Chapter 20

Southwest Savanna 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): Green violet, photo by Kitty Kohout; Short-eared Owl, photo by Jack Bartholmai; reflexed trillium, photo by Thomas Meyer, Wisconsin DNR; Henlow's Sparrow, photo © Laurie Smaglick Johnson; northern cricket frog, photo by Rori Paloski, Wisconsin DNR.

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Cover Photos

Top left: *The Upland Sandpiper (Wisconsin Threatened) has declined in many parts of its North American range. Large areas of unfragmented grassland are needed as breeding habitat by this bird. Photo by Dawn Scranton.*

Bottom left: *Dry-mesic hardwood forest, developing old-growth characteristics. This stand is on a rise within an oxbow of the Pecatonica River and was protected from many past fires. Lafayette County. Photo by Cathy Bleser, Wisconsin DNR.*

Top right: *Extensive grasslands occur today at only a few locations in Wisconsin, where less than 1% of the former prairie acreage still exists. This site in the Southwest Savanna is composed of surrogate grasslands, prairie pasture, and small scattered native prairie remnants. Photo by Thomas Meyer, Wisconsin DNR.*

Center right: *Important populations of the globally rare regal fritillary (Wisconsin Endangered) inhabit prairies in the Southwest Savanna. Photo by Mike Reese.*

Bottom right: *Stream flowing through prairie pasture and remnant oak savanna, steep slope supporting stands of native conifers (eastern white pine, eastern hemlock). Iowa County. Photo by Eric Epstein, Wisconsin DNR.*

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Size

The Southwest Savanna Ecological Landscape encompasses 1,950 square miles (1,248,126 acres), which is 3.5% of the area of Wisconsin.

Climate

Typical of southern Wisconsin, the mean growing season is 153 days, mean annual temperature is 45.6°F, mean annual precipitation is 35.2 inches, and mean annual snowfall is 39.9 inches. However, the Southwest Savanna has the fourth longest growing season, the most precipitation, the third lowest snowfall, and second warmest January low temperature among ecological landscapes in the state. The climate tends to be warmer in the southwestern part of the state, which affects the ecology of the Southwest Savanna and also makes it suitable for most agricultural uses. Eighty percent of this ecological landscape is devoted to row crops, small grains, and pastures.

Bedrock

The Southwest Savanna Ecological Landscape is underlain by sedimentary bedrock, especially dolomites and sandstones.

Geology and Landforms

The Southwest Savanna is part of Wisconsin's Driftless Area, a region that has not been glaciated for at least the last 2.4 million years. The topography is characterized by broad open ridgetops, deep valleys, and wooded, sometimes steep, slopes.

Soils

Soils on hilltops are mostly silt loams. In some areas, soils are shallow, with bedrock or stony red clay subsoil very close to or at the surface. In other locales, the ridgetops have a deep cap of loess-derived silt loam (these are the most productive agricultural soils). Valley soils include alluvial sands, loams, and occasionally peats.

Hydrology

The drainage patterns of streams in the Southwest Savanna are dendritic, which is a pattern characteristic of unglaciated regions but absent or uncommon in most of Wisconsin. Flowing waters include warmwater rivers and streams, coldwater streams, and springs. Natural lakes are virtually absent, though there are a few associated with the floodplains of the larger rivers, such as the Pecatonica. Impoundments and reservoirs have been constructed on some rivers and streams, and check dams have been built in ravines to hold storm and snow runoff.

Current Land Cover

Agricultural crops (corn, soybeans, small grains, hay) cover 70% of this ecological landscape, with lesser amounts of grassland (mostly pasture), forest, and residential areas. The major forest types are oak-hickory and maple-basswood. Prairie remnants of varying quality persist in a few places, mostly on rocky hilltops or slopes that are too steep to farm. Some pastures have never been plowed, and those that historically supported prairie may retain remnants of the former prairie biota. Pastures with scattered open-grown oaks still exist in some areas, mimicking oak savanna structure. A complement of native plants persists in some of these pastured savannas. The larger open areas can provide important habitat for grassland animals.

Socioeconomic Conditions

The counties included in this socioeconomic region are Iowa, Grant, Lafayette, and Green counties.

Population

The population in 2010 was 128,573, or 2.3% of the state total.

Population Density

41 persons per square mile

Per Capita Income

$28,795

Important Economic Sectors

In 2007 the most important economic sections were Retail Trade (15.2%); Government (14.0%); Agriculture, Fishing and Hunting (13.8%); and Manufacturing (non-wood) (9.1%), reflecting high dependence on retail trade, government, and agriculture. Agriculture and residential development have the largest impact on the natural resources in the ecological landscape at this time.

Public Ownership

About 96.5% of the land in the Southwest Savanna is privately owned while 3.5% belongs to state, county, or municipal governments. State-owned lands include state parks, wildlife areas, fisheries areas, state natural areas, and one state recreation area. These include Belmont Mound, New Glarus Woods, and Yellowstone Lake state parks; part of Blue Mounds State Park; Browntown-Cadiz Springs State Recreation Area; Hardscrabble Prairie State Natural Area; Mount Vernon Creek State Fishery Area; and Yellowstone Lake State Wildlife Area. A map showing public land ownership (county, state, and federal) and private lands enrolled in the forest tax programs can be found in Appendix 20.K at the end of this chapter.

Other Notable Ownerships

The Wisconsin Chapter of The Nature Conservancy has several active projects here, including Thomson Memorial Prairie and Barneveld Prairie. Three chapters of The Prairie Enthusiasts (Southwest Wisconsin, Empire-Sauk, and Prairie Bluff) have been very active in this ecological landscape and have at least ten projects underway including Mounds View Prairie and Erbe Road Prairie. Driftless Area Land Conservancy and Natural Heritage Land Trusts have protected several properties through easements. Pheasants Forever and the National Wild Turkey Federation are also very active in this ecological landscape.

Considerations for Planning and Management

The need for continuing partnerships between government agencies, NGOs, and private individuals is critical because less than 4% of the ecological landscape is publicly owned. Coordinated management of large areas will be difficult because of ownership patterns and the prevalence of intensively used agricultural land. Remnant prairies and savannas are small and often isolated, but in a few areas there are opportunities to develop partnerships that will accommodate a mix of active cropland, pasture, conservation reserve program lands, and reserves that feature high quality prairie and savanna remnants or other habitats known to be especially important to rare or otherwise sensitive species, including streams. The Southwest Wisconsin Grassland and Stream Conservation Area, a cooperative project involving many public and private partners, encompasses one of southwestern Wisconsin's best locations to accomplish this and is an excellent site at which to focus grassland protection efforts at larger scales.

Management Opportunities

The Southwest Savanna was once dominated by fire-dependant natural communities representing the continuum of prairie, oak savanna, oak woodland, and oak forest. Now dominated mostly by agricultural lands, and with less than 4% of land in public ownership, this ecological landscape still offers good opportunities to maintain expansive grassland and savanna habitats through public/private partnerships. Restoration and management of the entire continuum of fire-dependent natural communities native to southern Wisconsin is possible here.

This is arguably Wisconsin's best ecological landscape in which to manage grasslands at large scales. Native grasslands are currently rare here, as they are throughout the upper Midwest. However, some of the scattered remnants support rare plants, invertebrates, herptiles, birds, and other animals. In addition, abundant surrogate grasslands can provide the scale needed by some area-sensitive species and in some cases can connect isolated prairie patches. Large areas of surrogate grasslands can buffer prairie and savanna remnants from more intensively managed land, and there are sometimes opportunities to embed remnants within large acreages of CRP land, fallow agricultural land, pasture, and/or cropland. The surrogate grasslands may also provide missing environmental gradients of soil types, soil moisture, slope, and

Mostly open landscape with high potential for large-scale grassland management. Lafayette County. Photo by Eric Epstein, Wisconsin DNR.

Extensive grasslands, working farms. Photo by Cathy Bleser, Wisconsin DNR.

