Chapter 19
Southern Lake Michigan Coastal Ecological Landscape

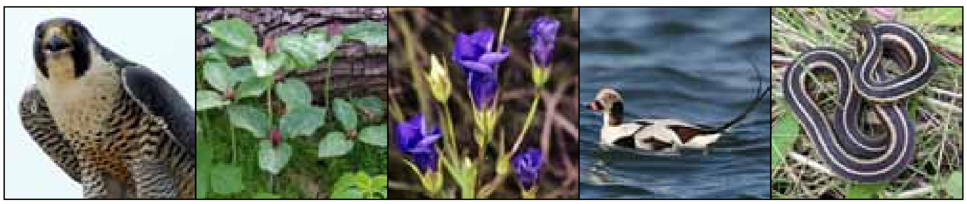




Where to Find the Publication

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): Peregrine Falcon, photo by Laura Erickson; reflexed trillium, photo by Thomas Meyer, Wisconsin DNR; Lesser-fringed gentian, photo by Thomas Meyer, Wisconsin DNR; Long-tailed Duck, photo by Wolfgang Wander; Butler's gartersnake, photo by Rori Paloski, Wisconsin DNR.

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Cover Photos

Top left: *Chiwaukee Prairie occurs on swell-and-swale topography near Lake Michigan in southeastern Kenosha County. This site supports an exceptionally high diversity of native grassland species, many of them now very rare. The dominant flowering forb in this photo, taken in spring, is eastern shooting star* (Dodecatheon meadia). *Photo by Thomas Meyer, Wisconsin DNR.*

Bottom left: *The Wisconsin Endangered smooth phlox is restricted in Wisconsin to just a few deep-soil, tallgrass prairie remnants. Kenosha County. Photo by Thomas Meyer, Wisconsin DNR.*

Top right: *The Peregrine Falcon, formerly extirpated in Wisconsin, has been successfully reintroduced to portions of its former range, including the City of Milwaukee. Photo by Laura Erickson.*

Center right: *Mesic hardwood forest composed of maples, oaks, and American beech. Habitat fragmentation is severe in southeastern Wisconsin; all remnants are small and usually isolated. Southern Milwaukee County. Photo by Emmet Judziewicz.*

Bottom right: *Remnant Oak Opening within extensive coastal prairie. Kenosha County. Photo by William E. Tans.*

Thomas Meyer, WDNR

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Size
This ecological landscape encompasses 843 square miles (539,830 acres), which is 1.5% of the area of the state.

Climate
The climate is moderated by Lake Michigan. The mean growing season is 169 days, and mean annual temperature is 47.2°F, the longest and warmest of any ecological landscape in the state. The mean annual precipitation is 34 inches, the second largest amount of precipitation among ecological landscapes. The mean annual snowfall is 41.9 inches, similar to other southern ecological landscapes. Lake effect snows occur in areas adjacent to Lake Michigan. The climate (temperature, growing degree days, and precipitation) is suitable for agricultural row crops, small grains, and pastures, which are prevalent land uses in the nonurbanized parts of this ecological landscape.

Bedrock
The bedrock that underlies this ecological landscapeis predominately Silurian dolomite, generally covered by deposits of glacial drift from 50 to over 100 feet in depth.

Geology and Landforms
Inland the primary landform is level to gently rolling ground moraine. Near Lake Michigan, landforms include subdued ridge-and-swale topography, beach and dune complexes, and wave-cut clay bluffs. The river mouths within large cities have all been heavily modified and many of their characteristic natural features destroyed.

Soils
In the uplands, soils are primarily moderately well-drained brown calcareous silty clay loam till. In the lowlands, soils are primarily very poorly drained non-acid mucks or silty and clayey lacustrine types.

Hydrology/Aquatic Features
Lake Michigan is the dominant aquatic feature. In the Southern Lake Michigan Coastal Ecological Landscape, there are 26 named lakes (>5,000 total acres) and around 1,500 unnamed lakes (most of these are very small, as these waterbodies total only around 1,800 acres). Important rivers include the Milwaukee, Menomonee, Kinnickinnic, Root, Des Plaines, (Southeast) Fox, and Pike. Four percent of the ecological landscape cover is open wetland.

Current Land Cover
This is the most urbanized ecological landscape in the state. WISCLAND data from 1992 indicate primarily agricultural (39%) and urban (24%) land uses and 16% grassland and 12% upland and lowland forest.

Socioeconomic Conditions

The counties included in this socioeconomic region are Kenosha, Milwaukee, and Racine.

Population
The population was 1,309,569 in 2010, 23% of the total state population.

Population Density
1,548 persons per square mile

Per Capita Income
$27,837

Important Economic Sectors
The largest employment sectors in 2007 were the service-based sectors (education services, administration and support services, health care and social services, transportation, and arts, entertainment, and recreation) and some resource based sectors (manufacturing, utilities, agriculture, and secondary wood products). Federal, state, county, and town governments all have offices in this ecological landscape. Agriculture and urbanization are having the largest impacts on the natural resources here.

Public Ownership
Public ownership is very low, encompassing only 1.1% of the ecological landscape. State-owned lands include Bong

Recreation Area, Chiwaukee Prairie State Natural Area (in part), several state wildlife areas and other state natural areas. Milwaukee County has an extensive park system, and small amounts of county-owned land occur in Racine and Kenosha counties. University of Wisconsin-Parkside has stewardship responsibilities for several tracts in Kenosha County. A map showing public land ownership (county, state, and federal) and private lands enrolled in the forest tax programs can be found in Appendix 19.K at the end of this chapter.

Other Notable Ownerships

Several designated state natural areas, such as Silver Lake Bog in Kenosha County and Seminary Woods in Milwaukee County, remain in private ownership. The Wisconsin Chapter of the Nature Conservancy is active at Chiwaukee Prairie in Kenosha County and at several other sites in the Southern Lake Michigan Coastal Ecological Landscape.

Considerations for Planning and Management

This is the most highly populated and heavily developed ecological landscape in the state. It has long been a hub of transportation, heavy industry, and commerce as well as a productive agricultural area, resulting in pervasive and long-term impacts to the land and water. Natural systems are severely fragmented and often highly disturbed by widespread and intensive agricultural, industrial, and residential development. Ongoing development may increase land values, taxes, and costs of public services. All of the formerly extensive plant community groups—forests, savannas, prairies, and wetlands—have been greatly reduced from their historical abundance. Most natural community remnants are small, isolated, and often degraded, occurring within a context of lands and waters that are now dedicated to supporting residential, industrial, and agricultural uses. Invasive species are a major problem here, more so than in other ecological landscapes. Wetland and aquatic ecosystems have been significantly altered, diminished or degraded, often leading to serious water management issues that are difficult and expensive to fix. Despite all of the development that has occurred, this ecological landscape still supports rare and declining species and communities that occur at few other locations. A 1990s critical features inventory planned and conducted by the Southeast Wisconsin Regional Planning Commission (SEWRPC) and Wisconsin DNR identified more than 18,000 acres of high quality remnant natural communities and critical species habitats throughout a seven-county SEWRPC area, which includes the entire Southern Lake Michigan Coastal Ecological Landscape. Several counties have extensive systems of parklands and green spaces, and conservation-oriented groups dedicated to a wide array of interests, including land stewardship, are well established and active. Stream restoration has attracted great local support. There may be significant opportunities to revegetate areas, especially brownfields, not necessarily as restoration sites for natural communities but to serve as surrogate habitats for wildlife. Urban forestry is important here and could represent and enhance ecological as well as socioeconomic opportunities.

Management Opportunities

The Southern Lake Michigan Coastal Ecological Landscape is the most highly populated and heavily developed ecological landscape in Wisconsin. Most ecosystems here are severely fragmented and disturbed by widespread and intensive agricultural, industrial, and residential development. Nevertheless, this ecological landscape provides some significant management opportunities.

Millions of citizens depend on Lake Michigan for a wide array of ecosystem services, economic uses, and social amenities. The lake, its shoreline habitats, and its nearshore waters support a unique complex of natural features that are of especially high significance to migratory birds and fish. Management and protection of Lake Michigan and its surroundings is both ecologically and economically important.

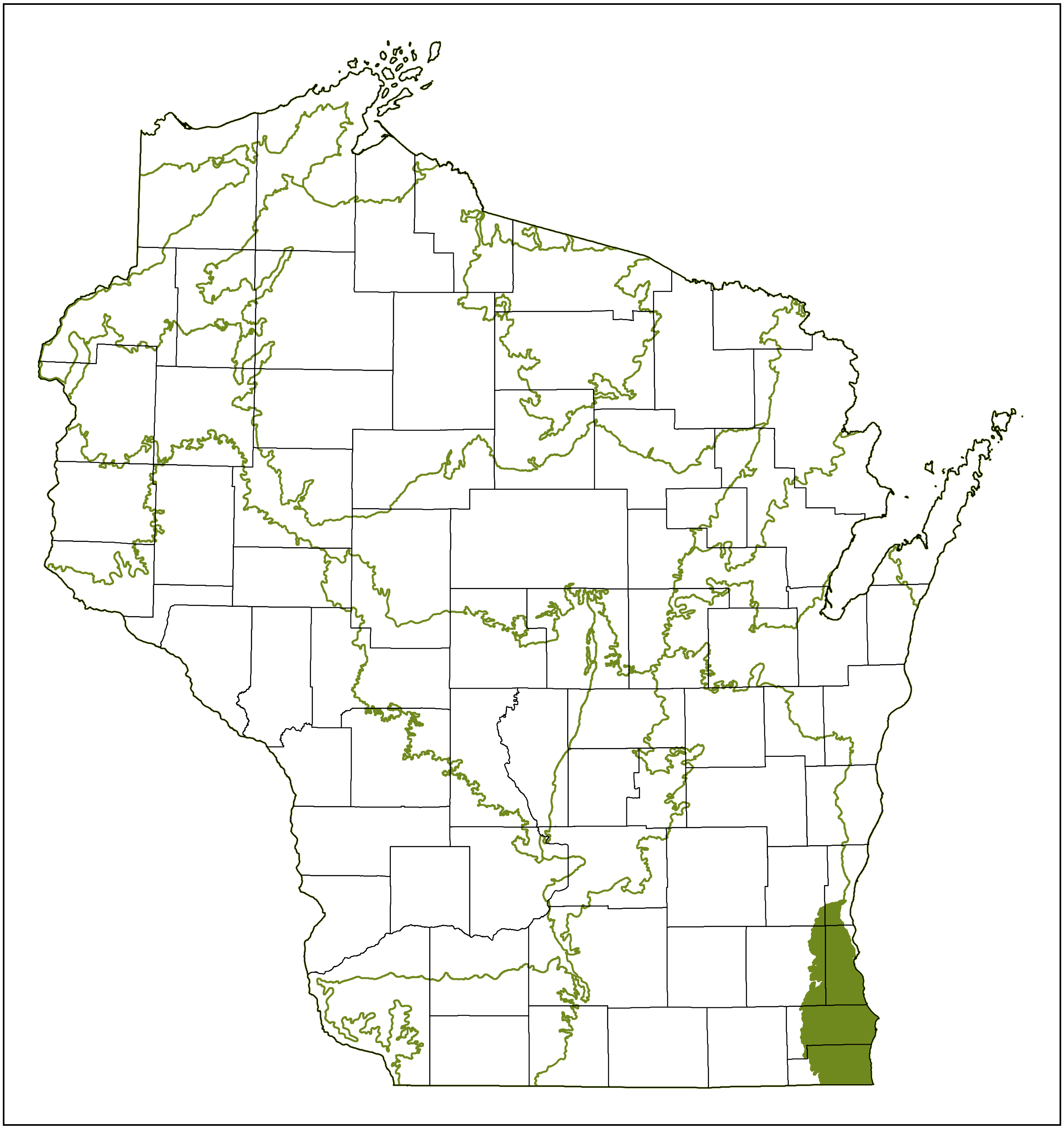
Great Lakes coastal prairies, a rarity in Wisconsin and across the Great Lakes region, are now restricted to a single location in the extreme southeastern corner of the state. Chiwaukee Prairie is one of the Upper Midwest's premier coastal wetland complexes featuring prairies. It is the only Wisconsin example of a Great Lakes-influenced coastal wetland composed mostly of tallgrass prairie and fen, and it includes one of Wisconsin's largest and most diverse occurrences of Wet-mesic Prairie. The site is globally significant and harbors numerous rare species, including plants, invertebrates, birds, and mammals. It is adjacent to other significant conservation lands just to the south at Illinois Beach State Park in northern Illinois. This and several other areas in the southeastern corner of the ecological landscape offer good opportunities for continued protection and management.

Large surrogate grasslands with embedded prairie, sedge meadow, and marsh community remnants at sites such as Bong State Recreation Area are important ecologically and for recreation. There may be opportunities to manage agricultural lands adjoining these areas in ways that would increase the amount of suitable habitat for area-sensitive grassland animals while buffering remnant prairie, meadow, marsh, forest, or other native vegetation from incompatible land uses.

Restoration and management of major river and stream corridors is a major ecological and socioeconomic priority, including the protection and restoration of their hydrological function and riparian corridors. Important rivers and streams here include the Milwaukee, Menomonee, Kinnickinnic, Des Plaines, and Root. Inland lakes, despite their generally developed condition, widespread water quality problems, and significant habitat losses, continue to support native fish, amphibians, reptiles, and invertebrates. Many birds and a few mammals are also strongly associated with and, in some cases, dependent on these lakes.

Natural communities in this ecological landscape often occur as small, scattered, isolated patches. Wherever possible, the least disturbed and most intact remnants should be embedded within larger management units or corridors of natural cover or green space.

Significant portions of the Southern Lake Michigan Coastal Ecological Landscape are now dominated by urban-industrial or other residential developments. Use of green infrastructure concepts can help improve the area's residential appeal, lessen the urban "heat sink" effect, and contribute to water infiltration, wildlife habitat, and other ecological benefits. Urban forestry may also help sequester carbon and improve human habitats in many other ways. Educational institutions situated here could inform the public locally and statewide about the societal values of ecosystem services, with a focus on opportunities associated with Lake Michigan.



Southern Lake Michigan Coastal Ecological Landscape

Thomas Meyer, WDNR

Southern Lake Michigan Coastal Ecological Landscape

Introduction

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

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

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

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

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

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

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

consideration for land and water managers, especially when Wisconsin supports a large proportion of a species' regional or global population or if a species is socially important. Our hope is that the book 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. "Southern Lake Michigan Coastal 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."

General Description and Overview

The Southern Lake Michigan Coastal Ecological Landscape is located in the southeastern corner of Wisconsin along Lake Michigan. Landforms along Lake Michigan are characteristic of those associated with and produced by past glacial lakes, such as lake dunes and beaches, ridge-and-swale topography, wave cut clay bluffs, and level lake plains. Further inland, gently undulating ground moraine is the dominant landform. Soils typically have a silt-loam surface overlying loamy and clayey tills.

The land surface of the northern and eastern parts of the ecological landscape is now heavily dominated by urban, industrial, and agricultural developments, which have resulted in clearing of forests, conversion of prairie and savannas to croplands, extensive drainage and filling of wetlands, construction of an extensive grid of railways, roads, and utility corridors, and grading to enable various types of construction. The percentage of impermeable surfaces (which include concrete, asphalt, and structures) is 16.5%, which is the highest of any ecological landscape in the state. Not much of the natural landscape remains here. In the southern and western parts of the ecological landscape, developed areas are interspersed with agricultural lands. There is a great emphasis on urban forestry, due to the large proportion of urban and suburban areas in the cities of Milwaukee, Racine, and Kenosha. Only 1.1% of the land area is in public ownership.

Lake Michigan is overwhelmingly the dominant aquatic feature here. The lake and its associated shoreline features provide essential support for a wide range of aquatic and upland species. Most of the rivers and streams have been altered and affected by historical and ongoing human activities. Channelization, dam construction, excessive inputs of sediments, nutrients, and pollutants, and loss of adjoining wetlands, have all contributed to the physical and biological degradation of surface waters. There are only 26 named inland lakes, which total over 5,000 acres, but there are nearly 1,500 unnamed lakes, totaling only about 1,800 acres. The vast majority of these small lakes are shallow ponds.

Historical vegetation in the northern and eastern parts of the Southern Lake Michigan Coastal Ecological Landscape was mostly forest, composed of sugar maple-basswood-beech or oaks (*Quercus* spp.). The southern and western parts were vegetated more extensively by fire-driven ecosystems such as oak forest, oak savanna, and prairie. In the southeastern corner of the ecological landscape along Lake Michigan, a ***mosaic*** of native prairie, meadow, marsh, fen, and dunes was associated with and partially maintained by post-glacial dynamics that created unusual landforms and topography. The largest remnant of these historical grasslands is Chiwaukee Prairie.

Most of the natural communities remaining here are small, isolated, and at least somewhat degraded. WISCLAND land use/land cover data from 1992 indicate that 39% of the land area was agricultural, 16% grassland (mostly pasture or urban green space—not native prairie), 24% urban, 12% forested (10% upland forest and 2% lowland forest), and 4% open wetland (WDNR 1993). Due in part to the scale, extent, and types of human development and disturbance now prevalent here, there are many nonnative invasive species that are a major problem in this ecological landscape. However, there are places that are still of high ecological significance that support rare and relatively undisturbed natural communities and rare species and constitute important reservoirs of native biodiversity.

The Southern Lake Michigan Coastal counties are highly urbanized and stand out from other parts of the state in several socioeconomic indicators, especially population attributes and income. Compared with other county approximations of ecological landscapes in the state, this one has the highest population density (1,548 persons per square mile), much higher than that of the state as a whole (105 persons per square mile). Note, however, that the percentage of the state population in these counties has declined since 1970. These counties have the highest percentage of people who are less than 18 years of age and the second lowest median age. The population of minorities, especially African American and Hispanic, is higher here than elsewhere in the state. Economically, the Southern Lake Michigan Coastal counties have an average wage that is the highest in the state, and the per capita income slightly lower than the statewide average. However, poverty rates, especially for children, are quite high.

Almost a quarter of the people in the state live here, and almost 20% of the jobs in the state are here. The economy has changed from a strong manufacturing base to one that is now service based. Although natural resources are used for some economic activities (e.g., agriculture, forestry), they are less important as an economic base here than in other parts of the state (with the notable exceptions of urban-industrial use of Lake Michigan waters, and water-based recreational activities along Lake Michigan). Major socioeconomic activities are the service-based sectors, some resource-based sectors, education services, and land use planning. Five of the 11 largest water technology companies in the world (e.g., manufacture of water meters, water heaters, sewage treatment equipment) have significant operations in the Milwaukee area.

Farmland in the Southern Lake Michigan Coastal counties has the highest market value per acre compared with the rest of the state, and the amount of farmland is decreasing rapidly. These counties have the highest percentage of farmland sold and diverted to other uses, primarily to residential development. Agricultural production on the remaining farms is high. As with agricultural lands, a fairly high percentage of forested land (though only 12% of the Southern Lake Michigan Coastal Ecological Landscape is forested) is sold and diverted to other uses each year. The counties have small acreages in inland water bodies, and the number of fishery and wildlife areas is second lowest of any ecological landscape in the state. Per capita water use figures are very high due to the high water usage by electrical generating plants.

Environment and Ecology

Physical Environment

Size

The Southern Lake Michigan Coastal Ecological Landscape encompasses 843 square miles (539,830 acres), representing 1.5% of the area of the state of Wisconsin.

Climate

Climate data were analyzed from seven weather stations within the ecological landscape (Union Grove, Germantown, Kenosha, Milwaukee Mitchell Field, Milwaukee Mount Mary College, Racine, and West Allis; WSCO 2011). The Southern Lake Michigan Coastal Ecological Landscape has a continental climate, with cold winters and warm summers, similar to other southern ecological landscapes (Central Lake Michigan Coastal, Central Sand Plains, Central Sand Hills, Southeast Glacial Plains, Southwest Savanna, Western Coulees and Ridges, and Western Prairie). The southern ecological landscapes in Wisconsin generally tend to have longer growing seasons, warmer summers, warmer winters, and more precipitation than the ecological landscapes farther north. Ecological landscapes adjacent to the Great Lakes generally tend to have warmer winters, cooler summers, and higher precipitation, especially snow. The climate in this far southeastern part of the state is moderated by its proximity to Lake Michigan, leading to warmer temperatures in the fall and early winter, and slightly cooler temperatures during spring and early summer. During spring and summer, onshore winds may produce local but dramatic cooling effects.

The growing season averages 169 days (base 32°F), ranging from 138 to 187 days. This is the longest growing season of all ecological landscapes in Wisconsin and is one of the factors that make the Southern Lake Michigan Coastal well suited for agriculture. The length of the growing season varies by 49 days among weather stations within the ecological landscape. This large amount of variation is primarily explained by the Germantown weather station which is in the far northern part of the ecological landscape and farther from Lake Michigan. It has 38 fewer growing degree days than the average of other weather stations here.

The annual average temperature is 47.2°F (44.6–48.2°). There is not much variation in temperature among weather stations within the ecological landscape except that Germantown is consistently colder (by 3°F) than the other stations in the ecological landscape. The average January minimum is 8.7°F, the warmest of any ecological landscape in the state. The average August maximum is 80.9°F, similar to other southern ecological landscapes.

Annual precipitation averages 34 inches (32.1–35.4), the second highest of any ecological landscape in the state (the Southwest Savanna has the highest amount of precipitation). There is more than 3 inches variation in precipitation among weather stations within the ecological landscape, with weather stations closer to Lake Michigan receiving the most precipitation. Annual snowfall averages 41.9 inches, ranging from 37.5 inches to 52.6 inches. There is a difference of 15 inches in the amount of snowfall among weather stations. Lake Michigan is likely causing local variation in the amount of snowfall with more snowfall occurring close to the lake. Winds coming off of the warm waters of Lake Michigan meet colder air over land and result in snow. The climate (temperature, growing degree days, and precipitation) is suitable for agricultural row crops, small grains, and pastures, all prevalent in the nonurbanized parts of this ecological landscape.

Bedrock Geology

Bedrock beneath the Southern Lake Michigan Coastal Ecological Landscape is mostly Silurian dolomite of the same type that forms the ***Niagara Escarpment*** to the north. The overlying glacial sediment is thick here, so the Silurian bedrock does not outcrop in bluffs and cliffs as it does in the Central Lake Michigan Coastal. A few places in the ecological landscape are underlain by Ordovician rocks, notably the area near Muskego Lake. Devonian bedrock, the youngest bedrock found anywhere in Wisconsin at 354 to 417 million years old, underlies a small area that includes the northern part of the city of Milwaukee (Evans et al. 2004). In general, bedrock outcroppings are rare here. A few exposures of the Devonian dolomite occur as ledges or low cliffs along the Milwaukee River (Milwaukee County). Silurian dolomites of the Racine Formation outcrop at Wind Point (Racine County) and at a few locations along the Root River, but most bedrock exposures are associated with quarries. (Nomenclature used here is according to the Wisconsin Geological and Natural History Survey Open-File Report *Bedrock Stratigraphic Units in Wisconsin;* WGNHS 2006.)

A long sequence of bedrock formation took place in this area. The oldest and deepest bedrock is Precambrian granite or quartzite, more than a billion years old. Layers of Paleozoic sedimentary rock thicker than 1,500 feet at the eastern edge overlay the Precambrian surface (SEWRPC 1997). The oldest Paleozoic deposit is Cambrian sandstone of the Elk Mound Group, including the Mt. Simon, Eau Claire, and Wonewoc formations. Above this lies the Tunnel City Formation of glauconitic sandstone, a thin layer of St. Lawrence Formation dolomite, and another thin layer of Jordan Formation sandstone (Evans et al. 2004).

Ordovician rocks overlying Cambrian deposits include scattered occurrences of dolomite of the Oneota Formation of the Prairie du Chien Group. The Ancell Group is next in the sequence, overlying the Oneota (or overlying other Cambrian layers, because in some locations the rock layers were eroded down to the Elk Mound Group before the Ancell Group was deposited). The Ancell Group is mostly sandstone of the St.

Peter Formation and can be up to 200 feet thick in places. Sinnipee Group dolomite overlies the Ancell group; it can be up to 260 feet thick where overlain by the Maquoketa Formation of dolomitic shale. The Maquoketa can also be thick up to 200 feet if overlain by Silurian rock (Clayton 2001, Evans et al. 2004).

Silurian dolomite, topmost in the sequence, is up to 330 feet thick in southeast Waukesha County (Clayton 2001). Evans et al. (2004) described the Silurian deposits as consisting of six different formations, including the Kankakee Equivalent (the oldest), Brandon Bridge, Waukesha, Manistique, Racine, and Waubakee. Each of the formations is dominantly dolomite, but there are differences in grain size, mineral content, color, and bedding. The Racine Formation is fossiliferous and well known for its many ancient reefs. The Silurian reefs are found in a ring around the Michigan basin but are most common in the areas between Green Bay and Racin, and south of Chicago into Indiana (Dott and Attig 2004). A number of reef mounds occur in the Milwaukee area where they have been studied since the mid-1800s by naturalists and geologists, including early Wisconsin geologist Increase A. Lapham. The Racine Reef is located offshore in Lake Michigan near the Racine harbor. The Schoonmaker Reef in Wauwatosa, and the Soldier's Home Reef adjacent to Miller Park Stadium in Milwaukee are national historic landmarks. The reefs contain fossils of over 200 different species, predominantly the extinct sponge-like stromatoporids, along with corals and bryozoans (Dott and Attig 2004). Racine Formation dolomite from inter-reef locations has been extensively quarried to produce the attractive "Lannon Stone," popular in southern Wisconsin landscaping.

Devonian rocks underlie a small area, mostly along the Milwaukee River. Devonian deposits include the Lake Church, Thiensville, Milwaukee, and Antrim Shale Formations. They are mostly dolomite and argillaceous dolomite (dolomite that contains clay minerals, also called shaly dolomite). The Antrim Shale Formation is composed of shale (also known as mudstone because it is formed from mud) to very argillaceous dolomite. Fossils can be found locally in all these Formations except the Antrim Shale (Evans et al. 2004).

Landforms and Surficial Geology

The boundary of the Southern Lake Michigan Coastal Ecological Landscape is based on glacial geology; the land surface here was covered by the Lake Michigan Lobe about 14,000 years ago. Only the Southern Lake Michigan Coastal was covered by this advance of the Lake Michigan Lobe (an earlier advance at about 18,000 years ago extended as far west as Darien, in Walworth County, and a later advance at about 13,000 years ago formed the Central Lake Michigan Coastal Ecological Landscape) (Dott and Attig 2004). The Lake Michigan Lobe was large, occupying the basin of Lake Michigan and extending well into what is now Lower Michigan as well as Illinois and Indiana. Near the western boundary of the ecological landscape, the lobe's laterally spreading margin bumped up against the Green Bay Lobe, creating the dramatic topography of the Kettle Moraine, an interlobate moraine described in Chapter 18, "Southeast Glacial Plains Ecological Landscape."

Glacial drift thickness ranges from zero in rock outcrop areas to over 300 feet in buried pre-glacial valleys but is typically 100 to 200 feet thick. Landforms are ground moraine of the Oak Creek Formation, made up of brown silty clay loam till derived from the silts and clays of former lakebeds (Clayton 2001, Dott and Attig 2004). Soils are calcareous because glacial activity mixed limestone fragments into the till as it traveled over bedrock. The ground moraine surface has been described as "nondescript" (Clayton 2001) because of its dominantly low relief, with landforms that are mostly level or gently undulating. A series of small ***recessional moraines***, known as the Lake Border moraines, lie roughly parallel to the lakeshore and have rolling topography (Lasca 1970, Albert 1995, Dott and Attig 2004). These morainal ridges were built during glacial retreat when climatic conditions temporarily cooled and the position of the ice sheet became stable for a time.

Several postglacial lakes existed in this area as the ice sheet retreated. A glacial lake, sometimes known as Lake Chicago, formed in the southern part of the Lake Michigan basin at around 12,800 years ago while the shrinking ice sheet still occupied the northern part of the basin. Lake Chicago shorelines had three stages at different elevations, with the highest level about 55 feet above current lake levels. Its shorelines have been identified in Racine and Kenosha counties (Martin 1965). At about 11,000 years ago, Lake Algonquin occupied the basins of both Lakes Michigan and Huron at water levels about 20 feet higher than the present lakes. The ***Nipissing Great Lakes*** formed about 5,000 years ago when ***crustal rebound*** closed outlets to the north, and water levels again rose to about 20 feet higher than present. Shoreline features of Lake Algonquin are not seen in the Southern Lake Michigan Coastal, likely having been cut away by Nipissing or Lake Michigan waters, but Nipissing shorelines are evident in some places. The shorelines are separated and more visible north of the Southern Lake Michigan Coastal, especially along the Door Peninsula, where crustal rebound raised the Algonquin shorelines before the Nipissing lakes existed (Dott and Attig 2004).

Landforms adjacent to Lake Michigan exhibit glacial lake influence, with ridge-and-swale complexes, remnant beach and lake dune communities, and wave-cut clay bluffs. Most shorelines here are steep bluffs with narrow beaches at the base. Erosion of the clay bluffs continues today, with wave action at the base of the bluff destabilizing the slope so that the clay slumps to the bottom and is carried away by the lake (Martin 1965). This stretch of shoreline is relatively straight and regular, broken only by a few embayments or capes (Wind Point in Racine County is the most notable exception) and trending in a generally north-south direction.

A map showing the ***Landtype Associations*** (WLTA Project Team 2002) in this ecological landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 19.K.

Topography and Elevation

Land surface elevation ranges from 577 to 978 feet (176 to 298 meters) within this ecological landscape. The topography here is subdued, with little relief evident at most locations. The clay bluffs along Lake Michigan exceed 50 feet in height in a few areas (e.g., in southern Milwaukee County), and there are several steep-sided, short ravines deeply incised into these bluffs, that open to Lake Michigan.

Soils

Soils are typically loamy and clayey tills with high silt content, though near Lake Michigan there are some deep lake plain clays derived from glaciolacustrine deposits. Most soils have a thin surface layer of wind-deposited silt, 6 inches thick or less (Hole 1976). Upland till soils are dominantly brown calcareous silty clay loams; they are moderately well drained with moderately slow permeability and high available water capacity. These are highly productive soils, enriched by the decomposition of prairie vegetation over thousands of years. Urban and exurban development has disturbed a large proportion of these soils, often removing the productive surface soil.

The major soils' range of characteristics includes drainage classes of moderately well drained to somewhat poorly drained, surface textures of silt loam to silty clay loam, moderate to slow permeability, and high to very high available water capacity. Lake plain soils formed in calcareous silty to clayey lacustrine material, with some sands deposited by wave action. Most lowland soils are very poorly drained non-acid muck or silty and clayey lacustrine. The major river valleys have soils formed in loamy to silty alluvium, drainage classes that range from moderately well drained to very poorly drained, and areas that are subject to periodic flooding.

Hydrology

Basins

This highly modified ecological landscape is drained by streams from three major basins: the Root-Pike, Illinois-Fox, and Milwaukee basins. Most streams and rivers in this ecological landscape have been greatly altered and ecologically degraded by human activities such as channelization and long periods of point and nonpoint pollution. There are only 26 named inland lakes, totaling over 5,000 acres, but there are nearly 1,500 very small unnamed lakes, totaling only about 1,800 acres.

Lake Michigan

Lake Michigan is the dominant aquatic feature in this ecological landscape. The lake's large volume of water serves as a heat sink that influences local climate (warmer in winter, cooler in summer). Its aquatic attributes and shoreline features are essential to supporting a wide range of water-dependent or water-associated species. Industries and municipalities rely on the lake as a source of water for industrial use, power plant cooling, drinking and other domestic uses, and as a discharge zone for treated wastewater. While still important to water-dependent transportation, the lake and its many ***navigable*** bays historically served as a major route for commercial shipping.

Lake Michigan is a major recreational resource. The lake is heavily used for water-based activities such as fishing and boating, while the shoreline is used for biking, hiking, and bird watching. This view is from Lake Michigan looking into downtown Milwaukee. Photo by Robert Queen, Wisconsin DNR.

Historically, Lake Michigan was the most productive of the ***oligotrophic*** Great Lakes in terms of yield to support a commercial fishery. The fish community of Lake Michigan was an important source of food for the subsistence of early human populations. Since the 1840s, many fish species have constituted an important commercial and sport fishery. However, the indigenous fish community has been drastically altered by the invasion of nonindigenous species such as sea lamprey (*Petromyzon marinus*), rainbow smelt (*Osmerus mordax*), and alewife (*Alosa pseudoharengus*), unsustainably heavy fishing pressure, and habitat degradation (see the "Fauna" section of this chapter for more detailed discussion of fish communities).

The phytoplankton of Lake Michigan was originally dominated by diatoms adapted to oligotrophic conditions. With increased nutrient loading to the lake, diatom species better adapted to eutrophic conditions became more prevalent. In the late 1960s, an additional shift occurred from diatoms to phytoplankton assemblages, with increasing proportions of both green and blue-green algae. In the Southern Lake Michigan Coastal Ecological Landscape, these shifts are most evident in the eutrophic waters now occurring from Milwaukee to the Illinois state line, and to the Chicago area (Schelske et al. 1980).

Recently, Lake Michigan has experienced a growing problem due to increased abundance of native filamentous green algae in the genus *Cladophora*. Masses of this plant wash ashore and give off a strong, sewage-like odor as it decays. A combination of factors are probably responsible for this new problem, including the abundance of nonnative filter-feeding mussels, warmer summer water temperatures, declining lake levels, and the continued introduction of excess phosphorous and other nutrients.

