Chapter 21

Superior Coastal Plain 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): Common Tern, photo by Ryan Brady, Wisconsin DNR; Merlin, photo by Ronald Laubenstein, U.S. Fish and Wildlife Service; arrow-leaved sweet-coltsfoot, photo by Daniel Spuhler; Great Gray Owl, photo by Ryan Brady; bull moose, photo by Donna Dewhurst.

Suggested Citation

Wisconsin Department of Natural Resources. 2015. *The ecological landscapes of Wisconsin: an assessment of ecological resources and a guide to planning sustainable management*. Wisconsin Department of Natural Resources, PUB-SS-1131 2015, Madison.

Suggested Citation for This Chapter

Wisconsin Department of Natural Resources. 2015. *The ecological landscapes of Wisconsin: an assessment of ecological resources and a guide to planning sustainable management*. Chapter 21, Superior Coastal Plain Ecological Landscape. Wisconsin Department of Natural Resources, PUB-SS-1131W 2015, Madison.

Cover Photos

Top left: *Long Island and Chequamegon Point were connected during a severe storm in November 1977. They now constitute one of the most extensive coastal barrier spits on the Great Lakes and support a distinctive array of natural communities that includes beach, dune, interdunal wetland, Great Lakes barrens, marsh, and fen. Ashland County. Photo by Eric Epstein, Wisconsin DNR.*

Center left: *Boreal forest dominated by white spruce and balsam fir, just south of Lake Superior. Brule River State Forest, Douglas County. Photo by Eric Epstein, Wisconsin DNR.*

Bottom left: *In recent decades, the only successful state nestings of the U.S. and Wisconsin Endangered Piping Plover have been at a handful of sites in the Superior Coastal Plain. Photo by Jack Bartholmai.*

Top right: *Interdunal wetland. Apostle Islands National Lakeshore, Ashland County. Photo by Eric Epstein, Wisconsin DNR.*

Bottom right: *In Wisconsin the State Endangered butterwort is limited to the Superior Coastal Plain, where it inhabits cliffs along Lake Superior. Photo by Thomas Meyer, Wisconsin DNR.*

Charles and Diane Pierce

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Thomas Meyer, WDNR

Superior Coastal Plain Ecological Landscape at a Glance

Physical and Biotic Environment

Size

This ecological landscape encompasses 1,416 square miles (905,929 acres), representing 2.5% of the area of the state.

Climate

The climate of the Superior Coastal Plain Ecological Landscape is typical of northern Wisconsin, though conditions are somewhat moderated by the proximity to Lake Superior. The mean growing season is 122 days, mean annual temperature is 40.2°F, mean annual precipitation is 32 inches, and mean annual snowfall is 87.4 inches. Cool summers, deep snows (including lake effect snows), high humidity, fog, mist, wave spray, currents, ice, and strong winds (e.g., along exposed coastlines, where blow-down events are frequent) affect parts of the ecological landscape, especially near Lake Superior. Some areas near Lake Superior now support grass-based agriculture (18.5% of the ecological landscape). Portions of the northern Bayfield Peninsula have a climate and soils favorable for growing apples and other fruits. Areas away from Lake Superior have shorter growing seasons, and forests and forestry become more important than agriculture.

Bedrock

Late Precambrian sandstones are exposed and form cliffs and ledges along the northern edge of the Bayfield Peninsula and on the shores of the Apostle Islands. Igneous rocks (e.g., basalts) form the underpinnings of several waterfalls.

Geology and Landforms

The Bayfield Peninsula is hilly, as are some of the Apostle Islands. Both are covered by glacial tills. The level plains on either side of the Bayfield Peninsula slope gently toward Lake Superior. They are dissected by many deeply incised streams and several large rivers that generally flow from south to north toward Lake Superior. Sandspits, often enclosing lagoons and wetlands, are well developed in the Apostle Islands archipelago and at river mouths; some of the larger spits are several miles long.

Soils

Important soils include deep, poorly drained reddish lacustrine clays on either side of the Bayfield Peninsula. The clay deposits include lenses of sand or coarse-textured till; these areas are especially erosion-prone when they are cut by streams. The tills covering the Bayfield Peninsula and Apostle Islands are variable in composition and include clays, silts, loams, and sands. Organic soils are limited in extent, occurring mostly in association with the peatlands on the margins of the coastal lagoons and to a lesser extent in basins underlain by impermeable tills.

Hydrology

Lake Superior has had an enormous influence on the climate, landforms, soils, vegetation, and economy of the Superior Coastal Plain. Freshwater estuaries are present along the coast. Inland lakes are rare, but lagoons, some of them quite large, occur behind the coastal sandspits. Important rivers include the St. Louis, Nemadji, Bad, White, Amnicon, and Bois Brule. Coldwater streams originate in the aquifers at the northern edge of the Northwest Sands Ecological Landscape in Bayfield County and flow north across the Superior Coastal Plain before emptying into Lake Superior. Many of the streams flowing across the clay plain suffered severe damage to their banks and beds during the era of heavy logging in the late 19th and early 20th centuries. Some of them have not yet recovered, and their slumping banks continue to dump sediments into the main channels and ultimately into Lake Superior. Water and soil management can be challenging in this ecological landscape.

Current Land Cover

Aspen-dominated boreal forests are abundant on the clay plains to the west and east of the Bayfield Peninsula. In some areas, white spruce, balsam fir, and eastern white pine (these were the dominant canopy trees prior to the Cutover) are now common understory species or are even colonizing abandoned pastures. Older stands of boreal conifers still occur in

a few places, such as the City of Superior Municipal Forest. Forest fragmentation is significant on the clay plain owing to the interspersion of forests with fields and pastures. Northern hardwood and hemlock-hardwood forests occur on the Apostle Islands and include old-growth remnants. Dry forests of pine and oak are scarce in this ecological landscape, but they do occur on some of the sandspits associated with coastal wetlands. The largest coastal wetlands cover thousands of acres, and these are composed of complex vegetation mosaics that include coniferous and deciduous forests, shrublands, wet meadows, and marsh. Large wetlands in the Superior Coastal Plain interior include the Bibon Swamp, a huge wetland of almost 10,000 acres along the White River on the southern edge of the ecological landscape, and Sultz Swamp, a peatland perched high on the northern Bayfield Peninsula. An extensive complex of wetlands of variable structure and composition occurs on poorly drained red clays in and around the City of Superior.

Socioeconomic Conditions

The counties included in this socioeconomic region are Douglas, Bayfield, and Ashland.

Population

The population in 2010 was 75,330, or 1.3% of the state total.

Population Density

20 persons per square mile

Per Capita Income

$26,597

Important Economic Sectors

Government, Tourism-related, Health Care and Social Services, and Retail Trade sectors employed the most people in 2007, reflecting high government service and recreation dependence. Some agriculture, including the growing of specialty crops such as apples, berries, and cherries, occurs here. Forestry, agriculture, urban development, and some types of recreation have the largest effects on the natural resources of the Superior Coastal Plain.

Public Ownership

Federal lands include Apostle Islands National Lakeshore, Whittlesey Creek National Wildlife Refuge, several U.S. Coast Guard light stations, and a very small portion of the Chequamegon-Nicolet National Forest. Important state-owned properties include the Brule River State Forest and several state parks, state wildlife areas, state fishery areas, and state natural areas. Most county-owned land is county forest (which includes several small but significant "special use" areas that are not managed primarily for wood products). The City of Superior owns a municipal forest of over 4,000 acres along the St. Louis River and a large part of Wisconsin Point (part of a coastal barrier spit separating St. Louis and Allouez bays from the waters of Lake Superior at Duluth-Superior). 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 21.K the end of this chapter.

Other Notable Ownerships

Other lands of high conservation value include the reservations of the Bad River and Red Cliff Bands of Lake Superior Ojibwa, several projects under the direction of nongovernmental organizations (NGOs) (e.g., local land trusts), and industrial forests. The Wisconsin Chapter of The Nature Conservancy has developed conservation easements with landowners along the Brule River and has also worked with many of the governmental units in this ecological landscape (including tribal governments) on conservation projects of mutual interest and benefit. Local land trusts have been active on Madeline Island in Ashland County and in Douglas and Bayfield counties.

Considerations for Planning and Management

Major planning and management considerations in the Superior Coastal Plain include climate change; impacts of water level changes on the coastal wetlands and associated biota (including attempts to stabilize the water level of Lake Superior); the continued appearance and spread of invasive species; population trends in certain native species; water management on the clay soils; and increasing the acreage of conifer-dominated boreal forest. Other important issues are shoreline development along rivers and Lake Superior and protection of areas used by migratory birds and spawning fish. Management of lands in the red clay country to lessen erosion and improve water quality and habitat for aquatic life and reduce negative edge impacts (construction, agriculture, forestry) are issues deserving major consideration. The occurrences of many rare and geographically limited natural communities of exceptional quality have been documented here recently, along with numerous associated rare species. The coastal estuaries are regionally significant repositories for intact natural communities, such as conifer swamp, sedge meadow, fen, and marsh. Many rare plants and animals have been documented in the estuaries, which are also important nursery areas for fish. Use of some of these coastal wetlands, lagoons, and associated sandspit habitats by migratory birds is high, and some of the rare species use these habitats to the exclusion of most or any others.

Management Opportunities

Lake Superior, the largest freshwater lake in the world, affects virtually all natural features and many economic aspects of the Superior Coastal Plain. Continued cooperation and coordination across county, state, and international boundaries

will be needed to sustainably manage this globally important resource over time.

The freshwater estuaries in this ecological landscape are exceptional and offer opportunities to protect or restore many high quality wetland habitats. The National Oceanic and Atmospheric Administration (NOAA) recently designated the St. Louis River Estuary as part of a nation-wide system of National Estuarine Research Reserves. This designation will present opportunities for coastal wetland-related research, stewardship, and education through private, state, and federal partnerships. The Bad River-Kakagon Sloughs was designated a "wetland of international significance" in 2012 through the Ramsar Convention on wetlands of international importance.

The Superior Coastal Plain offers excellent opportunities to maintain high-quality examples of many natural community types. The "sandscapes," with their beach, dune, barrens, and dry forest communities, are among the best examples known from the western Great Lakes region. Bedrock features include cliffs, glades, and ledges, and these provide habitat for rare plants, some of them at their extreme range limits. The extensive red clay wetlands in and around the city of Superior host exceptional concentrations of rare plants.

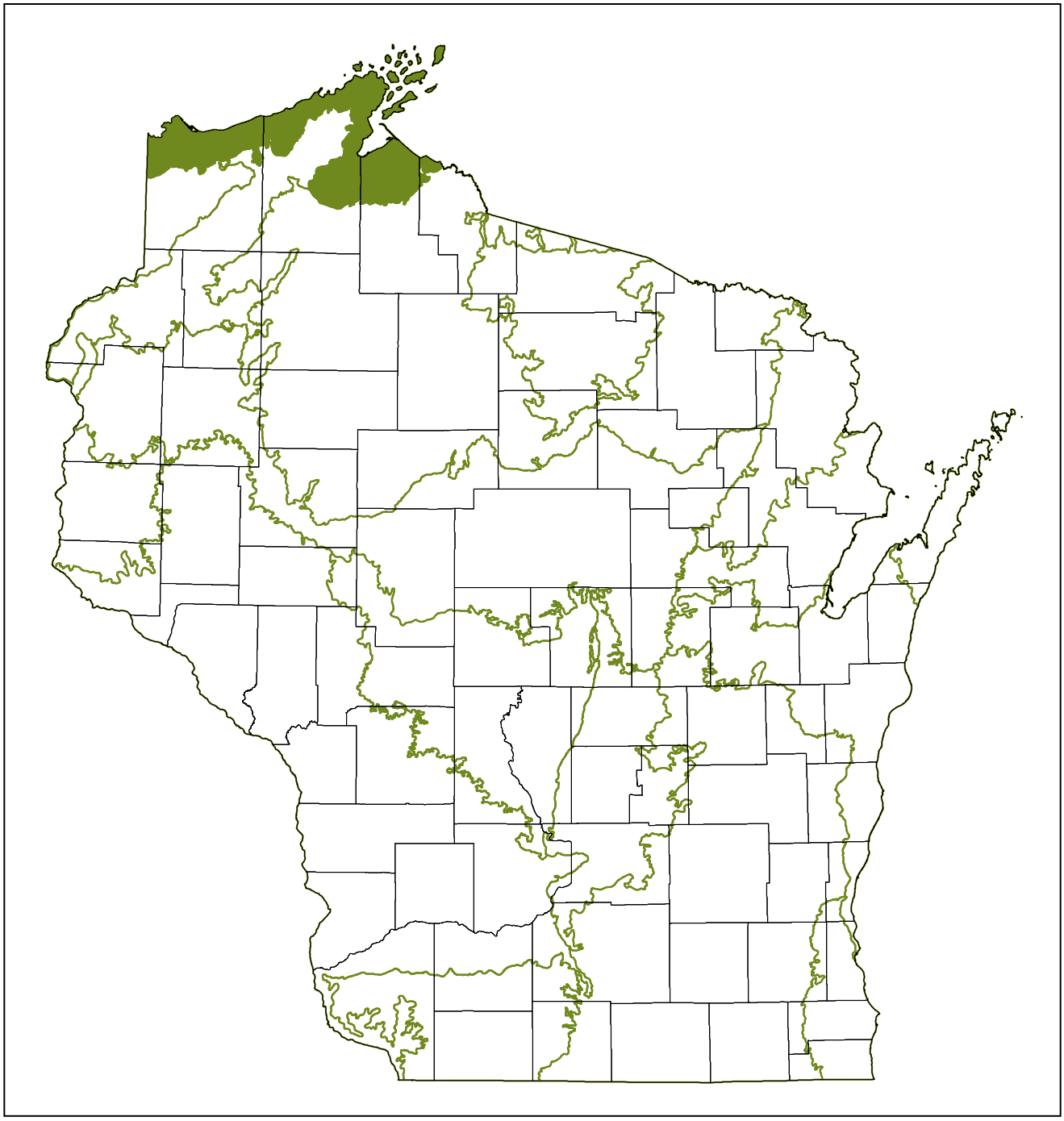
Boreal Forest once covered much of the Superior Coastal Plain, and the ecological landscape presents the state's best opportunities to protect, restore, and maintain this natural community. Restoring conifers to these forests, now largely dominated by aspen, is a major opportunity. Collectively, these forests also provide opportunities to increase large trees, cavity trees, coarse woody debris, patches of old-growth forest, large forest patches, and a reduction of the hard edge that is now prevalent throughout much of this region. Old-growth hemlock-hardwood forests, now extremely rare anywhere in Wisconsin, occur on several of the Apostle Islands. Browse-sensitive conifers, such as eastern hemlock, northern white-cedar, and Canada yew, are common and reproducing well in these island forests.

Several of the major river corridors, such as the Bad and Nemadji, contain stands of floristically rich mesic hardwood forests and the state's northernmost occurrences of floodplain forest. Streams coming out of the deep sand aquifers on the northern Bayfield Peninsula support coldwater assemblages of coldwater animals, which include native brook trout and numerous other species.

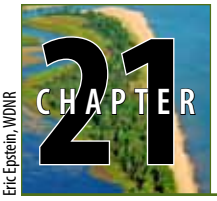
Significant opportunities to maintain breeding and migratory habitats in both natural and human caused or "surrogate" communities are found in this ecological landscape. For example, colonial bird rookeries are significant and include the only breeding sites on Lake Superior for the Wisconsin Endangered Common Tern. Some of the grass-dominated cleared lands in the lacustrine clay plain are extensive for this part of the state and are inhabited by rare and declining grassland birds. These grassland areas offer opportunities for careful assessment to determine which are best to maintain for their habitat value versus increasing the size of forest blocks to increase forest area, reduce forest edge, retain snow cover and water for longer periods, and provide habitat for forest interior species that are now relatively scarce in many parts of the Superior Coastal Plain.

Extensive low dunes and undeveloped beach at the "Sand Cut," Long Island-Chequamegon Point. Apostle Islands National Lakeshore, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

Young second-growth boreal forest of white spruce, balsam fir, and trembling aspen. Brule River State Forest, Douglas County. Photo by Eric Epstein, Wisconsin DNR. Photo by Eric Epstein, Wisconsin DNR.



Superior Coastal Plain Ecological Landscape



Eric Epstein, WDNR

Superior Coastal Plain 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 of the book, "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 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" (see 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 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. "Superior Coastal Plain 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 plans 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 in this book 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 Superior Coastal Plain is Wisconsin's northernmost ecological landscape. It is bordered on the north by Lake Superior and on the south by the Northwest Sands, Northwest Lowlands, and North Central Forest ecological landscapes. The climate is strongly influenced by Lake Superior, resulting in cooler summers, warmer winters, and greater precipitation compared to more inland locations. Exposed coastal areas are subject to significant disturbance from windstorms, waves, ice, currents, and periodic water level fluctuations. These disturbance regimes play significant roles in determining and maintaining the characteristic landforms and vegetation types of shoreline ecosystems. The most extensive landform in this ecological landscape is a nearly level plain of lacustrine clays that slopes gently northward toward Lake Superior. The coastal plain is cut by deeply incised stream drainages and interrupted by the comparatively rugged Bayfield Peninsula. An archipelago of sandstone-cored islands, the Apostles, occurs in Lake Superior just north and east of the Bayfield Peninsula. Wave-carved sandstone cliffs bracket stretches of the peninsula and also occur along the margins of several of the islands. Sandspits are a striking feature of the Lake Superior shoreline, typically separating the waters of the lake from interior lagoons and wetlands. The sandspits support rare and highly threatened natural communities such as beaches, dunes, Interdunal Wetlands, and Pine Barrens, all of which are inhabited by specially adapted plants and animals. The mouths of many of the streams entering Lake Superior are submerged, creating freshwater estuaries. A ridge of igneous rock of volcanic origin, primarily basalt, forms the southern boundary of portions of this ecological landscape.

Historically, the Superior Coastal Plain was almost entirely forested. A distinctive mixture of eastern white pine (*Pinus strobus*), white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), white birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), quaking aspen (*Populus tremuloides*), and northern white-cedar (*Thuja occidentalis*) occurred on the fine-textured glacio-lacustrine deposits bordering much of the Lake Superior coast. Sandy soils, sometimes interlayered with clays, occur in some places. Such areas supported forests dominated by eastern white pine and red pine (*Pinus resinosa*). Eastern white pine was strongly dominant in some areas, according to mid-19th century notes left by surveyors of the federal General Land Office. Dry-mesic to wet-mesic northern hardwoods or hemlock-hardwood forests were prevalent on the glacial tills of the Bayfield Peninsula and throughout the Apostle Islands. Large peatlands occurred along the Lake Superior shoreline, associated with ***drowned river mouths*** and protected from wind, wave, and ice action by sandspits. The most extensive of these wetland complexes were on the Bad and St. Louis rivers. A few large peatlands also occurred at inland sites, such as Bibon Swamp in the upper White River drainage, Blueberry Swamp west of the Bois Brule River in Douglas County, and Sultz Swamp, perched high on the northern Bayfield Peninsula. The present coastal plain forest has been fragmented by past and ongoing agricultural uses, and approximately one-third of this ecological landscape is now nonforested (or sparsely forested with new growth). Most of the open land is in grass cover, having been cleared and then subsequently pastured or plowed. Aspen and birch forests, managed for pulp, now occupy about 40% of the total land area and have increased in prominence over the formerly dominant boreal conifers. On the Bayfield Peninsula, second-growth northern hardwood forests are interspersed among extensive early successional aspen stands. Older forests are now rare throughout the Superior Coastal Plain Ecological Landscape. Small but exceptional stands of ***old-growth forest*** occur on the Apostle Islands, and these are often associated with U.S. Coast Guard lighthouse reservations.

The larger streams include the St. Louis, Nemadji, Bad, White, Bois Brule, Amnicon, Flag, Sand, and Sioux rivers and Fish Creek. The St. Louis is the largest river entering Lake Superior from the United States. Smaller streams flowing across the coastal plain typically occupy short, relatively straight, steep-sided valleys before emptying into Lake Superior. Other streams originate in the higher elevations of the Bayfield Peninsula and follow meandering courses toward the lake. Inland lakes are rare. Many wetlands persist, and these collectively form a regionally significant reservoir of rare plants and animals, intact natural communities, and natural processes. Groundwater conditions are among the cleanest in the state, based on Wisconsin DNR rankings. Most watersheds in this ecological landscape have not been ranked for watershed, stream, or lake pollution due to the relatively low acreages of nonpoint pollution sources. However, there are some major water quality problem areas associated with polluted sediments and surface waters (e.g., U.S. Steel Corporation Superfund site, the St. Louis River ***Area of Concern***).

The total area of the Superior Coastal Plain Ecological Landscape is approximately 906,000 acres, of which 57% is classified as ***timberland***. Publicly owned lands make up about one-fifth of the area—about half county forest, the remainder state or federally owned and managed. Two tribal reservations of the Lake Superior Ojibwa, the Red Cliff and Bad River Reservations, are situated along Lake Superior. The City of Superior Municipal Forest encompasses over 4,000 acres.

The Superior Coastal Plain counties have one of the lowest population densities and growth rates of all ecological landscape county approximations in the state. The population density (20 persons per square mile) is only about one-fifth that of the state as a whole (105 persons per square mile) (USCB 2012). Although there are few minorities, the Superior Coastal Plain region has the largest percentage of

American Indians. The Superior Coastal Plain counties are not economically prosperous. The per capita income and average wage are relatively low, and they have the highest poverty rates for both adults and children and the second highest rate of unemployment of all ecological landscape county approximations.

Government service and tourism/outdoor recreation are important contributors to the economy of the Superior Coastal Plain counties. The number of state parks, forests, and recreation areas, as well as acreage of federal lands, is relatively high, contributing to these sectors of the economy. Agriculture is not a major contributor to the economy and has seen the greatest decrease in the state in both farm numbers and acreage in agricultural land since 1970. Important educational institutions include Northland College in Ashland and the University of Wisconsin-Superior in Superior.

Environment and Ecology

Physical Environment

Size

The Superior Coastal Plain Ecological Landscape encompasses 1,416 square miles (905,929 acres), representing 2.5% of the area of the state of Wisconsin.

Climate

Climate data were analyzed from nine weather stations within the Superior Coastal Plain Ecological Landscape (Brule, Ashland, Bayfield, Foxboro, Gurney, Hurley, Madeline Island, Port Wing, and Superior; WSCO 2011). This ecological landscape has a continental climate, with cold winters and warm summers, similar to other northern ecological landscapes. The northern ecological landscapes in Wisconsin generally tend to have shorter growing seasons, cooler summers, colder winters, and less precipitation than the ecological landscapes farther south. Ecological landscapes adjacent to the Great Lakes generally tend to have warmer winters, cooler summers, and higher precipitation, especially snow. Lake Superior moderates temperatures in the summer and affects precipitation, especially winter snowfall, near the lake.

The growing season averages 122 days (base 32°F), ranging from 100 days in Foxboro to 143 days in Superior. This growing season length is similar to other northern ecological landscapes (excluding the Northern Lake Michigan Coastal Ecological Landscape, which is influenced by Lake Michigan). Weather stations located closer to Lake Superior had longer growing seasons than sites farther inland. Mean annual temperature is 40.2°F, about one degree colder than the average of other northern ecological landscapes. The average January minimum temperature is -2°F, and the average August maximum temperature is 79°F, almost a degree cooler than the mean of other northern ecological landscapes.

Annual precipitation averages 32 (28.6–34.4) inches, only half an inch less than the mean of other northern ecological landscapes. Annual snowfall averages 87.4 inches, greatly exceeding snowfall anywhere elsewhere in Wisconsin. There is considerable variation in the amount of snowfall reported among weather stations in the Superior Coastal Plain; means range from 50.8 inches to 165.3 inches. Some weather stations on the shore of Lake Superior report higher snowfall because of increased moisture collected by prevailing northwesterly winds that cross Lake Superior in winter (e.g., Brule, Bayfield, Hurley, and Gurney). Other stations where prevailing winds have not crossed Lake Superior have markedly less snowfall (Ashland, Superior, Foxboro). The highest snowfall occurs where winds cross Lake Superior and then cross the higher land of the Penokee Range (Hurley, Gurney). Heavy snowfalls impact the flora, fauna, and vegetation of this ecological landscape.

Ice cover on Lake Superior influences the climate by limiting the amount of lake water that can evaporate in winter, thereby affecting the production of lake effect snow. In addition, due to ice's ability to reflect solar radiation, longer periods and greater areas of ice cover lead to slower warming of the lake in summer (Austin and Colman 2007), and summer water temperatures, in turn, influence summer weather conditions in the ecological landscape. The length of time and the extent of ice cover on Lake Superior have been declining over the last 20 years. However, Lake Superior was almost completely covered by ice during the winters of 2008-09 and 2013-14, the greatest amount of ice cover in almost 20 years.

The warmer temperatures along Lake Superior in the fall and early winter and slightly cooler temperatures during spring and early summer influence the vegetation and ecology near the lake in this ecological landscape. Areas along Lake Superior support some grass-based agriculture (18.5% of the ecological landscape). The Bayfield Peninsula is affected by the influence of Lake Superior and has a climate favorable for growing apples and other fruits. Areas farther inland from the lake are too cool and have too short a growing season for agriculture. Here, forests are the dominant land cover. Deep snows that fall on the Penokee Range affect the plants and animals that can survive there.

Bedrock Geology

Bedrock underlying the Superior Coastal Plain consists of sedimentary, igneous, and metamorphic rocks of the Late Precambrian era, in the Keweenawan Supergroup. See the map "Bedrock Geology of Wisconsin" in Appendix G, "Statewide Maps," in Part 3. (Nomenclature used here is according to the Wisconsin Geological and Natural History Survey Open-File Report *Bedrock Stratigraphic Units in Wisconsin;* WGNHS 2006.) The Keweenawan Supergroup rocks are the youngest Precambrian rocks in Wisconsin and make up a portion of the midcontinent rift system that underlies this area. The rift formed around 1.1 billion years ago when the continent was nearly separated by volcanic eruptions in northwestern Wisconsin and Upper Michigan. Lava flowed for approximately 20 million years, producing the basalt, rhyolite, and gabbro that

are now exposed in the Penokee Range in the North Central Forest Ecological Landscape and the Copper Range in Upper Michigan (Dott and Attig 2004). After the volcanic period, the crust slowly subsided due to the weight of the accumulated lava. The subsidence created a synclinal structure whose low-lying bowl is located beneath Lake Superior. Over millions of years, sediments of rivers and lakes accumulated in the basin. About 900 million years ago, a continental collision in eastern North America produced compressive forces that uplifted a section in the center of the rift, exposing the volcanic rocks of the Penokees and South Range on the southern border of the ecological landscape and the Copper Range in Upper Michigan. In Duluth, high cliffs and other exposures of basalt and gabbro form the area known as "Hawk Ridge" on the northwest side of the old continental rift. Rift structures can still be detected in rocks beneath Lake Superior and have been traced in underground formations south to Kansas and east to Ontario near Lake Huron. See Dott and Attig (2004) and LaBerge (1994) for more detailed descriptions of the rifting and continental collision episodes.

Snakepit Falls, Amnicon Falls State Park, Douglas County. At the fall line between the Northwest Lowlands and Superior Coastal Plain ecological landscapes. Photo by Brian Collins.

Thick layers of sedimentary rocks in the Keweenawan Supergroup, including sandstone, conglomerate, and mudstone, accumulated over the midcontinent rift volcanic rocks during the subsidence period prior to the continental collision (Clayton 1984). These rocks, deposited between 1,050 and 1,110 million years ago, are now the uppermost layers of bedrock in the portion of the rift system not uplifted in the continental collision. They are subdivided into the Oronto and Bayfield Groups; Oronto Group rocks are older. Formations within the Oronto Group include (from oldest to youngest) Copper Harbor Conglomerates, Nonesuch shale, and Freda Sandstone. The Bayfield Group unconformably overlies the Oronto Group from the Apostle Islands and Bayfield Peninsula westward. Bayfield Group rocks are the Orienta, Devils Island, and Chequamegon Formations, consisting of nearly flat-lying quartz sandstone deposited during the Late Precambrian era (Clayton 1984). The red sandstones outcrop as ledges and sometimes as spectacular wave-cut cliffs along the northern edge of the Bayfield Peninsula and on several of the Apostle Islands. Most of the exposed bedrock is dry (with no internal water source), but many of the cliffs are influenced by wave spray, fog, and ice. Sandstones were quarried on the islands and along Highway 13 for "brownstone" buildings but primarily for railroad bridges and culverts (Dott and Attig 2004). The series of sedimentary rocks is exposed at Potato River Falls and at Copper Falls State Park (in the North Central Forest Ecological Landscape). Volcanic rift rocks as well as sedimentary rocks are exposed at Pattison State Park in the canyon below Big Manitou Falls, and also at Amnicon Falls State Park. At the mouth of the Montreal River, red sandstones topped by red glacial till and lacustrine sediments are exposed in bluffs along the Lake Superior shoreline.

Landforms and Surficial Geology

The Superior Coastal Plain Ecological Landscape formed in a glacial till plain that was smoothed during its submergence beneath glacial lakes, giving the land a low-lying, subdued appearance. This glacial geology is unique among ecological landscapes in Wisconsin. The area was glaciated most recently by the Superior Lobe and the Chippewa Sublobe between about 11,500 and 9,500 years before present (BP); these were the last advances of the Laurentide ice sheet into Wisconsin at the end of the last glaciation. After deposition, glacial lakes modified the surface of the entire ecological landscape. The thickness of glacial deposits, including those from glacial lakes, is typically 100–200 feet over bedrock, but near Lake Superior and at some other scattered locations, deposits are thicker, ranging up to 600 feet. Clayton (1984) studied the area extensively and is the primary reference for its glacial geology.

The well-known "red clay" soils are a dominant feature of the Superior Coastal Plain Ecological Landscape. These are soils that developed in the Miller Creek Formation, made up of reddish-brown, clayey glacial till and lake-deposited clay

Slumping clay banks along the Bad River. Ashland County. Photo by Emmet Judziewicz.

and silt. Miller Creek till is typically 3 to 65 feet thick. Within the formation, till of the Hanson Creek Member was deposited about 11,000 years ago and till of the Douglas Creek Member was deposited between about 10,000 and 9,500 yrs ago. The clay is derived from deep lake-bottom deposits in the Lake Superior basin, and gets its color from the reddish Precambrian sandstones of the Keweenaw Supergroup. It is also slightly calcareous, possibly due to inputs of glacial materials from Minnesota transported via meltwater sediments through the St. Louis River valley. These materials are thought to have been derived from limestone and dolomite in Manitoba and transported to Minnesota by the St. Louis Lobe of the glacier. Till of the Miller Creek Formation was waterlogged and somewhat fluid at the time it was deposited, creating subtle, indistinct landforms. They were further blurred by glacial lakes that covered the area as the ice sheet melted back into the Lake Superior basin. Lacustrine sediment was deposited over the till, and wave action washed away portions of the original landforms (Clayton 1984).

Glacial materials beneath the Miller Creek Formation are also important in the ecology of the area. These materials are of the Copper Falls Formation, deposited during the time when the Superior and Chippewa lobes advanced as far south as the St. Croix and Chippewa moraines and then retreated and readvanced several times. Readvances included the Tiger Cat Advance, Hayward Advance, Swiss and Airport Advances, Lake Ruth Advance, Porcupine Advance at approximately 11,000 years ago, and finally the Lake View Advance (10,000–9,500 years ago). The last two advances were responsible for surface materials of the Miller Creek Formation, while the others deposited the Copper Falls Formation (Clayton 1984). Copper Falls material is not exposed at the surface in this ecological landscape but does form most of the surficial deposits in areas to the south. It can be recognized quite easily in cut banks along rivers, where the overlying Miller Creek material is reddish and more clayey and the Copper Falls material is typically a reddish-brown sandy loam.

Copper Falls till was formed when the glacier's ice margin remained on land, depositing sandy loam till derived from the Precambrian sandstone bedrock and from meltwater stream sediments. After the Copper Formation was deposited and the ice melted back, a lake formed with a higher elevation than the current lake, and its sediments formed deep lacustrine clay deposits in the Lake Superior basin (Clayton 1984). Till of the Miller Creek Formation was derived from these lake deposits, which were scraped up as the ice sheet again advanced through the Lake Superior basin in a process sometimes compared to spreading peanut butter on a piece of bread.

Glacial Lake Duluth began as a small lake in front of the melting ice sheet and enlarged as the ice retreated eastward and exposed more of the Lake Superior basin. Eventually, Lake Duluth was more than a third the size of Lake Superior (Martin 1965). Its drainage outlet was through what are now the Bois Brule and St. Croix river valleys because, at this time, drainages to the east were blocked by ice. Elevations of about 886 to 1,082 feet along the southern boundary of the ecological landscape are mantled with shoreline sand deposits, typically about 3 feet thick, from the highest elevations of Glacial Lake Duluth. Wave action was most intense on steep slopes and in areas where the waves had the longest fetch, and in some places the Miller Creek till was completely removed by wave action. Beaches at various elevations are named for lake levels that existed as the ice sheet wasted away. The Duluth beaches formed after 9,900 years ago, possibly over a time period of about 300 years based on their degree of development and correlations with other glacial events. Other beaches may have formed in only a few decades, including the Highbridge, Moquah, Washburn, Manitou and Beaver Bay beaches, the latter of which formed before about 9,380 years ago. A Glacial Lake Nippissing beach, formed during the Middle Holocene, is evident at about 10 feet above the current level of Lake Superior (Clayton 1984).

Sandy materials occur in strata within the Miller Creek Formation, including between the Hanson Creek and Douglas Creek Members. Some sand strata originated from smaller lakes or streams that were not part of Glacial Lake Duluth, and others are from old shorelines (Clayton 1984). The interface between sand and clay strata is particularly unstable in cut banks along rivers, where erosion of the sand strata leads to massive slumping of clay and sedimentation into rivers. These banks are also unstable in roadcuts, where intensive efforts at revegetation and stabilization are often evident. It is uncertain how much bank slumping along rivers is natural and how much has been exacerbated by human activities. It seems that natural processes would have kept some banks open and actively eroding prior to extensive human occupancy of this ecological landscape, but changes since Euro-American settlement (e.g., log drives, deforestation of large portions of watersheds, development of infrastructure) have undoubtedly accelerated stream erosion. Remnants of logging structures (road crossing bridges, ***splash dams***, rail-

way grades, etc.) have forced streams to erode new channels around them, typically causing direct valley wall erosion.

The Superior Coastal Plain Ecological Landscape is cut by deep, narrow valleys with rivers and streams that run northward into Lake Superior; larger rivers that run across the clay plain include the Nemadji, Bois Brule, and Bad. The Sand and Raspberry rivers are examples of smaller streams that originate near the southern border of the ecological landscape. In many locations, material from the older Copper Falls Formation—sandy till and stream-deposited sand dating from before 11,500 years ago—is exposed in the lower parts of cut banks. Many of the steep valley sides are the result of postglacial erosion. Eroded material from valley sides accumulated at the base of hillslopes and was often moved by water and redeposited elsewhere as floodplains and terraces and into wetlands. These eroded sands typically move down the watercourses as bed-load in a slow "***sand slug***" fashion and bury in-stream fish habitat features, severely limiting reproductive success. Shoreline and stream deposition along Lake Superior formed beaches, spits, fans, swamps, and sloughs.

Some unusual landforms occur within the ecological landscape. A group of east-west sand dunes is located in far northwest Iron County near the lakeshore (north of Highway 2 and west of Cedar). Their orientation is due to prevailing south winds at the time of formation (between 9,500 and 5,000 years ago). A group of small drumlins, partly effaced by Glacial Lake Duluth, is located east of Odanah (Dott and Attig 2004). Important coastal features include freshwater estuaries and a variety of ***sandscapes*** including baymouth bar, ***tombolo***, ***cuspate foreland***, and sandspit, which often enclose or are otherwise associated with lagoons and diverse wetland ***mosaics*** (Matteson 1996).

The sandy hills of the central Bayfield Peninsula are mostly in the Northwest Sands Ecological Landscape but transition into a portion of the Superior Coastal Plain. These hills rise above the elevations of old shorelines of Glacial Lake Duluth and according to Clayton (1984) are thought to have been deposited by meltwater streams flowing out of subglacial tunnels and by supraglacial stream sediment that accumulated on top of the glacier and later collapsed as the ice melted.

Postglacial rebound is gradually raising the surface of the Earth's crust in areas that were compressed by the weight of ice sheets during the Wisconsin glaciation. The eastern end of Lake Superior is rising more rapidly than the western end by about 27 cm each century (Bruxer and Southam 2008). The differential ***crustal rebound*** makes the land area near Superior appear to be sinking and creates features such as the St. Louis River Estuary, a "drowned" river mouth with extensive associated wetlands. Slowly rising water levels also increase sediment accumulation in the already low gradient lower main stem (Fitzpatrick et al. 2006).

A map showing the Landtype Associations (WLTA Project Team 2002) in the Superior Coastal Plain Ecological Landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 21.K at the end of this chapter.

Topography and Elevation

The lowest elevation in the Superior Coastal Plain Ecological Landscape is at the shoreline of Lake Superior, which is 603 feet above sea level according to the International Great Lakes Datum of 1985. The highest elevation is 1,408 feet in the hills along the central Bayfield Peninsula. These hills are transitional to the Northwest Sands Ecological Landscape. Most of the land surface is level to undulating, with subdued topography created by the semi-fluid condition of the till at the time it was deposited and by smoothing due to glacial lake action afterward. The plain slopes gently toward Lake Superior and is cut by many steep-sided valleys containing streams that run from south to north. Areas within the hills of the central Bayfield Peninsula have topography that ranges from nearly level to steep.

Soils

Most upland soils of the ecological landscape are formed in reddish clay or silty clay loam till and are slightly calcareous with pH values around 7 in B horizons, increasing with depth to around pH 8 in C horizons. The dominant soil is moderately well drained and clayey, with a clay loam surface, very slow permeability, and very high available water capacity. Soil drainage classes range from well drained to somewhat poorly drained. Surface textures are generally clay to silt loam; permeability ranges from very slow to moderately slow, and available water capacity ranges from moderate to very high. Loess deposits are less than 6 inches thick in this area because glacial drainages here were relatively narrow and there was not a great amount of silt exposed in braided stream channels. Along the higher elevations of the ecological landscape some wave-action sand is intermingled with the clayey till. Most lowland soils are poorly drained and are also formed in reddish calcareous clay to silty clay loam till.

The major river valleys consist of moderately well drained to very poorly drained soils formed in sandy to clayey alluvium. Soils in swamps, sloughs, and wetlands along Lake Superior and in the Bibon Swamp are very poorly drained nonacid muck or mucky peat. The fine textures and slow permeability of these soils give them many of the functional characteristics of wetland soils, even when they occur on uplands. Water moves out of them very slowly, and surface ponding from runoff can be common in basins and lower lying areas. Vegetation communities on these soils typically contain species characteristic of wetlands, including northern white-cedar, black ash (*Fraxinus nigra*), and speckled alder (*Alnus incana*). Special management considerations for many of these soils are warranted because they are seldom completely dry. The Natural Resources Conservation Service gives ratings of "severe" for rutting hazards for many of the red clay soils, and some are rated "poorly suited" for forest harvesting equipment. When these clay soils are rutted or compacted, the effects can be long-lasting. Land managers should utilize guidelines, such as those found in *Wisconsin's Forestry Best Management Practices for Water Quality Field*

Manual (WDNR 1995) and in *Wisconsin Forest Management Guidelines* (WDNR 2003, WDNR 2007), to minimize damage to these soils.

Hydrology

Lake Superior is the dominant hydrological feature in the Superior Coastal Plain Ecological Landscape. It holds a vast amount of clean, fresh water and offers diverse aquatic and terrestrial Great Lakes habitats, ranging from rocky beaches and clay-dominated wetlands to deepwater reefs and deeper pelagic waters. The thermal mass of this lake affects the local climate and with a favorable surface wind can create significant "lake effect" snowfall for more than 20 miles inland (NWS 2007).

There are several Conservation Opportunity Areas (COAs) related to the unique hydrological features and attributes of this ecological landscape (WDNR 2008b). These include areas that are deemed significant on a global and a continental scale, while others are significant on a statewide scale. Bayfield Peninsula coastal headlands and estuaries, the Bad River Estuary, and the Apostle Islands are of global significance. The Pokegama-Nemadji Wetlands and the Brule Boreal Forest are of continental significance, while the St. Louis River Estuary, Bibon Swamp, the White-Bad rivers, and Fish Creek are COAs of state significance.

"Inland" lakes typical of northern Wisconsin are very rare in the Superior Coastal Plain Ecological Landscape. Most lakes in this ecological landscape are coastal lagoons and embayments cut-off from Lake Superior by baymouth sand bars. There are a small number of inland lakes and some impoundments that have been created on streams through construction of dams.

Numerous large and small rivers enter Lake Superior, the largest on the U.S. portion of the lake being the St. Louis River, which enters the lake at the "twin ports" of Superior, Wisconsin, and Duluth, Minnesota. Other large rivers include the Amnicon, Bad, Black, Bois Brule, Montreal, and Nemadji. Numerous small streams have cut deeply through the glacial clays en route to Lake Superior.

Flooding completely filled this oxbow on the Nemadji River with sediments a day or two before this photo was taken. The new channel can be seen in the lower left hand corner of the image. Second-growth boreal forest of trembling aspen, balsam fir, and white spruce. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Many of the slopes bordering rivers and streams here were badly damaged during the "Cutover," and raw, slumping slopes are still common on some streams. This has added both fine and coarse sediments to these rivers and streams, which ultimately end up in Lake Superior where they contribute to nearshore turbidity. The nature of some of these streams has changed in significant ways (see the "Water Quality" section of this chapter).

Basins

This ecological landscape lies entirely within the Lake Superior basin and is the only ecological landscape in Wisconsin to lie entirely within only one major hydrologic basin. All streams in this ecological landscape ultimately flow into Lake Superior, so land uses along these streams affect this coastal zone and the lake. Wisconsin's part of the Lake Superior basin contains all or portions of 15 watersheds (see Appendix 21.A at the end of this chapter).

Lake Superior

Lake Superior is the largest freshwater lake in the world by area and the deepest of the Great Lakes. Covering 31,820 square miles, with an average depth of 482 feet and a maximum depth of 1,332 feet, Lake Superior holds an estimated 2,900 cubic miles of freshwater. Approximately 77% of this volume is in those parts of the lake that are more than 250 feet deep, providing ample habitat for species that thrive in cold, deep water (Mattes 2008).

The St. Louis River is the largest stream entering Lake Superior from the United States. Other large rivers and streams feeding Lake Superior in this ecological landscape include the Nemadji, Bad, White, Iron, Flag, Amnicon, Sand, and Bois Brule. Chequamegon Bay, the largest bay on the lake, is fed by the White and Kakagon rivers, Fish Creek, and numerous small streams.

Water entering Lake Superior has a residence time of 191 years, so pollutants and sediments introduced into the lake have the potential to create long-term negative impacts. There are ongoing efforts to minimize the introduction of pollutants into the lake, as part of a "nondegradation" policy adopted by the ***International Joint Commission***. However, such efforts are generally limited to controlling industrial and municipal pollution discharges and do not offer protection against airborne pollutants traveling from hundreds, or even thousands, of miles away.

The lake remains an important link in the shipping route from Wisconsin and Minnesota eastward to the Atlantic Ocean. Ocean-going cargo vessels can travel from Superior to the Saint Lawrence Seaway via a series of locks built to connect all of the Great Lakes. A wide range of recreational vessels also use the lake.

Lake Superior is a major ecological and economic resource for this ecological landscape. Overall, its waters and tributaries are much more intact than those of the other four Great Lakes. The native biota of Lake Superior, though impacted by nonnative invasive species, is also the most intact of all the Great Lakes. Maintaining the aquatic biota in this state will require constant vigilance and continued management efforts.

Lake Superior holds abundant populations of native fish, including important sport and commercial species such as lake herring (*Coregonus artedi*), bloater chub (*Coregonus hoyi*), lake trout (*Salvelinus namaycush*), and lake whitefish (*Coregonus clupeaformis*). In all, there are 89 species of fish in the Lake Superior basin; of these, 68 species are native to Lake Superior, while 21 nonnative species have become established. See the "Fauna" section for more detailed information about fish.

There are approximately 3,100 square kilometers of rock and cobble substrate on the lake bottom that are less than 240 feet deep and suitable for lake trout spawning, and 20 of the 22 most important spawning sites in the Wisconsin waters of Lake Superior are off of the Bayfield Peninsula, mainly among the Apostle Islands. Some of the most important areas are at Gull Island Shoal, Devils Island, and Cat Island.

Lake Superior provides a continentally important concentration of freshwater estuaries, with natural communities that include Shore Fen, Poor Fen, Northern Sedge Meadow, Tamarack (Poor) Swamp, and various marsh types. Big Bay lagoon on Madeline Island is one example of an estuarine complex, which provides habitat for various life stages of numerous species. Other estuaries occur at river mouths on the northern Bayfield Peninsula, on the lower St. Louis River at Duluth-Superior, and at the mouths of the Bad and Kakagon rivers in Ashland County. Important lagoon complexes also occur on several of the Apostle Islands, e.g., Stockton and Outer. (See the "Natural Communities" section of this chapter for additional information.)

The surface waters of Lake Superior have been warming for the past several decades (Austin and Colman 2007). This appears to be leading to fewer days of extensive ice cover, which in turn promotes greater than normal losses of water due to evaporation and also increases water temperatures. Normally, evaporation throughout the year can create a drop in water level of about 1.5 feet, but this loss is generally restored by annual precipitation. However, winds over the lake also appear to be getting stronger, which can cause more winter precipitation to fall as snow outside of the Lake Superior basin. When this loss is not compensated by incoming precipitation, lake levels drop, which has the potential to disrupt commercial and recreational navigation (Alvord 2007).

Impacts of future water level changes are likely to be significant, especially to wetlands, but specific effects have yet to be determined. Long-term trends in physical characteristics such as water temperature and the area of winter ice cover are also likely to have important implications for the Lake Superior ecosystem and some of its present values and uses.

Inland Lakes

Inland lakes are very rare in the Superior Coastal Plain Ecological Landscape, owing to the topography and drainage patterns. According to the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015b), there are only 19 named lakes here, covering 804 acres, and another 864 unnamed lakes (all of these are very small, averaging only a few acres each) that total 2,798 acres. This is the smallest total lake number and acreage of any ecological landscape in the state except for the Southwest Savanna. The most common lakes are coastal lagoons or sloughs connected to Lake Superior via streams and often associated with drowned river mouths and/or sandspits. Examples include Honest John Lake, Bad River Slough, Bark Bay Lagoon, Big Bay Lagoon, Bibon Lake, and the Stockton Island tombolo. A few small lakes or ponds occur within the floodplains of the larger rivers, such as the St. Louis, Nemadji, and Bad, sometimes in abandoned river channels.

Kakagon-Bad River Sloughs is a vast, and arguably the most important, wetland complex on the Great Lakes. Honest John Lake can be seen just behind the undeveloped coastal barrier spit separating the wetlands from the waters of Lake Superior. Ashland County. Photo by Eric Epstein, Wisconsin DNR.

Seepage lake embedded in large swamp of tamarack, black spruce, northern white-cedar, and black ash. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

The estuaries and associated wetlands along the Lake Superior coast have some of the highest plant diversity of any of Wisconsin's Great Lakes wetlands. The Bad River-Kakagon Sloughs, owing to their size, condition, and mostly forested watershed, also provide significant habitat for invertebrates, fish, herptiles, and many birds.

Siskiwit Lake is one of the few natural lakes in the ecological landscape. It is shallow with a maximum depth of 13 feet. There is a health advisory against eating walleye (*Sander vitreus*) greater than 20 inches long, because atmospheric deposition of contaminants has led to high mercury levels in fish.