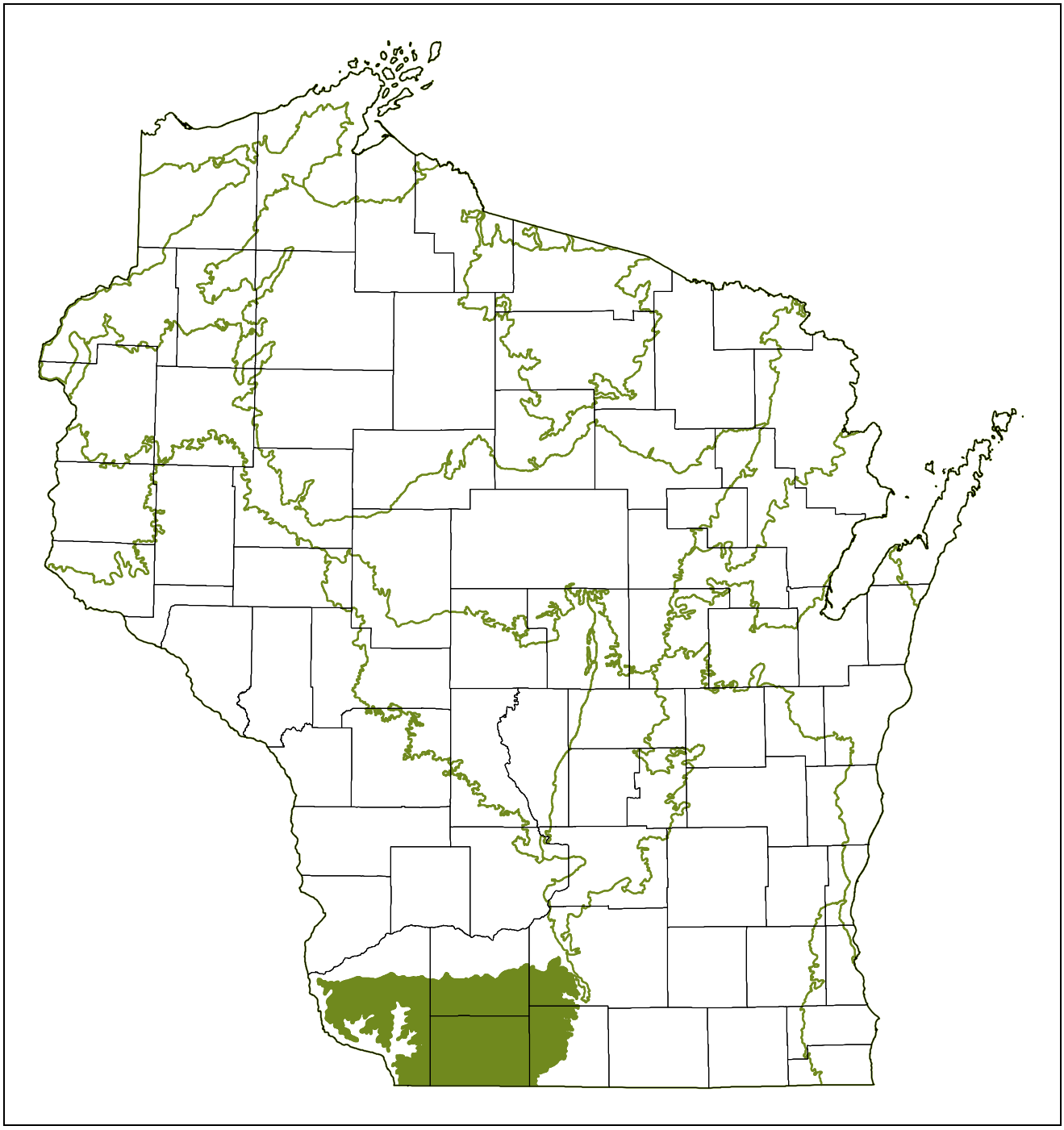
aspect, which may be needed for the vegetation and associated plant and animal species to adapt to long-term environmental changes.

The Wisconsin Natural Resources Board recently approved the Southwest Wisconsin Grassland and Stream Conservation Area, a project that will protect and restore grassland and stream habitats in the Southwest Savanna Ecological Landscape. The project boundary encompasses high-priority grasslands, prairies, savanna remnants, and watersheds across parts of southern Iowa, northern Lafayette, southwest Dane and far northwestern Green counties. This project represents major habitat management opportunities via numerous private-public partnerships.

Extensive areas of grazed but never plowed oak savanna occur at several locations in the Southwest Savanna. Survey needs include the identification of prairie remnants, unplowed prairie and savanna pastures, and other sites with diverse native flora. Floristically diverse remnants adjoining or embedded within extensive surrogate grasslands will offer the best restoration and management opportunities by reducing stand and population isolation and accommodating species that cannot persist at small sites.

Rivers and streams here afford opportunities to manage and conserve native aquatic species and their habitats and to provide recreational opportunities. The identification of aquatic habitats known to support sensitive species provides a starting point on which to focus restoration and protection efforts. Some sites will offer good opportunities to merge terrestrial and aquatic conservation projects.

Miscellaneous management opportunities in the Southwest Savanna include scattered hardwood forests, conifer relicts, springs and spring runs, and rare species populations. At some sites, there are good opportunities to maintain, restore, and manage these features, including restoration of oak forests that are succeeding to more shade and browse-tolerant species. Mesic maple-basswood forest occurs at a few locations, potentially providing refugia for regionally rare species. Conifer relicts could be mapped and monitored. The long-term viability of these relicts, especially the very rare Hemlock Relicts, is unknown and needs further investigation.



Southwest Savanna Ecological Landscape

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Southwest Savanna 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. "Southwest Savanna 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 provide 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 Southwest Savanna Ecological Landscape is located in the southwestern part of Wisconsin. It is characterized by rolling topography with broad open ridges and narrow river valleys. Forests are often associated with steeper valley slopes. The Southwest Savanna has been unglaciated for at least the last 2.4 million years and is therefore considered part of the Driftless Area. The climate is favorable for agriculture, but steep slopes limit it to the hilltops and valley bottoms. The soils are underlain by sedimentary bedrock, calcareous dolomites, and sandstones. Soils on ridge tops are loess-derived silt loams of varying depths. In some areas, these soils form a shallow layer over bedrock and stony red clay subsoil. Valley soils include alluvial sands, loams, and peats. Some hilltops are almost treeless due to the thin soils, the historical disturbance regime of periodic fire, and present land uses, while others have a deep silt loam cap which is very productive for agricultural crops.

Historical vegetation consisted of tallgrass prairie and oak savanna, with some slopes and draws supporting oak forest. According to WISCLAND (Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data), almost three-quarters of the land cover in 1992 (over 70%) was in agriculture with lesser amounts of grasslands and residential/urban areas (WDNR 1993). The Southwest Savanna has the largest acreage of pasture of any ecological landscape in Wisconsin (Sample and Mossman 1997). High-quality prairie remnants are uncommon and small but persist on rocky hilltops and slopes that are not farmed. Some prairie pastures and oak savannas still exist. Over 2,000 acres of unplowed prairie sod exists in York Township, Green County, alone (Gary Felder, member of The Prairie Enthusiasts, personal communication). The grassland areas harbor many rare grassland birds, invertebrates, and other grassland species of conservation interest. Where forests occur, the most common forest types are oak-hickory and maple-basswood. ***Relict*** stands of pine, and, rarely, eastern hemlock (*Tsuga canadensis*) occur usually in association with bedrock outcroppings undercut by streams.

The Southwest Savanna contains both warmwater and coldwater resources. Warmwater streams support rare aquatic species, including fish, herptiles, and invertebrates. While streams are common features in this ecological landscape, very few natural lakes occur here. Most "lakes" here are the result of stream impoundment.

The total area of the Southwest Savanna Ecological Landscape is approximately 1.2 million acres. Less than 4% of the ecological landscape is in public ownership. The economy of the Southwest Savanna counties (Grant, Lafayette, Iowa, Green) is highly dependent on agriculture (70% of the land cover is agricultural cropland). These counties have a greater percentage of farmland than those in any other ecological landscape ("farmland" includes all land under farm ownership, such as cropland, pastureland, and woodland). The Southwest Savanna counties rank second among ecological landscapes in milk production per acre and first in corn production per acre. Although much of the land is farmed, some parts of this ecological landscape are farmed less intensively than in other parts of the state, as evidenced by large pastures and the many lands enrolled in the Conservation Reserve Program. Contour strip cropping is widespread on slopes throughout this ecological landscape.

Compared to other ecological landscape county approximations, the number of fisheries and wildlife areas are low. The percentage of ***timberland*** being sold and diverted to other uses is higher here than in any other ecological landscape county approximation (however, the number of acres diverted to other uses is very small).

The population of the Southwest Savanna is primarily Caucasian and has, on average, lower attainment rates for high school and higher education than the statewide average. The population density (41 persons per square mile) is much lower than for the state as a whole (105 persons per square mile). The percentage of persons over 65 years of age is higher than the statewide percentage. There is a relatively low per capita income; however, poverty and unemployment rates are also low. The Southwest Savanna counties' jobs are concentrated in retail trade, government, and agriculture-related jobs.

Environment and Ecology

Physical Environment

Size

The Southwest Savanna Ecological Landscape extends over 1,950 square miles (1,248,126 acres), representing 3.5% of the area of the state of Wisconsin.

Climate

Climate data were analyzed from eight weather stations within the Southwest Savanna Ecological Landscape (Blanchardville, Blue Mounds, Martintown, Monroe, Platteville, Darlington, Dodgeville, and Lancaster; WSCO 2011). The Southwest Savanna 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, Southern Lake Michigan Coastal, Southeast Glacial Plains, 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 to the north. Ecological landscapes adjacent to the Great Lakes generally tend to have warmer winters, cooler summers, and higher precipitation, especially

snow. The climate is homogeneous and not highly variable throughout most of this small ecological landscape.

The growing season averages 153 days (base 32°F) in length, ranging from 148 to 161 days, the fourth longest among ecological landscapes in the state. Only the southern ecological landscapes closer to Lake Michigan (Southern Lake Michigan Coastal, Central Lake Michigan Coastal, and Southeast Glacial Plains) have longer growing seasons. Variation in growing degree days does not appear related to latitude but is more likely associated with local topography. The long growing season is one of the factors that make the Southwest Savanna well suited for agriculture.

