant group in the Northeast Sands Ecological Landscape. Within that group, eastern white pine had the highest RIV (22.2%) followed by red pine (14.5%) and jack pine (9.0%). Outside of the pine species, eastern hemlock (11.8% of RIV) was the only tree species with an RIV higher than 10%. See Appendix 13.K at the end of this chapter for the map "Vegetation of the Northeast Sands Ecological Landscape in the Mid-1800s."

Current Vegetation

There are several data sets available to help assess current vegetation at broad scales in Wisconsin. Each of these was developed for different purposes and has its own strengths and limitations in describing vegetation. For the most part, WISCLAND (Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data), the Wisconsin Wetlands Inventory (WWI), the U.S. Forest Service's Forest Inventory and Analysis (FIA), and the National Land Cover Database (NLCD) were used. Results among these data sets often differ because they are the products of different methodologies for classifying land cover, and each data set was compiled based on sampling or imagery collected in different years, sometimes at different seasons, and at different scales or resolutions. In general, information was cited from the data sets deemed most appropriate for the specific factor being discussed. Information describing the methodologies, strengths, and limitations of the data used is provided in Appendix C, "Data

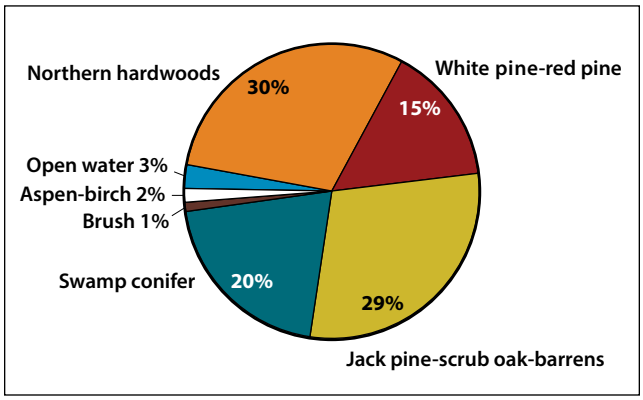


Figure 13.3. *Vegetation of the Northeast Sands Ecological Landscape during the mid-1800s, as interpreted by Finley (1976) from federal General Land Office public land survey information.*

Sources Used in the Book," in Part 3, "Supporting Materials." By percentage, the Northeast Sands Ecological Landscape is the most heavily forested of all of the ecological landscapes, based on 1992 satellite data (WDNR 1993). It is approximately 987,000 acres in size with approximately 746,000 forested acres (76%) in 1992. WISCLAND land use/land cover data from 1992 also indicates that only of the ecological landscape was in agricultural use at that time (66,000 acres). Wetlands (both forested and nonforested) accounted for 20% of the area of the ecological landscape (Figure 13.4).

According to the Wisconsin Wetlands Inventory (WDNR 2010b), wetlands in the Northeast Sands Ecological Landscape comprise 20% (approximately 198,000 acres) of the vegetation. Forested wetlands total nearly 157,000 acres, or 80% of the wetlands in the Northeast Sands Ecological Landscape. Shrub/scrub wetlands occur across more than 30,000 acres. Additional information on wetlands and wetland flora may be found in the "Natural Communities" and "Flora" sections of this chapter and in Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin."

According to FIA data summarized in 2004, approximately 79% of the total area in the Northeast Sands Ecological Landscape is forested and about 21% is nonforested. The predominant forest cover type group is aspen-birch (26% of the forested land area) followed by northern hardwoods (18% of the forested land area), oak-hickory (16% of the forested land area), pine (16% of the forested land area), and swamp conifer (10% of the forested land area) (Figure 13.5). All other forest types occupy 10% or less of the forested land area.

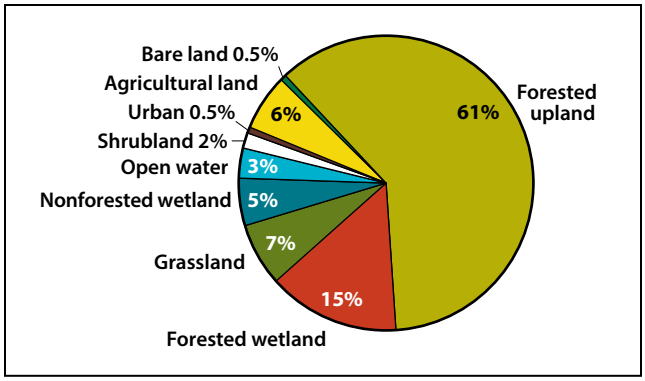


Figure 13.4. *WISCLAND land use/land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery for the Northeast Sands Ecological Landscape (WDNR 1993).*

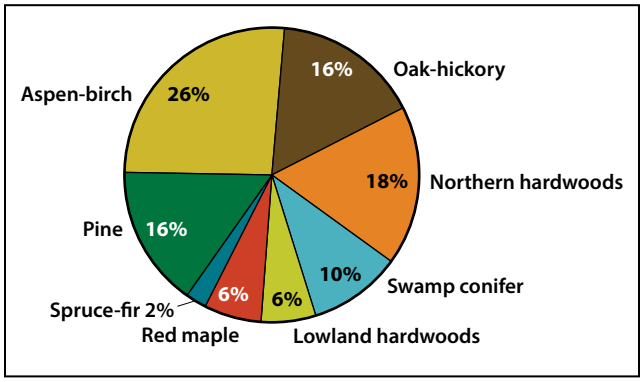


Figure 13.5. *Forest Inventory and Analysis data (USFS 2004) showing forest type as a percentage of forested land area (greater than 17% crown cover) for the Northeast Sands Ecological Landscape.*

Changes in Vegetation over Time

The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and communities that are now altered in number, size, or extent or that have been changed functionally (for example, by constructing dams, suppressing fires, or allowing white-tailed deer browse pressure to increase). Although data are limited to a specific snapshot in time, they provide valuable insights into Wisconsin's ecological capabilities, especially given the enormous and pervasive changes that followed settlement of Wisconsin by Euro-Americans. Maintaining or restoring some lands to more closely resemble historical systems and including some structural or compositional components of the historical landscape within actively managed lands can help conserve important elements of biological diversity. We do not mean to imply that entire ecological landscapes should be restored to historical conditions because this is neither possible nor necessarily desirable within the context of providing for human needs and desires. Information describing the methodologies, strengths, and limitations of the data used is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

The amount of forest cover has actually increased since the time of the federal public land survey in the mid-1800s from 67.1% of total area of the ecological landscape (Finley 1976) to 75.6% (WISCLAND) or 79.4% (FIA). This increase in forest cover is explained by the succession and conversion of open pine barrens communities (originally over 29% of the land cover, according to Finley) to closed forest. This was and is generally due to the discontinuation of human-caused fires as well as statewide fire suppression policies since the early 1900s to control wildfires. Prior to this, fires would have maintained large areas in open barrens and related bracken grassland communities. Also, some of the area that is often described as "barrens" from the Finley (1976) data was likely somewhere along a continuum between barrens and dry forest with higher tree densities than are often ascribed to barrens. In addition, agriculture is very limited in the Northeast Sands, and the FIA data considers land with only 17% crown cover as "forested." Ecologists would consider lands with such low crown cover as "savanna" in this region, mostly Pine Barrens.

In the Northeast Sands, fire was the dynamic force historically responsible for shaping and maintaining a majority of the upland vegetation. Areas identified by Finley (1976) as "jack pine, scrub oak, and barrens" (29.3%), "white pine-red pine forest" (15.2%), "aspen-birch forest" (1.5%), and "brush" (1%) were likely all the result of and somewhat dependent on periodic fire. In aggregate, the fire-dependent or fire-driven

communities were over 50% more abundant than the non-fire dependent "northern hardwoods" vegetation (which covered approximately 30% of this ecological landscape).

In order to explore the changes in compositions of tree species in forested areas of the ecological landscape, the RIV for tree species at the time of the mid-1800s federal public land survey was compared with FIA data summarized in 2004 (Figure 13.6). Here, only FIA data for trees greater than 6 inches in diameter were used to make those data more comparable to the public land survey data. It is also important to remember that RIV does not represent the amount of land covered by a given species or group of species. Rather, it gives an indication of how important (as an average of basal area and density of forested land area) a given tree species was in the current or past forested land. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for further discussion of RIV.

Current forest vegetation (based on FIA) has no clear dominant group of species, with only the pine species (including eastern white pine, red pine, and jack pine) collectively having an RIV (20.7%) of greater than 20% (Figure 13.6). Those same pine species have declined when compared with historical conditions from 45.6% to 20.7% of RIV. Northern hardwoods species have also declined from 23.1% to 11.2% of RIV. Red maple has increased from 0.2% to 12.7% of RIV, as has northern white-cedar (from 5.7% to 13.5% of RIV) and oak species (*Quercus* spp.) (from 2.6% to 15.9% of RIV). It is important to note, however, that RIV is a percentage of the total tree species reported. Therefore, it is unlikely that northern white-cedar actually increased. Rather, it likely maintained its level relative to the other species present. Oak reported for the Northeast Sands is largely northern pin oak (9.2% of RIV) because it is abundant in this ecological landscape on the sandier soils. Plantation-grown pine, especially red pine (more than 20,000 acres), has replaced many of the much more diverse natural pine forests that were present in the past, and jack pine has declined, similar to other areas within its Wisconsin range. Increases in aspen and red maple are exhibited here, similar to many of the northern ecological landscapes.

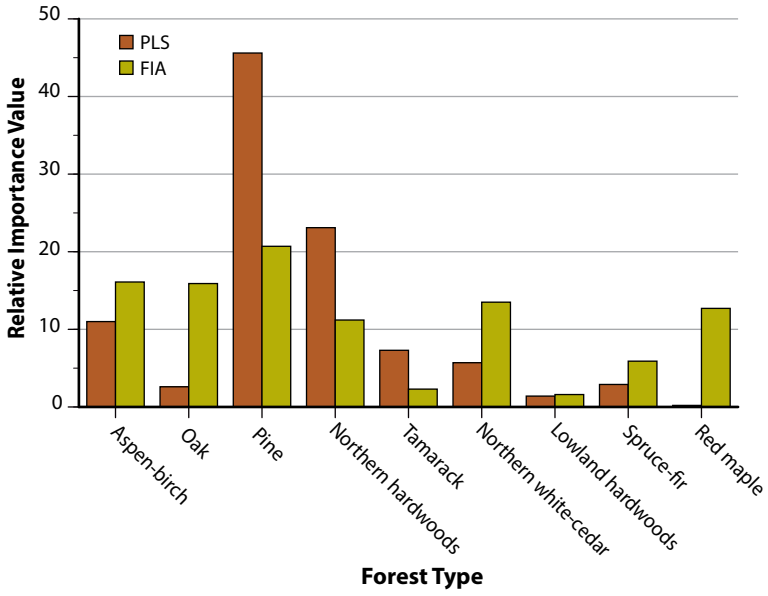


Figure 13.6. *Comparison of tree species' relative importance value (average of relative dominance and relative density) for the Northeast Sands Ecological Landscape during the mid-1800s, when federal General Land Office public land survey (PLS) data were collected, with 2004 estimates from Forest Inventory and Analysis (FIA) data (USFS 2004). Each bar represents the proportion of that forest type in the data set (totals equal 100). Trees of less than 6 inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.*

Natural Communities

This section summarizes the abundance and importance of major physiognomic (structural) ***natural community groups*** in this ecological landscape. Some of the exceptional opportunities, needs, and actions associated with these groups, or with some of the individual natural communities, are discussed briefly. For details on the composition, structure, and distribution of the specific natural communities found in the Northeast Sands, see Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin." Information on invasive species can be found in the "Natural and Human Disturbances" section of this chapter.

Forests. The extensive forests of the Northeast Sands vary from very dry to wet. Northern Dry Forests (usually composed of jack pine, northern pin oak, aspens, and occasionally red pine, or various mixtures of those species) are abundant and widespread here. Monotypic red pine plantations and even-aged aspen stands are now common on many sites that formerly supported Northern Dry Forest, especially on the drier sites within the county forests and on industrial lands.

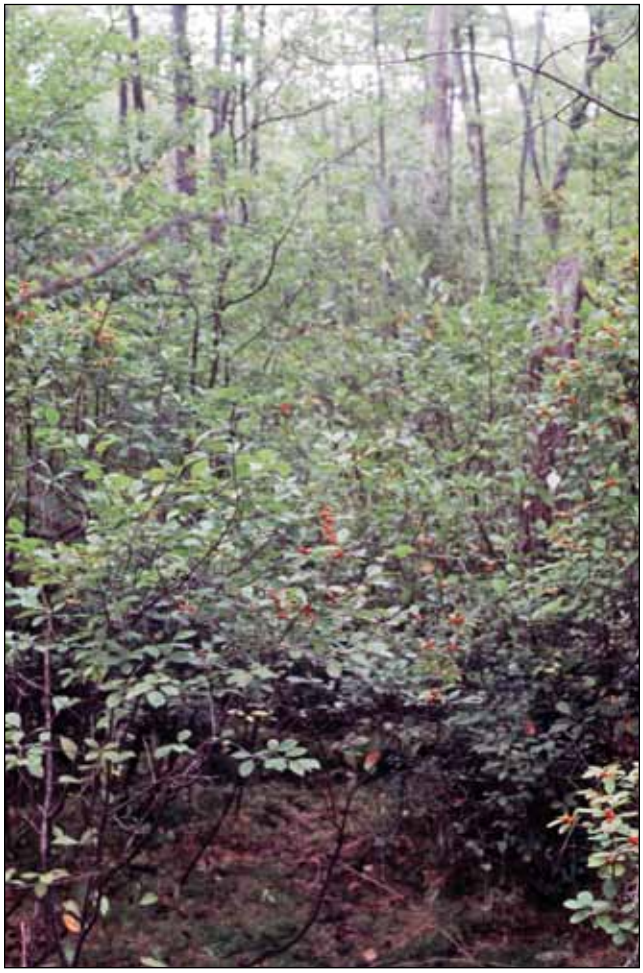
Northern Dry-mesic Forests dominated by eastern white and red pines, with associated northern red oak (*Quercus rubra*) and other hardwoods, were historically common in parts of this ecological landscape, but very few good quality remnants have been identified. This community was formerly extensive in northwestern Marinette and southeastern Florence counties and occurred at scattered locations elsewhere (Mladenoff et al. 2009).

Mesic forests are common in some areas but tend to be composed mostly of small or medium-size sugar maple (*Acer saccharum*), with American basswood (*Tilia americana*) and white ash (*Fraxinus americana*) among the associates ("northern hardwoods"). Dense sods of Pennsylvania sedge (*Carex pensylvanica*) may dominate the herbaceous layer, and ironwood (*Ostrya*

*Open stand of Northern Dry Forest with a sparse canopy of northern pin oak, black cherry (*Prunus serotina*), jack pine, and red pine. Photo by Eric Epstein, Wisconsin DNR.*

virginiana) is a common understory tree. The compositional and structural diversity of such stands is low. There are a few locations, for example, just east of the Peshtigo River along the Goodman Parkway in Marinette County, where mesic forests dominated by eastern hemlock and American beech are locally common. Several county parks support patches of older mesic forest that could be connected along the Peshtigo River corridor. Mesic forests of eastern hemlock, American beech, and sugar maple are also locally common in the northeastern part of the Menominee Indian Reservation and on adjoining parts of the Chequamegon-Nicolet National Forest (especially on the Lakewood-Laona District, in Oconto County). Eastern white pine was a characteristic if widely scattered and uncommon ***supercanopy*** tree in some of these mesic forests. Intact examples of such forests are now quite rare in eastern Wisconsin, especially older, structurally complex, floristically diverse stands.

Currently this second-growth stand of intensively managed northern hardwoods in Marinette County is dominated by pole-sized sugar maple, with ironwood and Pennsylvania sedge being the prevalent understory species. Photo by Eric Epstein, Wisconsin DNR.



*This stand of swamp hardwoods is dominated by red maple poles and features a shrubby understory in which common winterberry (*Ilex verticillata*) is prominent. Photo by Andy Clark, Wisconsin DNR.*

Wet-mesic forests dominated by northern white-cedar are common in the Northeast Sands and include several of the state's largest stands of this important forest community. These northern white-cedar swamps are noted for the high diversity of plants and animals they support, which may include many rare plant species. Good opportunities to protect this fragile natural community occur on the Chequamegon-Nicolet National Forest, within several state wildlife areas and on the Marinette and Oconto county forests. However, in most places regeneration of northern white-cedar does not progress beyond the small seedling stage due to excessive browse pressure from white-tailed deer. Northern white-cedar swamps are also highly vulnerable to invasion by aggressive exotic plants such as European swamp thistle (*Cirsium palustre*) and glossy buckthorn (*Rhamnus frangula*). The former is already widespread and locally common, especially in disturbed northern white-cedar swamps. Glossy buckthorn is common to the south and east of the Northeast Sands and has the potential to totally overwhelm the understories of all wet-mesic forest communities.

Several large, hydrologically intact stands of Northern Wet-mesic Forest are known from the Menominee Reservation, but the management direction and protection opportunities there are unknown at this time. Important canopy associates include tamarack, black spruce, balsam fir, and black ash. Hardwood swamps dominated by black ash are common in some parts of the Northeast Sands but have received relatively little survey effort.

Savannas. Barrens vegetation was widespread in nutrient poor, drought-prone, level-to-gently undulating portions of this ecological landscape that burned frequently prior to settlement of this region by Euro-Americans. The largest areas of semi-open (nonforested) vegetation occurred in Marinette County, eastern Florence County, and southern Oconto County. The easternmost part of the Menominee Reservation also supported some barrens vegetation.

With the widespread implementation of fire suppression policies in the early 1900s, most of the barrens sites succeeded to dense forests of pine, oak, and aspen. The persisting open remnants are generally small, becoming increasingly isolated, and are found almost exclusively on public lands. Several of the larger remnants are now the focus of restoration efforts. These include sites such as the Spread Eagle Barrens complex in eastern Florence County and Dunbar Barrens in Marinette County. Less extensive projects with a similar focus are occurring on federal lands. Many of the uplands in these areas now support open or semi-open vegetation. Managers are attempting to restore and maintain pine barrens and the somewhat similar bracken grassland vegetation at these locations by using a combination of prescribed burning, mechanical brushing, and commercial timber harvest.

Significant portions of the Spread Eagle Barrens complex in the northern part of the ecological landscape are now dominated by herbs, many of them exotic. These nonnative

Bracken grassland with prairie elements, Dunbar Barrens State Natural Area, Marinette County. Photo by Eric Epstein, Wisconsin DNR.

"cool season" grasses include Canada and Kentucky bluegrasses (*Poa canadensis* and *P. pratensis*, respectively) and smooth brome (*Bromus inermis*). Native graminoids such as poverty oat grass (*Danthonia spicata*) and Pennsylvania sedge occur there, along with bracken fern (*Pteridium aquilinum*) and low shrubs such as sweet fern (*Comptonia peregrina*), hazelnut (*Corylus* spp.), prairie willow (*Salix humilis*), and serviceberry (*Amelanchier* spp.). Sapling jack pine, northern pin oak, and quaking aspen (*Populus tremuloides*) are common and comprise a significant percentage of the vegetative cover in some areas.

Scattered pine barrens remnants of good quality are also known from the Athelstane area of central Marinette County. Other small patches of barrens vegetation exist in the southern part of the Northeast Sands, and special efforts should be made to identify those that may be restorable, particularly on the Menominee Reservation and in Oconto County (e.g., at Waubee Lake in the Chequamegon-Nicolet National Forest and at Peshtigo Brook Marsh State Wildlife Area east and south of the Brazeau Swamp). These southern remnants may be especially important to species dependent on certain prairie plants that are of limited (generally southerly) distribution within this ecological landscape.

Shrub Communities. Alder Thicket is a common and widespread tall shrub community that borders streams and lakeshores throughout the Northeast Sands. Shrub swamps, often alder-dominated, have replaced northern white-cedar in some areas where the hydrology has been altered and the water table has been raised. This can be caused by a number of factors, including beaver activity and, on some sites, intensive timber harvests. Recovery potential of sites affected by heavy logging and subsequent increases in water level is unknown.

Herbaceous Communities. Herbaceous wetland communities include Poor Fen, Northern Sedge Meadow, and various marshes (emergent, floating-leaved, and submergent). None

Bedrock exposures are common in parts of the Northeast Sands. Photo by Eric Epstein, Wisconsin DNR.

of these wetland types are especially common here compared with other ecological landscapes, but all of them have the potential to support sensitive species and should be protected and maintained where possible.

Exposed bedrock habitats are locally prominent in some parts of the ecological landscape and include cliffs, glades, and ***talus slopes***. Rare plants have been documented at some bedrock sites. Additional inventory efforts are needed for other rare taxa such as lichens, terrestrial snails, and other specialized invertebrates to better understand the conservation significance of these bedrock features.

Lakes in the Northeast Sands with upland shorelines, along with sandy soils and bottom substrates, have the potential for "Inland Beach" communities. These, in turn, may support rare plants, and some rare plants have already been documented growing on exposed sandy shores in and around the Nicolet National Forest in northern Oconto County. Additional surveys for the presence of intact Inland Beach communities, along with their associated flora and fauna, are needed.

"Surrogate Grasslands" are not common here, but they do occur in parts of the ecological landscape where agricultural uses are still locally important or where agriculture was practiced in the past but the land has remained in a nonforested condition. Management of surrogate grasslands are a priority where they adjoin existing barrens or bracken grassland restoration and management projects, where there are concentrations of frost pockets, or where significant populations of rare species (e.g., grassland birds) are known to occur.

Aquatic Communities. The prevalence of forest cover in most of the ecological landscape's watersheds has contributed to generally good water quality in many of the rivers, lakes, and streams. The exceptions are often due to the presence of dams, especially in areas affected by agricultural uses, mining, and other industries. There is relatively little urbanization with its associated increase in impervious surfaces and runoff-related problems. Additional biological surveys of lakes and associated wetlands are warranted because some of the waters are highly calcareous (e.g., lakes and ponds in which ***marl*** is precipitated) and have the potential to support unusual aquatic and wetland biota. Associated wetlands in areas with strongly calcareous ground and/or surface waters may also support uncommon species with an affinity for alkaline environments. Lake studies here have focused mostly on fish.

Forest Habitat Types

Within the Northeast Sands Ecological Landscape, site variability is high; five habitat type groups commonly occur (Table 13.1). Even so, soils are predominantly sandy and relatively nutrient poor. The most common habitat type groups are very dry to dry and dry to dry-mesic. These sites are associated with sand to loamy sand soils that are excessively, somewhat excessively, or moderately well drained and nutrient poor to medium. Common overstory dominants are northern pin oak, northern red oak, eastern white pine, red pine, jack pine, aspen, white birch, and red maple. Potential late-successional dominants are eastern white pine and red maple. Northern red oak, balsam fir, and white spruce (*Picea glauca*) may be included on some sites.

Wet-mesic to wet forested lowlands typically occur on poorly drained peat and muck soils. On nutrient poor to medium sites, most stands are dominated by swamp conifers. On less common nutrient medium to rich sites, stands can be dominated by either swamp conifers or swamp hardwoods.

Dry-mesic and mesic sites are typically associated with loamy soils that are well to moderately well drained and nutrient medium to rich. Most stands are dominated by aspen, northern red oak, or sugar maple accompanied by any mix of red maple, American basswood, white ash, white birch, and eastern white pine. On more dry-mesic sites, potential late-successional dominants are sugar maple, red maple, American basswood, and white ash. On more mesic sites, potential late-successional dominants are sugar maple, eastern hemlock, yellow birch, and American beech.

Flora

Intensive botanical surveys in the Northeast Sands have been limited and have generally occurred while information was being collected and analyzed to support land use decisions on major public properties such as the Chequamegon-Nicolet National Forest (Judziewicz 1983, TNC and NCC 2002), the Peshtigo River State Forest (Anderson et al. 2006), and other, smaller, state-managed properties.

The Wisconsin Natural Heritage Inventory (WDNR 2009) tracks a total of 51 species of vascular plants that have been documented in the Northeast Sands Ecological Landscape. Of these, three are listed as Wisconsin Endangered, seven are Wisconsin Threatened, and 41 are Wisconsin Special Concern. To date, no federally listed plants have been reported from the Northeast Sands. Two plant species found here are considered globally rare (NatureServe 2009): little goblin moonwort (*Botrychium mormo*) and rugulose grape-fern (*B. rugulosum*).

Table 13.1. *Forest habitat type groups and forest habitat types of the Northeast Sands Ecological Landscape (NES EL).*

Northern forest habitat type groups common within the NES EL[b]	Northern forest habitat types[a] common within the NES EL[b]	Northern forest habitat types minor within the NES EL[b]
Very dry to dry (VD-D)	PArVAo	
Dry to dry-mesic (D-DM)	PArVAa-Vb	PArVPo
Wet-mesic to wet (WM-W)	Forest Lowland (habitat types not defined)	
Mesic (M)		AFVb ATM ATFD
Dry-mesic (DM)	AVb	
Northern forest habitat type groups minor within the NES EL		
Mesic to wet-mesic (M-WM)		ArAbVC TMC

Source: Kotar et al. (2002).
[a]Forest habitat types are explained in Appendix 13.B ("Forest Habitat Types in the Northeast Sands Ecological Landscape") at the end of this chapter.
[b]Groups listed in order from most to least common:
Common occurrence is an estimated 10–50% of forested land area.
Minor occurrence is an estimated 1–9% of forested land area.
Present – Other habitat types can occur locally, but each represents < 1% of the forested land area of the ecological landscape.

Four rare plant species have been reported only from this ecological landscape: the Wisconsin Endangered squarestem spikerush (*Eleocharis quadrangulata*), the Wisconsin Threatened sheathed pondweed (*Potamogeton vaginatus*), the Wisconsin Special Concern orchid shining lady's-tresses (*Spiranthes lucida*), and the Wisconsin Special Concern Blue Ridge blueberry (*Vaccinium pallidum*). The squarestem spikerush and the sheathed pondweed are known from single populations, making them among Wisconsin's rarest plants. Only three populations of Blue Ridge blueberry have been reported in Wisconsin.

Based on the relatively high percentage of Wisconsin populations known to occur in the Northeast Sands, the species distribution, and the types of habitats available, rare and uncommon plants that are especially well represented here compared with other Wisconsin ecological landscapes include Deam's rockcress (*Arabis missouriensis* var. *deamii*), Rocky Mountain sedge (*Carex backii*), white adder's-mouth orchid (*Malaxis monophyllos* var. *brachypoda*), Indian cucumber root (*Medeola virginiana*), marsh grass-of-Parnassus (*Parnassia palustris*), marsh valerian (*Valeriana sitchensis* ssp. *uliginosa*), and narrow-leaved vervain (*Verbena simplex*). The full list of rare plant species known from the Northeast Sands Ecological Landscape as of 2009 can be found in Appendix 13.C.

Habitats known to be of especially high significance to rare or otherwise sensitive flora based on current knowledge include Northern Wet-mesic Forest (northern white-cedar swamps), Northern Mesic Forest (especially relatively undisturbed stands of eastern hemlock-American beech or American beech-maple), Forested Seeps, Pine Barrens, and bedrock exposures such as cliffs, glades, talus slopes, and waterfalls. Open wetlands have potential to support rare plant species,

The Wisconsin Special Concern orchid shining lady's-tresses was a recent discovery in Wisconsin. Photo by Emmet Judziewicz.

Significant Flora in the Northeast Sands Ecological Landscape

- Two globally rare plant species, the little goblin fern and rugulose grape-fern have been documented here.
- Three rare plant species have been reported from the Northeast Sands and from no other Wisconsin ecological landscape: squarestem spikerush, sheathed pondweed, and Blue Ridge blueberry.
- Important habitats for rare plants include bedrock exposures, spring seeps, Pine-Oak Barrens, Northern Wet-mesic Forests, and Northern Mesic Forests (hemlock-beech-maple).
- Marl Lakes occur in parts of the Northeast Sands Ecological Landscape and are associated with wetlands that support ***calciphiles***.