Inland Lakes

According to the Wisconsin DNR's 24K Hydrography Geodatabase, there are 26 named inland lakes, totaling over 5,000 acres in this ecological landscape (WDNR 2015b). There are nearly 1,500 unnamed lakes, all very small totaling only about 1,800 acres. More than half the named inland lakes here are supported by local lake associations or lake districts, which can provide impetus and direction to lake restoration and habitat improvement projects.

Two lakes, Little Muskego and Wind, are classified as impaired waters due to heavy inflows of nonpoint pollutants. Others, including Tichigan, Big Muskego, George, Camp, and Eagle lakes, tend to receive or store nutrient levels that make their waters somewhat eutrophic. Invasives are common in the inland lakes here, due in part to high levels of development and heavy recreational use by people who may unintentionally transport invasive species from one lake to another. The common carp (*Cyprinus carpio*) has been present in Southern Lake Michigan Coastal area for 125 years and continues to cause major problems in shallow lakes here. Another major inland lake problem is the exotic plant Eurasian water-milfoil (*Myriophyllum spicatum*). Purple loosestrife (*Lythrum salicaria*) occurs in many marshes and sedge meadows and along shorelines, where it replaces native wetland vegetation and reduces habitat values for many wildlife species.

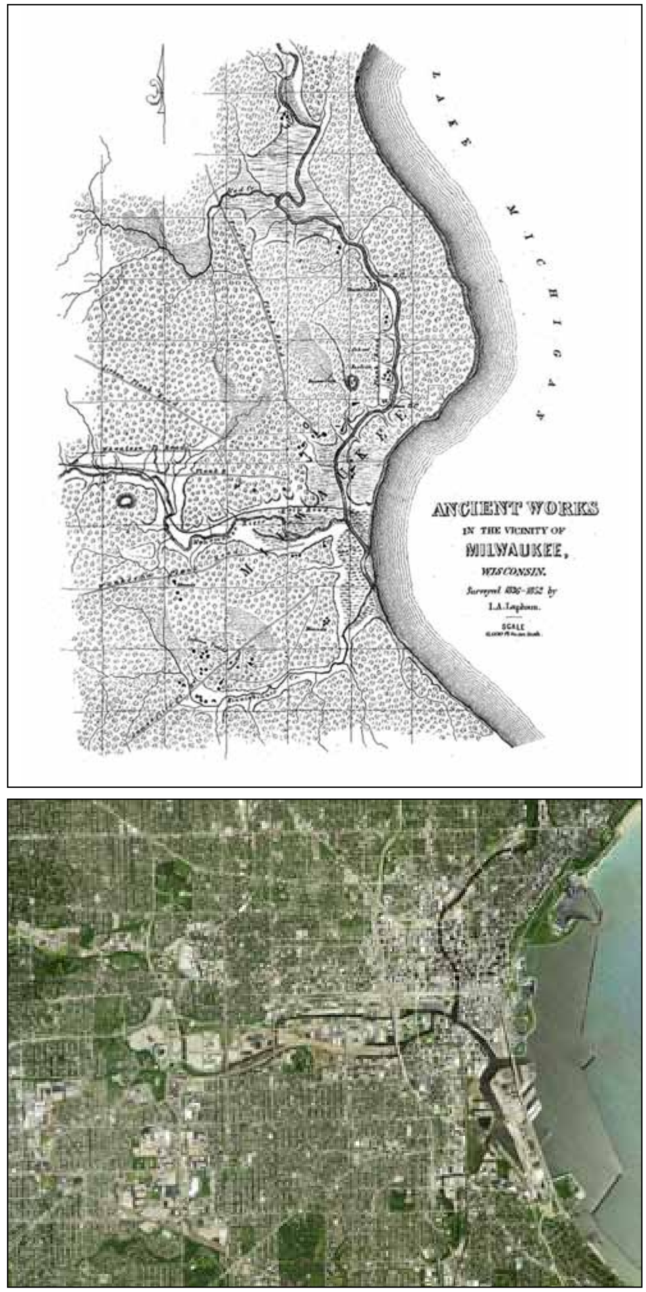
Impoundments

Many streams have been dammed for a variety of economic and recreational purposes. There are 5,811 acres of shallow impoundments behind 54 dams, storing 21,826 acre-feet of water (WDNR 2015b). Water quality problems in the artificial lakes created by these dams are common due to excess nutrient and sediment inputs, algal blooms, invasive aquatic plants, and common carp. At some sites, marshes have developed behind the dams, and these now provide habitat for a variety of wildlife species, especially birds, which may have relatively little suitable nesting or foraging habitat elsewhere. At other impoundments, dams have created extensive areas of open water, inundating and destroying marsh and sedge meadow communities. At some locations, there may be opportunities to remove dams and restore more natural hydrologic regimes and shoreline vegetation to impounded streams.

Rivers and Streams

Important rivers and streams in this ecological landscape include the Milwaukee, Menomonee, Kinnickinnic, Root, Des Plaines, and Pike. Further inland, the Southeast (or "Illinois") Fox River, which runs along or near the southwestern edge of the Southern Lake Michigan Coastal. Many small streams such as Sussex, Zion, and Frame Park creeks, as well as the upper Southeast (or "Illinois") Fox River are impacted by urban or exurban stormwater runoff that contributes to flash flows, bank erosion, and in-stream habitat loss.

Though historically damaged by various alterations and land use practices, many streams here have been the focus of revitalization projects, including dam removals, floodplain restoration, and in-stream habitat improvements. This includes the industry-altered estuaries of the Menomonee and Milwaukee rivers, where various agencies have embarked on projects to restore aquatic habitat features, including



The river valleys in Milwaukee County have changed significantly since Euro-American settlement. The drawing, done by Increase Lapham in the 1850s (Lapham 1855), shows the Milwaukee and Menomonee River valleys and associated wetlands prior to Euro-American settlement. The air photo (courtesy of the National Agriculture Imagery Program, 2013) shows the current conditions in those river valleys. Note the channelization of the rivers and wetland drainage and filling as well as the opening of the Milwaukee harbor done by dredging and filling (lower right).

spawning wetlands for fish and placement of substrate suitable for use by spawning lake sturgeon (*Acipenser fulvescens*).

Springs

There are 49 springs documented in the Southern Lake Michigan Coastal Ecological Landscape (Macholl 2007). This is the fourth smallest number of springs among the 16 ecological landscapes in the state. The majority of these mapped springs are in the western portion of this ecological landscape, farthest from the Milwaukee area and the influence of large groundwater withdrawals. Many previously existing springs are believed to have dried up due to the impact of groundwater withdrawal (Gotkowitz et al. 2008). These springs leave their names to neighborhoods and streets, such as Cold Spring Park and Silver Spring Drive.

While springs here do not support any significant coldwater streams, they do provide important base flow to streams, including the upper Menominee, upper ("Southern") Fox, and the lower Pike rivers. In Kenosha County, Petrifying Springs County Park protects a portion of the recharge area for its namesake springs and remains a popular recreation area.

In portions of this ecological landscape, flowing groundwater intersects fractured shallow bedrock that discharges to the surface in springs. In these areas, regional pumping from deep sandstone aquifers has been shown to have a drawdown effect on shallow groundwater flow paths (Feinstein et al. 2005). Because of this, springs in parts of this ecological landscape are more vulnerable to the impacts of groundwater withdrawal from both shallow and deep aquifers (Swanson et al. 2009).

Wetlands

According to the Wisconsin Wetlands Inventory (WWI) (WDNR 2010), wetlands are uncommon in the Southern Lake Michigan Coastal Ecological Landscape, comprising only 8.5%, (approximately 46,000 acres) of this ecological landscape's vegetation. Forested wetlands make up over 18,600 acres here and are the most abundant wetland type. Emergent/wet meadow occurs on more than 15,500 acres. The WWI wetland acreages and percentages differ slightly from WISCLAND data because they are from a more detailed data set that relied on interpretation of air photos rather than satellite imagery. Additional information on wetlands and wetland flora may be found in the "Natural Communities" and "Flora" sections below and in Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," in Part 1 of the book. Some of the important animals associated with wetlands are discussed in the "Fauna" section of this chapter.

While wetland losses have been high (approximately 58% have been destroyed since Euro-American settlement), relatively intact examples of wetland communities persist in some areas. Of special interest, because of their global rarity and generally good condition, are the coastal prairies, fens, and associated wetlands along and near Lake Michigan in southeastern Kenosha County. Floristic diversity of this area is exceptional, and many rare animals inhabit the site as well.

The largest extant wetland in the Southern Lake Michigan Coastal Ecological Landscape is a sedge meadow, shrub-carr, and emergent marsh complex adjacent to Big Muskego Lake. Much of this wetland is managed as part of Big Muskego Wildlife Area. It supports several native aquatic plants, including bulrush, that are important for sustaining a diversity of birdlife, including the Forster's Tern (*Sterna forsteri*), and Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*). This wetland is designated as a Wisconsin Important Bird Area. Elsewhere across this ecological landscape, several thousand acres of hardwood swamp/floodplain forest and sedge meadow remain, primarily along river corridors. There are more than 10,000 acres of wetland remaining in the Wisconsin portions of the Des Plaines and Southeast (or "Illinois") Fox River watersheds (WDNR 2002a), although much of this acreage has been degraded by ditching and infestations of invasive plants with the overall condition fair to poor. Only a few remnant conifer swamps persist. For example, at Germantown Swamp in Washington County there is a mixture of northern white-cedar (*Thuja occidentalis*), ash (*Fraxinus* spp.), and tamarack (*Larix laricina*). In addition, this ecological landscape contains high quality wetlands in the Southeast (or "Illinois") Fox River basin, and at other sites identified by the Southeastern Wisconsin Regional Planning Commission and the Wisconsin DNR.

Water Quality

The streams and lakes of this ecological landscape are among the most physically degraded, polluted, and urbanized in the state, according to watershed reports by the Wisconsin DNR. Watershed land cover here is typically 15% to 50% urban and ranges up to 90% in the Kinnikinnic River watershed (WDNR 2014a). In the past, large volumes of untreated or poorly treated industrial and municipal waste negatively impacted aquatic systems. Many stream courses and wetlands have been covered by urban and other developments exhibit unstable and slumping banks, or have been channelized and lined with concrete. A few sites are now in the process of restoration. A legacy of persistent (and sometimes toxic) pollutants remains in some places. Long-term atmospheric deposition of mercury, a product of coal combustion, continues to contaminate desirable fish species, as do polychlorinated biphenyl (PCB) residues from industrial cooling equipment and processes.

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. Both designations carry regulatory restrictions with them, with ORWs being the most restricted. These designations are intended to meet federal Clean Water Act obligations and prevent lowering of water quality or degradation of aquatic habitats. They are also used to inform and guide land use changes and human activities affecting these waters. Not surprisingly, there are currently no ORW or ERW in this ecological landscape. A complete list of ORW and ERW for Wisconsin can be found on the Wisconsin DNR website (WDNR 2014b).

Waters designated as impaired on the ***U.S. Environmental Protection Agency (EPA) 303(d) list*** exhibit various water quality problems including ***polychlorinated biphenyls*** (PCBs) in fish, sediments contaminated with industrial metals, mercury from atmospheric deposition, bacteria from farm and urban runoff, and habitat degradation. 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 a ORW or ERW. These designations are not mutually exclusive. A plan is required by the U.S. Environmental Protection Agency on how 303(d) designated waters will be improved by the department. This designation is used as the basis for obtaining federal funding, planning aquatic management work, and meeting federal water quality regulations. The complete list of 303(d) impaired waters and criteria can be viewed at the Wisconsin DNR's impaired waters web page (WDNR 2014c).

Urban and rural nonpoint pollution degrades or threatens many of the streams and inland lakes here as well as the Lake Michigan harbors and coastal waters, wetlands, and groundwater resources. Appendix 19.A shows rankings for nonpoint pollution in the Southern Lake Michigan Coastal Ecological Landscape. This ranking was derived through a process of evaluating water quality in streams, lakes, and groundwater.

Increased nutrient levels and pollutants in lakes and ponds from runoff and point source discharges produce algal blooms that foul beaches and waterways, impairing or even preventing public use. Sporadic pollution episodes (e.g., spills of untreated sewage into Lake Michigan through stormwater overflow) underscore the need to increase public support to improve stormwater management (Elder 2003).

The Greenseams land conservation program acquires undeveloped, privately owned land from willing sellers, either through outright sales or permanent conservation easements. The Greenseams land conservation program acquires undeveloped, privately owned land from willing sellers in the watersheds of the Milwaukee, Menomonee, and Root rivers and Oak Creek, either through outright sales or permanent conservation easements. The program targets property with water-absorbing soils in areas expected to see significant additional development pressures over the next 20 years. Each of these properties can aid the infiltration of rainwater into the ground, reducing the risk of flooding, sewer overflows, or sending polluted runoff into creeks, streams, rivers, and lakes (MMSD 2006). As part of the Greenseams program, the Milwaukee Metropolitan Sewerage District owns 80 properties comprising more than 2,000 acres of land as of 2011, many of which are within the Southern Lake Michigan Coastal counties.

A 1989 map of groundwater contamination potential (WGNHS 1989) indicates that more than half of this ecological landscape has a low potential for groundwater contamination, as does a 1997 map produced by the Southeastern Wisconsin Regional Planning Commission and the Wisconsin Geological and Natural History Survey (SEWRPC and WGNHS 2002). This map shows that areas along stream corridors and the Lake Michigan shoreline have a moderate to high susceptibility to contamination. However, under a more recent review using criteria of the state Nonpoint Source Priority Watershed Program, all the watersheds in the southern half of this ecological landscape received an overall "high priority" ranking, meaning attention is required to either remedy or prevent groundwater contamination. Most of this ranking is due to widespread urban and agricultural land uses, and the presence of agricultural contaminants in groundwater samples.

Groundwater here has become contaminated due to the extent and kinds of development that have occurred, especially agricultural usage in rural areas and industrial and landfill contamination in both rural and urban areas. Airborne pollutants such as motor vehicle exhaust and wind-carried pesticide dusts and vapors can seep below ground with precipitation and contaminate groundwater anywhere. Contaminants of concern at Superfund sites and other locations in Milwaukee and other communities include PCBs, heavy metals, coal tar, creosote, benzene, toluene, other flammable liquids, chlorinated solvents such as tetrachloroethylene and asbestos. At some sites, these substances have been removed or otherwise remediated to varying degrees under the Superfund and ***Brownfields*** programs, so the land can be put to other uses.

Groundwater withdrawn from a deep aquifer under eastern Waukesha County within this ecological landscape has produced radium levels in excess of EPA standards and excess salinity causing health and aesthetic concerns with drinking water (Gaumnitz et al. 2004). These issues complicate the management of regional growth and inter-community relations and are two of the issues addressed by the regional water supply plan produced by the Southeastern Wisconsin Regional Planning Commission (SEWRPC 2010).

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

Several sources were used to characterize the historical vegetation of the Southern Lake Michigan Coastal 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."

Historical vegetation in the northern part of this ecological landscape was dominated mostly by mesic hardwood forests of sugar maple-basswood-beech forest with some oak, while the southern part was dominated by fire-driven ecosystems such as oak forest, oak savanna, and prairie (Finley 1976; Figure 19.1). In the southeast corner of the ecological landscape near Lake Michigan, a mosaic of native grassland and savanna communities was associated with ridge-and-swale topography along the shoreline of the Great Lakes. Mesic, Wet-mesic, and Wet prairies were included, as were Southern Sedge Meadows and Calcareous Fens. Great Lakes beach and dune complexes were prominent at several locations along Lake Michigan, and oak savannas occurred on sandy ridges. Black ash (*Fraxinus nigra*) and ***relict*** conifer swamps of tamarack and northern white-cedar were found at a few locations in the northern portions of this ecological landscape. Conifers such as eastern white pine (*Pinus strobus*) and northern white-cedar also occurred as components of upland forests in cool, moist ravines along Lake Michigan. In total, in the mid-1800s about 63% of the ecological landscape was forested, with about 26% in prairie and oak savanna. The remainder was mostly open wetland of marsh and meadow.

Federal public land survey information has been converted to a database format and relative importance values (RIV) for tree species calculated based on the average of tree species density and ***basal area*** (He et al. 2000). This analysis indicates that, collectively, the oak-hickory forest type (68% of the RIV) was the most dominant group in the Southern Lake Michigan Coastal Ecological Landscape. Within that group, bur oak (*Quercus macrocarpa*) had the highest RIV (29%), followed by white oak (*Quercus alba*) (22%) and black oak (*Quercus velutina*) (11%). Outside of the oak species, sugar maple (*Acer saccharum*) had the highest RIV (9%), followed by American beech (*Fagus grandifolia*) (5% of RIV). See the map "Vegetation of the Southern Lake Michigan Coastal Ecological Landscape in the Mid-1800s" in Appendix 19.K at the end of this chapter.

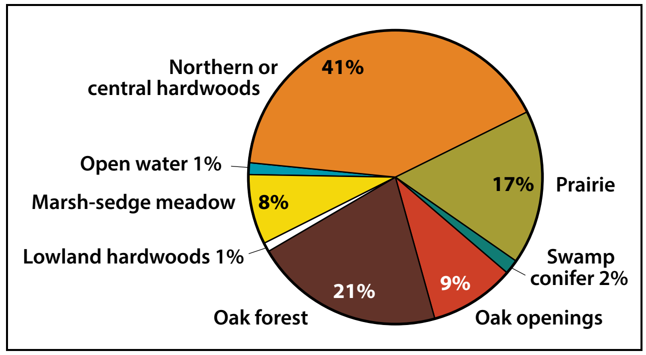


Figure 19.1. *Vegetation of the Southern Lake Michigan Coastal Ecological Landscape during the mid-1800s as interpreted by Finley (1976) from federal General Land Office public land survey information.*

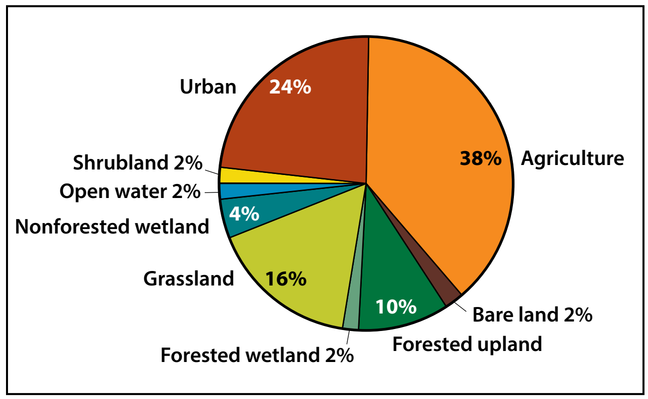


Figure 19.2. *WISCLAND land use/land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery for the Southern Lake Michigan Coastal Ecological Landscape (WDNR 1993).*

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. The land cover categories used by these entities do not always correspond on a 1:1 basis. 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 from 1992 indicate that most of the land area (65%, or 350,000 out of 540,000 acres) was classified as agricultural, urban, or bare land, with a relatively low percentage in grassland, forests, or wetlands (WDNR 1993; Figure 19.2). Very little of the Southern Lake Michigan Coastal Ecological Landscape is publicly owned; only about 1% is state-owned land designated primarily for conservation purposes. There is also a large system of city and county parks (see Appendix 19.G at the end of the chapter).

Forest Inventory and Analysis (FIA) data calculated from sample plot data from 2004 show that the vast majority (94%) of this ecological landscape is nonforested (USFS 2004). This generally agrees with the satellite imagery-based WISCLAND estimate of 88% of the ecological landscape being nonforested (WDNR 1993). Within the small percentage of land that is still forested, 36% is oak/hickory, 29% is northern or central hardwoods, 20% is lowland hardwoods, 8% is aspen, and 7%

is other forest types (Figure 19.3). Due to the small number of FIA plots in this ecological landscape the sampling error for these estimates are high, and these should be considered rough estimates.

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."

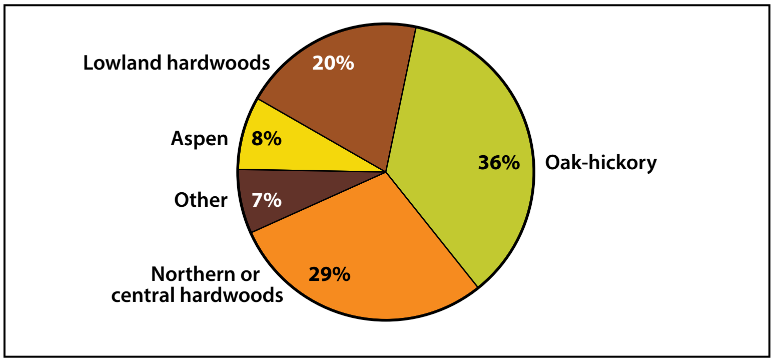


Figure 19.3. *Forest Inventory and Analysis data (USFS 2004) showing forest type as a percentage of forested land area (greater than 17% crown cover) for the Southern Lake Michigan Coastal Ecological Landscape. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the FIA data.*

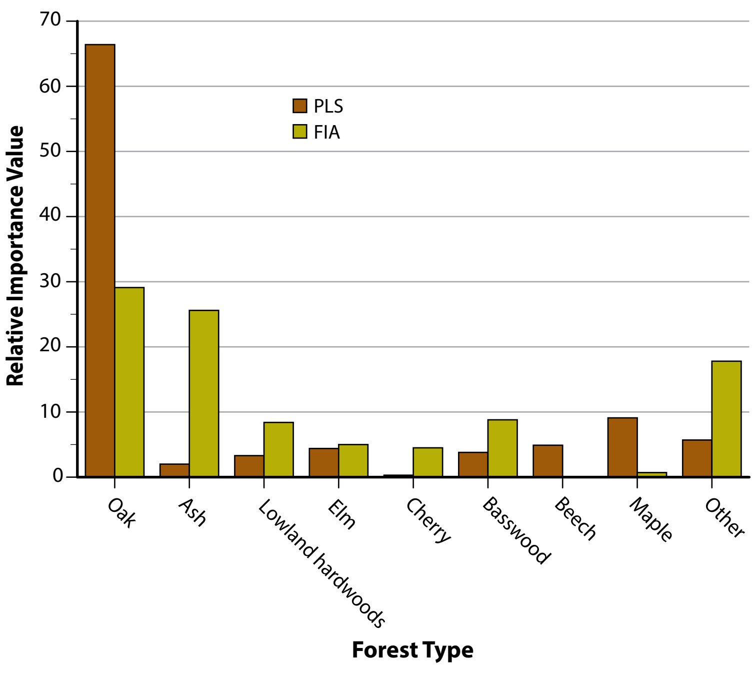


Figure 19.4. *Comparison of tree species' relative importance value (average of relative dominance and relative density) for the Southern Lake Michigan Coastal Ecological Landscape during the mid-1800s, when federal General Land Office public land survey (PLS) data were collected, with 2004 estimates from Forest Inventory and Analysis (FIA) data (USFS 2004). Each bar represents the proportion of that forest type in the data set (totals equal 100). Trees of less than 6-inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.*

Changes in Vegetation over Time

The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and communities 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 (albeit a very important one that coincided with settlement of Wisconsin by large numbers of Euro-Americans and the major changes in land cover and land use that followed), 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. We do not mean to imply that entire ecological landscapes should be restored to historical conditions, as this is neither possible nor is it necessarily desirable within the context of providing for human needs and desires. Information on the methodologies, strengths, and limitations of the vegetation change data used herein is provided in Appendix C, "Data Sources Used in the Book" in Part 3, "Supporting Materials."

Oak species have decreased dramatically in relative importance, while American basswood (*Tilia americana*), ashes, cherries (*Prunus* spp.), hackberry (*Celtis occidentalis*), and hickories (*Carya* spp.) have increased. American beech has been virtually lost from the Southern Lake Michigan Coastal Ecological Landscape (Figure 19.4). The decrease in the overall amount of forest cover has also been dramatic.

This ecological landscape contains a few stands of mesic, wet-mesic, and wet prairie, but only small areas of native grass remain. Virtually all of the prairie acreage was converted to crop production, and most of the prairie remnants that remain are not only small but isolated. For all communities and habitats here, isolation and fragmentation make dispersal of propagules and gene flow for some persisting native species problematic. Invasive plants are now abundant due to factors such as high levels of disturbance to remnant vegetation, a well-developed transportation system, and a large, mobile human population.

For more information about plant communities, see the "Natural Communities" and "Management Opportunities" sections of this chapter and Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," in Part 1 of the book.

Natural Communities

This section summarizes the abundance and importance of major physiognomic (structural) ***natural community groups*** (forest, savanna, shrub, herbaceous) 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, status, and distribution of the specific natural communities found in the Southern Lake Michigan Coastal Ecological Landscape, see Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," in Part 1 of the book. Information on invasive species can be found in the "Natural and Human Disturbances" section of this chapter.

All types of native vegetation have been greatly reduced in abundance and altered in character throughout this ecological landscape. Upland vegetation, forests, savannas, and most prairies now exist almost entirely as small isolated fragments of formerly much more common and widespread plant communities. Wetland plant communities have fared slightly better, though drainage has occurred in many areas, and the hydrological disruptions that have accompanied heavy development and rapid growth of residential areas throughout the ecological landscape have had dramatic and far-reaching effects. Shoreline communities, such as the beaches and dunes along Lake Michigan, have been almost entirely obliterated by residential development or construction of seawalls. The few remnants are highly disturbed and, in most cases, heavily used for recreational purposes. Aquatic environments have been affected by dams, ditches, loss of adjoining wetlands, and excessive inputs of nutrients, sediments, and various pollutants. All native plant communities and waterbodies have been significantly affected by the inadvertent or deliberate introduction of invasive species.

This is one of only a few ecological landscapes in which features such as urban forests, municipal park systems, and ***surrogate grasslands*** play major roles in the maintenance of natural or semi-natural systems and their components. Recognition of the ecological opportunities associated with these attributes merits a higher profile, increased coordination, and additional study.

■ **Forests.** Forest communities in the Southern Lake Michigan Coastal Ecological Landscape are almost entirely composed of hardwoods. The remnants are restricted to parks, riparian corridors, and farm woodlots. Among the key threats to forests here are fragmentation, stand isolation, disruption or cessation of the natural disturbance regimes (especially fire and flood) upon which these communities are dependent, the decline or loss of habitat specialists and increase of habitat generalists, the spread and proliferation of invasive species (e.g., plants, insects, pathogens), and incompatible recreational uses by increasing numbers of humans.

The long-term suppression and exclusion of fire has negatively impacted oak forests (and possibly "relict" tamarack stands), leading to the development of dense understories of woody plants and heavy shade. These conditions will negatively impact the more light-demanding native species, including the canopy dominants. Lowland forests are vulnerable to hydrological disruption as well as to the other threats mentioned. Grazing and ***high grading*** stands by extracting the timber of highest commercial value may still be locally important disturbances, negatively impacting species composition and stand structure. Invasive plants are now a significant problem in all forest communities in southeastern Wisconsin.

Southern Mesic Forest (sugar maple-basswood-beech) was historically most abundant in the northeastern part of the ecological landscape. The less disturbed remnants sometimes retain a component of American beech and may also support diverse assemblages of native understory plants, including rare species. Major threats to this type include excessive recreational use, severe infestations of invasive plants, and the loss of native species over time due to stand isolation, small population sizes, and limited dispersal abilities or opportunities. There has also been an institutional tendency to overlook the conservation values of this community, primarily because

Southern Mesic Forests exist mostly as small isolated remnants surrounded by intensively developed areas. Cudahy Woods State Natural Area, Milwaukee County. Photo by Joshua Meyer.

it is sometimes equated with the "northern hardwoods" ***cover type***, which is abundant—albeit in a greatly simplified form—in the much more extensive forests of northern Wisconsin.

Opportunities to conserve the Southern Mesic Forest community in this ecological landscape are limited but still important. Based on current status and distribution in Wisconsin, mesic hardwood forests of the maple-beech cover type should be considered priorities for conservation in this and most other ecological landscapes in which they occur, especially when stands support herb-rich understories composed of native species and have the potential to develop important forest structural features that are scarce or absent from most managed mesic forests across the state. At a few locations there may be opportunities to create or expand forest ***buffers*** around existing remnants, thereby reducing negative edge effects. This would help avoid the need for additional active intervention by stewards, improving the compatibility of the surrounding vegetation, and increasing the conservation value of the site.

Southern Dry and Southern Dry-mesic Forests are dominated by oaks when under the disturbance regime to which the oaks are best adapted, periodic wildfire. Remnant stands have now experienced long periods of fire exclusion and suppression, which will make it difficult to maintain or restore the characteristic structural, compositional, and functional attributes of these valuable forests. Almost all stands have experienced dramatic increases in the abundance of deciduous shrubs and saplings, typically at the expense of the more light-demanding native understory herbs. The combination of heavy soils, dense thickets of saplings and shrubs in which nonnative common (*Rhamnus cathartica*) and glossy (*R. frangula*) buckthorn and eurasian honeysuckles (especially *Lonicera tatarica*, *L. morrowii*, and the hybrid *Lonicera* x *bella*) are dominant, a history of grazing by domestic livestock, and many decades of fire exclusion have made management of oak forests exceedingly problematic. This very serious forest management problem is by no means limited to the Southern Lake Michigan Coastal Ecological Landscape.

Outreach and education programs will be essential to assure residents and local politicians that prescribed fire can be a safe and effective forest management tool. Forest managers would also benefit from an expanded toolkit on how to regenerate oak. Management opportunities for the oak-dominated Southern Dry-mesic and Southern Dry Forests are best west of the Root River corridor. Good examples may be found in several ***state natural areas*** and in some of the county parks.

Lowland hardwood forests composed of ashes, soft maples (*Acer* spp.), and elms (*Ulmus* spp**.)** are limited to riparian corridors and poorly drained insular basins that periodically flood. Though such forests are uncommon here, they support many native plants and animals, are highly significant to migratory birds, offer opportunities to link important natural or semi-natural habitats that would otherwise be separated, and provide a wide range of societal benefits including floodwater retention, diversity maintenance, recreation, and aesthetics.

*Spring flora at Renak-Polak Maple-Beech Woods State Natural Area in Racine County. This site contains one of very few remaining examples of Southern Mesic Forest in southeastern Wisconsin. The understory is largely composed of large-flowered trillium (*Trillium grandifolium*) and wild leek (*Allium tricoccum*), with American beech an important canopy component. Renak-Polak Maple Woods is owned by the University of Wisconsin-Parkside and was designated a state natural area in 1972. Photo by Owen Boyle, Wisconsin DNR.*

A small portion of Renak-Polak State Natural Area in Racine County contains a good quality, seasonally wet lowland hardwood forest dominated by green ash. Photo by Thomas Meyer, Wisconsin DNR.

Silver Lake Bog State Natural Area, Kenosha County, contains examples of northern plant communities such as Tamarack Swamp and Open Bog that are very close to their southernmost range limits. Photo by Thomas Meyer, Wisconsin DNR.

Coniferous forests are rare in this part of Wisconsin. Tamarack (Rich) Swamp (formerly known, in part, as "Bog Relict") occurs as far south as Kenosha County, where it is extremely rare. A few occurrences have been partially protected within designated state natural areas, such as Silver Lake Bog State Natural Area in Kenosha County. Hydrological disturbances such as ditching, damming, channeling, and groundwater withdrawals are common in this ecological landscape and may have had serious negative impacts on these sensitive forested wetlands. The explosive spread of invasive shrubs, such as glossy buckthorn, poses a significant problem, and unknown factors (successional pathways, suppression of fire, forest pests) threaten the viability of this type throughout its southern Wisconsin range.

Such "relicts" often support regionally rare plants and animals more commonly found in northern Wisconsin. Climate change may affect communities and species generally adapted to cooler and moister conditions, and such sites may make good candidates to monitor vegetation changes.

Savannas. Oak Openings were among the Upper Midwest's most characteristic plant communities. They are now among the rarest. Outright destruction, prolonged periods of heavy grazing by domestic livestock, and succession to dense forest that followed the implementation of fire suppression policies statewide have so reduced the Oak Openings that their former abundance seems almost imaginary. Today remnants are few, all are very small, and most are highly degraded. By far the greatest conservation limitation is the lack of legitimate opportunity. As intact remnants have not been identified, restoration, which requires the substantial expenditure of resources to bring back even a small acreage, is essential. Savanna remnants embedded within other plant communities that can be managed compatibly and efficiently with prescribed fire, are perhaps the highest priorities for restoration attention. These other communities include oak forest, any of our native prairies, and certain types of wetlands (for example, Southern Sedge Meadow, Calcareous Fen, and Shrub-carr) in which the use of prescribed fire would be appropriate and beneficial.

This remnant Oak Savanna occurs in Milwaukee County within a heavily urbanized landscape. Photo by Thomas Meyer, Wisconsin DNR.

Priority management activities include reducing the density of woody understory vegetation, controlling invasive plants, broadcasting seeds of native understory species, and reintroducing periodic fire via controlled burns to stimulate growth of native, fire-adapted understory plants.