Impoundments

Major impoundments are rare in this ecological landscape. Those that exist here total only 305 acres, by far the smallest acreage of impoundments of any of the state's 16 ecological landscapes (WDNR 2015b). Forty-nine dams remain on streams here, while six have been removed. There is a large dam on the St. Louis River in Minnesota, just upstream from the Wisconsin state line, with more dams farther upstream.

American beaver (*Castor canandensis*) are active on many of the streams draining into Lake Superior, in part because of the great increase in aspen cover (at the expense of conifers) compared to historical times, combined with difficulty in maintaining consistent trapping pressure. The warming effects of beaver dams and the physical barriers they create to fish movements on some streams have at least temporarily reduced trout habitat, in some cases severely diminishing trout populations and altering streamside vegetation in the impounded areas by holding it at nonforested stages (e.g., open water, marsh, wet meadow, or shrub swamp). The Wisconsin DNR contracted with U.S. Department of Agriculture Wildlife Services staff to trap beaver on 117 miles of coldwater streams in this ecological landscape to limit their impacts on trout habitat (WDNR 2015e).

Rivers and Streams

The St. Louis River is both the largest stream in this ecological landscape and the largest stream entering Lake Superior from the United States. Other major rivers include the Amnicon, Bad, Black, Bois Brule, Flag, Iron, Montreal, Nemadji, and White. Some of these streams originate in ecological landscapes with geological and soil characteristics that are different from those of the Superior Coastal Plain. These include the Northwest Lowlands, Northwest Sands, and North Central Forest, so the streams start out relatively clear before many of them pick up sediments and the reddish tints from the thick layer of red, lacustrine clays characteristic of the Superior Coastal Plain. Numerous small streams have cut deeply through these glacio-lacustrine clays enroute to Lake Superior. Chequamegon Bay, the largest bay on the lake, is fed by the Kakagon, Onion, and Sioux rivers, Fish Creek, and several smaller streams.

Many of the slopes bordering rivers and streams here were badly damaged by erosion accompanying deforestation during the Cutover, and raw, slumping slopes are still common on many streams (e.g., the Brule, Nemadji, and Sioux rivers and Fish Creek). As a result, these rivers and streams receive additional fine sediments that ultimately end up in Lake Superior where they can contribute to high turbidity in nearshore areas.

Upper St. Louis River Estuary, near the mouth of the Red River. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Researchers studying sediment cores from the floodplain and mouth of Fish Creek estimated that increased storm water runoff resulting from deforestation associated with early logging, followed by many decades of agricultural land use, caused the release of about nine times as much sediment into streams as had occurred before Euro-American settlement (Fitzpatrick et al. 1999). Similarly, sediment deposition along the ***reach*** where this stream transitioned from high gradient to low gradient flow increased approximately fivefold. This cycle of erosion and sedimentation disrupted ***steam morphology*** and habitat. Recovery has been very slow, and it is taking a long time to reach a new state of equilibrium. Even with the reforestation that is occurring in some watersheds, erosion still occurs at about 2.5 times the rate experienced prior to Euro-American settlement.

Some streams flow over bedrock exposures that create waterfalls, which are effective barriers to the upstream movements of most fish species. Waterfalls are important natural attractions within Amnicon Falls, Copper Falls, and Pattison state parks, and waterfalls are also present on the Potato River and streams in the Iron River drainage such as Muskeg, Dahl, Hill, Schacte, Middle, and several other creeks (WDNR/USFWS 2005).

Many streams support populations of rare species (those listed as "endangered," "threatened," or "special concern" by the state or federal governments), although there are usually only one or two such species per water body. The streams with the highest diversity of aquatic organisms are the larger rivers, such as the Bad, Nemadji, and Bois Brule. All of these originate outside of the Superior Coastal Plain. In general, aquatic diversity (pertaining to species richness only) increases with

waterbody size and higher temperatures. (See the "Fauna" section for more detailed discussion.)

A number of cold headwaters streams occur here, especially on the Bayfield Peninsula. They are fast, cold, and clear, with very good water quality. Examples include the Bark, Cranberry, Flag, and Sioux rivers and Pike's and Thompson creeks. Most support populations of potadromous brook trout (*Salvelinus fontinalis*) and other naturalized coldwater species. These streams also host seasonal runs of salmonids from Lake Superior.

Many noteworthy coolwater streams flow from the Superior Coastal Plain into Lake Superior. Several dozen streams in this ecological landscape support resident populations of brook trout as well as other species. Among the better known of these coolwater and coldwater streams are the Nemadji, Amnicon, Bois Brule, Iron, Sand, Sioux, White, and Bad rivers and Pike's Creek.

The St. Louis and lower Nemadji rivers are the primary warmwater streams in this ecological landscape. Both provide important spawning, nursery, and foraging habitat for fish. The mouths of the Nemadji, Pokegama, Bad, and several other rivers support important wetlands (see the "Wetlands" section below).

Springs

Only 14 springs have been mapped in the Superior Coastal Plain Ecological Landscape (Macholl 2007). Seepages, however, are common on the slopes flanking some streams (many of which cut to the aquifer, so there are no spring "ponds"). The movement of groundwater through the lacustrine clays and associated tills contributes to streambank instability in some areas.

Wetlands

The Superior Coastal Plain contains almost 111,000 acres of wetlands (WDNR 2010b), covering 12.2% of the surface area. Of the total wetland acreage, over 68,000 wetland acres are forested, approximately 37,000 are shrub dominated, and only around 5,000 are herb dominated. In terms of wetland percentage, the Superior Coastal Plain ranks 12th out of the 16 ecological landscapes, with 12.2% of the surface area covered in wetlands.

Some of the wetlands in this ecological lan have exceptionally high significance because of their ecological and cultural values. Among the especially noteworthy wetlands in the Superior Coastal Plain Ecological Landscape are those associated with the coastal estuaries and embayments (which includes the extensive wild rice [*Zizania* spp.] beds of the vast Bad River-Kakagon Sloughs), the corridors of the major rivers, perched wetlands on the Apostle Islands and Bayfield Peninsula, and the "red clay" wetlands, with their unusual species assemblages.

Wetlands here have distinctive attributes not shared with wetlands in other ecological landscapes. Especially important are the coastal peatlands, which occur as freshwater estuaries

Complex Great Lakes landforms, diverse mosaic of wetlands, and xeric forest. Stockton Island tombolo, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

at the mouths of rivers and in association with sandscapes and lagoons in the Apostle Islands. Unlike many other freshwater estuaries elsewhere in the Great Lakes, many of these coastal wetlands are still in good condition and are valuable repositories of regional biodiversity. The "red clay" wetlands on the nearly level plains on either side of the Bayfield Peninsula also have singular attributes. Even though many of the wetlands on these lacustrine clays have been disturbed by hydrological disruption, agriculture, and past logging, they support unusual assemblages of species and offer opportunities for restoration and management that are unique in Wisconsin. In and around the city of Superior especially, the ***red clay wetlands*** support many rare plants, some rare animals, and remnants of an unusual and geographically restricted variant of Boreal (spruce-fir) Forest.

Several of the coastal peatland complexes are very large, covering thousands of acres. Those close to the cities of Superior, Ashland, and a few others (e.g., Port Wing) have been subject to degradation by pollutants, dredging and the discharge of spoils, the spread of invasive species, and various types of development (Meeker and Fewless 2008). Others, such as those on the Apostle Islands, are essentially undisturbed and extremely important to protect and maintain for the diversity of native plants and animals they support and as benchmarks against which to compare similar wetlands on the mainland coast. The most characteristic wetland communities are peatland types, which include sedge-dominated open fens and bogs as well as conifer swamps. Wild rice marshes are extensive and well developed at a few locations. Many wetlands here support rare species, and for some of these, the coastal peatlands of the Superior Coastal Plain are their primary habitats (see sections on "Flora" and "Fauna" for additional information). Detailed descriptions of the coastal peatlands and the species they support may be found in Judziewicz and Koch (1993), Judziewicz (2008), and Wisconsin DNR (1997).

Historically, most of Lake Superior's estuarine wetlands were dominated by narrow-leaved sedges (commonly referred

to as "wiregrass"). Sedge-dominated peatlands have declined (here and elsewhere) or even disappeared where residential, industrial, and agricultural uses have altered water levels, degraded water quality, and changed flow patterns by ditch and dike construction. Differential isostatic rebound and increased wind fetch have also played roles in changes to the wetlands of the St. Louis River Estuary.

Increased sediment and nutrient inputs can speed the conversion of sedge meadow and fen to more common and widespread marsh associations. Robust graminoid plants, rather than the narrow-leaved sedges (the "wiregrasses"), become dominant, and these often include invasive nonnative species such as narrow-leaved cat-tail (*Typha angustifolia*) and common reed (*Phragmites australis*) (Meeker and Fewless 2008). In Lake Michigan (and the lower Great Lakes in general), these species have greatly increased in abundance and extent following the Cutover and Euro-American settlement as vast amounts of nutrient-rich sediments were transported from the upper parts of local watersheds and accumulated in the coastal wetlands. Most of the Lake Superior coastal wetlands have been less affected than those in the lower Great Lakes, but many of the problem species are now present, and some are well established and apparently spreading in the sensitive coastal peatlands along southwestern Lake Superior.

Dams on the St. Louis River impact wetland vegetation in the estuary. Five headwaters dams on tributaries and five more hydroelectric dams on the main stem (all in Minnesota) have altered the natural periodicity and quantity of water flow into the estuary by increasing winter flow, reducing the peak spring runoff flow and magnitude of flooding, and discharging year-round minimum flows to provide for powerboat-based recreation and fish habitat. These dams act as sediment traps and slow the rate of sediment replenishment in parts of the upper estuary. Conversely, the regulation of flows in the St. Louis River can minimize the natural flushing of sediments characteristic of a fully functional estuary by holding back or storing floodwaters.

In the St. Louis River Estuary, frequent ***seiches*** cause short-term changes in water level ranging from 1 to 10 inches and can temporarily reverse the direction of flow in the estuary. These seiche events create an inflow-outflow cycle of nutrients and sediments in parts of the estuary. The overall condition of the lower portion of the estuary, according to the St. Louis River Citizens Action Committee (SLRCAC 2002), varies from fair to good, except in industrial and dredged areas, which exhibit poor habitat conditions.

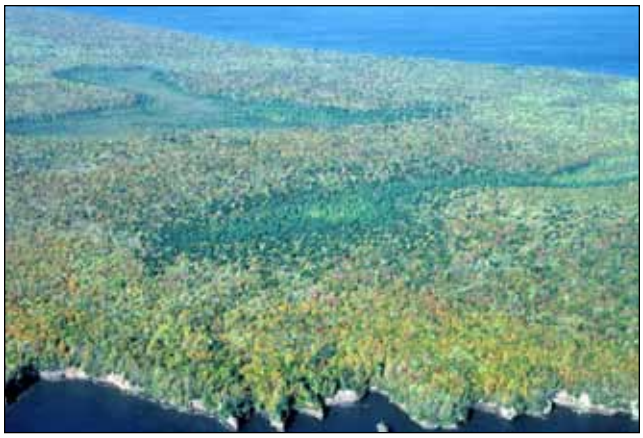
The industrial portions of the St. Louis River Estuary are impacted both by physical alteration and contaminants. The latter include mercury, ***polycyclic aromatic hydrocarbons*** (PAHs), lead, ***polychlorinated biphenyls*** (PCBs), and other toxins. In addition, storm water management, impervious surfaces, forest management practices, other land use changes, and hydrological modifications have created water flow that is more highly variable than it was historically. Runoff from storms and snowmelt consequently has much greater volume, speed, and erosional force than in the past and may therefore carry greater sediment loads from tributary streams into the estuary (SLRCAC 2002) except where flow is altered by dams.

The lower Nemadji and Pokegama river corridors (which flow into the St. Louis River Estuary) contain ecologically significant wetlands that act as important fish spawning and nursery areas and provide good quality habitat for waterfowl and other birds, mammals, herptiles, and invertebrates. The Bad River-Kakagon Sloughs is one of the largest and most intact freshwater estuaries in the world, contains a highly diverse ecosystem, and is an important spawning area for Lake Superior fish.

"Perched" wetlands are common in certain areas with heavy red clay soils, for which the Superior Coastal Plain Ecological Landscape is notorious. This is especially true on the more level plains east and west of the Bayfield Peninsula, but perched wetlands and ephemeral ponds also occur on some of the Apostle Islands. At some locations, the topographic high points in the ecological landscape are poorly drained and support wetland vegetation. Among the common ***cover types*** on such sites are wet meadows, shrub swamps, hardwood swamps, and conifer swamps. Historically, more of these areas may have been conifer swamps, while others may have been marginally wet "uplands" or transitional areas that could go either way, depending on local land use history and hydrological alterations.

Intensive logging can result in "swamping," where the water table rises because of reduced evapotranspiration following the removal of trees. Heavily disturbed areas, such as abandoned agricultural fields or formerly heavily grazed pastures, may now be dominated by monotypes of the exotic and invasive reed canary grass (*Phalaris arundinacea*) or tall native shrubs such as alders (*Alnus* spp.) or willows (*Salix* spp.).

Sultz Swamp is a large inland acid peatland complex that occurs in a depression on top of the spine of the Bayfield Peninsula. Several of the Apostle Islands also have perched



Boggy peatlands occur within the interior of Stockton Island, bordered by extensive stands of upland forest. Apostle Islands National Lakeshore, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

wetlands, and these may be of special interest since they are hydrologically intact and have had little if any recent direct human disturbance. Several of them (e.g., the "peak" on conical Bear Island) reflect past Great Lakes water levels.

Bibon Swamp is almost 10,000 acres in size (over 15 square miles), making it the largest wetland in Bayfield County and the largest non-coastal wetland in the Superior Coastal Plain Ecological Landscape. It occupies the basin of an extinct glacial lake drained by the White River. The vegetation is varied, as the result of site size, the behavior and chemical composition of groundwater, and land use history that included severe hydrological disruptions and the impacts of heavy logging and post-logging fires during the Cutover. The southwestern portion of the Bibon Swamp contains a rich wet-mesic conifer swamp of 150-year-old northern white-cedar, which supports a number of rare species. Bordering the northern white-cedar swamp is a black ash-dominated hardwood swamp. North of the White River, conditions are very different, with a large complex of acid peatland communities that includes open bog, spruce-tamarack muskeg, black spruce swamp, and tamarack swamp. Much of the eastern portion of the Bibon now supports vast shrub swamps, composed of willows, dogwoods (*Cornus* spp.), and alder. Much of this site is still in recovery from severe disturbances following and related to Euro-American settlement, but it supports a diverse array of rare and common native species and a diverse mosaic of wetland communities, and it occupies a strategic location within the upper White River watershed adjacent to the Chequamegon-Nicolet National Forest.

An estuarine wetland complex of several 100 acres occurs at the drowned mouth of Fish Creek, at the head of Chequamegon Bay. This site has been subjected to many disturbances in the past and as a consequence has lost much of its sedge-dominated peatland acreage. It remains vulnerable to further deterioration unless efforts are undertaken and maintained to address past and future water quality degradation and other negative impacts. This wetland is particularly dynamic because of the funnel shape of Chequamegon Bay and the seiche effects that cause frequent and sometimes substantial short-term water level changes (WDNR 2005b).

The most abundant wetland communities at Fish Creek are Emergent Marsh, Alder Thicket, and Northern Hardwood Swamp. The open waters of the "sloughs" also constitute an important feature and are used by fish and large numbers of waterfowl and other waterbirds as well as by herptiles and aquatic invertebrates.

Protection of Lake Superior's coastal wetlands is of the utmost importance because of their size, condition, associated diversity, and unique ecological and cultural attributes. Wetland threats include efforts to stabilize Lake Superior water levels, excessive sedimentation, inputs of nutrients and pollutants, shoreline development, and the spread of invasive species such as common reed, purple loosestrife (*Lythrum salicaria*), curly pondweed (*Potamogeton crispus*), and reed canary grass.

Ephemeral Ponds are locally common in the Apostle Islands and occur at scattered locations elsewhere on the Superior Coastal Plain in areas of poorly drained, usually forested, uplands.

Water Quality

In areas with low levels of urban-industrial and agricultural developments, most rivers and streams exhibit good water quality. Lake Superior remains the cleanest of the Great Lakes, and it is the subject of the binational Great Lakes Water Quality Agreement (Environment Canada 2008). There are more than 60 streams in this ecological landscape, all tributary to Lake Superior, that are designated as either ***Outstanding Resource Waters*** or ***Exceptional Resource Waters*** (WDNR 2012). Most waters here were not ranked for susceptibility to nonpoint pollution due to the relatively low acreages of nonpoint pollution sources such as row crop agriculture or intensive pasturage (roughly 21% of the cover in this ecological landscape is classified as agriculture and grassland, and another 1.3% is classified as urban).

Outstanding Resource Waters (ORW) or 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 additional protection from the effects of pollution or other factors that would lead to impairment. Both designations have regulatory restrictions associated with them, with ORWs being the most restricted. These designations are intended to meet federal Clean Water Act obligations and prevent the reduction of water quality or degradation of aquatic habitats in these waters. They are also used to guide consideration of certain land use changes and human activities near these waters.

ORWs are common here and include Lake Superior, the Bois Brule, White, Onion, Sioux, and Amnicon rivers and Anderson, Pike's, Whittlesey, Fish, and Pine creeks. ERWs include Empire, Saxine, and Oronto creeks as well as the Flag, Little Bois Brule, and Red rivers. A complete list of ORWs and ERWs in this ecological landscape can be found on the Wisconsin DNR's Outstanding and Exceptional Resource Waters web page (WDNR 2012).

Waters designated as impaired on the ***U.S. Environmental Protection Agency (EPA) 303(d) list*** exhibit various water quality problems, including PCBs in fish, sediments contaminated with industrial metals, mercury from atmospheric deposition, bacteria from farm and urban runoff, and habitat degradation. Since the 303(d) designation is narrowly based on the criteria above, a waterbody could be listed as a 303(d) water as well as an ORW or ERW. These designations are not mutually exclusive. A plan is required by the 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.

There are several 303(d) impaired waters here. These are primarily in the Duluth-Superior area and include the St. Louis River, Crawford Creek, Newton Creek, and Allouez Bay. Siskiwit Lake is impaired by atmospheric deposition of mercury. Lake Superior itself is classified as 303(d) impaired, due primarily to pollution associated with a few cities and harbors as well as bioaccumulation of atmospherically deposited mercury. Chequamegon Bay at Ashland is impacted by hydrocarbon pollution associated with coal transfer facilities. The complete list of 303(d) impaired waters and criteria can be viewed at the Wisconsin DNR's impaired waters web page (WDNR 2010a).

The destruction or conversion of mature or old-growth forests dominated by conifers to fields, pastures, residences, and short rotation aspen cover can result in less stable slopes and streambanks because of increased surface water runoff rates—especially if a relatively high percentage of the watershed has been affected. Impervious surfaces, road construction, and overgrazing also contribute to streambank instability. Large amounts of stream sediments have had negative effects on aquatic habitats, including Lake Superior, particularly on fish spawning sites. Nutrient leakage from private septic systems and runoff from barnyards and other sources are also concerns (USDA NRCS 2009).

The St. Louis and Nemadji rivers form the bulk of the St. Louis River Area of Concern, which was designated by the Great Lakes Water Quality Agreement between the United States and Canada in 1972. Nine beneficial use impairments have been recognized: restrictions on fish and wildlife consumption; degradation of fish and wildlife populations; fish tumors or other deformities; degradation of benthos; restrictions on dredging activities; eutrophication or undesirable algae; beach closings; degradation of aesthetics; and loss of fish and wildlife habitat (City of Superior 2007). These problems are being addressed in part via the St. Louis River Remedial Action Plan, begun in 1987. One site along the St. Louis River, the U.S. Steel Corporation site, which was a steel mill operated until 1979, is a U.S. Environmental Protection Agency Superfund site. Sediments in the St. Louis River adjacent to this site contain polycyclic aromatic hydrocarbons (PAHs), mercury, arsenic, lead, other metals, PCBs, and dioxin. To date, cleanup has occurred only on land, but no cleanup has been done of sediments in the water.

During a severe flood, the Nemadji River blasted through an oxbow, exposing raw banks of red clay. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

About one-third of the Nemadji River watershed is overlain with erodible red clay, which in places is up to 200 feet thick. Some of the heavy red clay sedimentation is natural, but human disturbance has exacerbated the problem by removing forest cover for permanent agricultural, residential, or industrial land uses and, formerly, by clearing stream vegetation to improve the efficient transport of logs. On average, the Nemadji deposits more than 105,000 tons of clay, silt, and, especially, sand into Superior Harbor every year, primarily due to slumping of steep valley walls bordering the deeply incised streams. About 33,000 tons are dredged out annually, at a current cost of more than $250,000. The Nemadji River Basin Plan was formulated in 1993 specifically to address this sediment load problem (City of Superior 2007).

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

Several sources were used to characterize the ***historical vegetation*** of the Superior Coastal Plain Ecological Landscape, relying 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 of historical land cover, based on his interpretation of PLS data, was also consulted (Finley 1976). Additional inferences about vegetative cover were sometimes drawn from information on land capability, climate, disturbance regimes, the activities of native peoples, and from 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 PLS data interpretation (Finley 1976), in the mid-1800s the Superior Coastal Plain Ecological Landscape was dominated by forest communities, most notably boreal forest, which occupied about 50% of the ecological landscape (Figure 21.1). Only about 2% of the Superior Coastal Plain was covered by nonforest community types, the least amount in any ecological landscape. PLS information has been converted to a database format, and relative importance values (RIV) for tree species were calculated based on the average of tree species density and ***basal area*** (He et al. 2000). This analysis indicates that there was a high degree of heterogeneity in tree species in this ecological landscape. Eastern white pine had the highest RIV (21.2%), followed by eastern hemlock (*Tsuga canadensis*) (11.7%) and

spruce species (9.7%). White birch, sugar maple (*Acer saccharum*), aspen (*Populus* spp.), northern white-cedar, tamarack (*Larix laricina*), yellow birch (*Betula alleghaniensis*), and balsam fir all had RIVs of 5% or higher. See the map entitled "Vegetation of the Superior Coastal Plain in the Mid-1800s" in Appendix 21.K at the end of this chapter.

Current Vegetation

There are several data sets available to help assess current vegetation on a broad scale in Wisconsin. Each 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, as 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. In general, information was cited from the data sets deemed most appropriate for the specific factor being discussed. Information on data source methodologies, strengths, and limitations is provided in Appendix C, "Data Sources Used in the Book," in Part 3 ("Supporting Materials"). WISCLAND land use/land cover data classifies general land cover attributes and can be useful in characterizing large-scale land use features and attributes. It is based on satellite imagery from 1992, so it does not represent present day information. WISCLAND was used here to offer a general view of the broad patterns of land use and land cover in a given ecological landscape.

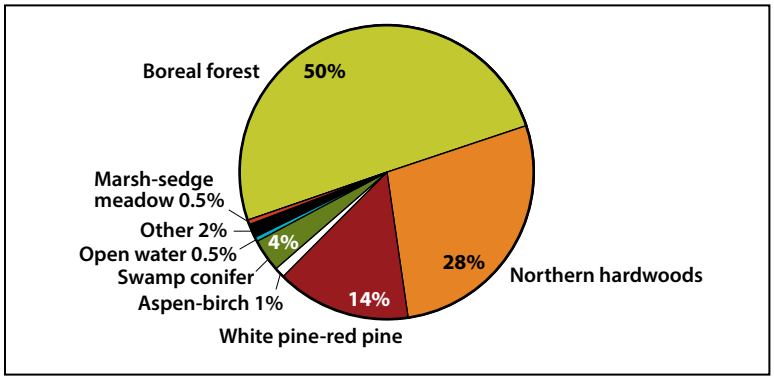


Figure 21.1. *Vegetation of the Superior Coastal Plain Ecological Landscape during the mid-1800s, as interpreted by Finley (1976) from federal General Land Office public land survey information.*

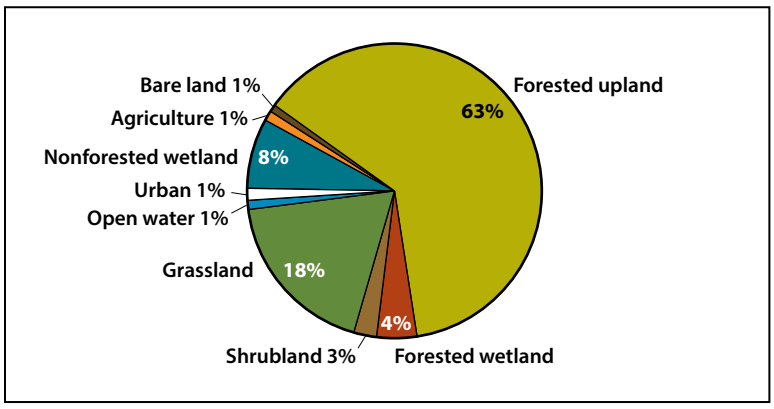


Figure 21.2. *WISCLAND land use/land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery (WDNR 1993) for the Superior Coastal Plain Ecological Landscape.*

The Superior Coastal Plain Ecological Landscape is approximately 906,000 acres in size, of which approximately 67% was forested and 33% was nonforested in 1992 (WDNR 1993). WISCLAND land use/land cover data from 1992 classified 18% of the ecological landscape as grassland (Figure 21.2), which is the highest percentage of grassland of all ecological landscapes in Province 212 (Cleland et al. 1997).

The Wisconsin Wetlands Inventory (WDNR 2010b) offers a more specific assessment of wetlands than is available with WISCLAND data but is limited to those wetlands that can be identified and classified from aerial photography. According to the Wisconsin Wetlands Inventory, wetlands occupy a relatively low portion of the Superior Coastal Plain, comprising 12.2% (approximately 111,000 acres) of this ecological landscape's vegetation. Forested wetlands make up over 68,000 acres of the ecological landscape, making these the most abundant wetlands in the Superior Coastal Plain. The next most abundant wetlands are scrub/shrub wetlands, which occupy approximately 37,000 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," in Part 1 of the book.

According to FIA data summarized in 2004 (USFS 2004), approximately 31% of land area in the Superior Coastal Plain Ecological Landscape is nonforested, and about 69% is forested (Figure 21.3). The predominant forest cover type group is aspen-birch (58% of the forested area), followed by northern hardwoods (19%). Each of the other forest types occupies less than 10% of the forested area.

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 or suppressing fires). Although data are limited to a specific snapshot in time,

they provide valuable insights into Wisconsin's ecological capabilities. 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 and retain management options for the future. We do not mean to imply that entire ecological landscapes be restored to historical conditions, as this is not possible and not necessarily desirable within the context of providing for human needs and desires. Information on the methodology, strengths, and limitations of the vegetation change data is provided in Appendix C, "Data Sources Used in the Book," in Part 3 ("Supporting Materials").

Current forest vegetation (based on FIA) is primarily aspen and birch (40.5% of RIV), red maple (*Acer rubrum*) (14.8% of RIV), northern hardwood species (12.4% of RIV), and fir-spruce (11.9% of RIV; Figure 21.4). Aspen-birch have increased dramatically (from 16.0% to 40.5% of RIV) as has red maple (from 0.1% to 14.8% of RIV). Pine species have decreased from 25.7% to 6.0% of RIV. Most notably, eastern white pine has decreased by 17.8% of RIV. Northern hardwood species have also decreased from 26.6% to 12.4% of RIV.

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 natural communities found in the Superior Coastal Plain Ecological Landscape, 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.

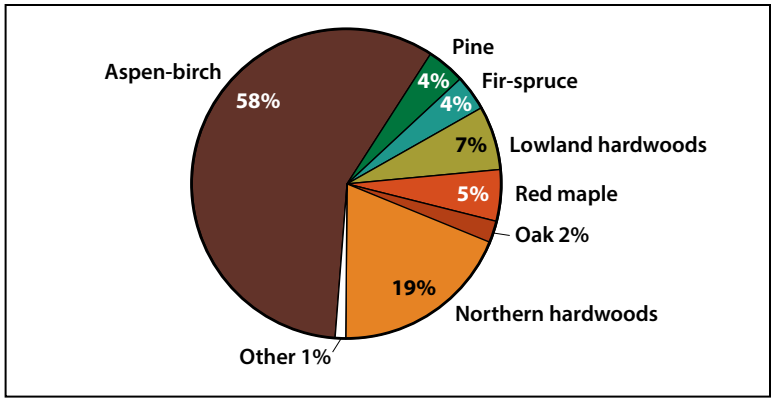


Figure 21.3. *Forest Inventory and Analysis data (USFS 2004) showing forest type as a percentage of forested land area (greater than 17% crown cover) for the Superior Coastal Plain Ecological Landscape. For more information about the FIA data, see Appendix C, "Data Sources Used in the Book," in Part 3 of the book, "Supporting Materials."*

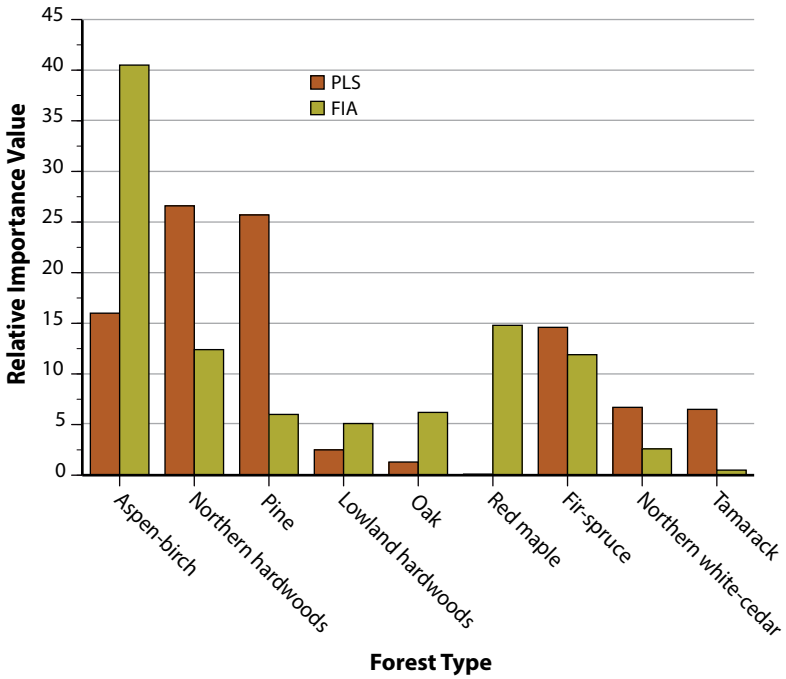


Figure 21.4. *Comparison of tree species' relative importance value (average of relative dominance and relative density) for the Superior Coastal Plain Ecological Landscape during the mid-1800s, when the federal General Land Office public land survey (PLS) data were collected, with 2004 estimates from 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.*

Forests. The Superior Coastal Plain Ecological Landscape was almost entirely forested prior to settlement by Euro-Americans. The poorly drained heavy clay soils east and west of the rugged Bayfield Peninsula historically supported "Boreal Forest" (Curtis 1959, Finley 1976), referred to by some as the "Clay Plain Forest." Canopy dominants included eastern white pine, white spruce, balsam fir, and white birch. Aspens, including quaking aspen and balsam poplar, were locally common and widespread but not necessarily dominant, as quaking aspen is in so many places today. Canopy associates included northern white-cedar, black ash, green ash (*Fraxinus pensylvanica*), red maple, red pine, and oddly (to those familiar with it

as a dominant tree in the oak savannas south of the ***Tension Zone***), bur oak (*Quercus macrocarpa*). These forests were diverse and structurally complex, especially as stands aged.

On the much rougher topography of the Bayfield Peninsula and throughout much of the Apostle Islands archipelago, the soils are more varied, and the vegetation is either dominated by or mixed with mesophytic species such as eastern hemlock, yellow birch, sugar maple, and northern red oak (*Quercus rubra*). Forests of northern white-cedar, yellow birch, and eastern hemlock, with dense understories of shrubs such as Canada yew (*Taxus canadensis*) (Judziewicz and Koch 1993) and mountain maple (*Acer spicatum*), were historically common in the poorly drained uplands of the Apostle Islands, and most of the old-growth remnants there are of this type. This forest community also occurred on the margins of the Bayfield Peninsula, but forests in that area have been and, with the exception of a narrow strip within Apostle Islands National Lakeshore, generally continue to be heavily cut. In recent years, the shorelines of the Bayfield Peninsula have been affected by increased residential development, and forests there now receive heavy browse pressure from white-tailed deer (*Odocoileus virginianus*).

Following the Cutover and subsequent slash fires of the late 1800s and early 1900s, there was a tremendous increase in aspen (especially quaking aspen), which often replaced the native conifers. In some of the current aspen forests of the Superior Coastal Plain, e.g., on the Brule River State Forest (Epstein et al. 1999), boreal conifers (especially white spruce and balsam fir) are strongly represented in the subcanopy and sapling layers, creating excellent opportunities to increase or restore diminished forest communities and associated missing compositional and structural features.

Pine-dominated dry and dry-mesic forests are characteristic of the forested portions of the sandspits that occur at the mouths of many of the rivers entering Lake Superior. Stands of northern pin oak (*Quercus ellipsoidalis*) also occur on some of the larger spits, e.g., on Long Island. Rocky sandstone headlands on the northern edge of the Bayfield Peninsula, as

Old-growth forest of yellow birch, northern white-cedar, and balsam fir. Canada yew is the dominant shrub. Devils Island, Apostle Islands National Lakeshore, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

The second-growth boreal forest on much of the Superior Coastal Plain west of the Bayfield Peninsula is heavily dominated by aspen (yellow-gold in this photo). Mouth of the Brule River, Douglas County. Photo by Eric Epstein, Wisconsin DNR.

A dense Northern Dry Forest dominated by jack pine covers much of Long Island. Northern pin oak and red pine are important trees on other parts of the island. Apostle Islands National Lakeshore, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

well as the margins of several of the Apostle Islands, may also support stands of pine, though these are seldom extensive. Where lenses of sand occur at or near the surface, stands of eastern white and red pines are sometimes present.

The bottomlands within the floodplains of the larger rivers and along their margins support floristically rich stands of mesic sugar maple-basswood forest as well as floodplain forest composed of silver maple (*Acer saccharinum*), green ash, box elder (*Acer negundo*), and bur oak. These communities and many of their associated floristic components are at or very close to their extreme northern range limits and contribute significantly to regional floristic diversity. Rich mesic hardwood and floodplain forests have been documented primarily on the lower Nemadji and Bad rivers and, to a much lesser degree, along some of the other streams entering Lake Superior.

Old-growth forest was historically common here but is now extremely limited. Some of the best remaining examples of old growth in the Superior Coastal Plain Ecological Landscape are associated with U.S. Coast Guard lighthouse reservations on the Apostle Islands. These are mostly wet-mesic forests dominated by various combinations of eastern hemlock, yellow birch, red maple, and northern white-cedar. Older forests of eastern white pine, red pine, jack pine (*Pinus banksiana*), and other conifers (including balsam fir and both native spruces) occur on sandspits on several of the islands.

Though the Superior Coastal Plain is farther north than any other ecological landscape in Wisconsin, forest fragmentation is significant, and the second-growth forest is broken up by agricultural lands and old fields almost everywhere but on the Bayfield Peninsula and in the Apostle Islands.

White-tailed deer browse is severe in parts of this ecological landscape, with only young white spruce avoiding heavy damage from white-tailed deer. The structural and compositional contrasts between forests with a dense understory of sapling conifers, Canada yew, and mountain maple on islands lacking deer with formerly similar stands on islands with deer (or on the mainland) are dramatic.

Savannas. Savannas are extremely limited in the Lake Superior region. Though rare, the "Great Lakes Barrens" community has been documented on sandspits in the Apostle Islands as well as on Long Island-Chequamegon Point. Barrens vegetation this far north in Wisconsin does not support understories rich in prairie species (which are a significant part of the pine and oak barrens floras found just to the southwest in the Northwest Sands Ecological Landscape). On the Superior Coastal Plain, the ground layer of this community is characterized by an odd assemblage of sclerophylls, such as false heather (*Hudsonia tomentosa*); other low shrubs including common juniper (*Juniperus communis*), blueberries (*Vaccinium* spp.), bearberry (*Arctostaphylos uva-ursi*), and sand cherry (*Prunus pumila*); wintergreen (*Gaultheria procumbens*); and an assortment of mosses, lichens, and fungi adapted to extremely xeric environments lacking a closed forest canopy.

Great Lakes Barrens community. Apostle Islands National Lakeshore, Ashland county. Photo by Eric Epstein, Wisconsin DNR.

Shrub Communities. Alder Thicket is a widespread and common tall shrub community throughout the Superior Coastal Plain Ecological Landscape, where it occurs along the edges of streams and on open wetland margins. Forests on the poorly drained clay soils (which are especially characteristic of the red clay country in the western third of the ecological landscape) can experience "swamping" if they are not carefully managed and may convert to alder if the water table is raised by the reduced evapotranspiration that follows canopy removal. The recovery of forests damaged in this way appears to be very slow. In the interim, alder may (and often has) become the dominant cover.

On the heavy red clays, especially in the vicinity of Lake Superior, mixed stands of willow, dogwoods, and other tall shrubs are present. These stands may include alder, but sometimes other shrubs are dominant.

Shrub swamps, although often overlooked or even treated with scorn because they are locally abundant and lack the aesthetic appeal of other native plant communities, support many species of conservation concern, due to rarity, declining populations, or recreational value. Examples include snowshoe hare (*Lepus americanus*), wood turtle (*Glyptemys insculpta*), American Woodcock (*Scolopax minor*), Veery (*Catharus fuscescens*), and Golden-winged Warbler (*Vermivora chrysoptera*). Alder-dominated habitats are also important for other game animals.

Although it does not precisely fit our definition of "Alder Thicket," which is a wetland community on muck soils, an assemblage of shrubs may develop on upland bluff edges or on natural berms along watercourses, dominated by green alder (*Alnus viridis*), russet buffalo-berry (*Shepherdia canadensis*), snowberry (*Symphoricarpos albus*), wolfberry (*S. occidentalis*), and common ninebark (*Physocarpus opulifolius*). A somewhat similar assemblage has been documented on clay bluffs along Lake Michigan south of Sturgeon Bay. The clay bluffs are often somewhat unstable, and the characteristic plants may include mixtures of weedy generalists and habitat specialists of limited distribution.

Alder Thicket, bordering lower reaches of the Sioux River. Bayfield County. Photo by Eric Epstein, Wisconsin DNR.

Emergent marsh along the Pokegama River, a tributary of the St. Louis River and part of the St. Louis River Estuary. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Allouez Bay is at the eastern end of the St. Louis River Estuary. Poor water quality, invasive species, and loss of sensitive vegetation are among the problems facing managers at this still valuable wetland. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Herbaceous Communities. Among the most distinctive and ecologically significant native herbaceous communities of the Superior Coastal Plain are the open peatlands associated with the freshwater estuaries and lagoons concentrated along the southwestern Lake Superior coast and on several of the Apostle Islands. Natural communities associated with such sites may include marshes, sedge meadows, and fens, but shrub swamps, conifer swamps, and bogs may also be present. Numerous rare species are associated with these coastal wetlands and the accompanying sandscapes. The associated sandspits often support Great Lakes Beach and Great Lakes Dune communities. See Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," for additional information.

Estuaries that have been polluted by the addition of sediments and nutrients have lost many of their characteristic plant species (including many rarities) and now support marsh vegetation composed mostly of coarse graminoids such as cat-tails, bur-reeds, and bulrushes (Meeker and Fewless 2008). Several of these marshes have been seriously invaded by purple loosestrife (e.g., at Fish Creek in Ashland and in parts of the St. Louis River Estuary). Common reed has now gained a toehold in several of the coastal wetlands and should be watched carefully because it is likely to spread.

Ridge-and-swale complexes are infrequent on western Lake Superior, but there is a good example on the Chequamegon Bay side of Long Island where a series of narrow sand ridges forested with pines alternates with open swales containing bog, sedge meadow, and shrub swamp vegetation.

The poorly drained red clays in the vicinity of the city of Superior support unusual variants of shrub swamp and sedge meadow communities. The meadows tend to be dominated by common broad-leaved species such as common lake sedge (*Carex lacustris*), but where springs and drainages are present, composition can be diverse and highly variable. The red clay wetlands in and around Superior are especially notable for the high number of rare plants they support, several of which have been found in no other part of Wisconsin (see the "Flora" section of this chapter for details).

Surrogate grasslands are common in parts of the clay plain, especially west of the Bois Brule River, east and south of the city of Superior, and south and west of Ashland. This open habitat includes mixtures of abandoned and active croplands, pasture, and fallow fields. Most of these grasslands are privately owned, though there are several relatively large complexes of open old fields, some of them supporting wetland vegetation, along Highway 13 within and adjacent to the Brule River State Forest.

The larger and less isolated grassland sites support sensitive and declining grassland birds, including Sharp-tailed Grouse (*Tympanuchus phasianellus*), Upland Sandpiper (*Bartramia longicauda*), Northern Harrier (*Circus cyaneus*), Bobolink (*Dolichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*), and Le Conte's Sparrow (*Ammodramus leconteii*). A comprehensive inventory of grassland sites in the Superior Clay Plain is needed to document and assess their conservation potential. Having such information would be a great help in selecting sites for various management scenarios, especially as restoration of forests and, especially, stream corridor vegetation is likely to be a higher priority at many locations. Opportunistic management of small scattered patches of grassland should be weighed carefully against the benefits of managing toward forested conditions to increase forest area, reduce forest edge, retain snow cover and water for longer periods, and provide habitat for forest interior species that are now relatively scarce in many parts of the Superior Coastal Plain.

Sites to consider for a grassland management focus would be large, in permanent grass cover (or with that potential), free of aggressive weeds that could spread to native habitats, support sensitive birds, contain wet or aquatic inclusions, and most importantly, would not conflict with opportunities to restore and/or manage Boreal (clay plain) Forest or with areas that are better suited to forest cover to enlarge effective forest area, reduce high contrast edge, and protect water quality.

Primary Communities. Beach and dune communities are associated with the Lake Superior coast, where they are central parts of the natural community mosaic of the "sandscapes," distinctive geological features of high ecological significance often associated with the freshwater estuaries and island lagoons. The beach and dune habitats of western Lake Superior are floristically depauperate when compared with such features on Lake Michigan, but they nevertheless support a distinctive group of highly specialized plants and are important to shorebirds, gulls, terns, and other animals. Migratory birds make heavy use of the larger sandscapes, such as those occurring at Wisconsin Point, Long Island, Outer Island, and the Stockton Island tombolo.

Bedrock exposures occur in relatively few areas in the Superior Coastal Plain. Most of them are on the north coast of the Bayfield Peninsula or in the Apostle Islands, where formations of late Precambrian sandstone, referred to collectively as the "Bayfield sandstones" (Dott and Attig 2004),

Sandstone bedrock forms a portion of the shoreline in the Apostle Islands archipelago. Cliffs, boulders, cobbles, and ledges provide habitat for plants that are extremely rare in Wisconsin. Photo by Emmet Judziewicz.

are exposed as cliffs or ledges. This is especially true on the windward sides of the islands. The sandstones receive frequent wave-splash, are often bathed in fogs, and in winter may be encased in ice. This has created unusual growing conditions that have favored the presence of highly specialized plants, many of them rare, such as the carnivorous common butterwort (*Pinguicula vulgaris*). This species has been found nowhere else in Wisconsin but on wet sandstone cliffs of the Apostle Islands.

There are a few highly localized exposures of rock elsewhere. Sandstones form the walls of short canyons on the Bayfield Peninsula, and igneous rock has been exposed as rapids, waterfalls, or gorges along streams in the western part of the ecological landscape.

Aquatic Communities. Lake Superior is the largest and deepest of the Great Lakes and by surface area is the largest freshwater lake in the world. Inland lakes are represented primarily by the lagoons found behind sandspits along the Lake Superior shore. The lagoons tend to be shallow and often support diverse marshes of emergent, floating-leaved, and submergent aquatic macrophytes. Wild rice is abundant in the Bad River-Kakagon Sloughs but elsewhere is very local (e.g., in a few parts of the St. Louis River Estuary).

Many streams in the eastern and western portions (Ashland, Iron, and Douglas counties) of the Superior Coastal Plain Ecological Landscape generally begin immediately in or north of either the Superior escarpment or the Penokee-Gogebic Range. They collect a small quantity of groundwater from a comparatively thin layer of glacial till lying on bedrock and then snake their way through valleys deeply incised in red clay deposits before reaching Lake Superior. These shallow aquifer streams are typically surface-water dominated, with groundwater only able to sustain the cold temperatures suitable for species such as brook trout in the upstream reaches. Several of these rivers have cut through the red clay

deposits and reached the underlying bedrock forming waterfalls, such as Copper Falls on the Bad River and Big Manitou Falls on the Black River.

The streams flowing into Lake Superior from the central portion of the ecological landscape in Bayfield County are unique. These streams gather most of their groundwater from deep aquifers at the interface between the Northwest Sands and Superior Coastal Plain ecological landscapes. They flow down deeply incised valleys through the Superior Coastal Plain into Lake Superior. Cold, clean groundwater is supplied by the deep sand aquifers (the deepest unconsolidated material in Wisconsin), providing conditions that are suitable for supporting assemblages of coldwater organisms for most of their length. Historically these streams contained high quality brook trout habitat.

The Bois Brule River in Douglas County (often referred to simply as "the Brule") has had a unique glacial and postglacial history. Approximately 10,000 years ago, it was the Brule "spillway" that carried water from Glacial Lake Duluth (Lake Superior's predecessor) to the south into what is now the St. Croix River. The Bois Brule has a spring-fed, low gradient headwaters section that originates in and cuts across the Northwest Sands Ecological Landscape for 15 miles before it drops down over the clays of the Superior Coastal Plain and flows for 25 miles before reaching Lake Superior (Bean and Thompson 1944).

The impervious nature of the red clay soils that cover much of this ecological landscape and form the base for most of the basin's streams causes the land to shed surface water quickly to the watercourses, especially where forest cover has been removed for various purposes, including some types of agriculture, road construction, logging practices, and residential development. In the steep-sided stream valleys of the red clay plain, surface drainage can move off the landscape so quickly that it has been termed "urban-like," resembling much more heavily populated and developed parts of Wisconsin where there is a high proportion of impervious surfaces.

Forest Habitat Types

The Superior Coastal Plain Ecological Landscape is dominated by two forest habitat type groups: mesic to wet-mesic and wet-mesic to wet (Table 21.1). Mesic, dry-mesic, and dry sites are uncommon within this ecological landscape.

Mesic to wet-mesic sites are associated with somewhat poorly drained, nutrient medium, clayey soils. Although somewhat poorly drained, a site can be very wet or very dry, depending on the season and on recent precipitation. Predominant soil textures are clay or sand over clay, but coarse clays (e.g., sandy clay, clay loam) also occur. The more productive sites tend to be coarser textured and better drained. Currently, the most common overstory dominant is quaking aspen, but balsam fir, white birch, and red maple also are common. Occasional associates and infrequent dominants include white spruce, eastern white pine, and red pine. On the less common, higher quality sites, associates often include sugar maple, ashes, and oaks. Potential late-successional dominants are red maple, balsam fir, white spruce, and eastern white pine. On the higher quality sites, sugar maple and ashes are important components.

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

Flora

Eighty-one species of plants native to the Superior Coastal Plain Ecological Landscape are tracked by the Wisconsin Natural Heritage Inventory (WDNR 2009) and are referred to as "rare" in this publication. Of these 81 species, 10 are listed as Wisconsin Endangered; 18 are Wisconsin Threatened; 53 are Wisconsin Special Concern. One Wisconsin Threatened plant, the Great Lakes endemic dune thistle (Pitcher's thistle) (*Cirsium pitcheri*) is also listed by the U.S. Fish and Wildlife Service as U.S. Threatened.