*Maidenhair spleenwort (*Asplenium trichomanes*) is a habitat specialist that occurs on bedrock features at several sites in the Northeast Sands. Photo by Thomas Meyer, Wisconsin DNR.*

*Though no longer tracked by Wisconsin Natural Heritage Inventory, the showy purple clematis (*Clematis occidentalis*) is uncommon. Photo by Christina Isenring, Wisconsin DNR.*

particularly when those wetlands are fed by calcareous groundwater. Additional surveys are needed for calcareous wetlands, whether forested or herb-dominated, spring seeps, beaches, and for all bedrock habitats. In the case of bedrock habitats, nonvascular plants may be of equal or greater significance than vascular species.

Specific invasive plants of concern are covered in the "Natural and Human Disturbances" section of this chapter. Invasive plants should be monitored at sites known to be of high significance for their native flora, where there are sensitive invertebrates dependent upon native plant species and where there is great potential for invasive plants to spread rapidly once they become established. This can be especially true of public lands receiving frequent and heavy visitation (including parks) or of areas subject to periodic disturbances (such as roadways and utility rights-of-way) that may facilitate the colonization and spread of invasive plant species.

Fauna

Changes in Wildlife over Time

Many wildlife populations have changed dramatically since humans arrived in the Northeast Sands Ecological Landscape, but these changes were not well documented before the mid-

*Remnants of Athelstane Barrens in Marinette County support several rare native species, including the Wisconsin Threatened dwarf milkweed (*Asclepias ovalifolia*). Photo by Eric Epstein, Wisconsin DNR.*

1800s. This section discusses only those wildlife species documented to have occurred in this ecological landscape. Of those, this review is limited to species that were known or thought to be especially important here in comparison to other ecological landscapes. For a more complete review of historical wildlife in the state, see *Wildlife in Early Wisconsin: A Collection of Works by A.W. Schorger* (Brockman and Dow 1982).

The Northeast Sands Ecological Landscape was important historically for many wildlife species, especially forest and barrens-associated birds and large, wide-ranging forest mammals. This ecological landscape was particularly important for American black bear (*Ursus americanus*), gray wolf (*Canis lupus*), fisher (*Martes pennanti*), bobcat (*Lynx rufus*), American beaver (*Castor canandensis*), North American river otter (*Lontra canadensis*), and Sharp-tailed Grouse (*Tympanuchus phasianellus*). Neotropical migrant birds and forest raptors were likely important in this ecological landscape as well. As forests were heavily logged in the late 19th and early 20th century and the ecological landscape was inhabited by Euro-American settlers, wildlife populations changed dramatically.

Historically, the gray wolf was found throughout the state (Schorger 1942). As the southern part of the state was settled and bounties were imposed, gray wolf populations persisted only in the more remote portions of northern Wisconsin by the 1920s (Thiel 1993). Gray wolf populations continued to decline in northern Wisconsin until 1958 when the last Wisconsin gray wolf was thought to have been killed by a car in Bayfield County. Occasional sightings of gray wolves occurred throughout the 1960s and 1970s, but they were thought to be lone gray wolves wandering into Wisconsin from Minnesota or Michigan. Not until the late 1970s was it determined that gray wolves had again become established and were breeding in Wisconsin. Gray wolves continued to emigrate from Minnesota, and the Wisconsin population increased. As of 2012, the gray wolf population was estimated at approximately 800 individuals (Wisconsin DNR unpublished data). Although not the stronghold of state gray wolf population, the Northeast Sands encompassed at least some portion of 15 gray wolf pack territories in 2011, based on Wisconsin DNR data.

The fisher had a Wisconsin range similar to that of the American marten (*Martes americana*) but was found farther south. There are records of fisher as far south as La Crosse, Milwaukee, Jefferson, and Sauk counties. The fisher was not as numerous as the American marten and was more common in hardwood forests as opposed to coniferous or mixed coniferous forests (Schorger 1942). Extensive logging, wildfires, and unregulated trapping drastically reduced the fisher population by the 1900s (Kohn et al. 1993; for a more complete history of the fisher and its reintroduction into Wisconsin see the "Fauna" section in Chapter 12, "North Central Forest Ecological Landscape," and Williams et al. 2007). Today the fisher occupies almost all suitable habitats in the Northeast Sands and the state as a whole. The statewide fisher population was estimated at over 11,000 animals in 2010.

Historically, the American beaver was present in the Northeast Sands Ecological Landscape, as it was across the rest of the state. As elsewhere, American beaver populations declined dramatically with unregulated trapping and hunting for the fur trade through the 1700s and mid-1800s (Schorger 1965). American beaver populations have recovered, and this is now an important species in the Northeast Sands. Large American beaver populations in this ecological landscape have negatively affected some cold water fisheries, and control efforts were made to reduce American beaver populations in the 1990s. American beaver can also impact forested wetlands such as northern white-cedar swamps by inundating the shallow-rooted trees and killing them. Today, American beaver populations are managed by setting population goals for management zones across the state (Figure 13.7) and adjusting the trapping season to meet these goals. This ecological landscape is in Beaver Management Zone B, which has a high American beaver population, excellent American beaver habitat, and excellent trout habitat. According to the Wisconsin DNR Beaver Management plan (WDNR 1990), trout stream protection takes precedence over protection of American beaver on high quality trout streams in this zone. Maintenance of a stable American beaver population is desired, so a helicopter survey is flown every three years to estimate the size of the American beaver population within each zone.

The North American river otter was historically as abundant, or more abundant, than the American beaver (Schorger 1970). As occurred for the American beaver, North American river otter populations declined dramatically with unregulated

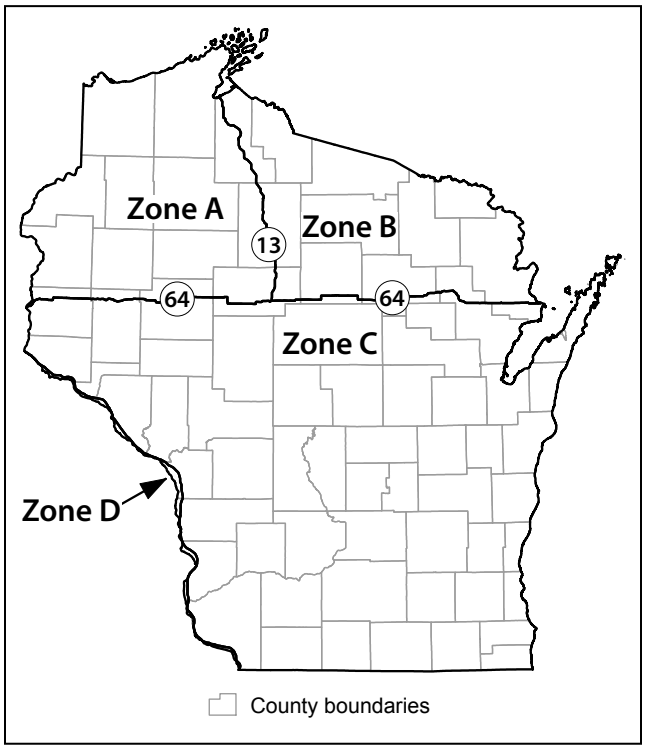


Figure 13.7. *American beaver management zones in Wisconsin.*

trapping for the fur trade. Today North American river otter populations have recovered, and 10,700 North American river otters were estimated to be present in the state in 2014 (Rolley et al. 2014). North American river otter populations are managed by setting population goals for three management zones (Figure 13.8) and adjusting the number of harvest permits to maintain the population. North American river otter harvest goals are set annually for each management zone based upon population size in relation to management goals. The number of harvest permits issued is based on the average trapper success rate during the previous three years in those zones. An aerial survey is flown annually to count the number of North American river otter tracks crossing a 30-mile transect to estimate the size of the North American river otter population in the state. North American river otter harvest in this ecological landscape is somewhat lower than other northern Wisconsin ecological landscapes.

White-tailed deer were found throughout the state and were likely more abundant in southern Wisconsin than in the northern part of the state (Schorger 1953) at the time of Euro-American settlement. Northern Wisconsin was vegetated primarily with mature coniferous-deciduous forest, not optimal habitat, which limited the size of the white-tailed deer population there. However, the pine barrens in this ecological landscape may have provided better habitat and sustained a larger white-tailed deer population. The white-tailed deer population expanded in northern Wisconsin after large-scale logging took place in the late 1800s. After cutting, the mature mixed conifer-hardwood forest in northern Wisconsin was replaced mainly by forests composed mostly of young deciduous trees, including vast acreages of quaking aspen and white birch and other forage plants that provided abundant food for white-tailed deer. However, the large number of settlers that followed logging depended on venison for food. Subsistence harvest, together with market hunting, likely reduced the state white-tailed deer population to its lowest level around the start of the 20th century (for more detailed discussion of the recovery of northern Wisconsin's white-tailed deer population, see the "Deer Population Changes" section in Chapter 5, "Current and Emerging Resource Issues").

In recent decades the white-tailed deer herd has often been above goal for the northern forest deer management region (Figure 13.9), and overbrowsing of plants, including particularly susceptible trees such as northern white-cedar and eastern hemlock, is common in this ecological landscape. In 2008–2011, white-tailed deer populations were near or slightly below goal in the northern forest.

White-tailed deer populations in this ecological landscape are large compared to their numbers prior to Euro-American

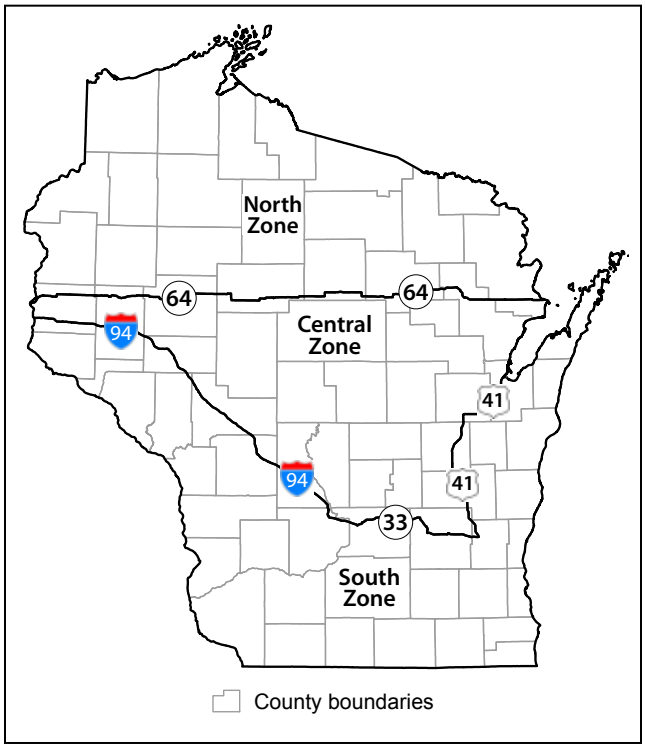


Figure 13.8. *North American river otter management zones in Wisconsin.*

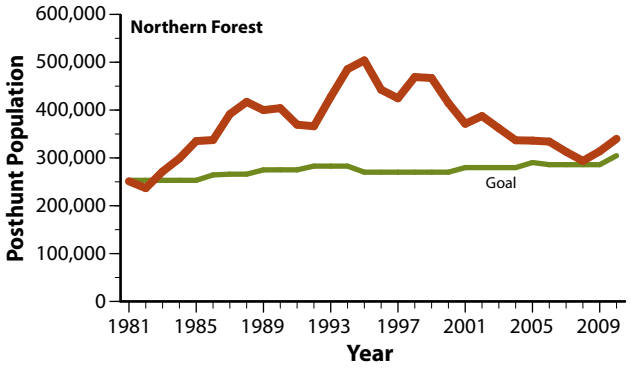


Figure 13.9. *White-tailed deer population size in relation to population goals in the northern forest deer management region, 1981–2010 (Wisconsin DNR unpublished data).*

Second-growth northern white-cedar swamp, severely overbrowsed by white-tailed deer. Photo by Andy Clark, Wisconsin DNR.

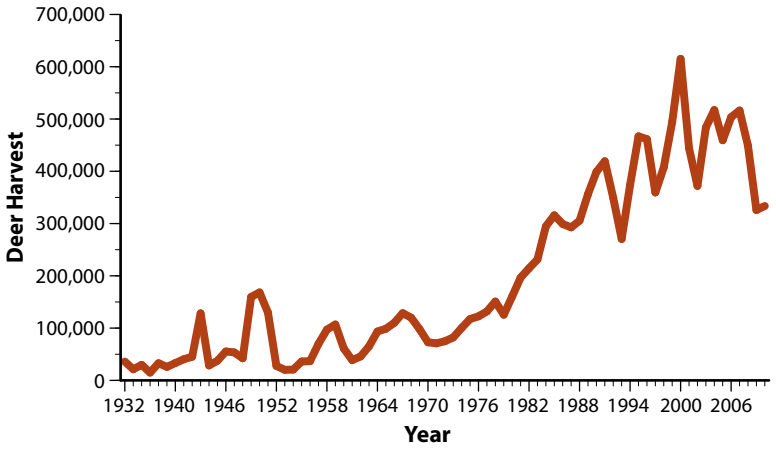


Figure 13.10. *Statewide white-tailed deer harvest, 1932–2010 (Wisconsin DNR unpublished data).*

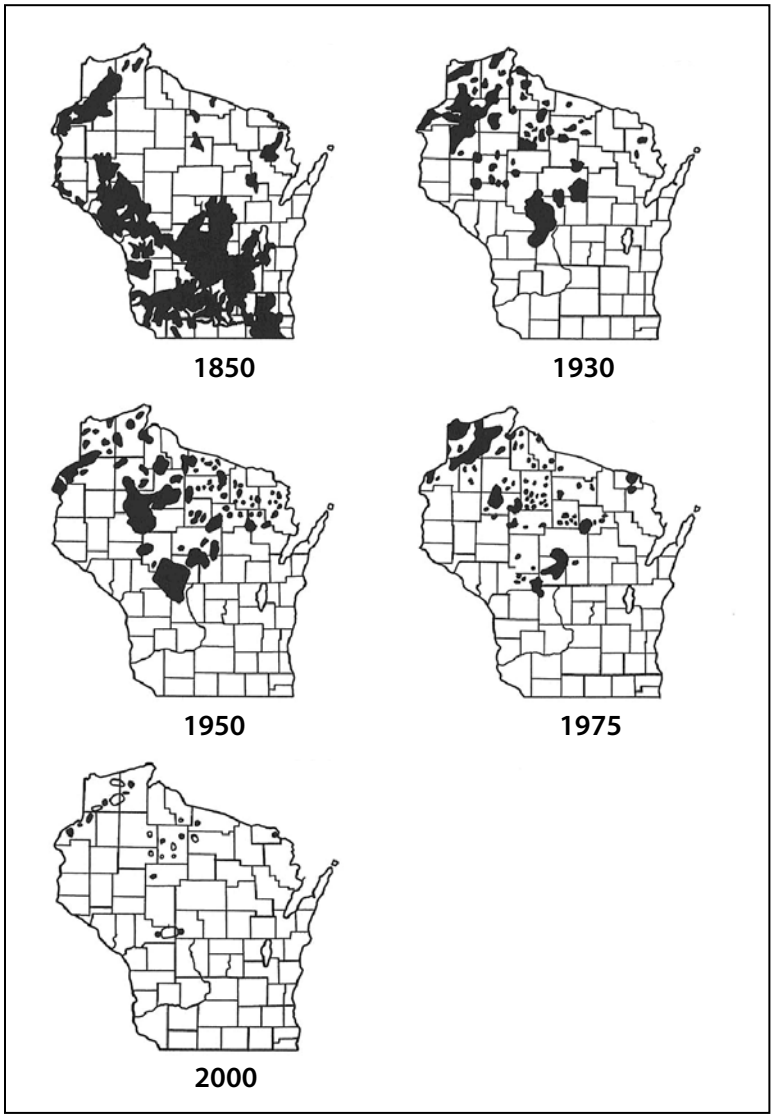


Figure 13.11. *Changes in Sharp-tailed Grouse range since Euro-American settlement. Figure reproduced from Gregg and Niemuth (2000) by permission of the Wisconsin Society for Ornithology.*

settlement (Figure 13.10). Logging and other human activities have kept portions of the forest in young hardwoods, which have provided abundant food for white-tailed deer. Relatively mild winters during the decades of the 1990s and 2000s reduced winter starvation and allowed the white-tailed deer herd to increase. Winter feeding of white-tailed deer by well-intentioned people became popular in the 1990s and may be contributing to increased winter survival and increased production of offspring the following spring. The current white-tailed deer management program sets white-tailed deer population goals for units within the state and uses antlerless white-tailed deer harvest to keep the white-tailed deer at the established goal.

American black bears were historically abundant throughout the northern and central parts of the state. American black bears remained in the northern part of the state throughout Euro-American settlement but in reduced numbers. Today American black bears occur throughout the Northeast Sands, and it is considered primary American black bear range. American black bear populations are regulated through issuing limited numbers of permits for specific management zones, similar to the way several other species are managed in the state.

There is little historical documentation of the Sharp-tailed Grouse in the Northeast Sands, but it must have occurred here, given the extent of the pine barrens and bracken grasslands habitats. Schoenebeck (1902) observed that it was a common resident in Oconto County in the southern part of this ecological landscape. Sharp-tailed Grouse were also present in the barrens habitat to the north in Marinette County. Gregg (2000) showed it as present here in 1850 with a remnant population persisting until 2000 (Figure 13.11). Today the Sharp-tailed Grouse is all but gone from this ecological landscape, but there is potential for a self-sustaining population with adequate restoration and maintenance of habitat.

Significant Wildlife

Wildlife are considered significant for an ecological landscape if (1) the ecological landscape is considered important for maintaining the species in the state and/or (2) the species provides important recreational, social, and economic benefits to the state. To ensure that all species are maintained somewhere in the state, "significant wildlife" includes both common species and species that are considered "rare" (in this book "rare" includes species listed as endangered or

threatened by either the State of Wisconsin or the federal government or species that are listed as "special concern" by the State of Wisconsin). Four categories of species are discussed: rare species, Species of Greatest Conservation Need (SGCN), responsibility species, and socially important species (see definitions in text box). (Note that there can be overlap between some of these categories.) Managing habitats are the most efficient way to manage and benefit a majority of wildlife species; therefore, we discuss management of different wildlife habitats in which significant fauna occur.

Rare Species. As of November 2009, the Wisconsin Natural Heritage Working List documented 60 rare animal species within the Northeast Sands Ecological Landscape, including three mammals, nine birds, four herptiles, four fishes, and 40 invertebrates (WDNR 2009). These include one federally listed species, five Wisconsin Endangered species, nine Wisconsin Threatened species, and 46 Wisconsin Special Concern species. See Appendix 13.D for the number of species per taxa (e.g., mammals, birds, herptiles, fish, and invertebrates) with special designations documented within the Northeast Sands Ecological Landscape; also see Appendix 13.C for a comprehensive list of the rare animals known to exist in the Northeast Sands.

Categories of Significant Wildlife

- **Rare species** are those that appear on the Wisconsin Natural Heritage Working List as U.S. or Wisconsin Endangered, Threatened, or Special Concern.
- **Species of Greatest Conservation Need (SGCN)** are described and listed in the Wisconsin Wildlife Action Plan (WDNR 2005b) as those native wildlife species that have low or declining populations, are "indicative of the diversity and health of wildlife" of the state, and need proactive attention in order to avoid additional formal protection in the future.
- **Responsibility species** are both common and rare species whose populations are dependent on Wisconsin for their continued existence (e.g., a relatively high percentage of the global population occurs in Wisconsin). For such a species to be included in a particular ecological landscape, a relatively high percentage of the state population needs to occur there, or good opportunities for effective population protection and habitat management for that species occur in the ecological landscape. Also included here are species for which an ecological landscape holds the state's largest populations, which may be critical for that species' continued existence in Wisconsin even though Wisconsin may not be important for its global survival.
- **Socially important species** are those that provide important recreational, social, or economic benefits to the state for activities such as fishing, hunting, trapping, and wildlife watching.

Federally Listed Species: The Karner blue butterfly (*Lycaeides melissa samuelis*), U.S. Endangered, is the only federally listed species that has been documented in the Northeast Sands. It is managed under a Habitat Conservation Plan approved by the U.S. Fish and Wildlife Service. The gray wolf, which occurs in this ecological landscape, was removed from the federal endangered species list in January 2012, granting management authority to the State of Wisconsin. The Wisconsin state legislature passed a law in April 2012 authorizing hunting and trapping seasons for wolves and directed that wolf hunting and trapping seasons be held starting in the fall of 2012. The first hunting and trapping seasons of gray wolves were conducted during October-December 2012. Gray wolves are now being managed under a 1999 gray wolf management plan (WDNR 1999) with addenda in 2006 and 2007, but the plan is being updated to reflect these recent changes in gray wolf management in Wisconsin. The Bald Eagle (*Haliaeetus leucocephalus*) was delisted by the federal government in 2007, but it remains protected by the U.S. Bald and Golden Eagle Protection Act and is listed as a Wisconsin Special Concern species.

Wisconsin Endangered Species: One bird is listed as Wisconsin Endangered, the Loggerhead Shrike (*Lanius ludovicianus*). Four invertebrates are listed as Wisconsin Endangered: snuffbox mussel (*Epioblasma triquetra*), northern blue butterfly (*Lycaeides idas*), phlox moth (*Schinia indiana*), and extra-striped snaketail dragonfly (*Ophiogomphus anomalus*).

Wisconsin Threatened Species: One Wisconsin Threatened bird occurs in this ecological landscape: the Red-shouldered Hawk (*Buteo lineatus*). Other species listed as Wisconsin Threatened include two herptiles, wood turtle (*Glyptemys insculpta*) and Blanding's turtle (*Emydoidea blandingii*), and four invertebrates (three mussels and one dragonfly): slippershell mussel (*Alasmidonta viridis*), salamander mussel (*Simpsonaias ambigua*), buckhorn (*Tritogonia verrucosa*), and pygmy snaketail (*Ophiogomphus howei*). Two Wisconsin Threatened fish, river redhorse (*Moxostoma carinatum*) and greater redhorse (*Moxostoma valenciennesi*) have been documented here, and recent surveys have also documented a third, the pugnose shiner (*Notropis anogenus*). This record had not yet been added to the Wisconsin Natural Heritage Working List as of 2009 at the time of this writing.

Wisconsin Special Concern Species: Wisconsin Special Concern species here include three mammals, seven birds, two herptiles, two fish, and 32 invertebrates (see Appendix 13.C). One of the Wisconsin Special Concern species, the Kirtland's Warbler (*Setophaga kirtlandii,* listed as *Dendroica kirtlandii* on the Wisconsin Natural Heritage Working List) has been found in the Northeast Sands and is U.S. Endangered.

Species of Greatest Conservation Need. Species of Greatest Conservation Need (SGCN) are those that appear in the Wisconsin Wildlife Action Plan (WDNR 2005b). SGCN include species already recognized as endangered, threatened, or special concern on the Wisconsin or federal statutory lists and species that are declining (for this section only vertebrate species are included). There are four mammals, 26 birds, six herptiles, and one fish species listed as SGCN for the Northeast Sands Ecological Landscape (see Appendix 13.E for complete list of Species of Greatest Conservation Need in this ecological landscape and the habitats with which they are associated).

Responsibility Species. This ecological landscape is potentially important for the recovery of the U.S. Endangered and globally imperiled Kirtland's Warbler. The Northeast Sands is one of four ecological landscapes in which this bird has been found and is one of only two ecological landscapes (the Central Sand Plains is the other) where breeding has been documented in Wisconsin. Single singing male Kirtland's Warblers were heard at two sites in Marinette County in 2008, and both birds were captured and banded. The presence of a female Kirtland's Warbler in the territory of one of the males that was banded was also confirmed. Subsequent observations suggested nesting activity, although no nest was located. However, several fledgling warblers were observed at this site on July 21 and 22, 2008, which appeared to be Kirtland's Warblers, but this could not be confirmed. In 2009, two males were documented at two separate sites, a female was observed with each male, and nesting was confirmed for one of these pairs. This nest successfully fledged three young. Males were then documented in Marinette County in each of the subsequent years through 2012.

The northern blue butterfly, a Wisconsin Endangered species, is found only in northeastern Wisconsin in association with the larval host plant, dwarf bilberry (*Vaccinium cespitosum*). Dwarf bilberry occurs in small patches beneath scattered pines on sandy soils in association with bracken fern, sweet-fern, and barren-strawberry (*Waldsteinia fragarioides*). Burning to maintain the openings needed for dwarf bilberry appears to be detrimental to the host plant and may also harm eggs or larvae of the northern blue butterfly, which are vulnerable to the effects of fire. Therefore, burn plans for site restoration and maintenance need to incorporate unburned areas covering significant portions of the habitat in which the

Nestling Red-shouldered Hawks (Wisconsin Threatened) in northern Wisconsin. Photo by Jim Woodford, Wisconsin DNR.

Northern blue butterfly in Marinette County. Photo by Mike Reese.

In recent years (2009), the U.S. Endangered Kirtland's Warbler has been documented as a successful breeding species in jack pine habitat in Marinette County in the Northeast Sands Ecological Landscape. Photo by Dean DiTomasso.

host plant occurs (Cuthrell 2001). Competition with aggressive species such as sweet-fern and bracken fern in the openings is also problematic for maintaining habitat patches with populations of food plants.

The extra-striped snaketail dragonfly, a Wisconsin Endangered species, occurs in the Peshtigo River in Forest County. Although it occurs more frequently in the Northwest Sands and North Central Forest ecological landscapes, its presence here is significant. It prefers clean, fast-flowing, small to large streams with gravel or sand substrates in largely forested watersheds. Its range is apparently limited in distribution by the type of substrate the larvae can survive in. Another dragonfly, the rare pygmy snaketail, is both Wisconsin Threatened and globally rare and occurs in the Oconto, Peshtigo, Pike, and Pine (Florence County) rivers. Although it occurs more frequently in the other ecological landscapes, because it is globally rare, its protection is important wherever it exists. The only known Wisconsin site for the Wisconsin Special Concern species, the delta-spotted spiketail (*Cordulegaster diastatops),* is Spur Creek (Marinette County). The larval stages of this dragonfly inhabit a clean, spring-fed, hard-bottomed, hardwater creek, with strong flow and a substrate that may include calcareous materials such as marl.

Rare terrestrial snails, including the eastern flat-whorl (*Planogyra asteriscus*), tapered vertigo (*Vertigo elatior*), mystery vertigo (*Vertigo paradoxa*), and honey vertigo (*Vertigo tridentata*), occur in this ecological landscape. The mystery vertigo has only been found at seven sites in the U.S., including several in Wisconsin. The eastern flat-whorl is found on slopes and cliffs with northern white-cedar. Land-use activities that remove forest canopy cover and alter other critical habitat requirements (such as cool microclimate and moisture availability) should be avoided at occupied sites.

Significant Wildlife in the Northeast Sands Ecological Landscape

- The Northeast Sands is one of three ecological landscapes in which the U.S. Endangered Kirtland's Warbler has been found and could potentially support a breeding population.
- This ecological landscape is one of only three ecological landscapes where management for species that depend on pine barrens and bracken grasslands can be effectively accomplished.
- Northern white-cedar swamps and their associated wildlife are common here.
- Large working forests make up an extensive portion of the ecological landscape and support many extensive forest wildlife species such as neotropical migrant birds and forest raptors, along with white-tailed deer, American black bear, and Ruffed Grouse.
- Menominee County with its older forests of eastern hemlock, sugar maple, yellow birch, American basswood, eastern white pine, American beech, northern white-cedar, and hardwood swamps provide a source area for many sensitive forest interior birds, including the rare and uncommon species Black-throated Blue and Canada Warblers.
- Cold and coolwater streams are abundant and provide habitat for native brook trout and rare invertebrates such as the extra-striped snaketail and pygmy snaketail dragonflies.
- Medium-size warmwater rivers such as the Menominee, Peshtigo, and Oconto provide habitat for rare mussels, and a significant warmwater recreational fishery.
- Marl lakes are unusual waterbodies that occur in parts of Oconto and Marinette counties. Their significance to aquatic animals has yet to be clarified.
- Rare terrestrial snails (eastern flat-whorl, tapered vertigo, mystery vertigo, honey vertigo) occur in this ecological landscape and are associated with calcareous habitats such as alkaline cliffs, talus slopes, glades, fens, and northern white-cedar swamps.