The best opportunities to manage for Oak Openings occur farther west, in the Southeast Glacial Plains (especially in the southern part of the Kettle Moraine region), Southwest Savanna, Western Coulees and Ridges, Central Sand Hills, and Central Sand Plains ecological landscapes. However, there are several opportunities to manage for this globally imperiled community in the Southern Lake Michigan Coastal Ecological Landscape. Franklin Savanna State Natural Area (in Milwaukee County) is perhaps the best opportunity here, though small but significant remnants occur at Chiwaukee Prairie, and especially, farther south, at Illinois Beach State Park.

Shrub Communities. Shrub-carr, in which native willows (*Salix* spp.) and dogwoods (*Cornus* spp.) are the dominant species, is by far the most common and widespread shrub community in this ecological landscape. "Shrub swamps" may persist where wetlands have not been eliminated by drainage or filling. In the absence of periodic fire, shrub swamps may increase, at least temporarily, sometimes at the expense of other wetland types, especially where hydrological disruptions have lowered the water table and partially drained open wetland communities such as sedge meadow, prairie, marsh, or fen.

Because of the rarity and continuing decline of so many of our native herb-dominated wetland communities, conservation-oriented wetland management is often aimed at reducing the abundance of woody plants. In part, this is done to restore habitat conditions to a more natural (open) state; in part it is done to accommodate the habitat needs of the large number of plants and animals that are dependent upon the maintenance of open conditions. Prescribed burning and mechanical brushing are among the most common techniques used to control woody vegetation.

Shrub-dominated wetlands are also native plant communities and support their own assemblages of plants and animals, including some that are rare or declining. The management goal should seldom, if ever, be to eliminate shrub swamps, or to think about them as if their intrinsic values are inherently low. They need to be considered and managed, just as other natural communities are. Shrub communities have not been studied in nearly as much detail as prairies, savannas, or forests, and care must be taken not to underestimate their importance to native animals.

Abandoned or fallowed agricultural lands in this region of heavy soils, especially in somewhat poorly drained areas, may be rapidly colonized by native dogwoods and willows as well as by a host of nonnative shrubs, some of which are highly invasive. Old agricultural fields reverting to more natural cover have obvious buffer value. Ecological management opportunities associated with such sites are generally dependent on the context in which they occur. For example, old fields in an open context could qabe managed to remain as grassland to complement prairie remnants or as surrogate grasslands. If the context is forest, and the site is important and appropriate for management as forest, then shrubs or trees could be encouraged to enlarge, buffer, or otherwise complement an existing forest remnant. However, if an old field is simply left as is, care should be taken that propagules of highly invasive species will not spread to nearby vegetation with higher conservation value.

Herbaceous Communities. The poorly drained ridge-and-swale topography along Lake Michigan in the southeastern corner of Kenosha County harbors a floristically diverse complex of Wet-mesic Prairie, Calcareous Fen, Southern Sedge Meadow, and Emergent Marsh communities. Many rare species (including several that are globally rare) occur here, and additional conservation lands occur just to the south in Illinois. This is arguably the single most important site to conserve in the entire ecological landscape. There is no similar site in Wisconsin. Major threats include hydrological disruptions, encroaching residential development, difficulties in using prescribed fire to manage the site, and the rapid spread of both native and exotic invasive plants.

Other prairie remnants in the Southern Lake Michigan Coastal Ecological Landscape are invariably small, isolated, and often narrowly linear, and these are highly vulnerable to damage from herbicide drift, the use of road salt, poorly timed mowing, abusive recreational uses, and colonization by invasive plants. Wherever possible, prairie remnants with high conservation value because of their condition and/or composition should be buffered by CRP (Conservation Reserve Program) fields, green space, pastures, or other relatively compatible management scenarios. Management and protection opportunities are best at sites containing other types of terrestrial or wet grasslands.

Mesic Prairie remnants, especially, are widely scattered and very small. This prairie community occupied fertile, well-drained sites with deep soils. Almost all (well over 99.9%) of Wisconsin's Mesic Prairie has been destroyed, primarily because those prairie lands have been converted to the production of agricultural crops. A few, usually weedy, remnants persist in various rights-of-way, e.g., near Kansasville and Franksville in Racine County and at the Benedict Prairie in Kenosha County. Miniscule patches of mesic prairie still survive on the upland margins of a few wetlands in the region. Local stewards are needed to periodically monitor these sites and assist with or conduct needed management activities such as prescribed burns, mechanical brush removal, invasive plant control, and posting of signage to indicate sensitive areas where use problems are already occurring.

Southern Sedge Meadow is an uncommon wetland community restricted to river floodplains, lakeshores, and the low spots in areas of ridge-and-swale topography such as that found at Chiwaukee Prairie. Many Southern Sedge Meadows (and the often closely associated Wet-mesic Prairies) were drained and converted to agricultural uses. Pasturage was a common and widespread use, and grazed meadows, especially when drainage had altered site hydrology, quickly became dominated by aggressive nonnative weeds such as reed canary grass (*Phalaris arundinacea*). During dry years, these drained meadows and "low" prairies were often plowed and planted to crops.

Emergent Marshes occur along rivers, on lakeshores, and in poorly drained glacial depressions. These plant communities are valuable to waterfowl, marsh birds, fish, amphibians, and invertebrates and are less easily converted to other uses. Several marshes in this ecological landscape have been designated as state wildlife areas. Some existing land use plans (e.g., SEWRPC 1997) call for maintenance and restoration of marsh habitats. There are opportunities to partner with local authorities to foster these efforts.

Aquatic Communities. Lake Michigan is the most important aquatic feature affecting the Southern Lake Michigan Coastal Ecological Landscape. Because of its size and depth, its heavy use by birds and the habitat it provides for fish, and the dependence of many local communities (including several of Wisconsin's largest cities) on it for a wide array of social and economic uses, protection of the lake and its associated resources is a global priority. Submerged reefs, deposits of Silurian dolomite, are known from the waters adjacent to this ecological landscape and can be important structural features for spawning fish. The north-south trending shoreline and the nearshore waters of Lake Michigan are ecological features of great importance to migratory and wintering birds and also provide a focal point for the protection of a unique suite of natural communities and habitats.

The Lake Michigan ecosystem has undergone dramatic and unpredictable changes over the past century, resulting in radical reorganization of the dominant species. Relatively recent introductions of nonnative game fish (e.g., chinook [*Oncorhynchus tschawytscha*] and coho [*Oncorhynchus kisutch*] salmon) have revitalized sport fishing here. See the "Fauna" section of this chapter for additional details.

South of the City of Kenosha, the Lake Michigan shoreline has been "protected" by rip-rapping and construction of a seawall. Protection of property and development potential has come at the expense of the coastal beach and dune complex that no longer has a source of sand. Photo by Robert H. Read.

Lakes and streams within the Southern Lake Michigan Coastal Ecological Landscape have been impacted by shoreline development, channelization, excess loads of nutrients and sediments, and pollutants, dam construction, and infestations of invasive plant and animal species. The economies of southeastern Wisconsin may no longer be as dependent on the direct extraction of commodities (such as fish) from the lakes as they once were, but they do require huge quantities of clean water. The "free" goods and services provided by lakes, streams, and wetlands had been vastly undervalued and taken for granted in the past, and the negative consequences from overutilization are now readily apparent. Remediation, wetland restoration, and improved watershed management are needed if the condition of many waterbodies is to substantially improve.

Forest Habitat Types

The Southern Lake Michigan Coastal Ecological Landscape is extensively developed and farmed. Most of the region is covered by loess (wind-blown silt) derived soils, which are nutrient rich and well drained. Forest habitat types reflect the limited site variability. Forests are uncommon, and sampling to determine habitat types has been limited. It appears that the dry-mesic to mesic habitat type group is most common. Other habitat type groups observed are mesic, mesic to wet-mesic, and wet-mesic to wet (Table 19.1).

Dry-mesic to mesic sites are typically associated with loamy soils that are well drained and nutrient rich. Forest stands are most commonly dominated by northern red oak (*Quercus rubra*) and white oak, often with sugar maple, white ash (*Fraxinus americana*), and American basswood. Frequent associates and occasional dominants include: black cherry (*Prunus serotina*), shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), elms, and red maple (*Acer rubrum*). Potential late-successional dominants are sugar maple, American basswood, and white ash.

Table 19.1. *Forest habitat type groups and forest habitat types[a] of the Southern Lake Michigan Coastal Ecological Landscape.*

Southern forest habitat type groups	Southern forest habitat types
Dry-mesic to mesic (DM-M) (includes phases)	ATiFrVb ATiFrVb(Cr)
Mesic (M) (includes phases)	ATiFrCa ATiFrCa(O)
Mesic to wet-mesic (M-WM)	Undefined wet-mesic (habitat types not defined)
Wet-mesic to wet (WM-W)	Forest Lowland (habitat types not defined)

Source: Kotar and Burger (1996).

[a]Forest habitat types are explained in Appendix 19.B, "Forest Habitat Types in the Southern Lake Michigan Coastal Ecological Landscape," at the end of this chapter.

Mesic sites are typically associated with loamy soils that are well to moderately well drained and nutrient rich. Forest stands can be dominated by any mix of red oak, white oak, sugar maple, American basswood, white ash, black cherry, shagbark hickory, and elms. Potential late-successional dominants are sugar maple, American basswood, and white ash.

Mesic to wet-mesic sites are typically associated with loamy soils that are somewhat poorly drained and nutrient rich to medium. Most forest stands are dominated by any mix of red maple, ashes, American basswood, and swamp white oak (*Quercus bicolor*).

Wet-mesic to wet forested lowlands occur on poorly drained soils. Most sites are dominated by swamp hardwoods composed of any mix of red maple, green ash (*Fraxinus pennsylvanica*), black ash, and swamp white oak.

Flora

This section highlights native vascular plants that have high conservation significance from a statewide perspective because they are better represented in the Southern Lake Michigan Coastal Ecological Landscape than in most other areas of Wisconsin. Global rarity and the presence of rare habitats that are known to harbor sensitive plant species were other factors considered when developing this section. For a complete list of Wisconsin's rare vascular plants tracked by Wisconsin Natural Heritage Inventory, see Appendix 19.C.

The Southern Lake Michigan Coastal Ecological Landscape borders Lake Michigan in the extreme southeastern corner of Wisconsin. Location plays a significant role in the distribution of several rare species. For example, the Wisconsin Endangered bluestem goldenrod (*Solidago caesia*) is one of several rare plants that reach their western and northern range limits in this ecological landscape. All of Wisconsin's 32 known populations of bluestem goldenrod occur here.

Other factors that play roles in species rarity here include dependence on geographically restricted and naturally rare communities (beaches, dunes, clay bluffs) that accommodate narrow habitat specialists; the intensity and extent of development and the widespread destruction of native habitats; the disruption of natural disturbance regimes (especially wildfire, flooding, and some dynamic processes associated with Great Lakes shorelines environments); competition with, and in some cases, displacement by, aggressive invasive plants or habitat generalists; unusual abiotic factors; and miscellaneous factors such as genetic bottlenecks, loss of pollinating insects, the presence of plant pests and diseases.

The Wisconsin Natural Heritage Working List (WDNR 2009) includes a total of 49 vascular plants that have been documented in this ecological landscape in recent decades. Of these, 11 species are Wisconsin Endangered, 12 are Wisconsin Threatened, and 26 are Wisconsin Special Concern (Appendix 19.C). One Wisconsin Endangered plant, the prairie white-fringed orchid (*Platanthera leucophaea*), is listed by the U.S. Fish and Wildlife Service as U.S. Threatened.

The Wisconsin Endangered bluestem goldenrod reaches its range extremities in rich, maple-beech forests in the southeastern corner of Wisconsin. Milwaukee County. Photo by Wisconsin DNR staff.

The remnant oak savannas and coastal prairies of southeastern Wisconsin are among the Upper Midwest's richest repositories of native plants. Photo by William E. Tans.

Prairie white-fringed orchid is a globally rare plant (listed as U.S. Threatened; Wisconsin Endangered) that is restricted to high quality prairie and fen remnants in only a few of Wisconsin's ecological landscapes, including the Southern Lake Michigan Coastal Ecological Landscape. Photo by William S. Alverson.

The Wisconsin Threatened forked aster is a globally rare plant that has been found in forests and woodlands at several sites in southeastern Wisconsin. Photo by Ryan O'Connor, Wisconsin DNR.

Several plant species found in the Southern Lake Michigan Coastal Ecological Landscape are globally rare, including pale false foxglove (*Agalinis skinneriana*), forked aster (*Aster furcatus*), sweet-scented Indian-plantain (*Cacalia suaveolens*), and the prairie white-fringed orchid. This ecological landscape is especially important to the conservation of forked aster and prairie white-fringed orchid because multiple populations of these species occur here, and several of them are large.

Additional plants that are rare elsewhere in Wisconsin but for which there are especially significant conservation opportunities here because of disproportionately strong representation include prairie milkweed (*Asclepias sullivantii*), false hop sedge (*Carex lupuliformis*), marsh blazing star (*Liatris spicata*), smooth phlox (*Phlox glaberrima* ssp. *interior*), reflexed trillium (*Trillium recurvatum*), and smooth black-haw (*Viburnum prunifolium*).

The state's only tree with statutory protection, the Wisconsin Threatened blue ash (*Fraxinus quadrangulata*), is represented here by the largest of its two extant populations. Both Wisconsin populations of the extremely rare. Wisconsin Endangered heart-leaved plantain (*Plantago cordata*) occur here, as do all three known occurrences of the Wisconsin Endangered ravenfoot sedge (*Carex crus-corvi*).

The prairies along Lake Michigan in southeastern Kenosha County are extraordinarily diverse, harboring over 400 species of native vascular plants (over 20% of Wisconsin's native plant species). Many of these species are now rare as are the prairie and wetland communities upon which these plants depend. The remaining acreage of prairie, meadow, fen, and marsh in this ecological landscape serves as a continentally significant reservoir of native plant and natural community diversity.

Hardwood forests now persist primarily in city or county parks, along undeveloped and flood-prone stream corridors, or as farm woodlots. A surprisingly high number of rare species persist in the remnant forests, such as blue ash, smooth black-haw (a tall upland shrub), bluestem goldenrod, American gromwell (*Lithospermum latifolium*), and reflexed trillium. Aquatic habitats within the ecological landscape's remnant forests may also support highly sensitive species, including one of Wisconsin's rarest native plants, heart-leaved plantain. Heart-leaved plantain now occurs at only two locations in Wisconsin, both in this ecological landscape, where calcareous headwaters streams run through mature, relatively undisturbed stands of mesic maple-beech forest. Ephemeral (or vernal) Ponds are temporary aquatic features that occur mostly within upland hardwood forests in poorly drained areas on ground moraine. These ponds provide habitat for rare plants such as the ravenfoot sedge or false hop sedge.

Habitat specialists such as American sea-rocket (*Cakile edentula*), seaside spurge (*Euphorbia polygonifolia*), and sand reedgrass (*Calamovilfa longifolia* var. *magna*) are almost entirely dependent on open beach and dune habitats along the Lake Michigan shore. The now U.S. Threatened dwarf lake iris (*Iris lacustris*) had been collected from beaches in the vicinity of Milwaukee early in the 19th century by Increase Lapham but has not been seen in that area in well over a century and is almost certainly extirpated from southeastern Wisconsin. The semi-stable calcareous clay bluffs created by Lake Michigan wave action along the eastern edge of this ecological landscape in southeastern Milwaukee and northeastern Racine counties support sensitive plants such as sticky false asphodel (*Tofieldia glutinosa*), lesser fringed gentian (*Gentianopsis procera*), and Ohio goldenrod (*Solidago ohioensis*), species that also occur in the alkaline prairies, sedge meadows, and fens of southeastern Kenosha County mentioned above.

In the Southern Lake Michigan Coastal Ecological Landscape, there are scattered outliers of vegetation types and species populations that are more characteristic of regions north of the ***Tension Zone***. These outliers are referred to in Wisconsin as "Bog Relicts," a shrub community that is dominated by coniferous trees, especially tamarack, and sometimes support understory plants that are more typical of northern Wisconsin wetlands such as sphagnum mosses (*Sphagnum* spp**.**), some peatland sedges (e.g., *Carex lasiocarpa, C. leptalea*), and ***ericaceous shrubs***. The latter include leather-leaf (*Chamaedaphne calyculata*), cranberries and blueberries (*Vaccinium* spp.), and bog-rosemary (*Andromeda glaucophylla*). Carnivorous species generally associated with boggy environments (some of these also occur in other communities) such as bladderworts (*Utricularia* spp.), sundews (*Drosera* spp.), and purple pitcher-plant (*Sarracenia purpurea*) may also be present. Many of southeastern Wisconsin's Bog Relicts have fared poorly in recent decades due to the effects of hydrological disruption, excess nutrient inputs, past grazing,

Significant Flora in the Southern Lake Michigan Coastal Ecological Landscape

- Rare plants of especially high conservation significance due to global rarity and/or very limited Wisconsin distribution include blue ash, hairy fimbristylis (*Fimbristylis puberula*), heart-leaved plantain, forked aster, bluestem goldenrod, prairie white-fringed orchid, and ravenfoot sedge.
- Geographic location is a significant factor in rare plant distribution here.
- Post-Pleistocene events created landforms along Lake Michigan that provide habitat for some of this ecological landscape's rarest plants.
- The remnant prairies of this ecological landscape support an exceptionally diverse native grassland flora.
- Rare, highly specialized fen plants occur in wetlands that receive a constant supply of clean, cold, calcareous groundwater.
- Rare plant species found nowhere else in the state persist in some of the few relatively undisturbed hardwood forests here.
- Aquatic habitats such as ephemeral ponds and undisturbed calcareous headwaters streams support rare plants such as ravenfoot sedge and heart-leaved plantain.

Lesser -fringed gentian is limited to alkaline habitats such as Calcareous Fen, Wet-mesic Prairie, Interdunal Wetland, and Great Lakes Alkaline Rockshore. Photo by Thomas Meyer, Wisconsin DNR.

infestations of invasive plants, absence of periodic fire in the surrounding uplands, removal of adjoining forests, desiccation, and perhaps, climate change.

The steep-sided ravines that have been cut into deep lacustrine clays by small streams entering Lake Michigan feature cool, moist microclimates that have permitted the establishment and persistence of characteristic northern Wisconsin plants such as northern white-cedar and eastern white pine. In most, if not all cases, these northern plants are locally rare but common elsewhere in the state.

Despite its small size, high degree of development, and tremendous loss of native vegetation, the Southern Lake Michigan Coastal Ecological Landscape continues to provide critical habitat for numerous rare native plants. These include species that are globally rare, others that are poorly represented or absent elsewhere in the state, and a number that are dependent on the maintenance and restoration of some of our rarest and most threatened natural communities, such as Oak Openings, Wet-mesic Prairie, and Calcareous Fen.

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 documented as occurring in the Southern Lake Michigan Coastal 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).

American bison (*Bos bison*) were reported in 1674 by Marquette along the shores of Lake Michigan near modern-day Racine (Figure 19.5). They were probably never very abundant, but this is unclear. American bison were more frequently reported to the west and northwest of this ecological landscape. American bison disappeared early from this ecological landscape due to the arrival of Euro-American settlers, overhunting, and conversion of the prairie to agricultural use (Schorger 1937).

Elk (*Cervus canadensis*) occurred here but declined rapidly after 1800 (Figure 19.6). They favored the prairies and oak savannas, where they intermingled with American bison. No elk were reported between Chicago and Milwaukee in 1800, but elk were reported as plentiful in this area in the winter of 1827–28 (Schorger 1954). Elk likely disappeared shortly thereafter from this ecological landscape.

The gray wolf (*Canis lupus*) was found in this ecological landscape but declined quickly after human settlement (Schorger 1942a). It ate primarily white-tailed deer (*Odocoileus virginianus*) and eastern cottontails (*Sylvilagus floridanus*). Schorger (1942a) recorded an 1839 report of gray

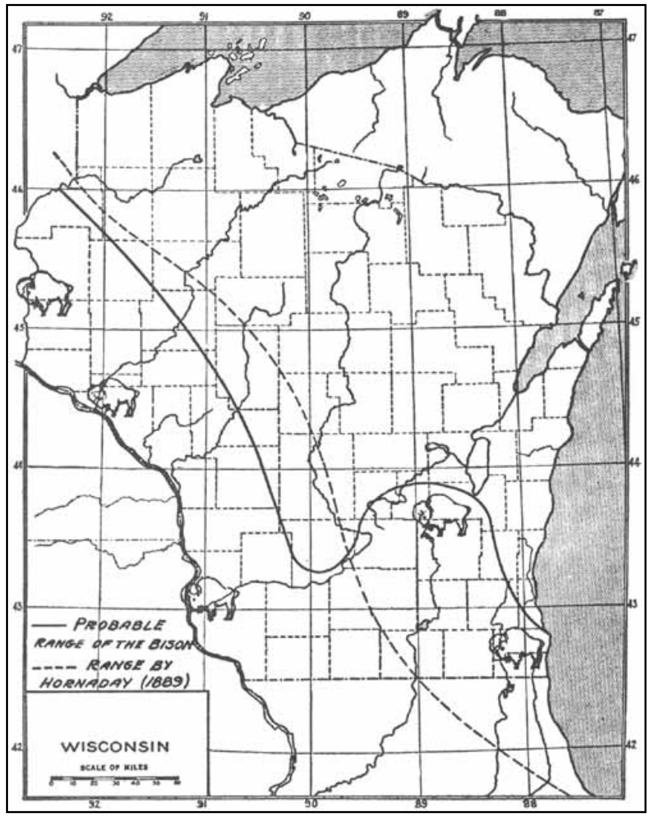


Figure 19.5. *Probable range of the bison in Wisconsin prior to Euro-American settlement. Figure reproduced from Schorger (1937) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

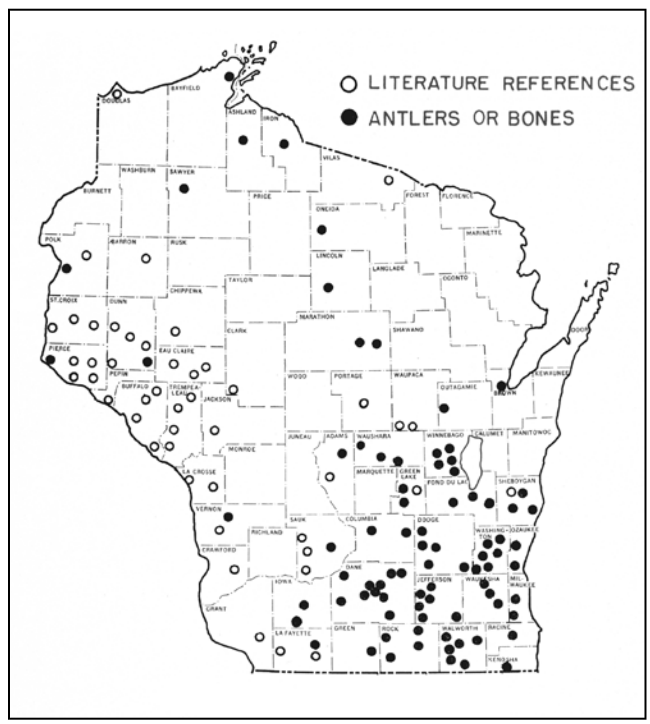


Figure 19.6. *Historical records of elk in Wisconsin. Figure reproduced from Schorger (1954) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

wolves in southeastern Wisconsin and an 1871 report of a gray wolf shot in Waukesha County.

The American beaver (*Castor canadensis*) was historically present along streams, rivers, and inland lakes but likely declined quickly in the late 1700s as the fur trade intensified and human settlement increased (Schorger 1965). The remains of old American beaver dams were reported in 1855 in Milwaukee County and as late as 1903 in Racine County. Milwaukee was a trading and shipping center for American beaver pelts from the area south and east of the Wisconsin and Fox rivers. The last recorded shipment of American beaver pelts from Milwaukee was 21.5 pounds in 1822. Today the American beaver still occupies some of the rivers and inland lakes in this ecological landscape where appropriate habitat exists.

The North American river otter (*Lutra canadensis*) was historically present in this ecological landscape and thought to be as abundant as, or more abundant than, the American beaver. North American river otters typically inhabit streams, rivers, and inland lakes, but there are some records of North American river otters using the shores of Lake Michigan. North American river otters were considered plentiful in Kenosha County in 1837 and were recorded as one of the indigenous animals in Milwaukee County in 1855 (Schorger 1970). There are records of harvested North American river otters in 1886 in Racine County. North American river otter numbers undoubtedly declined as did the American beaver as trapping pressure and settlement increased. North American river otter pelts were being traded and sold in Milwaukee from at least 1760 to 1840. North American river otters are still present in this ecological landscape today along rivers and streams with suitable fish populations and riparian habitat.

The Greater Prairie-Chicken (*Tympanuchus cupido*) was abundant here. There are reports that Greater Prairie-Chickens were brought into Milwaukee in 1842 "by the sleigh load" for the market and were considered "common fare" on the table (Schorger 1943). They were considered abundant through the 1850s. Numbers began plummeting by 1857 after a series of severe winters, wet cold springs, and years of market hunting and trapping. With the building of railroads, great numbers of Greater Prairie-Chickens were shipped to Chicago and cities to the east such as New York and Washington. By 1852 laws were passed to protect Greater Prairie-Chickens from hunting and trapping from January through August. Later, habitat loss due to succession of prairie and other open habitats to brush with the lack of fire and plowing of the prairies for agriculture further contributed to their decline. At first agriculture seemed to cause the Greater Prairie-chicken population to increase, but as agriculture became more intensive, populations declined. They are not found anywhere in the ecological landscape today.

The Sharp-tailed Grouse (*Tympanuchus phasianellus*) was historically very common, primarily occupying oak openings and brushy areas. It was considered the "commoner of the two species of prairie grouse" in southern Wisconsin and as being abundant in this ecological landscape (Schorger 1943). As prairie fires ceased, it only took a few years before the land was covered with brush, a habitat more suitable for Sharp-tailed Grouse. They were considered common in the Racine area but became rare throughout southeastern Wisconsin by 1852 and were thought to be nonexistent there by 1856. Therefore, it was never sent to the markets of the east after the railroads were built, as was the Greater Prairie-Chicken. Plowing of the prairies for agriculture and succession of brushy areas to forest in the absence of fire were thought to have caused the rapid decline of Sharp-tailed Grouse in this region. There are no Sharp-tailed Grouse in the ecological landscape today.

Introduction of a variety of races of Ring-necked Pheasants (*Phasianus colchicus)* began in the 1890s. In 1895 the Wisconsin legislature passed a law making it illegal to "take, catch, or kill any Mongolian, Chinese, or English Pheasants, or any other variety of pheasant for a period of 5 years" to provide protection while establishing populations of these nonnative birds (Schorger 1947). Many early releases were unsuccessful, but the Ring-necked Pheasant became established in this area and persists today.

The Wild Turkey (*Meleagris gallopavo*) was present in historical times. After a severe winter in 1842–1943, the Wild Turkey population declined dramatically and never recovered (Schorger 1942b). Prior to reintroduction efforts in the 1970s, the last documented record of a Wild Turkey near Racine was in the fall of 1846. Wild Turkeys have since been reintroduced (several times, most recently in 1976) and can be found in the ecological landscape today.

Although central Wisconsin is usually thought to have been the prime nesting area for the Passenger Pigeon (*Ectopistes migratorius*), they undoubtedly nested in this ecological landscape as well. One of their primary foods was beechnuts, which were found in southeastern Wisconsin (Schorger 1946). When beechnuts were abundant (every other year), large number of Passenger Pigeons nested and successfully produced young. Indiscriminate hunting and trapping on the nesting grounds and sale of Passenger Pigeons at city markets across the eastern part of the country caused the extinction of this species from the wild by 1899. In 1914 the last captive Passenger Pigeon died, and the species became extinct.

Significant Wildlife

Wildlife are considered significant for an ecological landscape if (1) the ecological landscape is considered important for maintaining the species in the state, and/or (2) the species provides important recreational, social, and economic benefits to the state. To ensure that all species are maintained in the state, "significant wildlife" includes both common species and species that are considered "rare." Four categories of species are discussed (note that these may overlap for some species): rare species, Species of Greatest Conservation Need (SGCN), responsibility species, and socially important species (see definitions in text box). As conservation of wildlife

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 2005b) as those native wildlife species that have low or declining populations, are "indicative of the diversity and health of wildlife" of the state, and need proactive attention in order to avoid additional formal protection.
- **Responsibility species** are both common and rare species whose populations are dependent on Wisconsin for their continued existence (e.g., a relatively high percentage of the global population occurs in Wisconsin). For such a species to be included in a particular ecological landscape, a relatively high percentage of the state population needs to occur there, or there are good opportunities for effective population protection and habitat management for that species. 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 at this time.
- **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.

and habitats are the most ecologically and economically 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 book, "rare" animals include 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 either the State of Wisconsin or the federal government. See Appendix 19.C at the end of this chapter for a comprehensive list of the rare animals known to exist in the Southern Lake Michigan Coastal Ecological Landscape. As of November 2009, the Wisconsin Natural Heritage Inventory documented 27 rare animal species within the Southern Lake Michigan Coastal Ecological Landscape.

Federally Listed Species: No federally endangered or threatened animals occur in the Southern Lake Michican Coastal Ecological Landscape. One species that is being considered for federal listing that historically occurred in the ecological landscape is the eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*). However, it has not been found here since 1977 despite extensive surveys and is considered extirpated from this ecological landscape.

Wisconsin Endangered Species: No Wisconsin Endangered mammals occur here. Three Wisconsin Endangered birds: Peregrine Falcon (*Falco peregrinus*), Forster's Tern, and Common Tern (*Sterna hirundo*); three herptiles: northern cricket frog (*Acris crepitans*), queen snake (*Regina septemvittata*), and eastern massasauga rattlesnake; two fishes: skipjack herring (*Alosa chrysochloris*) and striped shiner (*Luxilus chrysocephalus*), although it has not been found here in the last ten years; no mussels; and two invertebrates: Silphium borer moth (*Papaipema silphii*) and red-tailed prairie leafhopper (*Aflexia rubranura*) occur, or had occurred fairly recently, in this ecological landscape (WDNR 2009). The Common Tern nested in this ecological landscape in the 1990s but is not a breeding bird here at this time (2009). The eastern massasauga rattlesnake has not been found in this ecological landscape since 1977, the queen snake since 1971, and the northern cricket frog since 1987.

Wisconsin Threatened Species: No Wisconsin Threatened mammals occur in this ecological landscape. Wisconsin Threatened species documented here include four birds: Henslow's Sparrow (*Ammodramus henslowii*), Great Egret (*Ardea alba*), Red-shouldered Hawk (*Buteo lineatus*), and Osprey (*Pandion haliaetus*); two herptiles: Blanding's turtle (*Emydoidea blandingii*) and Butler's gartersnake (*Thamnophis butleri*); and four fishes: longear sunfish (*Lepomis megalotis*), redfin shiner (*Lythrurus umbratilis*), greater redhorse (*Moxostoma valenciennesi*), and pugnose shiner (*Notropis anogenus*) (WDNR 2009). No Wisconsin Threatened mussels, insects, or other invertebrates have been documented within the Southern Lake Michigan Coastal Ecological Landscape.

Wisconsin Special Concern Species: Wisconsin Special Concern species occurring here include one mammal, eight birds, one herptile, five fish, and 12 invertebrate species (see Appendix 19.C for a complete list of Wisconsin Special Concern species as of November 2009 (WDNR 2009).

Species of Greatest Conservation Need. Species of Greatest Conservation Need (SGCN) are those that appear in the Wisconsin Wildlife Action Plan (WDNR 2005b). SGCN include species already recognized as endangered, threatened, or special concern on Wisconsin or U.S. lists but also include more common species that are declining. Only vertebrate species were considered for SGCN in the 2005 plan. Species listed as SGCN for the Southern Lake Michigan Coastal Ecological Landscape include two mammals, 35 birds, five herptiles, and three fish (see Appendix 19.E for a complete list of vertebrate SGCN in the Southern Lake Michigan Coastal Ecological Landscape and the habitats with which they are associated).

Responsibility Species. There are a number of species for which management within this ecological landscape is important to sustain their populations. Peregrine Falcons have been reintroduced, and a resident population now nests on tall buildings or other structures. This population feeds primarily on the abundant Rock Pigeons (*Columba livia*) that occur in the major cities. Migratory Peregrine Falcons from breeding areas in the Arctic use the Lake Michigan shoreline as part of their migration route in spring and fall.

The Wisconsin Threatened Butler's gartersnake occurs only in the southeastern part of Wisconsin, mostly in the Southeast Glacial Plains and Southern Lake Michigan Coastal, and to a lesser extent in the Central Lake Michigan Coastal Ecological Landscape. The Wisconsin population is separated by hundreds of miles from the main part of its range in southeastern Michigan, northeastern Indiana, and northwestern Ohio. Butler's gartersnake relies heavily on wetlands bordering streams, where it overwinters in the burrows of the prairie crayfish (*Procambarus gracili*). Butler's gartersnake favors short-grass prairie uplands but has adapted to nonnative grasses, such as Kentucky bluegrass (*Poa pratensis*), that are now prevalent in open upland habitats in southern Wisconsin.

A rare species that was formerly important here was the queen snake, which was only found in southeastern Wisconsin where it inhabited clear spring-fed streams with flowing water and rocky bottoms. However, it has not been found in this ecological landscape since 1971.

The Wisconsin Special Concern prairie crayfish occurs here and inhabits wet prairies and other grasslands, usually where the water table is near the surface, although burrows have been known to go more than 6 feet deep.