The average annual temperature is 45.6°F (varies from 45.2 to 46.1°F), with little variability among weather stations within the ecological landscape. The mean temperature here is similar to the mean annual temperature of other southern ecological landscapes (45.1°F). The average January minimum temperature is 6.5°F, more than three degrees higher than the average for other southern ecological landscapes. The average August maximum temperature is 81.2°F, similar to the mean of other southern ecological landscapes (80.9°F).

Annual precipitation averages 35.2 (33.2–36.8) inches, the highest of any ecological landscape in the state, and almost 2.5 inches more than the mean of other southern ecological landscapes. Annual snowfall is the third lowest of any ecological landscape in the state, averaging just 39.9 inches, but similar to other southern ecological landscapes (42.2). Snowfall varies considerably among weather stations here, ranging from 28.4 inches in Martintown to 48.1 inches at Blue Mounds. These differences are most likely due to local topography. The high average annual snowfall at Blue Mounds may be due to the high elevation of Blue Mound itself.

Temperatures tend to be warmer and the growing season longer in the southwestern part of the state. This ecological landscape also has high precipitation. These factors affect the ecology of the area, allowing some species to exist here at their extreme northern range limits, such as the Kentucky coffeetree (*Gymnocladus dioicus*). It also makes the area suitable for agricultural row crops, small grains, and pastures, which are prevalent in this ecological landscape (69.9% of the area).

Bedrock Geology

Bedrock is near the surface in this ecological landscape and is an important influence on topography, hydrology, and vegetation. Bedrock is within 5 feet of the surface in most of the ecological landscape and within 50 feet in nearly all of the ecological landscape. The uppermost layer of bedrock was deposited during the Paleozoic Era (including the Cambrian, Ordovician, and Silurian Periods) and consists of sandstone, dolomite, limestone, and shale. The rock sequences were formed by cycles of marine deposition followed by erosion, occurring over approximately 80 million years. A description of these cycles and the marine conditions that led to the formation of different rock types is given in LaBerge (1994). Paleozoic bedrock is similar throughout southern Wisconsin, so the rock types discussed here are comparable to those of the Southeast Glacial Plains and Western Coulees and Ridges ecological landscapes (Dott and Attig 2004). Here, as throughout most of southern Wisconsin, Cambrian sandstones are important aquifers. The geology of this area has not been thoroughly investigated, except for the mineral-bearing formations, and there is not a compiled source for information about all of the bedrock that occurs in the Southwest Savanna. (Nomenclature used herein is according to the Wisconsin Geological and Natural History Survey Open-File Report *Bedrock Stratigraphic Units in Wisconsin*; WGNHS 2006.)

Precambrian igneous and metamorphic bedrock is the oldest rock that occurs beneath the ecological landscape, but it is deeply buried by Paleozoic deposits (Figure 20.1). Cambrian rocks of the Elk Mound, Tunnel City, and Trempealeau groups, mostly made up of poorly cemented sandstones, lie above the Precambrian surface. Above these layers are Ordovician limestone and dolomite of the Prairie du Chien, Ancell, and Sinnipee groups. A few remnants of Silurian dolomite and chert with Silurian fossils occur on the highest hills (Clayton and Attig 1997, Dott and Attig 2004). Many outcrops of Ordovician bedrock occur on hillsides and in roadcuts throughout the ecological landscape, with the Galena Formation being the most common, but Cambrian rock is not exposed (Heyl et al. 1978).

Sinnipee Group bedrock controls the surface topography of most of the ecological landscape. It includes the Platteville, Decorah, and Galena formations, made up of dolomites and shale of Ordovician age. This area is less dissected than the Western Coulees and Ridges Ecological Landscape because the thick layers of surface bedrock are predominantly dolomitic and more resistant to erosion than the older interbedded sandstones and dolomites to the north. A prominent feature along the northern boundary is the "Military Ridge," which is an outcrop of the Galena-Platteville ***cuesta***. This escarpment forms high bluffs on its north side, where the lower Wisconsin River cut through the Ordovician dolomite into the Cambrian sandstone. The Military Ridge is the drainage divide atop the cuesta, which, being relatively level and requiring few stream crossings, became the site of the 1830s Military Road between Portage and Prairie du Chien (Schultz 2004).

Deep beneath the Paleozoic deposits lies Precambrian bedrock, formed of volcanic and igneous intrusive material during the Archean Eon around 2.8 billion years ago. Later, it was mostly metamorphosed to gneiss (Dott and Attig 2004). The Precambrian surface slopes away from the ***Wisconsin Dome*** (centered under the Northern Highland Ecological Landscape) to the south, east, and west, so the highest elevation of the Precambrian surface is at around 1,000 feet below the land surface in Dane County, closest to the Wisconsin Dome. At the southwestern edge of Green County, elevation of the Precambrian bedrock is around 1,600 feet below the land surface. (Smith 1978) and Heyl et al. (1978) described the depth to the Precambrian basement in the mining district as 1,500 to 2,000 feet. Precambrian rock is not exposed in the ecological landscape.

Many layers of Paleozoic bedrock lie over the Precambrian surface (Figure 20.1). Cambrian bedrock is the oldest Paleozoic deposit, at between about 523 and 490 million years ago. The Mount Simon Formation was the first of the Cambrian deposits, part of the Elk Mound Group that also includes the Eau Claire and Wonewoc formations. The Mount Simon sandstone originated from a shallow marine environment as Cambrian seas advanced over the area. It is typically a thick deposit of pale colored sandstone, with bedding that thins toward the top as the Cambrian seas became deeper and quieter (Schultz 2004).

The Eau Claire Formation overlies the Mount Simon. It was deposited in a quieter marine environment as oceans rose to a greater depth over the area. Eau Claire Formation rock is usually a light brown sandstone, fossiliferous in places, containing a large amount of shale. After its deposition, the seas retreated and the surface of the Eau Claire was eroded (Schultz 2004).

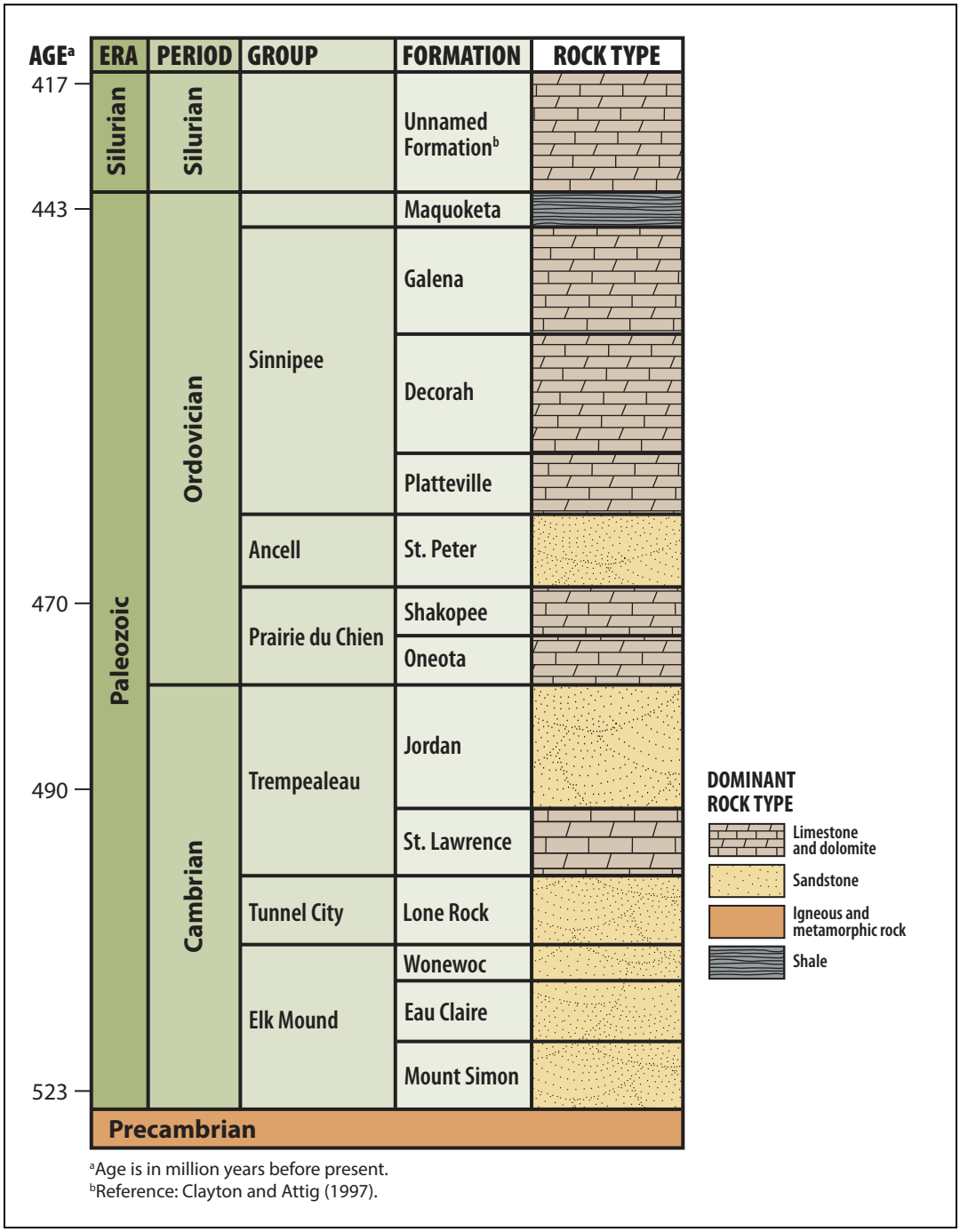

Figure 20.1. *Bedrock strata in the Southwest Savanna Ecological Landscape. Diagram based on WGNHS (2006).*

The Wonewoc Formation lies above the Eau Claire Formation. It was formed in nearshore environments and broad tidal flats as the Cambrian seas readvanced. The lower portion tends to be a thick deposit of poorly cemented white sandstone while the upper portion is a coarser-grained and slightly darker sandstone.