Socially Important Fauna. Species such as white-tailed deer, American black bear, American beaver, North American river otter, fisher, bobcat, Ruffed Grouse (*Bonasa umbellus*), American Woodcock (*Scolopax minor*), Mallard (*Anas platyrhynchos*), Wood Duck (*Aix sponsa*), and Ringed-necked Duck (*Aythya collaris*) are all important for hunting, trapping, and wildlife viewing in this ecological landscape. There are abundant and diverse populations of forest and barrens birds in the Northeast Sands that provide bird watching and bird feeding enjoyment for local residents and visitors. This ecological landscape has an important warmwater fishery that supports populations of northern pike, walleye, small and largemouth bass, bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), and other fish species sought by anglers. It has important coldwater streams for native brook trout.

Wildlife Habitats and Communities. Overall, nearly 77% of the ecological landscape is forested. Large working forests make up much of the Northeast Sands. In some of these, management emphasis is on short-rotation, early successional species such as quaking aspen, or on plantation-grown pine. The vegetation is moderately fragmented in forested areas by scattered clearcuts where stand turnover of aspen or shorter rotation pine is relatively frequent; it is also moderately fragmented in historically more open areas by succession to woody cover in the absence of periodic wildfire or conversion to pine plantations. In addition to intensively managed aspen forests and pine plantations, xeric forests of pine-oak-aspen are also present (Northern Dry and Dry-mesic Forest). Other important

natural communities include dry-mesic white pine-red pine forest (Northern Dry-mesic Forest) and localized areas of Northern Mesic Forest—some dominated by eastern hemlock, with a component of American beech. Interspersed with these upland forests are lowland conifer, lowland hardwoods, emergent wetland (sedge meadows and marshes), shrub swamp, and bedrock features. Wildlife that use the extensive forests of the Northeast Sands include white-tailed deer, American black bear, fisher, American beaver, North American river otter, Common Raven (*Corvus corax*), Ruffed Grouse, Red-breasted Nuthatch, American Redstart (*Setophaga ruticilla*), Black and White Warbler (*Mniotilta varia*), Blue-headed Vireo (*Vireo solitarius*), Broad-winged Hawk (*Buteo platypterus*) and Black-billed Cuckoo (*Coccyzus erythropthalmus*). Red-shouldered Hawk and Northern Goshawk (*Accipiter gentilis*) may be found where there are larger patches of older forest. Important public lands include the Chequamegon-Nicolet National Forest, Peshtigo River State Forest, and the Florence, Marinette, and Oconto county forests.

This is one of Wisconsin's few ecological landscapes where management for Pine Barrens and Bracken Grassland communities and their associated plant and animal species is feasible. Some of Wisconsin's largest stands of Bracken Grassland occur in the northern parts of the ecological landscape, making it arguably the best place in the state to manage for them. Examples of places where Pine Barrens and Bracken Grassland communities occur and where management for the species that use them can be done include Spread Eagle Barrens, Athelstane Barrens, and Dunbar State Wildlife Areas. Species that use these habitats and will benefit from their maintenance and management include Northern Harrier (*Circus cyaneus*), Upland Sandpiper, Brown Thrasher (*Toxostoma rufum*), Chestnut-sided Warbler (*Setophaga pensylvanica*), Clay-colored Sparrow (*Spizella pallida*), Field Sparrow (*Spizella pusilla*), and Eastern Towhee (*Pipilo erythrophthalmus*). Sharp-tailed Grouse occurred in these habitats historically, and restoration and expansion of barrens and bracken grasslands could allow them to reoccupy some of these areas. The Karner blue butterfly reaches the northeastern limits of its Wisconsin range near the southern edge of the Northeast Sands Ecological Landscape where it has been documented at a couple of sites within the Menominee Indian Reservation and on private property in adjacent Oconto County.

Northern white-cedar swamps are relatively common, and some of Wisconsin's largest examples are found here (e.g., the Brazeau Swamp and several sites within the Menominee Reservation). Some species that use this habitat are Winter Wren (*Troglodytes hiemalis*), Nashville Warbler (*Oreothlypis ruficapilla*), Canada Warbler (*Cardellina canadensis*, listed as *Wilsonia canadensis* by the Wisconsin Natural Heritage Working List), Gray Jay (*Perisoreus canadensis*), Boreal Chickadee (*Poecile hudsonicus*), Golden-crowned Kinglet (*Regulus satrapa*), Red-breasted Nuthatch (*Sitta canadensis*), Hermit Thrush (*Catharus guttatus*), bobcat, and white-tailed deer (as winter deer yards).

The eastern portion of the Menominee Indian Reservation (Menominee County) is in this ecological landscape and contains older forests of eastern hemlock, American beech, sugar maple, yellow birch, eastern white pine, northern white-cedar, and various swamp hardwoods. On the more mesic sites, much of the Menominee Indian Reservation has been managed by the Menominee Tribe for uneven-aged forest, which includes large trees. It has a rich and diverse fauna. Extensive areas of structurally complex older mesic and wet-mesic forests provide the core habitats for Black-throated Blue Warbler (*Setophaga caerulescens,* listed as *Dendroica caerulescens* on the Wisconsin Natural Heritage Working List) and Canada Warbler (Cutright et al. 2006) among others. Other important species in the upland forests here are Red-shouldered Hawk, Least Flycatcher (*Empidonax minimus*), Veery (*Catharus fuscescens*), Wood Thrush (*Hylocichla mustelina*), Blackburnian Warbler (*Setophaga fusca*), Black-throated Green Warbler (*Setophaga virens*), and Ovenbird (*Seiurus aurocapilla*). The extensive northern white-cedar swamps support Winter Wren, Swainson's Thrush (*Catharus ustulatus*), Hermit Thrush, Nashville Warbler, Canada Warbler, White-throated Sparrow (*Zonotrichia albicollis*), and many others.

An outlying area of sandy soils that historically supported oak and pine barrens occurs in the southeastern part of Menominee County and adjoining Oconto County. Most of this area has either grown up into dense dry forests or been converted to pine plantations.

As noted earlier, most rivers and streams here are largely within forested watersheds and as a result exhibit generally good water quality. Cold and coolwater streams are abundant and provide habitat for native brook trout, nongame fish, and several rare invertebrates. Rare dragonflies such as the extra-striped snaketail, pygmy snaketail, and elfin skimmer (*Nannothemis bella*) as well as other rare species such as the round pigtoe (*Pleurobema sintoxia*) and elktoe (*Alasmidonta raveneliana*) mussels, American bullfrog (*Lithobates catesbeianus*), wood turtle, and Blanding's turtle are found in some of these streams, backwaters, or lakes.

Medium-size warmwater rivers include stretches of the Menominee, Wolf, Peshtigo, Pike, Pine, and Oconto that flow through this ecological landscape. These rivers support populations of northern pike, walleye, small and largemouth bass, bluegill, yellow perch, black crappie, and other panfish sought by anglers. These rivers and streams support populations of rare mussel species such as the Wisconsin Endangered snuffbox, the Wisconsin Threatened slippershell, the salamander mussel, and the buckhorn.

In the Northeast Sands, the Menominee River below the White Rapids Dam to Baker Island has a native self-sustaining lake sturgeon population and is also known for good smallmouth bass and walleye fishing. This stretch of the Menominee also has at least one rare fish, the Wisconsin Special Concern western sand darter (*Ammocrypta clara*).

Although not yet fully surveyed, researchers have documented 117 different aquatic macroinvertebrate species in the

Peshtigo River (Wisconsin DNR Aquatic Invertebrate Database, unpublished data). This represents a very high level of species diversity, though not quite on par with streams such as the St. Croix, Chippewa, Flambeau, or Wolf rivers. Twelve of these invertebrate species are rare, including the caddisflies *Hydropsyche phalerata* and *Agarodes distinctus*. The northern part of the Peshtigo River consists of 21 miles of river upstream of Caldron Falls Reservoir and has high species diversity and harbors at least 87 species of aquatic macroinvertebrates including one Wisconsin Endangered, one Wisconsin Threatened, and several Wisconsin Special Concern species. The Peshtigo River between Johnson and Sandstone flowages harbors at least 100 species of macroinvertebrates, including three Wisconsin Threatened and several Wisconsin Special Concern species. The presence of four dams may account for the absence of other rare fish here and the limited distribution of species associated with flowing water, due to both thermal and habitat disruptions.

The stretch of the Wolf River flowing through the Northeast Sands is one of the more important rivers for aquatic macroinvertebrates in Wisconsin. The West Branch of the Wolf River supports a rare dragonfly, the pronghorned clubtail (*Gomphus graslinellus*). The Pike River is a medium-sized river and contains habitat that supports the rare pygmy snaketail dragonfly. Most of the Pine River in this ecological landscape is downstream of the Pine Hydro project impoundment. The Pine River provides quality habitat for eleven rare invertebrate species, mainly mayflies and caddisflies, in the free-flowing stretch below this impoundment. The Oconto River supports at least one rare invertebrate species, the caddisfly *Hydropsyche arinale*. The Oconto also supports good populations of common game fish. The Thunder River holds Wisconsin's only population of the caddisfly *Oligostomis pardalis*, which is more common in the southeastern U.S. Spur Creek is notable for being the Wisconsin station for the delta-spotted spiketail dragonfly (*Cordulegaster diastatops*), and it also harbors the elfin skimmer (*Nannothemis bella*).

There are scattered lakes in some of the sandy outwash areas with sandy upland shores. These lakes support warm water fisheries of northern pike, walleye, small and largemouth bass, bluegill, yellow perch, black crappie, and other panfish. Some lakes are stocked to provide musky fishing.

Lakes that precipitate marl owing to the very high concentrations of calcium carbonate in the water are present in parts of the Northeast Sands. Marl lakes have some unusual properties, but more study is needed to clarify their biological significance.

The Wisconsin Threatened pugnose shiner, along with lake chubsucker (*Erimyzon sucetta*) and banded killifish (*Fundulus diaphanus*) (both Wisconsin Special Concern) occur in Shawano Lake, where several invasive species and phosphorous loading creates concerns over long-term lake health. The last record of the Wisconsin Special Concern weed shiner (*Notropis texanus*), from Shawano Lake, was from 1931, so it may be extirpated. The Wisconsin Special Concern least darter (*Etheostoma microperca*) is known to exist in three populations in this ecological landscape. It was known also from records dating back several decades in White Clay Lake, but its present status there is unknown.

An infestation of an exotic trematode in Shawano Lake, which drains to the nearby Wolf River, kills numerous aquatic birds annually (mostly American Coot). There is concern that this infestation could spread to other waters and affect birds elsewhere. Protection of the biota and habitat of the Wolf River should be considered when planning actions to control this serious wildlife health problem in Shawano Lake to avoid unintended consequences.

The Legend Lake Chain is a series of lakes modified into a navigable chain by a dam on the lower portion of an unnamed tributary to the Wolf River, and this is home to a population of lake sturgeon. Lulu Lake supports a population of a rare crawling water beetle, *Aliplus pantherinus*. Huber Lake holds the Wisconsin Special Concern mottled darner (*Aeshna clepsydra*), a species at the eastern edge of its range here, as well as two other rare species.

Dams and the impoundments they create are numerous on Northeast Sands streams (see the "Hydrology" section of this chapter). While the dams pose barriers to the free movement of fish and other aquatic life, they do provide habitat for species that otherwise might not be present. Water quality is generally good in these impoundments, and many of them support game and panfish populations. White Rapids Flowage on the Menominee River holds naturally reproducing populations of walleye, smallmouth bass, largemouth bass, northern pike, and panfish and is well known for its smallmouth bass fishery (Donofrio 2006). The recently reintroduced Trumpeter Swan (*Cygnus buccinator*) now nests on some of these impoundments (e.g., within the Peshtigo River State Forest). Twin Falls Flowage is on the Menominee River and is a popular bass fishing site. Immediately downstream, Kingsford Flowage also supports an important smallmouth bass fishery. Pine River Flowage is just below a segment of the river that features white water and attracts many kayakers. It is also home to common species of gamefish and panfish.

Igneous and metamorphic bedrock exposures are significant features along the Menominee and Peshtigo rivers and at scattered locations in the southern portion of the Northeast Sands. Specialized biota, including rare land snails, are associated with some of the cliff, glade, and talus communities.

Natural and Human Disturbances

Fire, Wind, and Flooding

Fire was the most extensive natural disturbance agent in the Northeast Sands Ecological Landscape as evidenced by the topography, the dry sandy outwash soils, and the presence of fire-dependent vegetation such as pine forests and pine barrens. Schulte et al. (2005) described it as a "fire-prone" ecological landscape and estimated from federal public land survey (PLS) data from the mid-1800s that the stand-replacing fire rotation for this ecological landscape was 400–800 years;

however, surface fires, not recorded by PLS surveyors, were much more frequent. Studies of charcoal preserved in lake sediments suggested that fire return intervals were 140 years for jack pine and barrens (Swain 1978, Clark and Royall 1996); even this fire return interval was too long to maintain jack pine, let alone semi-open barrens. Simard and Blank (1982) found that fire intervals for jack pine forests in the highly flammable Mack Lake area of Michigan averaged 27 years during the time period prior to Euro-American settlement. At Itasca State Park in Minnesota, jack pine forests burned at an interval of about 22 years (Frissell 1973). In the driest portions of Northeast Sands, where vegetation was dominated by pine barrens or jack pine-oak barrens, experts believe that stand-replacing fires occurred at roughly 25- to 50-year intervals, along with low-intensity surface fires at intervals of two to four years (Alan Haney, University of Wisconsin-Stevens Point, personal communication). In mixed pine-oak systems that developed into savanna or forest, surface fires would have occurred somewhat less frequently, perhaps every 7–10 years. These fire intervals are estimates based on information from other parts of the Midwest and on studies of prescribed burning used to recreate the structure and composition of barrens (see, for example, Reich et al. 1990 and Nielsen et al. 2003). Frequent ground fires likely maintained pines, oaks, and aspens, and forest structure was composed of even-aged or multicohort systems (Schulte and Mladenoff 2005). Where fire was more frequent, it maintained pine barrens.

Various tribes of American Indians have occupied the Northeast Sands since the last glacial period and used fire as a tool to create desirable vegetation, clear land, drive game, and for other reasons. Modern data on lightning strikes (1982 to 2012) show relatively few occurrences (less than six annually) in the Northeast Sands (NOAA 2014), so it is likely that humans exerted a strong influence on pre-historic fire intervals in this ecological landscape.

Prescribed burning has been used successfully in the Northeast Sands to restore more open conditions to grassland, shrub, and barrens communities. Managers often regenerate dry pine forests through clearcutting, which partially mimics the effects of fire. Both are intensive, stand-replacing disturbances that open the site to full or partial sunlight. Fire is different from clearcutting in that it reduces the density of saplings, shrubs, and herbaceous litter, providing a competitive advantage for some regenerating tree (e.g., oak) and herb species. Fire also mineralizes organic material, making nutrients available for plant uptake or leaching, whereas logging removes a proportion of the site's nutrients. Pine forests are often regenerated using intensive site preparation methods such as ***furrowing***, scalping, and herbicide use, followed by planting (or sometimes by aerial seeding). This can lead to major changes in community structure and floristic composition, with an accompanying loss of native biota.

Windthrow disturbance was infrequent but occurred in forests of the Northeast Sands. Windthrow may have been more common in the swamp forests of tamarack or northern white-cedar where the shallow water table limited tree rooting depths and in pine forests where bedrock was close to the surface. However, in the uplands, Schulte and Mladenoff (2005) reported a major wind disturbance return interval over 4,000 years, and Schulte et al. (2005) did not report this ecological landscape as being wind-disturbance prone (in part this must have been because much of the landscape supported barrens rather than forest, and many of the forests were young and composed of relatively small trees). However, periodic tornadoes, with forceful cyclonic winds, occasionally occur here, creating swaths of forest disturbance.

The extent and frequency of flood disturbance prior to Euro-American settlement is unknown. Wetlands and sandy soils in this ecological landscape mitigate local flooding by rapidly absorbing or holding precipitation. Flooding was probably not very important except on the lower Menominee River (where the gradient is low and there is a well developed floodplain, with Floodplain Forest), and perhaps at a few other locations. A lot of the streams here are high gradient, and floodplain development is minimal. As American beaver populations recovered and aspen became the dominant tree in many areas, local inundation due to dam construction was probably a common phenomenon.

Forest Insects and Diseases

Northeast Sands forests are dominated by pines (jack, red, and eastern white), aspens, some oak (northern pin, northern red), and swamp species (northern white-cedar, tamarack). Each of these forest cover types is associated with particular insects and diseases that periodically affect forests here.

Conifers, including red, eastern white, and jack pines, can be affected by Annosum root rot. This disease is caused by the fungus *Heterobasidion annosum* and often occurs in plantations. Red pines are also subject to ***pocket mortality***, caused by a complex of insects and the fungal species *Leptographium terrebrantis* and *L. procerum*. Pocket mortality is more common in southern Wisconsin than in the north, possibly because trees are stressed by climatic conditions that are less than ideal for this species. Red pine is also susceptible to attack by pine blight fungus (*Diplodia pinea*) and pine sawfly (*Neodiprion* spp., *Diprion* spp.). White pine blister rust is an introduced fungal disease caused by *Cronartium ribicola*. Jack pine budworm (*Choristoneura pinus*) is a native insect whose infestations can cause large-scale mortality of mature jack pine, setting up fuel conditions for catastrophic fire (to which jack pine is well adapted because of its serotinal cones, which can be produced while the trees are still quite young).

Gypsy moth (*Lymantria dispar*) is an exotic insect now established in this ecological landscape, which will periodically affect oak and aspen forests. Dry conditions can facilitate gypsy moth population growth, leading to relatively faster rates of spread and more frequent outbreaks after establishment. The two-lined chestnut borer, *Agrilus bilineatus,* is a bark-boring insect that attacks oaks. Oak wilt is a vascular disease caused by the native fungus *Ceratocystis fagacearum*.

Aspen can be impacted by the forest tent caterpillar (*Malacosoma disstria*) as well as *Phellinus* and *Hypoxylon* fungi.

Tamarack is attacked by a variety of insect pests, which can occasionally kill large patches of tamarack forest. These include eastern larch beetle (*Dendroctonus simplex*), larch sawfly (*Pristiphora erichsonii*), and the nonnative larch casebearer (*Coleophora laricella*).

The emerald ash borer (*Agrilus planipennis*) is expected to have less impact across the Northeast Sands than many other ecological landscapes since ash species (*Fraxinus* spp.) are relatively less abundant here. However, emerald ash borer could dramatically impact Hardwood Swamps as these communities can be heavily dominated by ash and sometimes include very little representation from other species. In addition, ash trees can be locally common in mesic upland hardwood stands and Floodplain Forests.

Beech bark disease is a major threat to American beech in eastern North America and in the Northeast Sands. The disease is the result of an interaction between a beech scale insect (*Cryptococcus fagisuga*) and one of several species of fungi, and the disease does not occur if either is absent. One of these fungi (*Nectria galligena*) is a native North American fungus, and the other common fungus is an introduced species (*Nectria coccinea* var. *faginata*). Beech scale insects were accidentally introduced from Europe into Nova Scotia, Canada, around 1890. By the 1930s, the scale and an associated *Nectria* fungus were found to be killing trees in eastern Canada and Maine. The disease has continued to spread; it was discovered in Door County in September 2009 and is found in 11 eastern Wisconsin counties. Because this disease requires both the insect and fungus, killing the scales will prevent the disease from occurring. However, this is impractical at large scales. A small percentage of trees are resistant to the scale and do not develop disease symptoms even in heavily infected stands. Therefore, breeding resistant trees is a possible long-term management option. Management options depend on whether the infestation is small and isolated or widespread. Currently, the only recommendation for managing beech bark disease is to prevent its spread by not moving infected firewood or logs. However, when a stand is marked for thinning, consideration should be given to removing beech trees with low vigor and/or rough bark. Vigorous beech trees with smooth bark should be retained. Management guidelines may change over time due to changing disease distribution and new research findings.

More information about these forest diseases and insect pests of forest trees can be found at the Wisconsin DNR's forest health web page (WDNR 2013a) and at the U.S. Forest Service Northeastern Area forest health and economics web page (USFS 2013).

Invasive Species

Nonnative invasive plants and animals can outcompete native species and may eventually completely dominate a community, decreasing the abundance and diversity of native species and disrupting ecosystem function. Terrestrial invasive species occur in the Northeast Sands but are not yet widespread or abundant. Care needs to be taken to prevent the spread and introduction of invasive species. Along roads and in open or partially forested areas, spotted knapweed (*Centaurea biebersteinii*), wild parsnip (*Pastinaca sativa*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), and common tansy (*Tanacetum vulgare*) are present. These species, especially spotted knapweed and leafy spurge, are becoming more prevalent as they invade roadsides and trail corridors, from which they may then enter other habitats. During droughts, these and other nonnative species adapted to open habitats and dry conditions will continue to flourish. On some state lands, introduction of biocontrols for leafy spurge and spotted knapweed is becoming a management option. In forested community types, glossy and common buckthorns (*Rhamnus frangula* and *R. cathartica*), several nonnative honeysuckles (e.g., *Lonicera tatarica, L. morrowii, and L.* x *bella*), garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), and black locust (*Robinia pseudoacacia*) already pose problems. Japanese knotweed (*Polygonum cuspidatum*) is also present. These plants may initially colonize disturbed areas and edges but, once established can continue to invade surrounding habitats, including forests. There is an active "weed cooperative group" in the area that is concerned about the spread of invasive plants. Inventories have been done on state lands recently that will add to our knowledge of the location of invasive species.

In aquatic and wetland ecosystems, Eurasian water-milfoil, curly pondweed (*Potamogeton crispus*), rusty crayfish (*Orconectes rusticus*), zebra mussel, rainbow smelt (*Osmerus mordax*), common reed (*Phragmites australis*), purple loosestrife, and reed canary grass are the primary problem species. Watercress (*Nasturtium officinale*) is also present in cold, spring-fed streams.

The exotic marsh thistle (*Cirsium palustre*) has been observed in northern white-cedar swamp and sedge meadow habitats in the Northeast Sands. This species has high potential for spreading into many wetland communities in the Northeast Sands, including Northern Wet-mesic Forest (northern white-cedar swamp), Northern Sedge Meadow, and all of the northern fens. Each of these communities supports sensitive native plants. For more information on invasive species, see the Wisconsin DNR's invasive species web page (WDNR 2013b).

Land Use Impacts

Historical Impacts. During and before recorded history, humans have been a driving force in ecosystem composition, structure, and function. Fire was the major disturbance factor throughout much of the Northeast Sands Ecological Landscape, and fires were set by Americian Indians. Ecological impacts of logging and land uses in the latter half of the 19th century were immense, and some of the effects persist today. After almost complete removal of trees, intense, often extensive, fires often followed, burning slash and debris left

from logging operations and consuming regenerating forests. Access to forested lands and delivery of logs to sawmills was expedited by the network of waterways used to float logs to the mills. Riverways were cleared of large woody material to facilitate navigation and the movement of logs, river bottoms and banks were scoured during log drives, and deposition of bark and other woody debris changed the character of many water bodies. Habitats were rendered unsuitable for some of the aquatic and otherwise water-dependent species that had formerly lived there. After the Cutover, the Northeast Sands attracted settlers, who introduced activities such as agriculture, mining, housing construction, and railroad building. The forests here have regenerated, but they are often dominated by somewhat different species or species mixes and have different age structures and patch sizes from the forests prior to Euro-American settlement (Schulte et al. 2005). In the 20th century, drainage projects, as well as the construction of dams and impoundments, altered the aquatic and wetland environments, with cascading effects on vegetation, wildlife, and natural disturbances.

Current Impacts. Current disturbances are largely due to human activities, primarily fire suppression, periodic timber harvest, residential developments, and associated infrastructure**.** Fire suppression activities have reduced fire frequency and extent but have also increased the fuel load in some habitats, which could result in increased fire intensity in the future. Lack of fire has also led to changes in vegetation composition and structure, allowing more open early successional habitats such as pine and oak barrens to succeed to dense forests of pine, oak, or aspen.

Human disturbance includes the long-term conversion of land to roads, buildings, and utility corridors. Impoundments created for hydroelectric production or flood control often flooded sedge meadows, peatlands, or other native wetland communities. Shorter-term disturbances result from widespread activities such as logging and ATV use, which can spread invasives and cause erosion by rutting and the channeling of water in hilly areas with sandy soils.

A major difference between current and historical disturbances is that some of today's most common disturbance events are multiple and pervasive, affecting much of the ecological landscape relatively frequently. Many of the present disturbances had never occurred here prior to settlement by Euro-Americans. Examples include permanent dam construction, road and rail corridors and ditches, excessive nutrient and sediment inputs, and the introduction of invasive species.

In addition, from the 1980s through the 2000s, the white-tailed deer population has often been above the goals set for deer populations in the Northern Forest (see Figure 13.10), including the deer population in the Northeast Sands. Overbrowsing of plants, including susceptible trees such as northern white-cedar and eastern hemlock, is common here, preventing the regeneration of those species. Only since 2008 has the white-tailed deer population been near or slightly below the goals set for the northern forest. This large deer herd has had negative impacts on the ecosystems in the Northeast Sands (see the "White-tailed Deer Impacts on the Ecosystem" section in Chapter 5, "Current and Emerging Resource Issues," for examples).

Forest Management. Much of the publicly owned forest is used to produce pulp, timber, and habitat for selected wildlife species. Conversion of natural forests, pine barrens, and bracken grasslands to pine plantations has been common in some areas. The use of herbicides to aid in the establishment of these plantations can reduce or eliminate native plants and some of the animals dependent on native flora. There may be a threat of groundwater contamination by herbicides in some locations. Management practices should be designed to maintain patch sizes and age structures necessary to maintain or restore the full complement of native animals and avoid fragmentation, isolation, and simplification of habitats. There has been a focus on aspen management and early successional forests, and there is a lack of older forests in the Northeast Sands. The creation of large amounts of edge habitats has promoted generalist species at the expense of interior forest or barrens habitat specialists, area-sensitive species, and disturbance-sensitive species.

Changes in Hydrology. Some of Wisconsin's largest northern white-cedar swamps occur here. Altered hydrology from road construction and other developments and conversion of conifer swamps and other wetlands to agricultural production may diminish the amount of habitat available for native species.

Dams constructed to generate hydropower or for other purposes have fragmented rivers and streams and changed their characteristics. Fish and other aquatic species are restricted in their movements to segments either below or above dams. Water-level manipulation activities at dams can affect species both upstream and downstream. For example, if water levels are raised too high during the nesting season,

The Peshtigo River near Spring Rapids. Water flow is controlled by the dam upstream. Photo by Drew Feldkirchner, Wisconsin DNR.

birds may have their streamside nests flooded. Other species, such as invertebrates and herptiles, living below dams may be left without enough water to survive cold winters if too much water is being held during critical winter periods. Hydrologic alterations of many of our major rivers due to dam and impoundment construction have changed the frequency, timing, magnitude, and duration of flood events, casting uncertainty on long-term response of floodplain vegetation.

Agriculture. According to WISCLAND (WDNR 1993), there is little agriculture in this ecological landscape—less than 7% of the area is in farms.

Residential Development. Overall this area has almost 30% of its homes that are used seasonally or for recreational use (USCB 2012), with most of the seasonal housing in the northern part of the ecological landscape. Some of the ecological consequences of these human-influenced factors include an increase in generalist species and nonnative habitats (e.g., roads, utility rights-of-way, lawns, landscaped yards, golf courses, sand and gravel quarries), feeding of wildlife, introduction of invasive plants, and predation by free-ranging dogs and cats. The placement of structures such as piers, boat lifts, sand blankets, and ramps on shorelines and in littoral zones can reduce the type and amount of nearshore aquatic habitat that benefits fish, invertebrates, other wildlife species, and native plants.

Another recent factor has been a significant change in land ownership as large forest industrial holdings have been sold to other industrial owners, developers, and private individuals. Where land use changes accompany sales of industrial forests, parcelization, fragmentation, and habitat loss will occur. Public access for hiking, hunting, fishing, and other recreational pursuits on some of these lands may be limited or prohibited. This change in land ownership may not only reduce the amount of land open to the public for recreation, it will likely increase recreation on public lands. This change in ownership may also decrease the amount of wood products from these lands, potentially increasing pressure to harvest elsewhere, including public lands. Only a small proportion of these industrial lands have gone into public ownership when sold.