Among fishes formally listed as Wisconsin Endangered, Threatened, or Special Concern, the Milwaukee River Watershed may be the only place in the state where the Wisconsin Endangered striped shiner might still remain, but it has not been documented here in the last ten years. The viability of this species here and in the state as a whole is questionable.

Ice conditions permitting, Lake Michigan waters hosts large numbers of diving ducks in winter. One of the important species is the Long-tailed Duck. Photo by Wolfgang Wander.

Conservation of the Wisconsin Threatened Butler's gartersnake has been exceptionally challenging, due in part to its presence in heavily developed areas in southeastern Wisconsin. Photo by Rori Paloski, Wisconsin DNR.

The prairie crayfish is inhabits tallgrass prairies. Photo by Matthew Ignoffo.

Adult striped shiner, side view. Photo by John Lyons, Wisconsin DNR.

However, if restoration of this species were contemplated, this would be one of the important ecological landscapes to consider for these efforts because of its historical presence here.

Several species of globally rare invertebrates are found at Chiwaukee Prairie. Examples include the Liatris borer moth (*Papaipema beeriana*), Silphium borer moth, and red-tailed prairie leafhopper. These insects are dependent on specific plants to complete their life cycle. The obligate host plants for these invertebrates are more abundant at the Chiwaukee site than at most other prairie remnants in the state.

■ Socially Important Fauna. There is an important fishery of introduced, nonnative salmonid species in Lake Michigan. Rainbow (steelhead) (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) and chinook and coho salmon are present in some tributary streams flowing into Lake Michigan due to Lake Michigan stocking efforts. There is no natural reproduction of coho or chinook salmon and no or very poor reproduction in steelhead and brown trout in these streams. There is an important warmwater fishery in inland waters that supports populations of largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), and other panfish. Paddock, Browns, Rock, and Silver lakes are popular among anglers for game fish and panfish. White-tailed deer inhabit many suburban areas and their overabundance has become a problem, with increasing car-deer collisions and damage to ornamental plants. Efforts have been made to control white-tailed deer numbers in some municipalities by trapping and removing and/or by shooting. Coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and striped skunks (*Mephitis mephitis*) inhabit cities and suburbs, causing problems for urban residents by foraging in trash cans and harassing pets. Resident Canada Geese (*Branta canadensis*) and Mallards (*Anas platyrhynchos*) utilize artificial ponds and other water bodies to breed and have caused a nuisance for urban dwellers by defecating on lawns, golf courses, cemeteries, and beaches. Many other species of birds and wildlife are important for wildlife watching in this ecological landscape.

■ Wildlife Habitat and Communities. This ecological landscape contains important wildlife species associated with Lake Michigan and its shoreline (used for both migration and breeding), inland lakes, rivers and streams, and grasslands

Significant Wildlife in the Southern Lake Michigan Coastal Ecological Landscape

- Lake Michigan waters are important staging and wintering areas for many species of migratory waterfowl.
- The Lake Michigan shoreline is an important migratory route for raptors, gulls, terns, shorebirds, waterbirds, passerines, and others.
- Important Lake Michigan fish are yellow perch, lake sturgeon, lake trout, and introduced salmonid species.
- Large "grasslands" support significant nesting assemblages of declining grassland birds and other fauna.
- Several species of globally rare invertebrates are found at Chiwaukee Prairie.
- Peregrine Falcons nest on tall buildings or other structures.
- This ecological landscape is very important for rare species such as Butler's gartersnake, queen snake, prairie crayfish, and striped shiner, although it has not been found here in the last ten years.
- Overabundant white-tailed deer, Canada geese, ducks, and coyotes can cause ecological and social problems.

Efforts are ongoing to restore some of the native fish populations, such as lake sturgeon (shown here), that have disappeared or declined in this ecological landscape. Photo by William Wawrzyn, Wisconsin DNR.

*At least a few Snowy Owls (*Bubo scandiacus*) can be found along the Lake Michigan shoreline during most winters. Birds that take up temporary residence in urban areas often draw considerable attention from birders and others. Photo by Robert Kuhn.*

(see below). One Important Bird Area has been designated within or partially within the Southern Lake Michigan Coastal Ecological Landscape (Richard Bong State Recreation Area, Steele 2007; see the map "Ecologically Significant Places of the Southern Lake Michigan Coastal Ecological Landscape" in Appendix 19.K at the end of this chapter).

The waters of Lake Michigan are important migrating and wintering areas for birds that require large and/or deep bodies of water. Species making significant use of Lake Michigan during migration periods include Common Loon (*Gavia immer*), Horned Grebe (*Podiceps auritus*), Black Scoter (*Melanitta nigra americana*), Surf Scoter (*Melanitta perspicillata*), and White-winged Scoter (*Melanitta fusca deglandi*). Species that use Lake Michigan nearshore waters for wintering are Greater Scaup (*Aythya marila),* Lesser Scaup (*Aythya affinis*), Bufflehead (*Bucephala albeola*), Common Goldeneye (*Bucephala clangula*), Red-breasted Merganser (*Mergus serrator*), and Long-tailed Duck (*Clangula hyemalis*). Wisconsin DNR data from aerial surveys conducted in January (2001–2005) indicate that the Milwaukee Harbor has large numbers of Greater and Lesser Scaup, Common Goldeneye, Bufflehead, Common and Red-breasted Merganser, and large wintering populations of Long-tailed Ducks in some years (Wisconsin DNR unpublished data). A more comprehensive recent survey showed that tens of thousands of diving ducks and other water birds are using offshore habitats, some of them as many as 10 miles from shore (Mueller et al. 2010). Three waterfowl species comprised over 87% of the total waterfowl seen during this fall, winter, and spring survey in 2010–2011: Long-tailed Duck (47.6%), Red-breasted Merganser (29.9%), and Common Goldeneye (9.6%). The Red-breasted Merganser was found in the fall, winter, and spring surveys and was distributed all along the west coast of Lake Michigan (Figure 19.7), showing a concentration area off the Milwaukee Harbor.

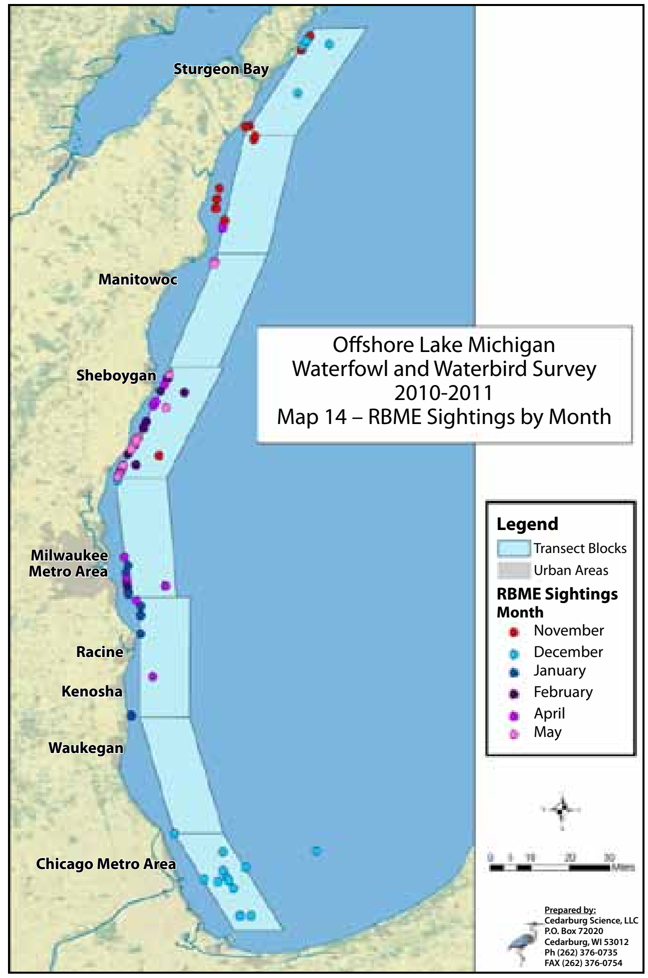


Figure 19.7. *Location of Red-breasted Mergansers on the west shore of Lake Michigan in 2010–2011. Figure provided by William Mueller of Western Great Lakes Bird and Bat Observatory and Ginny Plumeau, Amy Wagnitz, and Cindy Burtley of Cedarburg Science LLC.*

The Lake Michigan shoreline is important for many migratory birds and other wildlife. Patches of natural or semi-natural relatively undeveloped habitat along the Lake Michigan shoreline can attract large numbers of shorebirds, gulls, terns, raptors, and passerines during spring and fall migrations. Other species that migrate along the shoreline include several insects including dragonflies and butterflies such as the monarch (*Danaus plexippus*).

Yellow perch, lake whitefish (*Coregonus clupeaformis*), lake trout (*Salvelinus namaycush*), and lake herring (*Alosa chrysochloris*) were the most sought after native fish species in Lake Michigan by commercial fishermen. Additionally, sport anglers pursued northern pike, smallmouth bass (*Micropterus dolomieu*), and walleye (*Sander vitreus*). However, the indigenous fish community of Lake Michigan has been drastically altered by the invasion of exotic species such as sea lamprey, rainbow smelt, zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussels, alewife, the introduction of three species of salmon, heavy fishing pressure, and habitat degradation. Indigenous species such as lake sturgeon stocks were drastically reduced in the early 1920s from overexploitation and habitat degradation; lake trout stocks were extirpated in the 1950s with the dramatic increase in sea lamprey abundance; and yellow perch, lake herring, burbot (*Lota lota*) and bloater chub (*Coregonus hoyi*) all declined precipitously in the 1960s following the explosion of alewife.

First appearing in Lake Michigan in 1949 via the Welland Canal, by the 1960s the alewife comprised up to 80% of the total fish biomass in Lake Michigan. Great numbers of alewife died and washed up on Lake Michigan beaches during the 1960s, due to the difficulty this species has with dealing with quickly changing temperatures when they move to nearshore waters to spawn and the stress of spawning itself. Their decay left a rotten odor along shorelines and beaches, creating a major public nuisance. However, the alewife continued to persist and remain abundant in Lake Michigan waters. Chinook and coho salmon and brown and rainbow trout were introduced in the late 1960s to reduce the burgeoning alewife population and create an enhanced sport fishery. Since then, sport angling, especially charter boat fishing, has centered on these populations of nonnative salmonids, which are sustained by stocking and have no natural reproduction in Lake Michigan. Lake Michigan tributaries (in this and other Lake Michigan coastal ecological landscapes) are unsuitable and/or too degraded to allow survival of progeny. Most tributaries in the Lake Michigan basin have been impaired by eutrophication, sedimentation, toxic contamination, and damming, compromising tributary conditions and their suitability as spawning and nursery habitats. Eggs are taken from fish migrating into these tributary rivers to spawn and then reared in hatcheries. The Root River Steelhead Facility in the city of Racine (Racine County) is one of three major egg-collection locations along the Lake Michigan shore for producing trout and salmon for stocking in the Wisconsin waters of Lake Michigan (the other two facilities are the Besadny Anadromous Fish Facility on the Kewaunee River in Kewaunee, Kewaunee County, and Strawberry Creek in Door County).

Historically, Lake Michigan supported a "species group" of six species of deepwater ciscoes or "chubs": bloater chub, lake herring, deepwater cisco (*Coregonus johannae*), kiyi (*C. kiyi*), shortnose cisco (*C. reighardi*), and shortjaw cisco (*C. zenithicus*). Currently, only the bloater chub persists; the other five have been extirpated from Lake Michigan (the deepwater, and shortnose ciscos are globally extinct, but kiyi, lake herring, and shortjaw cisco persist in Lake Superior). The taxonomic validity of several of these species is questionable, but regardless of their taxonomic status, they represent unique evolutionary lineages worthy of preservation. Unfortunately, given the highly modified habitats and existing biological community of southern Lake Michigan, it is unlikely that any of the surviving cisco species could be reintroduced here without major environmental changes in the lake."Although this aquatic ecosystem has been greatly altered by past land uses, exploitation, and the invasion or introduction of nonnative species, Lake Michigan is still an extremely important aquatic resource for fish and wildlife. Several offshore reefs exist that are important for spawning yellow perch and reintroduced lake trout. Coho salmon provide an important recreational resource but can have impacts on the aquatic food chain by depleting forage fish populations such as alewife and smelt. Lake sturgeon and walleye have been reintroduced into Lake Michigan's nearshore waters in the Southern Lake Michigan Coastal.

Important rare fish species inhabiting inland waters include the greater redhorse, river redhorse (*Moxostoma carinatum*), banded killifish (*Fundulus diaphanus*), lake chubsucker (*Erimyzon sucetta*), least darter (*Etheostoma microperca*), longear sunfish, redfin shiner, pugnose minnow (*Opsopoeodus emiliae),* pugnose shiner, and the Wisconsin Endangered striped shiner, although it has not been found here in the last ten years.

Other aquatic fauna that are important in this ecological landscape are the Blanding's turtle, queen snake, mudpuppy (*Necturus maculosus maculosus*), and prairie crayfish.

A majority of the forest and savanna remnants here are too small and isolated to provide significant breeding habitat for most birds or secure permanent habitat for area or disturbance-sensitive mammals or herpetofauna. Small or linear patches of forest, especially along the ecological landscape's waterways, do receive heavy use by migratory birds of many kinds, including important groups of neotropical migrants such as wood warblers, vireos, flycatchers, and thrushes.

"Grasslands," including open wetlands (marshes and sedge meadows), prairies, and surrogate grasslands (old fields, CRP) support significant nesting assemblages of declining grassland birds. The more extensive terrestrial grassy habitats are important for breeding Upland Sandpiper (*Bartramia longicauda*), Henslow's Sparrow, Sedge Wren (*Cistothorus platensis*), and Bobolink (*Dolichonyx oryzivorus*) as well as wintering populations of species such as Short-eared Owl (*Asio flammeus*). Other important species that use grasslands here are Blue-winged Teal (*Anas discors*), Marbled Godwit (*Limosa fedoa*), Buff-breasted Sandpiper (*Tryngites subruficollis*), Northern Harrier (*Circus cyaneus*), Butler's gartersnake, and Franklin's ground squirrel (*Spermophilus franklinii*). If the grassland has a shrub component, it may be used by Species of Greatest Conservation Need such as Bell's Vireo (*Vireo bellii*), Brown Thrasher (*Toxostoma rufum*), and Field Sparrow (*Spizella pusilla*).

Natural and Human Disturbances

The Southern Lake Michigan Coastal Ecological Landscape, once covered by prairie, oak savanna, oak forest, and maple-beech-basswood forest, has been greatly changed by human disturbances since Euro-American settlement. Urban, exurban, and industrial development and agriculture have extensively altered the surface features of the land, disrupted the drainage patterns and hydrology, and changed land cover and natural disturbance regimes. This ecological landscape is more highly impacted by human disturbance than any other in Wisconsin.

WISCLAND land use/land cover data from 1992 show that about 38% (206,290 acres) of the ecological landscape was in agricultural use, 16% (88,770 acres) was "grassland" (almost all nonnative), and 24% (126,870 acres) was urban (WDNR 1993). This is a much higher percentage of urban land than occurs in any other ecological landscape and is an indicator of the extent to which this ecological landscape has been modified by humans since the mid-19th century.

Fire, Wind, and Flooding

The southern portion of this ecological landscape was historically dominated by tallgrass prairie, bur oak savanna, and white-black-bur oak forest (Finley 1976). The patterning and composition of vegetation in this ecological landscape was largely due to fire regimes that existed for 5,000–6,000 years (Bray 1960). Fires are known to be essential in maintaining tallgrass prairie and savanna, but there is disagreement about how frequently and intensely they burned prior to Euro-American settlement. Prairies may have burned at intervals of one to five years (Curtis 1959) and savannas at approximately 16-year intervals (Leitner et al. 1991). Activities of American Indians led to the ignition of many fires that maintained these community types both here and throughout the Midwest. Early Euro-American surveyors and travelers described extensive fires set by American Indians, which were particularly common in late fall. Furthermore, the only explanation for the open understories of oak forests and savannas is that surface fires of relatively low intensity must have been frequent at this time; otherwise, shrubs and vines would have become rampant (Olson 1996). Although lightning strikes are also known to have started fires, these would have been too few to account for the large areas burned (Dorney 1981) or the extent of fire-adapted vegetation. For prehistoric times, there is fair amount of circumstantial evidence that fire was probably used by human populations thousands of years ago to alter the vegetation (Bray 1995). Railroad fires may have maintained a more frequent fire regime from the 1870s to around 1920.

Historical fires would not have occurred with similar frequencies and intensities at all times because weather and climate conditions fluctuated. Burning patterns of American Indians are also likely to have varied over time. Differences in fire extent and severity would have led to spatially dynamic vegetative communities, with boundaries of forest, savanna, or prairie expanding or contracting depending on their relationship with fire.

The historical fire regime is not evident in today's highly modified landscape except in a few reserve areas where prescribed fire is used by managers attempting to maintain prairie vegetation, such as at Chiwaukee Prairie and Richard Bong State Recreation Area. In many areas, fire exclusion has allowed woody shrubs, including several prolific and aggressive nonnative species as well as the saplings of shade-tolerant tree species, to become abundant in forest understories and many open lands. These species produce litter that does not carry fire as well as dry oak leaves and prairie grasses, presenting further difficulty in the use of fire as an effective management tool.

In the northern part of the Southern Lake Michigan Coastal Ecological Landscape, a rougher, more dissected topography, broken by rivers (particularly the Menomonee River), lakes, and morainal ridges, presented barriers to the spread of fire. In these fire-protected areas, a forest dominated by sugar maple and American basswood developed. Near Wind Point, along Lake Michigan in Racine County, an area of beech-sugar maple-basswood forest was apparently protected from fire by the Root River and its associated riparian zones. These forests would have been most affected by wind disturbance, which created small canopy gaps at relatively frequent intervals. Large, extensive wind disturbances were probably uncommon since they were seldom referenced in the federal General Land Office's public land survey notes from the mid-1800s. However, some larger gaps created by wind, fire, or a combination of both would have been necessary to initiate development of the oak component. Browsing by native ungulates may also have played a role in forest composition and successional pathways.

Bottomland hardwood forests, found along rivers and streams in this ecological landscape, were historically disturbed by periodic episodes of high water. Disturbances included scouring by water, ice, and debris, sediment deposition, and periods of saturation or inundation interspersed with dry conditions. Vegetative composition, including successional trajectories, is affected by timing and severity of flooding. Flood regimes have been affected by dam construction in some parts of the ecological landscape (see the map "Dams of the Southern Lake Michigan Coastal Ecological Landscape" in Appendix 19.K) as well as by wetland drainage and filling, channelization, streambank stabilization, replacement of riparian vegetation and wetlands with lawns and agricultural fields, and development of transportation infrastructure, increasing amounts of impervious surfaces, all of which are associated with urban and exurban development.

Some drainage lakes (e.g., Big Muskego) have been dammed at their outlets, which has raised water levels and created more open water. This has resulted in the inundation of some shallow marshes and sedge meadows, reducing the extent of emergent vegetation. This alteration, along with sedimentation and the introduction of common carp, has led to the establishment of a completely different vegetative community. In some areas, hydrological modifications have been followed by the introduction and spread of highly invasive nonnative plants such as reed canary grass and Eurasian water-milfoil, often at the expense of native species and native plant diversity.

Forest Insects and Diseases

Emerald ash borer (*Agrilus planipennis*) is an exotic insect native to Asia. This extremely serious forest pest has been confirmed in 35 Wisconsin counties as of 2015, including the counties of the Southern Lake Michigan Coastal Ecological Landscape (WDATCP 2015). Affected counties have been placed under quarantine 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. Attempts to contain infestations in Michigan by destroying ash trees in areas where emerald ash borer was found have not been successful, perhaps because the insect was already well established before it was found and identified. The emerald ash borer typically kills a tree within one to three years. The emerald ash borer has been shown to feed on some shrub species such as privets (*Ligustrum* spp.) and lilacs (*Syringa* spp.), but it is still unknown as to whether shrub availability will contribute to its spread under field conditions. Because of the high percentage of ash trees in this ecological landscape (26%; USFS 2004), the emerald ash borer could have a significant impact on the tree composition here.

Asian longhorned beetle (*Anoplophora glabripennis)* is an insect not yet found in Wisconsin but would have major consequences if it were to become established. It is a major pest of maple species, including Norway (*Acer platanoides*), sugar, silver (*Acer saccharinum*), and red maples, and although it prefers maples, it will attack other hardwoods. Asian longhorned beetle was discovered in the Chicago area in 1998, and additional infestations have since been found in North America and Europe. The insect is believed to have entered North America inside wood packing materials and was likely introduced several times. The insect has thus far been contained in the Chicago area by destroying all susceptible trees in areas near where it has been found, but because new occurrences are occasionally discovered, a monitoring and eradication program continues. Because containment has been successful so far, there is hope that the insect may not become established in Wisconsin.

Dutch elm disease is caused by the fungus *Ophiostoma ulmi*, which is transmitted by two species of bark beetles or by root grafting. American elm (*Ulmus americana*) is more seriously affected than other elm species, but all of our native elms are somewhat susceptible, as is the nonnative Siberian elm (*Ulmus pumila*). American elm has essentially been eliminated as a component of the forest overstory (and as a shade tree on numerous city streets in urban areas) but is still a significant part of the understory and seedling layers. Its life span is typically now about 30 years before it succumbs to Dutch elm disease. The loss of American elm as a ***supercanopy*** or dominant tree has impacts on associated wildlife species, such as the Wood Duck (*Aix sponsa*). Reed canary grass may invade lowland hardwood forests that have been opened up by the death of the canopy elms. The thick, dense litter layer created by this nonnative grass may be a factor that is contributing to the poor regeneration of trees in some of these forests.

Gypsy moth (*Lymantria dispar*) is established throughout this ecological landscape. Its populations are expected to increase occasionally in the way a native insect would become more common at times. Impacts are expected to be variable, with some defoliations limited in extent and others larger. As gypsy moth defoliates trees, it is an additional stressor that can further weaken already drought-stricken or diseased trees. It is unlikely gypsy moth alone would kill a tree, but in combination with other factors, infestations could result in mortality. New England states are seeing a 30–40 year outbreak interval on average (but it is highly variable). Typically, drought precedes or coincides with gypsy moth outbreaks. Egg masses can be monitored to determine when a population increase large enough to produce defoliation is imminent.

Oak wilt is a vascular disease of oaks caused by the fungus *Ceratocystis fagacearum,* a species believed to be native to North America and known to occur in 21 states in the eastern and central U.S. The fungus plugs water-conducting vessels, causing leaves to wilt and fall, often killing the tree. All species of oak are susceptible, but species in the red oak group such as northern red, black, and northern pin (*Quercus ellipsoidalis*), are most readily killed. Once infected, trees can die within a few weeks. Oaks in the white oak group (white and bur) can be infected, but mortality occurs less frequently and more slowly. The fungus spreads from an infected tree to adjacent susceptible trees via root grafts, causing a progressively larger patch of oak forest to succumb to oak wilt. Sap-feeding beetles (Family Nitidulidae) and small oak bark beetles (*Pseudopityophthorus* spp.) can carry spores to nearby healthy trees.

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

Invasive Species

Due to the large scale and intensity of human development and disturbance, there are many nonnative invasive species that are now major problems here. Nonnative invasive plants and animals can outcompete native species and may eventually completely dominate a plant community, decreasing the abundance and diversity of native species and disrupting ecosystem function.

In forested community types, glossy and common buckthorn, nonnative honeysuckles, garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Dame's rocket (*Hesperis matronalis*), multiflora rose (*Rosa multiflora*), Norway maple, and black locust (*Robinia pseudoacacia*) already pose problems. These species may initially colonize disturbed areas and edges but once established can continue to invade surrounding habitats. In native prairie communities, problem species include nonnative grasses such as smooth brome (*Bromus inermis*), Kentucky bluegrass, and Canada bluegrass (*Poa compressa*); however, these nonnative species do provide habitat for grassland birds in surrogate grasslands. Other invasives are crown vetch (*Coronilla varia*), cut-leaved teasel (*Dipsacus laciniatus*), bird's foot trefoil (*Lotus corniculata*), white and yellow sweet clovers (*Melilotus alba* and *M. officinalis*), wild parsnip (*Pastinaca sativa*), and autumn olive (*Elaeagnus umbellata*). Invasive shrubs (e.g., glossy buckthorn, multiflora rose, and honeysuckles) are also serious problems in some remnant prairies.

Several native plant species in this area have become aggressive due to the alteration of "natural" (or historical) disturbance regimes (Rogers et al. 2008), grazing, or wetland drainage. These include prickly ash (*Zanthoxylum americanum*), red-osier dogwood (*Cornus stolonifera*), sumacs (*Rhus* spp.), river grapevine (*Vitis riparia*), and Virginia creeper (*Parthenocissus quinquefolia*). In some cases these plants may outcompete other native plants and result in community simplification.

In Lake Michigan, nonnative species such as the sea lamprey, alewife, round goby (*Neogobius melanostomus*), spiny water flea (*Bythotrephes cederstroemi*), and zebra and quagga mussels are affecting ecological functions in Lake Michigan.

By 1946 sea lamprey had invaded all of the Great Lakes and decimated some native fish populations such as lake trout, lake whitefish, and burbot. The decline of native fish populations created conditions that favored the explosive growth of nonnative invasive alewife populations, which in turn corresponded to reduced populations of yellow perch, cisco (*Coregonus* spp.), and lake herring. Fishery managers introduced nonnative salmon species in 1964, and these have effectively preyed upon alewife as a food source. These salmonid species have served to both reduce the alewife population and create a sportfishing industry. Smaller species of zooplankton became predominant because the alewife selectively preyed upon the larger zooplankton species (Wells 1960, W. Horns, Wisconsin DNR, personal communication).

Zebra mussel expansion appears to be associated with a precipitous decline in populations of the small, shrimp-like amphipod *Diporeia hoy*i that historically has supported an abundance of lake whitefish, lake trout, bloater chub, slimy sculpin (*Cottus cognatus*), and other species (Nalepa et al. 2005). Zebra mussels are also implicated in significant recent massive blooms of the filamentous green algae *Cladophora* because they provide both a substrate and deeper light penetration that promotes algal growth (GLWI 2015). More recently, zebra mussels seem to have been replaced in parts of Lake Michigan by a closely related, ecologically similar species, the quagga mussel. Some of the more recent mussel impacts, such as the possible link with *Cladophora* blooms, are probably caused by a combination of zebra and quagga mussels. The ability of these mussels to increase water clarity and increase the availability of phosphorus in the nearshore zone with their feces enhances the growth of *Cladophora*.

Rainbow smelt, which have recently declined in abundance, historically had a major effect on native fishes through predation on plankton and fish larvae. White perch (*Morone americana*) and threespine stickleback (*Gasterosteus aculaeatus*) are exotic species that are present, but their impacts in this ecological landscape are largely unknown.

Halting the introduction of additional exotic species will be one of the essential steps in allowing the Great Lakes ecosystem to at least partially recover from the disruptions caused by past colonizations. (Full recovery is not possible because of extinctions of native fish and the tremendous amount of development now affecting the Great Lakes.) This is one of the top nine priorities identified by the Council of Great Lakes Governors in December 2005 (GLRI 2005).

In inland aquatic and wetland ecosystems, Eurasian water-milfoil, curly pondweed (*Potamogeton crispus*), rusty crayfish (*Orconectes rusticus*), common carp, common reed (*Phragmites australis*), purple loosestrife, and reed canary grass are the primary problem species here.

Common carp, although present in the area for 125 years, continue to cause major problems in shallow lakes in the Southern Lake Michigan Coastal Ecological Landscape by destroying beds of aquatic plants and suspending fine sediments and associated nutrients. Large amounts of money and effort have been spent to control common carp here, most recently through the poisoning of Big Muskego Lake to kill all the common carp and replace them with more desirable native species. Common carp are also in Lake Michigan but are less of a problem there except in localized areas of shallow bays and harbors. Asian carp that are advancing from the Mississippi River drainage system toward Lake Michigan are another threat to the Great Lakes ecosystem (see the "Aquatic Resource Issues" section in Chapter 5, "Current and Emerging Resource Issues." Many inland lakes here are infested with zebra mussels. Another potential threat is the quagga mussel, which is established in Lake Michigan but not yet established in inland lakes in Wisconsin. However, it has recently (2015) been found in an inland lake chain in the state of Michigan (Ellison 2015). The potential ecological impact from these two mussel species in inland lakes has not yet been determined. The exotic rusty crayfish occurs in many inland lakes and rivers, where it sometimes reaches high densities, depleting native aquatic plant communities and interfering with fish spawning and feeding.

Another major inland lake problem is the exotic plant Eurasian water-milfoil. This submergent aquatic macrophyte reaches nuisance levels in many lakes, displacing more desirable native plants and forming thick, nearly impenetrable beds that impede boat traffic and hamper recreation. Local inland lake associations and governmental units spend large amounts of money and time to control Eurasian water-milfoil through mechanical harvesting and herbicide treatments. Purple loosestrife occurs in wetlands and along the shores of many lakes where it replaces native wetland vegetation and reduces or degrades wildlife habitat.

Mute swans (*Cygnus olor*) have established populations at the Muskego Lakes area and at other sites in Walworth, Racine, and Kenosha counties. In addition, there is a population nearby along the Southeast (or "Illinois") Fox River that poses a threat due to this species' ability and inclination to aggressively drive off native wildlife, its mobility and ability to establish new populations, and their consumption of large quantities of submerged vegetation.

Brown rats (*Rattus norvegicus*) were likely introduced into Wisconsin by ships or boats at ports along Lake Michigan in the east and along the Mississippi River in the west. Brown rats were reported in Prairie du Chien in 1823 and in the Southern Lake Michigan Coastal in 1840, when wheat was first raised near Racine. There are records indicating that quantities of stored wheat in the winter of 1840 were partly destroyed by brown rats. After that time, brown rats were reported as a nuisance throughout the ecological landscape. Brown rats continued to spread throughout central Wisconsin, initially via supply wagons and then more quickly with the completion of the railroads.

This ecological landscape is highly vulnerable to new invasions of problematic species. Human travel is a major vector for the transport of invasive species, and the combination here of a large human population, many different types of transportation, and a high level of interstate and intercity commerce make this ecological landscape a likely location for initial introductions. In addition, many invasive species are adapted to be highly competitive on disturbed sites, of which there are many due to continuing development. Some ornamental plants used in landscaping can spread and become invasive in native plant communities, a problem here because landscaping is a relatively important and lucrative industry.

For more information on invasive species and regulations that have been implemented to control them (Invasives Rule -NR 40), see the Wisconsin DNR's invasive species web page (WDNR 2015c).

Land Use Impacts

Historical Impacts. There have been dramatic changes in land use and land cover in this ecological landscape. Milwaukee became a major shipping port and industrial center early in Wisconsin's history. As Milwaukee developed, forests were cleared, wetlands were filled and drained, and streams were channelized to make way for factories and homes. In the areas surrounding Milwaukee and other large cities such as Kenosha and Racine, settlers plowed the prairies, drained the wetlands, and cut the forests for lumber and to make way for farmland. The vegetation cover went from forest (62% of ecological landscape), prairie and oak savanna (26%), and wetland (8%) at the time of Euro-American settlement (Finley 1976) to large urban-industrial areas centers surrounded by agricultural fields, scattered woodlots, riparian areas, pastures, and wetlands that were too difficult to drain. Urbanization continues to increase, resulting in the conversion of farmland, natural vegetation remnants, and other habitats to residential and business areas. In 1992 the land cover in this ecological landscape was composed of 39% agriculture, 24% urban areas, 16% grasslands, 10% forests, and 6% wetlands. This is the most urbanized ecological landscape in the state.

Current Impacts. Current disturbances in the ecological landscape are largely due to human activities, primarily increasing urbanization**.** This disturbance includes the long-term conversion of land to houses, businesses, roads, and other infrastructure. Indirect effects of these changes in land use may result in poorer air and water quality, elimination or fragmentation of habitats, and alteration of natural disturbance regimes. Wang et al. (2001) found that when 8%–12% of a watershed is made of connected impervious surfaces, it is at a threshold where additional increases in urbanization

Virtually all of the remnant natural communities in the Southern Lake Michigan Coastal Ecological Landscape are severely isolated and fragmented, as shown here at Cudahy Woods State Natural Area in Milwaukee County (left) and Sanders Park Hardwoods State Natural Area in Racine County (right). The diminished patch size, harsh edges, and encroaching development limit the conservation options for these remnant natural communities. Photos courtesy of the National Agriculture Imagery Program, 2013.

could result in major changes in stream condition. Flood disturbance has increased within the ecological landscape because of the drainage of wetlands, channelization, concrete lining of streams, and the large increase in impervious surfaces (16.5% of the ecological landscape is covered by impervious surfaces). Construction of dams on major rivers has disrupted the movement of fish, pollution from industry, and runoff from impervious surfaces has degraded water quality. Because this ecological landscape is the most heavily populated and developed ecological landscape in Wisconsin, most of the native vegetation has been removed, leaving only small isolated fragments, which makes it vulnerable to further degradation. Therefore, it is important to detail the major problems noted below.

■ **Urbanization.** This has been the most intensive and widespread disturbance in this ecological landscape. Urbanization has occurred and is increasing throughout the ecological landscape, especially near the larger cities (e.g., Milwaukee, Racine, and Kenosha). Urbanization is a permanent change and has created large areas of impervious surfaces from which pollutant laden runoff has degraded water quality. Urbanization has destroyed some habitats (wetlands, prairies, and forests) and resulted in habitat fragmentation and loss of connectivity of habitats in many less urbanized areas.