Table 21.1. *Forest habitat type groups and forest habitat types[a] of the Superior Coastal Plain Ecological Landscape.*

Northern forest habitat type groups[b]	Northern forest habitat types
Dominant within the Superior Coastal Plain	**Dominant within the Superior Coastal Plain**
Mesic to wet-mesic (M-WM)	ArAbSn ASnMi
Common within the Superior Coastal Plain	**Common within the Superior Coastal Plain**
Wet-mesic to wet (WM-W)	Forest lowland (habitat types not defined)

Source: Kotar et al. (2002).

[a]Forest habitat types are explained in Appendix 21.B ("Forest Habitat Types in the Superior Coastal Plain Ecological Landscape") at the end of this chapter.

[b]Habitat types listed in order from most to least common:
Dominant occurrence is an estimated > 50% of forested land area.
Common occurrence is an estimated 10–50% of forested land area.
Present: Other habitat types (from Habitat Type Regions 2 and 3) can occur locally, but each represents < 1% of the land area of the ecological landscape.

Five of these 81 tracked species are globally rare (assigned a global rank of GI through G3G4 by the international organization NatureServe): Schweinitz's sedge (*Carex schweinitzii*), dune thistle, ram's-head lady's-slipper (*Cypripedium arietinum*), Laurentian bladder fern (*Cystopteris laurentiana*), and auricled twayblade (*Listera auriculata*).

Of the 81 rare plant species tracked by the Wisconsin Natural Heritage Inventory, 16 are known in Wisconsin only from the Superior Coastal Plain Ecological Landscape. These plants include floating marsh-marigold (*Caltha natans*), large toothwort (*Cardamine maxima*), smooth black sedge (*Carex nigra*), English sundew (*Drosera anglica*), mamillate spike-rush (*Eleocharis mamallita*), slender spike-rush (*E. nitida*), woodland cudweed (*Gnaphalium sylvaticum*), Appalachian clubmoss (*Huperzia appalachiana*), auricled twayblade, broad-leaved twayblade (*Listeria convallarioides*), fly honeysuckle (*Lonicera involucrata*), common butterwort, satiny willow (*Salix pellita*), plains ragwort (*Senecio indecorus*), veined meadow-rue (*Thalictrum venulosum*), and narrow false oats (*Trisetum spicatum*).

Among the plants limited to the Superior Coastal Plain Ecological Landscape in Wisconsin, six are listed as Wisconsin Endangered: floating marsh-marigold, slender spike-rush, auricled twayblade, fly honeysuckle, common butterwort, and satiny willow. Four have Wisconsin Threatened status: English sundew, broad-leaved twayblade, plains ragwort, and narrow false oats. The others have Wisconsin Special Concern status. Efforts to retain and conserve these species in their natural habitats in Wisconsin obviously must be focused here.

For an additional 15 of the 81 rare species, half or more (but not all) of their Wisconsin populations occur here. This group includes shore sedge (*Carex lenticularis*), Michaux's sedge (*C. michauxiana*), Laurentian bladder fern, marsh horsetail (*Equisetum palustre*), northern oak fern (*Gymnocarpium jessoense* ssp. *parvulum*), fir clubmoss (*Huperzia selago*), Vasey's rush (*Juncus vaseyi*), Chilean sweet cicely (*Osmorhiza berteroi*), arrow-leaf sweet-colt's-foot (*Petasites sagittatus*), seaside crowfoot (*Ranunculus cymbalaria*), small yellow water crowfoot (*R. gmelinii*), brown beak-rush (*Rhynchospora fusca*), tea-leaved willow (*Salix planifolia*), northern bur-reed (*Sparganium glomeratum*), and white mandarin (*Streptopus amplexifolius*).

Additional information pertaining to the rare plants mentioned here, as well as others included on the Wisconsin Natural Heritage Working List (WDNR 2009), may be found in Appendix 21.C at the end of this chapter.

In Wisconsin the auricled twayblade is known only from a few sites in the Superior Coastal Plain. Photo by Charles and Diane Pierce.

Significant Flora of the Superior Coastal Plain Ecological Landscape

- The Superior Coastal Plain flora includes at least 16 plant species that occur in no other Wisconsin ecological landscape.
- Lake Superior coastal wetlands support a wealth of rare plant life, including species that are more abundant here than in any other ecological landscape.
- The unique array of coastal sandscapes and associated microhabitats support many rare and geographically restricted plants.
- Sandstone exposures on the Apostle Islands and coastal Bayfield Peninsula support many bedrock specialists.
- Cool, moist forested ravines opening to Lake Superior provide habitat for rare plants of limited state distribution.
- The shrub swamps, sedge meadows, and spring seeps comprising the red clay wetlands in and around the city of Superior support a rich flora that includes many rare plants, including species found nowhere else in Wisconsin.
- The boreal "clay plain" forests are unique to the Superior Coastal Plain, exhibit unusual characteristics, and support rare species of very limited distribution in Wisconsin.
- Many "southern" species at their northern range limits, including several disjuncts, inhabit forested terraces along some of the larger rivers.

Habitats of Especially High Value to Rare Plants and Other Flora

The coastal wetlands are major repositories of rare and otherwise sensitive flora. Sedges, rushes, orchids, and insectivorous species are especially well represented. The entire mosaic of natural communities associated with the freshwater estuaries is important, but the fens, in particular, stand out. Conifer swamps, shrub swamps, and marshes are also important parts of these wetland complexes. At several locations, wild rice is among the estuarine marsh dominants and forms extensive beds in some of the coastal wetlands. The aquatic macrophytes component of these complexes is also important. The lagoons, as well as the springs and streams that contribute water to the lagoons, support rarities such as lake cress (*Armoracia lacustris*) and autumnal water-starwort (*Callitriche hermaphroditica*).

Western Lake Superior's beach and dune habitats lack the Great Lakes endemics found farther east, with the exception of a single station for the U.S. and Wisconsin Threatened dune thistle. The beaches and dunes do, however, support a highly specialized flora, and they often contain small patch communities such as Interdunal Wetland (or "dune slack"), mud flats, or wet sand flats, which provide critical habitat for rare plants. Beach and dune habitats are inherently dynamic and on western Lake Superior usually occur on sandspits, which are themselves dynamic features. They may also be somewhat ephemeral, so the critical conservation consideration is to protect and maintain the processes that create, destroy, re-create, and continuously reconfigure these rare habitats. An additional important conservation consideration is that these beach and dune complexes and the sandspits upon which they occur afford protection from wave and ice damage to the wetlands that occupy the basins on the inland side of the spits.

Plant life on the margins of this coastal lagoon is strongly zoned by water depth. Pictured here are horned bladderwort (yellow), the diminutive northeastern bladderwort, and watershield. Apostle Islands National Lakeshore, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

The forests of the Superior Coastal Plain Ecological Landscape also support a number of rarities. Deep, cold, clay ravines on the flanks of the Apostle Islands and on the northern edge of the Bayfield Peninsula support rare herbs such as broad-leaved twayblade, giant rattlesnake-plantain (*Goodyera oblongifolia*), large round-leaved orchid (*Platanthera orbiculata*), whifte mandarin, and Chilean sweet cicely. Older, relatively undisturbed mesic to wet-mesic forests of eastern hemlock, yellow birch, northern white-cedar, and mountain maple, often mixed with boreal conifers such as white spruce and balsam fir, may contain dense thickets of Canada yew, especially on those islands in the Apostle Islands archipelago that have no white-tailed deer. On several of these islands (e.g., North Twin, Raspberry, and York), the growth of Canada yew is especially robust, with extensive, almost impenetrably dense stands, composed of plants exceeding 3 meters in height (Judziewicz and Koch 1993). In recent years, white-tailed deer have reached York and Sand islands and decimated stands of Canada yew, along with sapling northern white-cedar and eastern hemlock.

Floristically rich mesic sugar maple-basswood forests occur on high terraces associated with a few of the large rivers in the Superior Coastal Plain. Photo by Eric Epstein, Wisconsin DNR.

One of the more surprising recent botanical discoveries in this ecological landscape was the exceptionally rich herbaceous flora associated with the mesic maple-basswood forest occupying high terraces between meanders within the corridors of rivers such as the Bad and Nemadji. Many herbs documented in these forests were significantly north of their known Wisconsin ranges.

Lowland forests, especially those dominated by northern white-cedar, may support diverse assemblages of sedges, orchids, ferns, and lichens. In the Superior Coastal Plain, such forests are not common away from the Lake Superior coast. The Bibon Swamp is the largest and most outstanding inland example, though northern white-cedar is dominant in only a small part of this vast swamp. Black ash-dominated hardwood swamps are present, some of them now occupying sites formerly dominated by northern white-cedar. Boggier, more acid conifer swamps of black spruce (*Picea mariana*) and tamarack occur as integral components of the coastal estuaries, and these support rare orchids and sedges. Floodplain Forests (composed mostly of silver maple, green ash, bur oak, and box elder) are found along several of the larger rivers, including the Bad and Nemadji, and these assemblages feature some herbs and trees that reach their northern range limits in the Superior Coastal Plain.

Another major botanical surprise in the Superior Coastal Plain Ecological Landscape was the unusually diverse flora associated with the previously overlooked wetlands on heavy red clay soils, especially in the vicinity of the city of Superior. Though shrub swamps of alder, willows, and dogwoods are the common cover types, scattered meadows of broad-leaved sedges, and even old fields, proved to harbor numerous rare plants, including several species that had not been previously recorded in the state. The red clay soils occupy a belt paralleling the Lake Superior coast from the Duluth-Superior harbor east as far as northwestern Bayfield County, a short distance east of the Bois Brule River. The botanically richest area is within and just south of the city of Superior, especially between the Nemadji and St. Louis rivers. Among the species recently discovered or relocated in the red clay wetlands are floating marsh-marigold, smooth black sedge, slender spikerush, Vasey's rush, sweet coltsfoot, seaside crowfoot, small yellow water crowfoot, and northern bur-reed.

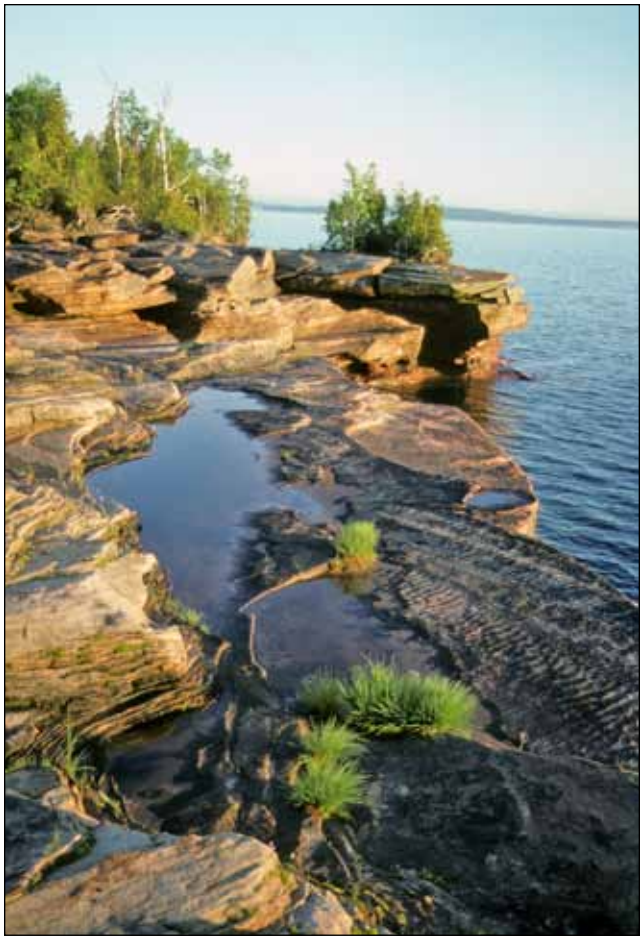
Red clay wetlands near the City of Superior include marsh, sedge meadow, shrub swamp, and seepage pond. Numerous rare plants have been documented here. Pokegama-Carnegie Wetlands, Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Because of the abundance of wetlands within the Superior city limits, the many documented populations of rare plants, and increasing residential and industrial development pressure in and around the city, a Special Area Management Plan, or SAMP, was created to provide a process by which wetland development proposals may be assessed to weigh impacts on wetlands and on rare plant populations. The first SAMP was authorized for ten years and ended in 2007. The U.S. Army Corps of Engineers approved SAMP II for the city of Superior (covering the city only) on November 3, 2008. The basic concept is to balance development and conservation, offering relatively high levels of protection to those wetlands meeting various "integrity" criteria that are part of a Rapid Assessment Methodology used to evaluate and rank wetlands covered by this plan. The largest and least disturbed wetlands and those known to support populations of rare species listed as endangered or threatened by the State of Wisconsin (especially those limited in distribution to and heavily dependent on the red clay wetlands of the western Lake Superior region) are given the highest ranking. Plants with "special concern" status are not given equivalent consideration at this time. Several of the special concern plants are now extremely rare in Wisconsin. For further information about SAMP II, see the City of Superior's SAMP web page (City of Superior 2014).

The red clay soils are also predominant east of the Bayfield Peninsula, in and around the city of Ashland. For reasons that have not yet been clarified, the red clay country east of the Bayfield Peninsula has yielded few or no records for many of the rare plant species documented in and around the city of Superior.

Sandstone cliffs and ledges in the Apostle Islands and on the northern fringe of the Bayfield Peninsula host many habitat specialists, including several that are very rare. The coastal sandstone exposures here may be engulfed by fogs and also receive wave spray, creating unusual microhabitats that are favored by plants such as fir clubmoss, shore sedge, narrow false oats, common butterwort, bird's-eye primrose (*Primula mistassinica*), and mountain cranberry (*Vaccinium vitis-idaea*). The nonvascular flora of these bedrock features has not yet been studied in detail but may prove to be of scientific and conservation interest in the future.

Clay Seepage Bluffs occur on several of the Apostle Islands, along some stretches of the Lake Superior mainland coast, and in deep ravines bordering the upper portions of the St. Louis River Estuary. These bluffs are unstable, and the vegetative cover may vary from bare clay to dense, mature forests. Some of the semi-stable sites have been colonized by an odd assemblage of graminoids, broad-leaved herbs, and shrubs. For example, Wisconsin's largest population of the Wisconsin



Sandstone exposures along Lake Superior support a sparse flora that includes many habitat specialists and rarities. Apostle Islands National Lakeshore. Photo by Emmet Judziewicz.

Threatened marsh grass-of-Parnassus (*Parnassia palustris*) occurs in this habitat on the Apostle Islands. Additional survey work is needed to better characterize the seepage bluffs, especially in the Superior area.

Public lands known to be highly significant for the conservation of rare flora in this ecological landscape include Apostle Islands National Lakeshore, Brule River State Forest, Big Bay State Park, the City of Superior Municipal Forest, portions of the Douglas and Bayfield County forests, and a number of ***state natural areas,*** including Bark Bay, Bibon Swamp, Lost Creek, Port Wing, and Nourse's Sugar Bush.

Among the privately owned lands of high importance to rare plant conservation are portions of the reservations of the Bad River and Red Cliff Bands of the Lake Superior Ojibwe. Several land trusts are active in this part of Wisconsin and have initiated or completed important land and water protection projects on Madeline Island, along Chequamegon Bay in Bayfield County, within the Bois Brule River watershed, and in western Douglas County.

A systematic survey of the nonvascular flora associated with substrates such as bare rock, clay seeps, open sand, and old-growth forests would have the potential to add significantly to our knowledge of plant distribution and abundance as well as conservation significance in the Superior Coastal Plain Ecological Landscape.

Fauna

Changes in Wildlife over Time

Many wildlife populations have changed dramatically since humans arrived on the landscape, but these changes were not well documented before the mid-1800s. This section discusses only those wildlife species previously documented in the Superior Coastal Plain 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 a collection of articles written by A.W. Schorger, compiled into the volume *Wildlife in Early Wisconsin: A Collection of Works by A.W. Schorger* (Brockman and Dow 1982).

Historically, the Superior Coastal Plain Ecological Landscape was especially important for wildlife species associated with boreal forest, forested and open wetlands, and the waters and shorelines of Lake Superior. Important species included American marten (*Martes americana*), fisher (*M. pennanti*), American black bear (*Ursus americanus*), American beaver, North American river otter (*Lontra canadensis*), Spruce Grouse (*Falcipennis canadensis*), and possibly, moose (*Alces americanus*) and caribou (*Rangifer tarandus*). Migratory birds, including passerines, shorebirds, gulls, terns, and raptors, were also likely important here then, as they are now. As forests were logged in the late 19th and early 20th century and the ecological landscape was inhabited by Euro-American settlers, wildlife populations and available habitats changed.

The gray wolf (*Canis lupus*) was found throughout the state (Schorger 1942), including the Superior Coastal Plain. It likely was not very abundant since its chief prey item was the white-tailed deer, which was uncommon in this region. Following Euro-American settlement in the mid-1800s, gray wolf populations declined dramatically. 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. 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 has increased to its current level of over 800 individuals (see Chapter 12, "North Central Forest Ecological Landscape," for a more complete discussion of the gray wolf). Today the Superior Coastal Plain Ecological Landscape supports several packs of gray wolves within its boundaries.

The American marten occurred in all timbered areas of Minnesota, Wisconsin, and Michigan. It was most frequently found in areas with conifers (Schorger 1942), including the Superior Coastal Plain Ecological Landscape. The rapid decline of the American marten was caused by an unregulated fur

trade and large-scale, heavy logging of the forests followed by burning. The last historical record of an American marten trapped in Wisconsin was near Maple, in Douglas County in 1925, and the last recorded historical sighting of a wild American marten in Wisconsin was in Sawyer County in 1939. In 1934 a French trapper was reported to have taken several American marten from Outer Island, but this was never authenticated. An unsuccessful attempt was made to reintroduce American marten on Stockton Island (one of the Apostle Islands) in 1953, but this population did not persist. Other attempts to reintroduce the American marten have been made in the North Central Forest Ecological Landscape. See Chapter 12, "North Central Forest Ecological Landscape," for a more detailed discussion of American marten history and reintroduction.

The fisher had a range similar to that of the American marten and also occurred in this ecological landscape. The fisher was not as numerous as the marten historically and was more common in hardwood forests (Schorger 1942). Extensive logging, wildfires, and unregulated trapping drastically reduced the fisher population by 1900 (Kohn et al. 1993). The last verified historical report of a fisher in Wisconsin prior to its reintroduction was in 1932. The U.S. Forest Service and Wisconsin Conservation Department cooperated to reestablish fisher in Wisconsin during 1956–67. Peterson et al. (1977) reported that fishers occurred throughout the northern quarter of the state by 1975. For a detailed account of fisher stocking, see Williams et al. (2007). Today the fisher occupies almost all forested habitats in the northern and central parts of the state.

Historically, American beaver were present throughout Wisconsin, including the Superior Coastal Plain Ecological Landscape. As elsewhere in the state, beaver populations declined dramatically with unregulated trapping and hunting for the fur trade through the 1700s and mid-1800s (Schorger 1965). Beaver populations have recovered due to the implementation of harvest regulations and an abundance of aspen, one of its preferred foods. The species is now considered a problem in some areas of the state because it dams streams, which raises water temperatures and renders them unsuitable for trout. The Superior Coastal Plain Ecological Landscape is in Beaver Management Zone A, which is described as having a high beaver population and excellent beaver habitat, relatively few people and beaver conflicts, and with a goal of a stable beaver population (WDNR 2005a).

Based on trapping records (Schorger 1970), the North American river otter was historically as abundant, or more abundant, in Wisconsin as the American beaver. Because of unregulated trapping for the fur trade, North American river otter populations declined dramatically throughout the state, as did the populations of other furbearers. Today North American river otter populations have recovered in many areas, and they are again found in the Superior Coastal Plain Ecological Landscape.

White-tailed deer were found throughout the state but were likely more abundant in southern Wisconsin than in the northern part of the state at the time of Euro-American settlement (Schorger 1953). Northern Wisconsin, including the Superior Coastal Plain, was vegetated primarily with nonoptimal habitat of mature deciduous-coniferous forest that limited the white-tailed deer population here. A deep snowpack near Lake Superior further limited white-tailed deer movements and access to food and at times led to severe winter mortality and further white-tailed deer herd reduction. The white-tailed deer population expanded here as it did in all of 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 by young deciduous forest, including vast acreages of aspen and white birch and other forage plants that provided an abundant food supply for white-tailed deer. The white-tailed deer population expanded in the 1930s, again in the mid-1960s, and dramatically since the 1980s (Figure 21.5) (see the "Changes to Fauna" section in Chapter 4, "Changes and Trends in Ecosystems and Landscape Features," in Part 1 for a statewide description of changes to white-tailed deer populations).

Today white-tailed deer populations are large compared to what they were before Euro-American settlement. Logging and other human activities have maintained much of the northern forest here in young hardwoods, including quaking aspen, which provides abundant food for white-tailed deer. However, white-tailed deer are still subject to starvation during severe winters because of deep snow and severe cold. 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. White-tailed deer populations throughout northern Wisconsin during the 1990s and 2000s have been consistently above goals (Figure 21.6). By 2008 the white-tailed deer herd in northern Wisconsin was back near established population goals again.

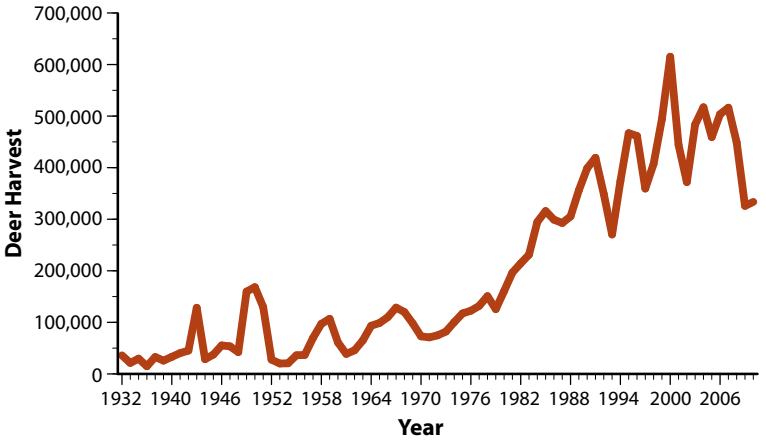


Figure 21.5. *Statewide white-tailed deer harvest, 1932–2010 (Wisconsin DNR unpublished data).*

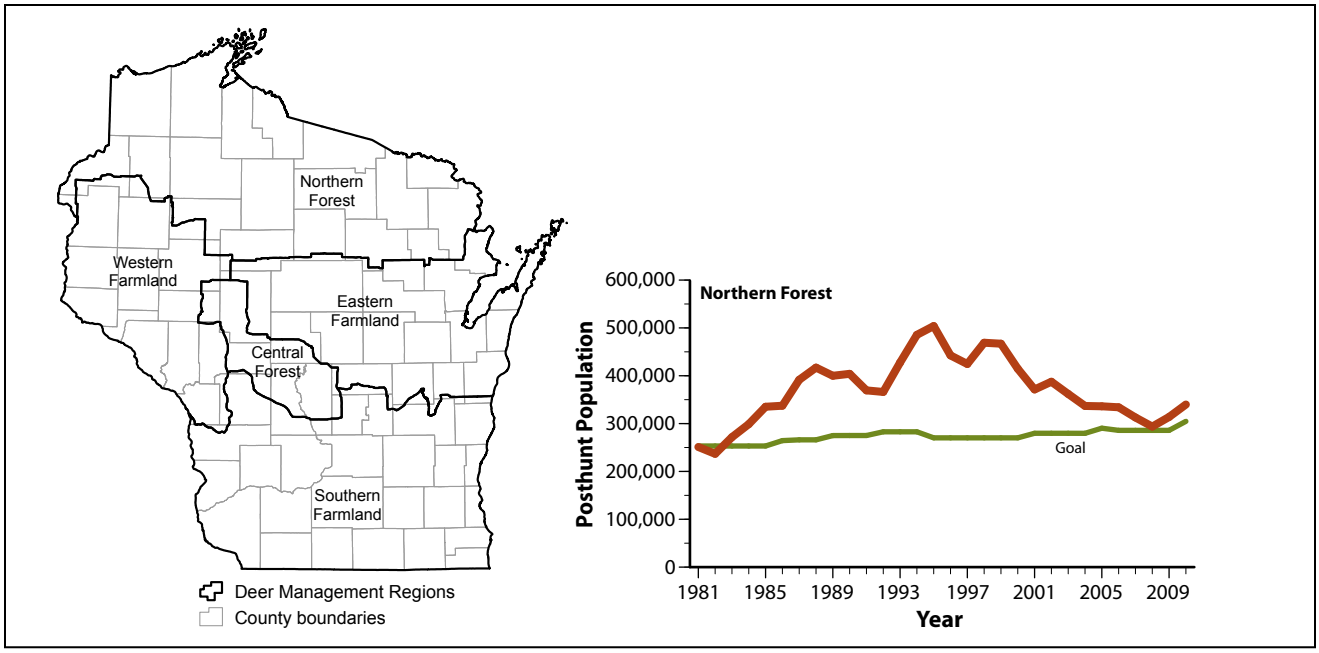


Figure 21.6. *White-tailed deer population size in relation to population goals in the northern forest deer management region, 1981–2010 (Wisconsin DNR unpublished data).*

In 2009 the white-tailed deer herd was near the established goals (15–20 deer per square mile of deer range) in the five deer management units in the Superior Coastal Plain Ecological Landscape. Overbrowsing can be a significant problem here, but it has been especially dramatic in confined areas, such as on those islands in the Apostle Islands archipelago that are or have been inhabited by white-tailed deer (Allison 2006). Conifers and other browse-sensitive plants will continue to decline unless white-tailed deer populations are reduced to sustainable levels that allow the vegetation to recover.

Historically, moose were found throughout the northern one-third of Wisconsin. The largest moose populations were in the northwestern part of the state. Due to uncontrolled hunting, few moose existed in the state after 1900. Today there are a small number of moose in this ecological landscape, which likely wander into Wisconsin from Minnesota or from the reintroduced population in Upper Michigan. At this time, northwestern Wisconsin does not appear to support a stable breeding population of moose.

Caribou were never common in Wisconsin, but there are a few historical records from the southern shores of Lake Superior. Most of these reports were from the Keweenaw Peninsula in Upper Michigan (Schorger 1942). There is a report of hunters killing caribou in Wisconsin in 1910, but those records are questionable. In 1906, 20 caribou were moved from Newfoundland to the Pierce estate on the Bois Brule River, but none of them survived.

American black bears were abundant throughout the northern and central parts of the state and remained in the northern part of the state throughout the Euro-American settlement period but in reduced numbers. Today American black bears occur throughout the Superior Coastal Plain Ecological Landscape and on several of the Apostle Islands. Stockton Island has the highest density of American black bears in North America (Garshelis 1994). The density of 2.1 American black bears per square mile on Stockton (in 1994) was considerably higher than the average of 1.0 American black bear per square mile on the Wisconsin mainland (Storlid 1995, Fleming 1997).

Bull moose. Moose are occasionally observed in the Superior Coastal Plain, but a stable breeding population does not occur there. Photo by Donna Dewhurst.

The Spruce Grouse was a common bird in the northern part of the state where conifers were abundant, so it was likely present in this ecological landscape. After the northern forests were logged, the Spruce Grouse quickly declined.

It was difficult to find them in the early 1900s (Schorger 1942). Today Spruce Grouse occur sporadically across the north where dense stands of conifers are found (Worland et al. 2009). They especially seem to use the edges between stands of upland and lowland conifers. The only place in or close to the Superior Coastal Plain where Spruce Grouse have been reported recently was the Brule River State Forest (Figure 21.7).

The Ruffed Grouse (*Bonasa umbellus*) was found throughout forested parts of Wisconsin prior to Euro-American settlement; however, the species was not common in the northern part of the state where old coniferous and hardwood forests predominated (Schorger 1945). Ruffed Grouse populations increased in the north as lumbering took place during the latter half of the 19th century. After coniferous trees were removed, younger birch and aspen-dominated forest habitats became established in many areas that were more favorable to Ruffed Grouse. By 1900 the Ruffed Grouse was reported as "almost abundant" in the northern part of the state (Schorger 1945). Today Ruffed Grouse are common throughout northern and central Wisconsin, although abundance varies with a ten-year population cycle thought to be caused by an influx of avian predators when prey population are scarce farther north.

In 1949 Capercaillie (*Tetrao urogallus*) and Black Grouse (*Lyrurus tetrix*) were introduced to Outer Island in the Apostles by the Wisconsin Conservation Department, the predecessor of the Department of Natural Resources (Gjestson 2013). Sixty birds were obtained from Europe for this attempt. Interestingly, 201 were also released on Grand Island, in Michigan's Upper Peninsula. All of these introduction attempts failed.

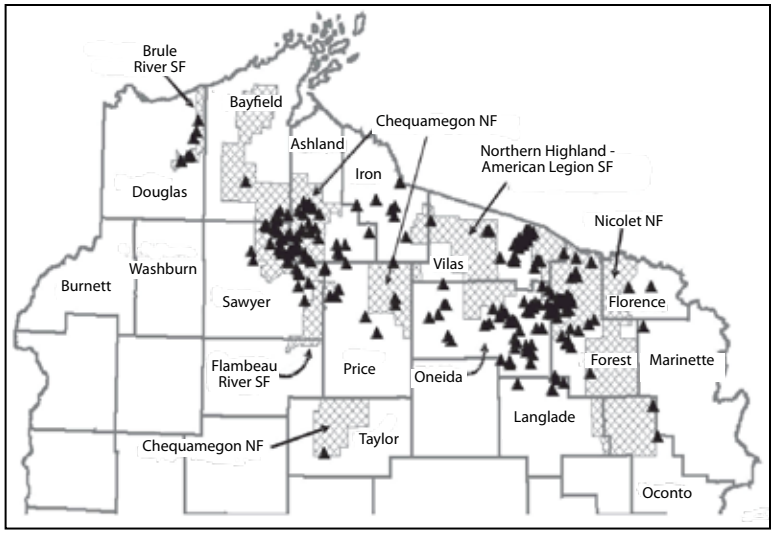


Figure 21.7. *Spruce Grouse observations in Wisconsin from 1980 to 2008, shown by black triangles. Cross-hatched areas are national forests and state forests. Figure reproduced from Worland et al. (2009) by permission of the Wisconsin Society for Ornithology.*

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 native species are maintained in Wisconsin, "significant wildlife" includes both common species and species that are considered "rare." 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). Because maintaining or restoring wildlife communities and habitats are the most efficient way to manage and benefit a majority of species, we also discuss management of different wildlife habitats in which significant fauna occur.

Rare Species. In this publication, "rare" includes all of those species that appear on the Wisconsin Natural Heritage Working List (WDNR 2009) and are classified as "endangered," "threatened," or "special concern" by the State of Wisconsin or the federal government (see Appendix 21.C for a comprehensive list of the rare animals known to exist in the Superior Coastal Plain Ecological Landscape). As of November 2009, the Wisconsin Natural Heritage Working List documented 62 rare animals including 3 mammals, 28 birds, 4 herptiles, 2 fishes, and 25 invertebrates within the Superior Coastal Plain Ecological Landscape. These include two U.S. Endangered species, five Wisconsin Endangered species, five Wisconsin Threatened species, and 52 Wisconsin Special Concern species. See Appendix 21.D at the end of this chapter for the number of species per taxa group with special designations documented within in the Superior Coastal Plain Ecological Landscape by the Natural Heritage Inventory program.

Federally Listed Species: The Piping Plover (*Charadrius melodus*) is listed as U.S. Endangered and breeds here. 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 directing 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*) (formerly U.S. Threatened) is also found here. Since its delisting, it was federally protected with a required monitoring program for five years to ensure that the population did not decline. The Bald Eagle is protected

under the federal Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. The Bald Eagle is now listed as a Wisconsin Special Concern species.

■ ***Wisconsin Endangered Species:*** One mammal (American marten) and four birds, including Piping Plover, Loggerhead Shrike (*Lanius ludovicianus*), Caspian Tern (*Hydroprogne caspia*, listed as *Sterna caspia* on the Wisconsin Natural Heritage Working List), and Common Tern (*Sterna hirundo*), are listed as Wisconsin Endangered. Recent surveys have documented a robust population of the Wisconsin Endangered warpaint emerald dragonfly (*Somatochlora incurvata*) at a northern fen on Stockton Island (DuBois et al. 2005). This record had not yet been added to the Natural Heritage Inventory database at the time of publication so it is not reflected in the table of Wisconsin Endangered species in the Superior Coastal Plain Ecological Landscape (Appendix 21.C). At this site in 2004, DuBois (DuBois et al. 2005) collected a dragonfly that had never before been documented in Wisconsin, the zigzag darner (*Aeshna sitchensis*).

■ ***Wisconsin Threatened Species:*** Three Wisconsin Threatened birds, including Yellow Rail (*Coturnicops noveboracensis*), Spruce Grouse, and Cerulean Warbler (*Setophaga cerulea,* listed as *Dendroica cerulea* on the Wisconsin Natural Heritage Working List), and two Wisconsin Threatened herptiles, including Blanding's turtle (*Emydoidea blandingii*) and wood turtle, occur here. No other Wisconsin Threatened animals are known to be present at this time.

■ ***Wisconsin Special Concern Species:*** Wisconsin Special Concern species include 2 mammals, 21 birds, 2 herptiles, one fish, and 25 invertebrate species within the ecological landscape (see Appendix 21.C at the end of this chapter for a complete rare species list).

The Piping Plover is extremely rare in Wisconsin where it nests only on undeveloped beaches along Lake Superior. Photo by Jack Bartholmai.

■ **Species of Greatest Conservation Need.** Species of Greatest Conservation Need (SGCN) appear in the Wisconsin Wildlife Action Plan (WDNR 2005d) and include those species already recognized as "endangered," "threatened," or "special concern" on state or federal lists along with nonlisted species that meet SGCN criteria. There are 11 mammals, 41 birds, 6 herptiles, and 3 fish species listed as SGCN for the Superior Coastal Plain Ecological Landscape (see Appendix 21.E at the end of this chapter for a complete list of vertebrate Species of Greatest Conservation Need in this ecological landscape and the habitats with which they are associated).

■ **Responsibility Species.** The U.S. Endangered Piping Plover nests here. Five pairs nested on Long Island, a part of Apostle Islands National Lakeshore, as recently as 2009, fledging a total of eight young (S. Matteson, Wisconsin DNR, personal communication). Removal of three coyotes (*Canis latrans*) and the translocation of one bobcat (*Lynx rufus*) by U.S. Department of Agriculture Wildlife Services staff likely enhanced the probability of fledging. Some level of predator control will likely have to occur routinely in the future. Nest exclosures are routinely used by the National Park Service as effective protection against most potential nest predators. Despite the constant threat of predation, the miles of undisturbed open

Pair of zigzag darners. In Wisconsin this boreal dragonfly has been documented only in peatlands on the Apostle Islands. Ashland County. Photo by Dennis Paulson.

beach and dune habitat and protective ownership on Long Island make this by far the best site in the state for breeding Piping Plovers (Matteson et al. 2007). The only other recent Wisconsin nesting attempt was on Lake Michigan in 2008 (in the Northern Lake Michigan Coastal Ecological Landscape), and that nest failed. In past decades, as many as five pairs have nested in the St. Louis River Estuary (Barker's Island, Duluth Port Authority terminal, Wisconsin Point, Superior Sewage Treatment Plant), but no nesting has occurred there since the 1980s.

Two colonies of the Wisconsin Endangered Common Tern occur in this ecological landscape. These are by far the largest nesting colonies in Wisconsin, and they are also the only extant Common Tern colonies on all of Lake Superior. The Duluth-Superior harbor colony contained 202 nests in 2008 and fledged 283 young. The Ashland colony contained 109 nests in 2008, from which 144 young fledged (F. Strand, Wisconsin DNR, personal communication).

This is one of the most important breeding areas in the state for the Merlin (*Falco columbarius*). It nests primarily in conifers, using old nests of other species such as crows, ravens, and hawks, and often nests on or near shorelines. In Wisconsin the Merlin is often associated with boreal forest but has also been recorded breeding in other forest habitats and sometimes in agricultural and even urban areas (Cutright et al. 2006). The coniferous and mixed forests, an abundant prey base, and the extensive Lake Superior shoreline make this ecological landscape an important breeding area for this species.

The lake sturgeon (*Acipenser fulvescens*) occurs in Lake Superior and has declined dramatically because of overfishing and the introduction of the sea lamprey (*Petromyzon marinus*). The population is carefully managed and monitored by the Wisconsin DNR to prevent overharvest and to ensure adequate spawning to maintain the population. Sport fishing of lake sturgeon is allowed, but the harvest is small and incidental to other fishing pursuits.

The Superior Coastal Plain Ecological Landscape has Wisconsin's only known breeding population of the zigzag darner dragonfly. This population occurs in a fen at the base of the tombolo on Stockton Island (DuBois et al. 2005). The only known breeding populations in the state of the Wisconsin Special Concern alkali bluet damselfly (*Enallagma clausum*) also occur here. Adults have been found only along the Lake Superior shoreline in Douglas and Bayfield counties. Exact breeding sites are unknown, but the specimens collected were not thought to be strays or migrants.

Categories of Significant Wildlife

- **Rare species** are those that appear on the Wisconsin Natural Heritage Working List as Wisconsin or U.S. Endangered, Threatened, or Special Concern.
- **Species of Greatest Conservation Need (SGCN)** are described and listed in the Wisconsin Wildlife Action Plan (WDNR 2005d) 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 highly 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.

Socially Important Fauna. Species such as white-tailed deer, American black bear, American beaver, North American river otter, fisher, bobcat, Ruffed Grouse, American Woodcock, Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*), Wood Duck (*Aix sponsa*), and Ring-necked Duck (*Aythya collaris*) are all important here for hunting, trapping, and wildlife viewing. Abundant and diverse populations of birds provide bird watching enjoyment for local residents and visitors at many locations in the Superior Coastal Plain (see the "Wildlife Habitat and Communities" section below). In addition, there are several important migratory stopovers in this ecological landscape that are known region-wide for the large concentrations of birds that stop there during spring and fall migrations, which include many rare species found regularly at few other locations in the state (e.g., Wisconsin Point; see "Wildlife Habitat and Communities" below).

Lake Superior has important commercial fisheries for lake whitefish, lake trout, and cisco (*Coregonus* spp.) species. Lake whitefish numbers had historically declined, but abundance has increased gradually in Wisconsin waters since the 1980s.

Lake trout were nearly extirpated in Lake Superior during the 1950s due to overfishing and sea lamprey parasitism. Creation of refuges/special use areas adjacent to spawning shoals, more restrictive fishing regulations, stocking of fertilized lake trout eggs in astro-turf bundles, and sea lamprey control have combined to increase lake trout abundance. Lake trout stocking is no longer needed in the Apostle Islands region

to maintain populations there (see the "Wildlife Habitat and Communities" section below for more details).

Prior to the 1960s, cisco species were abundant and an important component of the commercial fisheries in Lake Superior. During the 1960s and 1970s, lake herring (a type of cisco) abundance declined, which was likely due to commercial overharvest along with competition and egg predation by nonnative species. Since the 1980s, lake herring abundance has increased but appears to have sporadic recruitment. Lake herring remain an important commercial species in Wisconsin waters, and harvest occurs primarily during November and December, targeting females for their valuable roe (see the "Wildlife Habitat and Communities" section below).

Lake Superior supports an important sport fishery for lake trout, coho salmon (*Oncorhynchus kisutch*), lake whitefish, brown trout (*Salmo trutta*), lake herring, and rainbow smelt (*Osmerus mordax*) in the waters of the lake itself and walleye, smallmouth bass (*Micropterus dolomieu*), northern pike (*Esox lucius*), and yellow perch (*Perca flavescens*) in the shallower bays such as Chequamegon Bay. Chequamegon Bay receives substantial fishing pressure year-round. Chequamegon Bay has a national reputation as a trophy smallmouth bass fishery, which supports a small charter/guide industry. Charter boats from a number of communities along Lake Superior also take fishing customers to harvest lake trout, coho salmon, and brown trout. Tributaries to Lake Superior are spawning areas for introduced nonnative salmonids such as rainbow trout (*Oncorhynchus mykiss*), brown trout, and coho salmon, which are sought by anglers, especially during spawning runs from Lake Superior. The upper reaches and headwaters of some streams contain native brook trout, which are also popular with anglers.

Wildlife Habitat and Communities. This ecological landscape is important to wildlife that use Lake Superior, its islands, coastal estuaries, sandspits, wetlands and shrub swamps, forests, and streams. It also has surrogate grasslands that support rare birds such as Northern Harrier, American Bittern (*Botaurus lentiginosus*), Upland Sandpiper, Bobolink, and Sharp-tailed Grouse and mammals (e.g., Franklin's ground squirrel). It is an important place for both breeding and migrant birds, especially the Lake Superior shoreline, the Apostle Islands archipelago, and some of the major river corridors, such as those of the St. Louis, the Nemadji, the Bois Brule, and the Bad rivers. Forest mammals such as the fisher, American black bear, bobcat, American beaver, and North American river otter are important here. Other large, wide-ranging mammals such as the gray wolf and moose also occur in the Superior Coastal Plain.

Migratory Birds: Lake Superior and its coastal areas and islands are very important for migratory birds, including waterfowl, loons, grebes, cormorants, gulls, terns, raptors, and many passerines (Grveles et al. 2011). Many rare bird sightings occur here.

Significant Wildlife in the Superior Coastal Plain Ecological Landscape

- This is the best place in the state to manage for and restore boreal forests and associated wildlife.
- Long Island is Wisconsin's only current breeding site for the U.S. Endangered Piping Plover.
- Wisconsin's most important Common Tern nesting colonies occur here and are the only Common Tern colonies on Lake Superior.
- Franklin's ground squirrel (*Spermophilus franklinii*) is found on Wisconsin Point.
- Moose occasionally wander into this ecological landscape from Minnesota.
- Many important species occur in and are at least partially dependent on the extensive coastal wetlands.
- Lake Superior and its shoreline habitats, the Apostle Islands, and north-south river corridors receive heavy use by migratory birds. These areas also provide important breeding habitat for many species, including some that are rare.
- This area often has an influx of birds from more northerly regions during winter, especially owls, finches, Gyrfalcon, and Bohemian Waxwing.
- Lake trout, lake sturgeon, whitefish, short-jawed cisco, and kiyi (endemic to the Great Lakes) occur in Lake Superior waters.
- Native brook trout are found in coldwater streams entering Lake Superior, as are some introduced salmonids. All are sought by recreational anglers.
- A nationally recognized smallmouth bass fishery occurs in Chequamegon Bay.
- Rare invertebrates associated with boreal peatlands occur in the Superior Coastal Plain. Several of these have extremely limited Wisconsin distributions.

The Apostle Islands are an important migration stopover area, hosting tens of thousands of passerines and raptors. Since 1990, the Apostle Islands National Lakeshore has periodically conducted migratory bird surveys on Outer and Long islands as part of a long-term bird monitoring program. There are large fluctuations in the volume of migratory birds from year to year, especially on Outer Island, most likely due to highly variable weather conditions. The islands also provide important habitats for resident breeding birds, including many neotropical migrants. Over 89% of breeding birds in the lakeshore are migrants, of which 59% are neotropical migrants. The National Park Service established their annual breeding bird survey in response to the growing need to document abundance trends of neotropical migrant birds in the United States.

Lower Chequamegon Bay is an important migration stopover site for shorebirds, waterfowl (especially diving ducks), and many other waterbirds. Species such as Tundra Swan (*Cygnus columbianus*), Greater Scaup (*Aythya marila*), Lesser Scaup (*Aythya affinis*), Redhead (*Aythya americana*), Black Scoter (*Melanitta americana*), Surf Scoter (*Melanitta perspicillata*), White-winged Scoter (*Melanitta fusca*), Common Loon (*Gavia immer*), Horned Grebe (*Podiceps auritus*), American White Pelican (*Pelecanus erythrorhynchos*), Double-crested Cormorant (*Phalacrocorax auritus*), Great Blue Heron (*Ardea herodias*), Bonaparte's Gull (*Chroicocephalus philadelphia*), Ring-billed Gull (*Larus delawarensis*), and Herring Gull (*Larus argentatus*) are among the many birds using this area during migration. Many rare species have been recorded here, including Thayer's Gull (*Larus thayeri*), Glaucous Gull (*Larus hyperboreus*), Greater Black-backed Gull (*Larus marinus*), Lesser Black-backed Gull (*Larus fuscus*), Pacific Loon (*Gavia pacifica*), Red-throated Loon (*Gavia stellata*), Western Grebe (*Aechmophorus occidentalis*), Eared Grebe (*Podiceps nigricollis*), Arctic Tern (*Sterna paradisaea*), and Gyrfalcon (*Falco rusticolus*). Sandspits (e.g., Wisconsin Point) are important stopover areas for migrating shorebirds, waterfowl, and many landbirds. Large numbers of loons, grebes, and diving ducks use the offshore waters and the adjacent St. Louis River Estuary. Many gulls and terns, (including Caspian Tern, Common Tern, and Black Tern (*Chlidonias niger*), use the shoreline, the nearshore waters, and sandspits. Rare gulls such as Little Gull (*Hydrocoloeus minutus*), Black-headed Gull (*Chroicocephalus ridibundus*), Iceland Gull (*Larus glaucoides*), and Sabine's Gull (*Xema sabini*) have been recorded here in recent years, and this is the best location in the state to see jaegers (*Stercorarius* spp.).

In some years, this region experiences a winter influx of birds that typically inhabit more northerly areas. Species such as Great Gray Owl (*Strix nebulosa*), Boreal Owl (*Aegolius funereus*), Northern Hawk Owl (*Surnia ulula*), and Gyrfalcon are often seen in this ecological landscape during winter. Snowy Owls (*Bubo scandiacus*) winter regularly in and around the Superior and Ashland harbors. In the winter of 2004-05, there was a large irruption of Great Gray Owls, Hawk Owls, and Boreal Owls into this ecological landscape (Bacon and Paulios 2006). Great Gray Owls feed primarily on voles (up to 80% of their diet), and in 2004 small mammal surveys in Canada showed that the number of voles in Canada was the lowest in years. Rather than face starvation, these birds moved south into Wisconsin to find food.

■ ***Lake Superior Shoreline:*** The Lake Superior shoreline is an important nesting and migration area for many birds, including fish-eating colonial nesters, neotropical migrants, wetland species, and some raptors.

Colonial nesting birds such as Herring Gull, Ring-billed Gull, Common Tern, and Double-crested Cormorant have important breeding sites on Lake Superior, on islands, and, to a lesser extent, on cliffs. The Wisconsin DNR has been surveying the entire Wisconsin shore of Lake Superior for these species at their breeding colonies every five years since 1974 (S. Matteson, Wisconsin DNR, personal communication). The data from these surveys have appeared in various papers and reports and in the Wisconsin breeding bird atlas (Cutright et al. 2006), and are provided in raw form to National Park Service staff at Apostle Islands National Lakeshore. A Black Tern survey was repeated statewide from 1980 to 2011 to provide information on the species statewide population status and, ideally, on the causes for decline (Matteson et al. 2012). In 2009, Black Terns were not present as breeding birds at wetlands along and near the lakeshore such as Kakagon Sloughs, Fish Creek Sloughs, Allouez Bay, and the Wisconsin Department of Transportation Kimmes-Tobin Wetlands south of Superior. As noted above, the most important Common Tern nesting colonies in the state (and on Lake Superior) occur in the St. Louis River Estuary at Duluth-Superior and in Chequamegon Bay at Ashland on a former pier remnant, rebuilt especially for use by nesting terns (Matteson 1988). Analysis of 35 years of data from this long-term study of Common Terns is being planned. The Great Blue Heron occurred in low numbers at two colonies in 2009 (S. Matteson, Wisconsin DNR, personal communication).