Management Opportunities for Important Ecological Features of the Northeast Sands

Natural communities, waterbodies, and other significant habitats for native plants and animals have been grouped together as "ecological features" and identified as management opportunities when they

- occur together in close proximity, especially in repeatable patterns representative of a particular ecological landscape or group of ecological landscapes;
- offer compositional, structural, and functional attributes that are important for a variety of reasons and that may not necessarily be represented in a single stand;
- represent outstanding examples of natural features characteristic of a given ecological landscape;
- are adapted to and somewhat dependent on similar disturbance regimes;
- share hydrological linkage;
- increase the effective conservation area of a planning area or management unit, reduce excessive edge or other negative impacts, and/or connect otherwise isolated patches of similar habitat;
- potentially increase ecological viability when environmental or land use changes occur by including environmental gradients and connectivity among other important management and conservation design considerations;
- accommodate species needing large areas or those requiring more than one habitat;
- add habitat diversity that would otherwise not be present or maintained; and
- provide economies of scale for land and water managers.

A site's conservation potential may go unrecognized and unrealized when individual stands and habitat patches are managed as stand-alone entities. A landscape-scale approach that considers the context and disturbance history of an area, along with the types of communities, habitats, and species that are present, may provide the most benefits over the longest period of time. This does not imply that all of the communities and habitats associated with a given opportunity should be managed in the same way, at the same time, or at the same scale. Instead, we suggest that planning and management efforts incorporate broader management considerations and address the variety of scales and structures approximating the ***natural range of variability*** in an ecological landscape—especially those that are missing, declining, or at the greatest risk of disappearing over time.

Both ecological and socioeconomic factors were considered when determining management opportunities. Integrating ecosystem management with socioeconomic activities can result in efficiencies in the use of land, tax revenues, and private capital to achieve goals. This type of integration can also help to generate broader and deeper support for sustainable ecosystem management. Statewide integrated opportunities can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management."

Significant ecological management opportunities that have been identified for the Northeast Sands Ecological Landscape include

- Extensive forests
- Forest communities of high importance to the conservation of biodiversity

- Barrens and bracken grasslands
- River and stream corridors
- Bedrock features
- Miscellaneous natural features

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 13.2. Examples of some locations where these important ecological places may be found within the ecological landscape are shown on the map entitled "Ecologically Significant Places of the Northeast Sands Ecological Landscape" in Appendix 13.K at the end of this chapter.

Extensive Forests

Roughly 75% of the Northeast Sands Ecological Landscape (746,084 acres) is forested. The ecological landscape's extensive forests play a significant role in maintaining viable populations of many native plants and animals, including some that are scarce or declining. The large acreage of forest present also suggests the potential for management at larger scales, for great connectivity, and for the restoration of certain natural communities, cover types, successional stages, and developmental stages, as appropriate.

Old forests are now rare throughout this ecological landscape and will likely remain so in most areas. Large forest patches are now uncommon here and will probably continue to decrease, a trend that is prevalent statewide. Managing forests in larger patches where appropriate can benefit area-sensitive species and facilitate achieving economies of scale.

Mesic hardwood forests, often with very limited representation of conifers, are common in some parts of the Northeast Sands Ecological Landscape, but most of these are young to middle-aged smaller trees and lack diversity of structure and composition. Diversifying some parts of the ecological landscape's forests by promoting the development of missing or diminished compositional or structural attributes would have ecological as well as social benefits.

Early successional forests are abundant, especially on those public or industrial lands where there has been an emphasis on aspen management. However, other early successional types such as the ecologically important jack pine and scrub oak forests have declined greatly when compared with their historical abundance. Opportunities to increase the representation of scrub oak, natural red pine, and jack pine should be identified to ensure that they are present here in the future. Jack pine has decreased dramatically throughout its range in Wisconsin in recent decades (WDNR 2010a), and removals are exceeding growth for this species in the Northeast Sands (see the "Current Socioeconomic Conditions" section of this chapter), similar to other areas where it is found. Increasing these types would provide habitat for sensitive species; for example, Kirtland's Warbler could benefit greatly from an increase in young jack pine forests. Other potential benefits

View of extensive oak, pine, and aspen forest from the top of Hagar Mountain, Chequamegon-Nicolet National Forest, Oconto County. Photo by Eric Epstein, Wisconsin DNR.

Outstanding Ecological Opportunities in the Northeast Sands Ecological Landscape

- The Northeast Sands Ecological Landscape contains extensive forests, with large federal, state, county, and tribal holdings.
- Important forest communities here include mesic hemlock-beech, wet-mesic northern white-cedar swamps, and dry forests composed of various mixtures of pine, oak, and/or aspen.
- Several large remnant barrens/bracken grassland complexes occur here.
- The large rivers and streams support significant aquatic biota, including fish, mussels, and odanates.
- The forested corridors bordering rivers, streams, and some of their tributaries offer opportunities to connect scattered patches of conifers, older forests, and other important habitats.
- The complex bedrock geology of this ecological landscape is expressed at the surface as cliffs, glades, and talus slopes. These habitats support specialists, some of them rare in Wisconsin.
- Some lakes in this ecological landscape precipitate calcium carbonate, resulting in marl deposition. Rare plants associated with alkaline wetlands have been documented in or adjacent to several of these marl lakes.
- Miscellaneous opportunities include nonforested wetland communities, patches of floodplain forest, clusters of small undeveloped lakes, spring ponds, ephemeral ponds, surrogate grasslands, and scattered populations of rare species.

Table 13.2. *Natural communities, aquatic features, and selected habitats associated with each ecological feature within the Northeast Sands Ecological Landscape.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Extensive forests	Northern Dry Forest Northern Dry-Mesic Forest Northern Mesic Forest Northern Wet-mesic Forest
Forest communities: beech-hemlock, northern white-cedar, jack pine-scrub oak	Northern Dry Forest Northern Hardwood Swamp Northern Mesic Forest Northern Wet Forest Northern Wet- Mesic Forest Floodplain Forest
Barrens and bracken grasslands	Pine Barrens Oak Barrens Bracken Grassland Surrogate Grasslands
River and stream corridors	Floodplain Forest Alder Thicket Shrub-carr Northern Sedge Meadow Emergent Marsh Submergent Marsh Wild Rice Coldwater Stream Coolwater Stream Warmwater River Warmwater Stream
Bedrock exposures	Dry Cliff Moist Cliff Bedrock Glade
Miscellaneous features	Boreal Forest Open Bog Poor Fen Boreal Rich Fen Ephemeral Pond Inland Beach Impoundment/Reservoir Inland Lake

[a]An "ecological feature" is a natural community or group of natural communities or other significant habitats that occur in close proximity and may be affected by similar natural disturbances or interdependent in some other way. Ecological features were defined as management opportunities because individual natural communities often occur as part of a continuum (e.g., prairie to savanna to woodland, or marsh to meadow to shrub swamp to wet forest) or characteristically occur within a group of interacting community types (e.g., lakes within a forested matrix) that for some purposes can more effectively be planned and managed together rather than as separate entities. This does not imply that management actions for the individual communities or habitats are the same.

[b]See Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," for definitions of natural community types.

include maintaining or improving water quality for lakes and streams at local watershed levels, increased carbon sequestration, and potentially greater product and market flexibility.

Forests play important roles in the water cycle, and the extensive forests here are essential for maintaining high water quality and moderating stream flows. Where water quality problems exist, it is usually because of the presence of dams, the destruction of wetlands, agricultural and residential development, increase in the amount of impermeable surfaces, or industries that have generated pollutants that ended up in area lakes, rivers, and streams.

Management Opportunities, Needs, and Actions

- Older stands are now scarce and could be increased for some forest communities (mesic, wet-mesic, and dry-mesic) at appropriate locations to provide habitats that have been diminished elsewhere and ameliorate problems associated with small stand size and isolation.
- Larger habitat patches and better connectivity between small patches would improve conditions for sensitive species, increase the probability that populations of species lost due to various disturbance events would be able to recolonize and recover in local forest habitats, and ensure that all forest successional and developmental stages are available somewhere in the ecological landscape at all times.
- Where possible, coordinate management of early successional forests with management of remnant Pine Barrens and Bracken Grasslands to increase connectivity between now isolated open areas, increase effective habitat size, and reduce undesirable edge impacts.
- Monitor selected taxa (e.g., forest raptors, passerine birds, herptiles, and aquatic invertebrates) that utilize extensive unfragmented forests and certain related habitat features such as stand size, tree sizes and ages, and canopy cover.
- Identify key private holdings that contribute to extensive forest habitat and work with owners to perpetuate intact forest in these areas. Working forest easements may be one important tool, and it is already in use in other ecological landscapes.
- Continue to identify strategically located lands needed to create or maintain connectivity within the Northeast Sands and across the ecological landscape's boundaries. The recently established Menominee River State Park and Recreation Area is a good example of a project that works across boundaries—in this case collaborating with Michigan—to manage a forested corridor and protect a portion of a major river.

Forest Communities of High Importance to the Conservation of Biodiversity

All forest communities have value for the conservation of biodiversity, but here we focus on those types that are especially well represented and important in the Northeast Sands when compared with other areas of the state. Northern Dry forests composed mostly of jack pine, or mixed with red pine and "scrub" oak, are common and well suited to site conditions in many parts of this ecological landscape. The conversion of dry forests composed of species of relatively low economic value, or that are susceptible to disease, has been common in some parts of the state where red pine plantations have now replaced vast acreages of jack pine and northern pin oak.

Management of dry forests (jack pine, northern pin oak, aspen) should be compatible with sites supporting Pine Barrens and Bracken Grassland communities, especially where short rotations are feasible, appropriate, and desirable (for examples, see the "Conservation Design" section in Chapter 1, "Principles of Ecosystem and Landscape-scale Management"). This will help maintain habitat for sensitive species requiring the presence of certain structural features associated with these communities.

Northern Dry-mesic Forests, with large eastern white and red pines dominant, do occur here, but few stands of high ecological significance have been identified in the Northeast Sands. Opportunities to maintain older stands of Northern Mesic Forest with a significant component of American beech, especially with eastern hemlock as a co-dominant, are geographically limited to northeastern Wisconsin. Efforts should be made to identify additional stands of high conservation value (e.g., high conservation value forests) and work with managers to improve the compatibility of management on surrounding lands where feasible. For example, several county parks offer opportunities to create and maintain core areas of older forest, and these could be connected along the Peshtigo River corridor.

Northern Wet-mesic Forests dominated by northern white-cedar are common in the Northeast Sands Ecological Landscape, and these forests have been found to harbor high numbers of rare or uncommon plants and animals during through surveys on federal, state, and tribal lands. Northern white-cedar swamps are in need of more effective protection, especially from the negative impacts of hydrological modifications and from the excessive browse pressure that is a result of maintaining high populations of white-tailed deer. Even when fences are used to protect northern white-cedar from white-tailed deer browse (this is very expensive and impractical at large scales), it can take many years for trees to recover. Good opportunities to protect this fragile natural community occur on the Chequamegon-Nicolet National Forest, within state wildlife areas, and on the Marinette and Oconto county forests.

Northern Hardwood Swamps, often dominated by black ash, have not been well studied in Wisconsin but are also highly vulnerable to the negative impacts of hydrologic modifications as well as to invasion by exotic plants and animals. The detection of the exotic insect emerald ash borer at numerous Wisconsin locations may be especially problematic as no effective controls have been devised as of 2014.

Older conifer-hardwood forest composed of eastern hemlock, eastern white pine, red pine, red oak, red maple, sugar maple, and American beech. Photo by Eric Epstein, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Assess opportunities to maintain dry forests, particularly those dominated by jack pine, throughout the ecological landscape. Mixed stands of jack pine and oak and dry sites supporting natural stands of red pine are also management priorities in the Northeast Sands.
- Using a combination of satellite imagery, forest reconnaissance data, federal public land survey notes from the mid-1800s, and local knowledge, identify large sites for which dry forest and open barrens/bracken grassland vegetation could be managed cooperatively and in a coordinated fashion. This will better ensure that the habitat needs of species requiring large open areas such as the Northern Harrier and Upland Sandpiper are met, along with those of jack pine forest specialists such as the Connecticut Warbler (*Oporornis agilis*) and the globally imperiled Kirtland's Warbler.
- Identify management opportunities for older mesic forests of eastern hemlock-American beech and dry-mesic forests of eastern white pine-red pine-northern red oak. These forests are now uncommon here but could be protected or restored at several locations.
- Work with NGOs such as land trusts to develop projects that will further the protection of priority natural features, especially those that may be underrepresented on public lands. Small or medium-scale features, including natural communities, rare habitats, undeveloped waterbodies, and rare species populations are examples of potential focal points for such projects.
- Continue work with the Menominee Nation on efforts to document, monitor, and conserve rare or declining natural features in northeastern Wisconsin.
- Develop guidelines that will better protect valuable and fragile lowland forest communities such as those dominated by northern white-cedar or tamarack from the direct and indirect impacts of various land uses and developments.
- Promoting and managing for aspen in areas adjacent to northern white-cedar swamps may result in the construction of beaver dams along streams and spring runs that will potentially flood out and kill the northern white-cedar, render habitat for sensitive understory plants unusable, and degrade aquatic habitat conditions for species adapted to cold, highly oxygenated waters.
- Evaluate management plans for properties that include large, biologically diverse northern white-cedar forests such as the Brazeau Swamp and the Chequamegon-Nicolet National Forest. Devise monitoring programs that would track the conditions of these and other sensitive forest communities.

Barrens and Bracken Grasslands

Historically there were extensive areas of semi-open barrens and bracken grasslands mixed with dry forest in the Northeast Sands. These fire-dependent natural communities were concentrated in Marinette County (e.g., near Athelstane and Dunbar and in the Spread Eagle area of eastern Florence County). In addition, a large portion of eastern Menominee County and a much smaller area of adjoining Oconto County was mapped by Finley (1976) as "jack pine, scrub oak, and barrens" and "brush." There are historical records of rare barrens fauna from this area, including both the Karner blue and northern blue butterflies.

Although we are unaware of recent detailed studies of barrens and bracken grassland vegetation in this ecological landscape, the prairie component of the associated flora is gradually diminished from south to north. Open stands in the northern part of the Northeast Sands support relatively few prairie plants when compared with stands farther south or in other ecological landscapes such as the Northwest Sands, Central Sand Plains, or Central Sand Hills. The remnants, nevertheless, provide critical breeding habitat for many grassland birds and perhaps for some that are dependent on

Bracken Grassland-Pine Barrens complex restored and managed by the use of prescribed fire and timber harvest. Photo by Eric Epstein, Wisconsin DNR.

extensive areas of shrubs or small trees. A number of mammals, herptiles, and insects associated with these habitats are also among the beneficiaries.

Management Opportunities, Needs, and Actions

- Continue efforts to restore and maintain existing barrens and bracken grassland habitats at sites such as Dunbar Barrens and the Spread Eagle complex.
- Identify and explore opportunities to enlarge and connect existing barrens remnants.
- Identify relatively large areas (e.g., of several thousand acres) where there is potential to manage dry forests and barrens/bracken grasslands compatibly and in a coordinated manner. Large patches of both open and forested habitats are needed by sensitive species adapted to these ecosystems.
- Monitor managed sites periodically to assess the amount of habitat available, the vegetation in surrounding areas, and populations of selected plants and animals (including problem invasives such as spotted knapweed and leafy spurge).
- Evaluate the current management and restoration potential of barrens remnants in the Athelstane area of Marinette County because some of these areas support a relatively high diversity of prairie species, including several that are rare.
- Revisit sites near the southern edge of the ecological landscape in Menominee and Oconto counties that support, or formerly supported, rare Lepidoptera, including the U.S. Endangered Karner blue butterfly.
- Identify small-scale projects designed to protect rare plants and invertebrates.

River and Stream Corridors

Several Northeast Sands streams offer opportunities to protect aquatic habitats of high biodiversity value. In addition, some streams are bordered by bedrock outcroppings, stands of conifers, and/or relatively old forest. These stream corridors can support species that are rare elsewhere in the ecological landscape and region. In at least some cases, these streams may afford the best chances to connect small, scattered stands of older forest, especially coniferous forest, that persist along streams on state lands or in county parks. These areas could be designated as high conservation value forests.

The Wolf and Menominee rivers present the best opportunities for maintaining and enhancing large river habitats. Proper sewage treatment, agricultural practices, and maintenance of native riparian vegetation will assist in protecting water quality. Submerged wood is vitally important in all streams but particularly in larger rivers where substrate diversity is lacking and unstable bottom substrates of shifting sand, silt, or clay are prevalent. Removal of surveyed dams and drop structures can help improve stream habitat, habitat connectivity, water quality, and hydrologic regime. The corridor of large rivers such as the Menominee are significant beyond ecological landscape boundaries, and taking advantage of opportunities to maintain connectivity of aquatic habitats is an important management action.

Management Opportunities, Needs, and Actions

- Protect the Menominee River corridor, including the adjoining rock outcrops, seepages, spring runs, streamside habitats, and extensive forests within the corridor, via land use planning. Any portions of the river corridor containing rapids, riverine lakes, or floodplain forests would be appropriate potential focal points for site level conservation activities by private or public organizations. The Menominee is the largest river in this part of the state and offers the best chance to connect the vast forests of northern Wisconsin and Michigan with the Green Bay lowlands. The newly designated Menominee River State Park and Recreation Area offers a good opportunity to manage across state boundaries.
- Capitalize on future opportunities to remove dams or overcome their impacts as barriers to the movement of fish and other aquatic life.
- Install fish passage structures where appropriate and feasible at hydroelectric dams on the Menominee River to allow lake sturgeon and other fish species access to habitats used for spawning, wintering, and foraging.
- Continue to plan and implement lake sturgeon habitat improvements in the Menomonee River.
- Develop an inventory of stream corridors for this ecological landscape to identify the best opportunities to protect associated resources of high ecological value. These include aquatic and terrestrial habitats for rare species;

unusual features such as waterfalls, spring ponds and seepages; stands of older forest; and patches of native conifers or other cover types that have been diminished regionally.

- Work with managers of public lands to develop protection plans for ecologically valuable stream corridors as they are identified. In some cases, for example, on county-owned lands, these sites may qualify as high conservation value forests.

Bedrock Features

Exposures of bedrock are prominent and locally common in parts of the Northeast Sands. In areas cut by streams, rock-walled gorges, glades, and cliffs may be present. Uncommon plants and animals have the potential to occur in these habitats. Bedrock specialists, including rare plants, have been identified at several locations. To date, coordinated survey efforts have been focused on limited areas within specific public lands. Additional inventory work is warranted, ideally including taxa other than vascular plants, such as nonvascular plants and invertebrates.

Management Opportunities, Needs, and Actions

- Work with public land managers and local conservation groups to protect bedrock features, especially when they are known to support rare or otherwise unusual species.
- Work with public and private land managers to protect intact bedrock exposures, especially those that are large, and well connected to other natural communities and habitats.
- Identify sites with good potential to support rare or declining rock specialists and develop an inventory plan that includes site assessments of these natural features based on field work.
- The specialized biota occupying bedrock habitats can be easily and severely damaged by motorized recreational vehicles. Such uses should be discouraged in areas likely to harbor sensitive species.
- Consider bedrock habitats for special designation during planning efforts to protect important sites.

Miscellaneous Natural Features

Several additional natural communities, important habitats, and geological features are also important in the Northeast Sands. These include nonforested wetlands (bogs, sedge meadows, fens, and marshes) and surrogate grasslands, especially those in close proximity to barrens or bracken grassland management opportunities and/or that are capable of supporting sensitive species such as grassland birds.

Lakes are also important opportunities, especially those with unusual properties such as marl lakes, but lakes of virtually any type that have undeveloped shorelines and intact watersheds are increasingly rare here and elsewhere. Undeveloped lakes in the Northeast Sands include a number that are small, scattered, and encircled by relatively undisturbed bog or meadow vegetation. Isolation of such sites by infrastructure developments, residential construction, and major changes to land cover can be a significant management issue. Runoff that can produce excess sediment or nutrient inputs should be managed with great care because such waterbodies may be highly sensitive to such pollutants.

Other opportunities include ponds (simplistically, these are shallow lakes of less than 10 acres), especially spring ponds or ephemeral ponds. In addition, scattered populations of rare species warrant consideration. Sometimes these are found outside of what are normally considered high-quality habitats—even places such as roadsides in the case of certain rare plants and invertebrates. Some of these rare species are well represented here compared to other places.

Management Opportunities, Needs, and Actions

- Assess inventory adequacy and needs for rare taxa known or suspected to occur within this ecological landscape, based on knowledge of the types of habitats present and their overall distribution and condition.

Bedrock Glade on basalt outcrop. Photo by Eric Epstein, Wisconsin DNR.

Swamp hardwoods and ephemeral pond following spring snowmelt. Photo by Emmet Judziewicz.

- Work with local land trusts or other NGOs to help identify and prioritize conservation projects designed to protect vegetation, bedrock features, and waterbodies. The highest priorities would be those examples that are outstanding in terms of their condition and quality. Also important would be examples that demonstrate rare or unique attributes, are high quality and representative of the ecological landscape, support significant populations of rare species, and/or are not well represented on protected public lands.
- Consult with aquatic biologists to develop a list of sensitive habitats and aquatic biota for which surveys in the Northeast Sands are needed to locate populations and better understand their status and distribution.
- Design and implement an aquatic survey program that would address priority knowledge gaps and identify conservation priorities.
- The Northern Lakes Program, Smart Growth planning, and other programs with similar goals should be used to help ensure that the hydrologic functions of the diverse lakes in the Northeast Sands remain intact.

Figure 13.12. *Northeast Sands counties.*

Socioeconomic Characteristics

Socioeconomic information is summarized within county boundaries that approximate ecological landscapes unless specifically noted as being based on other factors. Economic data are available only on a political unit basis, generally with counties as the smallest unit. Demographic data are presented on a county approximation basis as well since they are often closely associated with economic data. The multi-county area used for the approximation of the Northeast Sands Ecological Landscape is called the Northeast Sands counties throughout this section. The counties included are Florence, Marinette, Oconto, and Menominee because at least 25% of each county lies within the ecological landscape boundary (Figure 13.12).

History of Human Settlement and Resource Use

American Indian Settlement

The archaeology of northern Wisconsin is fragmentary and often poorly understood. Given this, there are many gaps in our understanding of the cultural evolution of early peoples in northern Wisconsin. It can be generally said that technology and traditions occurred earlier in southern Wisconsin than in northern Wisconsin. There is little evidence of habitation in the Northeast Sands Ecological Landscape until the time of the Woodland Tradition. There have been several mound groups, including some burials in and around Keshena (Menominee County) with the relatively rare tapering linear mounds referred to as "catfish effigy" mounds (Stevenson et al. 1997). See the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions," for a description of the cultural traditions of Wisconsin.

Euro-American Contact and Settlement

The earliest historical reference to people in the Northeast Sands Ecological Landscape comes from Nicolet, who referenced meeting 'Menomini' people at a feast given by the Winnebago (Ho-Chunk) in his honor around 1634. He mentioned their "grand village" along the Menominee River, although he did not visit it, and it is unclear as to its exact whereabouts (Mason 1988). Regardless, the Menominee were established at this time in much of northeastern Wisconsin, centered on the Northeast Sands Ecological Landscape. For more information on the Menominee Indians and the history of human settlement and resource use in Wisconsin, see the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions."

Permanent Euro-American settlement began in Oconto County with its founding in 1851. Marinette County (founded in 1879) and Florence County (founded in 1882) were settled later as the widespread logging known as "the Cutover" moved north. Menominee County was not founded until 1961, so it is not included individually in this section's analysis (NACO 2010). The population of Marinette County quickly swelled past that of Oconto County, while Florence County remained sparsely populated, with few farms. Finnish immigrants arrived in significant numbers beginning in the 1880s, and many ultimately settled in Marinette County as stone quarry miners. Italian and Polish communities also sprang up intermittently in this area toward the end of the 19th century (The Wisconsin Cartographer's Guild 1998).

Early Agriculture

In 1860 there were reportedly 64 farms in Oconto County (ICPSR 2007). By 1890, with the three early Northeast Sands counties established, total population was 37,917, with 2,074

permanent farm settlements. As the Cutover advanced, farm settlements increased on logged land that was generally poorly suited for agriculture. In 1900 the Northeast Sands counties had an estimated 3,732 farms and a total population of 54,983. By 1920 the number of farms in the Northeast Sands counties had reached 5,994 (Figure 13.13), while the population began to decline in the Northeast Sands counties in the 1920s. Farm numbers in the Northeast Sands counties declined dramatically with the onset of the Great Depression. However, farm numbers had increased again by 1940 to 6,586.

Farms in the Northeast Sands counties tended to be smaller than the state average in the early part of the 20th century, until the Northeast Sands counties' farm size drew even with the state's average in 1950, averaging 137 acres per farm compared to 138 acres statewide (Figure 13.14). Following World War II, a combination of the failure of many smaller marginal farms, subsequent consolidation, and mechanization increased the average size of farms in the Northeast Sands counties. Farm numbers also began to decline sharply because much of the marginal land proved ill-suited for intensive agriculture. Mechanization also contributed to increase the average size of farms in the Northeast Sands counties, much as it did in the state as a whole. That trend continued throughout much of the remaining 20th century.

Total value of all crops indicates the extreme influence of the Great Depression on agriculture. In 1910 all crops harvested in the Northeast Sands counties had an estimated total value of $2.7 million, which more than tripled by 1920 ($9.3 million) (ICPSR 2007). However, total value of all crops in the Northeast Sands counties plummeted in 1930 ($5.2 million) and fell further by 1940 ($4.0 million). Total values of crops in the Northeast Sands counties comprised only 2.4% of total crop value in the state in 1940, with these crops coming from farms comprising 3.3% of all Wisconsin farm acreage. Farms in the Northeast Sands counties historically have not been as productive as those in the state as a whole, in part due to less fertile soils and shorter growing seasons than counties to the south.

Over the early part of the 20th century, farms in the Northeast Sands counties' were much less productive in terms of "cereals" crops, while "hay and forage" comprised a similar proportion of their overall crop value as that which occurred statewide. The 1910 federal agricultural census listed cereals as only 32.5% of the total value of

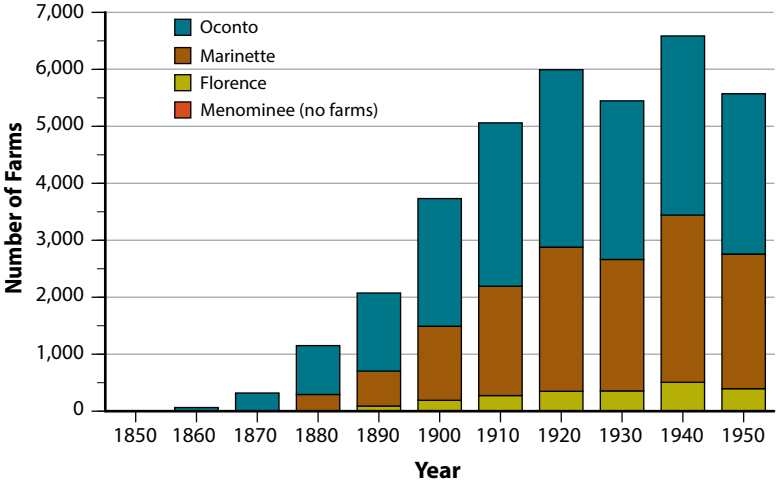


Figure 13.13. *Number of farms in the Northeast Sands counties between 1860 and 1950 (ICPSR 2007).*

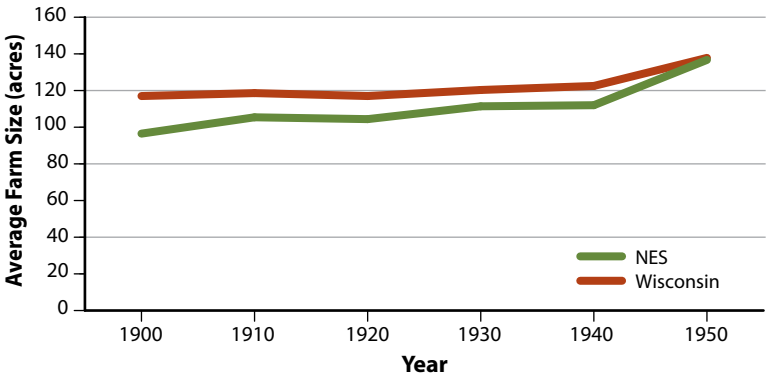


Figure 13.14 *Average farm size in Northeast Sands counties between 1900 and 1950 (ICPSR 2007).*

all crops harvested in the Northeast Sands counties, compared to 49.3% of statewide crop value (ICPSR 2007). By 1940 cereals comprised only 18.8% of crop value in the Northeast Sands counties, following a similar trend of decline statewide. Meanwhile, hay and forage, associated with livestock farming, was 32.5% of total value of crops harvested in the Northeast Sands counties in 1910, compared to only 27.5% statewide. Hay and forage had risen to 54.6% of total crop value in the Northeast Sands counties by 1940.