■ **Water Pollution.** As rural areas are urbanized and converted to homes and business, pollution sources affecting surface and groundwater will increase while wildlife habitat and water quality are diminished. Surface water pollutants can come from a single point of origin (point sources) or through many different, or diffuse, areas (nonpoint sources). Point sources of pollution are usually associated with industrial discharges or municipal wastewater treatment plants, while nonpoint sources of pollution are associated with sediments and nutrients running off of agricultural lands and large construction sites into surface waters (WDNR 2002a).

Storm water is considered both a point and nonpoint source of pollution. Areas with curbs and gutters generally have storm sewer systems that keep the water from pooling on streets, parking lots, rooftops, and other structures. Rainfall that runs off of many different areas is often collected in these storm sewer systems and discharged at a single point to a stream or lake. The pollutants found in urban storm water are different than those in rural runoff. Sediment runoff is a major concern in urban areas, but the particles making up sediment contain more than soil and nutrients. Although soil particles from construction sites are the largest component of urban sediment by volume, it also contains metals (such as zinc, cadmium, and chromium) from cars and trucks, particles from vehicle exhaust, pieces of pavement, lawn chemicals, pet waste, and fallout from chimneys and industrial smokestacks. This makes urban sediment more toxic because of the synergistic effect of multiple contaminants (UWEX 1997, USGS 2000, OEPA 2012).

Many pollutants cling to sediment particles and eventually settle on river and lake bottoms, creating polluted sediment deposits. These deposits serve as a sink for a variety of pollutants, including agricultural and urban pesticides, toxic heavy metals such as mercury, excessive phosphorous, oil and grease, road salt, and bacteria. These pollutants collect at elevated levels and are taken up by sediment-dwelling organisms, then concentrated in fish and other organisms that feed on the sediment-dwelling invertebrates. When sediments are disturbed through biological, hydrological, or human activity, these toxic pollutants can return to the water column and be taken up by invertebrates in the littoral zone, fish, and other organisms. High levels of sediment-caused turbidity can reduce sunlight and thereby reduce the growth of aquatic plants. Some pollutants no longer in use, such as polychlorinated biphenyls (PCBs), can remain in sediments for long periods of time. Over time, fish and other organisms exposed to PCBs and some other contaminants accumulate these substances in their bodies, often at levels that interfere with reproduction and cause other harm to individuals. The impacts of these pollutants vary with the pollutant type and concentration and include extirpation of pollution-intolerant species, lesions on fish, gastrointestinal disease in humans, and algal blooms that can both deplete oxygen levels for more sensitive species and pose neurotoxic and other health risks to people and pets (WDNR 2002b, USEPA 2014).

Sanitary sewer overflows to surface waters have been receiving increased attention by state and local government agencies since the late 1970s. Sewer overflows occurring in the Milwaukee metropolitan area are most often associated with intense rainfall events over short periods of time, but mechanical failure or other circumstances can also lead to the release of untreated sewage to surface waters. When a sewer system does not have the capacity needed to carry both sewage and the storm water that often leaks into the sewers to treatment plants, the system is built to discharge the excess in order to prevent overloading the sewage treatment plants. This excess ends up in basements through sewer backups, in the streets through overflowing manholes, or in nearby surface waters through gravity overflow or pumping.

These overflows to surface waters can be damaging to the environment and threaten human health. Excess solids, nutrients, and toxic substances found in untreated sewage can have a direct effect on water quality, habitat, fish, and wildlife. The pathogens found in sewage, such as certain types of bacteria, viruses, protozoa, and parasitic intestinal worms, can put humans that ingest these organisms at risk. Skin rashes can occur simply from contact with certain water-borne pathogens (WDNR 2002a).

In 1994 Milwaukee began operation of its Deep Tunnel system for storing excess sewage and storm water until it can be processed in one of two treatment plants. Milwaukee Metropolitan Sewerage District has also reduced the prevalence of combined sewers so that they now serve only 5% of the sewer service area (MCDES 2006). Even with the enormous capacity (nearly 500 million gallons) of underground tunnel storage and the separated sewer system, overflows still occur with intense rainfalls. However, these improvements have reduced the incidence of sanitary and combined sewer overflows from an average of 60 per year to about six per year (MCDES 2006). Additional projects are underway to reduce the generation of storm water at its many sources, to upgrade the efficiency of the treatment plants, and to improve the efficiency of the sewage collection system (NRDC 2011).

Nearly all municipal water supply systems in the Southern Lake Michigan Coastal Ecological Landscape use Lake Michigan as their water source, including the major metropolitan areas of Kenosha, Racine, and Milwaukee. A few smaller municipal water supply systems use groundwater (wells). There are also a number of smaller, nonmunicipal public water supply systems that draw water from the groundwater aquifer. The Great Lakes Compact was signed by the states and provinces bordering the Great Lakes in 2008 and prohibits the diversion of water out of the Great Lakes basin, with a few limited and strictly regulated exceptions (see "Aquatic Resource Issues" in Chapter 5, "Current and Emerging Resource Issues").

Lake Michigan is also a major recreational resource in this ecological landscape. Water quality at Lake Michigan swimming beaches has garnered a lot of attention from the media, politicians, and concerned citizens. This stems from the fact that many area beaches have been frequently closed over the past years. For example, the city of Racine's North Beach was closed for 62 days in 2000, and cities including Milwaukee and Madison experience periodic beach closings. The ultimate goal of the federal Beach Health Act and the Coastal Zone Management Act (overseen by the National Oceanic and Atmospheric Administration and implemented by Wisconsin DNR and the Wisconsin Coastal Zone Management Program in conjunction with the federal Clean Water Act) is to determine the sources of the bacterial pollutants responsible for the beach closures and develop and encourage measures to reduce or eliminate those pollutants to protect public health. Some work recently completed includes the Racine Interstitial Sand Beach Study, looking at whether *E. coli* bacteria (a pollution indicating organism) can survive or reproduce in beach sands and methods to limit incubation and growth of these organisms and associated pathogens (Kinzelman and McLellan 2009).

Changes in Hydrology. Many wetlands in this ecological landscape were filled or drained for agricultural, industrial, or residential development. The reduction of wetlands can lead to many consequences that affect society at scales far beyond a simple tally of the wetland acreage lost. Other modifications, such as stream channel straightening (channelization) or lining the bottom and sides of streams with concrete, have proven to be detrimental to water quality and wildlife and fish habitat. Many headwaters streams were ditched to facilitate drainage for agriculture or to more efficiently supply water for irrigation. Land was often cleared right up to the stream banks to obtain forest products and to maximize the amount of land that could be placed in agricultural production. Floodplain development and increases in impervious surfaces in urban and exurban areas have been accompanied by deepening, straightening, and lining channels to move storm water off the land and downstream more swiftly. Straightening stream channels increases stream velocity and stream energy, which can contribute to flooding, enhanced erosion, and poor water quality (WDNR 2002b). These problems are then exported downstream where they may be magnified unless remedial steps are taken.

The formerly common practice of floodplain destruction and development and the resultant loss of wetlands decreased the natural function of the affected floodplains to store flood waters. The floods of 1997 and 1998 in southeastern Wisconsin raised awareness and increased attention on finding solutions to the problems associated with urban flooding. One way to address this issue is to increase flood water storage capacity through the construction of stormwater detention ponds on newly developed areas, and, where feasible, building detention ponds into already developed areas. Creating more open space and reducing the amount of impervious surface along streams allows for more flood water storage and improves the wildlife and recreational values of riparian environmental corridors (e.g., Milwaukee Metropolitan Sewage District Greenseam's project). Restricting floodplain development is also a key factor in minimizing flood damage (WDNR 2002a).

Many dams were constructed in the Southern Lake Michigan Coastal for power production and grain milling. Regardless of their size, dams have profound effects on stream ecosystems because they convert flowing waters into waterbodies that more closely resemble lakes. Dams displace species that thrive in flowing waters, increase water temperatures, reduce oxygen levels, and slow or entirely prevent movements of fish and other aquatic life within the stream ecosystem. The effects can reverberate throughout a stream's food web. Streams rely on periodic high flows to remove sediments, especially fine sediments. These fine sediments are suspended in the water column and deposited on the inside of river bends (meanders). Behind dams, sediments accumulate covering coarser debris such as gravel, cobbles, or boulders, which many species rely on for reproduction and habitat. Slowed and warmed water behind dams attract tolerant ***rough fish*** such as common carp (WDNR 2002b).

The riparian corridor adjacent to a stream is an important part of the stream ecosystem, and its protection and maintenance benefit water quality and provide habitat for numerous native plants and animals. Some of these species have life cycles that use aquatic, palustrine, and terrestrial habitats, making the protection or restoration of intact and complete riparian corridors especially important. Prior to intensive development, most of the streams in this ecological landscape were lined with trees or bordered by various kinds of wetland vegetation. As riparian lands were cleared, streamside vegetation was replaced by agricultural fields and urban-industrial developments. Water quality declined as the streams lost the benefits of shading and soil retention that the streamside vegetation provided. Trees, shrubs, and grasses provide shade that can help keep water cool, stabilize stream banks and curb erosion, filter runoff, and attract insects that are used as food and support other organisms. Riparian vegetation also provides feeding, resting, and nesting areas for wildlife. Trees that fall into the water provide cover for fish, perches for swallows, kingfishers, herons, and raptors, and basking areas for snakes and turtles. Riparian corridors provide important travelways for many wildlife species. Without these continuous wildlife "highways," habitat becomes fragmented. Isolated wildlife populations often decline (SEWRPC 1997, WDNR 2002a).

Agriculture. Prior to Euro-American settlement, the Southern Lake Michigan Coastal was vegetated with hardwood forests, oak savanna, prairie, and a variety of wetland types. Almost all of the historical prairie and oak savanna acreage and most of the forest was quickly converted to agricultural uses because of the near-level topography and rich soils. WISCLAND land use/land cover data from 1992 show that farming occurred on over 39% of all land in this ecological landscape at that time, with 24% in urban uses (WDNR 1993). Agriculture usually employs modern conservation practices that minimize soil erosion and loss. However, groundwater contamination from agricultural use is still an issue in some parts of this ecological landscape, as is pollution of surface waters from nonpoint sources.

As urban development proceeds, farmland is lost to development. The three counties within the Southern Lake Michigan Coastal Ecological Landscape (Kenosha, Milwaukee, and Racine) have experienced double-digit percentage decreases in the number of farms and corresponding decreases in the numbers of acres used for farming.

Management Opportunities for Important Ecological Features of the Southern Lake Michigan Coastal Ecological Landscape

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

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

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

Outstanding Ecological Opportunities in the Southern Lake Michigan Coastal Ecological Landscape

- The Lake Michigan shoreline, shoreline habitats, and coastal waters are important management considerations here.
- Great Lakes coastal prairies and wetlands are very rare and only occur in the Southern Lake Michigan Coastal Ecological Landscape.
- There are management opportunities for rivers, streams, and riparian corridors such as the Milwaukee, Menomonee, Root, Pike, Kinnickinnic, and Des Plaines rivers.
- Inland lakes, adjoining wetlands, and associated biota occur in the Southern Lake Michigan Coastal Ecological Landscape.
- Some large surrogate grasslands are found in this ecological landscape and provide habitat for declining native grassland fauna.
- There are scattered miscellaneous natural communities (forests, savannas, prairies, various wetlands), habitats, and rare species populations that occur in the Southern Lake Michigan Coastal Ecological Landscape.

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. Rather, we suggest that planning and management efforts incorporate broader considerations and address the variety of scales and structures approximating the ***natural range of variability*** in an ecological landscape, especially those that are missing, declining, or at the greatest risk of disappearing over time.

Both ecological and socioeconomic factors were considered when determining management opportunities. Integrating ecosystem management with socioeconomic activities can result in efficiencies in the use of land, tax revenues, and private capital. This type of integration can also help to generate broader and deeper support for sustainable ecosystem management and highlight the values and benefits of the ***ecosystem services*** provided by this approach to resource management. Statewide integrated opportunities are discussed in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management."

Significant ecological management opportunities that have been identified for the Southern Lake Michigan Coastal Ecological Landscape include

- Lake Michigan shoreline, shoreline habitats, and nearshore waters;
- Great Lakes coastal prairies and wetlands;
- rivers, streams, and riparian corridors: the Milwaukee, Menomonee, Root, Pike, Kinnickinnic, and Des Plaines rivers;
- inland lakes, adjoining wetlands, and associated biota;
- surrogate grasslands; and
- scattered miscellaneous natural communities and habitats.

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 19.2. Examples of some locations where these important ecological places may be found within the Southern Lake Michigan Coastal Ecological Landscape are on the map entitled "Ecologically Significant Places Within the Southern Lake Michigan Coastal Ecological Landscape" in Appendix 19.K at the end of this chapter.

Due to the condition and context of the natural features within the Southern Lake Michigan Coastal Ecological Landscape, especially the widespread and intensive development and the high human population density, ecological management opportunities are limited. All of the historically extensive plant community groups, forests, savannas, prairies, and wetlands have been greatly reduced from their historical abundance, and many of their characteristic features significantly altered. Natural community remnants are small and isolated, occurring within a context of lands and waters that are now dedicated to supporting residential, industrial, and agricultural uses. Severe disruptions to native ecosystems have been caused by habitat destruction, fragmentation and isolation, hydrological disruption, fire suppression, the explosive increase of invasive species, grazing, high grading of forests, and heavy recreational use of a very limited public land base.

Despite the widespread loss of natural features from the local landscape, interest in conserving what remains is high. Several counties have extensive systems of parklands and green spaces, and conservation-oriented groups dedicated to a wide array of interests, including land stewardship and education, are well established and active.

There may be significant opportunities to revegetate areas, especially brownfields, not necessarily as natural communities but to serve as surrogate habitats for wildlife. Conservation potential can be enhanced by comprehensive planning, especially along shorelines, and by the strategic location and development of green space. Degraded wetlands and impaired aquatic systems could be restored at some locations to enhance habitat for fish and wildlife, buffer and expand wetland plant communities, store runoff to mitigate flood damage, and provide various recreational opportunities and other social benefits.

A 1990s inventory planned and conducted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), Wisconsin DNR, and others identified more than 18,000 acres of high quality remnant natural communities and critical species habitats throughout a seven-county area (that part of Wisconsin in which SEWRPC has jurisdiction), including the entire Southern Lake Michigan Coastal Ecological Landscape (SEWRCP 1997). This document is an excellent source of site-based conservation opportunities for counties, municipalities, NGOs, and individual citizens. Updates to various parts of this plan are available. SEWRPC, coupled with citizen concern and state "Smart Growth" assistance and incentives, offers a vehicle to work toward local and regional conservation goals.

Urban forestry is an important function of resource management agencies and municipalities. Specific activities might include encouraging the planting of native tree species while discouraging the utilization of nonnative species; maintaining natural or semi-natural forest communities in urban parks and other public use areas, which will provide habitat for some native species (e.g., some resident animals, representative forest floras, stopover sites for migratory birds); connecting and/or expanding disjunct forest remnants where ecologically appropriate; and reforesting abandoned industrial sites along waterways. Urban forests offer valuable ecosystem services, such as moderating temperatures, producing shade, mitigating the effects of some pollutants, slowing runoff, attracting wildlife desirable to many citizens, and offering aesthetic relief from areas of intensive development.

Table 19.2. *Natural communities, aquatic features, and selected habitats associated with each ecological feature within the Southern Lake Michigan Coastal Ecological Landscape.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Lake Michigan shoreline, shoreline habitats, and nearshore waters	Clay Seepage Bluff Great Lakes Beach Great Lakes Dune Lake Michigan Migratory Bird Concentration Areas
Great Lakes coastal prairies and wetlands	Mesic Prairie Southern Sedge Meadow Wet Prairie Wet-mesic Prairie Calcareous Fen Shrub-carr Emergent Marsh Oak Opening
Rivers, streams, and riparian corridors	Southern Hardwood Swamp Floodplain Forest Southern Mesic Forest Southern Dry-mesic Forest Coolwater Stream Warmwater River Warmwater Stream
Surrogate grasslands	Surrogate Grassland
Miscellaneous natural communities and habitats	Southern Dry Forest Southern Dry-mesic Forest Southern Mesic Forest Southern Tamarack Swamp Oak Opening Oak Woodland Bog Relict Dry-mesic Prairie Mesic Prairie Wet-mesic Prairie Wet Prairie
Inland lakes, adjoining wetlands, and associated biota	Shrub-carr Calcareous Fen Emergent Marsh Submergent Marsh Southern Sedge Meadow Southern Hardwood Swamp Ephemeral Pond Impoundment/Reservoir Inland Lake

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

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

In 1974 the abandoned Nike missile site in Milwaukee (top photo) was a highly disturbed area, abandoned and contaminated by past use. After becoming Havenwoods State Forest, the same area was remediated and revegetated. While this can not be labeled as a "natural" community, it provides habitat for wildlife and ecosystem function. Photos by Wisconsin DNR staff.

Lake Michigan Shoreline, Shoreline Habitats, and Nearshore Waters

Lake Michigan is arguably the most important natural feature of the Southern Lake Michigan Coastal Ecological Landscape due to its size and depth, its heavy use by birds and fish, and the dependence of millions of citizens upon it for a wide array of ecosystem services, economic uses, recreational opportunities, and social amenities.

While this ecological landscape is the most drastically altered of any in Wisconsin from its historical condition, the shoreline still supports small but critically important patches of beach and dune, prairie, open and shrub-dominated wetland communities, forests, and undeveloped clay bluffs. Many native species, including some that are quite rare, are dependent upon these diminished and dwindling habitats for their continued existence in the ecological landscape.

Urban parks and old fields tend to receive intensive recreational use, and most of what little vacant land remains is slated for residential or industrial development. But such sites can play important ecological roles, especially by providing habitat for migratory birds, which make heavy use of Lake Michigan coastal areas.

*A slumping Clay Seepage Bluff at Warnimont Bluff Fens State Natural Area in Milwaukee County. Note the swallow holes in the far side of the bluff. Also note the chickory (*Cichorium intybus*) growing in the foreground. Chickory is one of many weedy, nonnative plants that tend to invade the edges of these bluffs. Due to their proximity to Lake Michigan and economic value, many of the unstable clay bluffs have been stabilized and developed, which often allows more dense vegetation to become established but results in loss of habitat for some of the unusual wetland plants that may colonize such sites. Photo by Owen Boyle, Wisconsin DNR.*

A number of issues could potentially affect Lake Michigan's ecological and socioeconomic values (e.g., the attempted stabilization of Lake Michigan water levels, excessive groundwater or surface water withdrawals, storm and waste water overflows, invasive species, more intensive recreational development, and the development of industrial wind energy complexes).

Management Opportunities, Needs, and Actions

- Sites containing significant natural features are scattered along the Lake Michigan coast (one of them, Chiwaukee Prairie, is described in more detail in the section below). All of these sites, which include beaches, dunes, prairies, fens, shrublands, and forests, are important stopover locations for migratory birds as well as components of a regionally significant repository of rare ecosystems and native biota. More attention to their long-term protection is warranted.
- There are opportunities to manage urban parks, public beaches, the Milwaukee Harbor, and other waterfront locations in ways that could be much more bird-friendly, while enhancing recreational opportunities for residents and visitors. Urban planners, businesses, and conservationists will need to work together to achieve the maximum benefits possible.
- The nearshore waters of Lake Michigan host large numbers of migratory birds each spring and fall, including waterfowl, gulls, terns, loons, and grebes.

- This ecological landscape continues to provide wintering habitat for large numbers of waterfowl, including uncommon or localized species in Wisconsin such as Long-tailed Duck, Greater Scaup, and Black, White-winged, and Surf Scoters as well as more common and widespread species such as Common Goldeneye, Bufflehead, and Red-breasted Merganser.
- Beach and dune habitats are now extremely rare. Where they do still exist, they are heavily used and typically degraded by seawalls, invasive plants, and encroaching development. These are critical habitats for a number of highly specialized native plants and animals, and opportunities to protect and manage them should be sought, even in heavily used local park systems.
- Steep clay bluffs occur at several locations along the Lake Michigan shore (e.g., in southern Milwaukee and northern Racine counties) and in deep ravines that open onto the lake. These can provide habitat for specialized plants (some of which are most typically associated with Calcareous Fen, others with vegetation more typical of northern Wisconsin). These features are highly threatened locally by the desire to stabilize the slopes and enable additional residential development. Bluff erosion can be especially severe during periods of high water on Lake Michigan.
- Bluff stabilization leads to the destruction of the conditions that are responsible for supporting unusual plant species assemblages. If bluff hydrology is disrupted and the slopes (which are sometimes graded or covered with rip-rap) are stabilized and entirely dewatered, they may then be colonized by rank vegetation composed of weedy generalists and lose their fen or other seepage slope specialists.
- Identify additional shoreline habitat protection opportunities, including highly disturbed sites, which could serve as valuable stopover locations for migratory birds and perhaps other species.
- Review existing plans for public lands along the shore of Lake Michigan tributary streams and identify means by which their conservation values could be increased or enhanced. Review existing and potential funding sources for same.
- Lake Michigan provides valuable habitat for important aquatic species. Several offshore reefs are important for spawning lake perch and reintroduced lake trout. Coho salmon is an important recreational resource but is non-native and can have impacts on the aquatic food chain by depleting forage fish populations. Lake sturgeon and walleye have been reintroduced into Lake Michigan nearshore waters.
- Establish permanent monitoring sites for migratory birds at selected locations along the Lake Michigan shore. A broad array of private and public partners, educational institutions, and businesses could be involved in such efforts. Waterfowl should be systematically surveyed at intervals in the Milwaukee Harbor and at other coastal waters during spring, fall, and winter. An aerial component of these surveys should cover as much of the coastline and nearshore waters of this ecological landscape as possible, and extend a distance of at least several miles (perhaps 10 or more) into the lake.

Great Lakes Coastal Prairies and Wetlands

Coastal prairie complexes are extremely rare along the Great Lakes shores. In Wisconsin they are now restricted to a single location, on subdued ridge-and-swale topography in the extreme southeastern corner of the ecological landscape. Though the topographic variability is subtle, the vegetation mosaic is extremely complex and includes rare natural communities such as Wet Prairie, Wet-mesic Prairie, Calcareous Fen, and Southern Sedge Meadow. The adjacent uplands are almost entirely developed but include small patches of Mesic Prairie, Oak Opening, and Great Lakes Dune. Elsewhere in Wisconsin, similar coastal ridge-and-swale landforms support mosaics of 'northern' vegetation types, which are often dominated by coniferous forests (for examples, see Chapter 8, "Central Lake Michigan Coastal Ecological Landscape," and Chapter 15, "Northern Lake Michigan Coastal Ecological Landscape." Chiwaukee Prairie, one of the Upper Midwest's premier coastal wetland complexes, is located in southeastern Kenosha County. It is the only Wisconsin example of a Great Lakes-influenced coastal wetland ecosystem composed mostly of tallgrass prairie and fen communities. Chiwaukee includes one of Wisconsin's largest and most diverse occurrences of Wet-mesic Prairie. It harbors numerous rare species,

Chiwaukee Prairie features an exceptionally diverse flora and is the only sizable remnant of tallgrass coastal prairie in eastern Wisconsin. Plants in bloom here include marsh blazing star. The state natural area consists of two parts, separated by 116th Street. The southern portion (managed by The Nature Conservancy) is a large area of contiguous prairie, connected to valuable sites just to the south in Illinois. The northern part (managed by the Wisconsin DNR) consists of prairie and fen, fragmented by roads and scattered homes. Photo by Thomas Meyer, Wisconsin DNR.

including plants, invertebrates, birds, and mammals. The site is adjacent to other conservation lands of extremely high value that occur just to the south, in northern Illinois (e.g., Illinois Beach State Park, Spring Bluff Lake County Forest Preserve).

Chiwaukee Prairie State Natural Area (Kenosha County) is the core of native grassland conservation in this ecological landscape and is managed as a complex of interacting natural communities (Wet-mesic, Mesic, and Wet Prairies; Calcareous Fen; Southern Sedge Meadow; Emergent Marsh; Shrub-carr; and Oak Opening are all present). This complex is threatened by residential development, disrupted hydrology, and the rapid increase and spread of invasive plants.

A rare variant of Calcareous Fen that occurs at Chiwaukee Prairie is sometimes referred to as a "Panné." These are level areas of saturated, somewhat calcareous (even marly) sand, which at Chiwaukee are associated with Wet-mesic Prairie and Southern Sedge Meadow. The Clay Seepage Bluff community, mentioned above, shares some floristic similarities with Calcareous Fen, though the geologic settings and origins are very different.

Management Opportunities, Needs, and Actions

- The Chiwaukee Prairie complex in southeastern Kenosha County contains some of the Upper Midwest's best examples of rare natural communities: tallgrass prairies, wet meadows, and fens. These in turn support numerous rare plants and animals. The site is globally significant.
- The maintenance or restoration of hydrological function within the range of natural variation to which these coastal wetlands are adapted is critical to ensure the long-term viability of these complex features.
- Manage nearby uplands, roads, and ditches in a manner that avoids or eliminates the export of excess sediments and nutrients into the coastal wetlands and prairies.
- Manage project sites as a complex of interacting natural communities. At Chiwaukee the community mosaic includes: Wet-mesic, Mesic, and Wet Prairies; Calcareous Fen; Southern Sedge Meadow; Emergent Marsh, Shrub-carr, and Oak Opening.
- Continue and, as needed, strengthen the partnerships between Wisconsin DNR, The Nature Conservancy, UW-Parkside, local residents and businesses, and others on protection and management of this unique Great Lakes coastal complex.
- Spring Bluff Lake County Forest Preserve and Illinois Beach State Park are immediately south of Chiwaukee Prairie. Opportunities to conduct surveys, coordinate management, and design and implement monitoring and educational programs should continue with land stewards and institutions in northeastern Illinois.
- Periodic prescribed burning, mechanical brushing, and judicious use of herbicides are among the methods that may be used at given locations to reduce encroachment by invasive shrubs, saplings, and herbs into fens, meadows, prairies, and savannas.
- Herbaceous communities, such as those that occur here, are most efficiently and appropriately maintained by the careful use of prescribed fire. Local concerns about air quality and safety have sometimes made the use of fire in this heavily populated ecological landscape highly problematic. Additional educational efforts at local, town, county, and regional levels will be needed.

Rivers, Streams, and Riparian Corridors: the Milwaukee, Menomonee, Root, Pike, Kinnickinnic, and Des Plaines Rivers

Important stream corridors are associated with the Root, Des Plaines, Kinnickinnic, Pike, Menomonee, and Milwaukee rivers. Many of the streams in this ecological landscape offer limited conservation opportunities owing to severe past disturbances such as channelization; dam construction; clearing of natural vegetation right up to the stream bank; filling of adjacent wetlands; heavy loads of nutrients, sediments, and other pollutants; and colonization by invasive plants and animals. However, remediation for the purposes of improving water quality, restoring a sport fishery, and enhancing aesthetics has occurred in a few areas, and there is the possibility of doing similar work elsewhere. Free-flowing stretches of several larger streams, such as the Root and Des Plaines rivers, adjoin significant wetlands composed of sedge meadow, prairie, marsh, shrub swamp, and scattered patches of relatively undisturbed upland vegetation (usually small patches of hardwood forest composed of oak or beech-maple) that make logical focal points for conservation projects. Narrow strips of forested lowlands, especially Southern Hardwood Swamp or Floodplain Forest communities, are sometimes present and contribute to maintaining water quality and providing habitat for native plants and animals.

In the Southern Lake Michigan Coastal Ecological Landscape, river floodplains are often narrow and somewhat confined due to development, past filling, drainage, and channelization. Major threats to these riparian corridors include hydrological disruption, streamside development, loss of diversity due to the spread of invasive plants, and the loss of key species due to disease (e.g., American elm from Dutch elm disease) or high grading commercially valuable trees (especially for large oaks and ashes).

The river corridors contain concentrations of natural communities, serve as ***refugia*** for rare species, and provide important habitat for many common plants and animals. Riparian corridors may offer opportunities to increase connectivity, reduce the effects of fragmentation and isolation, manage natural lands more effectively and efficiently, and produce multiple social benefits (floodwater management, recreation, and aesthetics). Use by migratory birds, especially passerines, can be very heavy.

Colony of reflexed trillium, a native forest herb that reaches its northernmost range limits in extreme southern Wisconsin. Root River corridor, Racine County. Vulnerability of such species to extirpation is high. Photo by Thomas Meyer, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Protection and/or restoration of herbaceous, shrub, and forested wetlands adjoining streams are critical ecological needs to increase or improve available habitat for native plants and animals, and increase or reestablish connectivity between disjunct habitat patches.
- Socioeconomic reasons for protecting, restoring, and maintaining riparian corridors includes floodwater retention, increased recreational opportunities, and aesthetics.
- Riparian corridors offer this ecological landscape's best management opportunities for Southern Hardwood Swamp and Floodplain Forest communities. The Des Plaines and Root River corridors, in particular, offer potential for maintenance of lowland forest remnants and restoration possibilities for a more complete and better connected functional complex of riparian communities.

The remediation process for the North Avenue Dam portion of the Milwaukee River occurred over a ten- year period, captured in this series of photos taken from North Avenue. The impoundment (upper left) was popular with rowers and others in the late 1980s, prior to drawdown. In 1990 the impoundment was drawn down (upper right) in anticipation of dam removal, exposing mudflats for the first time after 100 years of inundation. In 1991, one growing season after the mudflats were exposed and seeded with a temporary cover crop, vegetation was extensive (lower left). After dam removal in 1997, the river regained its function as an important corridor for a variety of fish and other aquatic species, as seen in 2005 (lower right). Photos by William Wawrzyn, Wisconsin DNR.

- There are opportunities to restore hydrological function and native fish spawning habitat to stretches of rivers and streams through the removal of dams in this ecological landscape. Potential restoration sites include the Kinnickinnic River in the city of Milwaukee, the Des Plaines, Milwaukee, Menomonee, and Root rivers, Cedar Creek, Pigeon Creek, Poplar Creek, and Peterson Creek, and sites noted in the restoration strategy developed by the Great Lakes Commission in its 2004 restoration workshops (GLC 2005). Actions taken to eliminate the negative impacts of dams can help improve habitat for invertebrates as well as fish and other species.
- Striped shiners were formerly found in the lower Milwaukee River, but after a survey in 2010, it is thought that this species may no longer be present in the Milwaukee River or anywhere else in the state (J. Lyons, Wisconsin DNR, personal communication). If the striped shiner is extant in the Milwaukee River, this may represent Wisconsin's best opportunity to conserve and manage for this species. Surveys are needed to determine the species current status and better assess habitat suitability.

Inland Lakes

Inland lakes occur mostly in the southwestern corner of this ecological landscape and also along its western edge. Shorelines of all of the larger lakes have been developed, with residential development being particularly prevalent. Water quality issues are, or have been, common due to excessive inputs of nutrients, sediments, and other pollutants. Loss of shoreline habitat has been significant, and filling wetlands was formerly a common occurrence.

Despite their developed nature, widespread water quality problems, and significant habitat losses, the inland lakes of this ecological landscape provide homes for native fish, amphibians, reptiles, and invertebrates. Many birds and a few mammals are also strongly associated with, and in some cases, dependent on, inland lakes.

Management Opportunities, Needs, and Actions

- Inland lakes provide habitat for rare resident species such as Forster's Tern and Blanding's turtle and for many migratory birds that use water and wetlands.
- The Southeastern Wisconsin Regional Planning Commission report (SEWRPC 1997) identified and ranked several important lakeside wetland complexes. The best of these wetlands are large, relatively free of invasive species and contain the most representative examples of native plant communities associated with Inland Lakes in the Southern Lake Michigan Coastal Ecological Landscape. Such sites would make excellent protection projects for local governments or conservation groups.
- Undeveloped ponds, especially when bordered and protected by adjoining wetlands or other natural vegetation, should be rigorously protected as they provide critical habitat for wetland-dependent wildlife and are important stopover locations for many migratory birds in a heavily developed, highly disturbed ecological landscape.
- Remediation to address past water quality problems has been at least partially successful at several lakes. Such efforts should be continued and, where feasible and appropriate, expanded.
- There is an important warmwater fishery in the inland waters of the Southern Lake Michigan Coastal Ecological Landscape that supports populations of largemouth bass, northern pike, yellow perch, and other panfish.

Surrogate Grasslands

Surrogate Grasslands, which are composed mostly of non-native grasses, now occupy some active and abandoned agricultural areas, CRP lands, and public ownerships. Most noteworthy among the latter is Richard Bong State Recreation Area, an abandoned military airfield in Kenosha County, which encompasses 4,515 acres of old fields, ponds, and marshes. Areas such as this can now provide regionally significant habitat for many rare or declining grassland birds and other animals. The Bong site, which is far more extensive than any other surrogate grassland in this ecological landscape, also contains several small stands of native (Wet-mesic) prairie as well as patches of Emergent Marsh and Shrub-carr.

Grasslands are most efficiently maintained by the use of periodic prescribed fire, in conjunction with mechanical brushing, mowing, and the selective use of herbicides. Opportunities to use prescribed fire are sometimes limited due to local concerns about air quality and safety, making it essential to work with local residents and units of government when developing appropriate vegetation management plans for fire-driven ecosystems.