The Wonewoc Formation grades gradually into the overlying Tunnel City Group, which includes the Lone Rock Formation and the discontinuous Mazomanie Formation. Tunnel City rocks are thin-bedded sandstones of various colors, containing fossils of trilobites and brachiopods at some locations, which indicates marine deposition.

The St. Lawrence Formation, part of the Trempealeau Group, lies above the Lone Rock. It is typically a thin layer of siltstone and dolomitic siltstone. Jordan Formation bedrock, also part of the Trempealeau Group, overlies the St. Lawrence Formation. It is sandstone and sandy dolomite, typically in a thick deposit with strata of various colors. It is the youngest formation of the Cambrian Period, deposited by the third advance of the seas. It is similar in structure to the Mount Simon and Wonewoc formations, which were also deposited as seas were advancing over the area.

Ordovician bedrock was deposited between approximately 490 and 443 million years ago, and it occurs throughout the ecological landscape, usually near the surface. Ordovician deposits are primarily dolomite and limestone, as opposed to Cambrian deposits, which are mostly sandstone. The Prairie du Chien Group is the oldest Ordovician deposit, and includes the Oneota and Shakopee formations. The Oneota Formation is a thick deposit of light gray to light brown dolomite, containing cavities in which calcite and quartz have formed. Chert is also abundant, and fossils can be found in the chert. Shakopee Formation rocks are gray to brown, dominantly dolomite, with strata of dolomitic sandstone and siltstone.

The Prairie du Chien Group is overlain by younger rocks of the Ancell Group, St. Peter Formation. Between the Prairie du Chien and the St. Peter, a layer of red clay and chert residuum indicates that weathering occurred for some time before deposition resumed, and the Prairie du Chien's surface is dissected by erosion (Schultz 2004). The St. Peter Formation consists of white to pale yellow, quartz-rich sandstone. St. Peter rock is typically about 200 feet thick but ranges from about 50 to 400 feet thick (Mai and Dott 1985). Shaly sandstone of the Glenwood Formation overlies the St. Peter sandstone.

Rocks of the Sinnipee Group overlie the St. Peter Formation and can be up to 310 feet thick in Dane County (Clayton and Attig 1997). Sinnipee Group rocks are firm dolomites with some limestone and shale overlain by the Maquoketa Formation of dolomitic shale. The Platteville Formation is a light brownish to blue-grey dolomite with some limestone, 55 to 75 feet thick (Heyl et al. 1978). The Decorah Formation, a shaly dolomite and limestone about 32 to 44 feet thick, lies above the Platteville Formation. The Galena Formation is the uppermost Sinnipee Group deposit. It is a light brownish shaly dolomite that contains chert and fossils, around 225 feet thick.

The Maquoketa Formation, primarily made up of shale, has been much eroded due to the relative softness of that material but still exists in a 230-foot-thick deposit on West Blue Mound where it is capped by a resistant layer of Silurian material.

Silurian outliers such as the one atop West Blue Mound signify that the Silurian seas likely covered Wisconsin and that these deposits were widespread prior to erosion. West Blue Mound straddles the Iowa and Dane County line at the north edge of the ecological landscape. It is a noteworthy feature that rises 300 to 500 feet above the surrounding area. Its upper surface is a layer more than 100 feet thick, made up of chert with Silurian fossils (Clayton and Attig 1997). This layer is mostly silicified to chert (through a chemical process where silica fills cavities in the dolomite), making it more resistant to erosion (Black 1970, Schultz 2004). Below the chert lies a thick layer of Maquoketa Shale. East Blue Mound, 230 feet lower than Blue Mound, has a flatter surface because its upper bedrock layer is the Maquoketa shale, the dolomite cap having apparently been lost to erosion. (Black [1970] suggested that the lack of a cap could be evidence of glaciation; however, his arguments have not been generally accepted.) The cap of West Blue Mound was described by early geologists as an outlier of the ***Niagara Escarpment***, but current thinking is that it is not possible to tell which of the Silurian deposits contributed the chert and fossils found at the site (Clayton and Attig 1997). Boulders of the chert are exposed around the top and sides of West Blue Mound. Additional remnants of the Silurian chert are located on the Belmont, Platteville, and Sinsinawa mounds.

Karst and Caves

Karst features are cavities created when surface water and groundwater dissolve carbonate bedrock (limestone and dolomite); in the Southwest Savanna, this is typically Paleozoic dolomite, and most karst occurs in the Platteville-Galena formations (Day and Reeder 1989). Some of these cavities are considered caves if they are large enough for humans to enter. It is likely that there are over 200 caves in southwestern Wisconsin, but most are small and only a few have passages more than 1,600 feet in length. Other karst features include dry valleys, sinkholes, and springs.

Cronon (1970) described the processes of cave formation in sandstone in southwest Wisconsin, but the caves in Ordovician dolomite have not been well documented. Sandstone caves in the Ordovician St. Peter sandstone sometimes develop through collapse of the sandstone into dissolution cavities in Prairie du Chien dolomite. Rubble accumulates on the floors of the dolomite cavities, and the base level of the caves migrates upward until some are predominantly within the sandstone layer (Cronon 1970, Day and Kueny 1999, Schultz 2004).

Caves in the Galena Formation developed along joints in the rock, so they typically have long, straight, narrow passages. The widest and highest of these are oriented east-to-west. North-south passages, which are fewer and narrower,

intersect the main passages at right angles along other joints. A few very small passages intersect at oblique angles. The pattern of formation indicates that the caves formed by dissolution while below the water table (Bretz 1938).

Cave of the Mounds, located near Blue Mounds, is a cave in the Galena dolomite. The many caves that were excavated for lead mining were also in the Galena Formation, where lead and zinc sulfides could be found as crystals lining the caves. Bretz (1938) noted that "much of the mineral was found attached to the roof and in chimneys and pockets in the roof. Many walls were originally covered with the sulfides." Butterfield (1881) described his visit to Black's Mine (T1N, R2W, Sec. 24) in 1874: "The appearance of these caverns, as we passed through them, was a sight not soon to be forgotten. On the floor lay great masses of rock which had fallen from above, with clay, continually moistened from the dripping walls and arching roof, and, here and there, the feeble light revealed rich masses of glittering ore."

One of the excavated caves was the St. John Mine in Potosi, formerly known as Snake Cave, which was said to harbor many rattlesnakes (Heyl et al. 1978). It is difficult to estimate how many caves were impacted by mining, but it appears to be a significant number. In addition to the St. John Mine, at least two other caves were mined near Beetown in Grant County (Day and Reeder 1989), and many were mined near Dubuque, Iowa (Bretz 1938). Butterfield (1881) and Heyl et al. (1959) summarized information about the many mines in southwest Wisconsin and the mining districts of adjacent states, noting the dates at which mining commenced. It is likely that many of the early mines dating from the 1820s through the 1840s originated in caves (accessible from the surface) and fissures that were enlarged to provide access to cave-sized caverns, which was a common practice at the time. Edward Daniels (1854), the first Wisconsin state geologist, described surface clues for finding veins of lead ore: "The general character of the ground is first noticed. A surface cut by frequent ravines or presenting longitudinal depressions is always preferred, as these indicate the existence of fissures in the rock below." Butterfield (1881) and Heyl et al. (1959) gave details on the size and orientation of the caverns, providing further clues as to whether the mine described was partially within a cave. Many of these caverns were large. Kimmerer (1984) stated that there are "more than 2,000 small mines and associated waste dumps" in the three-state mining district, and Ludvigson and Dockal (1984) found that approximately 500 mining operations (including 700 to 2,000 shafts, 90 miles of tunnels, and many more exploration pits) were established in Iowa after 1820. With these large numbers, it is possible that mining may have destroyed up to a hundred caves and previously unopened underground caverns large enough to be considered caves.

Lead and Zinc Deposits

A notable lead and zinc mining area existed in southwest Wisconsin from the time of first Euro-American settlement, and minor ore deposits of copper and barite were also found. The mining district included nearly all of the Southwest Savanna Ecological Landscape as well as the southern portion of the Western Coulees and Ridges Ecological Landscape that borders the Mississippi River in Grant County and adjacent areas in eastern Iowa and northwest Illinois (Schultz 2004).

Ores occur in the Ordovician Sinnipee Group dolomites and shale in the Galena, Decorah, and Platteville formations. Lead was predominantly found in the Galena Formation (hence the name; galena is a lead sulfide), while zinc was associated with the lower part of the Galena as well as the Decorah and the upper two-thirds of the Platteville formations (Heyl et al. 1978). Ores were deposited in dissolution cavities, faults, and joints in the rocks, presumably by hot salt water (brine) that contained dissolved lead, zinc, copper, and sulfur from deep in the Earth (LaBerge 1994, Dott and Attig 2004, Schultz 2004).