Early Mining

Mining has occurred in Wisconsin for thousands of years. However, early mining was not important in the Northeast Sands Ecological Landscape.

Early Transportation and Access

In the early 19th century, a network of American Indian trails connected the many Indian villages throughout the Wisconsin portion of what was then Michigan Territory. In the 1860s, two military roads were developed in northeastern Wisconsin, connecting key cities and forts (Davis 1947). These military roads passed just to the south and west of the Northeast Sands Ecological Landscape. By the late 1800s, several smaller companies operated railroad lines through the Northeast Sands counties (Fisher

1937). The Quinnesec Logging Company, William Holmes and Sons, and the Dunbar and Wausaukee Railroad all were active in this ecological landscape. Additionally, the Wisconsin and Northwest Railroad, the Wisconsin and Michigan Railroad, the Fence River Logging Company, the Holt Lumber Company, and the Oconto Company all operated railroad lines in the Northeast Sands counties.

See the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions," for further discussion of the history of transportation in Wisconsin.

Early Logging Era

Sawmills were first built along rivers in areas containing large stands of timber. Where river conditions made it difficult to float logs, lumbermen built mills as close to the cutting area as possible, while on trouble-free rivers, sawmills were generally more centralized (Ostergren and Vale 1997). The continual westward surge of the agricultural frontier by Euro-American settlers to treeless lands in the western part of the country increased the demand for lumber from northern Wisconsin. Wisconsin also had the advantage of an extensive network of waterways flowing south from the northern timber region. Wisconsin lumber production reached its annual peak at more than three billion ***board feet*** in 1892 (The Wisconsin Cartographer's Guild 1998). Oconto, Peshtigo, and Marinette were three of the main mill centers in the Northeast Sands counties.

Roth (1898) described forest conditions in some of the northern Wisconsin counties at the close of the 19th century. Florence County was once a mixed forest of pine, hardwoods, and eastern hemlock but was heavily affected by fire, with burns covering 20% of the land area. The pine had been largely cut over, leaving an estimated 150 million board feet standing. Eastern hemlock and hardwood stands had only been harvested in small patches near established towns. Eastern hemlock had a standing volume of around 300 million board feet, while hardwoods were an estimated 400 million board feet. American basswood, birch, and maple were the principle hardwood species, comprising three-quarters of all hardwoods. Oak species were scarce. Florence County's swamps were relatively well stocked at an estimated 100 million board feet. By comparison, today there are 206 million board feet of pine, 173 million board feet of eastern hemlock and 623 million board feet of hardwood ***sawtimber*** in Florence County forests (USFS 2009).

In Marinette County, Roth (1898) noted that pine had been harvested in parts of each township. The greater part of this county was described as a pinery. The ***Peshtigo Fire*** in 1871 burned over much of the area close to Green Bay, which on the uplands was formerly pine mixed with hardwoods. After the fire, it was bare and supported brushland with some settlement. Estimated pine remaining in the county at the turn of the 20th century was 1.5 billion board feet. Other remaining sawtimber was estimated to be 500 million board feet, half of which was eastern hemlock. Noted hardwoods were maple, birch, and American basswood, with oak being rare. Large burned-over wastes existed in all parts of the county. By comparison, today there are 700 million board feet of pine, 74 million board feet of eastern hemlock, and 1.0 billion board feet of hardwood sawtimber in Marinette County forests (USFS 2009).

Pine was cut in nearly all parts of Oconto County during the Cutover (Roth 1898). Only 65 to 75 million board feet remained standing at the time of Roth's survey. Eastern hemlock was estimated at 500 million board feet, and hardwoods were estimated at 400 million board feet in 1897. Hardwoods were principally birch, American basswood, elm (*Ulmus* spp.), maple, and ash with little oak. The southern part of the county was cut-over with much of it bare and a large part settled. Today there are 587 million board feet of pine, 63 million board feet of eastern hemlock, and 709 million board feet of hardwood sawtimber in Oconto County (USFS 2009).

Resource Characterization and Use[1]

The Northeast Sands Ecological Landscape is a fairly small landscape at 1,495 square miles of land area (does not include area of open water). Its population density is only 27 people per square mile compared to the statewide average of 105 people per square mile (USCB 2012). The Northeast Sands Ecological Landscape has the highest percentage of forested land in the state. The proportion of public land is high, with much of it in county, state, or federal ownerships. However, the density of campgrounds and trails is much lower than average as is the number of visitors to state lands and the number of hunting and fishing licenses sold. There are more ATV trails but fewer hiking and biking trails compared to the rest of the state.

Agriculture is not a major factor in the economy of the Northeast Sands Ecological Landscape. This region ranks 11th (out of 16 ecological landscapes) in the percentage of land area in agriculture and 11th in net income per farmed acre. Corn and milk production are also below average for the state. Forestry, on the other hand, is much more important to the economy. The Northeast Sands Ecological Landscape has the highest percentage of its land in forest cover. ***Growing stock*** volume per acre and removals are both well above the state average.

In terms of infrastructure, transportation in the Northeast Sands Ecological Landscape is about average for road density. There are only three airports and no shipping ports. Due to a low population, the Northeast Sands Ecological Landscape does not use much energy, but it does produce a fair amount of hydroelectric power at six dam sites. This region also has a significant amount of woody biomass, which could be a potential source of energy. There are no wind or ethanol plants in this ecological landscape.

[1]When statistics are based on geophysical boundaries (using GIS mapping), the name of the ecological landscape is followed by the term "ecological landscape." When statistics are based on county delineation, the name of the ecological landscape is followed by the term "counties."

The Land

Of the 956,727 acres of land that make up the Northeast Sands Ecological Landscape (this figure does not include the area of open water), 84% is forested (USFS 2009). About 62% of all forested land is privately owned while 30% belongs to the state, counties, or municipalities, and 8% is federally owned.

Minerals

In 2007 there were six mining establishments in the Northeast Sands counties. Mining employment in Northeast Sands counties totaled 485 people with wages of $18.4 million (WDWD 2009). Due to confidential disclosure rules, much of this information is limited to summary data.

Water (Ground and Surface)

Water Supply

The data in this section are based on the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2012), which are the same as the data reported in the "Hydrology" section of this chapter; however, the data are categorized differently here so the numbers differ slightly. Surface water covers 32,495 acres in the Northeast Sands Ecological Landscape, or 3.4% of the total area. The 701 lakes and ponds add up to 22,061 acres, which is 68% of the surface water. There are five lakes over 500 acres in size and four that are over 1,000 acres—Shawano Lake, High Falls and Caldron Falls reservoirs (both part of the Peshtigo River), and White Potato Lake. Of the 5,964 acres of streams and rivers, the Menominee, Wolf, and Peshtigo rivers are the largest. Reservoirs and flowages account for the remaining 4,469 acres.

Water Use

Each day 58.4 million gallons of ground and surface water are withdrawn in the four counties of the Northeast Sands counties (Table 13.3). About 76% of the withdrawals are from surface water. Of the 88,064 people that reside in these counties, 39% are served by public water sources, and 61% are served by ***private wells*** (USGS 2010). Marinette County uses 84% of all water in the four-county area. The largest water withdrawals are for thermoelectric once-through power generation with Marinette County accounting for the bulk of this.

Recreation

Recreation Resources

Land use, ownership patterns, and vegetative cover partly determine the types of recreation that are available to the public. For instance, in the Northeast Sands Ecological Landscape, there is a 31% higher percentage of forest and a 24% lower proportion of agricultural land compared to the rest of the state (see Chapter 3 of the book, "Comparison of Ecological Landscapes," and/or the map "WISCLAND Land Cover [1992] of the Northeast Sands" in Appendix 13.K at the end of this chapter). This ecological landscape has the highest percentage of forested land in the state.

There is more public land by percentage in the Northeast Sands than in some other parts of Wisconsin. Approximately 38% of all forested land (based on FIA data) is in public ownership with 3.1% under state control, 7.8% federally owned, and 26.7% belonging to county and municipal governments (USFS 2007). However, the density of campgrounds and trails is much lower than average, as is the number of visitors to state lands and the number of hunting and fishing licenses sold (Wisconsin DNR unpublished data). There are fewer Land Legacy sites than in other ecological landscapes but more with significant recreation potential. In summary, the supply of recreational land is high, but the number of facilities like campgrounds and trails is not as high as elsewhere.

Supply

Land and Water. The Northeast Sands Ecological Landscape accounts for 2.8% of Wisconsin's total land area and 2.4% of the state's acreage in water (see Chapter 3, "Comparison of Ecological Landscapes"). There are 803,536 acres of forestland, or 5% of the total acreage in the state (USFS 2007). Streams and rivers make up 17% of the surface water area here, and lakes and reservoirs account for over 83% (WDNR 2012) . The largest rivers are the Menominee, Wolf, Peshtigo, Oconto, and Pine rivers. The largest lakes are Shawano Lake, High Falls Reservoir, Caldron Falls Reservoir, and White Potato Lake.

Public Land. Public access to recreational lands is vital to many types of recreational activity. In the Northeast Sands Ecological Landscape, almost 357,400 acres, or 36.2% of all land and

Table 13.3. *Water use (millions of gallons/day) in the Northeast Sands counties.*

County	Ground Water	Surface Water	Public Supply	Domestic[a]	Agriculture[b]	Irrigation	Industrial	Mining	Thermo-electric	Total
Florence	0.3	0.0	0.1	0.0	0.0	0.2	–	0.1	–	0.4
Marinette	7.8	40.6	4.1	1.3	4.8	1.8	10.2	0.2	26.0	48.5
Menominee	0.8	0.4	0.3	0.1	0.8	–	–	–	–	1.2
Oconto	5.0	3.5	1.4	1.3	1.7	0.8	2.8	0.3	–	8.4
Total	**13.9**	**44.0**	**6.0**	**3.0**	**7.0**	**3.0**	**13.0**	**1.0**	**26.0**	**58.4**
Percent of total	**24%**	**76%**	**10%**	**5%**	**12%**	**5%**	**22%**	**1%**	**45%**	

Source: Based on 2005 data from the U.S. Geological survey on water uses in Wisconsin counties (USGS 2010).
[a]Domestic self-supply wells.
[b]Includes aquaculture and water for livestock.

water, is publicly owned (WDNR 2005a). This is significantly higher than the statewide average of 19.5% and ranks this ecological landscape fifth out of 16 ecological landscapes in the proportion of public ownership. There are about 32,500 acres of public waters, 24,000 acres of state recreational lands, 72,000 acres of federal lands, and 231,000 acres of county lands.

State-owned lands and facilities are especially important to recreation in the Northeast Sands Ecological Landscape. There are over 9,200 acres of state forest (Peshtigo River State Forest). In addition, there are 7,330 acres of state trails and wild rivers (WDNR 2005a), including the Pike and Pine-Popple wild rivers, and about 7,700 acres of fisheries and wildlife management lands. The largest of these, Peshtigo Brook State Wildlife Area, the South Branch of the Oconto River State Fishery Area, and the Amberg State Wildlife Area, each provide over 1,000 acres of recreational land. Finally, there are two state parks, the Governor Thompson State Park and the newly established Menominee River State Park and Recreation Area.

Trails. Although the Northeast Sands counties have over 1,700 miles of recreational trails (Table 13.4), they rank 11th (out of 16 ecological landscapes) in trail density (miles of trail per square mile of land) (Wisconsin DNR unpublished data). There is a lower density of hiking, biking, and cross-country ski trails but a higher density of ATV trails compared to the rest of the state.

Land Legacy Sites. The Land Legacy project has identified over 300 places of significant ecological and recreational importance in Wisconsin, and 12 are either partially or totally located within the Northeast Sands Ecological Landscape (WDNR 2006b). Three of them, the Athelstane Barrens, the Chequamegon-Nicolet National Forest, and the Menominee County Forest, are rated as having the highest conservation significance. There are two Land Legacy sites with the highest recreation potential: the Chequamegon-Nicolet National Forest and the Peshtigo River.

Campgrounds. There are 64 public and privately owned campgrounds that provide about 2,300 campsites in the Northeast Sands counties (Wisconsin DNR unpublished data). With 4% of the state's campgrounds, this ecological landscape ranks 12th (out of 16 ecological landscapes) in both the number and density of campgrounds (per square mile of land). Another 100 campsites were developed for the Governor Thompson State Park in 2012–2013.

State Natural Areas. The Northeast Sands Ecological Landscape contains 19,629 acres of state natural areas, all of which are publicly owned, including government and educational institutions (Wisconsin DNR unpublished data). The largest state natural areas in this ecological landscape include the Spread Eagle Barrens (6,976 acres, Florence County), Waupee Lake Swamp (2,924 acres, Oconto County), Nelligan Lake (1,501 acres, Marinette and Oconto counties), Dunbar Barrens (1,401 acres, Marinette County), and Bonita Country (1,092 acres, Oconto County). Note that some of the designated state natural areas are within other public lands, such as the Chequamegon-Nicolet National Forest and Dunbar Barrens State Wildlife Area. For more information regarding Wisconsin state natural areas, see Wisconsin DNR (2013e).

Demand

Visitors to State Lands. The Peshtigo River State Forest and Governor Thompson State Park were created within this ecological landscape in 2001. From 2007 to 2011, 7,844 campers used these areas (Wisconsin DNR unpublished data).

Fishing and Hunting License Sales. Of all license sales, the highest revenue producers for the Northeast Sands counties were resident hunting licenses (43% of total sales), resident fishing licenses (30% of total sales), and nonresident fishing licenses (12% of total sales) (Wisconsin DNR unpublished data). Table 13.5 shows a breakdown of various licenses sold in the Northeast Sands counties. Marinette County has the highest number of licenses sold and the highest revenue from sales. This ecological landscape county approximation accounts for about 2% of total license sales in the state. However, persons buying licenses in the Northeast Sands counties may travel to other parts of the state to use them.

Metropolitan Versus Nonmetropolitan Recreation Counties. A research study (Johnson and Beale 2002) classified Wisconsin counties according to their dominant characteristics. One classification is "nonmetro recreation county." This type of county is characterized by high levels of tourism, recreation,

Table 13.4. *Miles of trails and trail density in the Northeast Sands counties compared to the whole state.*

Trail type	Northeast Sands (miles)	Northeast Sands (miles/100 mi^2)	Wisconsin (miles/100 mi^2)
Hiking	33	1.0	2.8
Road biking	14	0.4	4.8
Mountain biking	50	1.5	1.9
ATV: summer & winter	515	15.9	9.3
Cross-country skiing	127	3.9	7.2
Snowmobile	1,016	31.3	31.2

Source: Wisconsin DNR unpublished data.

Table 13.5. *Fishing and hunting licenses and stamps sold in the Northeast Sands counties.*

County[a]	Resident fishing	Nonresident fishing	Misc. fishing	Resident hunting	Nonresident hunting	Stamps	Total
Florence	2,209	1,084	64	4,147	333	996	8,833
Marinette	15,205	4,114	851	20,523	592	8,428	49,713
Oconto	9,927	1,236	202	12,177	133	4,798	28,473
Total	**27,341**	**6,434**	**1,117**	**36,847**	**1,058**	**14,222**	**87,019**
Sales ($)	**$620,223**	**$254,604**	**$20,166**	**$882,037**	**$140,177**	**$130,810**	**$2,048,017**

Source: Wisconsin DNR unpublished data, 2007.
[a] There is no information for Menominee County.

entertainment, and seasonal housing. All four of the Northeast Sands counties, Florence, Marinette, Menominee, and Oconto, are classified as nonmetro recreation counties.

Recreational Issues

Results of a statewide survey of Wisconsin residents indicated that a number of current issues are affecting outdoor recreation opportunities within Wisconsin (WDNR 2006a). Many of these issues, such as increasing ATV usage, overcrowding, increasing multiple-use recreation conflicts, loss of public access to lands and waters, invasive species, and poor water quality, are common across many regions of the state.

Silent Sports Versus Motorized Sports. Over the next decade, the most dominant recreation management issues will likely revolve around conflicts between motorized and nonmotorized recreation interests. From a silent-sport perspective, noise pollution from motorized users is one of the higher causes for recreation conflict (WDNR 2006a). Recreational motorized vehicles include snowmobiles, ATVs, motor boats, and jet skis. ATV use is especially contentious. ATV riding has been one of the fastest growing outdoor recreational activities in Wisconsin.

Timber Harvesting. A high percentage of statewide residents are concerned about timber harvesting in areas where they recreate (WDNR 2006a). Their greatest concern about timber harvesting is large-scale visual changes (i.e., large openings) in the forest landscape. Forest thinning and harvesting that creates small openings is more acceptable. Silent-sport enthusiasts as a group are the most concerned about the visual impacts of harvesting, while hunters and motorized users are somewhat less concerned.

Loss of Access to Lands and Waters. With ever-increasing development along shorelines and continued parcelization of forestlands, there has been a loss of readily available access to lands and waters within this ecological landscape. This may be due to the concentration of housing that has occurred with the advent of housing developments closing large areas of shoreline once open to the casual recreational user. Another element that may play into the perception of reduced access is a lack of information about where to go for recreational opportunities. In a statewide survey, this element was highly ranked as a barrier to increased outdoor recreation (WDNR 2006a).

Agriculture

Farm numbers in the Northeast Sands counties have decreased 37% since 1970. There were approximately 3,150 farms in 1970 and 1,986 in 2002 (USDA NASS 2004). Between 1970 and 2002, average farm size decreased from 187 acres to 166 acres, which is much lower than the statewide average of 201 acres. The overall land in farms has steadily decreased since the 1970s (Figure 13.15). In 1970 there were about 543,000 acres of farmland, and by 2002 acreage was down to 389,000 acres, a decrease of 28%. For the four counties, the percentage of land in farms ranges from 0.2% to 34%, averaging 18%. The counties with the highest percentage of agricultural land are Oconto with 34% and Marinette with 16%.

Agriculture is not an important part of the economy of the Northeast Sands counties. In 2002, net cash farm income totaled $26 million, or an average of $66 per agricultural acre, much lower than the statewide average of $91 per acre (USDA NASS 2004). The market value of all agriculture products sold in the Northeast Sands counties was $116 million (1% of the state total); 22% of this amount came from crop sales, while the remaining 78% was from livestock sales.

In 2007, 1,932 acres of farmland were sold, of which 96% stayed in agricultural use at an average selling price of

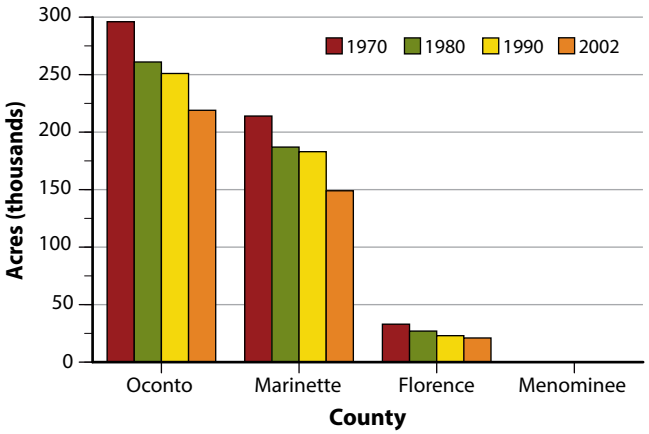


Figure 13.15. *Acres of farmland in the Northeast Sands counties by county and year (USDA NASS 2004).*

$2,822, and 4% was diverted to other uses at an average sale price of $12,814 per acre (USDA NASS 2009).

Timber

Timber Supply

Based on 2007 Forest Inventory and Analysis (FIA) data, 84% (803,536 acres) of the total land area for the Northeast Sands Ecological Landscape is forested (USFS 2007). This is about 5% of Wisconsin's total forestland acreage (USFS 2009). Forestland is defined by FIA as any land with more than 17% canopy cover. This partially obscures the historical and present condition of the Northeast Sands from an ecological perspective because many of the natural communities were barrens and savannas with less than 50% canopy cover.

Timber Ownership. Timberland is defined as forestland capable of producing 20 cubic feet of industrial wood per acre per year not withdrawn from timber utilization (see the glossary in Part 3, "Supporting Materials," for more detailed description of timberland). Of all timberland within the ecological landscape, 62% is owned by private landowners, 30% is owned by state and local governments, and the remaining 8% is federally owned (USFS 2009; Figure 13.16).

Growing Stock and Sawtimber Volume. There were approximately 1.1 billion cubic feet of growing stock volume in the Northeast Sands counties in 2007, or 5% of total volume in the state (USFS 2009). Most of this volume, 80%, was in hardwoods, greater than the proportion of hardwoods statewide, which was 74% of total growing stock volume. Hardwoods made up a lower proportion, 41%, of sawtimber volume. In comparison, statewide sawtimber hardwood volume was 67% of total volume.

Annual Growing Stock and Sawtimber Growth. Between 1996 and 2007, growing stock volume in the Northeast Sands Ecological Landscape increased by 159 million cubic feet, or 16% (USFS 2007). All of this increase occurred in softwood volume. Sawtimber volume increased by 878 million board feet, or 36%. Most of this change, 87%, was in softwood volume and may have been partly a result of an increase in timberland acreage from 757,085 to 796,388 acres,or 5% between 1996 and 2007. Statewide, timberland acreage increased by 3% during the same time period.

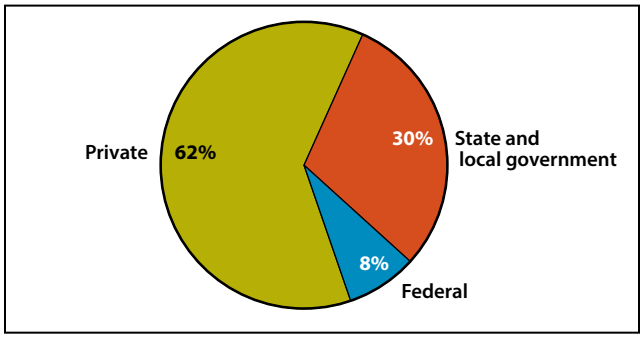


Figure 13.16. *Timberland ownership in the Northeast Sands Ecological Landscape (USFS 2009).*

Timber Forest Types. According to FIA data, the predominant forest type groups (see Appendix H, "Forest types That Were Combined into Forest Type Groups Based on Forest Inventory and Analysis (FIA) Data," in Part 3 of the book, "Supporting Materials") in terms of acreage are aspen-birch (27%), oak-hickory (19%), maple-basswood (16%), eastern white, red, and jack pines (16%), and spruce-fir (12%), with smaller amounts of oak-pine and bottomland hardwoods (USFS 2009). Acreage is predominantly in the pole and sawtimber size classes (42% and 34%, respectively) with only 23% in seedling and sapling classes (Table 13.6). Aspen is the major exception, with well over 50% of the acreage in the seedling-sapling class.

Timber Demand

Removals from Growing Stock. The Northeast Sands Ecological Landscape has about 5.5% of the total growing stock volume on timberland in Wisconsin (see the "Socioeconomic Characteristics" section in Chapter 3, "Comparison of Ecological Landscapes"). Average annual removals from growing stock were 20 million cubic feet, or about 5.6% of total statewide removals (349 million cubic feet) between 2002 and 2007 (USFS 2009). Average annual removals-to-growth ratios vary by species as can be seen in Figure 13.17 (only major species shown). Removals exceed growth for aspen, jack pine, and white birch. Northern white-cedar growth is much higher than removals, largely because it is not harvested since it cannot be reliably regenerated in most areas. Red pine growth is mainly plantation-grown trees.

Removals from Sawtimber. The Northeast Sands Ecological Landscape has about 5.6% of the total sawtimber volume on timberland in Wisconsin. Average annual removals from sawtimber were over 59 million board feet, or 5.6% of total statewide removals (1.1 billion board feet) between 2002 and 2007 (USFS 2009). Average annual removals-to-growth ratios vary by species as can be seen in Figure 13.18 (only major species shown). Sawtimber removals exceeded growth for aspen and jack pine.

Price Trends

In the Northeast Sands counties, sugar maple, northern red oak, and red maple were the highest priced hardwood sawtimber species in 2007. Northern white-cedar, eastern white pine, and red pine were the most valuable softwood timber types. Sawtimber prices for 2007 were generally much lower for softwoods and higher for hardwoods compared to the rest of the state (WDNR 2008). For pulpwood, red pine is the most valuable. Pulpwood values in the counties of the Northeast Sands Ecological Landscape were generally higher for hardwoods and softwoods compared to the statewide average.

Table 13.6. *Acreage of timberland in the Northeast Sands Ecological Landscape by forest type and stand size class.*

Forest type[a]	Seedling/sapling	Pole-size	Sawtimber	Total
Aspen	105,525	61,354	25,596	192,475
Post oak-blackjack oak	12,104	53,172	17,118	82,394
Sugar maple-beech-yellow birch	3,188	41,567	19,367	64,122
Red pine	3,709	14,022	42,418	60,149
Northern white-cedar	–	45,575	9,227	54,802
Northern red oak	–	1,270	30,166	31,436
Hard maple-basswood	1,277	13,370	16,387	31,033
Red maple-upland	1,170	13,202	12,338	26,711
Jack pine	339	20,035	6,324	26,698
Eastern white pine	5,306	2,359	17,094	24,759
White pine-red oak-white ash	10,665	4,973	8,690	24,329
Other pine-hardwood	2,873	3,782	16,884	23,538
Black ash-American elm-red maple	5,087	14,034	2,383	21,504
Red maple-oak	2,714	8,987	4,973	16,674
Tamarack	1,111	12,273	2,036	15,420
White oak-red oak-hickory	–	2,475	11,352	13,827
White birch	3,380	4,916	4,787	13,083
Eastern hemlock	–	–	10,437	10,437
Black spruce	3,110	7,070	–	10,180
Balsam fir	6,585	3,083	–	9,667
Mixed upland hardwoods	5,373	2,097	383	7,853
Cherry-ash-yellow-poplar	6,323	–	–	6,323
Balsam poplar	1,277	679	3,767	5,722
Sugarberry-hackberry-elm-green ash	–	3,393	1,277	4,669
Red maple-lowland	2,474	1,915	–	4,388
Nonstocked[b]				3,441
White spruce	2,046	679	638	3,363
Silver maple-American elm	–	–	2,714	2,714
White pine-hemlock	–	–	2,714	2,714
Chestnut oak-black oak-scarlet oak	–	–	1,573	1,573
Bur oak	–	–	388	388
Total	**185,636**	**336,281**	**271,031**	**796,388**

Source: U.S. Forest Service Forest Inventory and Analysis (FIA) Mapmaker (USFS 2009).

[a]U.S. Forest Service Forest Inventory and Analysis (FIA) uses a national forest typing system to classify FIA forest types from plot and tree list samples. Because FIA is a national program, some of the national forest types in the above table do not exactly represent forest types that occur in Wisconsin. For example, neither post oak nor blackjack oak occur to any great extent in Wisconsin, but since there is no "black oak forest type" in the FIA system, black oak stands in Wisconsin were placed in the "post oak-blackjack oak" category in this table.

[b]Nonstocked land is less than 16.7% stocked with trees and not categorized as to forest type or size class.

Infrastructure

Transportation

The transportation infrastructure of the Northeast Sands Ecological Landscape is somewhat less developed than in the rest of the state. For instance, road mile density is about the same (WDOA 2000), but railroad density is 9% lower (WDOT 1998), and airport runway density is 44% lower than the state as a whole. There are three airports in the Northeast Sands Ecological Landscape (WDOT 2012) but no shipping ports (WCPA 2010) (see Table 13.7).

Renewable Energy

Hydroelectric and wind turbine power are the only renewable energy sources quantified by county in Wisconsin energy statistics produced by the Wisconsin Department of Administration (WDOA 2006). Some general inferences can be drawn from other sources regarding the potential for renewable energy production in the Northeast Sands counties. Other than woody biomass, the Northeast Sands Ecological Landscape has a limited potential to produce a significant amount of renewable energy.