The extensive surrogate grasslands at Richard Bong State Recreation Area (Kenosha County) offer suitable habitat for many animals such as grassland birds and invertebrates. The grasses are mostly cool season exotics. This photo was taken after a spring controlled burn. Photo by Owen Boyle, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- There may be opportunities to manage agricultural lands adjoining Bong (and other sites with similar habitats) in ways that increase the area of suitable habitat for sensitive grassland animals and that are also compatible with buffering remnant prairies, sedge meadows, marshes, forests, or other native vegetation.
- Many grassland communities require active management, usually by employing prescribed fire, mowing, mechanical brushing, or a combination of these activities. Some obligate grassland animals are sensitive to fire, and this needs to be considered when developing and implementing management plans that include prescribed burning.
- There is a need to develop educational tools and demonstration areas that promote the benefits of prescribed fire and address local safety concerns.
- Grassland restoration activities (including plantings) will be most effective where there are opportunities to build on existing native prairie and sedge meadow remnants, where it is possible to work at relatively large scales, where local support is strong, and where there is potential to work toward making local land uses more compatible with conservation goals.

Miscellaneous Natural Communities and Rare Species Habitats

Natural community remnants in this ecological landscape tend to be small, isolated, and often adjoin developed areas that may not necessarily be compatible with the long-term maintenance of fragile natural systems. Examples include widely scattered farm woodlots; prairies within highway, railroad, and utility corridor rights-of-way; and isolated wetlands in poorly drained glacial moraine. Other community types, habitats, and features are included under the headings listed above.

Management Opportunities, Needs, and Actions

- Identify sites containing relatively intact examples of natural communities that are rare and not well represented in conservation projects elsewhere here.
- Work with the Wisconsin Department of Transportation, utilities, and railroads to ensure that valuable sites within rights-of-way are not inadvertently damaged or destroyed.
- Identify and work with institutions, and NGOs such as Land Trusts, that have the interest and capability of taking on management of scattered small remnant natural areas.
- Work with SEWRPC and others to provide information on the location of valuable natural features to appropriate conservation-minded land managers.
- Identify sites containing sensitive species, prioritizing for protection those that are not adequately represented in existing conservation projects, are rare or absent in other parts of the state or that are globally rare.

Socioeconomic Characteristics

Socioeconomic information is summarized within county boundaries that approximate ecological landscapes unless specifically noted as being based on other factors. Economic data are available only on a political unit basis, generally with counties as the smallest unit. Demographic data are presented on a county approximation basis as well since they are often closely associated with economic data. The multi-county area used for the approximation of the Southern Lake Michigan Coastal Ecological Landscape is called the Southern Lake Michigan Coastal counties. The counties included are Kenosha, Milwaukee, and Racine because at least 25% of each of those counties lies within the ecological landscape boundary (Figure 19.8).

This is the most highly populated, intensively developed ecological landscape in the state. Almost a quarter of the people in Wisconsin live here, and almost 20% of the jobs in the state are here. Throughout the Euro-American history of Wisconsin, this region has been a hub of transportation, industry, and commerce, resulting in large and long-term impacts to the land and water. The economy has changed from a strong manufacturing base to a service-based economy. Natural systems have been severely fragmented, reduced in abundance, isolated, and highly disturbed by widespread and intensive agricultural, industrial, and residential development. Although natural resources are used for some economic activities (e.g., agriculture, forestry), they are less important as an economic base here than in other parts of the state. Major socioeconomic concerns for natural resources are to protect or restore them in the face of continued urban expansion, maintain high quality of life, and protect drinking water quality.

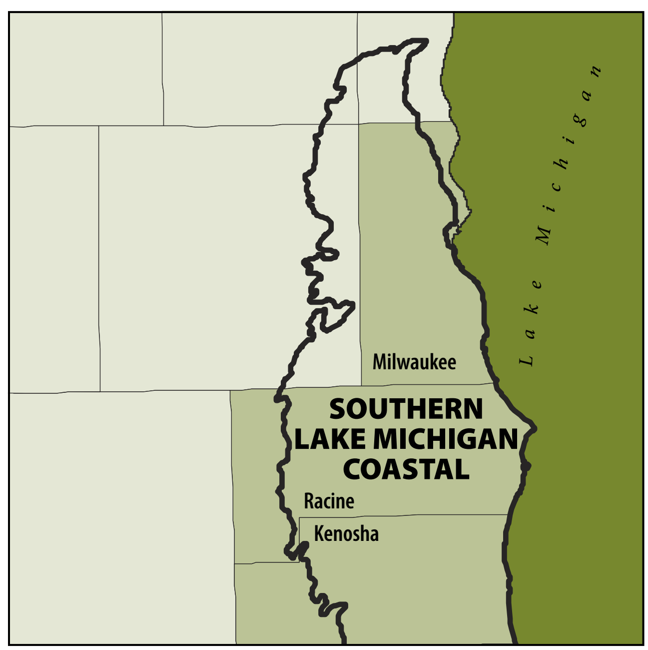


Figure 19.8. *Southern Lake Michigan coastal counties.*

Major socioeconomic opportunities are service-based sectors, some resource-based sectors, education services, ecological restoration, and land use planning. Urbanization, industry, and agriculture have the largest impacts on the ecological resources in this ecological landscape.

The Southern Lake Michigan Coastal counties are highly urbanized. Despite this fact, they support productive agriculture on farms that are comparatively smaller than in other areas of the state. However, the amount of farmland is decreasing rapidly. The Southern Lake Michigan Coastal counties have the highest percentage of farmland sold and diverted to other uses of all the county approximations in the state. The new land use is primarily residential construction. Per capita water use is very high in the Southern Lake Michigan Coastal counties (for details see the "Water Use" section of this chapter).

The Southern Lake Michigan Coastal counties stand out from the other ecological landscape county approximations for several socioeconomic indicators, especially population attributes and income. Among all areas of the state, they have the highest population density but have lost a percentage of their population since 1970, especially in Milwaukee County. The population density (1,655 persons per square mile) is much higher than that of the state as a whole (105 persons per square mile). They have the highest percentage of people under 18 and the second lowest median age. Ethnic minority populations, especially African American and Hispanic, are higher in the Southern Lake Michigan Coastal counties than elsewhere in the state.

Economically, the Southern Lake Michigan Coastal counties have the highest average wage in the state, the second highest per capita income, relatively high unemployment, and a high rate of poverty, especially for children. In terms of job distribution, the service sector provides more jobs than in any other ecological landscape county approximation. The relative importance of the agriculture and government sectors is close to the lowest of all ecological landscape county approximations.

History of Human Settlement and Resource Use

American Indian Settlement

Some of the oldest evidence of human activity in the state occurs in the Southern Lake Michigan Coastal Ecological Landscape, and there is evidence of occupation of this ecological landscape all the way into the historical period. In fact, two of the three Paleo-Indian sites that associate mastodon or mammoth bones with stone tools occur here at the Hebior and Schaefer sites in Kenosha County (Mason 1997). Increase Lapham's drawing *Ancient Works in the Vicinity of Milwaukee* (1855) shows numerous mounds that would date to the Woodland Tradition. For more information, see the "Statewide Socioeconomic Assessments" in Chapter 2, "Assessment of Current Conditions" in Part 1 of the book for further discussion of the history of human settlement and resource use in Wisconsin.

Just before the time of Euro-American contact, this area of the state was likely claimed by the Winnebago (Ho-Chunk) (Mason 1988). As tribes were forced westward by Euro-American expansion, the Winnebago were also in decline. The Potawatomi were perhaps the most established and largest tribe in the area in the early historical period, but the Kickapoo were also present. By 1820, about 10,000 Potawatomi lived in 100 villages throughout eastern Wisconsin including along the shores of Lake Michigan (The Wisconsin Cartographer's Guild 1998). For more information on the Potawatomi Indians, see the "Statewide Socioeconomic Assessments" in Chapter 2, "Assessment of Current Conditions" for further discussion of the history of human settlement and resource use in Wisconsin.

Euro-American Contact and Settlement

This area of the state proved to be rich in ethnic diversity. Many immigrants were drawn here by the variety of work available in fishing, lumbering, and agriculture and in factories and docks in the Milwaukee, Kenosha, and Racine areas (The Wisconsin Cartographer's Guild 1998). Germans, Danes, Finns, Icelanders, Belgians, Italians, Poles, Czechs, Irish, Slovaks, Greeks, Hungarians, Russians, Jews, Croatians, and Serbs, among others, flocked to the Southern Lake Michigan Coastal counties during the 19th and early 20th centuries.

Early Agriculture

Permanent Euro-American settlement began in Southern Lake Michigan Coastal counties well before 1850, when the first agriculture census data became available. The Southern Lake Michigan Coastal counties were among the first established in the state. In 1805 the Michigan Territory was established, which included all the land that would later become Wisconsin. In 1818 all land west of Lake Michigan in the Michigan Territory was divided into three counties. As the land was settled, additional counties were established from these original three counties. Milwaukee County was founded in 1834 and included all the land south along Lake Michigan to Illinois (NACO 2010). In 1836 the Wisconsin Territory was established, and Racine County was founded. Kenosha County was established in 1850 when it was separated from Racine County.

Agriculture was a significant component of local economies in Southern Lake Michigan Coastal counties at their inception but quickly faded as urban areas expanded and other areas of the state were settled and developed as farms. In 1850 there were 2,820 established farms in the Southern Lake Michigan Coastal counties, comprising about 14% of all farms in the state (ICPSR 2007). By 1860 the number of farms in the Southern Lake Michigan Coastal counties had grown to 4,733. Thereafter, the number of farms in Southern Lake Michigan Coastal counties continued to grow very slowly until reaching

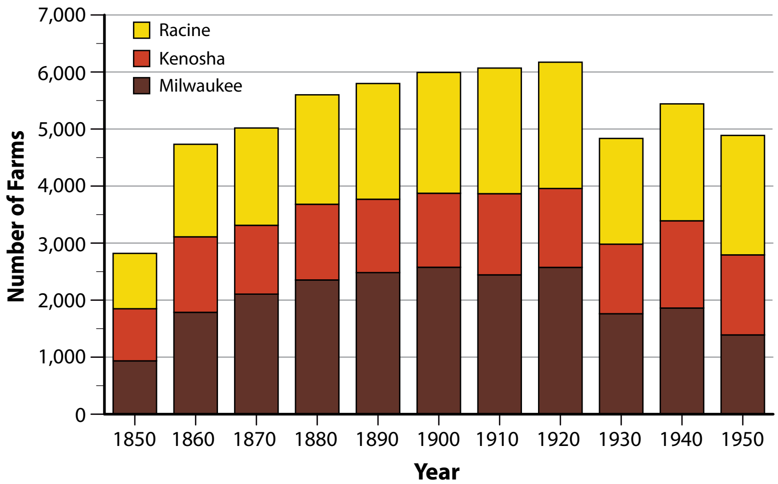


Figure 19.9. *Number of farms in Southern Lake Michigan Coastal Counties between 1850 and 1950 (ICPSR 2007).*

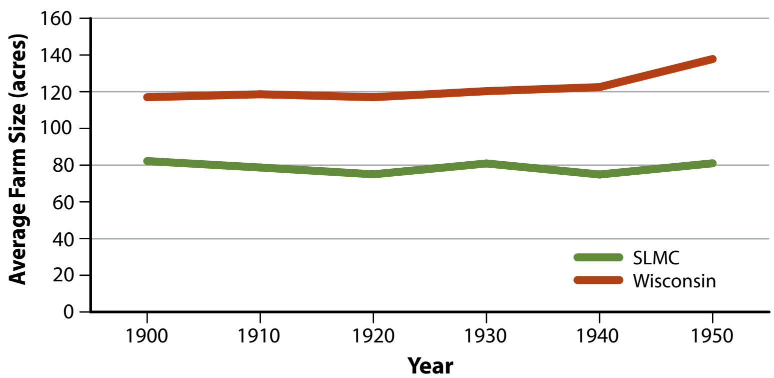


Figure 19.10. *Average farm size in the Southern Lake Michigan Coastal Counties between 1900 and 1950 (ICPSR 2007).*

a peak of 6,172, while the population had reached 669,694. Population in Southern Lake Michigan Coastal counties has continually grown in each subsequent decade, almost entirely in urban areas. With the onset of the Great Depression, farm numbers plummeted in Southern Lake Michigan Coastal counties in 1930 to 4,835, as some marginal farms were driven out of business (Figure 19.9).

Farm size in the Southern Lake Michigan Coastal counties maintained a trend of much smaller acreages than farms in the state as a whole. In 1950, the average Southern Lake Michigan Coastal county farm was only 81 acres compared to 138 acres statewide (ICPSR 2007). Following World War II, a combination of the failure of many smaller marginal farms, subsequent consolidation, and mechanization increased the average size of farms throughout the state but to a lesser degree in Southern Lake Michigan Coastal counties (Figure 19.10).

Total value of all crops indicates the extreme influence of the Great Depression on agriculture. In 1910 all crops harvested in Southern Lake Michigan Coastal counties had an estimated total value of $6.7 million, which had more than doubled by 1920 ($13.9 million) (ICPSR 2007). However, total value of all crops in Southern Lake Michigan Coastal counties plummeted in 1930 ($7.1 million), recovering slightly in 1940 ($7.3 million). Southern Lake Michigan Coastal counties have historically had some of the state's most productive farms. Total values of crops in the Southern Lake Michigan Coastal counties comprised 4.4% of total crop value in the state in 1940, and these crops came from farms comprising only 1.7% of all Wisconsin farm acreage.

Farms in the Southern Lake Michigan Coastal counties tended to be more diverse in crops grown than much of the state. The 1910 federal agricultural census listed "cereals" as 36.3% of the total value of all crops harvested in the Southern Lake Michigan Coastal counties, compared to 49.3% statewide (ICPSR 2007). Cereals comprised as little as 22.6% of total crop values in 1930, recovering only to 28.9% by 1940. Meanwhile, "hay and forage," associated with livestock farming, was only 27.2% of total value of crops harvested in the Southern Lake Michigan Coastal counties in 1910, rose to 40.1% of total crop value in 1920, then fell to 28% of total crop value by 1940, compared to 44.6% statewide. Combined, "cereals" and "hay and forage" comprised only 56.9% of total crop value in the Southern Lake Michigan Coastal counties, while these major crops were over 80% of crop value statewide.

Long before Wisconsin became America's Dairyland, Wisconsin was a beer state. Brewing began in Wisconsin in the 1830s, and by the 1890s, nearly every community had at least one operating brewery. Breweries supplied steady employment and bought grain from local farmers who in turn often fed brewery by-products to their livestock. Brewing was intimately tied to Wisconsin's people, particularly its German immigrants, who brought their knowledge and skills with them to North America. Owens' Brewery in Milwaukee is generally considered the first commercial brewery in Wisconsin (opened in 1840). As Owens' Brewery grew, its success soon brought competition, not only in Milwaukee but across the state. By 1860 nearly 200 breweries operated in Wisconsin, over 40 in Milwaukee alone.

The growth of the beer industry in Milwaukee was directly related to the city's large number of German immigrants. In the 1840s, Milwaukee began to take on a distinctly German character as waves of immigrants seeking economic opportunity and religious and political freedom settled in the area (WHS 2006). German consumers' demand for lager, a German brew, greatly expanded the city's beer industry and provided a large customer base for brewers. Many of these German immigrants were experienced brewers, saving owners both time and money in training.

The skills and experience of the German immigrants combined with Milwaukee's abundant natural resources—a good harbor, lumber for barrels, and ice for storage—to make Milwaukee, and Wisconsin, giants in the brewing industry.

Early Mining

The Southern Lake Michigan Coastal counties played an integral role in the early transport of Wisconsin mining products. By the 1830s, much of the lead ore being extracted from the mines of the lead district in southwestern Wisconsin was being transported to Milwaukee via "lead schooners," or wagons drawn by at least eight yoke of oxen (Austin 1948). In addition, shipping on Lake Michigan out of key port cities provided necessary export of these materials to eastern markets. For more information on early mining in the state, see the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions."

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 due to the rapid settlement during the 1830s (Davis 1947). A system of military roads was developed in Wisconsin during the same period, connecting key cities and forts with one another. One such road connected Milwaukee with Madison and then stretched farther west to Dubuque, Iowa. Another of these early roads joined Racine with Janesville. By 1870, however, the importance of railroads had caused highways to become of secondary value.

The first company to construct a railroad in Wisconsin was the Milwaukee and Waukesha Railroad Company in 1847 (Fisher 1937). Milwaukee also had the first railroad depot in the state. From here, the company branched out to Madison by 1854 and had reached the Mississippi River at Prairie du Chien by 1857. Additional railroad lines subsequently fanned out over the Southern Lake Michigan Coastal counties, connecting major cities like Milwaukee, Kenosha, and Racine with Waukesha and New Berlin within the same ecological landscape as well as with numerous other cities in Wisconsin and neighboring states.

In addition to railroad transport, the Southern Lake Michigan Coastal counties also played a large role in shipping transport and commerce. Milwaukee became a primary shipping point for wheat and flour during the 1850s. The city's role was determined by several factors: construction of grain elevators, rail links to wheat-producing areas, and the demand for grain during the Civil War (The Wisconsin Cartographer's Guild 1998).

In the Southern Lake Michigan coastal counties, another factor that contributed to ports' major role in the shipping industry was their protected lakeshore harbors and availability of timber. Major shipyards subsequently were established at Milwaukee as well as Manitowoc, Two Rivers, and Sturgeon Bay, in the ecological landscapes to the north.

Early Logging Era

Dr. Daniel Bigelow built the first Milwaukee sawmill in 1834 and others soon followed, mainly up and down the coast of Lake Michigan (The Wisconsin Cartographer's Guild 1998). Mills in this region of the state mostly processed trees from stands of southern Wisconsin hardwood forest and oak savanna. In 1848 a paper mill was established in Milwaukee, producing paper for the *Milwaukee Sentinel and Gazette* (Wisconsin Paper Council 2006). The paper was made from rags, with production climbing to 90 newspaper reams a week, "enough to supply the entire press of the state." Financial troubles, dam washouts, and difficulties obtaining an adequate supply of rags prevented the industry from becoming firmly established in southern Wisconsin. Another mill was built in the Milwaukee area in the early 1860s. It prospered until 1867 when a boiler explosion destroyed the mill. Although the Milwaukee area declined as a papermaking center, it is today a regional and national center for printing and paper converting (processing paper mill output into secondary or final product). See the "Statewide Socioeconomic Assessments" section in Chapter 2, "Assessment of Current Conditions," in Part 1 for a general description of the logging era in Wisconsin.

Resource Characterization and Use[1]

The Southern Lake Michigan Coastal Ecological Landscape is one of the state's smallest ecological landscapes, with only 829 square miles of land and 14 square miles of water. On the other hand, it has the second highest population, almost 1.3 million people, and the highest population density in the state, with over 1,500 people per square mile.

Among the factors to consider when evaluating current and potential recreational use, the Southern Lake Michigan Coastal Ecological Landscape has the highest percentage of urban area in the state but the second lowest percentage of public land, the lowest amount of state-owned land, very low numbers of visitors to state lands, and proportionately, 33% less forest than in other ecological landscapes in Wisconsin. It also has the lowest acreage in state natural areas and a very low number of Land Legacy sites. The density of multi-purpose trails, however, is the second highest in the state and the number of Land Legacy sites with high recreational potential is also above average. Municipal park systems (owned and administered by cities or counties) are well developed, especially in Milwaukee County.

Compared to other economic sectors, agriculture is not an important factor in the economy of the Southern Lake Michigan Coastal counties. These counties rank below average among ecological landscape county approximations in the

[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."

percentage of land area in agricultural use. However, it does have the second highest income per farmed acre in Wisconsin. Total corn and milk production are both below average. These counties have the highest annual percentage of farm acreage that is diverted to other uses and land values are among the highest in the state for these diverted agricultural acres.

Forestry, as well, is relatively unimportant to the economy. The Southern Lake Michigan Coastal Ecological Landscape ranks at the bottom in terms of the percentage of land in forest, the volume of ***growing stock,*** and removals. Forests here are productive, however, with the second highest timber volume per acre in the state (woodlots may be allowed to grow older in this ecological landscape).

Along with a very high population density, the Southern Lake Michigan Coastal Ecological Landscape has the highest density of roads, railroads, and airport runways. It has six airports and one port.

Although the high population of the Southern Lake Michigan Coastal counties uses a lot of energy, this region is not a major producer of hydroelectric power and does not produce significant amounts of woody biomass (less than 1% of the state total). This ecological landscape currently has one wind facility and no ethanol plants.

The Land

Of the 540,000 acres of land that make up the Southern Lake Michigan Coastal Ecological Landscape, only 7% is forested (USFS 2009). Almost 99% of all land is privately owned. Only 1% of the land base is in public ownership, all of which belongs to the state, counties, and municipalities.

As noted in the "Water Quality" section above, Milwaukee Metropolitan Sewerage District owns 80 properties comprising over 2,000 acres of land as part of the Greenseams land conservation program. Much of this land is within the Southern Lake Michigan Coastal counties.

The Southern Lake Michigan Coastal counties contain more than 12,400 registered brownfields sites. The great majority of these sites experienced short-term contamination and remain in commercial, industrial, or other use. A registry of brownfield sites and information on potential opportunities at abandoned sites can be obtained from the Wisconsin DNR's brownfields coordinator for each DNR region.

One example of a project that includes the remediation of brownfields is the Renew the Valley project, ongoing along the lower 4 miles of the Menomonee River valley in Milwaukee (from Miller Park to the Kinnickinnic River). It involves the reuse of brownfields and other sites for commercial and industrial redevelopment as well as the creation of new public open space. This project attracted $690 million in investment, created nearly 4,000 new jobs, constructed more than one-half million square feet of new energy-efficient structures, and created at least 70 acres of new parks, trails, and other open space, including river access and habitat restoration (MVPI 2007).

Water retention areas (shown here) are important components of the Renew the Valley project near the Menomonee River in Milwaukee. The Hank Aaron State Trail also winds its way through the project area. Photo courtesy of Menomonee Valley Partners, Inc.

Minerals

Milwaukee and Racine counties have full disclosure of mining revenues. Both are involved in the production of nonmetallic minerals (e.g., sand and gravel (construction), stone (crushed), lime, sand and gravel (industrial), and dimensional stone. In 2007 there were 11 mining establishments in the Southern Lake Michigan Coastal counties. Employment in Racine County totaled 41 people with wages of $2.3 million (WDWD 2009).

Water (Ground and Surface)

Water Supply

The data in this section are based on the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015b), which are the same as the data reported in the "Hydrology" section. However, the data are categorized differently here so the numbers differ slightly. Not including Lake Michigan, surface water covers 10,063 acres in the Southern Lake Michigan Coastal Ecological Landscape, or 1.9% of the total area. There are 8,510 acres of lakes and ponds, or 85% of total surface water. Of the 1,153 acres of streams and rivers, the Milwaukee, Root, Kinnickinnic, and Menomonee rivers are the major rivers here. There are 5,811 acres of reservoir and flowage surface water in the ecological landscape.

Water Use

Each day 1.3 billion gallons of ground and surface water are withdrawn in the Southern Lake Michigan Coastal counties (Table 19.3). Over 98% of the withdrawals are from surface water (mostly from Lake Michigan). Of the 1.28 million people that reside in these counties, 90% are served by public water sources and 10% are served by ***private wells***. Milwaukee County accounts for over 94% of all water withdrawals,

Table 19.3. *Water use (millions of gallons/day) in the Southern Lake Michigan Coastal counties.*

County	Ground-water	Surface Water	Public Supply	Domestic[a]	Agriculture[b]	Irrigation	Industrial	Mining	Thermo-electric	Total
Kenosha	3.9	26.7	15.6	2.5	0.4	0.7	2.0	0.4	9.0	30.6
Milwaukee	5.1	1,219.1	137.1	0.9	0.1	0.4	10.2	0.4	1,075.0	1,224.1
Racine	14.4	27.9	26.3	3.5	1.4	5.3	3.8	1.9	–	42.2
Total	**23.0**	**1,274.0**	**179.0**	**6.9**	**1.9**	**6.4**	**16.0**	**2.7**	**1,084.0**	**1,296.9**
Percent of total	**2%**	**98%**	**14%**	**1%**	**0%**	**1%**	**1%**	**0%**	**84%**	

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.

and 84% of water is used for thermoelectric power generation (USGS 2010).

Nearly all municipal water supply systems in this ecological landscape use Lake Michigan as their water source, including all the major metropolitan areas of Kenosha, Racine, and Milwaukee counties. A few smaller municipal systems use groundwater. There are also a number of smaller, nonmunicipal public water supply systems that draw water from the groundwater aquifer.

Groundwater withdrawals from the deep aquifer in this ecological landscape as well as in the neighboring Southeast Glacial Plain Ecological Landscape continue to affect the regional depth of groundwater, lowering the groundwater level far below where it was prior to Euro-American settlement. For example, in 1950 there was a cone of depression reaching to about 300 feet below pre-development levels, centered just 3 miles from the Milwaukee harbor. By 2000 the cone of depression had reached about 450 feet depth, and extensive development in Waukesha County moved the center of this drawdown about 10 miles further westward into Waukesha County (SEWRPC and WGNHS 2002).

The Southeast Wisconsin Regional Planning Commission (SEWRPC), in cooperation with the Wisconsin Geological and Natural History Survey, has developed a regional groundwater model to assist in developing regional groundwater policy. This policy will be incorporated as a future SEWRPC regional water supply plan.

Recreation

Recreation Resources

Land cover, land use, and ownership patterns partly determine the types of recreation that are available to the public. For instance, in the Southern Lake Michigan Coastal Ecological Landscape, there is a 22% higher percentage of urban land and a 33% lower proportion of forest compared to the rest of Wisconsin (see Chapter 3, "Comparison of Ecological Landscapes," and/or the map "WISCLAND Land Cover (1992) of the Southern Lake Michigan Coastal Ecological Landscape" in Appendix 19.K at the end of this chapter). This ecological landscape has the highest percentage of urban area in the state. The acres of surface water is fourth lowest, but the proportion of that water in rivers as opposed to inland lakes is above average.

The Southern Lake Michigan Coastal Ecological Landscape has the second lowest percentage of public land in the state with the lowest amount of state-owned land and a very low number of visitors to state lands (Wisconsin DNR unpublished data). It also has the lowest acreage in state natural areas and a very low number of Land Legacy sites. However, the density of multi-purpose trails is the second highest in the state, and the number of Land Legacy sites with high recreational potential is also above average.

Supply

Land and Water. The Southern Lake Michigan Coastal Ecological Landscape accounts for 1.5% of Wisconsin's total land area but only 0.7 % of the state's acreage in water (see Chapter 3, "Comparison of Ecological Landscapes"). There are 35,389 acres of forested land in the Southern Lake Michigan Coastal Ecological Landscape, 0.2% of the total state acreage (USFS 2009). Although the area in surface water is not great, Lake Michigan and its shoreline are extremely important to many forms of recreation, including boating, fishing, and sightseeing. Streams and rivers make up 11% of the surface water area of the Southern Lake Michigan Coastal Ecological Landscape, and lakes, ponds, and reservoirs make up 89% (WDNR 2015b). The Milwaukee and Root are the major rivers here.

Public Lands. Public access to lands and waters are vital to many types of recreational activity. In the Southern Lake Michigan Coastal Ecological Landscape, less than 20,000 acres, or 3% of all land and water combined, is publicly owned, mostly by the Milwaukee County Park System (WDNR 2005a; also see Appendix 19.G at the end of the chapter). This is significantly less than the statewide average of 19.5%, ranking this ecological landscape 15th out of 16 ecological landscapes in the proportion of public ownership.

State-owned lands and facilities are important to recreation in the Southern Lake Michigan Coastal Ecological Landscape. There are 520 acres of state forest (Havenwood Forest Preserve) and over 4,500 acres in state recreation areas (at Richard Bong State Recreation Area in Kenosha County; WDNR 2005a). In addition, state fisheries and wildlife management lands cover about 1,300 acres. The largest of these, Big Muskego Lake State Wildlife Area, provides 270 acres of recreational land.

Trails. The Southern Lake Michigan Coastal counties have only about 700 miles of recreational trails (Table 19.4) but rank second (out of 16 ecological landscapes) in terms of trail density (miles of trail per square mile of land). Compared to the rest of the state, there is a higher density of hiking, biking, and cross-country ski trails (Wisconsin DNR unpublished data).

Campgrounds. There are 18 public and privately owned campgrounds that provide about 1,656 campsites in the Southern Lake Michigan Coastal counties (Wisconsin DNR unpublished data). With only 1% of the state's campgrounds, this ecological landscape county approximation ranks 16th (out of 16 in the state) in terms of the number of campgrounds but eighth in campground density (campgrounds per square mile of land).

Land Legacy Sites. The Land Legacy project has identified over 300 places of significant ecological and recreational importance in Wisconsin, and 11 are either partially or totally located within the Southern Lake Michigan Coastal Ecological Landscape (WDNR 2006b). Two of them, the Root River and Bong Grassland, are rated as having the highest recreation significance. In addition, Chiwaukee Prairie is regarded as having the highest conservation potential.

State Natural Areas. The Southern Lake Michigan Coastal Ecological Landscape has 851 acres of state natural areas, of which 79% are publicly owned (including by Wisconsin DNR and several educational institutions) and 21% are privately owned (including by NGOs; Wisconsin DNR unpublished data). The largest state natural areas in this ecological landscape include Chiwaukee Prairie (460 acres, Kenosha County), Renak-Polak Maple-Beech Woods (107 acres, Racine County), Franklin Savanna (86 acres, Milwaukee County), Muskego Park Hardwoods (86 acres, Waukesha County), and Cudahy Woods (43 acres, Milwaukee County). For more information on Wisconsin state natural areas, see the Wisconsin DNR's website (WDNR 2015d).

Demand

Visitors to State Lands. In 2006 there were an estimated 269,430 visitors to state recreation areas and state forests in the Southern Lake Michigan Coastal Ecological Landscape (Wisconsin DNR unpublished data). The majority, 81%, visited the Richard Bong State Recreation Area. In addition, 52,000 people visited the Havenwoods State Forest Preserve.

Fishing and Hunting License Sales. Of all license sales, the highest revenue producers for the Southern Lake Michigan Coastal counties were resident hunting licenses (40% of total sales) and resident fishing licenses (38% of total sales; Wisconsin DNR unpublished data). Table 19.5 shows a breakdown of various licenses sold in the Southern Lake Michigan Coastal counties in 2007. Milwaukee County accounts for both the highest number of licenses sold and the highest revenue from sales. The Southern Lake Michigan Coastal county approximation accounts for about 4% of total license sales in the state. However, persons buying licenses in the Southern Lake Michigan Coastal counties may travel to other parts of the state to use them.

Table 19.4. *Miles of trails and trail density in the Southern Lake Michigan Coastal counties compared to the whole state.*

Trail type	Southern Lake Michigan Coastal (miles)	Southern Lake Michigan Coastal (miles/100 mi^2)	Wisconsin (miles/100 mi^2)
Hiking	62	7.4	2.8
Road biking	245	29.0	4.8
Mountain biking	43	5.0	1.9
ATV: summer & winter	0	–	9.3
X-country skiing	123	15.0	7.2
Snowmobile	235	28.0	31.2

Source: Wisconsin DNR unpublished data.

Table 19.5. *Fishing and hunting licenses and stamps sold in the Southern Lake Michigan Coastal counties.*

County	Resident fishing	Nonresident fishing	Misc. fishing	Resident hunting	Nonresident hunting	Stamps	Total
Kenosha	15,143	5,187	3,618	14,650	1,175	10,853	50,626
Milwaukee	42,943	969	1,393	31,961	125	18,351	95,742
Racine	19,469	1,374	1,539	20,186	114	9,842	52,524
Total	**77,555**	**7,530**	**6,550**	**66,797**	**1,414**	**39,046**	**198,892**
Sales	**$1,725,813**	**$332,783**	**$104,695**	**$1,841,000**	**$202,081**	**$357,673**	**$4,564,045**

Source: Wisconsin DNR unpublished data, 2007.

Metropolitan Versus Nonmetropolitan Recreation Counties. 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. The Southern Lake Michigan Coastal counties are highly urban, and none are categorized as nonmetro recreation counties.

Recreational Issues

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

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

Timber Harvesting. A high percentage of statewide residents are concerned about timber harvesting in areas where they recreate (WDNR 2006a). Their greatest concern about timber harvesting is large-scale visual changes (i.e., large openings) in a forest landscape. Since so small an area is forested in the Southern Lake Michigan Coastal, this is not an issue here.

Loss of Access to Lands and Waters. With ever-increasing development along shorelines and continued parcelization of undeveloped lands there has been a loss of readily available access to lands and waters within this ecological landscape. In some parts of the state, new housing developments have resulted in loss of public access to areas that were once open to recreational users. Lack of public land, high population density, and high demand for access are important factors here. Another element that may play into the perception of reduced access is a lack of information about where to go for recreational opportunities. This element was highly ranked as a barrier to increased outdoor recreation in a statewide survey (WDNR 2006a).