Mining initially involved removing lead sulfide (the mineral "galena"; see Figure 20.2) from existing caves, such as Snake Cave, which became the St. John Mine in Potosi. Chunks of lead ore could also be relatively easily removed from crumbling cliffs with a pick and shovel. Zinc was mined as lead became scarcer. Later, as ore in caves and outcroppings was depleted, shafts were constructed to work below ground. The heyday of mining took place in the 1830s through the mid-1850s, when large numbers of miners moved to the area to prospect. A large proportion of the lead used in bullets in the Civil War was mined here, and zinc mining was strong into the mid-1900s. One zinc mine continued to operate till 1979. After the minerals were extracted, mines were typically filled with rubble and trash, and the entrances gradually collapsed until the mine was inaccessible. Occasionally, an underground cavity left from mining will collapse, which poses some danger to developments and infrastructure in the area. A large hole developed in Hill Street, in Dubuque, on November 12, 1983, likely as a result of a collapse into the former Avenue Top Mine (Ludvigson and Dockal 1984). The Bevens Mine in Platteville, Badger Mine at Shullsburg, Merry Christmas Mine at Mineral Point, and the St. John Mine are open to the public for tours.

Figure 20.2. *A piece of galena, the lead sulfide ore that was mined in the Southwest Savanna. Photo from Stephen Hui Geological Museum/ Wikimedia Commons.*

Landforms and Surficial Geology

The Southwest Savanna Ecological Landscape is within the unique Driftless Area of southwestern Wisconsin, where no glacial features are found. Glaciers have not been active in this area for at least 2.4 million years, and if any glacial till was deposited prior to that time, it has been removed by erosional processes (Clayton et al. 1992). The dissected topography of this eroded landscape is characterized by deeply incised, steep-walled valleys, and ridge tops with outcrops of Paleozoic bedrock. It is the result of geomorphic processes including sheet wash, soil creep, and soil flowage that eroded the hillslopes, cut into the underlying Ordovician and Cambrian rock, and transported erosional debris to adjacent streams. These processes were active during the last glacial period when vegetation was absent, but they have also occurred during the past century due to agricultural practices. This has resulted in a dissected landscape with narrow to broad ridges (Military Ridge being the broadest), broad sloping shoulders, steep to very steep valley sides, ***pediments***, and narrow valley floors. The dissolution of the bedrock by surface water or groundwater has resulted in karst topography in places. The weaker sandstones north of the Military Ridge are deeply cut into steep slopes and valleys, many unsuitable for agriculture and more heavily forested. The more erosion-resistant dolomites south of the ridge are less deeply dissected and slope very gradually southward to the state line (about 5 to 6 feet per mile).

A thin to thick mantle of loess (wind-deposited silty material) covers most of the ecological landscape, with the thickest deposits on ridges and in areas closer to the Mississippi River, where loess can be up to 16 feet thick. Loess deposits are thinner to the east, about 2 to 4 feet thick in Dane and Green counties (Hole 1976). Much of the loess has moved downslope through erosion and has been incorporated into floodplain deposits. Hillslope erosion, along with stream cutting and deposition, formed floodplains, terraces, swamps, and sloughs along rivers on valley floors.

Streams in the Southwest Savanna Ecological Landscape are said to be "underfit" relative to the size of the valleys. An underfit stream is one that is too small to have eroded the large valley it runs through. These streams develop in valleys that at one time carried larger volumes of water, likely due to a different climate at the time. As the climate dried, flow rates decreased and valleys filled with alluvial sediment. Current streams developed narrow meander belts within the large floodplains, and these often have a different pattern than the meanders of the large valley (Dury 1974). An example of underfitness on the Mineral Point Branch of the Pecatonica, northwest of the city of Mineral Point along U.S. Highway 151, is given in Dury (1962). Part of the valley studied by Dury is now flooded by the impoundment that created Ludden Lake (Figure 20.3).

A map showing the Landtype Associations (WLTA Project Team 2002) in the Southwest Savanna Ecological Landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 20.K at the end of this chapter.

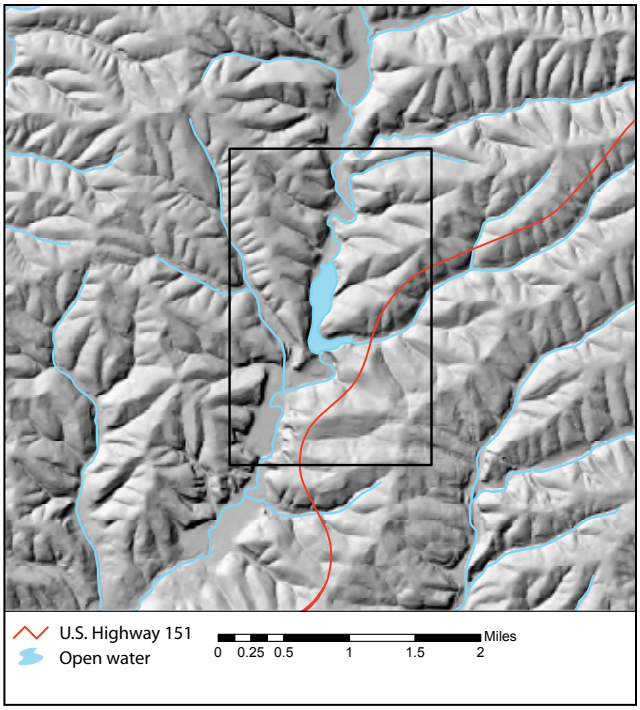

Figure 20.3. *Example of an underfit stream in a valley northwest of Mineral Point in Iowa County. Ludden Lake (inside the black box) was impounded in the area studied by Dury (1962).*

Topography and Elevation

The Southwest Savanna Ecological Landscape is a dissected landscape with narrow to broad ridges, broad sloping shoulders, steep to very steep valley sides, pediments, and narrow valley floors. Elevations range from about 676 feet in the Galena River valley near the Illinois border to 1719 feet at the top of West Blue Mound.

Soils

Soils on hilltops and sideslopes are formed in thick loess over loamy to clayey residuum or sandy to loamy colluvium, overlying bedrock of dolomite, limestone, or sandstone. The dominant soil is well drained and silty with a silt loam surface, moderate permeability, and moderate available water capacity. Soil drainage classes range from well drained to moderately well drained, and soils generally have silt loam surface textures, moderate permeability, and moderate to high available water capacity. The valleys and river bottoms have soils formed in silty alluvium. They range from moderately well drained to very poorly drained and have areas subject to periodic flooding. Loess deposits are thickest near the Mississippi River; some areas are mapped as having 8–16 feet of aeolian silt, and all of the ecological landscape has loess deposits at least 2 feet thick (Hole 1976). Loess forms a fertile soil with excellent moisture-holding characteristics, and floodplain soils with incorporated loess are highly productive. Upland ridges are also generally productive. Sideslopes, particularly on south- and west-facing slopes, tend to be dry

and erodible, and their shallow depths to bedrock can limit management options.

There are management concerns about soils in southwestern Wisconsin related to steep slopes and shallow bedrock. Steep slopes are subject to erosion and movement of sediment into streams. Shallow soils are also more susceptible to compaction and rutting. These soils can be squeezed between equipment and bedrock, compacting them and sometimes destroying soil structure so that rainfall can move the soil easily. These soils often have a lower nutrient supply because of the limited space available for holding nutrients. Calculations of nutrient balances on deeper soils assume that nutrients are available to tree roots within the upper 40 inches of soil, but a shallow soil may have half or less that amount of nutrients and may be susceptible to nutrient depletion after repeated timber harvests. Soils here are enriched in calcium and magnesium from the underlying dolomite, but nitrogen availability may still be a limiting factor to plant growth. Forest productivity in the upper Great Lakes region is often limited by soil nitrogen availability (Pastor et al. 1984, Zak et al. 1989). Increased harvests or excessive use of prescribed burning can have an impact on plant nutrients.

Hydrology

Basins

Only 2.6 square miles of open water has been identified and mapped in this small ecological landscape, which is drained by only two major water basins: the Sugar-Pecatonica and Grant-Platte. The Southwest Savanna occupies about 80% of the combined area of these basins. Twenty-five watersheds within these basins lie entirely or partially within this ecological landscape. Twenty-one of these watersheds drain southward into the Mississippi and the Rock rivers, while four drain north to the Wisconsin River. However, only a few square miles of these north-draining watersheds are included in this ecological landscape. This area is along the crest of the "Military Ridge," in the uppermost portions of five lower Wisconsin River watersheds (LW-1, LW-7, LW-9, LW-11, and LW-15). This small area is included in this ecological landscape due to closer similarities in geology, soils, and climate to the adjacent lands to the south.