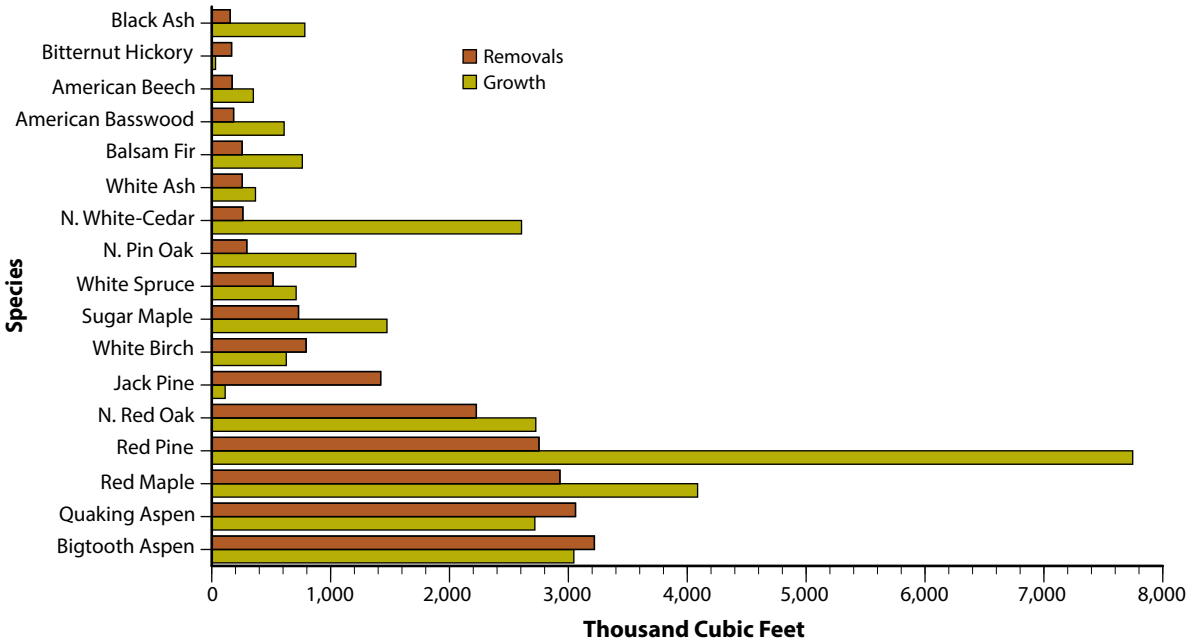


Figure 13.17. *Growing stock growth and removals (selected species) on timberland in the Northeast Sands Ecological Landscape (USFS 2009).*

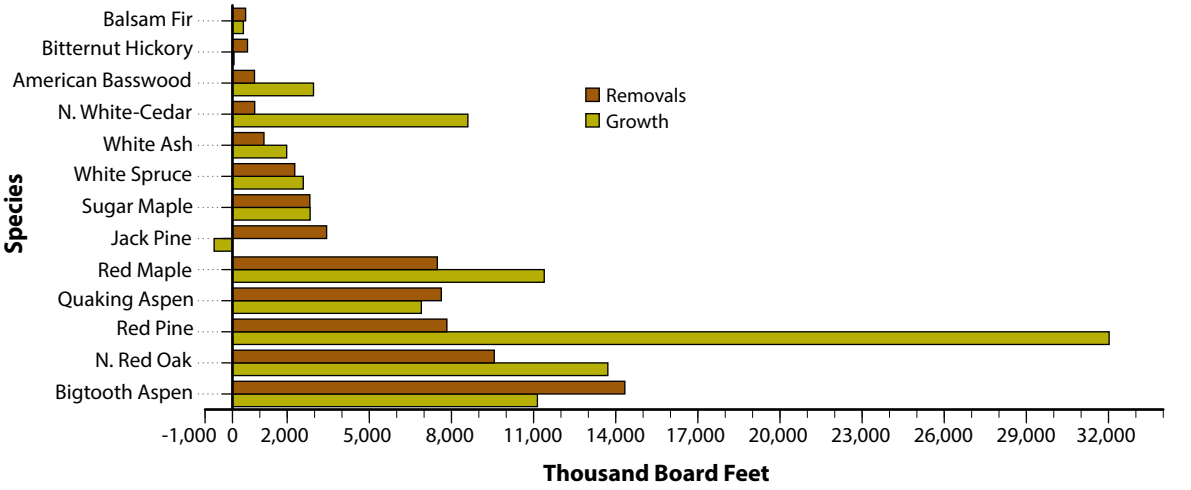


Figure 13.18. *Sawtimber growth and removals (selected species) on timberland in the Northeast Sands Ecological Landscape (USFS 2009).*

Biomass. Woody biomass is Wisconsin's most-used renewable energy resource, and the Northeast Sands Ecological Landscape produces 61.8 million oven-dry tons of biomass, or 6.2% of total statewide production (USFS 2007). Approximately 84% of the land base is forested, and this has increased by 5% in the last decade.

Hydroelectric. There are six hydroelectric power sites that generate 43.6 million kilowatt hours (kWh) in the Northeast Sands counties, or 3% of the state total (WDOA 2006). In the entire state, there are 68 sites, owned either by utility companies or privately owned, which generate a total of 1,462 million kilowatt hours.

Ethanol. The Northeast Sands counties produced 6.6 million bushels of corn in 2002, or 1.1% of total production in the state (USDA NASS 2004). Acreage in agriculture, at only 18% of the land base (some woodland is counted as agriculture by this source), decreased by 28% between 1970 and 2002. Currently there are no ethanol plants located in the Northeast Sands Ecological Landscape (RFA 2014).

Wind. Currently, there are no sited or permitted wind facilities in the Northeast Sands Ecological Landscape (WWIC 2014). Mean annual power densities are generally below 100 W/m^2 (watts per square meter) in this part of the state (USDE 2013).

Table 13.7. *Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of ports in the Northeast Sands Ecological Landscape.*

	Northeast Sands	State total	% of state total
Total road length (miles)[a]	5,230	185,487	3%
Road density[b]	3.5	3.4	–
Miles of railroads	132	5,232	3%
Railroad density[c]	8.8	9.7	–
Airports	3	128	2%
Miles of runway	1.5	95.7	2%
Runway density[d]	1.0	1.8	–
Total land area (square miles)	1,495	54,087	3%
Number of ports[e]	0	14	0%

[a]Includes primary and secondary highways, roads, and urban streets.
[b]Miles of road per square mile of land. Data from Wisconsin Roads 2000 TIGER line files (data set) (WDOA 2000).
[c]Miles of railroad per 100 square miles of land. Data from 1:100,000-scale Rails Chain Database (WDOT 1998).
[d]Miles of airport runway per 1,000 square miles of land. Data from Wisconsin Airport Directory 2011–2012 web page (WDOT 2012).
[e]Data from Wisconsin Commercial Ports Association (WCPA 2010).

Current Socioeconomic Conditions

Demography

Menominee County is comprised exclusively of the Menominee Reservation. Eighty-seven percent of its population is American Indian, and it represents a small but distinct portion of the demographic of the Northeast Sands counties. Florence County, to the north, is also sparsely populated and represents a very small portion of the ecological landscape's total population. Figures below for Marinette and Oconto counties include several small urban centers not actually part of the Northeast Sands Ecological Landscape, so their influence within the ecological landscape is somewhat overstated in this analysis.

The Northeast Sands counties are traditionally rural with low population density and housing density. The largely homogenous white population (with the exception of Menominee County) in rural areas is losing population and experiencing decreased economic activity, especially in places where tourism is less prevalent. The Northeast Sands counties are experiencing a net in-migration of retirement age adults and out-migration of young adults, with negative implications for the available workforce. Education levels of residents are lower than much of the state, especially in terms of higher education.

Population Distribution

According to 2010 Census Bureau estimates, the population of the Northeast Sands counties was 88,064, or 1.5% of the state total population (USCB 2012). About 72.3% of the population can be classified as rural, compared to 31.7% statewide. The vast majority of the Northeast Sands population resides in Marinette (population 42,690) and Oconto (population 37,256) counties. Florence (4,864) and Menominee (4,554) counties combined comprise a very small portion (just over 10%) of the total Northeast Sands counties' population (USCB 2009).

Of four urban centers (defined as cities with at least 2,500 inhabitants) in the Northeast Sands counties, none are actually located within the boundaries of the ecological landscape. Marinette (population 10,968) is the largest urban center, followed by Oconto (4,513), Peshtigo (3,502), and Oconto Falls (2,891) (USBC 2012). Oconto County (though 80.1% of its population is rural) is the only Northeast Sands County classified as "metropolitan" by the U.S. Department of Agriculture Economic Research Service in 2009. This classification is likely due to the influence of the Green Bay metropolitan area in Brown County directly to the south. Because no urban centers are actually within the boundaries of the Northeast Sands Ecological Landscape, the demographic figures cited throughout this section will tend to be greater than the reality within the physical borders of the ecological landscape, and economic opportunities are adversely affected by this.

Population Density

Reflecting the region's remote character, the population density in 2010 of the Northeast Sands counties (27 persons per square mile) is low compared to 105 persons per square mile in Wisconsin as a whole (USCB 2012). Among the Northeast Sands counties, Oconto (37.7 persons per square mile) and Marinette (28.8 persons per square mile) counties have generally higher population densities than do Menominee (11.8 persons per square mile) and Florence (9.1 persons per square mile) counties, which are among the most sparsely populated counties in the state and are likely more representative of the ecological landscape as a whole.

Population Structure

Age. Population in the Northeast Sands counties is older and aging compared to the rest of the state. About 21.7% of the 2010 population was under 18 years old, compared to 23.6% statewide. Conversely, 17.8% of the population is 65 or older, compared to 13.7% statewide (USBC 2012).

However, the median age in Menominee County (27.7 years old) is easily the lowest in the state and reflects both its high birth rate and its very low percentage of population over 65 (8.5%) (USCB 2009). Generally, Wisconsin counties with lower median ages are associated with demographics favorable for highly educated, well-paid, and healthy populations, but in the case of Menominee County, the low median age is more reflective of an underdeveloped economy. The remaining Northeast Sands counties have relatively high median ages more commonly associated with Wisconsin's remote, declining localities, ranging from 38.8 years in Oconto County to 41.9 years in Florence County, compared to the statewide average of 36 years.

Minorities. The Northeast Sands counties combined are less racially diverse than the state as a whole, but Menominee County is unique among Wisconsin counties with its very high proportion of American Indian residents. About 92.8% of the 2010 population in the Northeast Sands counties is white, non-Hispanic, compared to 86.2% statewide (USCB 2012). Florence, Marinette, and Oconto counties are among the most homogenous in the state, while Menominee County is made up almost exclusively of the Menominee Reservation, making its American Indian population (89.3%) the largest in the state. Other demographic and socioeconomic figures in Menominee County are heavily influenced by poverty, isolation, and lack of high-paying jobs.

Education. Northeast Sands counties residents 25 years of age or older have relatively low education levels compared to the state as a whole, especially in terms of higher education. According to the 2010 Census, only 87.2% of the Northeast Sands counties residents 25 or older have graduated from high school, compared to 89.4% statewide (USCB 2012). High school education attainment is highest in Marinette County (87.6%) and lowest in Menominee County (82.0%). The Northeast Sands counties' residents are the lowest of any other ecological landscape county approximation in terms of higher education attainment; only 13.5% of the Northeast Sands counties residents have received at least a bachelor's degree or higher, compared to 25.8% statewide. Only 14.2% of Marinette County residents hold a bachelor's degree or higher, while Florence (12.1%), Oconto (13.2%), and Menominee (12.9%) counties are all well below the statewide average.

Population Trends

The Northeast Sands counties' combined population grew at a faster rate than has the state's population from the 1970s until 2000, after which the Northeast Sands counties growth has dropped below that of the state (USCB 2009). No data existed for Menominee County until the 1970s. In the two preceding decades, the other three Northeast Sands counties endured negative or negligible population change as failing small farms and communities were abandoned for greater opportunities in larger urban centers. During the period from 1970 to 1980, population growth in the Northeast Sands counties (12.7%) exceeded statewide population change (6.5%), led by Florence (27%) and Menominee (29%) counties. From 1980 to 1990, population growth in the Northeast Sands counties (4.5% growth) continued slightly above the state's (4%) as Menominee County (15%) continued its trend as the fastest growing Northeast Sands county. The period from 1990 to 2000 saw increased growth both in the Northeast Sands counties and statewide (11.9 and 9.6%, respectively) with Oconto County (18%) and Menominee County (17%) growing especially quickly. From 2000 to 2006, estimates put the combined population growth rate of the Northeast Sands counties (1%) well behind statewide growth (4%). Florence and Marinette counties have lost population since the turn of the century, while Menominee County's population leveled, and only Oconto County (5%) exceeded statewide growth.

Housing

Housing Density. The Northeast Sands counties' combined housing density in 2010 (18.8 housing units per square mile of land) was less than half of the state's housing density (48.5 units per square mile) (USCB 2012). Paralleling population density, Northeast Sands counties' housing density was highest in Oconto (23.6 units per square mile) and Marinette (21.7) counties. Florence County (9.8 units per square mile) had much lower housing density, and Menominee County had the lowest housing density of any county in the state at 6.3 units per square mile.

Seasonal Homes. Seasonal and recreational homes are prevalent in the Northeast Sands counties, making up over a quarter (29.7%) of housing stock in 2010, compared to the statewide average of 6.3% (USCB 2012). Of the Northeast Sands counties, Florence County had the highest portion of its housing in seasonal homes (51.0%), followed by Menominee (31.7%), Marinette (30.7%), and Oconto (23.9%) counties.

Housing Growth. Combined housing growth in the Northeast Sands counties has met or surpassed statewide growth in every decade starting in the 1960s, with Menominee County seeing extraordinary growth in the 1960s (79.5%), 1970s (123.4%), and 1980s (64.7%) (USCB 2009). From 2000 to 2007, however, Menominee County's housing growth (5.7%) had slowed to the lowest among the Northeast Sands counties, while Oconto County saw the greatest housing growth (14.5%) during that period. The Northeast Sands counties combined experienced their greatest housing growth in the 1970s, with 40% growth compared to 30% growth statewide. Housing development in the Northeast Sands counties is bolstered most by the dynamics of change in the region toward more seasonal housing.

Housing Values. Housing values in each of the Northeast Sands counties in 2005–2009 were much lower than the statewide median housing value ($166,100) (USCB 2012).

Oconto ($142,500) and Florence ($115,000) counties have the Northeast Sands counties' highest median home values, while Marinette County ($109,800) has the sixth-lowest median housing value among counties statewide, with Menominee County ($74,300) even lower.

The Economy

Northeast Sands counties are very similar economically, with the exception of the relative poverty of Menominee County and the effects of Florence County being far from any population centers. The Northeast Sands counties support higher levels of natural resource-dependent, manufacturing, and government jobs and fewer high-paying jobs in sectors such as management, finance, and technology compared to the state as a whole. Unemployment rates are higher than statewide figures, and per capita income and average wages per job are low in the Northeast Sands counties, indicating a lack of higher paying jobs. With the exception of Menominee County, the Northeast Sands counties' poverty rates are comparable to statewide rates, due in part to the prevalence of an aging population with retirement or subsidized income. Property values, while relatively low due to isolation, are tied closely to the local prevalence of tourism and seasonal housing, with values highest in Oconto and Menominee counties.

Income

Per Capita Income. Total personal income for the Northeast Sands counties in 2006 was $2.48 billion (1.3% of the state total), with the vast majority of income in more heavily populated Marinette ($1.2 billion) and Oconto ($1.05 billion) counties (USDC BEA 2006). Combined per capita income in the Northeast Sands counties in 2006 ($27,677) was lower than the statewide average of $34,405 (Table 13.8). Florence ($28,210), Marinette ($28,043), and Oconto ($28,200) counties had tightly clustered per capita incomes at relatively low levels. Menominee County ($19,472) has extremely low per capita income.

Household Income. Estimates in 2005 for all four Northeast Sands counties were lower than the statewide median household income ($47,141) (USBC 2009). Oconto County ($44,670) had the highest median household income among the Northeast Sands counties, while Marinette ($39,789) and Florence ($38,734) counties had significantly lower median household incomes according to U.S. Census Bureau estimates. Menominee County has the lowest median household income ($30,839) among all counties statewide.

Earnings Per Job. Average earnings per job in 2006 within the Northeast Sands counties ($28,571) were considerably lower than the statewide average ($36,142), similar to per capita income (USDC BEA 2006). However, earnings per job figures showed a different pattern for the counties. Earnings per job in the Northeast Sands counties ranged from the lowest statewide in Florence County ($20,584) to the sixth-lowest figure among all counties in Oconto County ($25,106) to moderately low in Marinette County ($30,943). Notably, Menominee County (earnings per job of $26,155) did not fare as poorly in terms of earnings per job as it did with median household income or per capita income, indicating that the local lack of jobs contributes more to local poverty than does the low level of pay.

Unemployment

Unemployment is a critical problem for the isolated Northeast Sands counties, where joblessness is highest of any Wisconsin ecological landscape county approximation. The Northeast Sands counties had a combined 2006 unemployment rate of 6.5%, compared to the state average of 4.7%. Similar to per capita income, unemployment in Florence, Marinette, and Oconto counties was closely clustered between 6.1% and 6.6%. Menominee County (11.1%) had by far the highest unemployment in the state, a factor that drives much of the poverty in that county (USDL BLS 2006; Table 13.8). Unemployment rates became much higher throughout the state after 2008 but have become lower again.

Poverty

Poverty Rates. The U.S. Census Bureau estimated the Northeast Sands counties' combined 2005 poverty rate for all people (10.1%) very close to the state as a whole (10.2%) (USCB 2009). So while earnings were comparatively low for most

Table 13.8. *Economic indicators for the Northeast Sands counties and Wisconsin.*

	Per capita income[a]	Average earnings per job[a]	Unemployment rate[b]	Poverty rate[c]
Wisconsin	**$34,405**	**$36,142**	**4.7%**	**10.2%**
Florence	$28,210	$20,584	6.6%	10.4%
Marinette	$28,043	$30,943	6.4%	9.9%
Menominee	$19,472	$26,155	11.1%	26.3%
Oconto	$28,200	$25,106	6.1%	8.7%
Northeast sands counties	**$27,677**	**$28,571**	**6.5%**	**10.1%**

[a]U.S. Bureau of Economic Analysis, 2006 figures.
[b]U.S. Bureau of Labor Statistics, Local Area Unemployment Statistics, 2006 figures.
[c]U.S. Bureau of the Census, Small Area Income and Poverty Estimates, 2005 figures.

Northeast Sands county residents, they were not generally more likely to be living in poverty than citizens statewide (Table 13.8). However, Menominee County had a poverty rate symptomatic of a depressed economy, with the highest poverty rate in the state (26.3%).

Child Poverty Rates. Compared to the statewide average (14%), 2005 estimates of poverty rates for people under age 18 in the Northeast Sands counties followed similar trends as with overall poverty rates. Child poverty rates for the majority of the Northeast Sands counties were less than the statewide average and were lowest in Oconto County (11.1%), followed by Marinette (13.2%), and Florence (13.3%) counties. However, Menominee County's child poverty rate (39.7%) was by far the highest in the state and differed greatly from its Northeast Sands counties neighbors (USCB 2009).

Residential Property Values

Average residential property values in the Northeast Sands counties ($98,872 per housing unit) were well below the statewide average ($134,021). However, residential property values were highly variable among the Northeast Sands counties and were driven more by recreational property values than by values of homes. Oconto County ($122,951) and Menominee County ($117,789) had residential property values below the state average, but well above those in Florence County ($87,801) and Marinette County ($80,454) (Table 13.9). The Northeast Sands counties' disparate residential property values reflect the heavy economic influence of seasonal housing, aesthetic attraction, and even more by the degree to which they are isolated from more populated southern Wisconsin.

Important Economic Sectors

Northeast Sands counties together provided an estimated 41,185 jobs in 2007, or about 1.2% of the total employment in Wisconsin (Table 13.10; MIG 2009). The Government sector (16.5% of the Northeast Sands counties' employment) and Manufacturing (non-wood) (16.1%) are the leading sources of employment in the Northeast Sands counties, followed in importance by Tourism-related (11.8%), Health Care and Social Service (9.6%), and Retail Trade (9.0%). Manufacturing (non-wood) is the Northeast Sands counties leading source of income and economic output. For definitions of economic sectors, see the North American Industry Classification System web page (USCB 2013).

The importance of economic sectors within the Northeast Sands counties when compared to the rest of the state was evaluated using an economic base analysis to yield a standard metric called a location quotient (Quintero 2007). Economic base analysis compares the percentage of all jobs in an ecological landscape county approximation for a given economic sector to the percentage of all jobs in the state for the same economic sector. For example, if 10% of the jobs within an ecological landscape county approximation are in the manufacturing sector and 10% of all jobs in the state are in the manufacturing sector, then the quotient would be 1.0, indicating that this ecological landscape county approximation contributes jobs to the manufacturing sector at the same rate as the statewide average. If the quotient is greater than 1.0, the ecological landscape county approximation is contributing more jobs to the sector than the state average. Conversely, if the quotient is less than 1.0, the ecological landscape county approximation is contributing fewer jobs to the sector than the state average.

When compared with the rest of the state, the Northeast Sands counties had eight sectors of employment with quotients higher than 1.0 (Figure 13.19, Appendix 13.I). Of particular local importance are economic sectors dependent on the region's natural resource base. Forest Products and Processing's high location quotient is an indicator of the dependence upon forestry and natural resources within the Northeast Sands counties. The Forest Products and Processing sector's quotient in the Northeast Sands counties is third-ranked among ecological landscape county approximations statewide. Forest Products and Processing contributes a small amount of total jobs in the Northeast Sands counties (2,246 jobs), but those jobs represent more than twice as many jobs as occur proportionately statewide in Forest Products and Processing and contribute more income than do jobs in Retail Trade or in Tourism-related sectors. Similarly, the Agriculture, Fishing and Hunting sector is well represented in the Northeast Sands counties, with nearly twice the proportion of total jobs as are found statewide. The Mining sector in the Northeast Sands counties has the highest quotient among all ecological

Table 13.9. *Property values for the Northeast Sands counties and Wisconsin, assessed in 2006 and collected in 2007.*

	Residential property value	Housing units	Residential property value per housing unit
Wisconsin	**$340,217,559,700**	**2,538,538**	**$134,021**
Florence	$404,585,000	4,608	$87,801
Marinette	$2,287,056,800	28,427	$80,454
Menominee	$260,902,900	2,215	$117,789
Oconto	$2,720,054,500	22,123	$122,951
Northeast sands counties	**$5,672,599,200**	**57,373**	**$98,872**

Sources: Wisconsin Department of Revenue 2006–2007 property tax master file (except housing units); housing units: U. S. Census Bureau estimates for July 1, 2006.

Table 13.10. *Total and percentage of jobs in 2007 in each economic sector within the Northeast Sands (NES) counties. The economic sectors providing the highest percentage of jobs in the Northeast Sands Counties are highlighted in blue.*

Industry sector	WI employment	% of WI total	NES counties employment	% of NES counties total
Agriculture, Fishing & Hunting	110,408	3.1%	2,434	5.9%
Forest Products & Processing	88,089	2.5%	2,246	5.5%
Mining	3,780	0.1%	156	0.4%
Utilities	11,182	0.3%	59	0.1%
Construction	200,794	5.6%	2,142	5.2%
Manufacturing (non-wood)	417,139	11.7%	6,642	16.1%
Wholesale Trade	131,751	3.7%	809	2.0%
Retail Trade	320,954	9.0%	3,715	9.0%
Tourism-related	399,054	11.2%	4,872	11.8%
Transportation & Warehousing	108,919	3.1%	1,447	3.5%
Information	57,081	1.6%	451	1.1%
Finance & Insurance	168,412	4.7%	889	2.2%
Real Estate, Rental & Leasing	106,215	3.0%	420	1.0%
Professional, Science & Tech Services	166,353	4.7%	689	1.7%
Management	43,009	1.2%	104	0.3%
Administrative and Support Services	166,405	4.7%	451	1.1%
Private Education	57,373	1.6%	479	1.2%
Health Care & Social Services	379,538	10.7%	3,948	9.6%
Other Services	187,939	5.3%	2,450	5.9%
Government	430,767	12.1%	6,782	16.5%
Totals	**3,555,161**		**41,185**	**1.2%**

Source: IMPLAN, © MIG, Inc. 2009 (MIG 2009).

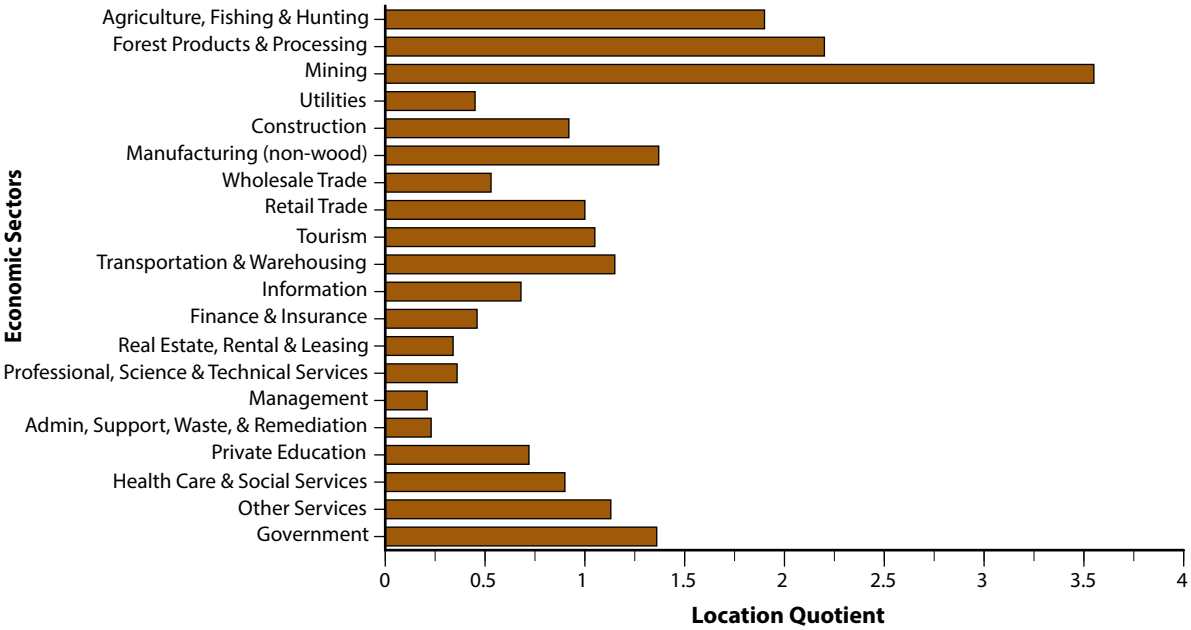


Figure 13.19. *Importance of economic sectors within the Northeast Sands counties when compared to the rest of the state. If the location quotient is greater than 1.0, the Northeast Sands counties are contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the Northeast Sands counties are contributing fewer jobs to that economic sector than the state average.*

landscape county approximations but still only represents an estimated 156 jobs in the Northeast Sands counties.

Other sectors providing a percentage of jobs in the Northeast Sands counties higher than the state average, listed in order of their relative employment contribution, are Manufacturing (non-wood), Government, Transportation and Warehousing, Other Services, and Tourism-related. These sectors of secondary relative importance can all be tied to the prominence of seasonal housing and recreation-based local economies in the Northeast Sands counties. Higher paying management, finance, and high-tech jobs are underrepresented in the Northeast Sands counties.

The Other Services sector consists primarily of equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, and providing services such as dry-cleaning and laundry, personal care, death care, pet care, photo finishing, and temporary parking. The Tourism-related sector includes relevant subsectors within Retail Trade, Passenger Transportation, and Arts, Entertainment, and Recreation. The Tourism-related sector also includes Accommodation and Food Services (Marcouiller and Xia 2008). The Forest Products and Processing sector includes sectors in logging, pulp and paper manufacturing, primary wood manufacturing (e.g., sawmills), and secondary wood manufacturing (e.g., furniture manufacturing).