Agriculture

Farm numbers in the Southern Lake Michigan Coastal counties decreased 40% between 1970 and 2002 (USDA NASS 2004). There were approximately 1,970 farms in 1970 and only 1,175 in 2002. Between 1970 and 2002, average farm size

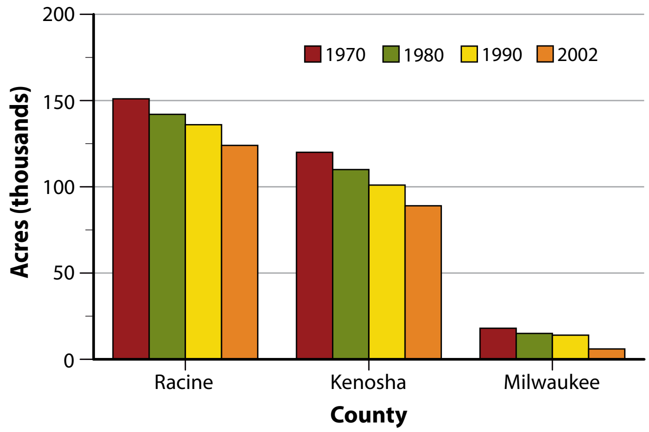


Figure 19.11. *Acreage of farmland by county and year in Southern Lake Michigan Coastal counties (USDA NASS 2004).*

increased from 132 acres to 153 acres, still much lower than the Wisconsin average of 204 acres. The overall land in farms has steadily decreased since the 1970s (Figure 19.11). In 1970 there were 289,000 acres of farmland, and by 2002, acreage was down to 218,000 acres, a decrease of 24%. For the three counties, the percentage of land in farms ranged from 4% to 57%, averaging 40%. The counties with the highest percentage of farmland are Racine County with 57% and Kenosha County with 50%.

There is not much land in agriculture in the Southern Lake Michigan Coastal counties, but income per acre is second highest in the state. In 2002, net cash farm income totaled $26 million, or an average of $120 per agricultural acre, much higher than the statewide average of $90 per acre (USDA NASS 2004). The market value of all agriculture products sold in the Southern Lake Michigan Coastal counties was $116 million (1.4% of state total); 59% of this amount came from crop sales, while the remaining 41% was from livestock sales.

In 2007, 1,647 acres of farmland were sold, of which only 34% stayed in agricultural use at an average selling price of $10,842, while 66% was diverted to other uses. Not only do the Southern Lake Michigan Coastal counties have the highest diversion rate in the state but also the highest price for agricultural land and the second highest price for land diverted from agricultural uses (USDA NASS 2009).

Timber

Traditional forestry is not common in this ecological landscape; however urban forestry is practiced extensively in the urbanized areas. The use of urban forest products has been increasing in recent years. For example, the city of Milwaukee markets most of its public urban trees that need to be removed due to age, disease, or storm damage to a local mill. Approximately 30% of this wood becomes dimensional lumber with the rest used as firewood, chips, or other products. This model has been successful in Milwaukee and is being used as an example for other parts of the state by the Wisconsin DNR Urban Forestry Program.

Timber Supply

According to Forest Inventory and Analysis (FIA) data, only 7% (35,389 acres) of the total land area in the Southern Lake Michigan Coastal Ecological Landscape is forested (USFS 2009). This is only 0.2% of Wisconsin's total forestland acreage.

■ **Timber Ownership.** Of all ***timberland*** within the ecological landscape, 67% is owned by private landowners. The remaining 33% is publicly owned (USFS 2009; Figure 19.12). ***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.

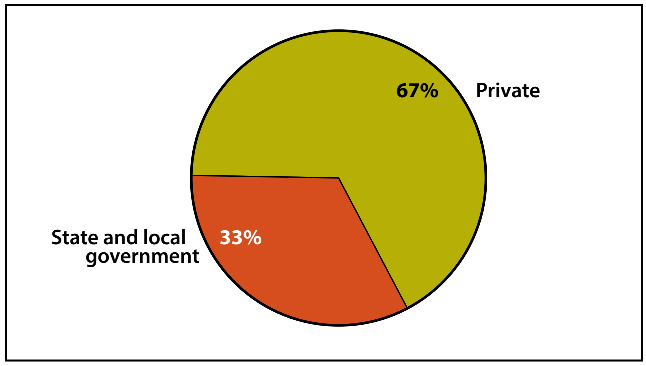


Figure 19.12. *Timberland ownership in the Southern Lake Michigan Coastal Ecological Landscape (USFS 2009).*

■ **Growing Stock and Sawtimber Volume.** There were approximately 55 million cubic feet of growing stock volume in the Southern Lake Michigan Coastal Ecological Landscape in 2007, or 0.3% of total volume in the state (USFS 2009). Ninety-five percent of this was in hardwoods, higher than the proportion of hardwoods statewide, which total about 74% of total growing stock volume. Hardwoods made up 100% of ***sawtimber*** volume in the Southern Lake Michigan Coastal Ecological Landscape. In comparison, hardwoods accounted for 67% of total volume statewide.

■ **Annual Growing Stock and Sawtimber Growth.** Between 1996 and 2007, the Southern Lake Michigan Coastal Ecological Landscape timber resource decreased by 9 million cubic feet, or 14% (USFS 2009). All of this decrease occurred in hardwood volume. Sawtimber volume decreased by 5 million ***board feet***, or 2%, again in hardwoods. This change was partly a result of a 33% decrease in timberland acreage, from 43,729 acres in 1996 to 29,202 acres in 2007. Statewide, timberland acreage increased by 3% during the same time period.

■ **Timber Forest Types.** According to Forest Inventory and Analysis (FIA) data (USFS 2009), the predominant forest type groups in terms of acreage are oak-hickory (41%), maple-basswood (20%), and bottomland hardwoods (18%), with smaller amounts of exotic softwoods and aspen-birch. See Appendix H, "Forest Types That Were Combined into Forest Type Groups Based on FIA Data," in Part 3, "Supporting Materials," for a description of forest type groups. Acreage is predominantly in the pole and sawtimber size classes (46% and 47%, respectively) with only 7% in seedling and sapling classes (Table 19.6).

Timber Demand

■ **Removals from Growing Stock.** The Southern Lake Michigan Coastal Ecological Landscape has about 0.3% of the total growing stock volume on timberland in Wisconsin (USFS 2009; see the "Socioeconomic Characteristics" section in Chapter 3, "Comparison of Ecological Landscapes," in Part 1 of the book). Average annual removals from growing stock were 775,000 cubic feet, or about 0.2% of total statewide removals (349 million cubic feet) between 2002 and 2007 (Figure 9.13). Average annual removals to growth ratios vary by species. Bur oak was the only major species harvested in this ecological landscape where removals exceeded growth for the time period shown.

Table 19.6. *Acreage of timberland in the Southern Lake Michigan Coastal Ecological Landscape by forest type and stand size.*

Forest type[a]	Seedling/sapling	Pole-size	Sawtimber	Total
White oak	–	–	8,868	8,868
Sugar maple-beech-yellow birch	–	2,093	1,537	3,630
Hard maple-basswood	–	3,227	–	3,227
Mixed upland hardwoods	2,045	1,043	–	3,088
Sugarberry-hackberry-elm-green ash	–	2,829	–	2,829
Aspen	–	2,180	–	2,180
White oak-red oak-hickory	–	2,049	–	2,049
Willow	–	–	1,396	1,396
Cottonwood	–	–	1,265	1,265
Black ash-American elm-red maple	–	–	670	670
Total	**2,045**	**13,421**	**13,736**	**29,202**

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.

Removals from Sawtimber. The Southern Lake Michigan Coastal Ecological Landscape has about 0.3% of the total sawtimber volume on timberland in Wisconsin (USFS 2009). Average annual removals from sawtimber in this ecological landscape were about 4 million board feet, or 0.4% of total statewide removals (1.1 billion board feet) between 2002 and 2007 (Figure 9.14). Average annual removals to growth ratios vary by species. As stated above, the only major species harvested in this ecological landscape was bur oak, where removals exceeded growth for the time period shown.

Price Trends

In the Southern Lake Michigan Coastal counties, black walnut (*Juglans nigra*), northern red oak, and white oak were the highest priced hardwood sawtimber species in 2007 (WDNR 2008). Northern white-cedar, eastern white pine, and red pine (*Pinus resinosa*) were the most valuable softwood timber species (although these species are rare in this ecological landscape). Sawtimber prices for 2007 were generally much higher for softwoods (although there are very few softwoods here) and lower for hardwoods compared to the rest of the state.

For pulpwood, red pine is the most valuable, but there's very little in this ecological landscape. Pulpwood values in the Southern Lake Michigan Coastal counties were generally lower for hardwoods and much lower for softwoods compared to the statewide average (WDNR 2008).

Infrastructure

Transportation

The transportation infrastructure of the Southern Lake Michigan Coastal Ecological Landscape is much more developed than in the rest of the state. For instance, road mile density is over three times higher (WDOT 2000), railroad density is about four times higher (WDOT 1998), and airport runway density is also almost four times higher than for the state as a whole (WDOT 2012).

There are six airports in the Southern Lake Michigan Coastal Ecological Landscape, one of which (Milwaukee Mitchell International) is a primary regional airport and three of which (Kenosha, Milwaukee, and Racine) are secondary airports (WDOT 2012). Mitchell International Airport handles 66% of all passenger flights in the state. There is one gateway port, at Milwaukee (WCPA 2010) (Table 19.7).

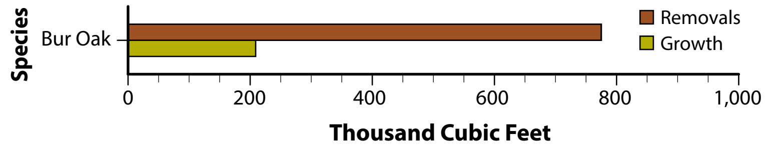


Figure 19.13. *Growing stock growth and removals on timberland in the Southern Lake Michigan Coastal Ecological Landscape (USFS 2009).*

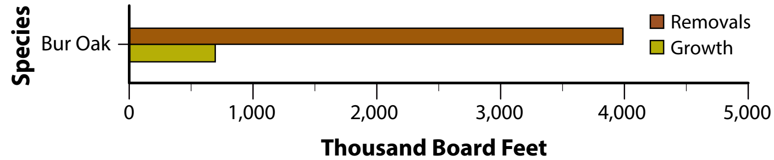


Figure 19.14 *Sawtimber growth and removals on timberland in the Southern Lake Michigan Coastal Ecological Landscape (USFS 2009).*

The Marquette interchange in the city of Milwaukee is the confluence of Interstate Highways 43, 94, and 794. Conceived in the 1950s and completed in the 1960s, the interchange has long been a cornerstone of southeastern Wisconsin's highway system. It is currently undergoing a makeover with new structures and roadways. Wisconsin DNR photo.

Renewable Energy

Hydroelectric and wind turbine power are the only renewable energy sources quantified by county in Wisconsin Energy Statistics produced by the Wisconsin Department of Administration (WDOA 2006). Some general inferences can be drawn from other sources regarding the potential for

Table 19.7. *Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of ports in the Southern Lake Michigan Coastal Ecological Landscape.*

	Southern Lake Michigan Coastal	State total	% of state total
Total road length (miles)[a]	8,795	185,487	5%
Road density[b]	10.6	3.4	–
Miles of railroads	317	5,232	6%
Railroad density[c]	38.3	9.7	–
Airports	6	128	5%
Miles of runway	5.6	95.7	6%
Runway density[d]	6.8	1.8	–
Total land area (square miles)	829	54,087	2%
Number of ports[e]	1	14	7%

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

renewable energy production in the Southern Lake Michigan Coastal counties.

Other than wind power generation, the Southern Lake Michigan Coastal Ecological Landscape has limited potential to produce a significant amount of renewable energy. Both woody biomass production and corn-based ethanol are limited because of the high degree of urban development and the high value of lands diverted from agriculture to other uses. The Southern Lake Michigan Coastal Ecological Landscape has only 0.2% of all woody biomass in Wisconsin, generates no hydroelectric power, and produces only 1.2% of the state's corn crop. This ecological landscape currently has no ethanol plants and one wind generating site in Mt. Pleasant.

■ **Biomass.** Woody biomass is Wisconsin's most-used renewable energy resource, and the Southern Lake Michigan Coastal Ecological Landscape produces 1.6 million oven-dry tons of biomass annually, or 0.2% of total production (USFS 2009). The ecological landscape's forested land base, at only 7%, decreased by 9,765 acres, or 22%, in the last decade.

■ **Hydroelectric.** There are no hydroelectric power sites in the Southern Lake Michigan Coastal Ecological Landscape (WDOA 2006).

■ **Ethanol.** The Southern Lake Michigan Coastal counties produced 7.3 million bushels of corn in 2002, or 1.2% of total production in the state (USDA NASS 2004). Acreage in agriculture (40% of the land base; some woodland was counted as agriculture by this source) decreased by 24% between 1970 and 2002. Increasing ethanol production would depend on converting land to corn, which is unlikely on any major scale in the Southern Lake Michigan Coastal counties. There are no ethanol plants located in this ecological landscape (Renewable Fuels Association 2014).

■ **Wind.** As of 2014, there was one industrial wind facility in the Southern Lake Michigan Coastal Ecological Landscape at Mt. Pleasant (WWIC 2014). Mean annual power densities are generally between 200 and 300 W/m^2 (watts/square meter) in this part of the state with some areas having power densities of 300–400 W/m^2 (USDE 2015). This indicates a good potential for future development of wind generated power in this part of the state; however, clarification of the environmental effects of any wind facilities sited in Lake Michigan would require detailed study.

Current Socioeconomic Conditions

The Southern Lake Michigan Coastal counties stand out among the ecological landscape county approximations of the state when comparing several socioeconomic indicators, especially population attributes and income. These counties have the highest population density but have lost population since 1970, especially in Milwaukee County. The Southern Lake Michigan Coastal counties have the highest percentage of people under 18 and the second lowest median age. The population of nonwhites, especially African American and Hispanic, is higher than elsewhere in the state.

Most of the population in the Southern Lake Michigan Coastal counties is doing quite well economically. Although the average wage is the highest in the state among ecological landscape county approximations, the per capita income is second highest, the unemployment rate is higher than the state average, and the poverty rate, especially for children, is quite high. In terms of job distribution, the Southern Lake Michigan Coastal counties' service sector provides more jobs than in any other ecological landscape county approximation. The relative importance of the agriculture and government sectors is among the lowest in all of the state's ecological landscape county approximations.

Demography

Population Distribution

The U.S. Census Bureau estimated the 2010 population of the Southern Lake Michigan Coastal counties to be 1,309,569, which is about 23% of the state total, the most of any ecological landscape county approximation in the state (USCB 2012a). The percentage of the state population in the Southern Lake Michigan Coastal counties has dropped significantly since 1970, when it was 30.3% of the state total (USCB 2009). The population has actually increased here but at a slower rate than for the rest of the state. The population is concentrated around the city of Milwaukee and its suburbs, and the cities of Racine and Kenosha. In total, there are 28 cities considered to be urban centers (populations over 2,500) within the Southern Lake Michigan Coastal counties. The largest city is Milwaukee with over 594,833 people in 2010 (USCB 2012a). Racine, Kenosha, and West Allis have populations over 50,000, and 16 other cities have populations over 10,000. Ninety-six percent of the population in the Southern Lake Michigan Coastal counties lives in urban areas.

Population Density

The population density in 2010 of the Southern Lake Michigan Coastal counties was much higher than the state average. There are 1,548 persons per square mile in the Southern Lake Michigan Coastal counties, compared to only 105 persons per square mile in Wisconsin as a whole (USCB 2012a).

Population Structure

■ **Age.** Approximately 25.0% of the population in 2010 in Southern Lake Michigan Coastal counties was under 18 years old, compared to 23.6% statewide, while 11.7% of the population is 65 or older, compared to 13.7% statewide (USCB 2012a). This age structure is similar to the rest of the state. The median age is 34.9 compared to 36 years statewide.

■ **Minorities.** There is a much higher percentage of minorities in the Southern Lake Michigan Coastal counties than the rest of the state. A total of 66.4% of the population is white, non-hispanic, compared to 86.2% statewide (USCB 2012a). Almost 22% of the population is African American, compared to 6.3% statewide, and Hispanics represent 12.8% of the population, compared to 5.9% statewide.

■ **Education.** Residents 25 years of age or older in Southern Lake Michigan Coastal counties have a slightly lower educational attainment than the statewide average. According to the 2010 federal census, 85.7% of residents 25 or older have graduated from high school, compared to 89.4% statewide, and 25.6% have received at least a bachelor's degree or higher, compared to 25.8% statewide (USCB 2012a).

Population Trends

Due to stagnant population growth in Milwaukee County (9%), from 1950 to 2006, combined population growth in Southern Lake Michigan Coastal counties (24%) has occurred at a much slower rate than the state's population growth (62%) (USCB 2009). The Southern Lake Michigan Coastal counties' fastest growth occurred in the 1950s and 1960s, the only recent decades in which Southern Lake Michigan Coastal counties' population growth (21%) outpaced the state's (15%). The population in Southern Lake Michigan Coastal counties actually dropped between 1970 and 1980, with most of the change (-8.5%) occurring in Milwaukee County as the population shifted to surrounding suburban counties. Since then, only Kenosha County's population has grown at an equal or greater rate than the state.

Housing

■ **Housing Density.** Southern Lake Michigan Coastal counties are highly developed with 1,732 homes per square mile in Milwaukee County in 2010 and 255 and 247 homes per square mile in Kenosha and Racine counties, respectively (USCB 2012b). Southern Lake Michigan Coastal counties have the highest average housing density of any ecological landscape county approximation in the state (673 home per square mile).

■ **Seasonal Homes.** Seasonal and recreational homes made up only 0.6% of the Southern Lake Michigan Coastal counties' housing stock in 2010, in comparison to the statewide average of 6.3% (USCB 2012c). This indicates a minimal degree of tourism and occasional residents here. Kenosha County has the largest number of these units in the Southern Lake Michigan Coastal counties, with 2.5%. Seasonal and recreation homes comprise only 1.3% of Racine County's housing stock and 0.2% of Milwaukee County's.

■ **Housing Growth.** Housing growth was the most rapid in the 1950s and 1960s with an annual housing growth rate of 2.7% in Kenosha County, 2.7% in Racine County, and 1.9% in Milwaukee County (USCB 2009). From 1970 to 2004, housing growth was relatively steady for Kenosha County (1.6–1.8% per year), 1.1%–1.3% for Racine County, and 0.2%–0.6% per year for Milwaukee County (USCB 2009). Generally, housing development has outpaced population growth in Southern Lake Michigan Coastal counties.

■ **Housing Values.** An interesting pattern of housing values occur in the Southern Lake Michigan Coastal counties. Home values within the cities of Milwaukee, Racine, and Kenosha are much lower (median of $120,500–$149,700) than home values in the surrounding areas ($168,700–$266,200) (USCB

2012a). The cities were prosperous during the manufacturing era of the 1950s through the 1970s, but money shifted away from city centers to the outlying areas. The city centers now have home values more similar to rural areas beyond the suburbs.

The Economy

Income

Per Capita Income. Total personal income in Southern Lake Michigan Coastal counties in 2006 was $44.5 billion (23.2% of the state total), with Milwaukee County as the major contributor ($32.5 billion) (USDC BEA 2006). Average per capita income in Southern Lake Michigan Coastal counties ($34,019) in 2006 was very similar to the statewide average of $34,405. Racine County has a slightly higher per capita income of $35,209, Milwaukee County ($34,128) approximates the state average, while Kenosha County has the lowest per capita income at $31,943. Overall, per capita income has been increasing for the Southern Lake Michigan Coastal counties. When adjusted for inflation, the per capita income for the region was $19,769 in 1970, $23,952 in 1980, $25,692 in 1990, and $29,793 in 1999 (2001 dollars).

Household Income. Compared to the 2005 statewide average of $47,141, median household income was higher in Kenosha ($52,757) and Racine ($50,831) counties and lower in Milwaukee County ($38,098), according to U.S. Census Bureau estimates (USCB 2009).

Earnings Per Job. In 2006, average earnings per job for the Southern Lake Michigan Coastal counties were $40,675, exceeding the statewide average of $36,142 (USDC BEA 2006). Milwaukee County ($41,674) had the highest average earnings per job in Southern Lake Michigan Coastal counties. Average wages have not increased significantly since 1970. In 1970 the average wage was $33,362, in 1980 it was $32,526, in 1990 it was $29,859, and in 1999 it was $33,580 (adjusted for inflation in 2001 dollars).

Unemployment

The Southern Lake Michigan Coastal counties (5.6%) had higher 2006 unemployment rates than the state (4.7%) (USDL BLS 2006). Kenosha County had the lowest rate of unemployment (5.4%), while Milwaukee and Racine counties were highest (5.7% each). Unemployment among African American males in the Milwaukee Metro area was 51.1%, second only to Buffalo, New York, among the nation's largest 35 metro areas. Unemployment rates became much higher throughout the state after 2008 but have become lower again.

Poverty

The U.S. Census Bureau estimated the Southern Lake Michigan Coastal counties' 2005 poverty rate for all residents at 15.2%, compared to the state average of 10.2% (USCB 2009). Milwaukee County's much higher poverty rate of 18.4% contrasts with lower rates in Racine (10.4%) and Kenosha (9.3%) counties. Nearly a quarter (24%) of children in Southern Lake

Table 19.8. *Economic indicators for the Southern Lake Michigan Coastal (SLMC) 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%**
Kenosha	$31,943	$34,854	5.4%	9.3%
Milwaukee	$34,128	$41,674	5.7%	18.4%
Racine	$35,209	$38,390	5.7%	10.4%
SLMC counties	**$34,019**	**$40,675**	**5.6%**	**15.2%**

[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 19.9. *Property values for the Southern Lake Michigan Coastal (SLMC) 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**
Kenosha	$10,462,476,400	66,693	$156,875
Milwaukee	$42,355,573,100	410,170	$103,263
Racine	$11,576,805,100	80,266	$144,230
SLMC counties	**$64,394,854,600**	**557,129**	**$115,583**

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.

Michigan Coastal counties live below the poverty line. Again, Milwaukee's higher childhood poverty rate of 27.9% contrasts with Racine and Kenosha counties' lower rates, hovering near the state average of 14.0% (Table 19.8).

Residential Property Values

The 2006 residential property value is lowest in Milwaukee County ($103,263), which is below the statewide average ($134,021) (Table 19.9). The residential property value in both Racine and Kenosha counties ($144,230 and $156,875, respectively) is above the statewide average.

Important Economic Sectors

Almost 23% of the state's jobs are found within the Southern Lake Michigan Coastal counties (Table 19.10; MIG 2009). Only the Southeast Glacial Plains counties provide more jobs (33% of the jobs in the state). The top five economic sectors in terms of the number of jobs provided to the local economy within the Southern Lake Michigan Coastal counties are Health Care and Social Services (14.1%), Tourism-related (11.4%), Government employment (10.7%), Manufacturing (non-wood) (10.2%), and Administrative and Support Services (7.7%). Service sector jobs have come to dominate the economy in the Southern Lake Michigan Coastal counties, with less than 17% of jobs being in Manufacturing, Transportation and Warehousing, and Construction combined. The Manufacturing sector is led by fabricated metal products (17% of all manufacturing products in the Southern Lake Michigan Coastal counties), Machinery Production (14%), Food Manufacturing (11%) of which the majority is Animal Processing, and Electrical Equipment and Appliances (10%). However, there are a number of higher paying jobs in the Health Care and Social Assistance, and Government sectors, which is reflected in the slightly higher income here than the state average, particularly in Milwaukee and Racine counties. For definitions of economic sectors, see the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

Comparing these economic sectors for the state as a whole, the Southern Lake Michigan Coastal counties provide 44% of the state's jobs for Private Education, 38% for Administrative and Support Services, 37% for Management, and 26% for Real Estate and Rentals (Table 19.10; MIG 2009). More than 25% of the state's jobs were provided in the Southern Lake Michigan Coastal counties for Information Services; Finance and Insurance; and Professional, Scientific, and Technical Services. Clearly these counties provide a large number of good paying jobs when compared to the state as a whole.

Importance of economic sectors within the Southern Lake Michigan Coastal counties when compared to the rest of the state was evaluated using an economic base analysis to

Table 19.10. *Total and percentage of jobs in each economic sector within the Southern Lake Michigan Coastal (SLMC) counties, 2007. The economic sectors providing the highest percentage of jobs in the Southern Lake Michigan Coastal counties are highlighted in blue.*

Industry sector	WI employment	% of WI total	SLMC counties employment	% of SLMC counties total
Agriculture, Fishing & Hunting	110,408	3.1%	2,413	0.3%
Forest Products & Processing	88,089	2.5%	6,478	0.8%
Mining	3,780	0.1%	166	0.0%
Utilities	11,182	0.3%	1,674	0.2%
Construction	200,794	5.6%	30,877	3.8%
Manufacturing (non-wood)	417,139	11.7%	83,282	10.2%
Wholesale Trade	131,751	3.7%	29,582	3.6%
Retail Trade	320,954	9.0%	58,670	7.2%
Tourism-related	399,054	11.2%	93,256	11.4%
Transportation & Warehousing	108,919	3.1%	20,716	2.5%
Information	57,081	1.6%	14,588	1.8%
Finance & Insurance	168,412	4.7%	45,435	5.6%
Real Estate, Rental & Leasing	106,215	3.0%	27,655	3.4%
Professional, Science & Tech Services	166,353	4.7%	57,716	7.1%
Management	43,009	1.2%	15,964	2.0%
Administrative and Support Services	166,405	4.7%	62,556	7.7%
Private Education	57,373	1.6%	25,504	3.1%
Health Care & Social Services	379,538	10.7%	114,897	14.1%
Other Services	187,939	5.3%	36,118	4.4%
Government	430,767	12.1%	87,585	10.7%
Totals	**3,555,161**		**815,132**	**22.9%**

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

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 location 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 Southern Lake Michigan Coastal counties had nine sectors with quotients higher than 1.0 (Figure 19.15). Five sectors stand out in the Southern Lake Michigan Coastal counties as having the highest respective location quotients among all ecological landscape county approximations in the state: Private Education; Administrative and Support Services; Management; Professional, Science, and Technical Services; and Health Care and Social Services. These sectors are more prevalent proportionally in Southern Lake Michigan Coastal counties than anywhere else in the state.

Other economic sectors providing a percentage of jobs higher than the state average, listed in order of their relative importance, are Finance and Insurance; Real Estate, Rental, and Leasing; Information services; and Tourism-related (Figure 19.15, Appendix 19.I).

The Tourism-related sector includes relevant subsectors within (1) Retail Trade; (2) Passenger Transportation; and (3) Arts, Entertainment and Recreation. The Tourism-related sector also includes all Accommodation and Food Services (Marcouiller and Xia 2008). The Administration and Support Services sector includes office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services. The Management sector comprises holding securities or other equity interests in companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or administering, overseeing, and managing companies or enterprises.

Urban Influence

The USDA's Economic Research Service divides counties into 12 groups on a continuum of urban influence, with 1 representing large metropolitan 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. The Southern Lake Michigan Coastal counties are highly urbanized, reflected in the classification of Milwaukee and Kenosha counties as large metropolitan areas

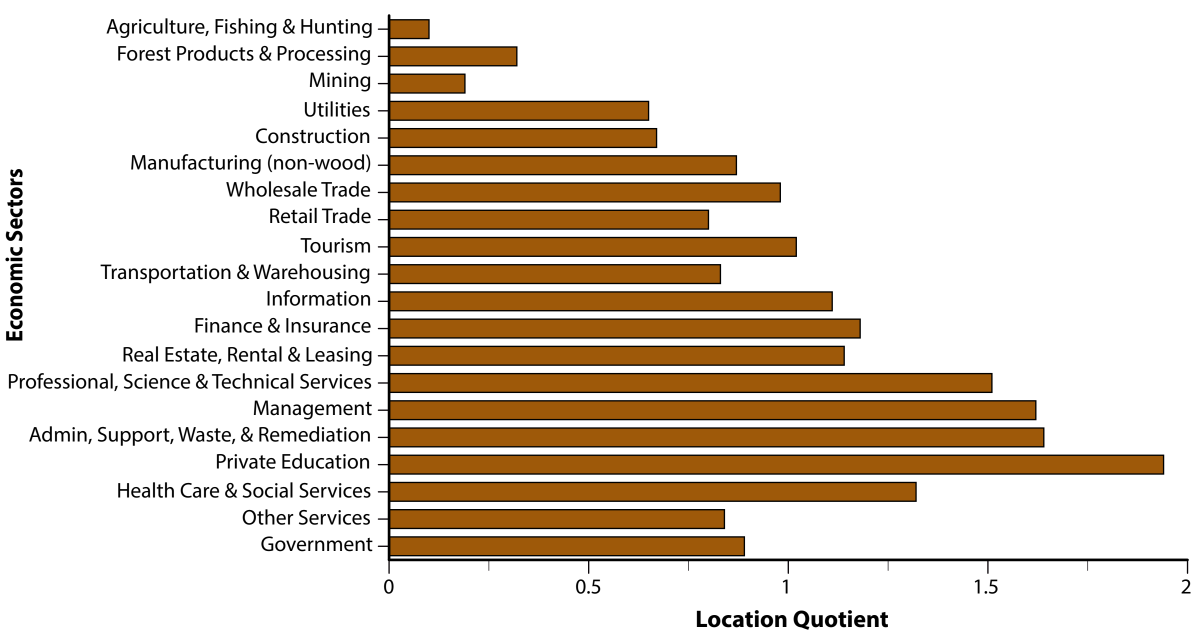


Figure 19.15. *Importance of economic sectors within the Southern Lake Michigan Coastal counties compared to the rest of the state. If the location quotient is greater than 1.0, the Southern Lake Michigan Coastal counties are contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the Southern Lake Michigan Coastal counties are contributing fewer jobs to that economic sector than the state average.*

(class 1 in urban influence). Racine County is classified as a smaller metropolitan area (class 2).

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). Kenosha and Racine counties were classified as manufacturing-dependent, while Milwaukee County was classified as service-dependent.

Policy Types

The USDA Economic Research Service also classifies counties according to "policy types" deemed especially relevant to rural development policy (USDA ERS 2012a). Despite their urban character, Southern Lake Michigan Coastal counties are also subject to these classifications, but neither Kenosha nor Racine County was assigned any of these special designations. However, Milwaukee County was classified as a county of concern in terms of both "population loss" (defined as any county with population decline both between the 1980 and 1990 censuses and between the 1990 and 2000 censuses) and "housing stress" (defined as any county in which 30% of more of households had one or more of the following housing conditions in 2000: lacked complete plumbing, lacked complete kitchen, paid 30% or more of income for owner costs or rent, or had more than one person per room).

Integrated Opportunities for Management

Use of natural resources for human needs within the constraints of sustainable ecosystems is an integral part of ecosystem management. Integrating ecological management with socioeconomic programs or activities can result in efficiencies in land use, tax revenues, and private capital. This type of integration can also help generate broader and deeper support for sustainable ecosystem management. However, any human modification or use of natural communities, aquatic features, and other habitats 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 being irreparably harmed. Maintaining healthy, sustainable ecosystems provides many benefits to people and the 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." 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 or at least not conflict when planning the management of natural resources within a given area.

Appendices

Appendix 19.A. *Watershed water quality summary for the Southern Lake Michigan Coastal Ecological Landscape.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
FX01	Des Plaines River	85,339	Fair to Good; 62% agr with 21% forest & grass; agr nutrients, sed, ditching & drainage; heavy lake shore development and use
FX02	Lower Fox River/IL	72,983	Fair to Good; 47% agr; industrial PS; agr & urban NPS pollutants; ditching
FX04	Middle Fox River/IL	158,543	Fair to Good; 41% agr; agr & urban NPS pollutants; ditching; some heavily developed, eutrophic lakes
FX07	Upper Fox River/IL	96,697	Poor to Fair; 20% urban & 21% agr; NPS; impoundments; flashy flows
MI01	Kinnickinnic River	21,344	Poor; 78% urban; urban NPS; stream bottom concrete and enclosure; loss of wetlands
MI02	Milwaukee River – South	107,456	Poor to Fair; 33% urban; 25% agr; stream bottom concrete and enclosure; sed contamination; urban NPS
MI03	Menomonee River	87,115	Poor to Fair; 42% urban; stream bottom concrete and enclosure; sed creosote contamination; urban NPS
MI04	Cedar Creek[b]	82,724	Fair to Good; 49% agr; PCBs
SE01	Pike River/Kenosha	17,180	Fair to Poor; 41% urban; NPS storm water; low D.O.; stream enclosure; wetland loss
SE02	Pike River	36,164	Fair; 52% agr; 19% urban; NPS storm water and flashy flows; recent storm water fix & hab buffers; agr & urban NPS
SE03	Root River	127,339	Very Poor to Good; 49% agr; 14% urban; NPS runoff; wetland loss
SE04	Wind Point	11,947	Fair; 36% urban; urban NPS; sed
SE05	Oak Creek	16,761	Fair to Poor; urban NPS; toxic municipal sewage

Source: Wisconsin DNR Bureau of Watershed data.

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

[b]Only a small fraction of this watershed lies within this ecological landscape, so overall impacts of land uses within this ecological landscape are unlikely to impact water quality within the watershed to any appreciable degree.

Abbreviations
Agr = Agricultural.
D.O. = Dissolved oxygen.
Hab = Stream habitat damage.
NPS = Nonpoint source pollutants, such as farm or parking lot runoff, or septic system leakage.
PCBs = Polychlorinated biphenyl industrial pollutants in sediment and aquatic life.
PS = Point source pollutants, such as treated municipal and industrial wastewater.
Sed = Excess sedimentation.
\> = Yields, creates or results in.