There is intensive agricultural activity (row crop production) in many of these watersheds, especially on the broad ridges. In the valleys, agricultural activity often occurs within a few feet of streams. Manure runoff and spills from livestock feedlots, manure lagoons, and other potential sources of contamination have caused fish kills in some rivers and streams. Livestock often have direct access to streams, causing bank damage, soil compaction, loss of streambank vegetation, and erosion problems. This has led to stream siltation, with the loss of aquatic species that are less tolerant of moderate or high levels of turbidity. Erosion of soils from agricultural lands used for row crop production can degrade water quality and impair habitat values. Heavy stream bottom siltation, loss of floodplain and upland forests, loss of grasslands and wetlands, and urban stormwater runoff are among the factors that degrade water quality (WDNR 2001). Excessive nutrient input and increased stream velocity due to incised banks can also be problems. This has led to this ecological landscape having one of the lowest overall levels of species diversity for aquatic invertebrates (based on data from the Wisconsin DNR Aquatic Macroinvertebrate Atlas; WDNR 2015a). However, watersheds in which there are large acreages of land enrolled in soil conservation programs such as the federal Conservation Reserve Program (CRP) have shown water quality improvements (Marshall et al. 2008).

Widespread stream degradation related to the factors mentioned above is reflected in the fact that in this ecological landscape only a portion of the Little Platte River and some of its tributaries have been designated as a Conservation Opportunity Area for Wildlife Species of Greatest Conservation Need in the Wisconsin Wildlife Action Plan (WDNR 2005b).

Inland Lakes

The well-developed natural ***dendritic drainage patterns***, the lack of previous glaciation, and the nature of the underlying geology have resulted in the occurrence of very few natural lakes within the Southwest Savanna. According to the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015c), there are only two named lakes, which cover 26 acres, and 547 unnamed lakes with a combined area of 457 acres. Many of these small unnamed lakes are of the "oxbow" type and are found within the floodplains of larger rivers such as the Pecatonica.

Impoundments

The Southwest Savanna Ecological Landscape has approximately 1,164 acres of impoundments (WDNR 2015c). There are 180 dams in place across perennial and intermittent streams here, and in recent years, seven dams have been removed for economic, safety, or ecological reasons. As is the case in other heavily agricultural landscapes, many of these structures are runoff check dams, dating back to the soil conservation programs of the New Deal during the 1930s.

The Pecatonica, East Branch of the Pecatonica, and Galena are this ecological landscape's largest rivers, although only the headwaters of most of these streams are within the ecological landscape boundary. While few dams exist on the main stems of these rivers, many tributaries have been blocked by dam construction. There are also several dams on the western tributaries of the Sugar River (the main stem of the Sugar is not in this ecological landscape). Many of the dams on these major rivers and small streams have existed since early Euro-American settlement, having been built to provide power for grain mills, saw mills, and other uses. Impoundments cause the loss of flowing water habitats, result in the loss of stream habitat connectivity, create barriers to the movements of aquatic organisms, and lead to increases in water temperature and local water quality impairment (WDNR 2001). In addition, many of the smaller tributaries have also been fragmented by

improperly placed culverts, particularly on town roads, which have collectively resulted in the fragmentation of many miles of streams (J. Amrhein, Wisconsin DNR, personal communication). The impact of this is unknown at this time.

Rivers and Streams

The Southwest Savanna is drained by many headwaters streams, a few larger streams, and several medium-sized rivers, totaling 4,647 miles of perennial streams (WDNR 2015c). The larger rivers here include the Pecatonica, East Branch of the Pecatonica, and Galena.

Some streams in this ecological landscape flow through calcareous bedrock (dolomite), which provides high levels of ***calcium*** ions to the water. This is beneficial to many aquatic invertebrates, as are the numerous ledge and pool habitats created by erosion or solution of the dolomite. A rare damselfly, the highland dancer (*Argia plana*), and several rare fish occur in these headwater streams. There are clusters of coldwater streams in the Sugar-Pecatonica basin that support populations of native brook trout. See the "Fauna" section for details.

Overall, the portions of the streams that remain in a healthy ecological condition are very limited. The turbid and nutrient-rich conditions in many rivers and streams limit aquatic life to those species that are tolerant of degraded water quality and in-stream habitats. Many aquatic invertebrates require coarse substrates, which allow them to burrow into the stream bottom while maintaining access to flow of aerated water. Excessive stream sedimentation has deposited deep layers of silt and muck that the more sensitive aquatic organisms cannot tolerate. However, a few short ***reaches*** of some streams here do support sensitive aquatic invertebrates.

Various private groups and local governments are in the process of restoring aquatic habitats and streambank cover and controlling erosion along small streams. In addition, the conversion of many croplands to CRP during the 1980s and 1990s improved infiltration and groundwater recharge of area streams, lowering water temperature. This resulted in a measurable cooling of stream temperatures in the rehabilitated reaches and restoration of former coldwater communities. The most successful projects were those where row crops were replaced by acreage enrolled in the Conservation Reserve Program along streams. One consequence of this has been that the fish species composition has changed with displacement of several species of fish that preferred somewhat warmer temperatures that had resulted from the previous stream degradation (Marshall et al. 2008). However, overall aquatic community diversity increased as a result of stream restoration measures.

The major warmwater rivers and streams are the middle and lower reaches of the Pecatonica, East Branch of the Pecatonica, and Galena rivers. Historically, these streams contained significant populations of smallmouth bass (*Micropteris dolomieu*), channel catfish (*Ictalurus punctatus*), northern pike (*Esox lucius*), and walleye (*Sander vitreus*). Over the years, these streams were significantly impacted by agricultural activities in the surrounding landscape, resulting in high levels of turbidity and nutrients. These rivers, which carry large amounts of sediment due to soil erosion from the surrounding uplands, ultimately empty into the Mississippi River, to which they add their large sediment load. Large quantities of nutrients, particularly nitrogen from fertilizers, also enter the Mississippi from these Wisconsin rivers, contributing to nutrient-caused hypoxia in the Gulf of Mexico (NOAA 2003). In less degraded stretches of warmwater rivers and streams, smallmouth bass, channel catfish, and northern pike are still common. Tributaries to these streams function as nurseries for young game fish.

Springs

There are 2,549 mapped springs in the Southwest Savanna (Macholl 2007), constituting the highest density of springs in any of Wisconsin's ecological landscapes. Many of these springs are clustered in watersheds that support coldwater and coolwater streams. The constant coldwater flow from these springs is critical to maintaining the low water temperature and high dissolved oxygen content vital to the health of these ecosystems. The springs help support a few populations of native brook trout and some invertebrates that cannot tolerate warm water temperatures. They are also vital to supporting transitional aquatic ecosystems that support cool-cold or cool-warm fish species and make up the bulk of stream communities in this area.

Wetlands

Wetlands are neither extensive nor abundant here, comprising less that 1% of the total land cover. There are 8,800 acres of mapped wetlands in the Southwest Savanna Ecological Landscape; roughly 75% are emergent/wet meadow, 12% forested, and 6% shrub types (the remainder is filled or drained wetlands (WDNR 2010c). The Southwest Savanna has the fewest number of acres and the least percentage of the land in

Wetland and stream channel restoration in the upper Pecatonica River watershed. Photo by Eric Booth.

wetlands of any of the ecological landscapes. Most wetlands are associated with the floodplains of the larger rivers and streams, such as the Pecatonica, or occur along stream margins in the lower elevations of valleys. While most wetlands here have been grazed, some higher quality sedge meadows remain. Beds of aquatic macrophytes may develop in some of the shallow impoundments. Wetland communities documented in the Southwest Savanna include Emergent Marsh, Southern Sedge Meadow, Wet-mesic Prairie, and Shrub-carr.

Water Quality

Approximately 70% of this ecological landscape is cultivated (WDNR 2001), and the predominant agricultural land uses pose potential and active threats to maintaining or restoring high water quality in the Southwest Savanna. The uppermost Little Platte River, for example, emerges from a modestly forested landscape, carrying relatively few pollutants into the more intensively cultivated agricultural area to the south. Because water quality in the headwater creeks and upper tributaries is generally good, under moderate flow conditions some of the upper main stems of the larger rivers, such as the Platte, remain relatively clean. The smaller tributaries, however, can be much more easily affected by land uses in their watersheds. Because their stream flow is much less than that of the main stems, many suffer from excess siltation and nutrient runoff from row-crop fields that may not be well managed or that lack vegetated ***buffers*** to minimize soil erosion. Pollutants carried by tributaries can eventually impact the main stems of the rivers that originate here but often not until the point where they flow into the Western Coulees and Ridges Ecological Landscape where they meet the Mississippi River.

Overall, increased agricultural runoff over the last 150 years has affected water quality, in-stream habitats, bank cover, and fish and aquatic invertebrate populations in streams in all watersheds in the Southwest Savanna. Agricultural practices are the primary cause of poor water quality, due to sediment and nutrient inputs, leading to high turbidity and low dissolved oxygen content following runoff events which flush nitrogen and phosphorous from fields, barnyards, and feedlots (WDNR 2001). Increased numbers of livestock per farm, failure to upgrade manure storage capacities, inability of farms with large manure storage holding tanks to recruit more landowners to allow spreading their manure on their fields so it is not concentrated on the farm with the large holding tank, and the lack of nutrient management plans are all contributing to water quality problems. Heavy grazing of streambanks and wetlands can result in bank slumping, additional erosion, degradation of riparian habitats, and the spread of invasive plants (Biedenharn et al. 1997, WDNR 2008).