The Great Gray Owl is an inhabitant of the northern hemisphere's boreal forests. During winters when food is scarce in the far north, Great Grays and other boreal species may move south in substantial numbers. The few confirmed breeding accounts from Wisconsin include recent records from the Superior Coastal Plain. Photo by Ryan Brady, Wisconsin DNR.

The coastal estuaries (e.g., St. Louis River, Port Wing, Bark Bay, Lost Creek, Sand Creek, Raspberry Bay, Whittlesey Creek, Fish Creek, and Bad River-Kakagon Sloughs) provide nesting habitat for many wetland birds. The Bad River-Kakagon Sloughs are one of the most extensive, diverse, and least

disturbed coastal wetlands in the entire Great Lakes Region (Steele 2007). The marshes, fens, shrub wetlands, and conifer swamps of these Great Lakes coastal estuaries support a diverse breeding bird community that includes Yellow Rail, Northern Harrier, Sedge Wren (*Cistothorus platensis*), Le Conte's Sparrow, Northern Waterthrush (*Seiurus noveboracensis*), and Golden-winged Warbler, and these habitats are used by tens of thousands of migrants annually. Near the mouth of Fish Creek, flats of sand and mud are exposed when the water level is low and are used heavily by waterfowl, gulls, terns, and shorebirds as resting or feeding sites. The forested river corridors draining into the sloughs (Bad, White, Potato, and Marengo rivers) host Canada Warbler (*Cardellina canadensis,* listed as *Wilsonia canadensis* on the Wisconsin Natural Heritage Working List), Nashville Warbler (*Oreothlypis ruficapilla*), Black-throated Green Warbler (*Setophaga virens*), Mourning Warbler (*Geothlypis philadelphia*), and large numbers of other species (Steel 2007). Rare invertebrates such as the lake darner dragonfly (*Aeshna eremita*), black meadowhawk dragonfly (*Sympetrum danae*), and a rare predaceous diving beetle (*Rhantus sinuatus*) are also found in these estuaries and other coastal wetlands. Wetlands on several of the Apostle Islands support populations of the Wisconsin Special Concern elfin skimmer dragonfly (*Nannothemis bella*).

The mixed coniferous and deciduous forests on the Apostle Islands support significant breeding populations of Yellow-bellied Flycatcher (*Empidonax flaviventris*), Least Flycatcher (*Empidonax minimus*), Veery, Swainson's Thrush (*Catharus ustulatus)*, American Redstart (*Setophaga ruticilla*), Northern Parula (*Setophaga americana*), Ovenbird (*Seiurus aurocapilla*), Nashville Warbler, Black-throated Green Warbler, Black-throated Blue Warbler (*Setophaga caerulescens,* listed as *Dendroica caerulescens* on the Wisconsin Natural Heritage Working List), Blackburnian Warbler (*Setophaga fusca*), Black-and-White Warbler (*Mniotilta varia*), Canada Warbler, and many others (Steele 2007).

Stockton Island (about 10,000 acres in size, the second largest of the Apostle Islands) had the highest density of American black bears in North America (2.1 per square mile) in 1994 (Garshelis 1994) and more than twice the density of American black bears found on the mainland of Wisconsin (1.0 per square mile; Storlid 1995; Fleming 1997). As mentioned above, the U.S. and Wisconsin Endangered Piping Plover nests on Long Island, the largest and least disturbed of the Lake Superior sandspits. Wisconsin Point, a large sandspit near the city of Superior, supports a population of the now rare Wisconsin Special Concern Franklin's ground squirrel and is of great importance to migratory birds.

■ ***Boreal Forest:*** This is the best Wisconsin ecological landscape in which to manage for boreal forest; however, extensive restoration will be needed to provide for all of the fauna associated with this community. Much of the present forest is young, fragmented by fields and other developments, and dominated by extensive stands of quaking aspen. Some of the larger patches of older boreal forest, especially where large trees and a significant conifer component has been retained, support boreal forest associates such as Sharp-shinned Hawk (*Accipiter striatus*), Merlin, Great Gray Owl, Olive-sided Flycatcher (*Contopus cooperi*), Golden-crowned Kinglet (*Regulus satrapa*), Ruby-crowned Kinglet (*Regulus calendula*), many wood warblers such as Blackburnian, Canada, Cape May (*Setophaga tigrina,* listed as *Dendroica tigrina* on the Wisconsin Natural Heritage Working List), Mourning, Nashville, Northern Parula, Wilson's (*Cardellina pusilla,* listed as *Wilsonia pusilla* on the Working List), and Yellow-rumped (*Setophaga coronata*) warblers, Dark-eyed Junco (*Junco hyemalis*), Purple Finch (*Carpodacus purpureus*), Pine Siskin (*Spinus pinus*), and Evening Grosbeak (*Coccothraustes vespertinus*) (Cutright et al. 2006). Species such as Black-backed Woodpecker (*Picoides arcticus*), Gray Jay (*Perisoreus canadensis*), Boreal Chickadee (*Poecile hudsonicus*), and Yellow-bellied Flycatcher are present but uncommon and very local and are largely confined to extensive conifer swamps (as they are elsewhere in northern Wisconsin).

■ ***Bibon Swamp:*** The Bibon Swamp is the Superior Coastal Plain's largest wetland away from Lake Superior and is one of the largest wetlands in northern Wisconsin (about 15 square miles). Wetland communities within the Bibon Swamp include conifer swamps dominated by northern white-cedar, black spruce, or tamarack as well as open bog/muskeg, northern hardwood swamp, northern sedge meadow, and extensive shrub swamps of willow and alder. Resident birds include boreal species such as Gray Jay, Boreal Chickadee, Merlin, and Black-backed Woodpecker as well as more widely distributed species such as Golden-winged, Canada, Mourning, and Nashville warblers, Alder Flycatcher (*Empidonax alnorum*), Veery, and Northern Waterthrush. The Wisconsin Threatened wood turtle occurs in the White River and some of the adjoining wetlands (e.g., in shrub swamp habitat). Within the Bibon Swamp, the White River supports a popular summer fishery for large (nonnative) brown trout.

■ ***Lake Superior:*** Lake Superior supports important fish populations, including important sport and commercial species such as lake herring, bloater chub, lake trout, and lake whitefish. Historically, fish populations declined, especially fish that were commercially harvested and/or susceptible to parasitism by the exotic sea lamprey (such as the lake trout). The fishery that had been supported by the extensive stocking of native and nonnative species has now been replaced by one maintained through the natural reproduction of native species. Although native species have been rehabilitated in many areas, an ongoing concern for the fish assemblages of Lake Superior is the accidental introduction of exotic species. Changes in fish population characteristics should be monitored and analyzed over the long term to better understand the effects of these ecosystem disruptions.

The invasion of the nonnative sea lamprey into the Great Lakes via navigation canals in the late 1930s brought the economically important native lake trout and lake whitefish populations to near collapse as these species succumbed to sea lamprey parasitism losses in combination with unsustainable commercial harvests. Native lake trout declined severely in the 1950s. Since the 1970s, lake trout populations have dramatically increased (Figure 21.8) due to more conservative regulations, the creation of refuge areas, and sea lamprey control. Newly fertilized eggs from wild Lake Superior trout have been stocked around the Apostle Islands since 1980 to reestablish populations on historically used offshore reefs. Stocking lake trout eggs in the Apostles no longer occurs because the lake trout population is now essentially self-sustaining. Fingerling lake trout are still stocked annually farther west of the Apostle Islands, in Lake Superior.

Siscowet, a native deep-water variant of lake trout, is not considered to be of commercial value due to its high fat content and the bioaccumulation of harmful contaminants over what can be a 40-year lifespan (Mattes 2008). They generally inhabit deeper areas (water depths exceeding 250 feet) than the more lean lake trout. Siscowet were also affected by lamprey predation, and populations are recovering.

Lake whitefish dramatically declined because of unsustainable commercial harvests and the introduction of the parasitic sea lamprey but now have increased in numbers (Figure 21.9). Currently, lake whitefish are the most commercially valuable species in Lake Superior. Lamprey control programs have helped minimize losses, and populations of lake whitefish have recovered well. Although their abundance has been highly variable, a trend of population increase has been recorded since the early 1990s. Lake whitefish require habitat similar to that of lake trout and are concentrated around the Bayfield Peninsula and the Apostle Islands. Whitefish are also found in nearshore areas that are not used by lake trout all along the Bayfield peninsula.

At the same time, lake trout and lake whitefish populations declined, there was an unintentional introduction of the nonnative rainbow smelt. Wisconsin introduced five nonnative salmonids to control the smelt population as well as to provide a sport fishery, which created jobs in the charter fishing industry that made up for some of the loss of commercial fishing. These introduced species are the brown and rainbow ("steelhead") trout; coho and chinook (*Oncorhynchus tschawytscha*) salmon; and splake *(Salvelinus namaycush* x *S. fontinalis)*. All but splake have self-sustaining populations. The pink salmon (*O. gorbuscha*) was introduced accidentally in Ontario waters and has spread and become established as a self-sustaining population in Lake Superior. It is now common in the northern and eastern part of the lake but is rare in Wisconsin waters.

Cisco species (which include the bloater, chubs, and lake herring) experienced severe population declines from overfishing and competition from or egg predation by nonnative invasive fish. The kiyi (*Coregonus kiyi*) occurs in very deep water, so few are encountered. However, when appropriate deep water habitat is sampled, it is not uncommon. It remains on the Wisconsin Special Concern list mainly because there are few quantitative population data.

The Wisconsin Special Concern shortjaw cisco (*Coregonus zenithicus*) has declined dramatically but remains in low numbers in Lake Superior (Lyons et al. 2000). The shortjaw cisco was once common in Lakes Huron, Michigan, and Superior, but populations were extirpated in Lakes Huron and Michigan during the 20th century and greatly reduced in Lake Superior, due largely to overharvest. From 1895 to 1908, shortjaw cisco was

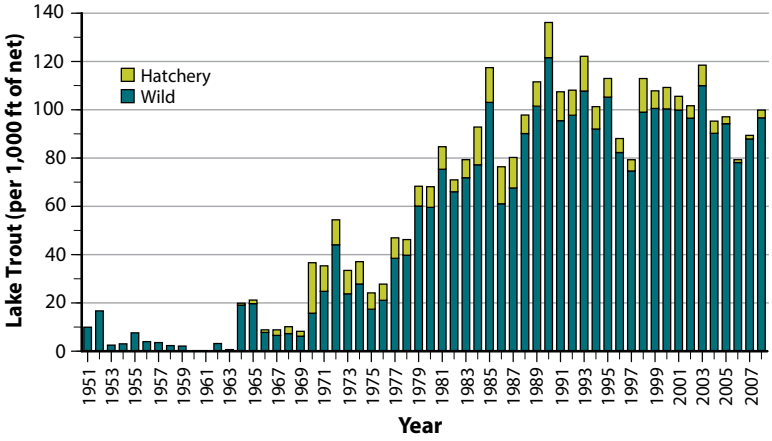


Figure 21.8. *Index to lake trout populations from fall spawning surveys at Gull Island Shoals (Apostle Islands) including the proportion of hatchery and natural reproducing fish, 1951–2008.*

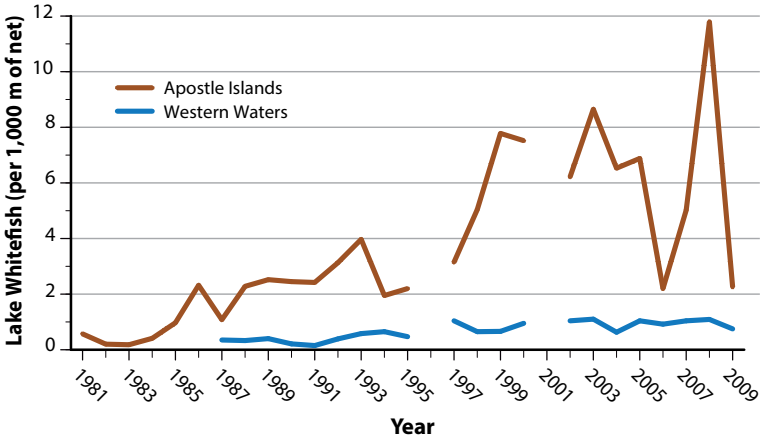


Figure 21.9. *Index to lake whitefish population size from spring surveys in the Apostle Islands and western Lake Superior area, 1981–2009.*

subjected to intense harvest (576 metric tons per year). Stocks recovered from 1909 to 1925 during a period of light harvest (55 metric tons per year). During this time, a lake-wide survey showed shortjaw cisco to be the most abundant chub species, representing greater than 90% of the catch in every region. In 1926 heavier harvests of the chub fishery resumed, and harvest declined over the next 30 years, averaging 221 metric tons per year. A 1953 survey of Lake Superior showed that shortjaw cisco remained the most abundant chub species in most areas of the lake, although in lower numbers than in the early 1900s, and the bloater chub was now becoming dominant or co-dominant in some areas.

For the next 30 years (1955–1987), harvest was high (617 metric tons per year). Assessments during this period showed a sharp decline in abundance of shortjaw cisco, which reached near-zero levels by the mid-1960s to late 1970s. By 1988 the commercial chub harvest declined to low levels and has since remained below 50 metric tons annually. Assessments conducted during 1999–2004 showed low densities of shortjaw cisco in eastern Lake Superior, with only a few specimens from the western half of the lake.

Lake herring populations have increased (Figure 21.10) and have shown strong but sporadic reproduction throughout Wisconsin waters since the 1970s. Other cisco populations, such as the bloater chub and kiyi, have increased since the 1970s but have been annually variable. Recent population declines in rainbow smelt, due to a combination of predation by introduced nonnative salmonids and lake trout recovery, have helped lake herring populations recover.

Native brook trout occurred historically in Wisconsin's Lake Superior waters along coastlines near coldwater streams. These brook trout spawned in the tributaries of Lake Superior and then spent part of their lives in the lake, usually along the shorelines, hence the descriptor "coaster" that is used to describe them today, returning to tributaries to spawn with stream resident siblings. Native coaster brook trout were once commonly found along rocky shorelines but are now absent or, at best, very rare. It is believed that the decline of coaster brook trout was caused by overharvest immediately followed by habitat destruction in the tributaries used for spawning. The U.S. Fish and Wildlife Service has been stocking brook trout derived from coaster brook trout populations from other parts of the lake into some Wisconsin waters, but it is unlikely these fish will establish a self-sustaining coaster brook trout population in Wisconsin because critical tributary habitat is no longer available (D. Pratt, Wisconsin DNR, personal communication). Previous attempts to "restore" these populations via stocking have failed.

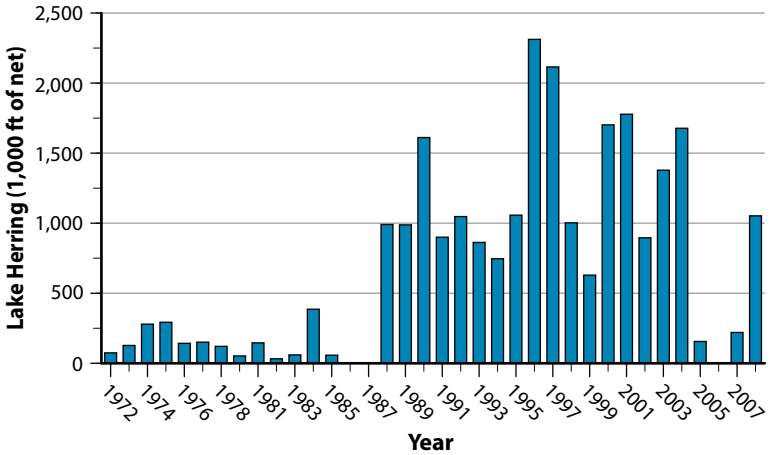


Figure 21.10. *Index to lake herring abundance from fall spawning surveys at Gull Island Shoals (Apostle Islands), 1972–2008.*

■ ***Rivers and Streams:*** Since Euro-American settlement, the streams emptying into Lake Superior have undergone great changes that have affected many aquatic organisms. Logs were floated down the high gradient streams, changing stream bottom and bank morphology. These streams are now prone to seasonal high velocity runoff events (WDNR and USFWS 2005). As an example, the Sand River historically had one of the more famous brook trout fisheries. Damage from this stream's first log drive quickly degraded trout and aquatic invertebrate habitat, the fishery rapidly declined, and recovery has never occurred. Nonnative fish species were released into these streams and coastal Lake Superior waters beginning with rainbow trout in the 1890s and later brown trout and Pacific salmon. These nonnative species are limited by the same watershed-related factors as brook trout (e.g., siltation, peak flood events, high velocity spring runoff) but to a lesser extent. Compared to brook trout, some of the introduced species choose higher velocity spawning sites and deposit more eggs. The fry emerge from the spawning gravel earlier and grow to a larger size sooner, allowing them a better chance of survival (WDNR and UWFWS 2005). Nonnative salmonids are at the top of the food chain and could be having an impact on native fish (e.g., brook trout) and invertebrates in these streams as well as in Lake Superior (Hansen 1990).

Another suspected impact to streams is sea lamprey control. Barriers are designed to allow passage of potadromous trout and salmon but may prevent other species from going upstream. Sea lamprey barriers help reduce the need to use chemical controls for lamprey such as 3-trifluoromethyl-4-nitrophenol (TFM). Wisconsin has three lamprey barriers: one on the Bois Brule River, one on the Middle River in Douglas County, and one on the Iron River in Bayfield County (the Iron River barrier was built when a hydroelectric dam was removed). Michigan, Minnesota, and Ontario have installed similar barriers on streams entering Lake Superior and have plans for more, but currently no additional barriers are planned for Wisconsin.

Fourteen streams are chemically treated with TFM to kill lamprey larvae in stream beds. These streams are the Montreal and Bad rivers; Fish and Redcliff creeks; Raspberry, Sand and Cranberry rivers; Reefer and Fish (Bayfield County) creeks; and the Bois Brule, Poplar, Middle, Amnicon, Nemadji, and St. Louis rivers. TFM does impact native lamprey species and may have negative impacts on some aquatic invertebrates as well (e.g., in the past, mussels and some other benthic fauna have been affected). Additional work on this issue is needed because some species, such as the Wisconsin Special Concern eastern elliptio mussel (*Elliptio complanata*), occur mostly at or near the mouths of rivers. For other species, such as those not surveyed or monitored, recovery from chemical treatment is unknown. A potential, if partial, solution may be to avoid treating the lower reaches of streams that are close together at the same time, but without more comprehensive monitoring the answers will remain elusive (B. Smith, Wisconsin DNR, personal communication).

Lake sturgeon occur in limited numbers and spawn in the larger tributaries of Lake Superior, including the St. Louis, Bad, and White rivers. Lake sturgeon numbers plummeted after 1885 due to unregulated commercial harvest and habitat degradation caused by dumping sawmill wastes in rivers and lakes, log drives, construction of hydroelectric (or other) dams, water pollution, and development of harbor facilities (Quinlan et al. 2007). There has been a long-term (20+ years) effort to restore lake sturgeon in the St. Louis River. Lake sturgeon now commonly occur there, but since lake sturgeon females take approximately 25 years to mature, it remains to be seen if this population will become self-sustaining (males have been congregating at the historical spawning area for the last decade—males mature at about 15 years).

The St. Louis and Nemadji rivers provide important spawning, nursery, and foraging habitat for at least 31 native fish species. Streams supporting populations of at least one rare aquatic invertebrate species include Sand, Bluff, Lost, Hanson, Newago, Pikes, Saxine, Eighteenmile, Twentymile, Vaughn, and Denomie creeks and Stony Brook. Siskiwit Creek is warm and stained brown by tannins near its origin (Siskiwit Lake), but downstream, clear, cold spring water enters the system, and it supports native brook trout and also supports a rare mussel, the eastern floater (*Pyganodon cataracta)*. The Bad River and the White River from Lake Superior all the way upstream to Drummond host the eastern elliptio mussel, found only in the Lake Superior basin.

Native brook trout populations in these streams are now small in comparison to populations reported in the mid-1850s to 1870s (WDNR and USFWS 2005). The range, size structure, and abundance of the brook trout populations have been greatly reduced in the Superior Coastal Plain. Brook trout still sustain themselves in the upper parts of watersheds in smaller channels that are less impacted by peak flood events and in larger stream reaches not severely impacted by sand bed-loading. Most other stream reaches contain few brook trout.

Natural and Human Disturbances

Fire, Wind, and Flooding

Stand-replacing fires were a relatively uncommon historical disturbance in this ecological landscape, with an estimated return interval of more than 2,000 years at a given site (Frelich and Lorimer 1991, Schulte and Mladenoff 2005). However, at any one time just prior to widespread Euro-American settlement, evidence of a few recent burns could be found somewhere on the landscape, as was documented by the first land surveyors (Schulte and Mladenoff 2005). Low fire frequency was likely due to the moderating influences of Lake Superior on climate, including increased humidity, a deep snowpack, and cooler temperatures. Heavy, wet clay soils and deep, steep-sided valleys may have acted as firebreaks. Eastern white pine, whose regeneration is usually associated with fire, was formerly widespread and fairly common throughout the Superior Coastal Plain. Its presence here may be linked in some cases to catastrophic stand-replacing fires or relatively light surface fires. Old-growth stands on similar lakeshore sites in Upper Michigan sometimes have fire scars and soil charcoal, although the frequency of surface fires is not well known (Frelich and Lorimer 1991).

Generally, severe windthrow was less frequent along the Great Lakes than in the rest of northern Wisconsin (Schulte and Mladenoff 2005). The return interval for severe windthrow for this ecological landscape was more than 2,800 years, based on surveyors records from the mid-1800s. Schulte and Mladenoff (2005) have suggested that this may have been due to the moderating influences on climate from Lake Superior, "including increased humidity and amelioration of the more severe thunderstorms." Shoreline areas immediately adjacent to Lake Superior are prone to gales, heavy snows, and sometimes ice build-up, but this disturbance occurs at finer spatial scales than those used in the federal General Land Office public land survey and is not reflected in these historical data. In many areas, there is a narrow but distinct "blowdown zone" along the Lake Superior shoreline, especially on exposed shores of the Apostle Islands and on bluffs above the lake on the mainland. Wind disturbance may be further reduced from historical conditions because forests are generally younger now and less subject to windthrow.

The extent and frequency of flood disturbance prior to Euro-American settlement is unknown. It is likely that the flooding of high gradient streams in this ecological landscape has increased in severity and frequency from historical times due to increased surface water runoff and the simplification of channel structure (reduced "roughness") because of sand bed-loading and channel incision. These effects occurred after, or were the result of, the severe logging that accompanied Euro-American settlement. Logs were floated down these streams, scouring the stream bottoms and banks of materials that would hold back or allow for better infiltration of water, resulting in more rapid flow and higher velocities during seasonal (spring) snow melt and following heavy

rain events. The clay banks along many of these streams have remained somewhat unstable and erosion-prone, leading to increased rates of sedimentation, reduced water quality, and degraded aquatic habitat downstream.

Since the retreat of the last glaciers some 10,000 years ago, the east end of Lake Superior has been rebounding from the weight of the ice faster than the west end. This has caused the inundation of many river mouths on the western end of the lake and is the reason that there is now a concentration of estuaries along the Wisconsin coastline. In addition, lake levels fluctuate with the amount of rainfall and evapotranspiration that occurs throughout the Lake Superior basin. Flooding and shoreline erosion and reconfiguration occur when Lake Superior water levels are high; the development of wetlands and beach habitats may occur or accelerate during periods of low lake levels. Within a range of natural variability for the Lake Superior ecosystem, these water level fluctuations are necessary to maintain some of the sensitive wetland communities and habitats found now and historically in the "pulse stable" coastal estuaries.

Forest Insects and Diseases

The Superior Coastal Plain Ecological Landscape supports a variety of forest types, each of them associated with different, sometimes very specific, insects and diseases.

Aspen is now common here and can be impacted by forest tent caterpillar (*Malacosoma disstria*), aspen heart rot fungus (*Phellinus tremulae*), and aspen Hypoxylon canker fungus (*Hypoxylon mammatum*). White birch can be affected by bronze birch borer (*Agrilus anxius*), and drought can predispose these trees to many diseases.

Conifers, including red and eastern white pines and white spruce, can be affected by Annosum root rot, caused by the fungus *Heterobasidion annosum*, particularly 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*. Red pine is also susceptible to attack by Diplodia 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*; it is most severe in low-lying areas.

The spruce budworm (*Choristoneura fumiferana)* affects spruce and fir forests of the eastern United States and Canada (Kucera and Orr 1981). Balsam fir is the species most severely damaged by the budworm in the eastern United States. White and black spruces are also suitable host trees, and some feeding by budworm larvae may occur on other conifers such as tamarack, pine, and eastern hemlock. Spruce mixed with balsam fir is more likely to suffer budworm damage than spruce in pure stands. Periodic outbreaks of the spruce budworm are a part of the natural cycle of events associated with the maturing of balsam fir. Once a spruce budworm outbreak begins, it usually continues until the larvae consume much of the available foliage. Balsam fir is common throughout the Superior Coastal Plain, though at this time it is more important in the understory than in the canopy. White spruce is increasing locally and has the potential to again become a forest dominant in some areas.

Gypsy moth (*Lymantria dispar*) is a nonnative insect currently becoming established in the state that will periodically affect oak and aspen forests. 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*. Oaks are locally distributed in the Superior Coastal Plain but are important on some of the sandspits, in several river corridors, and in some of the second-growth stands on the Apostle Islands.

The emerald ash borer is an exotic insect native to Asia. This extremely serious forest pest was first discovered in the state near the Milwaukee River in Ozaukee and Washington counties in 2008 and has been confirmed in 35 Wisconsin counties as of 2015 (WDATCP 2015). In the Superior Coastal Plain Ecological Landscape, the emerald ash borer has been confirmed in Douglas County. Wisconsin counties where it has been confirmed have been placed under quarantine in an effort to limit the inadvertent spread of the emerald ash borer, which may be present in ash nursery stock, ash firewood and timber, or other articles that could spread emerald ash borer into other parts of Wisconsin or other states. Other counties in the state have also been placed under quarantine because of their proximity to infestations in neighboring counties.

Attempts to contain infestations in Michigan through destroying ash trees in areas where emerald ash borer were found have not been successful, perhaps due to the fact that the insect was well established before it was discovered and treated. The emerald ash borer typically kills a tree within one to three years. Emerald ash borer has also been shown to feed on some shrub species such as privets (*Ligustrum* spp.) and lilacs (*Syringa* spp.) in greenhouse tests, but it is still unknown as to whether shrub availability will contribute to its spread under field conditions. Consult the Wisconsin emerald ash borer website (WDATCP 2015) for the most up-to-date information about the presence of emerald ash borer in Wisconsin.

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 2015a) and at the U.S. Forest Service Northeastern Area forest health and economics web page (USFS 2015).

Invasive Species

Due to high recreational use of the Superior Coastal Plain Ecological Landscape, the presence of several Great Lakes ports, numerous railroad lines, and several major highways, there is high potential for additional nonnative invasive species to become problems. Human travel is a major vector for transport of a variety of invasive species, and tourism, recreation, and further development give this area high potential for initial introductions and further spread throughout the ecological landscape. In addition, due to the shipping industry's use of

Lake Superior as a major route by which to deliver products to the Upper Midwest, ships from all over the world may release nonnative invasive species into Lake Superior when they discharge ballast water.

Terrestrial invasive species occur here, but few of them are serious problems at this time. Care needs to be taken to prevent the introduction and spread of invasive species. In forested habitats, plants such as glossy and common buckthorns (*Rhamnus frangula* and *R. cathartica*), nonnative honeysuckles, (e.g., *Lonicera morrowii* and *L. tatarica*), and Japanese barberry (*Berberis thunbergii*) already pose problems. Japanese knotweed (*Polygonum cuspidatum*) and giant knotweed (*Polygonum sachalinense*) are present and are spreading from gardens into roadside ditches and ravines (e.g., in and around Bayfield). Garden-heliotrope (*Valeriana officinalis*) is an abundant weed in and around the city of Superior and has the potential to invade the nonforested red clay wetlands. These species may initially colonize disturbed areas and edges, but once established, some can spread into surrounding habitats, including forests. Along roads and in open or partially forested areas, spotted knapweed (*Centaurea biebersteinii*), leafy spurge (*Euphorbia esula)*, wild parsnip (*Pastinaca sativa*), common periwinkle (*Vinca minor*), Canada thistle (*Cirsium arvense*), European swamp thistle *(C. palustre)*, coral-berry (*Symphoricarpos orbiculatus*), and common tansy (*Tanacetum vulgare*) are present. Several of these species have high potential to invade sandspits and the rare natural communities associated with them (e.g., Great Lakes Beach, Great Lakes Dune, Interdunal Wetland).

Poison ivy (*Toxicodendron radicans*), a native plant, has proven to be highly invasive in habitats such as disturbed dunes. Poison ivy now covers extensive areas of disturbed dune habitat at sites such as Wisconsin Point and at Bay Beach north of the mouth of the Sioux River in Bayfield County.

In aquatic and wetland ecosystems, problem invasives include Eurasian water-milfoil (*Myriophyllum spicatum*), curly pondweed, common reed, purple loosestrife, reed canary grass, and rusty crayfish (*Orconectes rusticus*). Invasive animals (some of them, such as the common carp [*Cyprinus carpio*], deliberately introduced) are now a problem in Lake Superior. Since the discovery of the pea clam (*Pisidium moitessierianumin*) in 1895 and the sea lamprey in 1938, many other invasive species have appeared in Lake Superior. Ruffe (*Gymnocephalus cernuus)*, round goby (*Neogobius melanostomus*), tubenose goby (*Proterorhinus marmoratus*—Lake Superior is the only Wisconsin location for this relative of the round goby), white perch (*Morone americana*), rainbow smelt, alewife (*Alosa pseudoharengus*), sea lamprey, quagga mussel (*Dreissena bugensis*), zebra mussel (*Dreissena polymorpha*), spiny waterflea (*Bythotrephes cederstroemi*), and New Zealand mudsnail (*Potamopyrgus antipodarum*) as well as 18 other nonnative aquatic invertebrates found within the last two years (D. Pratt, Wisconsin DNR, personal communication) have become established in these waters. Common carp were first stocked in Duluth Harbor in 1884 by the State of Minnesota. Common carp occur in Superior Harbor wetlands and at the mouths of a few Lake Superior tributaries (J. Lyons, Wisconsin DNR, personal communication).

Shore fen occupies swale between two coastal barrier spits at the mouth of the Sioux River. Wire-leaved sedges are still dominant, but common reed is beginning to invade this wetland. Bayview Beach, Bayfield County. Photo by Eric Epstein, Wisconsin DNR.

Ballast water discharges from oceangoing vessels are the source of some of the most problematic invasive species in the Great Lakes. The twin ports of Duluth and Superior, which receive international shipping traffic, appear to be likely points of entry for invasive aquatic animals, especially in recent years (USEPA 2007). Duluth-Superior harbor is the largest "in-ballasting" port in the Great Lakes, meaning that, because most ships arrive here without cargo, they carry ballast water that is then dumped into Lake Superior on arrival. The Twin Ports harbor area is infested with both zebra and quagga mussels, although zebra mussels had not spread to other areas of Lake Superior as of 2007. Duluth-Superior harbor is the first site on Lake Superior where quagga mussels were discovered. Native to Ukraine, over 4,000 miles away, quagga mussel were probably introduced to the Great Lakes from the ballast water discharges of transoceanic ships. First seen in the Great Lakes in 1989, quagga mussels had not been found in the Duluth-Superior harbor or elsewhere in Lake Superior until recently (USEPA 2007). The ruffe is one of the first fish species that arrived in the Great Lakes via ballast water. It is now one of the most numerous and well-studied exotic fishes in Twin Ports Harbor.

Efforts to increase awareness of invasive species and problems associated with them are underway in the Superior Coastal Plain Ecological Landscape**.** Federal, state, local, and tribal governments and other organizations have conducted inventories and mapped the occurrence of invasive species here. A Cooperative Weed Management Area (CWMA), the Northwoods CWMA, has been established. This partnership of public agencies and private groups and individuals works effectively across jurisdictional boundaries to advance awareness and control of invasive species. Control efforts have occurred throughout Superior Coastal Plain Ecological

Landscape. In recent years, there have been releases of biocontrol agents to combat leafy spurge and purple loosestrife infestations. For more information about invasive species in Wisconsin, see the Wisconsin DNR's web page on invasive species (WDNR 2015c).

Land Use Impacts

Historical Impacts. The ecological impacts of large-scale logging, agriculture, and other land uses that came with Euro-American settlement in the latter half of the 19th century were immense in the Superior Coastal Plain, and some of these effects persist today. Almost the entire region was logged prior to and during the Euro-American settlement period. Access to forested lands and delivery of logs to sawmills was expedited by using the streams that enter Lake Superior to float logs to the mills. Streams were cleared of large woody material, stream bottoms and banks were scoured during log drives, and deposition of bark and other woody debris on the lake and stream bottoms changed the character of the water bodies used in this way. After the extensive logging, the area attracted numerous settlers who engaged in activities such as agriculture, fishing, mining, and housing, road, and railroad right-of-way construction. The forests have regenerated in areas not cleared for agricultural, residential, or industrial uses, but they are now composed of different species, with different age structures and range of patch sizes than the original forests (Schulte et al. 2007).

Impacts of past land uses are still evident today. For example, due to past logging practices, there are few older forests, and conifers (e.g., eastern hemlock, eastern white pine, white spruce, balsam fir, and northern white-cedar) are now underrepresented in the forest canopy in most areas. Most forests here are now young, less than 100 years old. Log drives scoured river bottoms and eroded banks. Streams subsequently were more susceptible to rapid runoff during spring snowmelt and heavy rain events, changing stream morphology and hydrology. As bark sloughed off the floating trees, it accumulated on the bottom of sites such as Chequamegon Bay and several of the coastal estuaries, changing the substrate and smothering beds of aquatic plants and fish spawning habitat. Drainage networks created via ditching and the channelization of streams during road and railway construction along with the conversion of forested lands to crop land and pasture sped runoff. Even when fields revert to forest, these artificial drainage networks remain, maintaining unnatural hydrological behavior and contributing to excessive runoff conditions. More recently, residential developments have been increasing on the peninsula, especially in areas with Lake Superior views. This, and construction of the supporting infrastructure, such as roads and power line corridors, have led to the fragmentation of extensive, previously unbroken areas of forest on the highlands and more pressure on shorelines along the Highway 13 corridor. Overfishing and the introduction of invasive species, including the sea lamprey, had reduced populations of important native fish such as lake trout to low levels, though in recent years Lake Superior lake trout populations have largely recovered.

Significant forest fragmentation is apparent on much of the Superior Coastal Plain. Stands of trembling aspen have replaced many of the boreal conifers. Northern Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Current Impacts. Disturbances in the current landscape are largely due to human activities, including the long-term conversion of land from forest or other types of natural cover to grass-based agriculture or to crop production, buildings, roads, and utility corridors. Shorter-term disturbances result from logging and recreational pursuits. Some effects are indirect, such as the high level of herbivory by white-tailed deer, which is largely the result of human activities that create and often maintain habitats that favor large numbers of white-tailed deer and increase the size of white-tailed deer populations. A major difference from historical disturbances is that today's impacts are multiple and pervasive, affecting most of the landscape almost constantly. Some of them, such as shoreline development, are also cumulative, reducing habitat abundance and quality. Today most of the Superior Coastal Plain Ecological Landscape has been altered, with few areas left undisturbed.

Forest Management. There is a lack of older forests in this ecological landscape. A focus on stand-level forest management has resulted in many small to medium-sized patches of similar species composition and age-class structure, while at the broader scale there is a loss of patch size diversity, age-class diversity, important structural and compositional components, and connectivity. The creation of large amounts of edge habitats throughout the ecological landscape has promoted habitat generalists at the expense of interior forest habitat specialists, area-sensitive species, and disturbance-sensitive species.

At multiple scales, ecological simplification and homogenization are taking place, with quaking aspen, sugar maple,

and red maple increasing at the expense of other tree species, especially formerly dominant canopy conifers, but including certain hardwoods such as yellow birch. Specialized or more sensitive groundlayer plants (e.g., lilies, orchids, insect-pollinated species) are decreasing in abundance, while generalists and nonnatives are increasing (Rooney et al. 2004, Schulte et al. 2007).

Although not as extensive in the Superior Coastal Plain Ecological Landscape as in some others, the development of pine plantations, converted from other land cover types, creates patches of monotypic, structurally and compositionally simplified forest. Although there may be short- or medium-term economic advantages to developing plantations, they provide poor habitat for most wildlife species, including white-tailed deer (Kohn 1974) and seldom if ever support a diverse community of native plants. However, if pines are planted on abandoned agricultural lands, they might suppress the heavy sods of nonnative cool season grasses and make the site more amenable to managing for a more "boreal" forest over the long-term (this has not yet been rigorously tested, and the economic impacts of doing this have not been clarified). In highly fragmented areas, planted pines can reduce the abundance of hard edge and provide food for species that feed on conifer seeds.

Forest openings (commonly termed "wildlife openings") have been created on many state-owned and other public lands in northern Wisconsin, primarily to provide habitat for white-tailed deer. This has resulted in the creation of edge and some degree of forest fragmentation, even deep within extensive areas of interior forest. A great deal of money, time, and effort goes toward the maintenance of these openings. In some areas, artificially maintained forest openings may help increase white-tailed deer populations to levels that result in negative effects on native vegetation in the surrounding forests. White-tailed deer populations should be managed at goals set within the ***carrying capacity*** of the habitat. When maintaining existing openings or proposing the creation of new openings, landscape conditions and a broad array of management opportunities and options should be taken into consideration when weighing costs and benefits.

Development. In recent decades, the Superior Coastal Plain has experienced an influx of people. This has included both seasonal and permanent residents, especially along the shores of Lake Superior, creating a pattern of dispersed urbanization. This growth has increased housing and road densities in many areas. The construction of homes and marinas along the Lake Superior shoreline has impacted the sandspits as well as the embayments and coastal wetlands behind them.

Parcelization and dispersed residential development in rural areas has fragmented contiguous habitats and reduced their effective size, increased land values and the cost of public services, and created long-term alterations in aquatic and terrestrial systems. Some of the ecological consequences of these human-influenced factors include an increase in habitat generalists and nonnative habitats (e.g., roads, utility rights-of-way, lawns, landscaping, golf courses), feeding of wildlife, introduction of invasive plants and animals, and predation by raccoons, skunks, and free-ranging dogs and cats.

Entrance to Port Wing harbor. Jetties and seawalls have disrupted shoreline processes of erosion and deposition. Bayfield County. Photo by Wisconsin DNR staff.

Changes to Hydrology. Changes in vegetation and land use during the past several centuries have impacted the morphology of streams draining into Lake Superior. Dead woody material was removed from streams early in the process of Euro-American exploration and fur trading to gain access to areas inland. During the early logging period, log drives scoured stream bottoms and banks, increasing stream velocity. Many streambanks were also destabilized by the loss of forest vegetation, particularly where soils contain strata of easily eroded sand, resulting in bank slumping and increased deposition of sediments into streams and, ultimately, Lake Superior.

Permanent deforestation and conversion to open (nonforested) cover types has contributed to changes in hydrology at the watershed scale (Verry et al. 1983, Riedel et al. 2005). Without the forest canopy to intercept rainfall, facilitate evaporation, and slow snow melt and runoff, more precipitation reaches streams more quickly, and increased erosion occurs on the clayey soils. Deforestation has led to severe spring flooding during and following snowmelt. A forested watershed, particularly one with a large component of conifers, catches a considerable amount of snow on tree branches where some of it sublimates, and snow on the shaded ground beneath a forest canopy melts slowly. Snow exposed in the open melts rapidly and earlier in the season than snow in the forest, often when the ground is frozen and little infiltration of meltwater or rain can take place. Many watersheds in the Superior Coastal Plain have enough open land that peak flows and springtime flooding have increased due to the rate and timing of snowmelt and the greater overall quantity of water reaching streams. Agencies and landowners are making efforts toward reforestation and stream restoration to help correct this problem.

Road construction and development have eliminated, fragmented, and isolated many wetlands and degraded others by altering hydrology and facilitating the spread of invasive plants, especially in the Superior and Ashland areas. Loss of wetlands can lead to increased sedimentation and the transport of pollutants and pesticides, which can ultimately move into Lake Superior. Road and rail rights-of-way typically simplify drainages and decrease the time it takes for runoff to reach stream channels. Greater volumes of water reaching stream channels over a shorter time frame erode channel cross sections, enlarging them so that they can handle these larger peak flows, but this comes at the expense of important in-stream and streambank habitats.

Disrupting wetland hydrology by dewatering them can result in the succession of open marsh, sedge meadow, and fen communities into shrub thicket or other woody cover. In areas with poorly drained clay soils, the removal of trees can result in the long-term loss of forest vegetation if the water table rises because of reduced evapotranspiration. Locally, American beaver can also reduce forest vegetation along streams. Conversion of natural communities such as marshes, wet meadows, bogs, fens, and conifer swamps to other vegetation types reduces the amount of habitat available for native species dependent on those vegetation types. The impacts and abundance and extent of such ***type conversions*** need to be better understood as these may ultimately create additional management costs and challenges, many of them due to unintended consequences.

Ditched meadow on red clay soils near South Superior, Wisconsin. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Apples are one of several important specialty crops that do well in some areas near Lake Superior, especially on the Bayfield Peninsula. Photo by Mike Hendrickson, courtesy of the Bayfield Chamber of Commerce and Visitor Bureau.

Agriculture. Agriculture plays a role in this ecological landscape, but the cool temperatures and the length of time it takes for the heavy soils to warm up limit agricultural activities. Most farms are dairy, beef, or poultry operations because the growing season is generally too short for row crops such as corn. Today there are many old grassy fields or pastures scattered throughout the Superior Coastal Plain Ecological Landscape, especially along Highways 2, 13, and 63. Some of the larger fields (especially recently abandoned or lightly pastured grasslands) harbor populations of declining grassland birds.

The Bayfield Peninsula has a history of producing fruits such as berries and apples, due to the soils, the cool climate, and the longer growing season close to Lake Superior. Berry farms and apple orchards still operate today near the city of Bayfield, selling mostly to tourists visiting the area.

Herbivory. Except on some of the more remote Apostle Islands, white-tailed deer populations throughout the Superior Coastal Plain were above established goals for 10–15 years (1990–2005). Currently (2009), white-tailed deer populations are near goal levels. Because there is so much aspen, hard edge, and private land here, white-tailed deer populations tend to increase quickly when winter severity is moderate. On the Apostle Islands, there are dramatic contrasts in forest understory composition between islands with white-tailed deer and islands lacking white-tailed deer. On islands that did not have a historical white-tailed deer presence, rare forest communities and many understory plants are now being threatened because they have recently been colonized by white-tailed deer. On the Mainland Unit of Apostle Islands National Lakeshore, browse pressure on northern white-cedar, eastern hemlock, yellow birch, Canada yew, and other sensitive species is heavy. In and around the Brule River State Forest, white-tailed deer browse is heavy on conifer seedlings and saplings (except on white spruce). Some of the deep stream valleys of the Superior Coastal Plain contain important ***refugia*** for sensitive vegetation that was not directly affected by the Cutover. White-tailed deer wintering in these corridors to escape severe weather conditions can have serious negative impacts on the vegetation in a very short time.

Management Opportunities for Important Ecological Features of the Superior Coastal Plain

Natural communities, waterbodies, and 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 considerations;
- accommodate species needing large areas or those requiring more than one type of habitat;
- add habitat diversity that would otherwise not be present or maintained; and
- provide economies of scale and increase efficiency for land and water managers.

A site's conservation potential may go unrecognized and unrealized when individual stands and habitat patches are always managed as stand-alone entities. A landscape-scale approach that considers the context and 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.

Outstanding Ecological Opportunities in the Superior Coastal Plain Ecological Landscape

- Lake Superior is the largest freshwater lake in the world by area; it is deeper and holds more water than any lake in North America.
- The Apostle Islands host exceptional examples of old-growth forest, coastal wetlands, and sandstone cliffs.
- Southwestern Lake Superior features many sandscapes, drowned river mouths, and freshwater estuaries.
- The best—and only—opportunities in Wisconsin to manage for the unique Boreal (Clay Plain) Forest occur here.
- The red clay wetlands in the vicinity of Superior support a diverse flora which includes many rare plants, some of them found nowhere else in the state.
- Corridors of the larger rivers feature protection opportunities for unusual natural communities, habitat for rare species, and travelways for migrating and dispersing animals. The corridors of the St. Louis, Nemadji, Brule, and Bad rivers are especially notable.
- Important Migratory Bird Concentration Areas and stopovers occur in and around the St Louis River Estuary, Chequamegon Bay, and the Apostle Islands.
- Important nesting sites for colonial birds such as terns, gulls, and cormorants occur here.
- Scattered rare species populations, including plants and animals found nowhere else in Wisconsin.
- Miscellaneous rare communities or habitats (not covered by the previous bullets) underrepresented on public lands or in protected areas are found in the Superior Coastal Plain.

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. This integration can also help 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 Superior Coastal Plain Ecological Landscape include

- Lake Superior;
- Apostle Islands: sandscapes, maritime forests, cliffs;
- freshwater estuaries;
- Boreal (coastal plain) Forest;
- red clay wetlands;

- river corridors;
- Migratory Bird Concentration Areas;
- colonial birds: gulls, terns, cormorants;
- rare species management; and
- miscellaneous opportunities (old-growth forests, clay seepage bluffs, springs and spring runs, forest restoration, surrogate grasslands, scattered rare species populations).

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 21.2. Examples of locations where these important ecological places may be found within the ecological landscape are shown on the map entitled "Ecologically Significant Places in the Superior Coastal Plain" in Appendix 21.K at the end of this chapter.

Lake Superior

Lake Superior is the earth's largest freshwater lake by surface area and, at 1,332 feet, is the deepest lake, containing the greatest volume of water, on the North American continent. Currently, management must address problems caused by some of the past land uses and grapple with new challenges that appear annually, such as those posed by increased development, the introduction and spread of invasive species, and climate change. Cooperation must occur between nations (including tribal nations), states, counties, units of local government, and private partners if collective goals to maintain healthy and sustainable ecosystems in this ecological landscape are to be achieved.

Directly or indirectly, Lake Superior affects virtually all natural features (and many aspects of the human economies) within the Superior Coastal Plain Ecological Landscape.

Native fish occurring in Lake Superior that are rare or absent inland include commercially important species such as lake trout, lake whitefish, and four species of ciscoes or "chubs": lake herring, bloater, kiyi, and shortjaw cisco. Continued proactive monitoring and regulation of commercial fishing will help ensure the continuance of these species.

A number of rare animals and plants occur in the coastal wetlands and estuaries, which also support populations of common species that are an important part of the food base. Large numbers of waterfowl and other birds use the lake for foraging, resting, nesting, and in other ways.