Urban Influence

The U.S. Department of Agriculture Economic Research Service (USDA ERS) divides counties into 12 groups on a continuum of urban influence, with 1 representing large metropolitan areas, 2 representing smaller metro areas, and the remaining classes from 3 to 12 representing nonmetropolitan counties increasingly less populated and isolated from urban influence (USDA ERS 2012b). The concept of urban influence assumes population size, urbanization and access to larger adjacent economies are crucial elements in evaluating potential of local economies. Oconto County, in close proximity to the city of Green Bay in Brown County, is classified as a smaller metro area (class 2). The remaining Northeast Sands counties are composed of nonmetropolitan (rural) counties with moderate to slight degrees of "influence" from adjacent urban areas. Marinette County is a class 5 county, while Menominee and Florence counties are more remote as class 7 and 8 counties, respectively.

Economic Types

Based on the assumption that knowledge and understanding of different types of rural economies and their distinctive economic and sociodemographic profiles can aid rural policymaking, the USDA Economic Research Service classifies counties in one of six mutually exclusive categories: farming-dependent counties, mining-dependent counties, manufacturing-dependent counties, government-dependent counties, service-dependent counties, and nonspecialized counties (USDA ERS 2012a). Marinette County and Oconto County were classified as manufacturing-dependent in 2004 according to the USDA ERS's economic specialization definitions. Florence and Menominee counties, highly dependent on government services-oriented economies, were classified as nonspecialized counties.

Policy Types

The USDA ERS also classifies counties according to "policy types" deemed especially relevant to rural development policy (USDA ERS 2012a). Of particular interest in the Northeast Sands counties are the categories of "nonmetro recreation" and "retirement destination," which represent economic opportunity for such counties. In 2004 all four Northeast Sands counties were classified as nonmetro recreation counties (rural counties classified using a combination of factors, including share of employment or share of earnings in recreation-related industries in 1999, share of seasonal or occasional use housing units in 2000, and per capita receipts from motels and hotels in 1997), indicating economic dependence especially upon an influx of tourism and recreational dollars. Florence and Marinette counties were classified as both nonmetro recreation counties and retirement destination counties. Retirement destination counties (those in which the number of residents 60 and older grew by 15% or more between 1990 and 2000 due to in-migration) are shaped by an influx of an aging population and have particular needs for health care and services specific to that population.

Menominee County carries two other classifications that indicate it is a locality with extraordinary economic stress. As a "housing stress" county, Menominee County is designated as one of 302 rural U.S. counties in which 30% or more of households had one or more of these housing conditions in 2000: lacked complete plumbing, lacked complete kitchen, paid 30% or more of income for owner costs or rent, or had more than one person per room (USDA ERS 2012a). Menominee County was also categorized as one of 396 rural U.S. counties (and the only Wisconsin county) in which less than 65% of residents 21–64 years old were employed in 2000.

Integrated Opportunities for Management

Use of natural resources for human needs within the constraints of sustainable ecosystems is an integral part of ecosystem management. Integrating ecological management with socioeconomic programs or activities can result in efficiencies in land use, tax revenues, and private capital. This type of integration can also help generate broader and deeper support for sustainable ecosystem management. However, any human modification or use of natural communities has trade-offs that benefit some species and harm others. Even relatively benign activities such as ecotourism will have impacts on the ecology of an area. Trade-offs caused by management actions need to be carefully weighed when planning management to

ensure that some species are not being irreparably harmed. Maintaining healthy, sustainable ecosystems provides many benefits to people and our economy. The development of ecologically sound management plans should save money and sustain natural resources in the long run.

The principles of integrating natural resources and socioeconomic activities are similar across Wisconsin. See the "Integrated Ecological and Socioeconomic Opportunities" section in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management"; that section offers suggestions on how and when ecological and socioeconomic needs might be integrated and gives examples of the types of activities that might work together when planning the management of natural resources for a given area.

Appendices

Appendix 13.A. *Watershed water quality summary for the the Northeast Sands Ecological Landscape.*

Watershed number	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
GB03	Lower Oconto River	125,748	Good; three dams on river; some agriculture
GB04	Little River	134,617	Fair to Good; NPS agr sediment & nutrients persist
GB05	Lower North Branch Oconto River	249,138	Very Good; many wetlands & lakes; little agriculture
GB06	South Branch Oconto River	140,332	Very good; wetlands, trout waters, & lakes
GB07	Lower Peshtigo River	124,788	Good in the upper reach in this ecological landscape
GB08	Little Peshtigo River	101,397	Fair to Good; Bass Lake treated for excess nutrients
GB09	Middle Inlet & Lake Noquebay	99,570	Good; Lake Noquebay treated for NPS agr impacts
GB10	Middle Peshtigo & Thunder rivers	123,867	Good; three flowages; groundwater vulnerable to NPS
GB11	Upper Peshtigo River	216,530	Headwaters Good to Excellent; wetland and forests abundant
GB13	Wausaukee & Lower Menominee rivers	119,710	Fair to Poor; industrial & agr pollutants; many dams; lower Menominee an Area of Concern due to arsenic discharges
GB14	Pike River	182,234	Excellent; ORW streams; abundant forest & wetlands
GB15	Pemebonwon & Mid Menominee rivers	186,110	Very Good to Fair; dams; paper mill, good forest cover
GB16	Pine River	219,247	Very Good to Excellent; forest cover abundant; wetlands
GB17	Popple River	148,000	Good to Excellent; forest buffers & wetlands
WR09	North Br. & Mainstem Embarrass River	200,074	Very Good to Fair; trout waters upper; animal waste & soil erosion with low D.O. & impaired fishery, lower
WR14	Middle Wolf River	85,618	Good; some NPS animal waste and cropland runoff
WR15	Shawano Lake	45,544	Fair to Good; NPS nutrients > excessive weed growth
WR16	Red River	132,556	Very Good; trout headwaters; NPS agr nutrients a threat
WR17	West Branch Wolf River	170,311	Very Good to Good; dairyland clearing upper; forest lower
WR18	Wolf River/Langlade & Evergreen River	115,035	Good/ORW; recreation use > some bank damage

Source: Wisconsin DNR Bureau of Watershed Management data.

[a]Based on Wisconsin DNR watershed water quality reports.

Abbreviations:
Agr = Agricultural.
D.O. = Dissolved oxygen.
ORW = Outstanding Resource Water (very good to excellent water quality, with no point source discharges).
NPS = Nonpoint source pollutants, such as farm field and parking lot runoff.
> = Yields, creates, or results in (the listed impacts).

Appendix 13.B. *Forest habitat types in the Northeast Sands Ecological Landscape.*

The forest habitat type classification system (FHTCS) is a site classification system based on the floristic composition of plant communities. The system depends on the identification of potential climax associations, repeatable patterns in the composition of the understory vegetation, and differential understory species. It groups land units with similar capacity to produce vegetation. The floristic composition of the plant community is used as an integrated indicator of those environmental factors that affect species reproduction, growth, competition, and community development. This classification system enables the recognition and classification of ecologically similar ecological landscape units (site types) and forest plant communities (vegetation associations).

A forest habitat type is an aggregation of sites (units of land) capable of producing similar late-successional (potential climax) forest plant communities. Each recognizable habitat type represents a relatively narrow segment of environmental variation that is characterized by a certain limited potential for vegetation development. Although at any given time, a habitat type can support a variety of disturbance-induced (seral) plant communities, the ultimate product of succession is presumed to be a similar climax community. Field identification of a habitat type provides a convenient label (habitat type name) for a given site, and places that site in the context of a larger group of sites that share similar ecological traits. Forest habitat type groups more broadly combine individual habitat types that have similar ecological potentials.

Individual forest cover types classify current overstory vegetation, but these associations usually encompass a wide range of environmental conditions. In contrast, individual habitat types group ecologically similar sites in terms of vegetation potentials. Management interpretations can be refined and made significantly more accurate by evaluating a stand in terms of the current cover type (current dominant vegetation) plus the habitat type (potential vegetation).

Habitat types	**Description of forest habitat types found in the Northeast Sands Ecological Landscape.**
AFVb	*Acer saccharum-Fagus grandifolia/Viburnum acerifolium* Sugar maple-American beech/Maple-leaved viburnum
ArAbVc	*Acer rubrum-Abies balsamea/Vaccinium angustifolium-Cornus canadensis* Red maple-Balsam fir/Blueberry-Bunchberry
ATFD	*Acer saccharum-Tsuga canadensis-Fagus grandifolia/Dryopteris spinulosa* Sugar maple-Eastern hemlock-American beech/Spinulose shield fern
ATM	*Acer saccharum-Tsuga canadensis/Maianthemum canadense* Sugar maple-Eastern hemlock/Wild lily-of-the-valley
AVb	*Acer saccharum/Viburnum acerifolium* Sugar maple/Maple-leaved viburnum
PArVAa-Vb	*Pinus strobus-Acer rubrum/Vaccinium angustifolium-Aralia nudicaulis*, *Viburnum acerifolium* variant White pine-Red maple/Blueberry-Wild sarsaparilla, Maple-leaved viburnum variant
PArVAo	*Pinus strobus-Acer rubrum/Vaccinium angustifolium-Apocynum androsaemifolium* White pine-Red maple/Blueberry-Spreading dogbane
PArVPo	*Pinus strobus-Acer rubrum/Vaccinium angustifolium-Polygonatum pubescens* White pine-Red maple/Blueberry-Hairy Solomon's seal
TMC	*Tsuga canadensis/Maianthemum canadense-Coptis groenlandica* Eastern hemlock/Wild lily-of-the-valley-Goldthread

Source: Kotar and Burger (2002).

Appendix 13.C. *The Natural Heritage Inventory (NHI) table of rare species and natural community occurrences (plus a few miscellaneous features tracked by the NHI program) for the Northeast Sands (NES) Ecological Landscape in November 2009. See the Wisconsin Natural Heritage Working List online for the current status (http://dnr.wi.gov, keyword "NHI").*

Scientific name (common name)	Lastobs Date	EOs[a] in NES	EOs in WI	Percent in NES	State rank	Global rank	State status	Federal status
MAMMALS								
Canis lupus (gray wolf)	2008	10	204	5%	S2	G4	SC/FL	LE
Napaeozapus insignis (woodland jumping mouse)	1970	1	15	7%	S2S3	G5	SC/N	
Sorex arcticus (arctic shrew)	1990	1	31	3%	S3S4	G5	SC/N	
BIRDS[b]								
Accipiter gentilis (Northern Goshawk)	2008	8	141	6%	S2B,S2N	G5	SC/M	
Bartramia longicauda (Upland Sandpiper)	2008	3	54	6%	S2B	G5	SC/M	
Buteo lineatus (Red-shouldered Hawk)	2007	33	301	11%	S3S4B,S1N	G5	THR	
Chlidonias niger (Black Tern)	1988	1	60	2%	S2B	G4	SC/M	
Dendroica tigrina (Cape May Warbler)[c]	2008	1	26	4%	S3B	G5	SC/M	
Haliaeetus leucocephalus (Bald Eagle)	2008	53	1286	4%	S4B,S2N	G5	SC/P	
Lanius ludovicianus (Loggerhead Shrike)	1973	1	31	3%	S1B	G4	END	
Pandion haliaetus (Osprey)	2008	31	733	4%	S4B	G5	SC/M	
Wilsonia canadensis (Canada Warbler)[c]	2008	1	20	5%	S3B	G5	SC/M	
HERPTILES								
Emydoidea blandingii (Blanding's turtle)	2008	12	316	4%	S3	G4	THR	
Glyptemys insculpta (wood turtle)	2008	24	262	9%	S2	G4	THR	
Hemidactylium scutatum (four-toed salamander)	2003	1	63	2%	S3	G5	SC/H	
Lithobates catesbeianus (American bullfrog)	2003	1	70	1%	S3	G5	SC/H	
FISHES								
Acipenser fulvescens (lake sturgeon)	1991	5	99	5%	S3	G3G4	SC/H	
Fundulus diaphanus (banded killifish)	1995	1	105	1%	S3	G5	SC/N	
Moxostoma carinatum (river redhorse)	1982	1	43	2%	S2	G4	THR	
Moxostoma valenciennesi (greater redhorse)	2003	1	56	2%	S3	G4	THR	
MUSSELS/CLAMS								
Alasmidonta marginata (elktoe)	1997	5	44	11%	S4	G4	SC/P	
Alasmidonta viridis (slippershell mussel)	1991	2	16	13%	S2	G4G5	THR	
Epioblasma triquetra (snuffbox)[d]	1995	1	5	20%	S1	G3	END	
Pleurobema sintoxia (round pigtoe)	1997	4	50	8%	S3	G4G5	SC/P	
Simpsonaias ambigua (salamander mussel)	1992	3	51	6%	S2S3	G3	THR	
Tritogonia verrucosa (buckhorn)	2005	1	12	8%	S2	G4G5	THR	
MISCELLANEOUS INVERTEBRATES								
Planogyra asteriscus (eastern flat-whorl)	1997	1	1	100%	S1	G4	SC/N	
Vertigo elatior (tapered vertigo)	1997	1	12	8%	S3	G5	SC/N	
Vertigo paradoxa (mystery vertigo)	1997	1	6	17%	S1	G4G5Q	SC/N	
Vertigo tridentata (honey vertigo)	1997	1	7	14%	S3	G5	SC/N	
BUTTERFLIES/MOTHS								
Callophrys henrici (Henry's elfin)	1993	1	19	5%	S1S2	G5	SC/N	
Erynnis persius (Persius dusky wing)	1990	1	26	4%	S2	G5	SC/N	
Hesperia leonardus (Leonard's skipper)	2000	5	29	17%	S3	G4	SC/N	
Hesperia metea (cobweb skipper)	1994	1	12	8%	S2	G4G5	SC/N	

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Appendix 13.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in NES	EOs in WI	Percent in NES	State rank	Global rank	State status	Federal status
Lycaeides idas (northern blue)	1990	2	9	22%	S1	G5	END	
Lycaeides melissa samuelis (Karner blue)	2001	2	316	1%	S3	G5T2	SC/FL	LE
Lycaena dorcas (dorcas copper)	1988	1	23	4%	S1S2	G5	SC/N	
Oeneis chryxus (chryxus arctic)	1994	1	9	11%	S2?	G5	SC/N	
Phyciodes batesii lakota (Lakota crescent)	2002	5	24	21%	S3	G4T4	SC/N	
Pieris virginiensis (West Virginia white)	2002	2	25	8%	S3	G3G4	SC/N	
Psectraglaea carnosa (pink sallow)	1995	1	2	50%	S2	G3	SC/N	
Schinia indiana (phlox moth)	1992	2	31	6%	S2S3	G2G4	END	
DRAGONFLIES/DAMSELFLIES								
Aeshna eremita (lake darner)	1978	1	15	7%	S3	G5	SC/N	
Cordulegaster diastatops (delta-spotted spiketail)	1991	1	1	100%	S1	G5	SC/N	
Gomphus graslinellus (pronghorned clubtail)	1979	2	5	40%	S2	G5	SC/N	
Hetaerina titia (dark rubyspot)	1999	1	4	25%	S1S2	G5	SC/N	
Libellula incesta (slaty skimmer)	2002	1	4	25%	S1	G5	SC/N	
Nannothemis bella (elfin skimmer)	1991	2	12	17%	S2S3	G4	SC/N	
Nasiaeschna pentacantha (cyrano darner)	1988	1	14	7%	S3	G5	SC/N	
Ophiogomphus anomalus (extra-striped snaketail)	2002	1	14	7%	S3	G4	END	
Ophiogomphus howei (pygmy snaketail)	1999	6	33	18%	S4	G3	THR	
Somatochlora ensigera (lemon-faced emerald)	1988	1	2	50%	S1	G4	SC/N	
Somatochlora forcipata (forcipate emerald)	1991	4	10	40%	S2	G5	SC/N	
BEETLES								
Cicindela longilabris (a tiger beetle)	2002	1	6	17%	S2S3	G5	SC/N	
Cicindela patruela huberi (a tiger beetle)	1999	1	84	1%	S3	G3T3	SC/N	
Cicindela patruela patruela (a tiger beetle)	2002	12	26	46%	S2	G3T3	SC/N	
Haliplus pantherinus (a crawling water beetle)	2000	1	13	8%	S2S3	GNR	SC/N	
MISCELLANEOUS INSECTS/SPIDERS								
Hebrus burmeisteri (a velvet water bug)	1999	1	2	50%	S2S3	GNR	SC/N	
Isoperla bilineata (a perlodid stonefly)	1999	1	8	13%	S2S3	G5	SC/N	
Isoperla marlynia (a perlodid stonefly)	1979	1	5	20%	S3	G5	SC/N	
PLANTS								
Amerorchis rotundifolia (round-leaved orchis)	1998	1	9	11%	S2	G5	THR	
Arabis missouriensis var. *deamii* (Deam's rockcress)	2007	17	22	77%	S2	G5?QT3?Q	SC	
Arethusa bulbosa (swamp-pink)	2007	6	96	6%	S3	G4	SC	
Asclepias ovalifolia (dwarf milkweed)	2009	9	60	15%	S3	G5?	THR	
Asplenium trichomanes (maidenhair spleenwort)	2001	5	27	19%	S3	G5	SC	
Botrychium mormo (little goblin moonwort)	1997	3	82	4%	S3	G3	END	
Botrychium oneidense (blunt-lobe grape-fern)	2006	3	35	9%	S2	G4Q	SC	
Botrychium rugulosum (rugulose grape-fern)	1980	1	7	14%	S2	G3	SC	
Calamagrostis stricta (slim-stem small-reedgrass)	2001	1	34	3%	S3	G5	SC	
Calypso bulbosa (fairy slipper)	1982	1	34	3%	S3	G5	THR	
Cardamine pratensis (cuckooflower)	2004	6	42	14%	S3	G5	SC	
Carex backii (Rocky Mountain sedge)	1982	1	4	25%	S1	G4	SC	
Carex gynocrates (northern bog sedge)	2005	4	31	13%	S3	G5	SC	
Carex livida var. *radicaulis* (livid sedge)	2001	1	21	5%	S2	G5T5	SC	
Carex sychnocephala (many-headed sedge)	1982	1	15	7%	S2	G4	SC	
Carex tenuiflora (sparse-flowered sedge)	2007	5	84	6%	S3	G5	SC	

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Appendix 13.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in NES	EOs in WI	Percent in NES	State rank	Global rank	State status	Federal status
Carex vaginata (sheathed sedge)	2007	8	35	23%	S3	G5	SC	
Ceratophyllum echinatum (prickly hornwort)	1982	1	61	2%	S2	G4?	SC	
Clematis occidentalis (purple clematis)	2000	3	32	9%	S3	G5	SC	
Cypripedium arietinum (ram's-head lady's-slipper)	1988	1	21	5%	S2	G3	THR	
Cypripedium reginae (showy lady's-slipper)	2007	14	99	14%	S3	G4	SC	
Deschampsia cespitosa (tufted hairgrass)	2001	1	17	6%	S2	G5	SC	
Deschampsia flexuosa (crinkled hairgrass)	2001	1	44	2%	S3	G5	SC	
Dryopteris fragrans var. *remotiuscula* (fragrant fern)	2001	2	27	7%	S3	G5T3T5	SC	
Eleocharis olivacea (capitate spikerush)	2000	2	12	17%	S2	G5	SC	
Eleocharis quadrangulata (squarestem spikerush)	2003	1	1	100%	S1	G4	END	
Eleocharis quinqueflora (few-flower spikerush)	2001	2	18	11%	S2	G5	SC	
Eleocharis robbinsii (Robbins' spikerush)	1982	3	28	11%	S3	G4G5	SC	
Eleocharis rostellata (beaked spikerush)	2001	1	14	7%	S2	G5	THR	
Epilobium palustre (marsh willow-herb)	2007	4	37	11%	S3	G5	SC	
Epilobium strictum (downy willow-herb)	2000	2	22	9%	S2S3	G5?	SC	
Equisetum variegatum (variegated horsetail)	2000	4	47	9%	S3	G5	SC	
Eriophorum alpinum (alpine cotton-grass)	2008	4	25	16%	S2	G5	SC	
Gymnocarpium robertianum (limestone oak fern)	2007	1	8	13%	S2	G5	SC	
Malaxis monophyllos var. *brachypoda* (white adder's-mouth)	2005	18	48	38%	S3	G4Q	SC	
Medeola virginiana (Indian cucumber-root)	2007	19	42	45%	S3	G5	SC	
Ophioglossum pusillum (adder's-tongue)	1980	2	12	17%	S2	G5	SC	
Parnassia palustris (marsh grass-of-parnassus)	2001	3	7	43%	S2	G5	THR	
Platanthera dilatata (leafy white orchis)	1999	3	31	10%	S3	G5	SC	
Platanthera hookeri (Hooker's orchid)	1998	4	20	20%	S2S3	G4	SC	
Platanthera orbiculata (large roundleaf orchid)	2007	5	78	6%	S3	G5	SC	
Primula mistassinica (bird's-eye primrose)	1973	1	42	2%	S3	G5	SC	
Ribes hudsonianum (northern black currant)	2007	10	76	13%	S3	G5	SC	
Triglochin maritima (common bog arrow-grass)	2007	4	59	7%	S3	G5	SC	
Triglochin palustris (slender bog arrow-grass)	2001	1	36	3%	S3	G5	SC	
Utricularia purpurea (purple bladderwort)	1982	2	55	4%	S3	G5	SC	
Utricularia resupinata (northeastern bladderwort)	1995	4	29	14%	S3	G4	SC	
Vaccinium cespitosum (dwarf huckleberry)	2003	1	6	17%	S2	G5	END	
Vaccinium pallidum (blue ridge blueberry)	2003	3	3	100%	S1	G5	SC	
Valeriana sitchensis ssp. *uliginosa* (marsh valerian)	2007	4	16	25%	S2	G4Q	THR	
Verbena simplex (narrow-leaved vervain)	2000	1	3	33%	S1	G5	SC	
COMMUNITIES								
Alder Thicket	2006	6	106	6%	S4	G4	NA	
Bedrock Glade	2007	9	20	45%	S3	G2	NA	
Black Spruce Swamp	2007	4	41	10%	S3?	G5	NA	
Boreal Forest	1981	1	36	3%	S2	G3?	NA	
Boreal Rich Fen	2001	3	18	17%	S2	G4G5	NA	
Bracken Grassland	1986	4	6	67%	S2	G3	NA	
Dry Cliff	1982	1	88	1%	S4	G4G5	NA	
Emergent Marsh	1982	7	272	3%	S4	G4	NA	
Floodplain Forest	2007	3	182	2%	S3	G3?	NA	
Forested Seep	2005	1	15	7%	S2	GNR	NA	
Glaciere Talus	1998	1	6	17%	S2	G2G3	NA	
Hardwood Swamp	2007	3	53	6%	S3	G4	NA	

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Appendix 13.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in NES	EOs in WI	Percent in NES	State rank	Global rank	State status	Federal status
Inland Beach	2000	1	17	6%	S3	G4G5	NA	
Lake--Deep, Hard, Drainage	1982	5	30	17%	S3	GNR	NA	
Lake--Deep, Hard, Seepage	1982	7	22	32%	S2	GNR	NA	
Lake--Deep, Soft, Seepage	1981	5	49	10%	S3	GNR	NA	
Lake--Deep, Very Soft, Seepage	1999	2	29	7%	S3	GNR	NA	
Lake--Hard Bog	1981	2	18	11%	S2	GNR	NA	
Lake--Shallow, Hard, Drainage	1999	3	35	9%	SU	GNR	NA	
Lake--Shallow, Hard, Seepage	1999	6	52	12%	SU	GNR	NA	
Lake--Shallow, Soft, Drainage	1981	1	36	3%	S3	GNR	NA	
Lake--Shallow, Soft, Seepage	1987	8	87	9%	S4	GNR	NA	
Lake--Soft Bog	1981	1	52	2%	S4	GNR	NA	
Lake--Spring	1981	3	13	23%	S3	GNR	NA	
Lake--Unique	1982	5	7	71%	SU	GNR	NA	
Moist Cliff	1981	1	176	1%	S4	GNR	NA	
Muskeg	2001	1	45	2%	S4	G4G5	NA	
Northern Dry Forest	1987	3	63	5%	S3	G3?	NA	
Northern Dry-mesic Forest	2003	28	284	10%	S3	G4	NA	
Northern Mesic Forest	2006	18	383	5%	S4	G4	NA	
Northern Sedge Meadow	2007	17	231	7%	S3	G4	NA	
Northern Wet Forest	2003	29	322	9%	S4	G4	NA	
Northern Wet-mesic Forest	2007	30	243	12%	S3S4	G3?	NA	
Open Bog	1987	9	173	5%	S4	G5	NA	
Pine Barrens	2007	10	56	18%	S2	G2	NA	
Poor Fen	2007	2	46	4%	S3	G3G4	NA	
Shrub-carr	2007	4	143	3%	S4	G5	NA	
Southern Sedge Meadow	2003	1	182	1%	S3	G4?	NA	
Spring Pond	1982	9	69	13%	S3	GNR	NA	
Springs and Spring Runs, Hard	1991	2	71	3%	S4	GNR	NA	
Stream--Fast, Hard, Cold	1982	12	98	12%	S4	GNR	NA	
Stream--Fast, Hard, Warm	1982	3	10	30%	SU	GNR	NA	
Stream--Fast, Soft, Cold	1977	1	15	7%	SU	GNR	NA	
Stream--Slow, Hard, Cold	1982	1	22	5%	SU	GNR	NA	
Stream--Slow, Hard, Warm	1982	2	20	10%	SU	GNR	NA	
Submergent Marsh	2000	1	6	17%	S4	G5	NA	
Talus Forest	2007	4	6	67%	S1	G4G5	NA	
Tamarack (Poor) Swamp	2007	3	33	9%	S3	G4	NA	
OTHER ELEMENTS								
Bird rookery	1998	1	54	2%	SU	G5	SC	

[a]An element occurrence is an area of land and/or water in which a rare species or natural community is, or was, present. Element occurrences must meet strict criteria that is used by an international network of Heritage programs and coordinated by NatureServe.
[b]The common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.
[c]The American Ornithologist's Union lists these warblers as Cape May Warbler (*Setophaga tigrina*) and Canada Warbler (*Cardellina canadensis*).
[d]The snuffbox mussel (*Epioblasma triquetra*) was listed as U.S. Endangered in 2012.

STATUS AND RANKING DEFINITIONS

U.S. Status—Current federal protection status designated by the Office of Endangered Species, U.S. Fish and Wildlife Service, indicating the biological status of a species in Wisconsin:

LE = listed endangered.
LT = listed threatened.
PE = proposed as endangered.
NEP = nonessential experimental population.
C = candidate for future listing.
CH = critical habitat.

Appendix 13.C, *continued.*

State Status—Protection category designated by the Wisconsin DNR:

END = Endangered. Endangered species means any species whose continued existence as a viable component of this state's wild animals or wild plants is determined by the Wisconsin DNR to be in jeopardy on the basis of scientific evidence.

THR = Threatened species means any species of wild animals or wild plants that appears likely, within the foreseeable future, on the basis of scientific evidence to become endangered.

SC = Special Concern. Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proven. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Wisconsin DNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are as follows:

SC/P = fully protected;

SC/N = no laws regulating use, possession, or harvesting;

SC/H = take regulated by establishment of open closed seasons;

SC/FL = federally protected as endangered or threatened but not so designated by Wisconsin DNR;

SC/M = fully protected by federal and state laws under the Migratory Bird Act.

Global Element Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factor(s) making it vulnerable to extinction throughout its range; typically 21-100 occurrences.

G4 = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery) and usually widespread. Typically > 100 occurrences.

G5 = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery). Not vulnerable in most of its range.

GH = Known only from historical occurrence throughout its range, with the expectation that it may be rediscovered.

GNR = Not ranked. Replaced G? rank and some GU ranks.

GU = Currently unrankable due to lack of data or substantially conflicting data on status or trends. Possibly in peril range-wide, but status is uncertain.

GX = Presumed to be extinct throughout its range (e.g., Passenger pigeon) with virtually no likelihood that it will be rediscovered.

Species with a questionable taxonomic assignment are given a "Q" after the global rank. Subspecies and varieties are given subranks composed of the letter "T" plus a number or letter. The definition of the second character of the subrank parallels that of the full global rank. (Examples: a rare subspecies of a rare species is ranked G1T1; a rare subspecies of a common species is ranked G5T1.)