Agricultural practices that result in excessive inputs of sediments and nutrients to surface waters have led to serious water quality problems within impoundments situated in the Platte-Grant and Sugar-Pecatonica basins. These problems include excessive blooms of green and blue-green algae, increases in undesirable rooted aquatic plants, reduced levels of dissolved oxygen (which can lead to fish kills), and poor water clarity (turbidity). In some areas, polluted urban runoff can also be a problem. Most impoundments are shallow and vulnerable to rapid sedimentation and are preferred habitat for certain invasive species such as common carp (*Cyprinus carpio*). Carp additionally degrade these systems by uprooting vegetation and/or causing turbidity, which suppresses the growth of more desirable, or at least noninvasive, aquatic plants. These impoundments also tend to act as nurseries for carp, which augments populations in the impoundments and upstream. Water quality problems, coupled with the generally small size of impoundments in this ecological landscape, limit their recreational use.

An extensive evaluation of Rountree Branch, in the vicinity of Platteville, highlights some of the ongoing and potential water quality problems for streams in this ecological landscape. Due to Rountree Branch's location in the Driftless region, the watershed's steep slopes increase the potential for excessive sediment delivery to the stream. In addition, Rountree Branch flows through the city of Platteville, with its high proportion of impervious surfaces and stream behavior during storm events and snowmelt. This at times causes a more extreme peak flow and creates ***flashy stream*** conditions. Flashy conditions can contribute to increased levels of streambank erosion due to the increased volume of water and its high velocity. Streambank erosion widens stream channels, decreases stream velocity, and increases stream temperature (which will result in lower levels of dissolved oxygen). This streambank erosion combined with cropland erosion contributes to significant pollution problems, including sedimentation and the inflow of excess nutrients. Municipal discharges from the wastewater treatment plant and storm sewers, in addition to industrial and construction activities within the city, are other sources of point and nonpoint pollution. Rountree Branch is also threatened by high bacterial counts as well as metal toxicity due to runoff from mining waste and ***roaster piles*** (waste rock left over from inefficient thermal processing of zinc sulfide ore to zinc oxide concentrate) left at abandoned mines. All of these sources of nonpoint and point source pollution can ultimately change the nature of the aquatic habitats in Rountree Branch.

The lower reaches of the Grant River, downstream from the Southwest Savanna in the Western Coulees and Ridges Ecological Landscape, carries one of the highest suspended solids loads in the state. This is due primarily to agricultural runoff, a portion of which originates in the Southwest Savanna Ecological Landscape. Blake Fork, Hackett Branch, Day Branch, Martin Branch, Rogers Branch, and the Little Grant River are some of the other streams that are significantly impacted by nonpoint pollution sources.

The Southwest Savanna's shallow aquifers are the source of virtually all of the drinking water here. The fractured dolomite bedrock can facilitate the movement of pollutants into and

through the aquifers. The most common groundwater problem is a high level of nitrate in the shallower wells (a number of wells tested in Iowa County exceed the federal and state standards for drinking water (WDNR 2006a, USGS 2008). For example, of 837 wells tested in the Sugar-Pecatonica basin, 20% exceeded the federal/state standard of 10 parts per million, a concentration at which enforcement action can be taken. Atrazine, triazine (a metabolic product of atrazine), and other pesticides are also a major groundwater concern and were detected in all of 639 wells tested in the Sugar-Pecatonica basin. As of 2007, nearly 9,000 acres of cropland are within an atrazine prohibition area. The historical mining region is full of abandoned zinc and lead mines. Thousands of drill holes and airshafts that have not been properly sealed can act as routes by which pollutants may reach aquifers.

A major groundwater study was completed in Iowa County (Gotkowitz 2010). Using county funds, hydrogeologists from the Wisconsin Geological and Natural History Survey mapped bedrock types, thicknesses, and elevations throughout the county. With additional topographic information, and well-log and water-level data, the researchers produced maps of significant groundwater aquifers and models of the regional groundwater flow system. This provided final maps showing the locations of groundwater recharge areas and areas with high vulnerability for contamination. This information is useful for evaluating ***groundwater protection areas*** within the contexts of grassland conservation and minimizing pesticide use in areas of highest groundwater recharge.

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 have regulatory restrictions, with ORWs being the most restricted.

There are few waters here that are of high enough quality to be classified as ORW. A portion of Mt. Vernon Creek is designated as an ORW, and there are a few streams classified as ERW. ERW include the Galena River, a small ***segment*** of the upper Platte River, the Little Sugar River, Spring Valley Creek, lower Burgy Creek, Blue Mounds Branch, Frye's Feeder, and Deer Creek. A complete list of ORW and ERW in this ecological landscape can be found on the Wisconsin DNR website (WDNR 2010a).

Waters designated as impaired on the ***U.S. Environmental Protection Agency 303(d) list*** exhibit various water quality problems, such as bacteria from farm and urban runoff and general habitat degradation. A plan is required by EPA on how 303(d) designated waters will be improved by the Wisconsin Department of Natural Resources. This designation is used as the basis for obtaining federal funding, planning and prioritizing aquatic management work, and meeting federal water quality regulations. Since the 303(d) designation is narrowly based on the criteria given above, a waterbody could be listed as a 303(d) water as well as a ORW or ERW. These designations are not mutually exclusive. These designations are intended to meet federal Clean Water Act obligations and prevent loss of water quality or degradation of aquatic habitats. They are also used to help guide and inform land use and human activities near designated waters.

Waters designated as 303(d) impaired include Rogers Branch, Martin Branch, Martinville Creek, Bacon Branch, Livingston Branch, Brewery Creek, Dodge Branch, upper Burgy Creek, Cherry Branch, Silver Spring, and Louisburg Creek. Nonpoint runoff and bank erosion are the primary sources of impairment leading to the habitat degradation for most of these streams. The complete list of 303(d) impaired waters and criteria can be viewed at the Wisconsin DNR's impaired waters web page (WDNR 2010b).

Susceptibility of streams and groundwater to nonpoint source pollution is rated as "high" in nearly all watersheds in the Southwest Savanna. As of April 2006, every watershed in this ecological landscape had a "high" susceptibility rating for groundwater pollution (WDNR 2006a). This is related in part to the interaction of soils and geology of these watersheds, the intensive agriculture that is the dominant land use here, and some suburban and urban land use impacts.

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

Several sources were used to characterize the historical vegetation of the Southwest Savanna 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 various descriptive narratives. More information about these data sources is available in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

According to Finley's map and data interpretation (Finley 1976), in the mid-1800s the Southwest Savanna Ecological Landscape was almost entirely vegetated by a continuum of fire-adapted natural communities that included prairie, oak savanna, and oak forest. An unknown but probably significant proportion of the lands considered to have supported "oak forest" would have been classified today as "oak woodland," a community with relatively high canopy cover (50–95%) that was affected by frequent fires of low intensity. In aggregate, these communities covered about 95% of the ecological landscape (Figure 20.4). This is by far the largest percentage of land occupied collectively by these fire-dependent

communities in any ecological landscape (also see the map "Vegetation of Wisconsin in the Mid-1800s" in Appendix G, "Statewide Maps," in Part 3). The amount of land occupied by shrubs, and especially by ***oak grubs*** (sprouts from trees top-killed by periodic wildfire), is impossible to determine by examining the PLS notes. It's likely, though, that shrubs and grubs were widespread and at least locally important.

PLS information has been converted to a database format, and relative importance values (RIV) for tree species were calculated based on the average of tree species density and ***basal area*** (He et al. 2000). This analysis indicates that there was a high degree of homogeneity in tree species in this ecological landscape. Oak species had the five highest RIVs and had the only RIVs higher than 1%. White oak (*Quercus alba*) had the highest RIV (44.6%), followed by bur oak (*Quercus macrocarpa*) (36.2%), and black oak (*Quercus velutina*) (10.9%). See the map "Vegetation of the Southwest Savanna in the Mid-1800s" in Appendix 20.K at the end of the chapter.

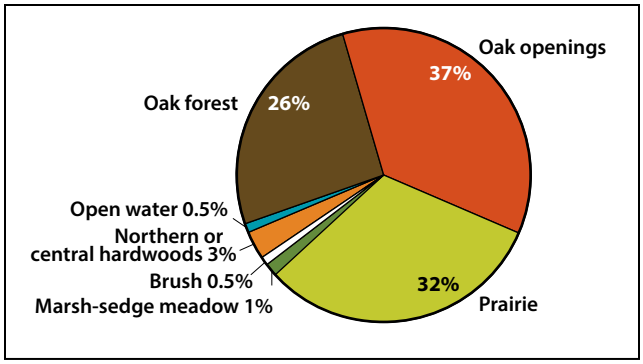

Figure 20.4. *Vegetation of the Southwest Savanna Ecological Landscape during the mid-1800s, as interpreted by Finley (1976) from the federal General Land Office public land survey information.*

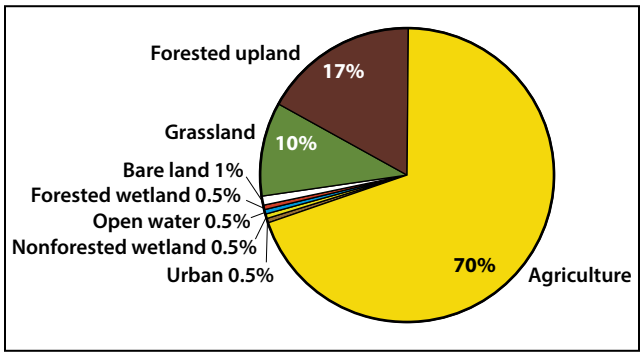

Figure 20.5. *WISCLAND land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery for the Southwest Savanna Ecological Landscape (WDNR 1993).*

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, the Wisconsin Wetlands Inventory (WWI), the U.S. Forest Service's Forest Inventory and Analysis (FIA), and the National Land Cover Database (NLCD) were used. Results among these data sets often differ as they are the products of different methodologies for classifying land cover, and each data set was compiled based on sampling or imagery collected in different years, sometimes at different seasons, and at different scales. In general, information was cited from the data sets deemed most appropriate for the specific factor being discussed. Information on data source methodologies, strengths, and limitations is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

WISCLAND land use/land cover data from 1992 classifies general land cover attributes and can be useful in characterizing large-scale land use features and attributes (WDNR 1993). It is based on satellite imagery from 1992, so it does not represent present day information. We use it here to offer a general view of the broad patterns of land use and land cover in a given ecological landscape.