Management Opportunities, Needs, and Actions

- Understand and maintain the short-term and long-term dynamics needed to sustain Lake Superior's coastal ecosystems, especially the estuaries, beaches and dunes.
- Conduct or support continuing efforts to monitor Lake Superior's physical characteristics, such as water temperature, water clarity, and ice cover.
- Take proactive steps to guard against the introduction of new invasive species.
- Identify sources of pollution and work to diminish or terminate their sources. These include municipal and industrial sources as well as accelerated erosion caused by past disturbances such as unregulated logging.
- Protect shorelines from developments that will degrade habitats, impair ecosystem function, and lower water quality.
- Provide information and incentives to private owners of shoreline properties to encourage them to increase their protection and stewardship efforts.
- Monitor natural communities and habitats associated with Lake Superior and its shorelines, such as beaches, dunes, coastal estuaries, "maritime" forests, and boreal forests.
- Monitor taxa that are of high importance in the Lake Superior region, including habitat specialists, boreal species and southern disjuncts, selected plants, aquatic invertebrates, fish, and birds.
- Survey and monitor the use of Lake Superior by resident and migratory birds, including shorelines, nearshore waters, and deepwater habitats. Identify and characterize sensitive areas and distribute that information to appropriate agencies, organizations, and individuals.
- Support and maintain the Lake Superior National Estuarine Research Reserve.
- Maintaining or continuing to enhance populations of lake trout, lake whitefish, cisco species, lake sturgeon, and brook trout are priorities here. The protection of spawning and nursery areas is critical to maintaining sustainable populations of recreationally and commercially desirable fish as well as rare or declining species.
- The most important focus of the existing lake trout restoration plan for Lake Superior is to keep sea lamprey densities low. While offshore spawning habitat is generally secure, lake trout populations may benefit from additional habitat restoration and protection for other life stages. Toxic pollutants, poor water quality, sedimentation, eutrophication, and residential and commercial developments can adversely affect lake trout reproduction and survival in parts of the Lake Superior ecosystem.
- Develop and implement a management plan to restore and then maintain populations of shortjaw cisco, the most vulnerable of the Lake Superior cisco species. Assessments conducted during 1999–2004 showed low densities of shortjaw cisco in eastern Lake Superior and very few of these fish in the western half of the lake. Research is needed to fill information gaps to better understand life histories, ecology, recruitment dynamics, mortality, and stock structure in order to devise effective recovery actions.
- A number of actions are needed in order to maximize the opportunity for restoring brook trout and other aquatic species in Lake Superior. These actions are noted in a joint Wisconsin DNR-U.S. Fish and Wildlife Service restoration

Table 21.2. *Natural communities, aquatic features, and selected habitats associated with each ecological feature within the Superior Coastal Plain Ecological Landscape.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Lake Superior	Great Lakes Barrens Great Lakes Beach Great Lakes Bedrock Shore Great Lakes Dune Great Lakes Ridge and Swale Shore Fen Lake Superior
Apostle Islands	Boreal Forest Northern Dry Forest Northern Dry-mesic Forest Northern Mesic forest Great Lakes Barrens Great Lakes Ridge and Swale Shore Fen Interdunal Wetland Ephemeral Pond Dry Cliff Moist Cliff Great Lakes Dunes Great Lakes Beach
Freshwater estuaries	Black Spruce Swamp Tamarack Swamp Alder Thicket Shrub-carr Northern Sedge Meadow Poor Fen Shore Fen Emergent Marsh Marsh – Wild Rice Submergent Marsh
Boreal (Clay Plain) Forest	Boreal Forest Northern Mesic Forest Ephemeral Pond
Red clay wetlands	Boreal Forest Alder Thicket Shrub-carr Northern Sedge Meadow Emergent Marsh Submergent Marsh
River corridors	Northern Dry forest Northern Dry-Mesic Forest Northern Mesic Forest Northern Wet-Mesic Forest Northern Wet Forest Northern Hardwood Swamp Floodplain Forest Coldwater Stream Coolwater Stream Warmwater River Warmwater Stream

Continued on next page

Table 21.2, *continued.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Migratory Bird Concentration Areas	Boreal Forest Northern Dry Forest Northern Dry-mesic Forest Northern Mesic Forest Emergent Marsh Shore Fen Great Lakes Dune Great Lakes Beach Great Lakes Ridge and Swale Lake Superior
Colonial birds: gulls, terns, cormorants	Emergent Marsh Shore Fen Great Lakes Dune Great Lakes Beach Great Lakes Ridge and Swale Lake Superior
Rare species	Virtually all natural communities and many aquatic features
Miscellaneous opportunities	Boreal Forest Northern Mesic Forest Surrogate Grasslands Open Bog Emergent Marsh – Wild Rice Clay Seepage Bluff

[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," in Part 1 of the book for definitions of natural community types.

plan (WDNR and USFWS 2005) and include maintaining or restoring riparian forests, remediating the effects of man-made obstructions to migration, reducing sand bed-load in spawning streams, reestablishing large woody debris volumes in streams, and continuing to control American beaver activity in key stream sections.

- Strong actions (e.g., policy, legislation, and enforcement) are needed to prevent additional losses to the biological integrity of Lake Superior from a continuous stream of nonnative invasive species, most of which are introduced via ballast water from merchant ships. A lack of federal standards motivated the states of Michigan and California to enact their own ballast water regulations; Wisconsin and other states have enacted similar measures. The Great Lakes Commission has asked for federal ballast water treatment regulations that would be applied uniformly across the region (GLC 2007). This regulatory effort needs continual advocacy and support until Wisconsin and all other Great Lakes states achieve a successful and unified regional program.
- From an overall ***ecosystem health*** perspective, it is important to reduce atmospheric deposition of mercury and to implement ***total maximum daily load*** (TMDL) limits for nutrient pollutants to the lake. These issues are addressed in the 2006 Lakewide Management Plan (LaMP) (USEPA 2006).

The Apostle Islands: Sandscapes, Maritime Forests, and Cliffs

The vegetation of the Apostle Islands is more similar to that of the northern Bayfield Peninsula and parts of the Penokee Range than to the level, more boreal clay plain. Three sandstone formations, the Orienta, Devils Island, and Chequamegon, form the islands' bedrock underpinnings. The sandstones are exposed as cliffs or shelf-like ledges on a number of the islands, most dramatically on Devils, Stockton, Otter, and Madeline. For a review of the complex postglacial history of the islands, see Farrand (1969).

The glaciers deposited clayey till on all of the islands, which is exposed in many locations on the island margins

as open, sometimes eroding, bluffs. Old beach terraces are visible at higher elevations on some of the larger islands (e.g., Bear, Oak, and Outer islands). The perched wetlands occurring in the interiors of several islands occupy the sites of ancient beach and lagoon complexes. Ephemeral Ponds are present on some of the more level, poorly drained islands (e.g., on Basswood and parts of Outer).

Compared to the adjacent mainland, the climate of the Apostle Islands is warmer in winter and cooler in summer, with spring arriving later and fall lasting longer. The windward sides of the outermost islands in the Apostle Islands archipelago bear the brunt of the most severe storms, especially in fall and winter. Within the archipelago, the northernmost islands have noticeably cooler climates than those closer to the mainland (Judziewicz and Koch 1993). A summary of data on the climate of the area may be found in Phillips and McCulloch (1972).

The entire archipelago was historically forested, with the exception of the beaches and dunes, the coastal lagoon complexes, small portions of some of the interior wetlands, and even smaller areas of exposed bedrock. Though the vast majority of the archipelago was cut-over (and much of it also burned), remnant stands of old-growth wet-mesic to mesic yellow birch-white cedar-eastern hemlock forest occur on several of the smaller islands and in association with several of the Coast Guard light stations on some of the larger islands. Small fishing villages, logging camps, a few farms, and a resort formerly existed on the islands.

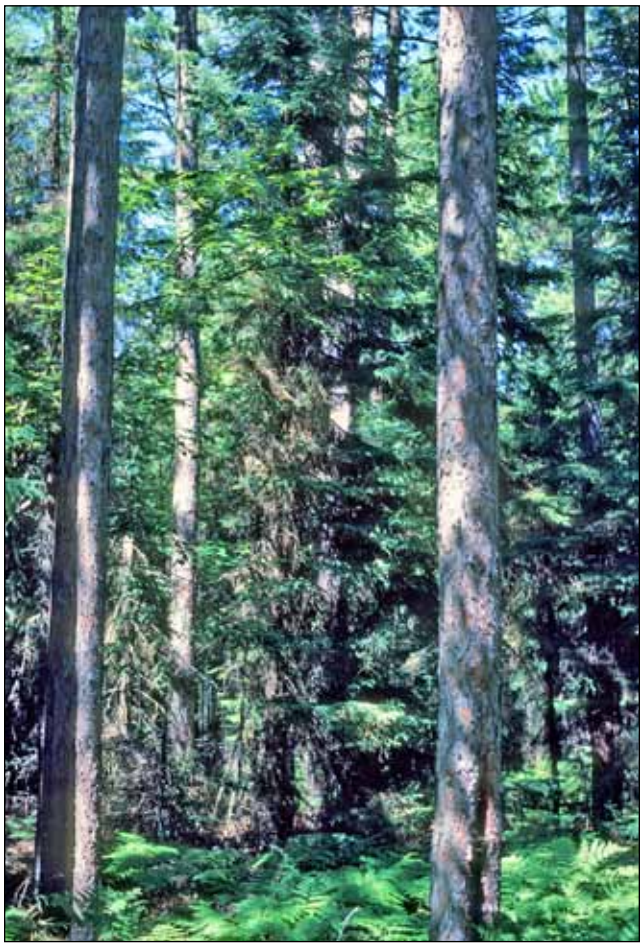
In 1970 Apostle Islands National Lakeshore was created, totaling approximately 42,500 acres and encompassing 21 of the 22 Apostle Islands (13,000-acre Madeline Island was excluded). In 1986 Long Island was added to the National Lakeshore. In 2004 the Gaylord Nelson Wilderness Area was established, encompassing 80% of the park's land area.

Long Island is a special case. It is part of the Apostle Islands National Lakeshore, but geologically it is not similar to the other islands (it is a recurved barrier spit). It has not been an "island" since 1975, when a fierce November storm filled the channel separating Long Island from Chequamegon Point with immense quantities of sand. In 2010 Long "Island" is still connected to the mainland via Chequamegon Point and an isthmus known as the "Sand Cut."

The sandscapes and their associated lagoons are some of the least disturbed and most diverse ecosystems on the western Great Lakes. The natural community mosaic includes some of the most extensive pine forests in this ecological landscape (with black spruce as an important component of these upland forests that are otherwise dominated by red and eastern white pines), one of Wisconsin's very few examples of Great Lakes Barrens, beaches and dunes, interdunal wetlands, and a wide array of marshes, fens, sedge meadows, and bogs. These natural communities in turn support diverse floras that include many rare plants (see the "Flora" section, also Judziewicz and Koch 1993 and Wisconsin DNR 1997) as well as rare invertebrates (R.J. DuBois, J. Pleski, W. Smith, and E. Epstein, Wisconsin DNR, unpublished data) and birds (Matteson 1996).

The forests on the Apostle Islands exhibit some unique properties. Dominants in the old-growth stands include eastern hemlock, northern white-cedar, yellow birch, and maples, and the understory of those islands from which white-tailed deer are absent often support a lush growth of sapling eastern hemlock and northern white-cedar and dense stands of Canada yew. In poorly drained areas, ephemeral ponds are present. At a few locations, the old-growth forests have a strong boreal character, with spruce and fir dominant, sometimes mixed with northern white-cedar and yellow birch. Lichens often cover the branches of the conifers, imparting an aspect to these stands that is highly unusual in Wisconsin. The much more abundant second-growth forests are generally dominated either by aspen or northern hardwoods, but in some areas, there are second-growth forests in which northern red oak is currently an important species.

Sandstone is exposed on several islands as cliffs, or more rarely as ledges, and provides habitat for highly specialized plants, including rarities.



Northern Dry Forest dominated by red pine and black spruce. Stockton Island tombolo, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

Wave and ice-carved sandstone cliffs are prominent features on the Apostle Islands and nearby mainland. Bedrock exposures are critical habitat for several rare species. Devils Island, Ashland County. Photo by Eric Epstein, Wisconsin DNR.

Southern tip of Outer Island, with lagoon and fen enclosed by sandspit. Photo by Eric Epstein, Wisconsin DNR.

Remnant old-growth hemlock-hardwood forest features large living trees, snags, coarse woody debris, and a multi-layered canopy. Such forests were historically abundant in northern Wisconsin but are now exceedingly rare. Apostle Islands National Lakeshore. Photo by Mike Mossman, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Most of the island archipelago is within Apostle Islands National Lakeshore, a portion of which is now designated as a federal Wilderness Area. A number of ecologically valuable sites have been designated as state natural areas, in cooperation with the Wisconsin DNR. Additional sites merit special recognition, protection, and management efforts based on the types and quality of the natural communities present and/or because populations of rare species are present.
- Madeline Island contains stands of older conifer-hardwood forest, perched wetlands, and sandstone cliffs. Ownership is a mix of private, tribal, and state.
- Madeline Island is the largest of the Apostle Islands, but it is not part of the National Lakeshore. Work with NGOs and others to expand protection of valuable wetlands, forests, and cliffs. Two wetland complexes of high biodiversity and aesthetic significance, Big Bay (much of it a state park) and Amnicon Bay (under tribal and private ownerships), occur on Madeline Island. Additional protection for these sites is highly desirable.
- Long-term monitoring of vegetation and selected species (e.g., those of boreal affinity) is needed to serve as benchmarks with which sites on the mainland might be compared.
- Continue to monitor migratory and breeding bird use of the Apostle Islands and Long Island.
- The archipelago's flora, especially the boreal, arctic, and alpine elements, may offer excellent opportunities to study climate change, especially if mainland sites are included.

Freshwater Estuaries and Coastal Wetlands

Due to differential rates of isostatic rebound from past glaciation, southwestern Lake Superior has been inundated, creating the extensive wetlands (especially the sensitive peatland communities such as the coastal fens, which have been destroyed or altered in many other parts of the Great Lakes) and drowned river mouths that are characteristic of this part of the lake's basin. Sites associated with drowned river mouths are considered freshwater estuaries, and these host a complex and distinctive mosaic of natural communities. Each estuary, including several that are only a few acres in extent, is bordered by a sandspit. The best developed of these spits support natural communities that are restricted to the shores of the Great Lakes, such as Great Lakes Beach, Great Lakes Dune, Great Lakes Barrens, and Interdunal Wetland. The pine forests occurring on several of the larger sandspits are also of very high significance regionally because these occurred on such sites historically, and pines are now important at very few other locations in the ecological landscape, support rare plants and nesting birds (including forest raptors), and receive heavy use as stopover sites by migratory birds.

Lake Superior estuaries provide significant spawning and nursery habitats for lake sturgeon, northern pike, walleye, and many other fish species as well as important breeding and foraging habitat for birds such as gulls, Double-crested Cormorant, Common Tern, Piping Plover, and raptors. In October 2010, the St. Louis River Estuary, connected to Lake Superior in Douglas County, was established by the National Oceanographic and Aeronautic Administration (NOAA) as a National Estuarine Research Reserve (NOAA 2014 and UWS-UWEX 2014). Only one other freshwater estuary in the United States—a site on Lake Erie—is part of NOAA's National Estuarine Research Reserve system.

The significance of the coastal peatlands for invertebrates is high. A key consideration for managers and planners to keep in mind is that the invertebrate fauna of the coastal wetlands includes species that do not occur in the inland bogs and fens.

Management Opportunities, Needs, and Actions

- Maintain or restore the natural processes upon which these systems are dependent, including longshore transport of sand, fluctuating water levels within the range of variability needed to maintain all habitats and forest successional and developmental stages, and the quality and quantity of water entering the estuaries via the streams that feed Lake Superior.
- Monitor gross changes in habitat abundance and distribution of the key vegetation types with air photos and satellite imagery. Follow-up with periodic ground-truthing to assess in greater detail changes in extent, composition, and condition of important vegetation types and habitats.
- Support the Lake Superior National Estuarine Research Reserve and participate in the development of a research, education, and management plan.
- Design a network of research sites to address vegetation change due to water level and water quality changes, changing land uses, the spread of invasive species, nutrient enrichment, and climate change. Identifying and maintaining adequate controls should be a priority.
- Support efforts of the Lake Superior Ojibwa to protect the Bad River-Kakagon Sloughs, an estuarine complex of roughly 10,000 acres that is arguably the most important freshwater estuary in North America because of its size, condition, associated biodiversity, and cultural significance.
- Maintain (or develop) cooperative agreements between the Lake Superior Ojibwa, the National Park Service, NGOs, and private individuals to afford maximum protection to Long Island-Chequamegon Point—the largest, least disturbed, and most intact coastal barrier spit on Wisconsin waters of Lake Superior—from damage and degradation. No other site on western Lake Superior offers such opportunities.

Extensive Emergent Marsh within Great Lakes estuary complex. This site is now part of a National Estuarine Research Reserve established by the National Oceanic and Atmospheric Administration (NOAA). St. Louis River, Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Eastern end of Bark Bay, a diverse coastal wetland complex along Lake Superior. Note springs, outlet stream. Bayfield County. Photo by Eric Epstein, Wisconsin DNR.

Raspberry Bay, the mouth of the Raspberry River, undisturbed fen, sedge meadow, and shrub swamp. Red Cliff Ojibwe Reservation, Bayfield County. Photo by Eric Epstein, Wisconsin DNR.

- Other important coastal wetlands management opportunities occur at Big Bay, Amnicon Bay (on Madeline Island), Sioux River, Raspberry Bay, Sand River, Lost Creek, Bark Bay, Port Wing, and at several locations within the St. Louis River Estuary. Smaller estuaries with limited but still significant management opportunities occur at Little Sand Bay, Frog Bay, the mouth of the Bois Brule River, the mouth of the Amnicon River, and at several other locations.
- Due to its size and ecological and economic significance, the vegetation that historically characterized the St. Louis River Estuary needs to be better understood before certain types of remediation are attempted. The estuary's dynamics as well as water quality, water quantity, and type and extent of aquatic vegetation have been dramatically influenced by the changes that accompanied the urban and industrial development of the Twin Ports metroplex.
- Protect and restore shoreline and wetland habitat at harbors and river mouths to provide more spawning and nursery habitat for rare and common species. Protect or restore hydrological connections between lakes, streams, and wetlands. Continue to try preventing the introduction and spread of aquatic invasive species through ballast water discharge prohibitions and other means.
- Implement recommendations regarding replicating as fully as possible the normal variation in river flows, remediation of contaminated sediments, and control of storm water inflows from the Lower St. Louis River Habitat Plan (SLRCAC 2002).
- Avoid loss of open water habitat and continue to improve water quality in the St. Louis River and its estuary. It may be appropriate to increase the amount of vegetated wetlands, to compensate for wetlands lost to alteration, degradation, and outright destruction due to filling. Protect and, where possible, enhance the existing sheltered bays. Prevent further filling of industrially influenced bays and slips established for cargo ships, in addition to remediating and reducing damaging sediment inputs. Work to improve and then maintain the quality of aquatic and wetland habitats in Allouez Bay, in addition to reducing siltation in and mimicking natural flow variation of its tributary streams.
- In some areas, such as parts of the St. Louis River Estuary and Fish Creek Sloughs (at the head of Chequamegon Bay), require continued efforts to control or eliminate purple loosestrife, using various programs as sources of support.
- Problem invasive plants such as common reed and narrow-leaved cat-tail are present (and spreading) but not yet dominant in some of the coastal wetlands. These species (and others that have similar potential to take over natural systems) should be monitored carefully and eradicated whenever possible.

Boreal (Clay Plain) Forest

On either side of the rugged Bayfield Peninsula, the Superior Coastal Plain's heavy red clay soils historically supported one of northern Wisconsin's most distinctive forest communities. Dominant trees included white spruce, eastern white pine, balsam fir, and white birch. Important associates included quaking aspen, northern white-cedar, and balsam poplar. The Cutover and subsequent fires of the late 19th and early 20th centuries produced a second-growth forest with few conifers, virtually no large trees, and vast expanses of aspen, sometimes mixed with white birch.

The present forest on the "clay plain" remains aspen-dominated and has also been significantly fragmented by farm fields and pastures, roads, railroad and utility rights-of-way, and other developments. Portions of this ecological landscape, however, represent the best potential to restore missing elements of the boreal forest such as more conifer representation, large trees, snags, coarse woody debris, patches of old-growth forest, large forest patches, and a reduction of the hard edge that is now prevalent throughout much of this region.

Diverse, structurally complex, remnant boreal forest near the Bad River. Canopy includes white spruce, balsam fir, eastern white pine, red pine, balsam poplar, and white birch. Ashland County. Photo by Eric Epstein, Wisconsin DNR.

Though the best boreal forest restoration opportunities may be in northern Douglas County, there are also some excellent opportunities on the clays dissected by the Bad River and its tributaries in Ashland County. Northwestern Iron County also offers boreal forest restoration opportunities, though these are less extensive than in other jurisdictions.

The forests of the Bayfield Peninsula and Apostle Islands are somewhat different, with dominant canopy species that are strongly associated with the more mesic forests found elsewhere across northern Wisconsin, such as eastern hemlock, yellow birch, maples (both sugar and red), and in a few areas, including on several of the Apostle Islands, a significant amount of northern red oak. Some of the older hemlock-hardwood remnants, however, do have a boreal flavor, with a significant component of white spruce and balsam fir. Areas where the glacial tills contain a lot of clay tend to be poorly drained. The northern portions of Devils Island (one of the northernmost and most exposed of the Apostle Islands) support a forest in which spruce and fir are dominant and where there is also representation by eastern white pine and northern white-cedar. Scattered, usually much smaller, boreal patches of white spruce and balsam fir occur elsewhere on the Apostle Islands.

Conifer-hardwood forests on the northeastern Door Peninsula have also been termed "boreal" and share similar tree species with the boreal remnants of the Superior Coastal Plain Ecological Landscape. On the Door Peninsula, however, the understory composition, soils, past land use, and bedrock geology (Niagara dolomites, which are close to the surface and exposed in many areas) differ significantly from the Lake Superior Boreal (clay plain) Forest.

Abandoned agricultural land in Superior Coastal Plain recolonized by boreal conifers (white spruce, balsam fir, eastern white pine). Brule River State Forest, Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Identify and protect remnant stands exhibiting relatively little evidence of past disturbance. Initially these might come from the public land base or on lands identified and managed by NGOs via acquisition or conservation easement.
- Continue to collect plot data from remnant boreal forest stands in the Superior Coastal Plain Ecological Landscape in order to better describe the community and enable comparisons with the boreal forests of the northeastern Door Peninsula and western Ontario.
- Design and initiate a boreal forest restoration project somewhere on the Lake Superior clay plain in which the objectives will include an increase in conifer cover, an increase in effective forested area, better representation of large trees and coarse woody debris, a reduction in forest edge (especially "hard" edge), and regional distribution of study sites (e.g., both west and east of the Bayfield Peninsula).
- Examine the composition of the clay plain forests prior to Euro-American settlement and clarify the natural disturbance regimes that sustained them. The roles of fire and periodic spruce budworm outbreaks, for example, are not well understood here.

Kimball's Bay, an arm of the St. Louis River Estuary, is flanked by a mature forest of boreal conifers. Superior Municipal Forest, Douglas County. Photo by Eric Epstein, Wisconsin DNR.

- Address the impacts of excessive browse by white-tailed deer on conifers, especially on Canada yew, balsam fir, northern white-cedar, and eastern white pine.
- An expanded inventory on private lands to locate remnants worthy of consideration for protection and/or restoration is needed. If there is tribal interest in participation, some of the lands within the boundaries of the Bad River and Red Cliff reservations might be included in such an inventory.
- Given the widespread concerns and confusion over the potential impacts of climate change, the boreal forests and selected plants and animals associated with those forests might be considered as subjects for a statewide or regional monitoring program.

Red Clay Wetlands

Areas in and around the city of Superior are characterized by poorly drained, heavy red clay soils that often support wetland vegetation, even on sites locally occupying the higher elevations. The most common wetland cover types in these areas at the present time are shrub swamps (with willows and dogwoods often dominant), sedge meadows (composed mostly of sedges, grasses, and rushes), and marshes (with a variety of robust graminoid species dominant). Uncommon cover types or features of these red clay wetlands include ponds or small pools, springs, and remnant conifer swamps (which were apparently much more common on the clays in the past). Areas that were cleared, burned, drained, cultivated, and abandoned are now dominated by various exotic grasses as well as some native plants (especially sedges, Canada bluejoint grass, and shrubs).

Ecologically, the red clay wetlands are most remarkable for the unusual flora they support. Many rare species have been documented in these habitats, including a number of plants that occur nowhere else in Wisconsin and several that are rare globally. Among the plants that occupy red clay wetland habitats, and for which the Superior area populations are especially important because of their number, population size, or the plant's legal status, are the Wisconsin Endangered slender spike-rush and small yellow water crowfoot and the Wisconsin Threatened arrow-leaf sweet-colt's-foot, alkali buttercup (*Ranunculus cymbalaria*), tea-leaved willow, and northern bur-reed. Several plants on Wisconsin's Special Concern list are also especially important here because they have been documented nowhere else in the state. These include smooth black sedge, mamillate spike-rush, and veined meadow-rue. See the "Flora" section for additional details.

The most common cover type is shrub swamp, with tall shrubs such as willows, dogwoods, and alder especially prominent. "Islands" of boreal forest occur on slightly better drained sites or on slight rises, and these vary in composition from stands composed mainly of quaking aspen to mixed stands of aspen, white birch, white spruce, balsam fir, and eastern white pine. These wetlands have proven to be challenging to manage as they are extensive, difficult to drain, and in recent years have proven to be "in the way" of many development plans.

Because of the large number of high quality wetlands within the city of Superior, a Special Area Management Plan (SAMP) was implemented in 1996 to provide a way to balance development with conservation and management of wetlands and rare plant populations within the city limits (City of Superior 2014), offering relatively high levels of protection to wetlands meeting various "integrity" criteria in a Rapid Assessment Methodology used to evaluate and rank wetlands for this plan. The original SAMP ended in 2007, and SAMP II was authorized by the U.S. Army Corps of Engineers on November 3, 2008. See the "Flora" section of this chapter for further description of the SAMP.

Management Opportunities, Needs, and Actions

- Implement those portions of the Superior Special Area Management Plan that will protect the most intact and viable wetlands falling into the red clay group and those that support the greatest concentrations and largest populations of rare species.
- Restore hydrology in wetlands deemed to have high ecological significance to prevent further deterioration from the many modifications that have affected water movement and quality over the past century.
- Monitor selected rare plant populations from the lists developed by botanists familiar with the regional flora.
- Conduct surveys for selected animals, especially birds, as casual observations have shown that these wetlands are important for species such as Veery, Golden-winged Warbler, and Mourning Warbler. It is likely that some of these areas receive heavy use by migrant passerines and possibly raptors. Better documentation is needed to clarify the significance of these wetlands to birds and other animals, including invertebrates, herptiles, and mammals.

Red clay wetlands southeast of the City of Superior support emergent marsh, sedge meadow, and shrub swamp communities. This small pool contained a population of the Wisconsin Threatened northern bur-reed. Photo by Emmet Judziewicz.

- Establish the importance of the red clay wetlands to migratory birds and dispersing or resident mammals. The significance of wetland corridors in this ecological landscape is potentially high.
- Examine the original federal public land survey notes, the Bordner surveys (WDA 1930–1947), and recent air photos to clarify the nature and magnitude of vegetation and land use changes that have occurred in and around Superior over the past 150 years.
- Develop effective methods with which to restore the hydrology of those sites that are most important to maintain as functional wetlands.
- Monitor significant wetlands for invasive species and develop effective control measures.
- Coordinate management efforts, recreational use, and protection among jurisdictions and various projects in and around the red clay wetlands. There are appropriate roles for federal, state, and local governments as well as for NGOs and other private entities.
- Because these wetlands are locally common and generally not viewed as attractive, the red clay wetlands are sometimes taken for granted or perceived as nothing but obstacles to progress. Additional information needs to be disseminated, not only on their biological values but also on the services they provide at virtually no cost to those who benefit.

River Corridors

The largest rivers of the Superior Coastal Plain Ecological Landscape originate in regions to the south and west. The floodplains and associated terraces of the St. Louis, Bad, and Nemadji rivers support examples of communities that are generally scarce this far north. Some of the higher terraces feature rich, mesic sugar maple-basswood forests that are not only floristically diverse but contain herbs that are uncommon this far north (some of these mesophytic herbs have been documented in no other habitat within the Superior Coastal Plain Ecological Landscape). Wisconsin's northernmost stands of Floodplain Forest occur along the large rivers, dominated by silver maple, ashes, bur oak, and box elder. Some of these stands are mixed with boreal conifers such as white spruce and balsam fir, and balsam poplar is sometimes a common deciduous tree.

Smaller streams, including the Amnicon, Bois Brule, Flag, and Sioux rivers and Fish Creek, lack the extensive terraces that support the unusual communities mentioned above, but they may provide similar opportunities at smaller scales as well as important breeding habitat, foraging areas, and travel corridors for many native species. Maintaining or restoring the most appropriate vegetation cover to these corridors will not only enhance these habitats but stabilize streambanks and reduce the quantities of sediments that are transported to Lake Superior. Corridors that tend to run north-south may be especially important for migratory species such as birds. Old oxbows and abandoned channels within these river corridors often contain marsh, sedge meadow, or shrub swamp vegetation and, occasionally, conifer swamp (usually of tamarack).

Many of the critical salmonid spawning habitats in the upper portions of the coldwater streams have been heavily impacted by past American beaver occupation. Streamside forests provide large woody debris to the streams, which is essential in-stream structure for brook trout (and other species). American beaver set back streamside vegetation with muck-bottomed impoundments that prevent succession to forests and result in extensive areas of open water, wet meadow, or shrub swamp.

Management Opportunities, Needs, and Actions

- Identify and protect additional forested sites along river corridors crossing the Superior Coastal Plain Ecological Landscape. Natural communities that merit especially high levels of protection include Boreal Forest, Northern Mesic Forest (rich, hardwood-dominated stands), Floodplain Forest, and various wetland types that occupy former river channels or sites receiving groundwater seepage.
- Protect coastal wetlands and adjoining uplands that occur at river mouths. Examine the restoration potential of stream

Botanist Emmet Judziewicz in floristically rich stand of mesic maple-basswood forest on terrace just above the floodplain of the Bad River. Photo by Eric Epstein, Wisconsin DNR.

corridors throughout the ecological landscape (this will require additional field assessment with help from remote sensing imagery and the development of methods that will permit comparisons between watersheds and sites at present and in the past).

- Identify problem watersheds or areas within river corridors that contribute to reduced water quality. Such areas include unstable eroding banks that were damaged during the Cutover and never fully recovered as well as areas affected by more recent disturbance activities.
- Establish acceptable rates of flow and (normal) levels of erosion for the streams crossing the Superior Coastal Plain, especially in the areas characterized by thick deposits of clay soils.
- Experiment with methods of managing lands and vegetative cover that will reduce the rapidity of water flow into streams.
- The Bois Brule, Nemadji, Black, Bad, White, and other rivers provide dispersal and movement corridors for plants, terrestrial animals, fish, and birds. These corridors and their steep slopes need to be kept intact or restored and spared further fragmentation from roads, commercial or residential developments, intensive logging, and other disruptive impacts.
- Actively restore American beaver-impacted riparian areas of critical coldwater tributaries by removing problem American beaver and developing techniques to jump start streamside forest recovery.
- Lake sturgeon spawn in several of the rivers that drain into Lake Superior. Some fish managers have questioned whether the use of the lampricide TFM (3-trifluoromethyl-4-nitrophenol) may have a negative impact on recruitment of sturgeon spawning in streams that are treated to control lamprey eels. A study conducted on the Bad River did not yield any insight into this question (USFWS 2006). There is an opportunity to conduct a more thorough analysis of whether the current lamprey treatment protocol has any impact on sturgeon populations. Support for ongoing sturgeon rehabilitation efforts should result in better security for Lake Superior sturgeon populations.
- Some streams entering the Superior Coastal Plain Ecological Landscape from the south flow over bedrock formations (usually at or close to the southern edge of this ecological landscape), creating waterfalls that are prized for their scenic beauty and have become featured attractions in several state parks. Amnicon, Big Manitou, Copper, Iron River, Bad River, Siskiwit River, and Potato River falls are just a few of the more than 24 waterfalls mapped in or on the margins of the Superior Coastal Plain. Waterfalls provide moist microclimates for habitat specialists, including plants and possibly invertebrates. Such sites are sensitive and may require special protection.

The undeveloped corridor of the Nemadji River includes riverine ponds, emergent marsh, sedge meadow, shrub swamp, hardwood swamp, and alluvial terraces with patches of floodplain forest. The rough terrain drained by the Nemadji supports extensive second-growth boreal forest of aspen, spruce, and fir. Douglas County. Photo by Eric Epstein, Wisconsin DNR.

Migratory Bird Concentration Areas

Large numbers of migratory birds move through the Superior Coastal Plain Ecological Landscape (Steele 2007, Grveles et al. 2011). Wisconsin Point, for example, is used by large numbers of passerines and raptors, especially during the spring migration. The immediate shoreline and nearshore waters surrounding Wisconsin Point host waterfowl, loons, grebes, shorebirds, terns, and gulls in large numbers during both spring and fall. Wisconsin Point is also well known as a location at which to find rare birds.

Hawk Ridge is a bedrock feature in Minnesota that borders the northwestern shore of Lake Superior. It is also one of the most significant raptor concentration areas in North America. During the fall, huge numbers of raptors are funneled along the ridge to the head of the lake. From there, the birds disperse somewhat on their journey south, with some of them using portions of the St. Louis River Estuary to hunt and rest.

Chequamegon Bay also hosts large numbers of waterfowl, other waterbirds, and shorebirds. The spring raptor migration is significant along the west side of the bay and has been well documented by observers at the Great Lakes Visitor Center west of Ashland (Brady 2004).

Heavy flights of passerines have been documented in the Apostle Islands in the fall, and large numbers of raptors have also been noted moving through the archipelago. Long Island and Chequamegon Point experience heavy movements of passerines, and sometimes raptors, in the spring. Shorebirds, waterfowl, loons, grebes, gulls, and terns may be present in large numbers during both the spring and fall.

Smaller but still significant concentrations of migratory birds occur at some of the other coastal estuaries, such as the mouth of the Bad River, Bark Bay, Port Wing, and the mouth of the Bois Brule River.

Also worth mentioning is the use this area receives in winter from species seen far less often in most other parts of Wisconsin such as Gyrfalcon, Great Gray Owl, Northern Hawk Owl, and Boreal Owl. Irruptive species such as Bohemian Waxwing (*Bombycilla garrulus*), Pine Grosbeak (*Pinicola enucleator*), Evening Grosbeak, Red Crossbill (*Loxia curvirostra*), White-winged Crossbill (*Loxia leucoptera*), Common Redpoll (*Acanthis flammea*), and Hoary Redpoll (*Acanthis hornemanni*) are observed here in large numbers in some years.

Management Opportunities, Needs, and Actions

- More systematic monitoring of the avian use of sites such as Wisconsin Point and the adjacent waters of Lake Superior, Allouez Bay, and St. Louis Bay is needed.
- Portions of the St. Louis River Estuary that are heavily used by birds need to be identified, monitored, and protected from incompatible uses and developments.
- Implementation of the Wisconsin Migratory Bird Stopover Conservation Plan (Grveles et al. 2011) will provide a framework that ensures that sites heavily used by migratory birds are identified and will not be disturbed (e.g., by power boats) during critical periods. Update existing plans and emphasize coordination, cooperation, and partnerships among interest groups.
- The protection and management needs for sites identified as significant to migratory or breeding birds should be assessed and appropriate actions proposed and implemented by various agencies, organizations, or individuals.
- Establish the importance of areas such as north-south river corridors to migratory birds (potentially important sites, besides those already mentioned elsewhere in the document, include the Amnicon, Flag, Iron, Middle, Poplar, and Montreal).
- The potential effects of wind turbines on migrating birds in this ecological landscape need study.

Colonial Birds: Terns, Gulls, Cormorants

Important bird colonies occur on small islands in Chequamegon Bay, the Apostle Islands archipelago, and in the St. Louis River Estuary. For example, the Wisconsin Endangered Common Tern nests at only two sites on Lake Superior—both of them within the Superior Coastal Plain. The tern colonies are monitored annually by Wisconsin DNR staff from the Bureaus of Wildlife Management and Natural Heritage Conservation. Other colonial nesters have been monitored at annual or five-year intervals since 1974. Besides Common Terns, the monitored species include Black Tern, Great Blue Heron, Double-crested Cormorant, Herring Gull, and Ring-billed Gull.

Management Opportunities, Needs, and Actions

- Continue to monitor colonial birds at recommended intervals. Gull and cormorant rookeries have been monitored at five-year intervals by Wisconsin DNR personnel from the Bureaus of Wildlife Management and Natural Heritage Conservation.
- Compile data and summarize the results of 35 years of survey data. Make this information available to land and water managers, researchers, and other interested parties.
- Assess the status and management needs of each monitored species and make recommendations for appropriate levels of protection.
- Black Terns no longer occur as breeding birds at wetlands along and near the lakeshore such as Kakagon Sloughs, Fish Creek Sloughs, Allouez Bay, or at the Wisconsin Department of Transportation Kimmes-Tobin Wetlands south and west of Superior.

Rare Species Management

The majority of rare species opportunities should be covered under one of the significant features described above. In addition, many rare species populations occur on public lands and receive at least a minimal level of consideration in management plans, if not outright protection. However, there will

Only two Common Tern colonies occur on Lake Superior, one near Ashland and the other near Duluth-Superior. Photo by Ryan Brady, Wisconsin DNR.

Arrow-leaved sweet-coltsfoot (Wisconsin Threatened) and marsh marigold in understory of perched alder thicket on red clays. Brule River State forest, Douglas County. Photo by Daniel Spuhler.

be exceptions, and interested conservationists should seek management and protection guidance from the available sources. Rare species protection needs can be prioritized by referencing the Partners In Flight (PIF) Bird Conservation Plan for the Boreal Hardwood Transition (Bird Conservation Region 12) and Wisconsin's Wildlife Action Plan (Matteson et al. 2009 and Wisconsin DNR 2005d). For a few rare species, management guidelines are available from public agencies (e.g., the Wisconsin DNR's forest raptor management guidelines and state recovery plans). In cases where the management needs of a rare species are inadequately known, the interim conventions are usually to monitor the population while documenting and protecting its habitat.

Management Opportunities, Needs, and Actions

- Continue to build and update the Wisconsin DNR's database of rare plants and animals. Periodically reassess the status of species tracked by the Natural Heritage Inventory program.
- NGOs, agency and tribal biologists, university staff, and local naturalists with an interest in biodiversity protection and rare species should convene regularly to share information and evaluate potential project needs and priorities.
- Assess protection status and needs of rare species (WDNR 2009) in the Superior Coastal Plain. Identify those that are not adequately protected on public lands.
- Assess the adequacy of previous survey efforts for rare taxa and develop a plan to fill gaps in our knowledge of poorly known or overlooked taxa.
- Identify a subset of rare and representative rare species that may be especially vulnerable to climate change and design and implement a population monitoring program. Ideally such a program would have multiple public and private partners.

Miscellaneous Features

This section is meant to capture ecological features that are of relatively high conservation value to ensure that rare species, structural features, habitats, successional stages, and natural communities are maintained somewhere in the ecological landscape. Not all of these features occur or are well represented in the opportunities previously discussed, nor are they all on public lands.

Old-growth Forests

Though small stands of old-growth forest occur on the Apostle Islands and restoration opportunities exist on public lands such as the Brule River State Forest and in the City of Superior Municipal Forest, this formerly abundant stage in forest development is now extremely rare. Old-growth stands demonstrate unique structural and compositional features and are needed for a wide variety of ecological and socioeconomic reasons (WDNR 2006a). A recent acquisition by the State of Wisconsin on the Bayfield Peninsula, "Nourse's Sugarbush," features one of northern Wisconsin's best examples of a sugar maple-basswood forest with old-growth characteristics. There are several stands within the boundaries of the Red Cliff Ojibwa Reservation that contain stands of older mesic forest with significant representation by some of the regionally diminished conifers such as eastern hemlock, northern white-cedar, white spruce, and eastern white pine. Sugar maple, yellow birch, and American basswood (*Tilia americana*) are present, so these stands appear more closely aligned with the hemlock-hardwood types (Northern Mesic Forest) than with the boreal forest. In areas receiving heavy amounts of snow (due to proximity with Lake Superior or high elevation), remnant patches of Canada yew may persist, and reproduction by browse-sensitive coniferous trees may still occur.

Remnant mesic hardwood forest with old-growth characteristics on the Bayfield Peninsula. Nourse's Sugarbush, Bayfield County. Photo by Eric Epstein, Wisconsin DNR.

Clay Seepage Bluffs

This community has not been well studied in Wisconsin or, apparently, anywhere else. Clay bluffs are common in the Apostle Islands (Judziewicz and Koch 1993), along the mainland shore in parts of Bayfield, Douglas, and Iron counties, and

in the vicinity of the city of Superior. Rare plants are present at some of these sites. Clay is exposed at many locations in the steep-sided valleys of streams running to Lake Superior. Clay bluffs provide nesting habitat for the Belted Kingfisher (*Megaceryle alcyon*) and large colonies of Bank Swallows (*Riparia riparia*). Highly unstable sites are often devoid of any vegetation and may be colonized by rank weeds.

Surrogate Grasslands

Extensive areas of nonnative grassland are common, especially west of the Bois Brule River and south of the city of Superior and south and west of Ashland. These open habitats include mixtures of abandoned and active croplands, pasture, and fallow fields. Most of these grasslands are privately owned, though there are several relatively large complexes of abandoned fields along Highway 13 within and adjacent to the Brule River State Forest. At least some of the larger and less isolated grassland sites support sensitive grassland birds.

Opportunistic management of small scattered patches of grassland should be considered carefully compared to the benefits of managing toward more forested conditions to which this ecological landscape is more ecologically suited. Sites to consider for a grassland management emphasis should be large, already in permanent grass cover, relatively free of invasive species that could cause problems in native plant communities, support sensitive birds, contain wet or aquatic inclusions, and most importantly, would not conflict with opportunities to restore and/or manage Boreal Forest, or with areas that are better suited to forest cover to enlarge effective forest area, reduce edge, and better protect water quality.

Management Opportunities, Needs, and Actions

- Protect stands of old-growth forest where they occur or have the best opportunities for developing. In upland situations, priorities could include boreal forests, mesic to wet-mesic hemlock-hardwood forests, eastern white and red pine forests, and rich mesic maple-basswood forests. Lowland priorities would include stands of northern white-cedar, black spruce, tamarack, black ash, or silver maple-green ash. The biggest caution is that stand size and context can have significant impacts on forest viability and conservation value. Some of the best opportunities may be on tracts within or adjacent to existing public lands, along stream corridors, or as part of wetland complexes.
- Identify practical methods by which conifers and missing structural features can be restored to sites that formerly supported Boreal Forest. Sites within or adjacent to large blocks of existing forest, or associated with stream corridors would be among the potential priorities.
- Stream corridors that are primarily in private ownership and have both forest restoration potential and water management/erosion issues might be considered relatively high protection and restoration priorities.
- Identify large contiguous areas of open (nonforested) uplands, or uplands adjacent to open wetlands, that have the best potential to support rare grassland birds. Plan and complete surveys to document sites at which some of these species are present in the greatest numbers. Design and select grassland protection projects that are of sufficient scale and appropriate configuration and that do not conflict with other conservation priorities, especially those focused on boreal forest or for forests that could increase interior forest habitat for area-sensitive species, or aid in soil and streambank protection.
- Identify partners with an interest in protecting grassland bird habitat in this ecological landscape. Very few sites with high grassland management potential at large scales will occur on public lands, and private lands may be undergoing accelerated parcelization. Incorporating adjoining agricultural lands may have better potential than small scattered open sites on public ownerships.
- Detailed plant surveys are needed for clay seepage bluffs to better characterize the composition, structure, and variability expressed by these communities and to increase knowledge of those factors that contribute to the support of rare species. The development of protection priorities and preliminary management guidelines would emerge from the results of a well-designed survey. In the meantime, opportunistic protection of sites supporting unusual flora or fauna may be legitimate conservation goals, with the caveat that maintaining hydrological function may be the most important consideration.

In a few places on the Superior Coastal Plain there are patches of nonnative "surrogate grassland" large enough to offer management opportunities for declining wildlife species, especially birds. Bayfield County. Photo by Eric Epstein, Wisconsin DNR.

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

Figure 21.11. *Superior Coastal Plain counties.*

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 Superior Coastal Plain Ecological Landscape is called the Superior Coastal Plain counties (Figure 21.11). The counties included are Douglas, Bayfield, and Ashland, because at least 25% of each county lies within the ecological landscape boundary.

History of Human Settlement and Resource Use

American Indian Settlement

Early archaeology in northern Wisconsin is poorly understood, and this is particularly true of the Superior Coastal Plain Ecological Landscape. There are no large archaeological sites in the Superior Coastal Plain, and fragmentary evidence does not lead to even an estimate of when this ecological landscape was first occupied.

Historically, a number of tribes settled temporarily in this region. The Iroquois wars of the 17th century forced a flood of eastern refugee tribes westward. Among those to settle on the Superior Coastal Plain were the Huron (Wyandot), the Ottawa, and the Ojibwe (Chippewa). Of these tribes, only the Chippewa remain here today. The Red Cliff Band of Lake Superior Chippewa continues to make their home on the northern shoreline of the Bayfield Peninsula in Bayfield County (Red Cliff Band of Lake Superior Chippewa 2004). The Bad River Band owns and maintains a reservation in Ashland County along the lower Bad River. Tribal lands also occur on the northernmost part of Madeline Island at Amnicon Bay.

Euro-American Contact and Settlement

During the 17th century, French fur traders, soldiers, and missionaries began arriving in this region. As a result of Euro-American contact with American Indian tribes, trading posts, missions, and forts were established along river routes and lakes. There are historical records of occupation, specifically at Chequamegon Bay and Madelaine Island, which together became known as "La Pointe." In the 17th century, refugee Huron took up occupation at La Pointe, and the area quickly became known as a very active place to trade for French trade goods. Early records indicate that the brisk trade at La Pointe attracted people from great distances, such as Cree and Illinois Indians (Mason 1997). During the 1800s, American Indian tribes ceded large areas of land to the U.S. government, and permanent Euro-American settlement began in earnest.

Officially, permanent Euro-American settlement began in the Superior Coastal Plain counties with the founding of Bayfield County in 1866. Douglas County was founded in 1854, followed by Ashland County in 1860 (NACO 2010). Finnish immigrants began to arrive in significant number during the 1880s. They settled in and around Ashland and Superior and took jobs in factories and on the docks in this region. See the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions," for further discussion of the history of early Euro-American settlement in northern Wisconsin.

Early Agriculture

Agriculture was not prominent in the early history of the Superior Coastal Plain counties. In 1850 there were only five established farms in Bayfield County, and that number fluctuated over the next several decades, with 47 farms in all three Superior Coastal Plain counties in 1880 (ICPSR 2007). By 1900, coinciding with extensive logging in the region, the number of farms in the Superior Coastal Plain counties began to grow more rapidly, reaching 1,215 farms, while population had reached 70,903. Population continued to grow in each of the subsequent decades until reaching a peak of 91,510 in 1920; thereafter, population declined in the Superior Coastal Plain counties. Meanwhile, farm numbers continued to grow in the Superior Coastal Plain counties, even through the Great Depression, reaching 5,475 farms in 1940 (Figure 21.12). However, farm numbers in the Superior Coastal Plain counties had decreased sharply by 1950, as some marginal farms failed and went out of production.

Farms tended to be growing smaller on average in the Superior Coastal Plain counties than in the state as a whole until 1950, when average farm size in the Superior Coastal Plain counties increased to 136 acres compared to 138 acres statewide. 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 Superior Coastal Plain counties. That trend continued throughout much of the remaining 20th century (Figure 21.13).

Total value of all crops indicates the extreme influence of the Great Depression on agriculture. In 1910 all crops harvested in the Superior Coastal Plain counties had an estimated total value of $970,000, which had more than quadrupled by 1920 ($4.7 million) (ICPSR 2007). However, total value of all crops in the Superior Coastal Plain counties plummeted in 1930 ($2.3 million) and fell further by 1940 ($1.6 million). Total values of crops in the Superior Coastal Plain counties comprised only 1.0% of total crop value in the state in 1940, though these crops came from farms comprising 2.4% of all Wisconsin farm acreage. Farms in the Superior Coastal Plain counties historically have not been as productive here as in the state as a whole, as a result of cold, wet clay soils, cooler climate, and a shorter growing season.