State Element Ranks:

S1 = Critically imperiled in Wisconsin because of extreme rarity, typically 5 or fewer occurrences and/or very few (<1,000) remaining individuals or acres, or due to some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in Wisconsin because of rarity, typically 6–20 occurrences and/or few (1,000– 3,000) remaining individuals or acres, or due to some factor(s) making it very vulnerable to extirpation from the state.

S3 = Rare or uncommon in Wisconsin, typically 21–100 occurrences and/or 3,000–10,000 individuals.

S4 = Apparently secure in Wisconsin, usually with > 100 occurrences and > 10,000 individuals.

S5 = Demonstrably secure in Wisconsin and essentially ineradicable under present conditions.

SNA = Accidental, nonnative, reported but unconfirmed, or falsely reported.

SH = Of historical occurrence in Wisconsin, perhaps having not been verified in the past 20 years and suspected to be still extant. Naturally, an element would become SH without such a 20-year delay if the only known occurrence were destroyed or if it had been extensively and unsuccessfully looked for.

SNR = Not Ranked; a state rank has not yet been assessed.

SU = Currently unrankable. Possibly in peril in the state, but status is uncertain due to lack of information or substantially conflicting data on status or trends.

SX = Apparently extirpated from the state.

State ranking of long-distance migrant animals:

Ranking long distance aerial migrant animals presents special problems relating to the fact that their nonbreeding status (rank) may be quite different from their breeding status, if any, in Wisconsin. In other words, the conservation needs of these taxa may vary between seasons. In order to present a less ambiguous picture of a migrant's status, it is necessary to specify whether the rank refers to the breeding (B) or nonbreeding (N) status of the taxon in question. (e.g., S2B, S5N).

Appendix 13.D. *Number of species with special designations documented within the Northeast Sands Ecological Landscape, 2009.*

Listing status[a]	Taxa					Total fauna	Total flora	Total listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
U.S. Endangered	1	0	0	0	1	2	0	2
U.S. Threatened	0	0	0	0	0	0	0	0
U.S. Candidate	0	0	0	0	0	0	0	0
Wisconsin Endangered	0	1	0	0	4	5	3	8
Wisconsin Threatened	0	1	2	2	4	9	7	16
Wisconsin Special Concern	3	7	2	2	32	46	41	87
Natural Heritage Inventory total	**3**	**9**	**4**	**4**	**40**	**60**	**51**	**111**

Note: State-listed species always include federally listed species (although they may not have the same designation); therefore, federally listed species are not included in the total.

[a]The snuffbox mussel (*Epioblasma triquetra*) was listed as U.S. Endangered in 2012 and is not included in the numbers above.

Appendix 13.E. *Species of Greatest Conservation Need (SGCN) found in the Northeast Sands Ecological Landscape.*

These SGCN have a high or moderate probability of being found in this ecological landscape and use habitats that have the best chance for management here. Data are from the Wisconsin Wildlife Action Plan (WDNR 2005b) and Appendix E, "Opportunities for Sustaining Natural Communities in Each Ecological Landscape," in Part 3, "Supporting Materials." For more complete and/or detailed information, please see the Wisconsin Wildlife Action Plan. The Wildlife Action Plan is meant to be dynamic and will be periodically updated to reflect new information; the next update is planned for 2015.

Only SGCN highly or moderately (H = high association, M = moderate association) associated with specific community types or other habitat types and that have a high or moderate probability of occurring in the ecological landscape are included here (SGCN with a low affinity with a community type or other habitat type and with low probability of being associated with this ecological landscape were excluded). Only community types designated as "Major" or "Important" management opportunities for the ecological landscape are shown.

Bald Eagle.
Photo by Herbert Lange.

	MAJOR								IMPORTANT										
	Bracken Grassland	Coldwater Streams	Coolwater Streams	Northern Dry Forest	Northern Dry-mesic Forest	Northern Wet-mesic Forest	Pine Barrens	Warmwater Rivers	Alder Thicket	Boreal Rich Fen	Emergent Marsh	Impoundments/Reservoirs	Inland Lakes	Moist Cliff	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Open Bog	Submergent Marsh
Species that are significantly associated with the Northeast Sands Ecological Landscape																				
MAMMALS																				
Northern flying squirrel				M	H	H									M	H		H		
Water shrew		H	H			H			M				M		H	M		H		
BIRDS[a]																				
American Woodcock									H						M	M				
Bald Eagle								H				H	H							M
Black-billed Cuckoo							M		H							M				
Bobolink																	H		M	
Brown Thrasher	H						H													
Field Sparrow	M						M													
Golden-winged Warbler				M	M				H						M	M		M	M	
Grasshopper Sparrow	M																			
Least Flycatcher				M	M										M	H				
Osprey								H				H	H							
Red Crossbill				H	H		M													
Veery					M				H						H	M		M		
Vesper Sparrow	H						H													
Whip-poor-will				M	M		M													
Wood Thrush																M				
HERPTILES																				
Mink frog		M	H					H	M	M	H	H	H				H		H	H
Mudpuppy		M						H				H	H							
Wood turtle	H	H	H			M	H	H	H						M	H	M	M		H
FISH																				
Lake sturgeon								H				H	H							

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Appendix 13.E, *continued.*

Gray wolf.
Photo by John and Karen Hollingsworth, courtesy of USFWS.

	MAJOR								IMPORTANT										
	Bracken Grassland	Coldwater Streams	Coolwater Streams	Northern Dry Forest	Northern Dry-mesic Forest	Northern Wet-mesic Forest	Pine Barrens	Warmwater Rivers	Alder Thicket	Boreal Rich Fen	Emergent Marsh	Impoundments/Reservoirs	Inland Lakes	Moist Cliff	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Open Bog	Submergent Marsh
Species that are moderately associated with the Northeast Sands Ecological Landscape																				
MAMMALS																				
Gray wolf	H			M	H	H	M		H						M	H		H	M	
Woodland jumping mouse						M									M	H		M		
BIRDS																				
American Bittern											H						H		H	
Canada Warbler					M	H			M	M					H	M		M		
Lark Sparrow							M													
Northern Goshawk					M											H				
Northern Harrier	M						M										H		M	
Red-shouldered Hawk					M											M				
Rusty Blackbird									M		M								M	
Sharp-tailed Grouse	M						H										M			
Solitary Sandpiper		M	M								H								M	
Upland Sandpiper	H						M													
HERPTILES																				
Blanding's turtle	H	M	M				H	M	M		H	H	H				M			H
Four-toed salamander		M	M			H			H		H				M	H	M	M	H	
Pickerel frog		H	H			M		H	M		H	H	M			M	H	M	M	H

[a]The common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

Appendix 13.F. *Natural communities[a] for which there are management opportunities in the Northeast Sands Ecological Landscape.*

Major opportunity[b]	Important opportunity[c]	Present[d]
Northern Dry Forest	Northern Mesic Forest	Boreal Forest
Northern Dry-mesic Forest	Northern Wet Forest	
Northern Wet-mesic Forest	Northern Hardwood Swamp	Floodplain Forest
Pine Barrens	Alder Thicket	Shrub-carr
Bracken Grassland	Northern Sedge Meadow	Surrogate Grasslands
Coolwater Stream	Open Bog/Muskeg/Poor Fen	Wild Rice Marsh
Coldwater Stream	Emergent Marsh	Ephemeral Pond
Warmwater River	Submergent Marsh	
		Inland Beach
	Dry Cliff (Curtis' Exposed Cliff)	
	Moist Cliff (Curtis' Shaded Cliff)	Warmwater Stream
	Impoundment/Reservoir	
	Inland Lake	

[a]See Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," for definitions of natural community types. Also see Appendix E, "Opportunities for Sustaining Natural Communities in Each Ecological Landscape," in Part 3 ("Supporting Materials") for an explanation on how the information in this table can be used.

[b]Major opportunity – Relatively abundant, represented by multiple significant occurrences, or ecological landscape is appropriate for major restoration activities.

[c]Important opportunity – Less abundant but represented by one to several significant occurrences or type is restricted to one or a few ecological landscapes.

[d]Present – Uncommon or rare, with no good occurrences documented. Better opportunities are known to exist in other ecological landscapes, or opportunities have not been adequately evaluated.

Appendix 13.G. *Public conservation lands in the Northeast Sands Ecological Landscape, 2005.*

Property name	Size (acres)[a]
STATE	
Amberg State Wildlife Area	1,170
Board of Commissioners of Public Land	3,000
Dunbar Barrens State Natural Area	1,320
Miscauno State Wildlife Area	620
North Branch Beaver Creek State Fishery Area[b]	450
Peshtigo Brook State Wildlife Area	2,200
Peshtigo River State Forest	9,200
Pike Wild River	4,410
Pine-Popple Wild Rivers	21,270
South Branch Oconto River State Fishery Area	640
Spread Eagle Barrens State Natural Area	26,010
Governor Thompson Centennial State Park	2,500
Town Corner State Wildlife Area	900
Miscellaneous Lands[c]	2,570
FEDERAL	
Chequamegon-Nicolet National Forest[b]	71,950
COUNTY FOREST[d]	
Florence County Forest[b]	20,250
Marinette County Forest[b]	183,490
Oconto County Forest[b]	27,500
TOTAL	**339,450**

Source: *Wisconsin Land Legacy Report* (WDNR 2006b).

[a]Actual acres owned in this ecological landscape.

[b]This property also falls within adjacent ecological landscape(s).

[c]Includes public access sites, fish hatcheries, fire towers, streambank and nonpoint easements, lands acquired under statewide wildlife, fishery, forestry, and natural area programs, Board of Commissioners of Public Lands holdings, small properties under 100 acres, and properties with fewer than 100 acres within this ecological landscape.

[d]Locations and sizes of county-owned parcels enrolled in the Forest Crop Law are presented here. Information on locations and sizes of other county and local parks in this ecological landscape is not readily available and is not included here, except for some very large properties.

Appendix 13.H. *Land Legacy places in the Northeast Sands Ecological Landscape and their ecological and recreational significance.*

The *Wisconsin Land Legacy Report* (WDNR 2006b) identified 12 places in the Northeast Sands Ecological Landscape that merit conservation action based upon a combination of ecological significance and recreational potential.

Map Code	Place name	Size	Protection initiated	Protection remaining	Conservation significance[a]	Recreation potential[b]
AB	Athelstane Barrens	Medium	Limited	Substantial	xxxxx	xxx
BZ	Brazeau Swamp	Medium	Substantial	Limited	xxx	x
CN	Chequamegon-Nicolet National Forest	Large	Substantial	Limited	xxxxx	xxxxx
MC	Menominee County Forest	Large	Substantial	Limited	xxxxx	x
MR	Menominee River	Large	Substantial	Moderate	xxxx	xxx
OR	Oconto River	Large	Moderate	Moderate	xxxx	xxx
PW	Pemebonwon River	Medium	Moderate	Moderate	xxx	xx
PE	Peshtigo River	Large	Substantial	Moderate	xxx	xxxxx
PM	Pike (Marinette) River	Large	Substantial	Limited	xxxx	xxx
PP	Pine-Popple River	Large	Substantial	Moderate	xxxx	xxx
RD	Red River	Medium	Limited	Substantial	xxx	xxx
SE	Spread Eagle Barrens	Medium	Substantial	Limited	xxxx	xx

[a]**Conservation significance.** See the *Wisconsin Land Legacy Report* (WDNR 2006b), p. 43, for detailed discussion.

- xxxxx Possesses outstanding ecological qualities, is large enough to meet the needs of critical components, and/or harbors globally or continentally significant resources. Restoration, if needed, has a high likelihood of success.
- xxxx Possesses excellent ecological qualities, is large enough to meet the needs of most critical components, and/or harbors continentally or Great Lakes regionally significant resources. Restoration has a high likelihood of success.
- xxx Possesses very good ecological qualities, is large enough to meet the needs of some critical components, and/or harbors statewide significant resources. Restoration will typically be important and has a good likelihood of success.
- xx Possesses good ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors statewide or ecological landscape significant resources. Restoration is likely needed and has a good chance of success.
- x Possesses good to average ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors ecological landscape significant resources. Restoration is needed and has a reasonable chance of success.

[b]**Recreation potential.** See the *Wisconsin Land Legacy Report*, p. 43, for detailed discussion.

- xxxxx Outstanding recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet many current and future recreation needs, is large enough to accommodate incompatible activities, could link important recreation areas, and/or is close to state's largest population centers.
- xxxx Excellent recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet several current and future recreation needs, is large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to large population centers.
- xxx Very good recreation potential, could offer a variety of land and/or water-based recreation opportunities, could meet some current and future recreation needs, may be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized to large population centers.
- xx Good to moderate recreation potential, could offer some land and/or water-based recreation opportunities, might meet some current and future recreation needs, may not be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized population centers.
- x Limited recreation potential, could offer a few land and/or water-based recreation opportunities, might meet some current and future recreation needs, is not likely large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to small population centers.

Appendix 13.I. *Importance of economic sectors (based on the number of jobs) within the Northeast Sands counties compared to the rest of the state.*

Industry	CLMC	CSH	CSP	FT	NCF	NES	NH	NLMC	NWL	NWS	SEGP	SLMC	SWS	SCP	WCR	WP
Agriculture, Fishing & Hunting	0.87	2.14	2.41	2.15	2.15	1.90	0.50	2.71	0.43	1.29	0.76	0.10	4.46	0.87	2.36	2.30
Forest Products & Processing	1.64	0.98	1.83	2.40	3.43	2.20	1.33	1.74	0.41	1.07	0.65	0.32	0.45	1.44	0.96	0.69
Mining	1.08	1.64	0.79	0.79	2.69	3.55	0.91	2.16	0.16	0.34	1.47	0.19	0.62	0.08	0.77	1.21
Utilities	2.44	1.08	0.81	0.39	0.61	0.45	0.58	0.41	1.96	1.76	0.67	0.65	0.81	1.83	1.19	0.51
Construction	1.12	1.02	0.89	0.96	1.14	0.92	2.38	1.08	1.07	1.14	1.08	0.67	0.98	1.13	1.03	1.11
Manufacturing (non-wood)	1.23	1.02	0.74	0.98	0.90	1.37	0.21	1.15	0.49	0.59	1.19	0.87	0.78	0.46	0.77	0.99
Wholesale Trade	0.99	0.63	0.61	0.95	0.62	0.53	0.47	0.60	1.15	0.72	1.16	0.98	0.89	0.76	0.83	0.53
Retail Trade	1.01	1.00	0.99	1.11	1.11	1.00	1.66	1.03	1.30	1.19	1.02	0.80	1.69	1.11	1.11	1.13
Tourism-related	0.99	1.12	0.97	0.86	0.99	1.05	1.51	1.28	1.34	1.41	0.94	1.02	0.78	1.33	1.08	1.12
Transportation & Warehousing	0.95	1.32	2.13	1.40	1.19	1.15	0.80	0.89	3.25	2.15	0.82	0.83	0.74	2.12	1.39	0.99
Information	0.76	0.49	0.69	0.74	0.58	0.68	0.80	0.70	0.38	0.49	1.22	1.11	1.09	0.64	0.62	0.57
Finance & Insurance	1.22	1.31	0.89	0.96	0.56	0.46	0.43	0.48	0.47	0.46	1.04	1.18	0.65	0.45	0.70	0.55
Real Estate, Rental & Leasing	0.84	0.73	0.59	0.60	0.52	0.34	1.37	0.95	0.42	0.50	1.17	1.14	0.47	0.46	0.87	0.66
Pro, Science & Tech Services	0.85	0.53	0.46	0.55	0.41	0.36	0.43	0.45	0.51	0.47	1.04	1.51	0.49	0.47	0.63	0.81
Management	0.80	0.26	0.63	0.54	0.37	0.21	0.17	0.24	0.65	0.47	0.94	1.62	0.08	0.64	0.87	0.45
Admin, Support, Waste, & Remediation	0.99	0.42	0.43	0.46	0.34	0.23	0.61	0.34	0.61	0.43	0.92	1.64	0.58	0.51	0.70	0.63
Private Education	0.86	0.68	0.39	0.42	0.86	0.72	0.87	0.55	0.08	0.12	0.80	1.94	0.09	1.53	0.68	0.55
Health Care & Social Services	0.85	0.88	1.27	1.04	0.82	0.90	0.87	0.84	0.96	0.91	0.83	1.32	0.84	0.99	1.09	0.94
Other Services	1.08	1.32	1.10	1.05	1.10	1.13	1.25	1.19	1.36	1.09	1.06	0.84	1.14	1.13	0.91	1.29
Government	0.78	1.09	1.11	1.03	1.26	1.36	1.08	1.03	1.36	1.54	1.04	0.89	1.15	1.50	1.14	1.21

Source: Based on an economic base analysis using location quotients (Quintero 2007). Definitions of economic sectors can be found at the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

Appendix 13.J. *Scientific names of species mentioned in the text.*

Common name	Scientific name
American basswood	*Tilia americana*
American beaver	*Castor canandensis*
American beech	*Fagus grandifolia*
American black bear	*Ursus americanus*
American bullfrog	*Lithobates catesbeianus*
American Coot[a]	*Fulica americana*
American marten	*Martes americana*
American Redstart	*Setophaga ruticilla*
American Woodcock	*Scolopax minor*
Annosum root rot fungus	*Heterobasidion annosum*
Ashes	*Fraxinus* spp.
Aspens	*Populus* spp.
Bald Eagle	*Haliaeetus leucocephalus*
Balsam fir	*Abies balsamea*
Banded killifish	*Fundulus diaphanus*
Barren-strawberry	*Waldsteinia fragarioides*
Beech bark disease fungi	*Nectria galligena; N. coccinea* var. *faginata*
Beech scale insect	*Cryptococcus fagisuga*
Black ash	*Fraxinus nigra*
Black cherry	*Prunus serotina*
Black crappie	*Pomoxis nigromaculatus*
Black locust	*Robinia pseudoacacia*
Black spruce	*Picea mariana*
Black Tern	*Chlidonias niger*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Blackburnian Warbler	*Setophaga fusca*
Black-throated Blue Warbler	*Setophaga caerulescens,* listed as *Dendroica caerulescens,* on the Wisconsin Natural Heritage Working List
Black-throated Green Warbler	*Setophaga virens*
Black-and-white Warbler	*Mniotilta varia*
Blanding's turtle	*Emydoidea blandingii*
Bluegill	*Lepomis macrochirus*
Blue-headed Vireo	*Vireo solitarius*
Blue Ridge blueberry	*Vaccinium pallidum*
Bobcat	*Lynx rufus*
Boreal Chickadee	*Poecile hudsonicus*
Bracken fern	*Pteridium aquilinum*
Broad-winged Hawk	*Buteo platypterus*
Brook trout	*Salvelinus fontinalis*
Brown Thrasher	*Toxostoma rufum*
Buckhorn	*Tritogonia verrucosa*
Caddisflies	*Order Trichoptera*
Caddisfly	*Hydropsyche phalerata*
Caddisfly	*Agarodes distinctus*
Caddisfly	*Hydropsyche arinale*
Caddisfly	*Oligostomis pardalis*
Canada bluegrass	*Poa canadensis*
Canada thistle	*Cirsium arvense*
Canada Warbler	*Cardellina canadensis,* listed as *Wilsonia canadensis* on the Wisconsin Natural Heritage Working List
Chestnut-sided Warbler	*Setophaga pensylvanica*
Clay-colored Sparrow	*Spizella pallida*
Common buckthorn	*Rhamnus cathartica*
Common Raven	*Corvus corax*
Common reed	*Phragmites australis*

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Appendix 13.J, *continued.*

Common name	Scientific name
Common tansy	*Tanacetum vulgare*
Connecticut Warbler	*Oporornis agilis*
Crawling water beetle	*Aliplus pantherinus*
Curly pondweed	*Potamogeton crispus*
Deam's rockcress	*Arabis missouriensis* var. *deamii*
Delta-spotted spiketail	*Cordulegaster diastatops*
Diplodia fungus	*Diplodia*
Dragonflies	*Order Odonata*
Dwarf bilberry	*Vaccinium cespitosum*
Dwarf milkweed	*Asclepias ovalifolia*
Eastern flat-whorl	*Planogyra asteriscus*
Eastern hemlock	*Tsuga canadensis*
Eastern larch beetle	*Dendroctonus simplex*
Eastern Towhee	*Pipilo erythrophthalmus*
Eastern white pine	*Pinus strobus*
Elfin skimmer	*Nannothemis bella*
Elktoe	*Alasmidonta raveneliana*
Elms	*Ulmus* spp.
Emerald ash borer	*Agrilus planipennis*
Eurasian water-milfoil	*Myriophyllum spicatum*
European swamp thistle	*Cirsium palustre*
Extra-striped snaketail	*Ophiogomphus anomalus*
Field Sparrow	*Spizella pusilla*
Fisher	*Martes pennanti*
Forest tent caterpillar	*Malacosoma disstria*
Garlic mustard	*Alliaria petiolata*
Glossy buckthorn	*Rhamnus frangula*
Golden-crowned Kinglet	*Regulus satrapa*
Gray Jay	*Perisoreus canadensis*
Gray wolf	*Canis lupus*
Greater redhorse	*Moxostoma valenciennesi*
Gypsy moth	*Lymantria dispar*
Hazelnuts	*Corylus* spp.
Hermit Thrush	*Catharus guttatus*
Honeysuckle (nonnative)	*Lonicera morrowii, Lonicera tatarica,* and *Lonicera* x *bella*
Honey vertigo	*Vertigo tridentata*
Hypoxylon fungi	*Hypoxylon* spp.
Indian cucumber root	*Medeola virginiana*
Ironwood	*Ostrya virginiana*
Jack pine	*Pinus banksiana*
Jack pine budworm	*Choristoneura pinus*
Japanese barberry	*Berberis thunbergii*
Japanese knotweed	*Polygonum cuspidatum*
Karner blue butterfly	*Lycaeides melissa samuelis*
Kentucky bluegrasses	*Poa pratensis*
Kirtland's Warbler	*Setophaga kirtlandii,* listed as *Dendroica kirtlandii* on the Wisconsin Natural Heritage Working List
Lake chubsucker	*Erimyzon sucetta*
Lake sturgeon	*Acipenser fulvescens*
Larch casebearer	*Coleophora laricella*
Larch sawfly	*Pristiphora erichsonii*
Largemouth bass	*Micropterus salmoides*
Least darter	*Etheostoma microperca*
Least Flycatcher	*Empidonax minimus*
Leafy spurge	*Euphorbia esula*

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Appendix 13.J, *continued.*

Common name	Scientific name
Little goblin moonwort fern	*Botrychium mormo*
Loggerhead Shrike	*Lanius ludovicianus*
Maidenhair spleenwort	*Asplenium trichomanes*
Mallard	*Anas platyrhynchos*
Marsh grass-of-Parnassus	*Parnassia palustris*
Marsh thistle	*Cirsium palustre*
Marsh valerian	*Valeriana sitchensis* ssp. *uliginosa*
Mayflies	Order Ephemeroptera
Mottled darner	*Aeshna clepsydra*
Mystery vertigo	*Vertigo paradoxa*
Narrow-leaved vervain	*Verbena simplex*
Nashville Warbler	*Oreothlypis ruficapilla*
North American river otter	*Lontra canadensis*
Northern blue butterfly	*Lycaeides idas*
Northern Goshawk	*Accipiter gentilis*
Northern Harrier	*Circus cyaneus*
Northern pike	*Esox lucius*
Northern pin oak	*Quercus ellipsoidalis*
Northern red oak	*Quercus rubra*
Northern white-cedar	*Thuja occidentalis*
Oak species	*Quercus* spp.
Oak wilt fungus	*Ceratocystis fagacearum*
Ovenbird	*Seiurus aurocapilla*
Pennsylvania sedge	*Carex pensylvanica*
Phellinus fungi	*Phellinus* spp.
Phlox moth	*Schinia indiana*
Pines	*Pinus* spp.
Pine sawfly	*Neodiprion* spp., *Diprion* spp.
Poverty oat grass	*Danthonia spicata*
Prairie willow	*Salix humilis*
Pronghorned clubtail	*Gomphus graslinellus*
Pugnose shiner	*Notropis anogenus*
Purple clematis	*Clematis occidentalis*
Purple loosestrife	*Lythrum salicaria*
Pygmy snaketail	*Ophiogomphus howei*
Rainbow smelt	*Osmerus mordax*
Red maple	*Acer rubrum*
Red-osier dogwood	*Cornus stolonifera*
Red-breasted Nuthatch	*Sitta canadensis*
Red pine	*Pinus resinosa*
Red pine pocket mortality fungi	*Leptographium procerum* and *L. terrebrantis*
Red-shouldered Hawk	*Buteo lineatus*
Reed canary grass	*Phalaris arundinacea*
Ring-necked Duck	*Aythya collaris*
River redhorse	*Moxostoma carinatum*
Rocky Mountain sedge	*Carex backii*
Round pigtoe	*Pleurobema sintoxia*
Ruffed Grouse	*Bonasa umbellus*
Rugulose grape-fern	*Botrychium rugulosum*
Rusty crayfish	*Orconectes rusticus*
Salamander mussel	*Simpsonaias ambigua*
Serviceberry	*Amelanchier* spp.
Sheathed pondweed	*Potamogeton vaginatus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Shining lady's-tresses	*Spiranthes lucida*

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Appendix 13.J, *continued.*

Common name	Scientific name
Slippershell	*Alasmidonta viridis*
Smallmouth bass	*Micropterus dolomieu*
Smooth brome	*Bromus inermis*
Snuffbox mussel	*Epioblasma triquetra*
Speckled alder	*Alnus incana*
Spotted knapweed	*Centaurea biebersteinii*
Square-stem spike-rush	*Eleocharis quadrangulata*
Sugar maple	*Acer saccharum*
Swainson's Thrush	*Catharus ustulatus*
Sweet fern	*Comptonia peregrina*
Sweet gale	*Myrica gale*
Tamarack	*Larix laricina*
Tapered vertigo	*Vertigo elatior*
Quaking aspen	*Populus tremuloides*
Trumpeter swan	*Cygnus buccinator*
Two-lined chestnut borer	*Agrilus bilineatus*
Veery	*Catharus fuscescens*
Upland Sandpiper	*Bartramia longicauda*
Walleye	*Sander vitreus*
Watercress	*Nasturtium officinale*
Weed shiner	*Notropis texanus*
Western sand darter	*Ammocrypta clara*
White adder's-mouth	*Malaxis monophyllos* var. *brachypoda*
White ash	*Fraxinus americana*
White birch	*Betula papyrifera*
White pine blister rust	*Cronartium ribicola*
White spruce	*Picea glauca*
White-tailed deer	*Odocoileus virginianus*
White-throated Sparrow	*Zonotrichia albicollis*
Wild parsnip	*Pastinaca sativa*
Wild rice	*Zizania* spp.
Willows	*Salix* spp.
Winterberry	*Ilex verticillata*
Winter Wren	*Troglodytes hiemalis*
Wood Duck	*Aix sponsa*
Wood Thrush	*Hylocichla mustelina*
Wood turtle	*Glyptemys insculpta*
Yellow birch	*Betula alleghaniensis*
Yellow perch	*Perca flavescens*
Zebra mussel	*Dreissena polymorpha*

[a]The common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

Appendix 13.K. *Maps of important physical, ecological, and aquatic features within the Northeast Sands Ecological Landscape.*

- Vegetation of the Northeast Sands Ecological Landscape in the Mid-1800s
- Land Cover of the Northeast Sands Ecological Landscape in the Mid-1800s
- Landtype Associations of the Northeast Sands Ecological Landscape
- Public Land Ownership, Easements, and Private Land Enrolled in the Forest Tax Programs in the Northeast Sands Ecological Landscape
- Ecologically Significant Places of the Northeast Sands Ecological Landscape
- Exceptional and Outstanding Resource Waters and 303(d) Degraded Waters of the Northeast Sands Ecological Landscape
- Dams of the Northeast Sands Ecological Landscape
- WISCLAND Land Cover (1992) of the Northeast Sands Ecological Landscape
- Soil Regions of the Northeast Sands Ecological Landscape
- Relative Tree Density of the Northeast Sands Ecological Landscape in the Mid-1800s
- Population Density, Cities, and Transportation of the Northeast Sands Ecological Landscape

Note: *Go to http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=9 and click the "maps" tab.*

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