Appendix 19.B. *Forest habitat types in the Southern Lake Michigan Coastal 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 Southern Lake Michigan Coastal Ecological Landscape
ATiFrVb	*Acer saccharum-Tilia-Fraxinus/Viburnum* sp. Sugar maple-Basswood-white ash/Viburnum
ATiFrVb(Cr)	*Acer saccharum-Tilia-Fraxinus/Viburnum* sp. *Cornus racemosa* Phase Sugar maple-Basswood-white ash/Viburnum Gray dogwood Phase
ATiFrCa	*Acer saccharum-Tilia-Fraxinus/Caulophyllum* Sugar maple-Basswood-white ash/Blue cohosh
ATiFrCa(O)	*Acer saccharum-Tilia-Fraxinus/Caulophyllum Osmorhiza* Phase Sugar maple-Basswood-white ash/Blue cohosh Sweet cicely Phase

Source: Kotar and Burger (1996).

Appendix 19.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 Southern Lake Michigan Coastal (SLMC) 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 SLMC	EOs in WI	Percent in SLMC	State rank	Global rank	State status	Federal status
MAMMALS								
Spermophilus franklinii (Franklin's ground squirrel)	2005	1	12	8%	S2	G5	SC/N	
BIRDS[b]								
Ammodramus henslowii (Henslow's Sparrow)	1993	1	82	1%	S3B	G4	THR	
Ardea alba (Great Egret)	2003	1	14	7%	S2B	G5	THR	
Bartramia longicauda (Upland Sandpiper)	1999	3	54	6%	S2B	G5	SC/M	
Buteo lineatus (Red-shouldered Hawk)	1982	1	301	0%	S3S4B,S1N	G5	THR	
Chlidonias niger (Black Tern)	1993	1	60	2%	S2B	G4	SC/M	
Falco peregrinus (Peregrine Falcon)	2006	5	23	22%	S1S2B	G4	END	
Gallinula chloropus (Common Moorhen)	1998	2	10	20%	S2B	G5	SC/M	
Haliaeetus leucocephalus (Bald Eagle)	2008	1	1286	0%	S4B,S2N	G5	SC/P	
Ixobrychus exilis (Least Bittern)	1999	3	23	13%	S3B	G5	SC/M	
Pandion haliaetus (Osprey)	2008	3	733	0%	S4B	G5	SC/M	
Spiza americana (Dickcissel)	2000	8	46	17%	S3B	G5	SC/M	
Sterna forsteri (Forster's Tern)	2004	2	31	6%	S1B	G5	END	
Sterna hirundo (Common Tern)	1997	1	14	7%	S1B,S2N	G5	END	
Sturnella neglecta (Western Meadowlark)	1997	5	39	13%	S2B	G5	SC/M	
HERPTILES								
Acris crepitans (northern cricket frog)	1987	2	102	2%	S1	G5	END	
Emydoidea blandingii (Blanding's turtle)	2008	13	316	4%	S3	G4	THR	
Lithobates catesbeianus (American bullfrog)	1993	2	70	3%	S3	G5	SC/H	
Regina septemvittata (queensnake)	1971	1	8	13%	S1	G5	END	
Sistrurus catenatus catenatus (eastern massasauga)	1977	1	13	8%	S1	G3G4T3T4Q	END	C
Thamnophis butleri (Butler's gartersnake)	2008	52	114	46%	S3	G4	THR	
FISHES								
Alosa chrysochloris (skipjack herring)	1991	1	4	25%	S1	G5	END	
Aphredoderus sayanus (pirate perch)	1996	5	39	13%	S3	G5	SC/N	
Erimyzon sucetta (lake chubsucker)	1995	13	85	15%	S3	G5	SC/N	
Etheostoma microperca (least darter)	1995	4	83	5%	S3	G5	SC/N	
Fundulus diaphanus (banded killifish)	1995	4	105	4%	S3	G5	SC/N	
Lepomis megalotis (longear sunfish)	2000	1	25	4%	S2	G5	THR	
Luxilus chrysocephalus (striped shiner)	1979	5	10	50%	S1	G5	END	
Lythrurus umbratilis (redfin shiner)	2004	4	37	11%	S2	G5	THR	
Moxostoma valenciennesi (greater redhorse)	1996	2	56	4%	S3	G4	THR	
Notropis anogenus (pugnose shiner)	1995	4	49	8%	S2	G3	THR	
Opsopoeodus emiliae (pugnose minnow)	1995	3	31	10%	S3	G5	SC/N	
MUSSELS/CLAMS								
Alasmidonta marginata (elktoe)	2001	1	44	2%	S4	G4	SC/P	
MISCELLANEOUS INSECTS/SPIDERS								
Procambarus gracilis (prairie crayfish)	2003	13	17	76%	S2?	G5	SC/N	
BUTTERFLIES/MOTHS								
Euphyes bimacula (two-spotted skipper)	1993	1	17	6%	S3	G4	SC/N	
Lycaena dione (gray copper)	1992	1	14	7%	S2	G5	SC/N	
Papaipema beeriana (Liatris borer moth)	1992	1	11	9%	S2	G2G3	SC/N	

Continued on next page

Appendix 19.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in SLMC	EOs in WI	Percent in SLMC	State rank	Global rank	State status	Federal status
Papaipema silphii (Silphium borer moth)	2001	1	15	7%	S2	G3G4	END	
Poanes massasoit (mulberry wing)	1993	2	56	4%	S3	G4	SC/N	
Poanes viator (broad-winged skipper)	1989	1	36	3%	S3	G5	SC/N	
Pompeius verna (little glassy wing)	1988	1	7	14%	S1?	G5	SC/N	
DRAGONFLIES/DAMSELFLIES								
Archilestes grandis (great spreadwing)	1984	1	3	33%	S2	G5	SC/N	
Chromagrion conditum (aurora damselfly)	1992	2	17	12%	S3	G5	SC/N	
Enallagma basidens (double-striped bluet)	1989	1	5	20%	S2	G5	SC/N	
Somatochlora ensigera (lemon-faced emerald)	1978	1	2	50%	S1	G4	SC/N	
MISCELLANEOUS INSECTS/SPIDERS								
Aflexia rubranura (red-tailed prairie leafhopper)	2001	1	25	4%	S2	G2	END	
PLANTS								
Agalinis gattingeri (roundstem foxglove)	1985	1	23	4%	S3	G4	THR	
Agalinis skinneriana (pale false foxglove)	2000	1	8	13%	S2	G3G4	END	
Asclepias purpurascens (purple milkweed)	1990	2	39	5%	S3	G5?	END	
Asclepias sullivantii (prairie milkweed)	2000	5	23	22%	S2S3	G5	THR	
Aster furcatus (forked aster)	2008	18	44	41%	S3	G3	THR	
Astragalus neglectus (cooper's milkvetch)	1997	2	3	67%	S1	G4	END	
Botrychium campestre (prairie dunewort)	2005	1	4	25%	S1	G3G4	END	
Cacalia muehlenbergii (great Indian-plantain)	1998	2	25	8%	S2S3	G4	SC	
Cacalia suaveolens (sweet-scented Indian-plantain)	1976	2	28	7%	S3	G4	SC	
Cacalia tuberosa (prairie Indian plantain)	2002	9	62	15%	S3	G4G5	THR	
Cakile lacustris (American sea-rocket)	1992	5	40	13%	S3	G5	SC	
Calamintha arkansana (low calamint)	2001	2	18	11%	S2	G5	SC	
Calamovilfa longifolia var. magna (sand reedgrass)	1992	1	10	10%	S2	G5T3T5	THR	
Carex crus-corvi (ravenfoot sedge)	1996	3	3	100%	S1	G5	END	
Carex formosa (handsome sedge)	2001	6	16	38%	S2	G4	THR	
Carex lupuliformis (false hop sedge)	2003	9	11	82%	S1	G4	END	
Cypripedium parviflorum var. *makasin* (northern yellow lady's-slipper)	1995	2	78	3%	S3	G5T4Q	SC	
Echinacea pallida (pale-purple coneflower)	1987	1	54	2%	S3	G4	THR	
Epilobium strictum (downy willow-herb)	1992	3	22	14%	S2S3	G5?	SC	
Equisetum variegatum (variegated horsetail)	1995	1	47	2%	S3	G5	SC	
Eupatorium sessilifolium var. *brittonianum* (upland boneset)	1976	1	40	3%	S3	G5T3T5	SC	
Euphorbia polygonifolia (seaside spurge)	2000	2	20	10%	S2	G5?	SC	
Fimbristylis puberula (hairy fimbristylis)	1986	2	2	100%	S1	G5	END	
Fraxinus quadrangulata (blue ash)	1995	1	2	50%	S1	G5	THR	
Gentiana alba (yellow gentian)	2000	4	80	5%	S3	G4	THR	
Gentianopsis procera (lesser fringed gentian)	2000	6	66	9%	S3	G5	SC	
Gymnocladus dioicus (Kentucky coffee-tree)	2002	2	9	22%	S2	G5	SC	
Jeffersonia diphylla (twinleaf)	1999	6	23	26%	S3	G5	SC	
Juncus marginatus (grassleaf rush)	2001	1	10	10%	S2	G5	SC	
Liatris spicata (marsh blazing star)	2001	14	26	54%	S3	G5	SC	
Lithospermum latifolium (American gromwell)	2008	29	62	47%	S3	G4	SC	
Orobanche uniflora (one-flowered broomrape)	1992	1	30	3%	S3	G5	SC	
Parthenium integrifolium (American fever-few)	2002	10	83	12%	S3	G5	THR	
Phlox glaberrima ssp. interior (smooth phlox)	2002	9	9	100%	S2	G5TNR	END	

Continued on next page

Appendix 19.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in SLMC	EOs in WI	Percent in SLMC	State rank	Global rank	State status	Federal status
Plantago cordata (heart-leaved plantain)	2002	2	2	100%	S1	G4	END	
Platanthera leucophaea (prairie white-fringed orchid)	2008	6	22	27%	S2	G2G3	END	LT
Ptelea trifoliata (wafer-ash)	2000	4	14	29%	S2	G5	SC	
Quercus muehlenbergii (chinquapin oak)	2001	2	6	33%	S1S2	G5	SC	
Scleria verticillata (low nutrush)	2000	1	10	10%	S2	G5	SC	
Scutellaria ovata (heart-leaved skullcap)	2001	6	16	38%	S3	G5	SC	
Solidago caesia (bluestem goldenrod)	2008	35	35	100%	S3	G5	END	
Solidago ohioensis (ohio goldenrod)	2000	15	74	20%	S3	G4	SC	
Thalictrum revolutum (waxleaf meadowrue)	2000	6	13	46%	S2	G5	SC	
Tofieldia glutinosa (sticky false-asphodel)	2001	5	23	22%	S2S3	G4G5	THR	
Triglochin maritima (common bog arrow-grass)	1986	1	59	2%	S3	G5	SC	
Triglochin palustris (slender bog arrow-grass)	2000	4	36	11%	S3	G5	SC	
Trillium nivale (snow trillium)	2001	3	34	9%	S3	G4	THR	
Trillium recurvatum (reflexed trillium)	2004	40	58	69%	S3	G5	SC	
Viburnum prunifolium (smooth black-haw)	2003	22	23	96%	S2	G5	SC	
COMMUNITIES								
Alder Thicket	1992	1	106	1%	S4	G4	NA	
Bog Relict	1992	1	8	13%	S3	G3	NA	
Calcareous Fen	1993	4	84	5%	S3	G3	NA	
Dry-mesic Prairie	2001	1	37	3%	S2	G3	NA	
Emergent Marsh	2003	11	272	4%	S4	G4	NA	
Floodplain Forest	2001	13	182	7%	S3	G3?	NA	
Great Lakes Dune	1991	1	15	7%	S2	G3	NA	
Hardwood Swamp	1995	1	53	2%	S3	G4	NA	
Lake—Oxbow	1976	1	14	7%	SU	GNR	NA	
Lake—Soft Bog	1976	1	52	2%	S4	GNR	NA	
Mesic Prairie	1993	8	44	18%	S1	G2	NA	
Northern Wet Forest	1992	3	322	1%	S4	G4	NA	
Oak Opening	1992	1	25	4%	S1	G1	NA	
Shrub-carr	1992	3	143	2%	S4	G5	NA	
Southern Dry Forest	1993	4	97	4%	S3	G4	NA	
Southern Dry-mesic Forest	2005	29	293	10%	S3	G4	NA	
Southern Hardwood Swamp	2001	3	30	10%	S2	G4?	NA	
Southern Mesic Forest	2006	40	221	18%	S3	G3?	NA	
Southern Sedge Meadow	1993	6	182	3%	S3	G4?	NA	
Southern Tamarack Swamp (Rich)	1992	2	32	6%	S3	G3	NA	
Springs and Spring Runs, Hard	1985	1	71	1%	S4	GNR	NA	
Stream—Slow, Hard, Warm	1985	1	20	5%	SU	GNR	NA	
Wet Prairie	1993	2	22	9%	SU	G3	NA	
Wet-mesic Prairie	2003	18	81	22%	S2	G2	NA	
OTHER ELEMENTS								
Bird rookery	1993	3	54	6%	SU	G5	SC	

[a]An element occurrence is an area of land and/or water in which a rare species or natural community is, or was, present. Element occurrences must meet strict criteria that is used by an international network of Heritage programs and coordinated by NatureServe.

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

Status and ranking definitions on next page

Appendix 19.C, *continued.*

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.)

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 19.D. *Number of species with special designations documented within the Southern Lake Michigan Coastal Ecological Landscape, 2009.*

Listing status	Taxa					Total fauna	Total flora	Total listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
U.S. Endangered	0	0	0	0	0	0	0	0
U.S. Threatened	0	0	0	0	0	0	1	1
U.S. Candidate	0	0	1	0	0	1	0	1
Wisconsin Endangered	0	3	3	2	2	10	11	21
Wisconsin Threatened	0	3	2	4	0	9	12	21
Wisconsin Special Concern	1	8	1	5	12	27	26	53
Natural Heritage Inventory total	**1**	**14**	**6**	**11**	**14**	**46**	**49**	**95**

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

Appendix 19.E. *Species of Greatest Conservation Need (SGCN) found in the Southern Lake Michigan Coastal Ecological Landscape.*

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

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

Blanding's turtle.
Photo courtesy of U.S. Fish and Wildlife Service.

	MAJOR			IMPORTANT																			
	Lake Michigan	Warmwater streams	Wet-Mesic Prairie	Bog Relict	Calcareous Fen (Southern)	Emergent Aquatic	Ephemeral Pond	Great Lakes Dune	Impoundments/Reservoirs	Inland lakes	Mesic Prairie	Northern Wet Forest	Oak Opening	Shrub Carr	Southern Dry Forest	Southern Dry-Mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp	Surrogate Grasslands	Warmwater Rivers	Wet Prairie
Species That Are Significantly Associated with the Southern Lake Michigan Coastal Ecological Landscape																							
MAMMALS																							
Franklin's ground squirrel			M					H			M		H								M		
BIRDS[a]																							
Black Tern						H			M	M													
Bobolink			H								H								M		H		H
Brown Thrasher													H								M		
Buff-breasted Sandpiper			M			M															M		M
Dickcissel											H										H		
Dunlin						M			M													M	
Eastern Meadowlark			M								H		M						M		H		
Field Sparrow			M								M		H								M		
Forster's Tern						H			M														
Henslow's Sparrow			M								H		M								H		M
Horned Grebe	H																						
Lesser Scaup									M	M												M	
Short-billed Dowitcher						H			M														
Vesper Sparrow													M										
Whimbrel						M																	
Willow Flycatcher			M	M	M						M			H					M		M		M
Wood Thrush															M	H		H					
HERPTILES																							
Blanding's turtle		M	M			H	H		H	H	M		H	M		M	M	M	M	M		M	H
Butler's garter snake			H		H	H					H			H					H				H
Mudpuppy	H								H	H												H	

Continued on next page

Appendix 19.E, *continued.*

Lake sturgeon. Photo by Eric Engbretson.

	MAJOR			IMPORTANT																			
	Lake Michigan	Warmwater streams	Wet-Mesic Prairie	Bog Relict	Calcareous Fen (Southern)	Emergent Aquatic	Ephemeral Pond	Great Lakes Dune	Impoundments/Reservoirs	Inland lakes	Mesic Prairie	Northern Wet Forest	Oak Opening	Shrub Carr	Southern Dry Forest	Southern Dry-Mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp	Surrogate Grasslands	Warmwater Rivers	Wet Prairie
FISH																							
Striped shiner																						H	
Species That Are Moderately Associated with the Southern Lake Michigan Coastal Ecological Landscape																							
MAMMALS																							
Prairie vole											M		M								M		
BIRDS																							
American Bittern						H													M				
American Woodcock				M	M									H						M			
Bell's Vireo			M											M							M		M
Black-billed Cuckoo														H						M			
Blue-winged Teal			M			H			M	M	M								M		M		M
Blue-winged Warbler				M									M	M	M	M		M		M			
Grasshopper Sparrow																					H		
Hudsonian Godwit						H																	
King Rail						H													M				
Marbled Godwit			M			H					M										M		M
Northern Harrier			H								H								M		H		M
Piping Plover								H															
Red-headed Woodpecker													H		M	M							
Rusty Blackbird				M	M	M	M							M			H			M			
Short-eared Owl			H								H			M					M		H		M
Solitary Sandpiper		M				H	H																
Yellow-billed Cuckoo														M		M	M	M					
Yellow-crowned Night-Heron						M	H							M			M					M	
HERPTILES																							
Eastern massasauga rattlesnake			H		H	H	H				H			H			M		H				H
Queen snake		H				H			M	M				H					H			H	H
FISH																							
Greater redhorse	M	H							M	M												M	
Lake sturgeon	H								H	H												H	

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

Appendix 19.F. *Natural communities[a] for which there are management opportunities in the Southern Lake Michigan Coastal Ecological Landscape.*

Major opportunity[b]	Important opportunity[c]	Present[d]
Wet-mesic Prairie	Southern Dry-Mesic Forest	Southern Dry Forest
	Southern Mesic Forest	Floodplain Forest
Lake Michigan	Southern Hardwood Swamp	
Warmwater Stream	Southern Tamarack Swamp	Oak Woodland
	Oak Opening	Dry-Mesic Prairie
	Bog Relict	Submergent Marsh
	Shrub-carr	
		Great Lakes Beach
	Mesic Prairie	
	Wet Prairie	Coolwater Stream
	Southern Sedge Meadow	
	Surrogate Grasslands	
	Calcareous Fen	
	Emergent Marsh	
	Ephemeral Pond	
	Clay Seepage Bluff	
	Great Lakes Dune	
	Impoundment/Reservoir	
	Inland Lake	
	Warmwater River	

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

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

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

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

Appendix 19.G. *Public conservation lands in the Southern Lake Michigan Coastal Ecological Landscape, 2005.*

Property name	Size (acres)[a]
STATE	
Big Muskego Lake State Wildlife Area	270
Bong (Richard) State Recreation Area[b]	4,370
Chiwaukee Prairie-Carol Beach State Natural Area	380
Eagle Lake State Fishery Area	100
Havenwoods State Forest Preserve	215
Miscellaneous Lands[c]	530
FEDERAL	
None	
COUNTY FOREST[d]	
Milwaukee County Park System	14,000
TOTAL	**19,865**

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

[a]Actual acres owned in this ecological landscape.

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

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

[d]Locations and sizes of county-owned parcels enrolled in the Forest Crop Law 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 19.H. *Land Legacy places in the Southern Lake Michigan Coastal Ecological Landscape and their ecological and recreational significance.*

The *Wisconsin Land Legacy Report* (WDNR 2006b) identified 11 places in the Southern Lake Michigan Coastal Ecological Landscape that merit conservation action based upon a combination of ecological significance and recreational potential. In addition, the *Wisconsin Land Legacy Report* notes that Fitzsimmons Woods, Whitnall Park Woods, Tabor Woods, Menomonee Falls Swamp, and Ryan Creek are all worthy of consideration for additional conservation protection.

Map code	Place name	Size	Protection initiated	Protection remaining	Conservation significance[a]	Recreation potential[b]
BM	Big Muskego Lake	Small	Substantial	Moderate	xxx	xxxx
BG	Bong Grassland	Medium	Substantial	Moderate	xxx	xxxxx
CP	Chiwaukee Prairie	Small	Substantial	Limited	xxxxx	x
DG	Des Plaines River Floodplain and Lake George Wetland	Medium	Substantial	Moderate	xx	xxx
HV	Havenwoods State Forest Preserve	Small	Substantial	Limited	x	xxx
MN	Menomonee and Little Menomonee rivers	Large	Moderate	Substantial	xx	xxx
MI	Milwaukee River Estuary	Medium	Limited	Limited	xx	xxxxx
OK	Oak Creek	Small	Moderate	Moderate	x	xxxx
PK	Pike (Kenosha) River	Medium	Moderate	Moderate	x	xxx
RO	Root River	Medium	Moderate	Moderate	xx	xxxxx
SF	Seminary Woods – St. Francis Lakeshore	Small	Limited	Substantial	xx	xxxx

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

xxxxx Possesses outstanding ecological qualities, is large enough to meet the needs of critical components, and/or harbors globally or continentally significant resources. Restoration, if needed, has a high likelihood of success.

xxxx Possesses excellent ecological qualities, is large enough to meet the needs of most critical components, and/or harbors continentally or Great Lakes regionally significant resources. Restoration has a high likelihood of success.

xxx Possesses very good ecological qualities, is large enough to meet the needs of some critical components, and/or harbors statewide significant resources. Restoration will typically be important and has a good likelihood of success.

xx Possesses good ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors statewide or ecological landscape significant resources. Restoration is likely needed and has a good chance of success.

x Possesses good to average ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors ecological landscape significant resources. Restoration is needed and has a reasonable chance of success.

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

xxxxx Outstanding recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet many current and future recreation needs, is large enough to accommodate incompatible activities, could link important recreation areas, and/or is close to state's largest population centers.

xxxx Excellent recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet several current and future recreation needs, is large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to large population centers.

xxx Very good recreation potential, could offer a variety of land and/or water-based recreation opportunities, could meet some current and future recreation needs, may be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized to large population centers.

xx Good to moderate recreation potential, could offer some land and/or water-based recreation opportunities, might meet some current and future recreation needs, may not be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized population centers.

x Limited recreation potential, could offer a few land and/or water-based recreation opportunities, might meet some current and future recreation needs, is not likely large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to small population centers.

Appendix 19.I. *Importance of economic sectors (based on the number of jobs) within the Southern Lake Michigan Coastal counties compared to the rest of the state.*

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

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

Appendix 19.J. *Scientific names of species mentioned in the text.*

Common name	Scientific name
Alewife	*Alosa pseudoharengus*
American basswood	*Tilia americana*
American beaver	*Castor canandensis*
American beech	*Fagus grandifolia*
American bison	*Bos bison*
American elm	*Ulmus americana*
American gromwell	*Lithospermum latifolium*
American sea-rocket	*Cakile lacustris*
Amphipod	*Diporeia hoyi*
Ashes	*Fraxinus* spp.
Asian longhorned beetle	*Anoplophora glabripennis*
Autumn olive	*Elaeagnus umbellata*
Banded killifish	*Fundulus diaphanus*
Bell's Vireo[a]	*Vireo bellii*
Bird's-foot trefoil	*Lotus corniculata*
Bitternut hickory	*Carya cordiformis*
Black ash	*Fraxinus nigra*
Black cherry	*Prunus serotina*
Blackfin cisco	*Coregonus nigripinnis*
Black locust	*Robinia pseudoacacia*
Black oak	*Quercus velutina*
Black Scoter	*Melanitta americana*
Black walnut	*Juglans nigra*
Bladderworts	*Utricularia* spp.
Blanding's turtle	*Emydoidea blandingii*
Bloater chub	*Coregonus hoyi*
Blue ash	*Fraxinus quadrangulata*
Blueberries	*Vaccinium* spp.
Bluestem goldenrod	*Solidago caesia*
Blue-winged Teal	*Anas discors*
Bobolink	*Dolichonyx oryzivorus*
Bog-rosemary	*Andromeda glaucophylla*
Brown rat	*Rattus norvegicus*
Brown Thrasher	*Toxostoma rufum*
Brown trout	*Salmo trutta*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Bufflehead	*Bucephala albeola*
Burbot	*Lota lota*
Bur oak	*Quercus macrocarpa*
Butler's garter snake	*Thamnophis butleri*
Canada bluegrass	*Poa compressa*
Canada Goose	*Branta canadensis*
Cherries	*Prunus* spp.
Chickory	*Cichorium intybus*
Chinook salmon	*Oncorhynchus tschawytscha*
Ciscoes	*Coregonus* spp.
Cladophora algae	*Cladophora*
Coho salmon	*Oncorhynchus kisutch*
Common buckthorn	*Rhamnus cathartica*
Common carp	*Cyprinus carpio*
Common Goldeneye	*Bucephala clangula*
Common Loon	*Gavia immer*
Common reed	*Phragmites australis*
Common Tern	*Sterna hirundo*
Coyote	*Canis latrans*

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Appendix 19.J, *continued.*

Common name	Scientific name
Cranberries	*Vaccinium* spp.
Crown vetch	*Coronilla varia*
Curly pondweed	*Potamogeton crispus*
Cut-leaved teasel	*Dipsacus laciniatus*
Dame's rocket	*Hesperis matronalis*
Deepwater cisco	*Coregonus johannae*
Dogwoods	*Cornus* spp.
Dutch elm disease fungus	*Ophiostoma ulmi*
Dwarf lake iris	*Iris lacustris*
Eastern cottontail	*Sylvilagus floridanus*
Eastern massasauga rattlesnake	*Sistrurus catenatus catenatus*
Eastern shooting star	*Dodecatheon meadia*
Eastern white pine	*Pinus strobus*
Elk	*Cervus canadensis*
Elms	*Ulmus* spp.
Emerald ash borer	*Agrilus planipennis*
Eurasian honeysuckles	*Lonicera tatarica*, *Lonicera morrowii*, and *Lonicera* x *bella*
Eurasian water-milfoil	*Myriophyllum spicatum*
False hop sedge	*Carex lupuliformis*
Field Sparrow	*Spizella pusilla*
Forked aster	*Aster furcatus*
Forster's Tern	*Sterna forsteri*
Franklin's Ground Squirrel	*Spermophilus franklinii*
Garlic mustard	*Alliaria petiolata*
Glossy buckthorn	*Rhamnus frangula*
Gray wolf	*Canis lupus*
Great Egret	*Ardea alba*
Greater Prairie-Chicken	*Tympanuchus cupido*
Greater redhorse	*Moxostoma valenciennesi*
Greater Scaup	*Aythya marila*
Green ash	*Fraxinus pennsylvanica*
Gypsy moth	*Lymantria dispar*
Hackberry	*Celtis occidentalis*
Hairy fimbristylis	*Fimbristylis puberula*
Heart-leaved plantain	*Plantago cordata*
Henslow's Sparrow	*Ammodramus henslowii*
Hickories	*Carya* spp.
Horned Grebe	*Podiceps auritus*
Japanese barberry	*Berberis thunbergii*
Kentucky bluegrass	*Poa pratensis*
Kiyi	*Coregonus kiyi*
Lake chubsucker	*Erimyzon sucetta*
Lake herring	*Coregonus artedii*
Lake sturgeon	*Acipenser fulvescens*
Lake trout	*Salvelinus namaycush*
Lake whitefish	*Coregonus clupeaformis*
large-flowered trillium	*Trillium grandifolium*
Largemouth bass	*Micropterus salmoides*
Least darter	*Etheostoma microperca*
Leather-leaf	*Chamaedaphne calyculata*
Lesser fringed gentian	*Gentianopsis procera*
Lesser Scaup	*Aythya affinis*
Liatris borer moth	*Papaipema beeriana*
Lilacs	*Syringa* spp.
Longear sunfish	*Lepomis megalotis*

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Appendix 19.J, *continued.*

Common name	Scientific name
Long-tailed Duck	*Clangula hyemalis*
Mallard	*Anas platyrhynchos*
Maples	*Acer* spp.
Marbled Godwit	*Limosa fedoa*
Marsh blazing star	*Liatris spicata*
Monarch butterfly	*Danaus plexippus*
Mudpuppy	*Necturus maculosus maculosus*
Multiflora rose	*Rosa multiflora*
Mute Swan	*Cygnus olor*
North American river otter	*Lontra canadensis*
Northern cricket frog	*Acris crepitans*
Northern Harrier	*Circus cyaneus*
Northern pike	*Esox lucius*
Northern pin oak	*Quercus ellipsoidalis*
Northern red oak	*Quercus rubra*
Northern white-cedar	*Thuja occidentalis*
Norway maple	*Acer platanoides*
Oaks	*Quercus* spp.
Oak bark beetle	*Pseudopityophthorus* spp.
Oak wilt fungus	*Ceratocystis fagacearum*
Ohio goldenrod	*Solidago ohioensis*
Osprey	*Pandion haliaetus*
Pale false foxglove	*Agalinis skinneriana*
Passenger Pigeon	*Ectopistes migratorius*
Peregrine Falcon	*Falco peregrinus*
Prairie crayfish	*Procambarus gracilis*
Prairie milkweed	*Asclepias sullivantii*
Prairie white-fringed orchid	*Platanthera leucophaea*
Prickly ash	*Zanthoxylum americanum*
Privets	*Ligustrum* spp.
Pugnose minnow	*Opsopoeodus emiliae*
Pugnose shiner	*Notropis anogenus*
Purple loosestrife	*Lythrum salicaria*
Purple pitcher-plant	*Sarracenia purpurea*
Quagga mussel	*Dreissena bugensis*
Queen snake	*Regina septemvittata*
Raccoon	*Procyon lotor*
Rainbow smelt	*Osmerus mordax*
Rainbow trout	*Oncorhynchus mykiss*
Ravenfoot sedge	*Carex crus-corvi*
Red maple	*Acer rubrum*
Red pine	*Pinus resinosa*
Red-breasted Merganser	*Mergus serrator*
Redfin shiner	*Lythrurus umbratilis*
Red-osier dogwood	*Cornus stolonifera*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed prairie leafhopper	*Aflexia rubranura*
Reed canary grass	*Phalaris arundinacea*
Reflexed trillium	*Trillium recurvatum*
Ring-necked Pheasant	*Phasianus colchicus*
River grapevine	*Vitis riparia*
River redhorse	*Moxostoma carinatum*
Rock Pigeon	*Columba livia*
Round goby	*Neogobius melanostomus*
Rusty crayfish	*Orconectes rusticus*

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Appendix 19.J, *continued.*

Common name	Scientific name
Sand reedgrass	*Calamovilfa longifolia* var. *magna*
Sap feeding beetle	Family Nitidulidae
Sea lamprey	*Petromyzon marinus*
Seaside spurge	*Euphorbia polygonifolia*
Sedges	*Carex lasiocarpa* and *C. leptalea*
Sedge Wren	*Cistothorus platensis*
Shagbark hickory	*Carya ovata*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Short-eared Owl	*Asio flammeus*
Shortjaw cisco	*Coregonus zenithicus*
Shortnose cisco	*Coregonus reighardi*
Siberian elm	*Ulmus pumila*
Silphium borer moth	*Papaipema silphii*
Silver maple	*Acer saccharinum*
Skipjack herring	*Alosa chrysochloris*
Slimy sculpin	*Cottus cognatus*
Smallmouth bass	*Micropteris dolomieu*
Smooth black-haw	*Viburnum prunifolium*
Smooth brome	*Bromus inermis*
Smooth phlox	*Phlox glaberrima* ssp. *interior*
Snowy Owls	*Bubo scandiacus*
Sphagnum mosses	*Sphagnum* spp.
Spiny water flea	*Bythotrephes cederstroemi*
Sticky false asphodel	*Tofieldia glutinosa*
Striped shiner	*Luxilus chrysocephalus*
Striped skunk	*Mephitis mephitis*
Sumacs	*Rhus* spp.
Sugar maple	*Acer saccharum*
Sundews	*Drosera* spp.
Surf Scoter	*Melanitta perspicillata*
Swamp white oak	*Quercus bicolor*
Sweet-scented Indian-plantain	*Cacalia suaveolens*
Tamarack	*Larix laricina*
Threespine stickleback	*Gasterosteus aculaeatus*
Upland Sandpiper	*Bartramia longicauda*
Virginia creeper	*Parthenocissus quinquefolia*
Walleye	*Sander vitreus*
White ash	*Fraxinus americana*
White oak	*Quercus alba*
White perch	*Morone americana*
White sweet clover	*Melilotus alba*
White-tailed deer	*Odocoileus virginianus*
White-winged Scoter	*Melanitta fusca*
Wild leek	*Allium tricoccum*
Wild parsnip	*Pastinaca sativa*
Wild Turkey	*Meleagris gallopavo*
Willow	*Salix* spp.
Wood Duck	*Aix sponsa*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Yellow perch	*Perca flavescens*
Yellow sweet clover	*Melilotus officinalis*
Zebra mussel	*Dreissena polymorpha*

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

Appendix 19.K. *Maps of important physical, ecological, and aquatic features within the Southern Lake Michigan Coastal Ecological Landscape.*

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

Note: *Go to http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=3 and click the "maps" tab.*

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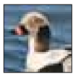

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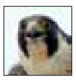

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