Over the early part of the 20th century, farms in the Superior Coastal Plain counties were much less productive in terms of "cereals" than what occurred statewide. The 1910 federal agricultural census listed cereals as only 9.6% of the total value of all crops harvested in the Superior Coastal Plain counties, compared to 49.3% total value of all crops harvested statewide (ICPSR 2007). By 1940 cereals comprised 10% of crop value in the Superior Coastal Plain counties, compared to 36.6% statewide. Meanwhile, "hay and forage," associated with livestock farming, was 43.0% of total value of crops harvested in the Superior Coastal Plain counties in 1910, compared to 27.5% statewide. By 1940 hay and forage had risen to 60.7% of total crop value in the Superior Coastal Plain counties, compared to 44.6% statewide.

Early Mining

Iron and copper, among other minerals and metals, drew large groups of Euro-American settlers to Wisconsin during the 19th and early 20th centuries. However, extensive mining did not occur in the Superior Coastal Plain Ecological Landscape. The Superior Coastal Plain region of the state did, however, play a vital role in the transportation and export of mining products from the Penokee-Gogebic Range to eastern and some western markets. After railroads reached this range, mining production in the surrounding area increased dramatically, and during the 1880s, Ashland's port began to ship ore to steel mills around the region (The Wisconsin Cartographer's Guild 1998).

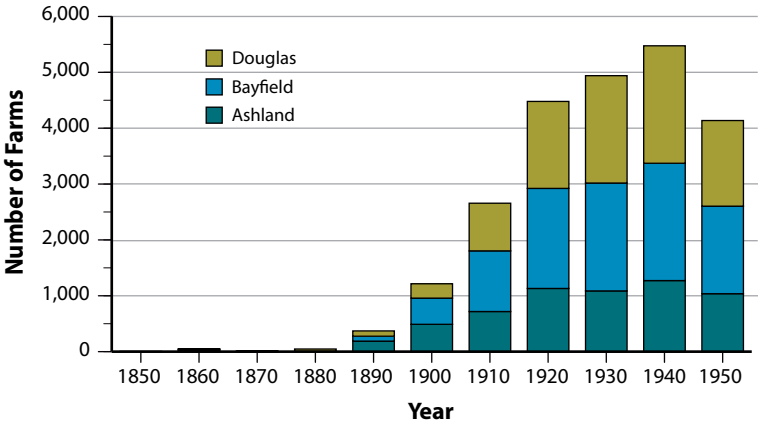


Figure 21.12. *Number of farms in the Superior Coastal Plain counties between 1850 and 1950 (ICPSR 2007).*

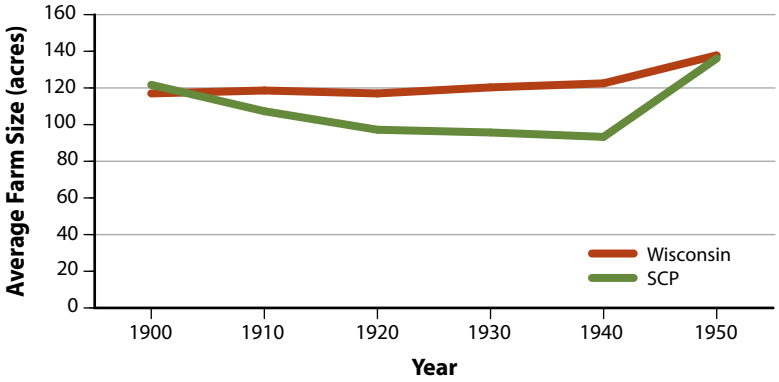


Figure 21.13. *Average farm size in Superior Coastal Plain counties between 1900 and 1950 (ICPSR 2007).*

Early Transportation and Access

In the early 19th century, an extensive network of American Indian trails existed throughout the territory. These trails were widened into roads suitable for ox carts and wagons. By 1870 the importance of railroads had caused these relatively primitive roadways to become of secondary value. Both the Wisconsin Central line and the Northern Pacific line serviced the Superior Coastal Plain counties (Fisher 1937). The Wisconsin Central line began in Menasha and terminated in Ashland, while the Northern Pacific ran from Duluth, Minnesota, east to Washburn and Ashland.

Lake Superior itself served as an invaluable means of transportation. By 1900 the shipyards of the Superior Coastal Plain counties, along with the rest of the Lake Superior shore, constructed two thirds of all new ships used on the upper Great Lakes (The Wisconsin Cartographer's Guild 1998). Not only did this endeavor provide transportation, it also supplied a viable means of trade with eastern and foreign markets.

Early Logging Era

Sawmills started along rivers in areas containing large stands of timber. Lumbermen built mills as close to the cutting areas as possible in areas where the rivers were unsuited to floating logs, whereas on easier rivers, sawmills were generally more centralized (Ostergren and Vale 1997). The

continual westward surge of Euro-American settlers into the great plains increased the demand for lumber from northern Wisconsin. See the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions," for a general description of the logging era in Wisconsin.

Roth (1898) described forest conditions in some of the northern Wisconsin counties at the close of the 19th century. Pine was reported to have been heavily harvested in the mixed pine-hardwood forest of the southern portion of Ashland County and in the north along Lake Superior (associated with the Superior Coastal Plain Ecological Landscape). Pine remained the predominant commercial timber within the Bad River Indian Reservation and along streams but was estimated at only 300 million ***board feet***, compared to the larger volume of uncut eastern hemlock and hardwoods. Northern white-cedar, tamarack, and spruces stocked Ashland County's swamps and other poorly drained areas. Eastern hemlock volume was estimated at 700 million board feet. Birch and American basswood were the principle species among the estimated 900 million board feet of hardwoods, comprising 60% of that volume, while oak was considered a secondary species (Roth 1898). By comparison, today there are an estimated 201 million board feet of pine, 114 million board feet of eastern hemlock, and over 1 billion board feet of hardwood ***sawtimber*** in Ashland County forests (USFS 2009).

Roth (1898) noted that pine had been harvested heavily along Lake Superior as well as along the Namekagon and White rivers in the southeastern third of Bayfield County and along the Northern Pacific Railway corridor. Vast extents of land were barren in the wake of the Cutover. However, a large pine resource of an estimated 3 billion board feet remained uncut at the time of Roth's report. Standing volume of eastern hemlock was estimated at 400 million board feet. Birch, American basswood, and maple were the principle merchantable hardwood species, which totaled an estimated 400 million board feet. By comparison, today there are an estimated 1 billion board feet of pine, 96 million board feet of eastern hemlock, and over 1.5 billion board feet of hardwood sawtimber in Bayfield County forests (USFS 2009). However, it should be noted that this includes all of Bayfield County, not just the portion in the Superior Coastal Plain Ecological Landscape.

Roth described the northern third of Douglas County as a boreal mixed forest, with eastern white pine, white and yellow birch, other hardwoods, and some northern white-cedar and tamarack. Though Roth reported the pinery to be cutover along Lake Superior and along the railroads and the St. Croix River (Roth 1898), there remained an estimated 3.5 billion board feet of pine in Douglas County. Though hardwoods were reportedly secondary to the forest composition of Douglas County, they comprised an estimated 700 million board feet. Though harvests of hardwoods were not heavy, oak comprised 25% of the yield, despite its small share of the forest cover. By comparison, today there are only 328 million board feet of pine and 709 million board feet of hardwood sawtimber in Douglas County forests (USFS 2009).

Resource Characterization and Use[1]

The Superior Coastal Plain Ecological Landscape is one of the smaller ecological landscapes, with a total area of almost 906,000 acres composed of just under 900,000 acres of land and about 9,700 acres of surface water. It has the second lowest acreage in lakes and reservoirs in the state.

In terms of current and potential recreational use, the Superior Coastal Plain Ecological Landscape has a much higher percentage of combined forest and grassland than the state as a whole. The proportion of federal and state land is above average. The density of campgrounds and multi-purpose trails is about average as is the number of visitors to state properties. Acreage in state natural areas is relatively high as is the number of Land Legacy sites. However, the number of sites with significant recreational potential is low.

Agriculture is not a major factor in the economy of the Superior Coastal Plain Ecological Landscape. It ranks 14th (out of 16 ecological landscapes in the state) in the percentage of land area in agriculture and 15th in net income per farmed acre. This ecological landscape is near the bottom in terms of milk and corn production.

The Superior Coastal Plain Ecological Landscape is about average among northern ecological landscapes in terms of the percentage of land in forests but ranks near the bottom in terms of timber volume per acre because of its cold climate and wet soils.

This ecological landscape has a very low density of roads and airport runways but ranks fourth among ecological landscapes in the density of railroads. Although there are only three airports, there are four major ports, more than any other ecological landscape in the state.

The Superior Coastal Plain Ecological Landscape does not use a lot of energy relative to the rest of the state nor is it a major producer of hydroelectric power. It does, however, produce an above average amount of biomass, 6% of the state total (USFS 2009). There are no industrial wind facilities or ethanol plants here.

The Land

Of the 896,536 acres of land that make up the Superior Coastal Plain Ecological Landscape (this does not include area of open water), 66% is forested. About 71% of all forested land is privately owned while 26% belongs to the state, counties, or municipalities and 3% is federally owned (USFS 2009).

Minerals

Of the Superior Coastal Plain counties, only Douglas County is involved in the production of nonmetallic minerals. In 2010 there were two mining establishments in the Superior

[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."

Coastal Plain counties (USCB 2010). Due to limited participation in mining, employment and earnings information is not disclosed.

Water (Ground and Surface)

Water Supply

The data in this section are based on the 24K Hydrography Geodatabase (WDNR 2015b), 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 will differ slightly. Surface water covers 9,726 acres in the Superior Coastal Plain Ecological Landscape, or 1.8% of the total area. There are approximately 215 lakes (over 1 acre in size). All lakes add up to 3,603 acres, which is 37% of the surface water. There is one lake over 1,000 acres, on the St. Louis River. Of the 5,818 acres of streams and rivers, the Saint Louis, Bad, and White rivers are the largest. There are 44 impoundments covering 305 acres.

Water Use

Each day 78 million gallons of ground and surface water are withdrawn in the three Superior Coastal Plain counties (Table 21.3). About 89% of withdrawals are from surface water (USGS 2010). Of the 75,980 people that reside in these counties, 55% are served by public water sources, and 45% are served by ***private wells***. The largest water usage, 65%, is for thermoelectric power generation, with Ashland County accounting for the bulk of this. Ashland uses 71% of all withdrawals.

Recreation

Recreation Resources

Land use and ownership patterns, in addition to the types of natural features present, partly determine the extent and types of recreation that are available to the public. For example, in the Superior Coastal Plain Ecological Landscape, there is a much higher percentage of forest and grassland and a lower proportion of agricultural land compared to the rest of the state (see the map entitled "WISCLAND Land Cover of the Superior Coastal Plain" in Appendix 21.K at the end of this chapter). The percentage of surface area in water is fourth lowest among ecological landscapes, but the proportion of that water in rivers as opposed to lakes is above average.

The percentage of federal and state land in the Superior Coastal Plain Ecological Landscape is above average. The density of campgrounds and multi-purpose trails is about average as is the number of visitors to state properties (Wisconsin DNR unpublished data). Acreage in state natural areas is relatively high as is the number of Land Legacy sites. However, the number of Land Legacy sites with significant recreational potential is low. Approximately 29% of all forestland is in public ownership with 7% under state control, 3% federally owned, and 19% belonging to county and municipal governments (USFS 2009).

Supply

Land and Water. The Superior Coastal Plain Ecological Landscape accounts for 2.6% of Wisconsin's total land area but only 1.3% of the state's acreage in water (see Chapter 3, "Comparison of Ecological Landscapes"). There are 583,058 acres of forestland, which is 3.6% of the total acreage in the state (USFS 2009). Although the area in surface water is not great, Lake Superior and its shoreline are extremely important to many forms of recreation, including boating, camping, fishing, and sightseeing. Streams and rivers make up 48% of the surface water area of the Superior Coastal Plain Ecological Landscape, and lakes and reservoirs make up over 51% of the surface water area (WDNR 2015b). The major rivers are the Saint Louis, the Bad, and the White.

Public Lands. Public access to recreational lands is vital to all types of recreational activity. In the Superior Coastal Plain Ecological Landscape, almost 191,100 acres, or 21% of all land and water, is publicly owned (WDNR 2005c). This is higher than the statewide average of 19.5% and ranks this ecological landscape seventh out of 16 ecological landscapes in proportion of public ownership. There are 49,700 acres of state lands, 43,400 acres of federal lands, and 88,200 acres of county lands.

State-owned lands and facilities are important to recreation in the Superior Coastal Plain Ecological Landscape. There are over 15,500 acres of state forest (part of the Brule River State Forest), over 4,800 acres in parks including Big Bay and Amnicon Falls state parks as well as parts of Pattison and Copper Falls state parks (WDNR 2005c). In addition, there are 1,350 acres of state trails, including the Wild Rivers and

Table 21.3. *Water use (millions of gallons/day) in the Superior Coastal Plain counties.*

County	Ground-water	Surface water	Public supply	Domestic[a]	Agriculture[b]	Irrigation	Industrial	Mining	Thermo-electric	Total
Ashland	0.8	54.3	1.0	0.3	0.7	0.1	2.5	0.0	50.6	55.0
Bayfield	6.0	7.9	0.4	0.5	11.7	0.2	0.2	0.9	–	14.0
Douglas	1.5	7.7	3.1	0.8	3.6	0.4	1.0	0.3	–	9.0
Total	**8.3**	**69.9**	**4.5**	**1.5**	**16.1**	**0.7**	**3.7**	**1.2**	**50.6**	**78.0**
Percent of total	**11%**	**89%**	**6%**	**2%**	**21%**	**1%**	**5%**	**2%**	**65%**	

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.

the Saunders trails. Wisconsin DNR Fisheries and Wildlife Management lands cover about 16,700 acres. The largest of these, South Shore Lake Superior Fish and Wildlife Area and the St. Louis River Stream Bank Area, each provide over 6,000 acres of recreational land.

Trails. The Superior Coastal Plain counties have about 2,200 miles of recreational trails (Table 21.4) and rank eighth (out of 16 ecological landscapes) in terms of trail density (miles of trail per 100 square miles of land). Compared to the rest of the state, there is a higher density of mountain-biking, ATV, and cross-country ski trails (Wisconsin DNR unpublished data).

Land Legacy Sites. The Land Legacy project identified over 300 places of significant ecological and recreational importance in Wisconsin, and 17 are either partially or totally located within the Superior Coastal Plain Ecological Landscape. The Apostle Islands, the Chequamegon Point-Kakagon Sloughs, and the western Lake Superior drowned river mouths are regarded as having the highest conservation significance. In addition, the Bois Brule River is rated as having both the highest recreational and conservation significance (WDNR 2006c).

Campgrounds. There are 79 public and privately owned campgrounds that provide about 2,393 campsites in the Superior Coastal Plain counties (Wisconsin DNR unpublished data). With 4% of the state's campgrounds, this ecological landscape ranks 10th (out of 16) in both the number and density of campgrounds (campgrounds per square mile of land.

State Natural Areas. The Superior Coastal Plain Ecological Landscape also has about 27,900 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 here include Bibon Swamp (8,798 acres, Bayfield County), Apostle Islands Maritime Forests (6,358 acres, Ashland and Bayfield counties), Dwight's Point and Pokegama Wetlands (3,154 acres, Douglas County), Apostle Islands Yew Forest (2,786 acres, Ashland and Bayfield counties), and Pokegama-Carnegie Wetlands, (1440 acres, Douglas County). For more information regarding Wisconsin's state natural areas program, see the Wisconsin DNR's website (WDNR 2015d).

Demand

Visitors to State Lands. In 2004 there were an estimated 642,350 visitors to state recreation areas, parks, and forests in the Superior Coastal Plain counties (Wisconsin DNR unpublished data). The majority, 84%, visited the state parks, especially Pattison, Copper Falls and Big Bay. In addition, over 100,000 people visited the Brule River State Forest.

Fishing and Hunting License Sales. Of all license sales, the highest revenue producers for the Superior Coastal Plain counties were resident hunting licenses (32% of total sales), nonresident fishing licenses (23% of total sales), and resident fishing licenses (18% of total sales) (Wisconsin DNR unpublished data). Table 21.5 shows a breakdown of various licenses sold in the Superior Coastal Plain counties in 2007. Douglas County accounts for both the highest number of licenses sold and the highest revenue from sales. This ecological landscape accounts for about 2% of total license sales in the state. Licenses sold in the Superior Coastal Plain counties may be used in other parts of the state.

Table 21.4. *Miles of trails and trail density in the Superior Coastal Plain counties compared to the whole state.*

Trail type	Superior Coastal Plain (miles)	Superior Coastal Plain (miles/100 mi^2)	Wisconsin (miles/100 mi^2)
Hiking	84	2.2	2.8
Road biking	94	2.5	4.8
Mountain biking	97	2.5	1.9
ATV: summer and winter	634	16.6	9.3
Cross-country skiing	361	9.5	7.2
Snowmobile	934	24.5	31.2

Source: Wisconsin DNR unpublished data.

Table 21.5. *Fishing and hunting licenses and stamps sold in the Superior Coastal Plain counties.*

County	Resident fishing	Nonresident fishing	Misc. fishing	Resident hunting	Nonresident hunting	Stamps	Total
Ashland	3,969	1,174	517	9,140	446	4,615	19,861
Bayfield	5,421	6,206	960	5,854	592	5,274	24,307
Douglas	8,092	4,638	902	12,630	1,377	7,158	34,797
Total	**17,482**	**12,018**	**2,379**	**27,624**	**2,415**	**17,047**	**78,965**
Sales ($)	**$396,489**	**$499,358**	**$36,327**	**$702,094**	**$366,602**	**$161,746**	**$2,162,616**

Source: Wisconsin Department of Natural Resources unpublished data, 2007.

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, entertainment, and seasonal housing. One of the Superior Coastal Plain counties, Bayfield County, is categorized as a nonmetro recreation county.

Recreational Issues

The results of a statewide survey of Wisconsin residents indicated that certain issues are causing impediments to outdoor recreation opportunities within Wisconsin (WDNR 2006b). Many of these issues, such as an increase in 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 2006b). 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. Many ATV riders feel there is a distinct lack of ATV trails, and they are looking primarily to public lands for places to expand their riding opportunities.

Timber Harvesting. A high percentage of statewide residents are concerned about timber harvesting in areas where they recreate (WDNR 2006b). Their greatest concern about timber harvesting is that it not disturb their recreational activities. They are most opposed to 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 the ever-increasing development by new and seasonal residents along shoreline and forested properties, there has been a loss of easy access to lands and waters within the Superior Coastal Plain Ecological Landscape. This may come from the fact that housing developments have become more concentrated and have closed large areas of shoreline once open to the casual recreation user. Another element that may also play into lost access is the lack of knowledge about where to find information on access to public lands and waters. This element was high on the list of barriers for increased outdoor recreation in a statewide survey (WDNR 2006b).

Agriculture

Farm numbers in the Superior Coastal Plain counties have decreased 41% since 1970. There were approximately 1,850 farms in 1970 and 1,086 in 2002 (USDA NASS 2004). Between 1970 and 2002, average farm size increased from 178 acres to 238 acres, which is higher than the statewide average of 201 acres. The overall land in farms has steadily decreased since the 1970s (Figure 21.14). In 1970 there were about 327,000 acres of farmland, and by 2002 acreage was down to 255,000 acres, a decrease of 22%. For the three counties, the percentage of land in farms ranges from 9% to 12%, averaging 10%. The counties with the highest percentage of agricultural land are Bayfield with 12% and Douglas with 10%.

Agriculture is not an important part of the economy of any of the counties in the Superior Coastal Plain. However, on an ecological landscape basis, most of the agriculture in these counties is in the Superior Coastal Plain. In 2002 net cash farm income totaled $3.8 million or an average of $15 per agricultural acre, much lower than the statewide average of $91 per acre (USDA NASS 2004). Also in 2002, the market value of all agriculture products sold in the Superior Coastal Plain counties was $23 million (less than 1% of state total); 27% of this amount came from crop sales, while the remaining 73% was from livestock sales. In 2007, 1,031 acres of farmland had been sold, of which 87% stayed in agricultural use at an average selling price of $1,912, and 13% was diverted to other uses at an average sale price of $3,836 per acre (USDA NASS 2009). Superior Coastal Plain counties have some of the lowest priced land in the state, both agricultural and developed.

Timber

Timber Supply

Based on 2007 Forest Inventory and Analysis (FIA) data, 66% (approximately 583,000 acres) of the total land area for the Superior Coastal Plain Ecological Landscape is forested (USFS 2007). This is 3.6% of Wisconsin's total forestland acreage. Forestland is defined by FIA as any land with more than 17% canopy cover.

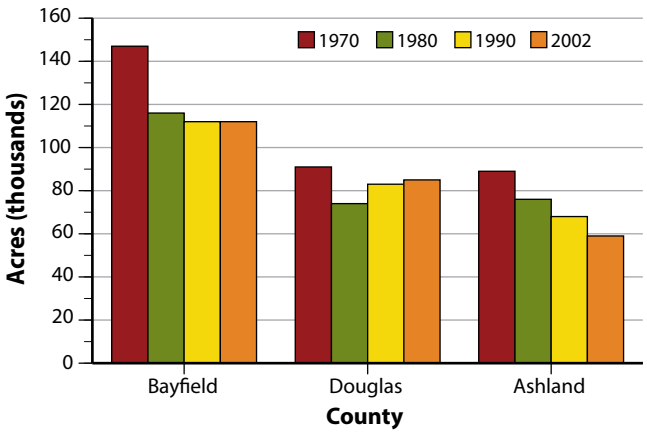


Figure 21.14. *Acreage of farmland in the Superior Coastal Plain counties by county and year (USDA NASS 2004).*

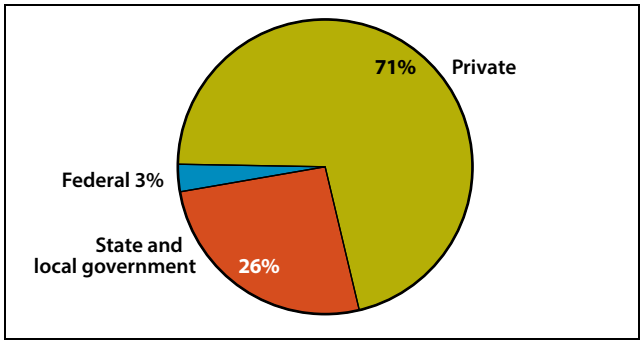


Figure 21.15. *Timberland ownership in the Superior Coastal Plain Ecological Landscape. (USFS 2009).*

Timber Ownership. ***Timberland*** is defined as forestland capable of producing 20 cubic feet of industrial wood per acre per year that is not withdrawn from timber utilization (see the glossary in Part 3, "Supporting Materials," for a more detailed description of "timberland"). Of all timberland within the ecological landscape, 71% is owned by private landowners. The remaining 26% is owned by state and local governments, and 3% is federally owned (USFS 2009; Figure 21.15).

Growing Stock and Sawtimber Volume. There was approximately 596 million cubic feet of ***growing stock*** volume in the Superior Coastal Plain Ecological Landscape in 2007, or 3% of total volume in the state (USFS 2007). Most of this volume, 74%, was in hardwoods, equal to the proportion of hardwoods statewide, which was 74% of total growing stock volume. Hardwoods made up a lower percentage of sawtimber volume, 61%, in the Superior Coastal Plain Ecological Landscape. In comparison, statewide hardwood sawtimber volume was 67% of total volume.

Annual Growing Stock and Sawtimber Growth. Between 1996 and 2007, the timber resource in the Superior Coastal Plain Ecological Landscape increased by 47 million cubic feet, or 9% (USFS 2007). Approximately 60% of this increase occurred in hardwood volume. Sawtimber volume increased by 205 million board feet, or 17%, again mostly in hardwoods. This change was partly a result of a 9% increase in timberland acreage from 519,994 acres in 1996 to 564,836 acres in 2007. Statewide, timberland acreage increased by 3% during the same time period.

Timber Forest Types. According to FIA (USFS 2009), the predominant forest type groups in terms of acreage are aspen-birch (58%) and maple-basswood (19%), with smaller amounts of bottomland hardwoods, oak-hickory, white, red and jack pines, oak-pine and spruce fir (see Appendix H, "Forest types That Were Combined into Forest Type Groups Based on Forest Inventory and Analysis (FIA) Data," in Part 3, "Supporting Materials"). Acreage is predominantly in the pole (43%) and seedling and sapling classes (34%) with only 23% in the sawtimber size class (Table 21.6).

Timber Demand

Removals from Growing Stock. The Superior Coastal Plain Ecological Landscape has about 2.9% of the total growing stock volume on timberland in Wisconsin. Average annual removals from growing stock were 7 million cubic feet or about 2.1% of total statewide removals (349 million cubic feet) between 2000–2002 and 2005–2007 (see the "Socioeconomic Characteristics" section in Chapter 3, "Comparison of Ecological Landscapes," in Part 1 of this book). Average annual removals to net annual growth ratios vary by species (only major species shown), as can be seen in Figure 21.16. Removals exceed net growth for quaking aspen, balsam fir, and white birch.

Removals from Sawtimber. The Superior Coastal Plain Ecological Landscape has about 2.3% of the total sawtimber volume on timberland in Wisconsin. Average annual removals from sawtimber were about 16 million board feet or 1.6% of total statewide removals (1.1 billion board feet) between 2000–2002 and 2005–2007. Average annual removals to net annual growth ratios vary by species, as can be seen in Figure 21.17 (only major species shown). Sawtimber removals exceeded net growth for balsam fir and white birch.

Price Trends

In the counties of the Superior Coastal Plain Ecological Landscape, sugar maple, white birch, and oaks were the highest priced hardwood sawtimber species in 2007 (WDNR 2008a). Red pine and eastern white pine were the most valuable softwood timber species. Sawtimber prices for 2007 were generally slightly lower for both softwoods and hardwoods compared to the rest of the state.

For pulpwood, oak and red maple are the most valuable species. Pulpwood values in the counties of the Superior Coastal Plain Ecological Landscape were slightly lower for both softwoods and hardwoods compared to the statewide average (WDNR 2008a).

Infrastructure

Transportation

The transportation infrastructure of the Superior Coastal Plain Ecological Landscape is more developed than the rest of the state in some ways and less developed in others (Table 21.7). For instance, road mile density is 19% lower (WDOA 2000), but railroad density is 23% higher (WDOT 1998) and airport runway density is 2% higher (WDOT 2010) than the state as a whole. There are three airports in the Superior Coastal Plain Ecological Landscape, none of which are primary regional airports. There are four shipping ports: one gateway port at Duluth/Superior and three limited cargo ports at Ashland, Bayfield, and Washburn (WCPA 2010).

Renewable Energy

Hydroelectric and wind turbine power are the only renewable energy sources quantified by county in energy statistics

Table 21.6. *Acreage of timberland in the Superior Coastal Plain Ecological Landscape by forest type and size class.*

Forest type[a]	Seedling/sapling	Pole-size	Sawtimber	Total
Aspen	117,186	103,852	50,456	271,494
Sugar maple-beech-yellow birch	8,593	25,434	18,134	52,161
Black ash-American elm-red maple	20,495	29,593	70	50,158
White birch	5,761	26,639	12,094	44,494
Hard maple-basswood	–	13,404	13,858	27,263
Red maple - upland	4,857	15,962	5,824	26,644
Balsam poplar	5,555	6,057	–	11,613
Mixed upland hardwoods	8,130	3,175	–	11,305
Northern red oak	–	8,490	2,401	10,891
Red pine	3,273	2,400	4,860	10,533
White pine-red oak-white ash	7,214	–	2,658	9,872
Eastern white pine	3,148	–	3,873	7,022
Other pine-hardwood	–	–	5,215	5,215
Eastern hemlock	–	–	3,911	3,911
Red maple-oak	3,273	–	–	3,273
Northern white-cedar	–	–	3,273	3,273
Black spruce	3,200	–	–	3,200
Nonstocked[b]	–	–	–	2,658
White oak-red oak-hickory	–	–	2,401	2,401
Tamarack	–	2,401	–	2,401
Red maple-lowland	2,381	–	–	2,381
White spruce	–	1,479	–	1,479
Balsam fir	–	1,198	–	1,198
Total	**193,066**	**240,084**	**129,028**	**564,836**

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.

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

Table 21.7. *Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of portsin the Superior Coastal Plain Ecological Landscape.*

	Superior Coastal Plain	State total	% of state total
Total road length (miles)[a]	3,842	185,487	2%
Road density[b]	2.8	3.4	–
Miles of railroads	165	5,232	3%
Railroad density[c]	11.9	9.7	–
Airports	3	128	2%
Miles of runway	2.5	95.7	3%
Runway density[d]	1.8	1.8	–
Total land area (square miles)	1,390	54,087	3%
Number of ports[e]	4	14	29%

[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), Wisconsin Department of Administration, Office of Land Administration Services (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. From Wisconsin Airport Directory 2009–2010 web page (WDOT 2010).

[e]Data from Wisconsin Commercial Ports Association (WCPA 2010).

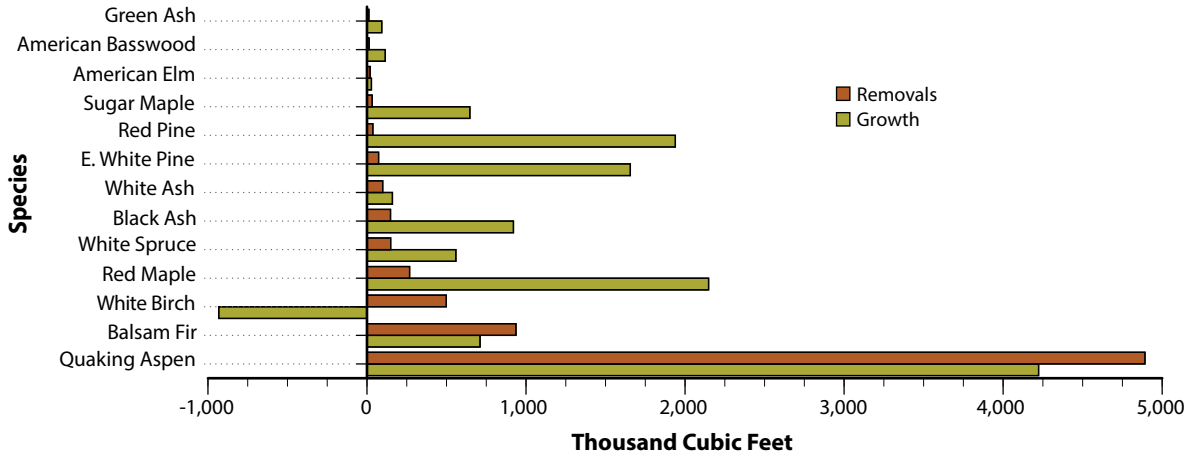


Figure 21.16. *Growing stock growth and removals (selected species) on timberland in the Superior Coastal Plain Ecological Landscape (USFS 2009).*

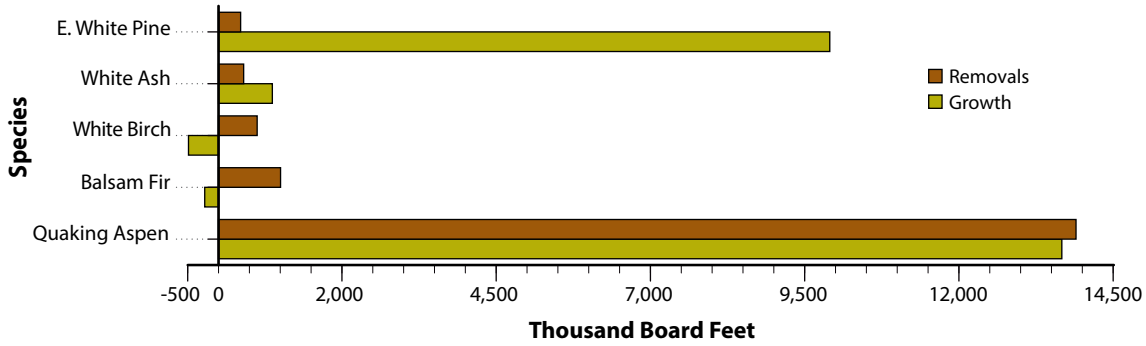


Figure 21.17. *Sawtimber growth and removals (selected species) on timberland in the Superior Coastal Plain Ecological Landscape (USFS 2009).*

(WDOA 2006) produced by the Wisconsin Department of Administration. Some general inferences can be drawn from other sources regarding the potential for renewable energy production in the Superior Coastal Plain counties. Other than woody biomass, the Superior Coastal Plain Ecological Landscape has a limited potential to produce a significant amount of renewable energy. The Superior Coastal Plain counties have only 1% of the state's population and, by inference, the state's energy use. The Superior Coastal Plain Ecological Landscape has 6.3% of all woody biomass in Wisconsin. The Superior Coastal Plain counties generate 0.3% of hydroelectric power and produce about 0.1% of the state's corn crop; the counties do not have any industrial ethanol plants or wind generating sites.

Ships from all over the world visit the ports of Duluth-Superior. Photo by Eric Epstein, Wisconsin DNR.

Biomass. Woody biomass is Wisconsin's most used renewable energy resource, and the Superior Coastal Plain Ecological Landscape produces 62.7 million oven-dry tons of biomass, or 6.3% of total production (USFS 2009). About 66% of the land base is forested, and this has increased by 44,840 acres, or 9%, in the last decade.

Hydroelectric. There is one hydroelectric power site that generates 3.9 million kilowatt hours (kWh) (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 Superior Coastal Plain counties produced only 371,000 bushels of corn in 2002, or about 0.1% of total corn production in the state (USDA NASS 2004). Agricultural

acreage in Bayfield, Douglas, and Ashland counties (at only 10% of the land base) decreased by 22% between 1970 and 2002. Increasing ethanol production would depend on converting land to corn, which is unlikely due to the unfavorable growing season for corn. There are no ethanol plants located in the Superior Coastal Plain counties at this time (Renewable Fuels Association 2013).

Wind. There are currently no sited or proposed wind farms in the Superior Coastal Plain counties (WWIC 2013). Mean annual power densities are generally below 100 W/m^2 (watts/square meter) in this part of the state, indicating very limited potential for wind generation (USDE 2013). This does not include the open waters of Lake Superior.

Current Socioeconomic Conditions

The Superior Coastal Plain counties are characteristically sparsely populated, with the exception of the city of Superior in northern Douglas County. The population of Superior Coastal Plain counties is largely white but includes a significant American Indian population due to the Bad River and Red Cliff Reservations. The Superior Coastal Plain counties have aging, shrinking populations but have attained slightly more education compared to many of their northern Wisconsin neighbors. Though home values are very low, property values are elevated, especially in Bayfield County, by higher recreational property values. While loss of a younger workforce and low wages are hindrances to economic development in the Superior Coastal Plain counties, the in-migration of retirees and prevalence of the tourism-related industry represent economic opportunities.

Demography

Population Distribution

In 2010 the population of the three Superior Coastal Plain counties was 75,330 or 1.3% of the state total population (USCB 2012). The Superior Coastal Plain counties are composed of one metropolitan county (Douglas County) and two nonmetropolitan (rural) counties (Ashland and Bayfield counties), as classified by the USDA Economic Research Service in 2004 (USDA ERS 2012b). Superior (population of 27,244 in 2010) is the largest Superior Coastal Plain counties' urban center (defined as those cities with at least 2,500 inhabitants) and comprises over one-third of all the population in the three counties. Ashland (population 8,216) in Ashland County is the ecological landscape's only other urban center. Officially, 54% of the population in Superior Coastal Plain counties is categorized as "rural," though the vast majority of Superior Coastal Plain counties' land area is among the most sparsely populated in the state (USCB 2009).

Population Density

The population density of the Superior Coastal Plain counties is the second lowest of any ecological landscape county approximation in Wisconsin. There are less than 20 persons per square mile in Superior Coastal Plain counties combined, compared to 105 persons per square mile in Wisconsin as a whole (USCB 2012). However, the physical boundaries of the Superior Coastal Plain Ecological Landscape encompass the northern coastal portions of each of the three counties, which tend to be more densely populated than the area to the south.

Population Structure

Age. The population in Superior Coastal Plain counties is somewhat older and aging more rapidly compared to the rest of the state. Approximately 21.3% of the 2010 population in Superior Coastal Plain counties was under 18 years old, compared to 23.6% statewide, while 16.0% of the population is 65 or older, compared to 13.7% statewide (USCB 2012). Perhaps more telling is the low percentage of persons aged 25 to 49 (34.8%) in Superior Coastal Plain counties compared to the statewide average of 36.9%. This indicates a loss in young people and is an indicator of possible slowed growth, higher out-migration, and/or lowered birth rates. Bayfield County's median age of 42.1 years old is especially high, while Douglas (37.7) and Ashland (36.9) counties have median ages much closer to the statewide average of 36 years (USCB 2009).

Minorities. The Superior Coastal Plain counties are less racially diverse than the state as a whole but have the state's highest concentration of American Indian population. Ninety percent of the 2010 population in Superior Coastal Plain counties was white, non-Hispanic, compared to 86.2% statewide. American Indian/Alaskan Native identification comprised 5.5% of Superior Coastal Plain counties' population in 2010. American Indian populations were particularly concentrated in Ashland (11.1%) and Bayfield (9.6%) counties. The Red Cliff Reservation is within Bayfield County, and the Bad River Reservation is within Ashland County (USCB 2012).

Education. According to the 2010 federal census, 90.6% of Superior Coastal Plain counties' residents 25 or older have graduated from high school, similar to 89.4% statewide (USCB 2012). Superior Coastal Plain counties compare favorably to their rural northern neighbors in terms of higher education attainment but fall below statewide levels; 22.7% of Superior Coastal Plain counties' residents have received a bachelor's degree or higher, compared to 25.8% statewide.

Population Trends

Superior Coastal Plain counties are among the least populated in the state. Population growth in the Superior Coastal Plain counties has been constantly slower than that of Wisconsin in each decade since 1950, and while Wisconsin's overall population grew by 62% from 1950 to 2006, Superior Coastal Plain counties' combined population actually shrunk by nearly 10% during that period, according to U.S. Census Bureau estimates (USCB 2009).

Population loss in Superior Coastal Plain counties has been sporadic as the effect of early to mid-20th-century egress from failing settlements and farms moderated, along with the fluctuating transfer of seasonal homes to permanent residences. From 1950 to 1960, Superior Coastal Plain counties endured negative population change (-7.1%), followed by moderated losses from 1960 to 1970 (1.6% population loss). Led by Bayfield County's 15.5% growth from 1970 to 1980, Superior Coastal Plain counties combined for population growth (2.7%) but remained below statewide growth of 6.5%. From 1980 to 1990, population fell again in Superior Coastal Plain counties (3.9% loss, compared to 4% growth statewide). The only decade of population growth in all three Superior Coastal Plain counties was from 1990 to 2000 but at a rate slower than statewide (4.3% compared to 9.6% statewide). Of the three counties, only Bayfield County (8.8% population growth) has not lost population over the extended half century, though it too has experienced population loss since 2000 (USCB 2009). There was little population growth in the Superior Coastal Plain counties (0.2%) from 2000 to 2010 (USCB 2012).

Housing

Housing Density. The Superior Coastal Plain counties have the lowest housing density (11.9 housing units per square mile of land in 2010) of any ecological landscape county approximation in the state, compared to the statewide average housing density of 48.5 units per square mile (USCB 2012). Bayfield County (8.8 units per square mile) has the fourth lowest housing density statewide, while Ashland County (9.2) and Douglas County (17.5) are also well below statewide housing density.

Seasonal Homes. Seasonal and recreational homes are relatively prevalent in Superior Coastal Plain counties, comprising 20.8% of housing stock in 2010, with each Superior Coastal Plain county exceeding the statewide average of 6.3% (USCB 2012). Percentage of seasonal housing is highest among Superior Coastal Plain counties in Bayfield County (40.5%), followed by Ashland (22.3%) and Douglas counties (8.8%).

Housing Growth. Housing development in the Superior Coastal Plain counties (especially in Bayfield County) has grown independently of population growth, largely because of the proliferation of seasonal housing even while resident populations left these counties for greater opportunities in larger population centers. Housing growth in Superior Coastal Plain counties from 1950 to 1960 (21.7%) lagged behind statewide averages (40.4%) but drew closer to statewide housing growth through the 1960s (20.4% in Superior Coastal Plain counties versus 27.2% statewide) and nearly even with it in the 1970s (28.8% in Superior Coastal Plain counties versus 30.3% statewide) (USCB 2009). Since then, housing growth in the Superior Coastal Plain Ecological Landscape has remained at levels around 75–90% of that of the state as a whole. Notably, Bayfield County has exceeded state growth for each decade starting in the 1960s, while Ashland and Douglas counties are consistently below statewide housing growth.

Housing Values. Median housing values in Superior Coastal Plain counties are lower than in the state as a whole ($166,100 in 2010) (USCB 2012). Ashland County has a median housing value of $100,300 while Douglas County ($124,000) is not a great deal higher. Homes in Bayfield County ($159,200) are still valued below the state as a whole, but the high proportion of seasonal and recreational homes in Bayfield County drives up their value somewhat.

The Economy

Superior Coastal Plain counties support higher levels of government and service jobs compared to the state as a whole. Wages in the service sector tend to be lower than in other economic sectors, with a higher proportion of part-time and seasonal jobs. Conversely, manufacturing sector jobs associated with higher wages are not well represented in the Superior Coastal Plain counties. There is a net increase of retirement age adults and out-migration of young adults, with profound implications for the available workforce. Relative age of the remaining population is increasing. Per capita and household incomes and average wages per job are lower in the Superior Coastal Plain counties while unemployment and poverty rates are higher than in the state as a whole. Tourism-based economy is strongest in Bayfield County, Forest Products and Processing are especially strong in Ashland County, and the port city of Superior makes Transportation and Warehousing an important sector in Douglas County.

Income

Per Capita Income. Total personal income for the Superior Coastal Plain counties in 2006 was $2 billion (1% of the state total), with Douglas County contributing over half of that total ($1.16 billion) (USDC BEA 2006). Per capita income in 2006 in Superior Coastal Plain counties combined ($26,597) was lower than the statewide average of $34,405 (Table 21.8). Per capita incomes in Superior Coastal Plain counties are tightly clustered between Bayfield County ($27,066) and Douglas County ($26,396).

Household Income. In 2005 all of the Superior Coastal Plain counties had lower median household income levels than the statewide average ($47,141), but this varied more than per capita income (USCB 2009). Median household income was much lower in Ashland County ($32,418) than in Bayfield ($40,984) or Douglas ($39,420) counties.

Earnings Per Job. Earnings per job in Superior Coastal Plain counties are low compared to statewide but vary differently than household income (Table 21.8). In 2006 average earnings per job for Superior Coastal Plain counties were $29,237, compared to the statewide average of $36,142 (USDC BEA 2006). Bayfield County ($22,403) had the state's second lowest wages

per job figures, belying its much better figure for household income. Earnings per job in Ashland ($28,991) and Douglas ($31,072) counties were somewhat higher than in Bayfield County. Bayfield County has a high proportion of seasonal homes, some transitioning into permanent residences, but with jobs not based in the county. Thus, household income might reflect relatively high-paying jobs that do not actually exist within the county and are not reflected in earnings per job figures.

Unemployment

The Superior Coastal Plain counties each had higher 2006 average annual unemployment rates than the state as a whole (4.7%) and had a combined unemployment rate of 5.5% (USBLS 2006) Douglas County's unemployment rate (5.0%) was lowest among Superior Coastal Plain counties while more rural Ashland (6.1%) and Bayfield (6.4%) counties had higher unemployment (Table 21.8). Unemployment rates became much higher throughout the state after 2008 but have become lower again.

Poverty

Poverty Rates. The U.S. Census Bureau estimated that the Superior Coastal Plain counties' combined 2005 poverty rate for all people (12.4%) was higher than for the state as a whole (10.2%) and ranked second highest among all ecological landscape county approximations (USCB 2009). Ashland County (14.8%) had the fourth highest poverty rate statewide. Both Douglas County (12.4%) and Bayfield County (11.2%) had relatively high poverty rates as well.

Child Poverty Rates. Compared to the statewide average (14%), 2005 estimates of poverty rates for people under age 18 were higher in all three Superior Coastal Plain counties (USCB 2009). Child poverty rates in these counties ranged from 19% in Ashland County to 17.5% in Bayfield County.

Residential Property Values

Average residential property values in the combined Superior Coastal Plain counties ($112,772 per housing unit) was lower than the statewide average ($134,021 per housing unit) (Table 21.9). However, residential property values were highly variable between Superior Coastal Plain counties, ranging from low values in Ashland County ($88,797) to relatively high values in Bayfield County ($149,885). Residential property values in Bayfield County can be attributed to the prevalence of vacation and second home properties whose value is not necessarily reflected in the value of the homes but more in the land itself.

Important Economic Sectors

Superior Coastal Plain counties together provided 37,872 jobs in 2007, or about 1.1% of the total employment in Wisconsin (Table 21.10; MIG 2009). Douglas County (19,902 jobs in 2007) has over half of the employment in Superior Coastal Plain counties, followed by Ashland County (11,922) and Bayfield County (6,048). The Government sector (18.2% of all employment in Superior Coastal Plain counties) is the leading source of employment in Superior Coastal Plain counties, followed in importance by the Tourism-related sector (15.0%), Health Care and Social Services (10.5%), and Retail

Table 21.8. *Economic indicators for the Superior Coastal Plain 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%**
Ashland	$26,705	$28,991	6.1%	14.8%
Bayfield	$27,066	$22,403	6.4%	11.2%
Douglas	$26,396	$31,072	5.0%	12.4%
Superior Coastal Plain counties	**$26,597**	**$29,237**	**5.5%**	**12.4%**

[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.

Table 21.9. *Property values for the Superior Coastal Plain 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**
Ashland	$831,759,000	9,367	$88,797
Bayfield	$1,941,013,500	12,950	$149,885
Douglas	$2,157,611,600	21,403	$100,809
Superior Coastal Plain counties	**$4,930,384,100**	**43,720**	**$112,772**

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.

Trade (10.0%). Economic sectors of secondary importance in terms of employment include Transportation and Warehousing (6.5%), Construction (6.4%), Other Services (6.0%), and Manufacturing (non-wood) (5.4%). For definitions of economic sectors, see the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

Importance of economic sectors within the Superior Coastal Plain 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. 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 Superior Coastal Plain counties had nine sectors of employment with quotients higher than 1.0 (Figure 21.18, Appendix 21.I). The Transportation and Warehousing sector has the highest quotient among sectors in Superior Coastal Plain counties, due in major part to the Lake Superior ports in Superior and Ashland. Other sectors providing a percentage of jobs higher than the state average, listed in order of their relative importance in the Superior Coastal Plain counties, are Utilities, Private Education, Government, Forest Products and Processing, Tourism-related, Construction, Other Services, and Retail Trade. Higher paying jobs in management, financial sectors, and manufacturing are underrepresented in Superior Coastal Plain counties, accounting for the region's relatively low wages per job.

The Other Services sector consists primarily of equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, providing drycleaning and laundry services, personal care services, death care services, pet care services, photo finishing services, and temporary parking services. The Tourism-related sector, especially prominent in Bayfield county, includes relevant subsectors within Retail Trade, Passenger Transportation, and Arts, entertainment and recreation. The Tourism-related sector also includes all Accommodation and Food Services

Table 21.10. *Total and percentage of jobs in 2007 in each economic sector within the Superior Coastal Plain (SCP) counties. The economic sectors providing the highest percentage of jobs in the Superior Coastal Plain counties are highlighted in blue.*

Industry sector	WI employment	% of WI total	SCP counties employment	% of SCP counties total
Agriculture, Fishing & Hunting	110,408	3.1%	1,019	2.7%
Forest Products & Processing	88,089	2.5%	1,352	3.6%
Mining	3,780	0.1%	3	0.0%
Utilities	11,182	0.3%	218	0.6%
Construction	200,794	5.6%	2,415	6.4%
Manufacturing (non-wood)	417,139	11.7%	2,056	5.4%
Wholesale Trade	131,751	3.7%	1,073	2.8%
Retail Trade	320,954	9.0%	3,797	10.0%
Tourism-related	399,054	11.2%	5,665	15.0%
Transportation & Warehousing	108,919	3.1%	2,465	6.5%
Information	57,081	1.6%	390	1.0%
Finance & Insurance	168,412	4.7%	805	2.1%
Real Estate, Rental & Leasing	106,215	3.0%	518	1.4%
Professional, Science & Tech Services	166,353	4.7%	830	2.2%
Management	43,009	1.2%	295	0.8%
Administrative and Support Services	166,405	4.7%	905	2.4%
Private Education	57,373	1.6%	938	2.5%
Health Care & Social Services	379,538	10.7%	3,984	10.5%
Other Services	187,939	5.3%	2,254	6.0%
Government	430,767	12.1%	6,890	18.2%
Totals	**3,555,161**		**37,872**	**1.1%**

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

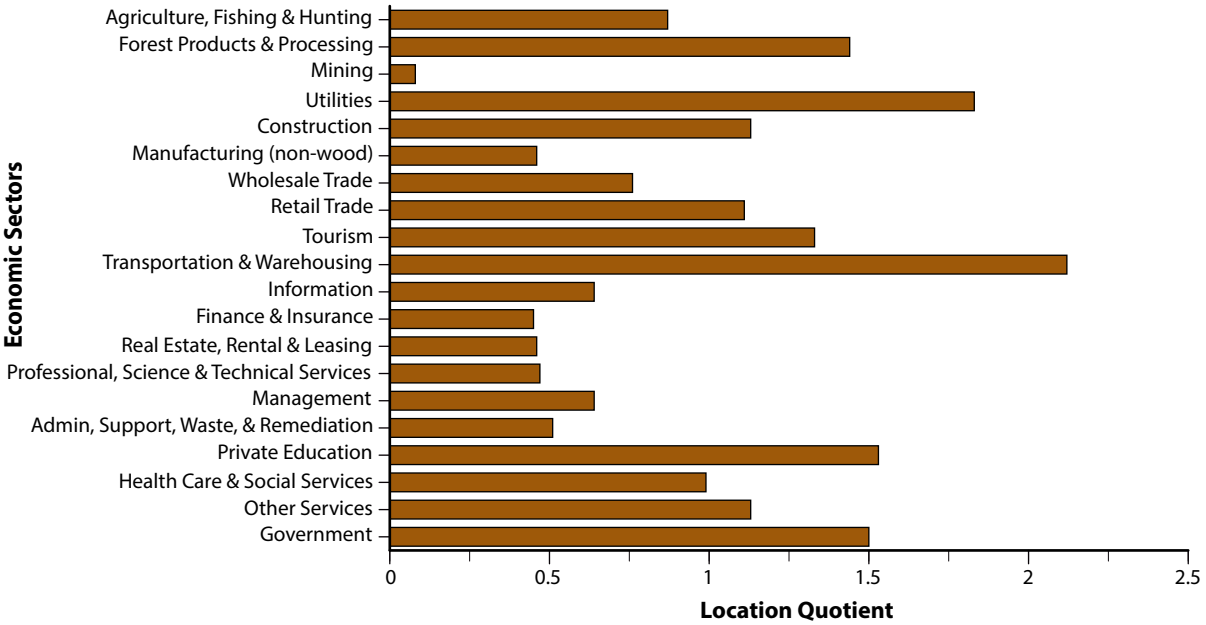


Figure 21.18. *Importance of economic sectors within the Superior Coastal Plain counties when compared to the rest of the state. If the location quotient is greater than 1.0, the Superior Coastal Plain counties are contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the Superior Coastal Plain counties are contributing fewer jobs to that economic sector than the state average.*

(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). The Forest Products and Processing sector comprises over 8% of all employment in Ashland County, which contributes over 72% of all Forest Products and Processing jobs in the Superior Coastal Plain counties combined.

Urban Influence

The U.S. Department of Agriculture (USDA) Economic Research Service divides counties into 12 groups on a continuum of urban influence, with 1 representing large metro areas, 2 representing smaller metropolitan 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. Douglas County, with Superior and neighboring Duluth, Minnesota, is classified as a smaller metropolitan area. Bayfield is a nonmetropolitan (rural) class 7 county because of its proximity to Douglas County, while Ashland County is among the counties most isolated from urban influence, classified as a class 11 county.

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). All three Superior Coastal Plain counties were classified as nonspecialized.

The Great Lakes Visitor Center houses several public agencies and hosts natural resource-oriented programs and conferences aimed at Great Lakes management and restoration issues, research, public education and outreach, interpretation, and Great Lakes natural and cultural history. Bayfield County. Photo by Northern Great Lakes Visitor Center staff.

Big Top Chautauqua is an outdoor tent show in Bayfield County that features live music by national acts all summer long and well into the fall. These shows are very popular with local, statewide, and regional audiences and draw many patrons. Photo courtesy of the Bayfield Chamber of Commerce and Visitor Bureau.

Policy Types

The USDA ERS also classifies counties according to "policy types" deemed especially relevant to rural development policy (USDA ERS 2012a). In 2004 Bayfield County was the only Superior Coastal Plain county to be classified as a "nonmetro recreation" county (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).

Integrated Opportunities for Management

Use of natural resources for human needs within the constraints of maintaining 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 or habitats are not 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 the state. A discussion of "Integrated Ecological and Socioeconomic Opportunities" can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management," in Part 1 of the book. 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 within a given area.

Appendices

Appendix 21.A. *Watershed water quality summary for the Superior Coastal Plain Ecological Landscape.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
LS01	St. Louis & Lower Nemadji Rivers	101,759	Very Poor to Good; past industrial PS/NPS; Hg in Sed; low D.O.; urban NPS; a binational RAP site; good wetland habitat areas
LS02	Black and Upper Nemadji Rivers	80,399	Good to Very Good; several ERWs; NPS; Sed; Hab; Flux; excess weeds; turbidity; priority wetland sites
LS03	Amnicon and Middle Rivers	184,908	Fair to Very Good; erosion; Flux; excess weeds; turbidity; silt; septic leakage; urban NPS; streambank grazing/dams > Hab; rich coastal wetlands; Lake Superior spawning sites
LS04	Bois Brule River	127,773	Fair to Excellent; many ORW/ERW streams; cropland/forestry on steep clays > erosion/turbidity/silt; quality soft seepage & acid bog lakes & wetlands; septic leakage
LS05	Iron River	136,568	Good to Very Good; urban NPS; Flux; dams > Sed storage; crop/streambank pasturing > erosion; barnyard NPS; clay turbidity; septic leakage; "slime"
LS06	Bayfield Peninsula Northwest	151,070	Very Good to Excellent; many ORW/ERW streams; erodable clay; quality coastal wetlands; bank erosion > turbidity/Flux > Hab
LS07	Bayfield Peninsula Southeast	192,950	Poor to Excellent; many ORW streams; urban NPS > bank erosion > turbidity/Flux > Hab; industrial contamination; forestry on clays > erosion; coliform; beaver dams > Temp; priority wetlands
LS08	Fish Creek	100,194	Good to Excellent; many ORW/ERW streams; crop/streambank pasturing/clay bluffs > erosion > NPS/turbidity/Flux > Hab; past logging > Sed; past wetland fill > small loss of function; urban NPS; PAHs in Lake Superior
LS09	Lower Bad River	79,308	Good; tribal stream monitoring under way; forestry/clay soils > Hab/Sed/turbidity; septic leakage > coliform; urban NPS; priority coastal wetlands; landfills impact GW
LS10	White River	234,339	Very Good to Excellent; many ORW/ERW; forest mgmt > NPS; beaver dams > Sed/Hab/Temp; streambank erosion; small high-quality lakes
LS11	Potato River	89,5547	Very Good; several ERWs; forestry/beaver dams > Sed/Hab; need lakes data
LS12	Marengo River	139,219	Very Good; several ERWs; streambank pasturing/beaver dams > erosion/Sed/Hab; need lakes data
LS13	Tyler Forks	50,409	Good to Very Good; some ERWs; barnyards/cropland/streambank grazing > Sed/Hab/nutrients/Temp
LS15	Montreal River	144,807	Very Good; several ERWs; Hg in Sed; streambank pasturing > erosion Sed/Hab

Source: Wisconsin DNR Bureau of Watershed management data.
[a]Based on Wisconsin DNR watershed water quality reports.

Abbreviations
D.O. = Dissolved oxygen.
ERW = Exceptional Resource Water (very good to excellent water quality, with point source discharges).
Flux = Abnormal highs and lows in stream flow fluctuation due to lack of groundwater infiltration, etc., often due to loss of forest cover, or creation of excessive impermeable surface.
GW = Groundwater (without modifiers, indicates high nitrates, radon, manganese or other negative use condition).
Hab = Stream habitat damage.
Hg = Mercury contamination of fish, mainly deposited by coal combustion, or sometimes by industry.
NPS = Nonpoint source pollutants, such as farm or parking lot runoff, or septic system leakage.
ORW = Outstanding Resource Water (very good to excellent water quality, with no point source discharges).
PAH = Polycyclic aromatic hydrocarbon contamination, often with other toxic substances.
PS = Point source pollutants, such as treated municipal and industrial wastewater.
RAP = Remedial Action Plan.
Sed = Excess sedimentation.
Temp = Elevated temperatures in some stream reaches.
> = Yields, creates or results in (the listed impacts).

Appendix 21.B. *Forest habitat types in the Superior Coastal Plain 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 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 Superior Coastal Plain Landscape
ArAbSn	*Acer rubrum-Abies balsamea/Sanicula marilandica* Red maple-Balsam fir/Black snakeroot
ASnMi	*Acer saccharum/Sanicula marilandica-Mitchella repens* Sugar maple/Black snakeroot-Partridgeberry

Source: Kotar et al. (2002).

Appendix 21.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 Superior Coastal Plain (SCP) 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 in SCP	EOs in WI	Percent in SCP	State rank	Global rank	State status	Federal status
MAMMALS								
Canis lupus (gray wolf)	2008	19	204	9%	S2	G4	SC/FL	LE
Martes americana (American marten)	2008	2	3	67%	S3	G5	END	
Spermophilus franklinii (Franklin's ground squirrel)	2008	2	12	17%	S2	G5	SC/N	
BIRDS[b]								
Accipiter gentilis (Northern Goshawk)	2009	5	141	4%	S2B,S2N	G5	SC/M	
Ammodramus leconteii (Le Conte's Sparrow)	2000	4	22	18%	S2S3B	G4	SC/M	
Anas rubripes (American Black Duck)	1999	1	2	50%	S2B	G5	SC/M	
Asio otus (Long-eared Owl)	1990	1	8	13%	S2B	G5	SC/M	
Bartramia longicauda (Upland Sandpiper)	2000	12	54	22%	S2B	G5	SC/M	
Botaurus lentiginosus (American Bittern)	2005	7	41	17%	S3B	G4	SC/M	
Bucephala clangula (Common Goldeneye)	1990	1	5	20%	S2B	G5	SC/M	
Catharus ustulatus (Swainson's Thrush)	2007	11	18	61%	S2B	G5	SC/M	
Charadrius melodus (Piping Plover)	2006	5	6	83%	S1	G3	END	LE
Chlidonias niger (Black Tern)	1997	2	60	3%	S2B	G4	SC/M	
Coturnicops noveboracensis (Yellow Rail)	2005	1	22	5%	S1B	G4	THR	
Cygnus buccinator (Trumpeter Swan)	1999	1	22	5%	S4B	G4	SC/M	
Dendroica caerulescens (Black-throated Blue Warbler)[c]	2000	9	27	33%	S3B	G5	SC/M	
Dendroica cerulea (Cerulean Warbler)[c]	1996	1	92	1%	S2S3B	G4	THR	
Dendroica tigrina (Cape May Warbler)[c]	1999	11	26	42%	S3B	G5	SC/M	
Falcipennis canadensis (Spruce Grouse)	1990	1	33	3%	S1S2B,S1S2N	G5	THR	
Haliaeetus leucocephalus (Bald Eagle)	2006	44	1286	3%	S4B,S2N	G5	SC/P	
Ixobrychus exilis (Least Bittern)	1997	2	23	9%	S3B	G5	SC/M	
Lanius ludovicianus (Loggerhead Shrike)	2007	1	31	3%	S1B	G4	END	
Oporornis agilis (Connecticut Warbler)	1999	12	27	44%	S2S3B	G4	SC/M	
Poecile hudsonicus (Boreal Chickadee)	1996	1	25	4%	S2S3B	G5	SC/M	
Spiza americana (Dickcissel)	1988	3	46	7%	S3B	G5	SC/M	
Sterna caspia (Caspian Tern)[c]	1991	2	7	29%	S1B,S2N	G5	END	
Sterna hirundo (Common Tern)	2001	5	14	36%	S1B,S2N	G5	END	
Strix nebulosa (Great Gray Owl)	1991	1	4	25%	S1B	G5	SC/M	
Sturnella neglecta (Western Meadowlark)	1999	14	39	36%	S2B	G5	SC/M	
Tympanuchus phasianellus (Sharp-tailed Grouse)	1996	1	7	14%	S1B,S2N	G4	SC/H	
Wilsonia canadensis (Canada Warbler)[c]	2009	4	20	20%	S3B	G5	SC/M	
HERPTILES								
Diadophis punctatus edwardsii (northern ring-necked snake)	1996	1	23	4%	S3?	G5T5	SC/H	
Emydoidea blandingii (Blanding's turtle)	1998	1	316	0%	S3	G4	THR	
Glyptemys insculpta (wood turtle)	2008	20	262	8%	S2	G4	THR	
Hemidactylium scutatum (four-toed salamander)	1976	2	63	3%	S3	G5	SC/H	
FISHES								
Acipenser fulvescens (lake sturgeon)	1991	2	99	2%	S3	G3G4	SC/H	
MUSSELS/CLAMS								
Elliptio complanata (eastern elliptio)	1987	1	2	50%	S3	G5	SC/P	

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Appendix 21.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in SCP	EOs in WI	Percent in SCP	State rank	Global rank	State status	Federal status
MISCELLANEOUS INVERTEBRATES								
Vertigo paradoxa (mystery vertigo)	1997	1	6	17%	S1	G4G5Q	SC/N	
Zoogenetes harpa (boreal top)	1997	1	3	33%	S1	G5	SC/N	
BUTTERFLIES/MOTHS								
Boloria eunomia (bog fritillary)	1996	4	49	8%	S3	G5	SC/N	
Lycaena dione (gray copper)	1990	2	14	14%	S2	G5	SC/N	
Lycaena dorcas (dorcas copper)	1996	2	23	9%	S1S2	G5	SC/N	
Macrochilo bivittata (an owlet moth)	1996	1	8	13%	S3	G3G4	SC/N	
Phyciodes batesii lakota (Lakota crescent)	1991	2	24	8%	S3	G4T4	SC/N	
Pieris virginiensis (West Virginia white)	1996	2	25	8%	S3	G3G4	SC/N	
DRAGONFLIES/DAMSELFLIES								
Aeshna eremita (lake darner)	1989	2	15	13%	S3	G5	SC/N	
Chromagrion conditum (aurora damselfly)	1996	2	17	12%	S3	G5	SC/N	
Enallagma vernale (Gloyd's bluet)	1996	1	2	50%	S1	G4	SC/N	
Somatochlora forcipata (forcipate emerald)	1997	1	10	10%	S2	G5	SC/N	
Sympetrum danae (black meadowhawk)	1989	2	6	33%	S3	G5	SC/N	
BEETLES								
Cicindela hirticollis rhodensis (beach-dune tiger beetle)	2003	6	8	75%	S2	G5T4	SC/N	
Hydroporus pseudovilis (a predaceous diving beetle)	1996	2	4	50%	S1S2	GNR	SC/N	
Hydroporus vittatus (a predaceous diving beetle)	1996	4	17	24%	S3	GNR	SC/N	
Oreodytes scitulus (a predaceous diving beetle)	1996	1	1	100%	S1	GNR	SC/N	
MISCELLANEOUS INSECTS/SPIDERS								
Arphia conspersa (speckled rangeland grasshopper)	1996	1	8	13%	S2	G5	SC/N	
Booneacris glacialis (wingless mountain grasshopper)	2005	1	8	13%	S3	G5	SC/N	
Isoperla bilineata (a perlodid stonefly)	1996	2	8	25%	S2S3	G5	SC/N	
Isoperla marlynia (a perlodid stonefly)	1996	1	5	20%	S3	G5	SC/N	
Lepidostoma libum (a lepidostomatid caddisfly)	1996	1	5	20%	S1?	G3G4	SC/N	
Melanoplus flavidus (blue-legged grasshopper)	1996	1	2	50%	S2S3	G4	SC/N	
Melanoplus islandicus (forest locust)	2005	2	2	100%	S2S4	G5	SC/N	
PLANTS								
Arethusa bulbosa (swamp-pink)	2005	14	96	15%	S3	G4	SC	
Armoracia lacustris (lake-cress)	1995	1	4	25%	S1	G4?	END	
Asplenium trichomanes (maidenhair spleenwort)	1996	1	27	4%	S3	G5	SC	
Botrychium lunaria (moonwort grape-fern)	1977	1	6	17%	S1S2	G5	END	
Botrychium minganense (Mingan's moonwort)	1990	2	17	12%	S2	G4	SC	
Calamagrostis stricta (slim-stem small-reedgrass)	1996	4	34	12%	S3	G5	SC	
Callitriche hermaphroditica (autumnal Water-starwort)	2005	5	11	45%	S2	G5	SC	
Caltha natans (floating marsh-marigold)	1995	2	2	100%	S1	G5	END	
Cardamine maxima (large toothwort)	1996	1	1	100%	S1	G5	SC	
Carex assiniboinensis (assiniboine sedge)	1996	2	33	6%	S3	G4G5	SC	
Carex capillaris (hair-like sedge)	2001	3	9	33%	S2	G5	SC	
Carex concinna (beautiful sedge)	2001	1	5	20%	S1	G4G5	THR	
Carex crawei (crawe sedge)	1996	1	24	4%	S3	G5	SC	
Carex exilis (coast sedge)	2007	2	5	40%	S1	G5	THR	
Carex lenticularis (shore sedge)	2001	13	18	72%	S2	G5	THR	

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Appendix 21.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in SCP	EOs in WI	Percent in SCP	State rank	Global rank	State status	Federal status
Carex livida var. *radicaulis* (livid sedge)	2007	7	21	33%	S2	G5T5	SC	
Carex michauxiana (Michaux's sedge)	2007	5	8	63%	S2	G5	THR	
Carex nigra (smooth black sedge)	2001	3	3	100%	S1	G5	SC	
Carex pallescens (pale sedge)	2001	5	27	19%	S3	G5	SC	
Carex prasina (drooping sedge)	1992	1	31	3%	S3	G4	THR	
Carex tenuiflora (sparse-flowered sedge)	2006	7	84	8%	S3	G5	SC	
Cirsium pitcheri (dune thistle)	1998	1	9	11%	S2	G3	THR	LT
Clematis occidentalis (purple clematis)	2008	4	32	13%	S3	G5	SC	
Cypripedium arietinum (ram's-head lady's-slipper)	1993	7	21	33%	S2	G3	THR	
Cypripedium parviflorum var. *makasin* (northern yellow lady's-slipper)	2008	2	78	3%	S3	G5T4Q	SC	
Cypripedium reginae (showy lady's-slipper)	1996	6	99	6%	S3	G4	SC	
Cystopteris laurentiana (Laurentian bladder fern)	1991	7	11	64%	S2	G3	SC	
Deschampsia cespitosa (tufted hairgrass)	2001	3	17	18%	S2	G5	SC	
Deschampsia flexuosa (crinkled hairgrass)	2007	19	44	43%	S3	G5	SC	
Drosera anglica (English sundew)	1995	1	1	100%	S1	G5	THR	
Dryopteris expansa (spreading woodfern)	1979	3	13	23%	S2	G5	SC	
Dryopteris fragrans var. *remotiuscula* (fragrant fern)	2001	7	27	26%	S3	G5T3T5	SC	
Eleocharis compressa (flat-stemmed spike-rush)	2001	1	9	11%	S2	G4	SC	
Eleocharis mamillata (spike-rush)	1995	2	2	100%	S1	G4?	SC	
Eleocharis nitida (slender spike-rush)	2001	18	18	100%	S2	G4	END	
Eleocharis robbinsii (Robbins' spikerush)	2005	4	28	14%	S3	G4G5	SC	
Epilobium palustre (marsh willow-herb)	*1992*	*4*	*37*	*11%*	*S3*	*G5*	*SC*	
Epilobium strictum (downy willow-herb)	1988	3	22	14%	S2S3	G5?	SC	
Equisetum palustre (marsh horsetail)	2002	13	21	62%	S2	G5	SC	
Equisetum variegatum (variegated horsetail)	1997	7	47	15%	S3	G5	SC	
Eriophorum alpinum (alpine cotton-grass)	1996	3	25	12%	S2	G5	SC	
Eriophorum chamissonis (russet cotton-grass)	1974	1	6	17%	S2	G5	SC	
Gnaphalium sylvaticum (woodland cudweed)	2001	1	1	100%	S1	G4	SC	
Goodyera oblongifolia (giant rattlesnake-plantain)	2005	2	4	50%	S1	G5?	SC	
Gymnocarpium jessoense ssp. *parvulum* (northern oak fern)	2001	1	1	100%	S1	G5T4	SC	
Gymnocarpium robertianum (limestone oak fern)	1975	2	8	25%	S2	G5	SC	
Huperzia appalachiana (Appalachian clubmoss)	1998	1	1	100%	S1	G4G5	SC	
Huperzia selago (fir clubmoss)	1996	6	7	86%	S2	G5	SC	
Juncus vaseyi (Vasey's rush)	2003	28	30	93%	S3	G5?	SC	
Leucophysalis grandiflora (large-flowered ground-cherry)	1992	1	3	33%	S1	G4?	SC	
Listera auriculata (auricled twayblade)	2001	2	2	100%	S1	G3G4	END	
Listera convallarioides (broad-leaved twayblade)	2001	5	5	100%	S1	G5	THR	
Lonicera involucrata (fly honeysuckle)	1996	1	1	100%	S1	G4G5	END	
Ophioglossum pusillum (adder's-tongue)	1996	3	12	25%	S2	G5	SC	
Orobanche uniflora (one-flowered broomrape)	1995	4	30	13%	S3	G5	SC	
Osmorhiza chilensis (Chilean sweet cicely)	1996	28	33	85%	S3	G5	SC	
Parnassia palustris (marsh grass-of-parnassus)	2005	3	7	43%	S2	G5	THR	
Petasites sagittatus (arrow-leaved sweet-coltsfoot)	2008	26	31	84%	S3	G5	THR	
Pinguicula vulgaris (common butterwort)	2005	5	5	100%	S1	G5	END	
Platanthera dilatata (leafy white orchis)	1995	3	31	10%	S3	G5	SC	
Platanthera hookeri (hooker orchis)	1995	2	20	10%	S2S3	G4	SC	

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Appendix 21.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in SCP	EOs in WI	Percent in SCP	State rank	Global rank	State status	Federal status
Platanthera orbiculata (large roundleaf orchid)	2005	25	78	32%	S3	G5	SC	
Polystichum braunii (Braun's holly-fern)	1996	1	39	3%	S3	G5	THR	
Primula mistassinica (bird's-eye primrose)	2001	8	42	19%	S3	G5	SC	
Ranunculus cymbalaria (seaside crowfoot)	2000	13	15	87%	S2	G5	THR	
Ranunculus gmelinii (small yellow water crowfoot)	2001	12	16	75%	S2	G5	END	
Rhynchospora fusca (brown beakrush)	2007	13	21	62%	S2	G4G5	SC	
Ribes hudsonianum (northern black currant)	1996	1	76	1%	S3	G5	SC	
Ribes oxyacanthoides (canada gooseberry)	1991	2	7	29%	S2	G5	THR	
Salix pellita (satiny willow)	2001	2	2	100%	S1	G5	END	
Salix planifolia (tea-leaved willow)	2001	7	9	78%	S2	G5	THR	
Scirpus torreyi (Torrey's bulrush)	1995	2	21	10%	S2	G5?	SC	
Senecio indecorus (plains ragwort)	2002	3	3	100%	S1	G5	THR	
Sparganium glomeratum (northern bur-reed)	2002	13	19	68%	S2	G4?	THR	
Streptopus amplexifolius (white mandarin)	2001	24	29	83%	S3	G5	SC	
Thalictrum venulosum (veined meadowrue)	1997	1	1	100%	S1	G5	SC	
Triglochin maritima (common bog arrow-grass)	1997	8	59	14%	S3	G5	SC	
Trisetum spicatum (narrow false oats)	2001	19	19	100%	S2	G5	THR	
Utricularia resupinata (northeastern bladderwort)	1995	2	29	7%	S3	G4	SC	
Vaccinium vitis-idaea ssp. *minus* (mountain cranberry)	2005	2	7	29%	S1	G5T5	END	
Woodsia oregana ssp. *cathcartiana* (Oregon woodsia [Tetraploid])	1985	1	2	50%	S1	G5T5	SC	
COMMUNITIES								
Alder Thicket	2007	2	106	2%	S4	G4	NA	
Bedrock Shore	1996	1	1	100%	S2	G3G4	NA	
Black Spruce Swamp	2007	4	41	10%	S3?	G5	NA	
Boreal Forest	2007	17	36	47%	S2	G3?	NA	
Dry Cliff	1996	5	88	6%	S4	G4G5	NA	
Emergent Marsh	2005	10	272	4%	S4	G4	NA	
Emergent Marsh – Wild Rice	1991	1	15	7%	S3	G3G4	NA	
Floodplain Forest	2005	2	182	1%	S3	G3?	NA	
Great Lakes Barrens	1999	1	2	50%	S1	G2	NA	
Great Lakes Beach	2005	6	24	25%	S2	G3	NA	
Great Lakes Dune	1996	6	15	40%	S2	G3	NA	
Interdunal Wetland	2000	3	6	50%	S1	G2?	NA	
Lake—Deep, Hard, Drainage	2005	1	30	3%	S3	GNR	NA	
Lake—Soft Bog	1980	1	52	2%	S4	GNR	NA	
Mesic Floodplain Terrace	2007	2	2	100%	S2	GNR	NA	
Moist Cliff	2002	12	176	7%	S4	GNR	NA	
Muskeg	2005	3	45	7%	S4	G4G5	NA	
Northern Dry Forest	2007	5	63	8%	S3	G3?	NA	
Northern Dry-mesic Forest	2007	10	284	4%	S3	G4	NA	
Northern Mesic Forest	2005	8	383	2%	S4	G4	NA	
Northern Sedge Meadow	2000	6	231	3%	S3	G4	NA	
Northern Wet Forest	1991	3	322	1%	S4	G4	NA	
Northern Wet-mesic Forest	1996	4	243	2%	S3S4	G3?	NA	
Open Bog	2007	9	173	5%	S4	G5	NA	
Poor Fen	2007	11	46	24%	S3	G3G4	NA	
Shore Fen	2007	9	11	82%	S2	GNR	NA	
Spring Pond	1990	2	69	3%	S3	GNR	NA	

Continued on next page

Appendix 21.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in SCP	EOs in WI	Percent in SCP	State rank	Global rank	State status	Federal status
Springs and Spring Runs, Soft	1990	1	12	8%	SU	GNR	NA	
Stream–Fast, Hard, Cold	1995	1	98	1%	S4	GNR	NA	
Stream–Fast, Soft, Cold	1996	1	15	7%	SU	GNR	NA	
Stream–Slow, Hard, Cold	1983	1	22	5%	SU	GNR	NA	
Submergent Marsh	1996	2	6	33%	S4	G5	NA	
Tamarack (Poor) Swamp	2007	4	33	12%	S3	G4	NA	
OTHER ELEMENTS								
Bird rookery	2008	2	54	4%	SU	G5	SC	
Migratory bird concentration site	1996	4	8	50%	SU	G3	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 birds as Black-throated Blue Warbler (*Setophaga caerulescens*), Cerulean Warbler (*Setophaga cerulea*), Cape May Warbler (*Setophaga tigrina*), Canada Warbler (*Cardellina canadensis*), and Caspian Tern (*Hydroprogne caspia*).

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.

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.)

Status and ranking definitions continued on next page

Appendix 21.C, *continued.*

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 21.D. *Number of species with special designations documented within the Superior Coastal Plain Ecological Landscape, 2009.*

Listing status	Taxa					Total fauna	Total flora	Total listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
U.S. Endangered	1	1	0	0	0	2	0	2
U.S. Threatened	0	0	0	0	0	0	1	1
U.S. Candidate	0	0	0	0	0	0	0	0
Wisconsin Endangered	1	4	0	0	0	5	10	15
Wisconsin Threatened	0	3	2	0	0	5	18	23
Wisconsin Special Concern	2	21	2	2	25	52	53	105
Natural Heritage Inventory total	**3**	**28**	**4**	**2**	**25**	**62**	**81**	**143**

Note: Wisconsin-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.

Appendix 21.E. *Species of Greatest Conservation Need (SGCN) found in the Superior Coastal Plain Ecological Landscape.*

These SGCNs 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 2005d) 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 SGCNs highly or moderately (H = high association, M = moderate association) associated with specific community types or other habitat types and which have a high or moderate probability of occurring in the ecological landscape are included here (SGCNs 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.


Trumpeter Swan.
Photo by Wisconsin DNR staff.

	MAJOR															IMPORTANT											
	Boreal Forest	Coldwater Streams	Coolwater Streams	Dry Cliff	Emergent Marsh	Emergent Marsh – Wild Rice	Great Lakes Barrens	Great Lakes Beach	Great Lakes Dune	Interdunal Wetland	Lake Superior	Moist Cliff	Open Bog	Shore Fen	Submergent Marsh	Warmwater Streams	Alder Thicket	Floodplain Forest	Northern Dry Forest	Northern Dry-mesic Forest	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Shrub-carr	Surrogate Grasslands	Warmwater rivers
Species That Are Significantly Associated with the Superior Coastal Plain Ecological Landscape																											
MAMMALS																											
Franklin's ground squirrel									H																	M	
Gray wolf	H												M				H	M	M	H	M	H		H	H	M		
Northern flying squirrel	H						M											M	M	H	M	H		H	H			
Water shrew	H	H	H													M	M	M			H	M		H	H			
Woodland jumping mouse	M																	M			M	H		M	M			
BIRDS[a]																											
American Bittern					H								H										H				
American Golden Plover					M																					M	
American Woodcock																	H				M	M			H		
Bald Eagle											M				M												H
Black Tern					H	M									M								M				
Black-billed Cuckoo																	H	M				M			H		
Black-throated Blue Warbler																				M		H					
Blue-winged Teal					H	M									M			M					M			M	
Bobolink													M										H			H	
Brown Thrasher																										M	
Buff-breasted Sandpiper					M																					M	
Canada Warbler	H																M			M	H	M		M	H			
Common Tern					M			H			H																	
Dunlin					M			H																				M
Eastern Meadowlark																										H	
Golden-winged Warbler													M				H		M	M	M	M		M		H		
Horned Grebe											H																	

Continued on next page

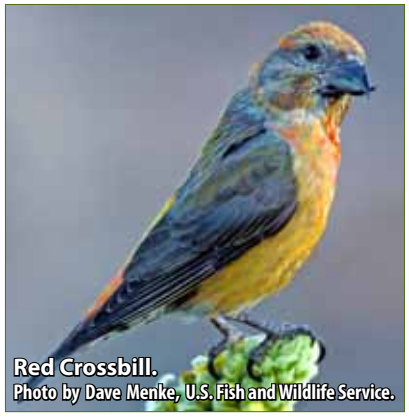
Appendix 21.E, *continued.*


Canvasback.
Photo by Wisconsin DNR staff.

	MAJOR															IMPORTANT											
	Boreal Forest	Coldwater Streams	Coolwater Streams	Dry Cliff	Emergent Marsh	Emergent Marsh – Wild Rice	Great Lakes Barrens	Great Lakes Beach	Great Lakes Dune	Interdunal Wetland	Lake Superior	Moist Cliff	Open Bog	Shore Fen	Submergent Marsh	Warmwater Streams	Alder Thicket	Floodplain Forest	Northern Dry Forest	Northern Dry-mesic Forest	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Shrub-carr	Surrogate Grasslands	Warmwater rivers
Le Conte's Sparrow													M	H									H				H	
Least Flycatcher	M																	M	M	M	M	H						
Lesser Scaup						M									H													M
Marbled Godwit					H																						M	
Northern Harrier													M										H				H	
Peregrine Falcon				H																								
Piping Plover								H	H																			
Short-billed Dowitcher					H																							
Trumpeter Swan					H	H								M	H													
Upland Sandpiper																											H	
Veery	H																H	M		M	H	M		M		H		
Whimbrel					M			H																				
Wood Thrush																		M				M						
HERPTILES																												
Boreal chorus frog					H					H			H	M									H					
Four-toed salamander	M	M	M		H								H	H			H	H			M	H	M	M	H	H		
Mink frog		M	H		H	M							H		H	H	M						H			M		H
Mudpuppy		M									H																	H
Wood turtle		H	H				H								H	H	H	H			M	H	M	M	M	H		H
FISH																												
Kiyi											M																	
Lake sturgeon											H																	H
Shortjaw cisco											M																	
Species That Are Moderately Associated with the Superior Coastal Plain Ecological Landscape																												
MAMMALS																												
American marten	H																			H		H						
Eastern red bat	M	H	H		M								M	M	M	M	M	M	M	M	M	M	M	M	M	M		M
Hoary bat	M	H	H		M								M	M	M	M	M	M	M	M	M	M	M	M	M	M		M
Moose	H				H								M		H	M	H	M			H	M	M	M	H	H		M
Northern long-eared bat		H	H		M								M		M	M	M	M	M	M	M	M	M			M		M
Silver-haired bat	M	H	H		M								M	M	M	M	M	M	M	M	M	M	M	M	M	M		M
BIRDS																												
Black-backed Woodpecker	M																		M					H				
Canvasback						M									H													H

Continued on next page

Appendix 21.E, *continued.*


Red Crossbill.
Photo by Dave Menke, U.S. Fish and Wildlife Service.

	MAJOR																IMPORTANT											
	Boreal Forest	Coldwater Streams	Coolwater Streams	Dry Cliff	Emergent Marsh	Emergent Marsh – Wild Rice	Great Lakes Barrens	Great Lakes Beach	Great Lakes Dune	Interdunal Wetland	Lake Superior	Moist Cliff	Open Bog	Shore Fen	Submergent Marsh	Warmwater Streams	Alder Thicket	Floodplain Forest	Northern Dry Forest	Northern Dry-mesic Forest	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Shrub-carr	Surrogate Grasslands	Warmwater rivers
Hudsonian Godwit					H																							
Olive-sided Flycatcher	M												M											H	M			
Red Crossbill																			H	H								
Rusty Blackbird					M								M				M	H								M		
Sharp-tailed Grouse																							M				M	
Solitary Sandpiper		M	M		H					M			M			M		H										
Yellow Rail													H	M									H					
HERPTILES																												
Pickerel frog		H	H		H								M	M	H	H	M	M				M	H	M	M	M		H

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

Appendix 21.F. *Natural communities[a] for which there are management opportunities in the Superior Coastal Plain Ecological Landscape.*

Major opportunity[b]	Important opportunity[c]	Present[d]
Boreal Forest	Northern Dry Forest	Ephemeral Pond
	Northern Dry-mesic Forest	
Great Lakes Barrens	Northern Mesic Forest	Great Lakes Ridge and Swale
	Northern Wet-mesic Forest	
Open Bog	Northern Wet Forest	Impoundment/Reservoir
Shore Fen	Northern Hardwood Swamp	Inland Lake
Emergent Marsh		
Emergent Marsh – Wild Rice	Floodplain Forest	
Submergent Marsh		
Interdunal Wetland	Alder Thicket	
	Shrub-carr	
Dry Cliff (Curtis's Exposed Cliff)		
Moist Cliff (Curtis's Shaded Cliff)	Northern Sedge Meadow	
Great Lakes Dune	Surrogate Grasslands	
Great Lakes Beach		
	Clay Seepage Bluff	
Coldwater Stream	Great Lakes Bedrock Shore	
Coolwater Stream		
Lake Superior	Warmwater River	
Warmwater Stream		

[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 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 21.G. *Public conservation lands in the Superior Coastal Plain Ecological Landscape, 2005.*

Property name	Size (acres)[a]
STATE	
Amnicon Falls State Park	830
Bibon Swamp State Natural Area[b]	7,880
Big Bay State Park	2,300
Brule River State Forest[b]	15,090
Copper Falls State Park[b]	600
Lost Creek Bog State Natural Area	460
Pattison State Park[b]	1,100
South Shore Lake Superior State Fish And Wildlife Area[b]	5,390
St. Louis River Stream Bank Protection Area	6,230
White River State Fishery Area	1,430
White River State Wildlife Area[b]	950
Miscellaneous Lands[c]	2,900
FEDERAL	
Chequamegon-Nicolet National Forest[b]	2,150
Apostle Islands National Lakeshore	41,100
Whittlesey Creek National Wildlife Refuge	300
COUNTY FOREST[d]	
Bayfield County Forest[b]	69,870
Douglas County Forest[b]	9,130
Iron County Forest[b]	7,630
Superior Municipal Forest	4,500
TOTAL	179,540

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

[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 program 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 21.H. *Land Legacy places in the Superior Coastal Plain Ecological Landscape and their ecological and recreational significance.*

The *Wisconsin Land Legacy Report* (WDNR 2006c) identified 17 places in the Lake Superior Coastal Plain 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]
AI	Apostle Islands	Large	Substantial	Limited	xxxxx	xxx
BD	Bad River	Large	Substantial	Limited	xxxx	xx
BY	Big Bay	Small	Substantial	Limited	xxxx	x
BB	Bois Brule River	Large	Substantial	Limited	xxxxx	xxxxx
CK	Chequamegon Point - Kakagon Sloughs	Small	Substantial	Limited	xxxxx	x
HW	Highway 2 Grasslands	Small	Limited	Moderate	xx	x
LS	Lake Superior South Shore Streams	Large	Substantial	Moderate	xxx	xxx
MU	Manitou Falls - Black River	Small	Substantial	Limited	xx	xx
MD	Middle River Contact	Small	Limited	Moderate	x	xx
MT	Montreal River	Large	Moderate	Moderate	xxx	xxx
MA	Mt. Ashwabay	Small	Substantial	Limited	xx	xx
NJ	Nemadji River and Wetlands	Medium	Limited	Moderate	xxx	x
QP	Quarry Point to Bark Point	Small	Limited	Moderate	xx	xx
ST	St. Louis Estuary and Pokegama Wetlands	Large	Substantial	Moderate	xxxx	xxx
WL	Western Lake Superior Drowned River Mouths	Medium	Moderate	Moderate	xxxxx	x
WR	White River	Large	Moderate	Moderate	xxxx	xx
WI	Wisconsin Point	Small	Limited	Moderate	xxx	x

[a]**Conservation significance.** See the *Wisconsin Land Legacy Report* (WDNR 2006c), 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 21.I. *Importance of economic sectors within the Superior Coastal Plain 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	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,fessional, 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 21.J. *Scientific names of species mentioned in the text.*

Common name	Scientific name
A rare predaceous diving beetle	*Rhantus sinuatus*
Alders	*Alnus* spp.
Alder Flycatcher[a]	*Empidonax alnorum*
Alewife	*Alosa pseudoharengus*
Alkali bluet damselfly	*Enallagma clausum*
Alkali buttercup	*Ranunculus cymbalaria*
American basswood	*Tilia americana*
American beaver	*Castor canandensis*
American Bittern	*Botaurus lentiginosus*
American black bear	*Ursus americanus*
American marten	*Martes americana*
American Redstart	*Setophaga ruticilla*
American White Pelican	*Pelecanus erythrorhynchos*
American Woodcock	*Scolopax minor*
Annosum root rot fungus	*Heterobasidion annosum*
Appalachian clubmoss	*Huperzia appalachiana*
Arctic Tern	*Sterna paradisaea*
Arrow-leaf sweet-colt's-foot	*Petasites sagittatus*
Aspen heart rot fungus	*Phellinus tremulae*
Aspen Hypoxylon canker fungus	*Hypoxylon mammatum*
Aspens	*Populus* spp.
Auricled twayblade	*Listera auriculata*
Autumnal water-starwort	*Callitriche hermaphroditica*
Bald Eagle	*Haliaeetus leucocephalus*
Balsam fir	*Abies balsamea*
Balsam poplar	*Populus balsamifera*
Bank Swallow	*Riparia riparia*
Bearberry	*Arctostaphylos uva-ursi*
Belted Kingfisher	*Megaceryle alcyon*
Bird's-eye primrose	*Primula mistassinica*
Black-and-White Warbler	*Mniotilta varia*
Black ash	*Fraxinus nigra*
Black Grouse	*Lyrurus tetrix*
Black meadowhawk	*Sympetrum danae*
Black Scoter	*Melanitta americana*
Black spruce	*Picea mariana*
Black Tern	*Chlidonias niger*
Black-backed Woodpecker	*Picoides arcticus*
Blackburnian Warbler	*Setophaga fusca*
Black-headed Gull	*Chroicocephalus ridibundus*
Black-throated Blue Warbler	*Setophaga caerulescens,* listed as *Dendroica caerulescens* on the Wisconsin Natural Heritage Working List
Black-throated Green Warbler	*Setophaga virens*
Blanding's turtle	*Emydoidea blandingii*
Bloater chub	*Coregonus hoyi*
Blueberries	*Vaccinium* spp.
Bobcat	*Lynx rufus*
Bobolink	*Dolichonyx oryzivorus*
Bohemian Waxwing	*Bombycilla garrulus*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Boreal Chickadee	*Poecile hudsonicus*
Boreal Owl	*Aegolius funereus*
Box elder	*Acer negundo*
Broad-leaved twayblade	*Listeria convallarioides*
Bronze birch borer	*Agrilus anxius*

Continued on next page

Appendix 21.J, *continued.*

Common name	Scientific name
Brook trout	*Salvelinus fontinalis*
Brown beak-rush	*Rhynchospora fusca*
Brown trout	*Salmo trutta*
Bur oak	*Quercus macrocarpa*
Canada Goose	*Branta canadensis*
Canada thistle	*Cirsium arvense*
Canada Warbler	*Cardellina canadensis,* listed as *Wilsonia canadensis* on the Wisconsin Natural Heritage Working List
Canada yew	*Taxus canadensis*
Cape May Warbler	*Setophaga tigrina,* listed as *Dendroica tigrina* on the Wisconsin Natural Heritage Working List
Capercaillie	*Tetrao urogallus*
Caribou	*Rangifer tarandus*
Caspian Tern	*Hydroprogne caspia,* listed as *Sterna caspia* on the Wisconsin Natural Heritage Working list
Cerulean Warbler	*Setophaga cerulea,* listed as *Dendroica cerulea* on the Wisconsin Natural Heritage Working List
Chilean sweet cicely	*Osmorhiza berteroi*
Chinook salmon	*Oncorhynchus tschawytscha*
Common buckthorn	*Rhamnus cathartica*
Coho salmon	*Oncorhynchus kisutch*
Common butterwort	*Pinguicula vulgaris*
Common carp	*Cyprinus carpio*
Common juniper	*Juniperus communis*
Common lake sedge	*Carex lacustris*
Common Loon	*Gavia immer*
Common ninebark	*Physocarpus opulifolius*
Common periwinkle	*Vinca minor*
Common Redpoll	*Acanthis flammea*
Common reed	*Phragmites australis*
Common tansy	*Tanacetum vulgare*
Common Tern	*Sterna hirundo*
Coral-berry	*Symphoricarpos orbiculatus*
Coyote	*Canis latrans*
Curly pondweed	*Potamogeton crispus*
Dark-eyed Junco	*Junco hyemalis*
Diplodia pine blight fungus	*Diplodia pinea*
Dogwoods	*Cornus* spp.
Double-crested Cormorant	*Phalacrocorax auritus*
Dune thistle (Pitcher's thistle)	*Cirsium pitcheri*
Eared Grebe	*Podiceps nigricollis*
Eastern elliptio	*Elliptio complanata*
Eastern floater	*Pyganodon cataracta*
Eastern hemlock	*Tsuga canadensis*
Eastern Meadowlark	*Sturnella magna*
Eastern white pine	*Pinus strobus*
Elfin skimmer	*Nannothemis bella*
Emerald ash borer	*Agrilus planipennis*
English sundew	*Drosera anglica*
Eurasian honeysuckles	*Lonicera morrowii* and *L. tatarica*
Eurasian water-milfoil	*Myriophyllum spicatum*
European swamp thistle	*Cirsium palustre*
Evening Grosbeak	*Coccothraustes vespertinus*
False heather	*Hudsonia tomentosa*
Fir clubmoss	*Huperzia selago*

Continued on next page

Appendix 21.J, *continued.*

Common name	Scientific name
Fisher	*Martes pennanti*
Floating marsh-marigold	*Caltha natans*
Fly honeysuckle	*Lonicera involucrata*
Forest tent caterpillar	*Malacosoma disstria*
Franklin's ground squirrel	*Spermophilus franklinii*
Garden-heliotrope	*Valeriana officinalis*
Giant knotweed	*Polygonum sachalinense*
Giant rattlesnake-plantain	*Goodyera oblongifolia*
Glaucous Gull	*Larus hyperboreus*
Glossy buckthorn	*Rhamnus frangula*
Golden-crowned Kinglet	*Regulus satrapa*
Golden-winged Warbler	*Vermivora chrysoptera*
Gray Jay	*Perisoreus canadensis*
Gray wolf	*Canis lupus*
Great Blue Heron	*Ardea herodias*
Great Gray Owl	*Strix nebulosa*
Greater Black-backed Gull	*Larus marinus*
Greater Scaup	*Aythya marila*
Green alder	*Alnus viridis*
Green ash	*Fraxinus pennsylvanica*
Gypsy moth	*Lymantria dispar*
Gyrfalcon	*Falco rusticolus*
Herring Gull	*Larus argentatus*
Hoary Redpoll	*Acanthis hornemanni*
Horned Grebe	*Podiceps auritus*
Iceland Gull	*Larus glaucoides*
Jack pine	*Pinus banksiana*
Jaegers	*Stercorarius* spp.
Japanese barberry	*Berberis thungbergii*
Japanese knotweed	*Polygonum cuspidatum*
Kiyi	*Coregonus kiyi*
Lake cress	*Armoracia lacustris*
Lake darner	*Aeshna eremita*
Lake herring	*Coregonus artedi*
Lake sturgeon	*Acipenser fulvescens*
Lake trout	*Salvelinus namaycush*
Lake whitefish	*Coregonus clupeaformis*
Large round-leaved orchid	*Platanthera orbiculata*
Large toothwort	*Cardamine maxima*
Laurentian bladder fern	*Cystopteris laurentiana*
Le Conte's Sparrow	*Ammodramus leconteii*
Leafy spurge	*Euphorbia esula*
Least Flycatcher	*Empidonax minimus*
Lesser Black-backed Gull	*Larus fuscus*
Lesser Scaup	*Aythya affinis*
Lilacs	*Syringa* spp.
Little Gull	*Hydrocoloeus minutus*
Loggerhead Shrike	*Lanius ludovicianus*
Mallard	*Anas platyrhynchos*
Mamillate spike-rush	*Eleocharis mamallita*
Marsh grass-of-Parnassus	*Parnassia palustris*
Marsh horsetail	*Equisetum palustre*
Merlin	*Falco columbarius*
Michaux's sedge	*Carex michauxiana*
Moose	*Alces americanus*

Continued on next page

Appendix 21.J, *continued.*

Common name	Scientific name
Mountain cranberry	*Vaccinium vitis-idaea*
Mountain maple	*Acer spicatum*
Mourning Warbler	*Geothlypis philadelphia*
Narrow false oats	*Trisetum spicatum*
Narrow-leaved cat-tail	*Typha angustifolia*
Nashville Warbler	*Oreothlypis ruficapilla*
New Zealand mudsnail	*Potamopyrgus antipodarum*
North American river otter	*Lontra canadensis*
Northern bur-reed	*Sparganium glomeratum*
Northern Harrier	*Circus cyaneus*
Northern Hawk Owl	*Surnia ulula*
Northern oak fern	*Gymnocarpium jessoense* ssp. *parvulum*
Northern Parula	*Setophaga americana*
Northern pike	*Esox lucius*
Northern pin oak	*Quercus ellipsoidalis*
Northern red oak	*Quercus rubra*
Northern Waterthrush	*Seiurus noveboracensis*
Northern white-cedar	*Thuja occidentalis*
Oak wilt fungus	*Ceratocystis fagacearum*
Olive-sided Flycatcher	*Contopus cooperi*
Ovenbird	*Seiurus aurocapilla*
Pacific Loon	*Gavia pacifica*
Pea clam	*Pisidium moitessierianumin*
Pine Grosbeak	*Pinicola enucleator*
Pine sawfly	*Neodiprion* spp.
Pine sawfly	*Diprion* spp.
Pine Siskin	*Spinus pinus*
Pink salmon	*Oncorhynchus gorbuscha*
Piping Plover	*Charadrius melodus*
Plains ragwort	*Senecio indecorus*
Poison ivy	*Toxicodendron radicans*
Privets	*Ligustrum* spp.
Purple Finch	*Carpodacus purpureus*
Purple loosestrife	*Lythrum salicaria*
Quagga mussel	*Dreissena bugensis*
Quaking aspen	*Populus tremuloides*
Rainbow smelt	*Osmerus mordax*
Rainbow trout	*Oncorhynchus mykiss*
Ram's-head lady's-slipper	*Cypripedium arientinum*
Red Crossbill	*Loxia curvirostra*
Red maple	*Acer rubrum*
Red pine	*Pinus resinosa*
Red pine pocket mortality fungal species	*Leptographium terrebrantis* and *L. procerum*
Redhead	*Aythya americana*
Red-throated Loon	*Gavia stellata*
Reed canary grass	*Phalaris arundinacea*
Ring-billed Gull	*Larus delawarensis*
Ring-necked Duck	*Aythya collaris*
Round goby	*Neogobius melanostomus*
Ruby-crowned Kinglet	*Regulus calendula*
Ruffe	*Gymnocephalus cernuus*
Ruffed Grouse	*Bonasa umbellus*
Russet buffalo-berry	*Shepherdia canadensis*
Rusty crayfish	*Orconectes rusticus*
Sabine's Gull	*Xema sabini*

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Appendix 21.J, *continued.*

Common name	Scientific name
Sand cherry	*Prunus pumila*
Satiny willow	*Salix pellita*
Schweinitz's sedge	*Carex schweinitzii*
Sea lamprey	*Petromyzon marinus*
Seaside crowfoot	*Ranunculus cymbalaria*
Sedge Wren	*Cistothorus platensis*
Sharp-shinned Hawk	*Accipiter striatus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Shore sedge	*Carex lenticularis*
Shortjaw cisco	*Coregonus zenithicus*
Silver maple	*Acer saccharinum*
Slender spike-rush	*Eleocharis nitida*
Small yellow water crowfoot	*Ranunculus gmelinii*
Smallmouth bass	*Micropterus dolomieu*
Smooth black sedge	*Carex nigra*
Snowberry	*Symphoricarpos albus*
Snowshoe hare	*Lepus americanus*
Snowy Owl	*Bubo scandiacus*
Speckled alder	*Alnus incana*
Spiny waterflea	*Bythotrephes cederstroemi*
Splake	*Salvelinus namaycush* x *S. fontinalis*
Spotted knapweed	*Centaurea biebersteinii*
Spruce budworm	*Choristoneura fumiferana*
Spruce Grouse	*Falcipennis canadensis*
Sugar maple	*Acer saccharum*
Surf Scoter	*Melanitta perspicillata*
Swainson's Thrush	*Catharus ustulatus*
Tamarack	*Larix laricina*
Tea-leaved willow	*Salix planifolia*
Thayer's Gull	*Larus thayeri*
Tubenose goby	*Proterorhinus marmoratus*
Tundra Swan	*Cygnus columbianus*
Two-lined chestnut borer	*Agrilus bilineatus*
Upland Sandpiper	*Bartramia longicauda*
Vasey's rush	*Juncus vaseyi*
Veery	*Catharus fuscescens*
Veined meadow-rue	*Thalictrum venulosum*
Walleye	*Sander vitreus*
Warpaint emerald	*Somatochlora incurvata*
Western Grebe	*Aechmophorus occidentalis*
White birch	*Betula papyrifera*
White mandarin	*Streptopus amplexifolius*
White perch	*Morone americana*
White pine blister rust fungus	*Cronartium ribicola*
White spruce	*Picea glauca*
White-tailed deer	*Odocoileus virginianus*
White-winged Crossbill	*Loxia leucoptera*
White-winged Scoter	*Melanitta fusca*
Wild parsnip	*Pastinaca sativa*
Wild rice	*Zizania* spp.
Willows	*Salix* spp.
Wilson's Warbler	*Cardellina pusilla*, listed as *Wilsonia pusilla* on the Wisconsin Natural Heritage Working List
Wintergreen	*Gaultheria procumbens*
Wolfberry	*Symphoricarpos occidentalis*

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Appendix 21.J, *continued.*

Common name	Scientific name
Wood Duck	*Aix sponsa*
Wood turtle	*Glyptemys insculpta*
Woodland cudweed	*Gnaphalium sylvaticum*
Yellow birch	*Betula alleghaniensis*
Yellow perch	*Perca flavescens*
Yellow Rail	*Coturnicops noveboracensis*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Yellow-rumped Warbler	*Setophaga coronata*
Zebra mussel	*Dreissena polymorpha*
Zigzag darner	*Aeshna sitchensis*

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

Appendix 21.K. *Maps of important physical, ecological, and aquatic features within the Superior Coastal Plain Ecological Landscape.*

- Vegetation of the Superior Coastal Plain Ecological Landscape in the Mid-1800s
- Land Cover of the Superior Coastal Plain Ecological Landscape in the Mid-1800's
- Landtype Associations (LTAs) of the Superior Coastal Plain Ecological Landscape
- Public Land Ownership, Easements, and Private Land Enrolled in Forest Tax Programs in the Superior Coastal Plain Ecological Landscape
- Ecologically Significant Places of the Superior Coastal Plain Ecological Landscape
- Exceptional and Outstanding Resource Waters and 303(d) Degraded Waters (2010 Update) of the Superior Coastal Plain Ecological Landscape
- Dams of the Superior Coastal Plain Ecological Landscape
- WISCLAND Land Cover (1992) of the Superior Coastal Plain Ecological Landscape
- Soils of the Superior Coastal Plain Ecological Landscape
- Relative Tree Density of the Superior Coastal Plain Ecological Landscape in the Mid-1800s
- Population Density, Cities, and Transportation of the Superior Coastal Plain Ecological Landscape

Note: *Go to http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=15 and click the "maps" tab.*

Literature Cited

Allison, T.D. 2006. *Canada yew and white-tailed deer at the Apostle Islands: summary of research to date with recommendations for continued monitoring and management*. National Park Service Great Lakes Inventory and Monitoring, Network Report GLKN/2006/04, Lincoln, Massachusetts.

Alvord, K. 2007. Lake Superior warming fast: researchers surprised by strong trends. Available online at http://www.keweenawnow.com/news/climate_change_07_05/climate_change.htm. Accessed May 3, 2007.

Austin, J.A., and S.M. Colman. 2007. Lake Superior summer water temperatures are increasing more rapidly than regional air temperatures: a positive ice-albedo feedback. *Geophysical Research Letters* 34 L06604 doi:10.1029/2006GL029021.

Bacon, B., and A. Paulios. 2006. The northern owl invasion in Wisconsin, 2004–2005. *The Passenger Pigeon* 68(1):3–18.

Bean, E.F., and J.W. Thompson. 1944. Topography and geology of the Brule River basin. *Transactions of the Wisconsin Academy of Science, Arts and Letters* 36:7–17.

Brady, R. 2004. Observations of uncommon raptors at Chequamegon Bay Hawkwatch, 1999–2004. *The Passenger Pigeon* 66(4):371–380.

Brockman, K.M., and R.A. Dow, editors. 1982. *Wildlife in early Wisconsin: a collection of works by A.W. Schorger*. Student Chapter of The Wildlife Society, Stevens Point, Wisconsin.

Bruxer, J., and C. Southam. 2008. Analysis of Great Lakes volume changes resulting from glacial isostatic adjustment. International Upper Great Lakes Study website. Available online at http://www.iugls.org/project/Analysis%20of%20Great%20Lakes%20Volume%20Changes%20Resulting%20from%20Glacial%20Isostatic%20Adjustment. Accessed Jan. 2, 2011.

City of Superior. 2007. Nemadji River. Web page. Available online at http://www.ci.superior.wi.us/index.asp?NID=365. Accessed April 1, 2009.

City of Superior. 2014. Special Area Management Plan (SAMP). Available online at http://www.ci.superior.wi.us/index.aspx?NID=565.

Clayton, L. 1984. *Pleistocene geology of the Superior Region, Wisconsin*. University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey Information Circular No. 46, Madison.

Cleland, D.T., P.E. Avers, W.H. McNab, M.E. Jensen, R.G. Bailey, T. King, and W.E. Russell. 1997. National hierarchical framework of ecological units. Pages 181–200 *in* M.S. Boyce and A. Haney, editors. *Ecosystem management: applications for sustainable forest and wildlife resources*. Yale University Press, New Haven, Connecticut.

Curtis, J.T. 1959. *Vegetation of Wisconsin: an ordination of plant communities*. University of Wisconsin Press, Madison.

Cutright, N.J., B.R. Harriman, and R.W. Howe, editors. 2006. *Atlas of the breeding birds of Wisconsin*. Wisconsin Society for Ornithology, Waukesha. 602 pp.

Davis, M.G., compiler and editor. 1947. *A history of Wisconsin highway development, 1835–1945*. State Highway Commission of Wisconsin and the U.S. Public Roads Administration, Federal Works Agency, Madison.

Dott, R.H., and J.W. Attig. 2004. *Roadside geology of Wisconsin*. Mountain Press Publishing Company, Missoula, Montana.

DuBois, R.B., J.M. Pleski, W.A. Smith, E.J. Epstein, and K. Mead. 2005. First records for *Aeshna sitchensis* (Odonata: Aeshnidae) and *Enallagma clausum* (Odonata: Coenagrionidae), and a northwestern record for the state-endangered *Somatochlora incurvata* (Odonata: Corduliidae) in Wisconsin. *The Great Lakes Entomologist* 37:126–130.

Environment Canada. 2008. Great Lakes Water Quality Agreement. Available online at http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=45B79BF9-1. Accessed April 1, 2009.

Epstein, E., W. Smith, J. Dobberpuhl, and A. Galvin. 1999. *Biotic inventory and analysis of the Brule River State Forest: a baseline inventory (1995–97) and analysis of natural communities, rare plants and animals, aquatic invertebrates, and other selected features in preparation for state forest master planning.* Wisconsin Department of Natural Resources, Bureau of Endangered Resources, Wisconsin's Natural Heritage Program, PUB ER-799 1999, Madison.

Farrand, W.R. 1969. The quaternary history of Lake Superior. Pages 181–197 *in International Association of Great Lakes Research, Proceedings of the 12th Conference*, Ann Arbor, Michigan.

Finley, R. 1976. *Original vegetation of Wisconsin*. Map compiled from U.S. General Land Office notes. U.S. Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Fisher, C.E., editor. 1937. *The railroads of Wisconsin, 1827–1937*. The Railway and Locomotive Historical Society, Inc., Boston.

Fitzpatrick, F.A., J.C. Knox, and H.E. Whitman. 1999. *Effects of historical landcover changes on flooding and sedimentation, North Fish Creek, Wisconsin.* U.S. Geological Survey, Water-Resources Investigations Report 99–4083, Middleton, Wisconsin.

Fitzpatrick, F.A., M.C. Peppler, M.M. DePhilip, and K.E. Lee. 2006. *Geomorphic characteristics and classification of Duluth-area streams, Minnesota.* U.S. Geological Survey, Scientific Investigations Report 06–5029, Middleton, Wisconsin.

Fleming, K.C. 1997. *A demographic comparison of a hunted and an unhunted population of black bears in northern Wisconsin.* Master's thesis, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin.

Frelich, L.E., and C.G. Lorimer. 1991. Natural disturbance regimes in hemlock-hardwood forests of the upper Great Lakes region. *Ecological Monographs* 61:145–164.

Garshelis, D.L. 1994. Density-dependent population regulation of black bears. Pages 3-14 *in* M. Taylor, editor. *Monograph of meeting on density-dependent population regulation in black, brown, and polar bears*. International Conference on Bear Research and Management Monograph Series 3.

Gjestson, D.L. 2013. *The gamekeepers: Wisconsin wildlife conservation from WCD to CWD*. Wisconsin Department of Natural Resources, PUB-SS-1079 2013, Madison.

Great Lakes Commission (GLC). 2007. Congress urged to make ballast water rules #1 Great Lakes priority. Great Lakes Commission News Archive web page. Available online at http://glc.org/announce/2007-congress-urged-make-ballast-water-rules-priority/. Accessed April 10, 2009.

Grveles, K.M., S.W. Matteson, S. Eichhorst, and K. Kreitinger. 2011. *Protecting bird migration stopover habitat in the western Great Lakes: Final Report.* Wisconsin Department of Natural Resources, Endangered Resources Program, Madison.

Hansen, M.J. 1990. *Lake Superior: the state of the lake in 1989.* Great Lakes Fishery Commission Special Publication 90-3, Ann Arbor, Michigan.

He, H.S., D.J. Mladenoff, T.A. Sickley, and G.G. Guntenspergen. 2000. GIS interpolations of witness tree records (1839–1866) for northern Wisconsin at multiple scales. *Journal of Biogeography* 27:1031–1042.

Inter-university Consortium for Political and Social Research (ICPSR). 2007. United States historical census data browser. Available online at http://mapserver.lib.virginia.edu or http://www.icpsr.umich.edu/. Accessed September 2009.

Johnson, K.M., and C.L. Beale. 2002. Nonmetro recreation counties: their identification and rapid growth. *Rural America* 17(4):12–19.

Judziewicz, E.J. 2008. Plant communities of Great Lakes islands. Pages 115–125 *in* D. Waller and T. Rooney, editors. *The vanishing present: Wisconsin's changing lands, waters and wildlife*. The University of Chicago Press, Chicago.

Judziewicz, E.J., and R.G. Koch. 1993. Flora and vegetation of the Apostle Islands National Lakeshore and Madeline Island, Ashland and Bayfield Counties, Wisconsin. *Michigan Botanist* 32(2):43–189.

Kohn, B.E. 1974. *Relationship between pine management and summer deer densities on the Brule Pines study area*. Wisconsin Department of Natural Resources, Pittman-Robertson Project W-141-R-9, Madison.

Kohn, B.E., N.F. Payne, J.A. Ashbrenner, and W.E. Creed. 1993. *The fisher in Wisconsin.* Wisconsin Department of Natural Resources, Technical Bulletin 183, Madison.

Kotar, J., J. A. Kovach, and T. L. Burger. 2002. *A guide to forest communities and habitat types of northern Wisconsin*. Second edition. University of Wisconsin-Madison, Department of Forest Ecology and Management, Madison.

Kucera, D.R., and P.W. Orr. 1981. *Spruce budworm in the eastern United States.* U.S. Forest Service Forest, Forest Insect and Disease Leaflet 160, Washington, D.C.

LaBerge, G.L. 1994. *Geology of the Lake Superior region*. Penokean Press, Oshkosh, Wisconsin.

Lyons, J., P.A. Cochran, and D. Fago. 2000. *Wisconsin fishes 2000: status and distribution.* University of Wisconsin Sea Grant Institute, Madison.

Macholl, J.A. 2007. Inventory of Wisconsin's springs. Wisconsin Geological and Natural History Survey Open-File Report 2007-03, Madison.

Manies, K.L., and D.J. Mladenoff. 2000. Testing methods to produce landscape-scale presettlement vegetation maps from the U.S. public land survey records. *Landscape Ecology* 15:741–754.

Marcouiller, D., and X. Xia. 2008. Distribution of income from tourism-sensitive employment. *Tourism Economics* 14(3):545–565.

Martin, L. 1965. *The physical geography of Wisconsin*. Third edition. The University of Wisconsin Press, Madison.

Mason, C.I. 1997. The historic period, native peoples. *The Wisconsin Archeologist* 78(1–2):298–319.

Mattes, B. 2008. Growing data bank on Lake Superior's deep-water fish. Great Lakes Indian Fish and Wildlife Commission newsletter, *Mazina'igan – a chronicle of the Lake Superior Ojibwe*. Winter 2008–2009.

Matteson, S.W. 1988. *Wisconsin common tern recovery plan.* Wisconsin Department of Natural Resources, Bureau of Endangered Resources, Report 41, Madison.

Matteson, S.W. 1996. Birds of Wisconsin's lake beaches and dunes. *The Passenger Pigeon* 58(4):335–413.

Matteson, S.W., J.V. Stappen, P. Burkman, and T. Doolittle. 2007. Piping plovers breeding in Wisconsin, 1891–2006. *The Passenger Pigeon* 69(1):47–79.

Matteson, S., Kreitinger, G. Bartelt, G. Butcher, D. Sample, and T. Will. 2009. Partners in Flight Bird Conservation Plan for the Boreal Hardwood Transition (Bird Conservation Region 12 – U.S. Portion). Version 1.0. Partners in Flight. Available online at www.partnersinflight.org.

Matteson, S.W., M.J. Mossman, and D.A. Schaler. 2012. Population decline of Black Terns in Wisconsin: a 30-year perspective. *Waterbirds* 35(2):185–193.

Meeker, J., and G. Fewless. 2008. Change in Wisconsin's coastal wetlands. Pages 183–192 *in* D. Waller, and T. Rooney, editors. *The vanishing present: Wisconsin's changing lands, waters, and wildlife*. University of Chicago Press, Chicago.

Minnesota IMPLAN Group Inc. (MIG). 2009. IMPLAN data. Available online at https://implan.com. Accessed April 2009.

National Association of Counties (NACO). 2010. Website. Available online at http://www.naco.org. Accessed October 2010.

National Oceanic and Atmospheric Administration (NOAA). 2014. National Estuarine Research Reserve: Lake Superior. Website. Available online at http://www.nerrs.noaa.gov/Reserve.aspx?ResID=LKS.

National Weather Service (NWS). 2007. Lake effect snow. Available online at http://www.crh.noaa.gov/dlh/?n=lakesnow. Accessed April 17, 2009.

Ostergren, R., and T.Vale, editors. 1997. Wisco*nsin land and life*. University of Wisconsin Press, Madison.

Petersen, L.R., M.A. Martin, and C.M. Pils. 1977. *Status of fishers in Wisconsin.* Wisconsin Department of Natural Resources, Research Report 92, Madison.

Phillips, D., and J. McCulloch. 1972. *The climate of the Great Lakes basin.* Atmospheric Environment Service, Climatological Studies Number 20, Toronto, Canada.

Quinlan, H., M. Chase, M. Friday, P. Furlong, T. Pratt, S. Schram, M. Seider, B. Mattes, and M. Ebener. 2007. Rehabilitation of native fish in Lake Superior. Presented at Making a Great Lake Superior conference, October 29–31, 2007, Duluth, Minnesota. Powerpoint presentation available online at http://www.seagrant.umn.edu/superior2007/presentations/. Accessed April 1, 2009.

Quintero, J. 2007. *Regional economic development: an economic base study and shift-share analysis of Hays County, Texas.* Texas State University, Applied Research Projects, Paper 259, San Marcos. 85 pp. Available online at https://digital.library.txstate.edu/handle/10877/3656.

Red Cliff Band of Lake Superior Chippewa. 2004. Website. Available online at http://www.redcliff-nsn.gov.

Renewable Fuels Association. 2013. Biorefinery locations. Web page. Last update May 10, 2013. Available online at http://www.ethanolrfa.org/biorefinery-locations/.

Riedel, M., E. Verry, and K. Brooks. 2005. Impacts of land use conversion on bankfull discharge and mass wasting. *Journal of Environmental Management* 76:326–337.

Rooney, T., S. Wiegmann, D. Rogers, and D. Waller. 2004. Biotic impoverishment and homogenization in unfragmented forest communities. *Conservation Biology* 18:787–798.

Roth, F. 1898. *Forestry conditions and interests of Wisconsin.* U.S. Department of Agriculture, Division of Forestry, Bulletin No. 16, Washington, D.C. 76 pp.

St. Louis River Citizens Action Committee (SLRCAC). 2002. *Lower St. Louis River Habitat Plan.* St. Louis River Citizens Action Committee, U.S. Environmental Protection Agency under Grant Contract Number X995385010, with additional support from the Minnesota Department of Natural Resources Conservation Partners Program, U.S. Fish and Wildlife Service, and The Nature Conservancy, Duluth, Minnesota.

Schorger, A.W. 1942. Extinct and endangered mammals and birds of the upper great lakes region. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 34:23–44. Available online at http://digital.library.wisc.edu/1711.dl/WI.WT1942.

Schorger, A.W. 1945. The ruffed grouse in early Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters* 37:35–90. Available online at http://digital.library.wisc.edu/1711.dl/WI.WT1945.

Schorger, A.W. 1953. The white-tailed deer in early Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 42:197-247. Available online at http://digital.library.wisc.edu/1711.dl/WI.WT1953.

Schorger, A.W. 1965. The beaver in early Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 54:147–179. Available online at http://digital.library.wisc.edu/1711.dl/WI.WT1965.

Schorger, A.W. 1970. The otter in early Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 58:129–146. Available online at http://digital.library.wisc.edu/1711.dl/WI.WT1970.

Schulte, L.A., and D.J. Mladenoff. 2001. The original U.S. public land survey records: their use and limitations in reconstructing pre-European settlement vegetation. *Journal of Forestry* 99:5–10.

Schulte, L.A., and D.J. Mladenoff. 2005. Severe wind and fire regimes in northern forests: historical variability at the regional scale. *Ecology* 86(2):431–445.

Schulte, L.A., D.J. Mladenoff, T.R. Crow, L.C. Merrick, and D.T. Cleland. 2007. Homogenization of northern U.S. Great Lakes forests due to land use. *Landscape Ecology* 22:1089–1103.

Storlid, S.A. 1995. *Spring and summer habitat use and food habits of black bears in northern Wisconsin.* Master's thesis, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin.

Steele, Y. 2007. *Important Bird Areas of Wisconsin: critical sites for the conservation and management of Wisconsin's birds.* Wisconsin Department of Natural Resources, PUB-WM-475-2007, Madison. 240 pp.

The Wisconsin Cartographer's Guild. 1998. *Wisconsin's past and present: a historical atlas*. The University of Wisconsin Press, Madison. 123 pp.

University of Wisconsin-Superior (UWS) and University of Wisconsin Extension (UWEX). 2014. Lake Superior National Estuarine Research Reserve. Website. Available online at http://lsnerr.uwex.edu/.

U.S. Census Bureau (USCB). 2009. U.S. Census Bureau website. Available online http://www.census.gov. Accessed April 2009.

U.S. Census Bureau (USCB). 2010. County business patterns. Available online at http://www.census.gov/econ/cbp/index.html. Accessed January 2010.

U.S. Census Bureau (USCB). 2012. 2010 census data. State and county quick facts web page. Available online at http://quickfacts.census.gov/qfd/states/55000.html. Accessed January 2012.

U.S. Census Bureau (USCB). 2013. North American Industry Classification System, 2007. Website. Available online at http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2007.

U.S. Department of Agriculture Economic Research Service (USDA ERS). 2012a. 2004 county typology codes. Available online at http://www.ers.

usda.gov/data-products/county-typology-codes.aspx. Updated July 5, 2012.

U.S. Department of Agriculture Economic Research Service (USDA ERS). 2012b. 2003 Urban influence codes for U.S. counties. Available online at http://www.ers.usda.gov/data-products/urban-influence-codes.aspx. Last updated July 5, 2012.

U.S. Department of Agriculture, National Agricultural Statistics Service (USDA NASS). 2004. *2002 Census of Agriculture: Wisconsin state and county data.* Volume 1, Chapter 2: County level data. Table 1: County summary highlights: 2002. Available online at http://www.agcensus.usda.gov/Publications/2002/Volume_1,_Chapter_2_County_Level/Wisconsin/. Accessed December 2010.

U.S. Department of Agriculture, National Agricultural Statistics Service (USDA NASS). 2009. *2007 Census of Agriculture: Wisconsin state and county data.* Volume 1, Chapter 2: County level data. Table 1: County summary highlights: 2007. Available online at http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Wisconsin/. Accessed December 2010.

U.S. Department of Agriculture, Natural Resources Conservation Service. (USDA NRCS). 2009. Web soil survey. Available online at http://websoilsurvey.nrcs.usda.gov/app/. Accessed June 1, 2009.

U.S. Department of Commerce, Bureau of Economic Analysis (USDC BEA). 2006. Regional accounts data: local area personal income. Available online at http://www.bea.gov/. Accessed August 2009.

U.S. Department of Energy (USDE). 2013. *Wisconsin 50-meter wind power*. Map. Web page. Available online at http://www.windpoweringamerica.gov/maps_template.asp?stateab=wi.

U.S. Department of Labor, Bureau of Labor Statistics (USBLS). 2006. Local area unemployment statistics data. Available online at http://www.bls.gov/lau/. Accessed July 2009.

U.S. Environmental Protection Agency (USEPA). 2006. Lake Superior lakewide management plan (LaMP) 2006. Lake Superior Binational Program. Available online at http://www.epa.gov/grtlakes/lakesuperior/2006/. Accessed April 10, 2009.

U.S. Environmental Protection Agency (USEPA). 2007. Quagga mussels confirmed in Duluth - Superior harbor by USEPA. Available online at http://www.seagrant.umn.edu/downloads/quagga_mussel_nr.pdf. Accessed April 8, 2009.

U.S. Fish and Wildlife Service (USFWS). 2006. Proceedings of the 2006 Great Lakes lake sturgeon coordination meeting. Available online at http://www.fws.gov/midwest/sturgeon/documents/2006-lakesuperior.htm. Accessed January 22, 2009.

U.S. Forest Service (USFS). 2009. Forest Inventory and Analysis, Mapmaker, Version 4.0. Previously available online at http://www.ncrs2.fs.fed.us/4801/fiadb/fim40/wcfim40.asp. Accessed July 2009. (*Note: USFS has discontinued the Forest Inventory and Analysis Mapmaker program. See the U.S. Forest Service's "Tools and Applications" web page, http://www.nrs.fs.fed.us/tools/software/.)*

U.S. Forest Service (USFS). 2015. Forest health and economics. Web page. Available online at http://na.fs.fed.us/fhp/index.shtm.

U.S. Geological Survey (USGS). 2010. Estimated use of water in the United States in 2005: data by county. Web page. Available online at http://water.usgs.gov/watuse/data/2005/index.html. Accessed June 2010.

Verry, E., J. Lewis, and K. Brooks. 1983. Aspen clearcutting increases snowmelt and storm flow peaks in north central Minnesota. *Water Resources Bulletin* 19(1):59–67.

Williams, B.W., J.H. Gilbert, and P.A. Zollner. 2007. *Historical perspective on the reintroduction of the fisher and American marten in Wisconsin and Michigan.* U.S. Forest Service, General Technical Report NRS-5, Newton Square, Pennsylvania.

Wisconsin Commercial Ports Association (WCPA). 2010. Wisconsin ports. Web page. Available online at http://www.wcpaports.org/ports. Accessed December 2010.

Wisconsin Department of Administration (WDOA). 2000. Wisconsin roads 2000 TIGER line files (dataset). Wisconsin Department of Administration, Office of Land Information Services, Madison.

Wisconsin Department of Administration (WDOA). 2006. *Wisconsin energy statistics, 2006.* Wisconsin Department of Administration, Division of Energy, Madison. 150 pp. Available online at http://www.doa.state.wi.us/, keywords "energy statistics."

Wisconsin Department of Agriculture (WDA). 1930–1947. *Wisconsin Land Economic Inventory.* Available online at University of Wisconsin Digital Collections, http://uwdc.library.wisc.edu/collections/EcoNatRes/WILandInv.

Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP), University of Wisconsin-Madison, U.S. Department of Agriculture Animal and Plant Health Inspection Service, Wisconsin Department of Natural Resources, University of Wisconsin Extension, and U.S. Forest Service. 2013. Wisconsin's emerald ash borer information source. Website. Available online at https://datcpservices.wisconsin.gov/eab/index.jsp.

Wisconsin Department of Natural Resources (WDNR). 1993. Wisconsin landcover data (WISCLAND). Available online at http://dnr.wi.gov/, keyword "WISCLAND." Accessed December 2009.

Wisconsin Department of Natural Resources (WDNR). 1995. *Wisconsin's forestry best management practices for water quality field manual*. Wisconsin Department of Natural Resources, PUB-FR-093, Madison.

Wisconsin Department of Natural Resources (WDNR). 1997. *Wisconsin's Lake Superior coastal wetlands evaluation, including other selected features of the Lake Superior basin.* Wisconsin Department of Natural Resources, PUB-ER-095 99, Madison.

Wisconsin Department of Natural Resources (WDNR). 1999. *Wisconsin wolf management plan.* Wisconsin Department of Natural Resources, PUBL-ER-099 99, Madison. Available online at http://dnr.wi.gov, keywords "wolf publications." Accessed April 2009.

Wisconsin Department of Natural Resources (WDNR). 2003. *Wisconsin forest management guidelines.* Wisconsin Department of Natural Resources, PUB-FR-226, Madison.

Wisconsin Department of Natural Resources (WDNR). 2005a. *Beaver damage control: guidelines for people with beaver damage problems.* Wisconsin Department of Natural Resources, PUBL WM-007-05 REV, Madison.

Wisconsin Department of Natural Resources (WDNR). 2005b. Lake Superior coastal wetlands – Fish Creek Slough. Available online at http://dnr.wi.gov, keywords "Lake Superior coastal wetlands." Accessed April 23, 2009.

Wisconsin Department of Natural Resources (WDNR). 2005c. Wisconsin DNR managed lands – "dissolved" version. Wisconsin Department of Natural Resources, Madison. See Wisconsin DNR managed lands web mapping application for current database, available at http://dnr.wi.gov/, keywords "managed lands web mapping application."

Wisconsin Department of Natural Resources (WDNR). 2005d. *Wisconsin's strategy for wildlife species of greatest conservation need.* Wisconsin Department of Natural Resources, Wildlife Action Plan, PUB-ER-641 2005, Madison. Available at http://dnr.wi.gov/, keywords "wildlife action plan."

Wisconsin Department of Natural Resources (WDNR). 2006a. *Old-growth and old forests handbook*. Wisconsin Department of Natural Resources Handbook 2480.5, Madison.

Wisconsin Department of Natural Resources (WDNR). 2006b. *The 2005-2010 Wisconsin statewide comprehensive outdoor recreation plan.* Wisconsin Department of Natural Resources PUB-PR-026-2006, Madison.

Wisconsin Department of Natural Resources (WDNR). 2006c. *Wisconsin land legacy report: an inventory of places to meet conservation and recreation needs.* Wisconsin Department of Natural Resources, PUB-LF-040-2006, Madison.

Wisconsin Department of Natural Resources (WDNR). 2007. *Managing woodlands on Lake Superior's red clay plain.* Wisconsin Department of Natural Resources, PUB-FR-385 2007, Madison.

Wisconsin Department of Natural Resources (WDNR). 2008a. Managed forest law stumpage rates. These data are available by request from the forest tax program, Wisconsin Department of Natural Resources, Madison.

Wisconsin Department of Natural Resources (WDNR). 2008b. *Wisconsin's Wildlife Action Plan (2005–2015). Implementation: Priority Conservation Actions and Conservation Opportunity Areas.* Wisconsin Department of Natural Resources, Madison. Available online at http://dnr.wi.gov/,

keywords "wildlife action plan." Accessed October 2008.
Wisconsin Department of Natural Resources (WDNR). 2009. *Wisconsin Natural Heritage Working List*. April 2009. Wisconsin Department of Natural Resources, Bureau of Endangered Resources, Madison. Accessed March 11, 2010. Current Working List available online at http://dnr.wi.gov/, keyword "NHI." (*Note: The Wisconsin Natural Heritage Working List is dynamic and updated periodically as new information is available. The April 2009 Working List was used for this book. Those with questions regarding species or natural communities on the Working List should contact Julie Bleser, Natural Heritage Inventory Data Manager, Bureau of Natural Heritage Conservation, Wisconsin DNR at (608) 266-7308 or julie.bleser@wisconsin.gov.*)
Wisconsin Department of Natural Resources (WDNR). 2010a. Wisconsin's impaired waters list. Available online at http://dnr.wi.gov, keywords "impaired waters." Accessed April 2010.
Wisconsin Department of Natural Resources (WDNR). 2010b. Wisconsin wetland inventory. Available online at http://dnr.wi.gov/, keywords "wetland inventory." Accessed September 2010.
Wisconsin Department of Natural Resources (WDNR). 2012. Outstanding and Exceptional Resource Waters. Web page. Available online at http://dnr.wi.gov, keywords "ORW/ERW." Accessed January 2012.
Wisconsin Department of Natural Resources (WDNR). 2015a. Forest health. Web page. Available online at http://dnr.wi.gov, keywords "forest health."
Wisconsin Department of Natural Resources (WDNR). 2015b. Hydrography Geodatabase. Web page. Available online at http://dnr.wi.gov/, keywords "hydrography geodatabase."
Wisconsin Department of Natural Resources (WDNR). 2015c. Invasive species. Web page. Available online at http://dnr.wi.gov/, keywords "invasive species."
Wisconsin Department of Natural Resources (WDNR). 2015d. State Natural Areas Program. Web page. Available online at http://dnr.wi.gov/, keywords "state natural areas."
Wisconsin Department of Natural Resources (WDNR). 2015e. *Wisconsin beaver management plan 2015–2025.* Wisconsin Department of Natural Resources, PUB WM-610 2015, Madison.
Wisconsin Department of Natural Resources (WDNR) and U.S. Fish and Wildlife Service (USFWS). 2005. *Wisconsin Lake Superior basin brook trout plan: a joint plan between Wisconsin Department of Natural Resources and U.S. Fish and Wildlife Service.* Wisconsin Department of Natural Resources, Madison.
Wisconsin Department of Transportation (WDOT). 1998. 1:100,000-scale Rails Chain Database. Wisconsin Department of Transportation, Bureau of Planning, Madison.
Wisconsin Department of Transportation (WDOT). 2010. Wisconsin airport directory 2009–2010. Available online at http://wisconsindot.gov/Pages/home.aspx, keywords "airport directory." Accessed December 2010.
Wisconsin Geological and Natural History Survey (WGNHS). 2006. *Bedrock stratigraphic units in Wisconsin.* Wisconsin Geological and Natural History Survey, Open-File Report 2006-06, Madison.
Wisconsin Landtype Associations (WLTA) Project Team. 2002. *Landtype Associations of Wisconsin.* Map. Wisconsin Department of Natural Resources, Madison.
Wisconsin State Climatology Office (WSCO). 2011. Climate summaries by location. Retrieved April 29, 2011, from http://www.aos.wisc.edu/~sco/, "past Wisconsin climate" tab to "daily data from National Weather Service reporting stations."
Wisconsin Wind Information Center (WWIC). 2013. Existing Wisconsin wind farms: commercial wind energy installations in Wisconsin 1998–2013. Web page. Available online at http://www.wiwindinfo.net/projects/.
Worland, M., K. Martin, and L. Gregg. 2009. Spruce grouse distribution and habitat relationships in Wisconsin. *The Passenger Pigeon* 71(1):5–18.

Additional References

Bohlen, P.J., D.M. Pelletier, P.M. Groffman, T.J. Fahey, and M.C. Fisk. 2004. Influence of earthworm invasion on redistribution and retention of soil carbon and nitrogen in northern temperate forests. *Ecosystems* 7:13–27.
ESA Success. 2009. Longjaw cisco (*Coregonus alpenae*). Web page. Available at http://esasuccess.net/reports/northeast/ne_species/longjaw-cicso.html.
Fisk, M.C., T.J. Fahey, P.M. Groffman, and P.J. Bohlen. 2004. Earthworm invasion, fine-root distributions, and soil respiration in north temperate forests. *Ecosystems* 7:55-62.
Fitzpatrick, F., and J. Knox. 2000. Spatial and temporal sensitivity of hydrogeomorphic response and recovery to deforestation, agriculture, and floods. *Physical Geography* 21:89-108.
Gorman, O.T., and T.N. Todd. 2007. History of the shortjaw cisco (*Coregonus zenithicus*) in Lake Superior, 1895–2003. Pages 433-458 *in* M. Jankun, P. Brzuzan, P. Hliwa, and M. Luczynski, editors. *Biology and Management of Coregonid Fishes–2005: Proceedings of the Ninth International Symposium on the Biology and Management of Coregonid Fishes,* Olstyn, Poland, August 2005. *Advances in Limnology* 60, Contribution #1399. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, Germany.
Gundale, M.J. 2002. Influence of exotic earthworms on the soil organic horizon and the rare fern *Botrychium mormo*. *Conservation Biology* 16(6):1555–61.
Hale, C.M., L.E. Frelich, and P.B. Reich. 2005. Exotic European earthworm invasion dynamics in northern hardwood forests of Minnesota, USA. *Ecological Applications* 15:848–860.
Hendrix, P.F., and P.J. Bohlen. 2002. Exotic earthworm invasions in North America: ecological and policy implications. *Bioscience* 52:801–811.
Hoff, M.H., and T.N. Todd. 2004. Status of the shortjaw cisco (*Coregonus zenithicus*) in Lake Superior. *Annales Zoologici Fennici* 41:147–154.
Kourtev, P.S., W.Z. Huang, and J.G. Ehrenfeld. 1999. Differences in earthworm densities and nitrogen dynamics in soils under exotic and native plant species. *Biological Invasions* 1:237–245.
Lake Superior Bi-National Program. 2006. The Lake Superior decision support project – Important habitat sites and areas in the Lake Superior Basin 2006. Web page. Available online at http://www.nrri.umn.edu/lsgis/importanthabitat.htm. Accessed April 23, 2009.
Larson, N., and K. Plass. 2003. Restoring lake trout in Lake Superior: success, with a caveat. *Wisconsin Natural Resources* April 2003. Available online at http://dnr.wi.gov/wnrmag/html/supps/2003/apr03/trout.htm. Accessed April 23, 2009.
Luyssaert S., E. Detlef Schulze, A. Börner, A. Knohl, D. Hessenmöller, B. E. Law, P. Ciais, and J. Grace. 2008. Old-growth forests as carbon sinks. *Nature* 455:213–215.
Mattes, B. 2009. Indicators show gichigami warming. Great Lakes Indian Fish and Wildlife Commission newsletter, *Mazina'igan – a chronicle of the Lake Superior Ojibwe*. Spring 2009.
Minnesota Sea Grant. 2008. Superior pursuit: facts about the greatest Great Lake. Web page. Available online at http://www.seagrant.umn.edu/superior/facts. Accessed April 10, 2009.
Krumenaker, B. 2008. Not-so-early worries about climate change: adapting to climate change around Lake Superior. National Park Service, climate change presentation. Available online at http://www.seagrant.umn.edu/climate/intel.
Mortsch, L. 2008. From global to local: climate change in the Lake Superior basin. Environment Canada, climate change presentation. Available online at http://www.seagrant.umn.edu/climate/intel.
National Oceanic and Atmospheric Administration (NOAA) – National Center for Research on Aquatic Invasive Species. 2009. Great Lakes aquatic nonindigenous species list. Available online at http://nas.er.usgs.gov/queries/greatlakes/Search.aspx. Accessed March 30, 2009.
Nekola, J. 1998. Butterfly (Lepidotera: Lyceniidae, Nymphalidae, and Satyridae) faunas of three peatland habitat types in the Lake Superior drainage basin of Wisconsin. *Great Lakes Entomologist* 31:27–37.
Newman, L.E., R. Dubois, and T.N. Halpern, editors. 2003. *A brook trout rehabilitation plan for Lake Superior.* Great Lakes Fishery Commission Miscellaneous Publication 2003-03, Ann Arbor, Michigan.
Robinson, P., and R. Shepard. 2007. *An assessment of Wisconsin's Great Lakes freshwater estuary: applied research, management, and outreach needs.* University of Wisconsin-Extension, Green Bay.
Roe, L.A., 1991. *A history of Wisconsin mining.* Rocco, Madison, Wisconsin.

Rolley, R. 2007. *Wildlife reports: white-tailed deer population status 2012*. Wisconsin Department of Natural Resources, Madison. Available online at http://dnr.wi.gov/, keywords "wildlife reports."

Pratt, D., and B. Blust. 2005. Little streams feed a big fishery. *Wisconsin Natural Resources* December 2005.

Simon, T.P., and P.M. Stewart, editors. *Coastal wetlands of the Laurentian Great Lakes: health, habitat, and indicators*. Author-House, Bloomington, Indiana.

Suarez, E.R., D.M. Pelletier, T.J. Fahey, P.M. Groffman, P.J. Bohlen, and M.C. Fisk. 2004. Effects of exotic earthworms on soil phosphorous cycling in two broadleaf temperate forests. *Ecosystems* 7:28-44.

U.S. Department of Agriculture. 2013. *Summary report: 2010 national resources inventory*. Natural Resources Conservation Service, Washington, D.C. and Center for Statistics and Metholodology, Iowa State University, Ames, Iowa. Available online at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167354.pdf.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2013. Rapid watershed assessment: Bad-Montreal River. Available online at http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/dma/rwa/.

U.S. Environmental Protection Agency. 2012. Lake Superior lakewide management plan (LaMP): annual report 2012. Lake Superior binational program web page. Available online at http://www.epa.gov/greatlakes/lakesuperior/index.html.

University of Wisconsin Sea Grant Institute. 2013. Fish of the Great Lakes. Website. Available online at http://www.seagrant.wisc.edu/home/Topics/FishandFisheries.aspx.

Wiegmann, S.M., and D.M. Waller. 2006. Fifty years of change in northern upland forest understories: identity and traits of "winner" and "loser" plant species. *Biological Conservation* 129:109–123.

Wisconsin Department of Natural Resources. 1999. *Northern state forest assessment: regional ecology*. Wisconsin Department of Natural Resources PUB-FR-135 99, Madison.

Wisconsin Department of Natural Resources. 2005. *Wisconsin lakes*. Wisconsin Department of Natural Resources, PUB-FM-800, Madison.

Wisconsin Department of Natural Resources. 2007. *Progress report of wolf population monitoring in Wisconsin for the period October 2006-March 2007*. Wisconsin Department of Natural Resources, Madison.

Wisconsin Department of Natural Resources. 2008. The Lake Superior basin: watersheds and basins. Web page. Available online at http://dnr.wi.gov/, keywords "watershed and basins."

Wisconsin Department of Natural Resources. 2010. *Lake Superior basin: regional assessment and report compendium*. Wisconsin Department of Natural Resources, PUB-FR-470-2010, Madison.

Acknowledgments

John Lyons provided much needed expertise and advice on fish and aquatic ecology and provided technical review of the aquatic sections.

Julie Bleser interpreted Natural Heritage Inventory data, provided tables of endangered, threatened, and special concern species, and made distribution maps of rare species and natural community occurrences.

Peter David (Great Lakes Indian Fish and Wildlife Commission) provided data on wild rice lakes in the Ceded Territories as well as many useful comments.

David Hvizdak, Massachusetts state soil scientist, formerly Natural Resources Conservation Service Major Land Resource Areas project coordinator in northwest Wisconsin, provided information on soils and glacial geology.

Dr. James B. Stoltman (UW-Madison Emeritus Professor of Archeology) provided invaluable information, advice, and consultation on the American Indian history text.

Yoyi Steele provided the shapefiles for Important Bird Areas.

Mitch Moline, Kate Barrett, Bill Shockley, Nina Janicki, Sally Dahir, Kathy Hanson, Elizabeth Spencer, and Jennifer Skoloda performed GIS analyses, prepared maps, and provided other background materials.

Sarah Herrick and Jescie Kitchell provided editorial assistance and compiled data and other needed materials for this document.

Technical review was provided by Joan Elias (National Park Service), Julie Van Stappen (National Park Service), Dennis Pratt (Wisconsin DNR-Fisheries), Bill Blust (Wisconsin DNR-Fisheries), Fred Strand (Wisconsin DNR-Wildlife Management), Sumner Matteson (Wisconsin DNR-Natural Heritage Conservation), Craig Lorimer (UW-Madison), Mike Seider (Wisconsin DNR-Fisheries), John DuPlissis (UW-Stevens Point), Andy Paulios (Wisconsin DNR-Wildlife Management), Bob DuBois (Wisconsin DNR-Natural Heritage Conservation), Jay Gallagher (Wisconsin DNR-Forestry), and John Lyons (Wisconsin DNR-Science Services).

Detailed discussions on various topics covered by this book, including some that were pertinent to this chapter, were provided by Andy Paulios, Mike Mossman, Bill (William A.) Smith, Sumner Matteson, Tom Bernthal, Pat Trochlell, Matt Dallman, Mike Grimm, Pat Robinson, and Randy Hoffman.

Sarah Hurley, Signe Holtz, Darrell Zastrow, Paul DeLong, Laurie Osterndorf, Mark Aquino, Jack Sullivan, Karl Martin, and Steve Miller provided important administrative support for the project.

Funding

Funding for this project and publication of this report was provided by the Wisconsin Department of Natural Resources Divisions of Forestry, Lands, and Enforcement and Science; by grants from the Wisconsin Wildlife Action Plan Fund; and in part by funds from the Federal Aid to Wildlife Restoration Act under Pittman-Robertson Project W-160-P.

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Credits

Publication assistance was provided by Dreux Watermolen. Patricia Duyfhuizen provided the edit, organizational advice, graphic design, and technical layout as well as many helpful editing suggestions. Michelle Voss developed the graphs and provided assistance with other figures. Andy Stoltman, Wisconsin DNR-Forestry, produced the maps and prepared other cartographic presentations found in this publication.

Sources of photographs include the following: Jack Bartholmai; Ryan Brady, Wisconsin DNR; Brian Collins; Donna Dewhurst; Eric Epstein, Wisconsin DNR; Mike Hendrickson, courtesy of the Bayfield Chamber of Commerce and Visitor Bureau; Emmet Judziewicz; Ronald Laubenstein, U.S. Fish and Wildlife Service; Dave Menke, U.S. Fish and Wildlife Service; Mike Mossman, Wisconsin DNR; Thomas Meyer, Wisconsin DNR; Northern Great Lakes Visitor Center staff; Dennis Paulson; Charles and Diane Pierce; Daniel Spuhler; Wisconsin DNR staff.

Sources of illustrations include the following: Wisconsin Society for Ornithology and Wisconsin Department of Natural Resources.

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Wisconsin Department of Natural Resources
P.O. Box 7921, Madison, WI 53707

PUB-SS-1131W 2015