The Southwest Savanna Ecological Landscape is approximately 1,248,000 acres in size, of which approximately 17% was forested and 83% was nonforested in 1992 (WDNR 1993). WISCLAND land use/land cover data from 1992 also indicates that 70% of the ecological landscape was classified as agricultural use, which is the highest percentage of land in agricultural use of all of Wisconsin's ecological landscapes (Figure 20.5). Although according to WISCLAND data (WDNR 1993) the category of "grassland" totals 10%, almost none of this is native prairie ("grasslands" classified by WISLAND include established CRP, pasture, idle farmland, and restored prairie).

Native prairies have fared no better here than in other parts of Wisconsin and are now reduced to a fraction of 1% of their former abundance. However, the Southwest Savanna provides a comparatively much more open landscape than other parts of Wisconsin and includes scattered prairie remnants, pastured prairies that have never been plowed, and pastures, CRP lands, and fallow fields composed mostly of nonnative grasses and forbs. The Southwest Savanna has more area of pastured prairies that have never been plowed than any other ecological landscape (Sample et al. 2003). These are among the key factors that contribute to an excellent opportunity to manage and restore grassland ecosystems at scales that are not possible or feasible in most other parts of the state.

The Wisconsin Wetlands Inventory (WWI) offers a more detailed and specific assessment of wetlands than is available from the use of WISCLAND data alone but is limited to those areas identified from interpretation of aerial photography as wetland (WDNR 2010c). According to the WWI, wetlands occupy a very low portion of the Southwest Savanna Ecological Landscape, comprising less than 1% (approximately 9,000 acres) of this ecological landscape's vegetation. This is by far the smallest amount of wetlands, both by acreage and by percentage of land area, of any ecological landscape. Emergent/wet meadow wetlands make up the majority of wetland vegetation

here (6,600 acres). As virtually all of these wetlands have been grazed and received inputs of sediments and nutrients from croplands and livestock, reed canary grass (*Phalaris arundinacea*) and other aggressive nonnative species are often among the current dominants.

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." Some of the important animals associated with wetlands (as well as those associated mostly with terrestrial habitats) are discussed in the "Fauna" section.

Forest Inventory and Analysis (FIA) data are from a U.S. Forest Service program that compiles point samples of forested lands to assess the timber resources of the country (USFS 2004). It contains information on forest types and species composition, which can be generalized across ecological landscapes but offers more specific information about forested lands than WISCLAND. Because FIA is derived from on-the-ground sampling (and extrapolations from those samples) as opposed to interpretations of satellite imagery or other remote sensing methods, the numbers may lead to different interpretations of the status and composition of forests than WISCLAND. According to FIA data summarized in 2004, the predominant forest ***cover type*** group is oak-hickory (55.1% of the forested area), followed by central hardwoods (31.8%) (USFS 2004). All other forest types occupy less than 10% of the forested area. Keep in mind that overall forest cover is low here and that extensive areas dominated by forests are virtually absent.

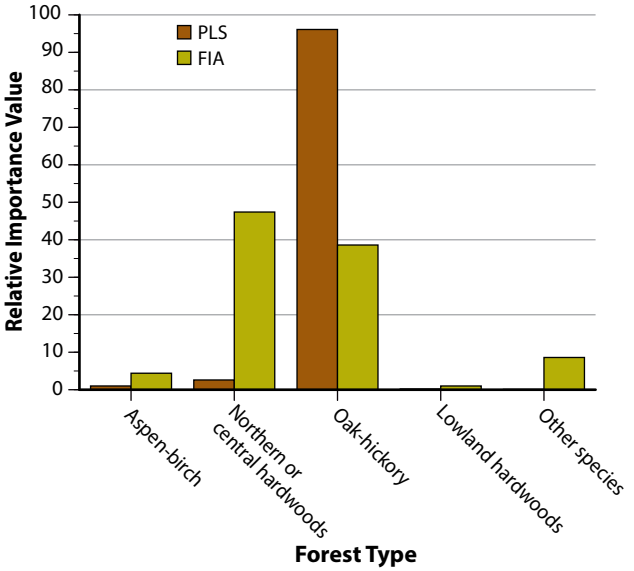

Figure 20.6. *Comparison of tree species' relative importance value (average of relative dominance and relative density) for the Southwest Savanna during the mid-1800s, when federal General Land Office public land survey (PLS) data were collected, with 2004 estimates from Forest Inventory and Analysis (FIA) data (USFS 2004). Each bar represents the proportion of that forest type in the data set (totals equal 100 but include forest types only). 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 specific snapshots in time, they provide valuable insights into Wisconsin's former vegetative cover and current 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 desirable within the context of providing for human needs and desires. Information on the methodology, strengths, and limitations of the vegetation change data is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

Current forest vegetation (based on FIA) is primarily central hardwood species (American elm, black walnut, basswood, etc.) (47.4% of RIV) and oak-hickory (38.6% of RIV) (Figure 20.6). Central hardwood species have increased dramatically (from 2.6% to 47.4% of RIV) as has aspen-birch (from 1.0% to 4.4% of RIV). Oak species have decreased from 96.1% to 38.6% of RIV. Most notably, white oak has decreased from 44.6% to 11.5% of RIV, and bur oak has decreased from 36.2% to 12.9% of RIV.

Note that the FIA data are applicable only to forests and that these make up a relatively small proportion of the vegetative cover of this ecological landscape. Comparable information is not available for other types of vegetation. The historically abundant prairie and savanna communities (and fire-shaped oak-dominated vegetation) have all declined tremendously across southern Wisconsin. These communities are now among the priorities for restoration and management where the best such opportunities exist in the Southwest Savanna Ecological Landscape. In addition to the loss of prairie and savanna vegetation, white oak, a species of great ecological significance in this ecological landscape, is being removed in the ***sawtimber*** class at high rates and replacement is apparently so low that it's virtually undetectable (see the "Timber Demand" section and Table 20.6, Figure 20.21, and Figure 20.22 in "Socioeconomic Characteristics" below). White oak was a dominant species in savannas, woodlands, and some forests here.

Natural Communities

This section summarizes the abundance and importance of major physiognomic (structural) natural community groups in the Southwest Savanna Ecological Landscape. Some of the exceptional opportunities, needs, and actions associated

with these groups, or with some of the individual natural communities, are discussed briefly. For details on the composition, structure, and distribution of the specific natural communities found in the Southwest Savanna, 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.

Historically, most of the vegetation of the Southwest Savanna Ecological Landscape was fire-driven, fire-adapted, and/or fire-dependent, resulting in vast areas of tallgrass prairie and oak savanna arranged as a ***mosaic*** across the landscape that was related to differences in topography, slope, aspect, and soil characteristics. Smaller areas of oak woodland and forest were also present, for example, in areas that were subject to fires of lower intensity and frequency than elsewhere. Shrublands composed of native species such as hazelnut (*Corylus* spp.), dogwoods (*Cornus* spp.), or prickly ash (*Zanthoxylum americanum*) and frequently burned areas dominated by oak grubs also occurred, but their extent was unrecorded and unknown. Shrubs probably occurred both in the open prairie (e.g., in draws and on the margins of bedrock outcroppings) and as part of the understory of oak savanna. Existing prairie remnants are all small and often somewhat degraded (e.g., with nonnative "weeds"), but some of them are embedded within larger areas of "prairie pasture," or occur in association with "surrogate savannas" (an incomplete canopy of scattered open-grown oaks over an understory that has been altered by prolonged grazing) that had never been cleared and plowed.

Browntown Oaks State Natural Area contains a mesic to dry-mesic hardwood forest with ***old-growth*** *characteristics. Green County. Photo by Eric Epstein, Wisconsin DNR.*

This is one of the few Wisconsin ecological landscapes that offers the opportunity to manage large blocks of mostly open land that encompass the entire vegetation continuum of fire-dependent terrestrial communities from treeless prairie, to savanna, to open oak woodland, to closed oak forest. The Southwest Savanna offers our best opportunity to manage for large blocks of grassland habitat and ecologically related communities (see Figure 20.15).

For a recent summary of the values and current status of prairies and savannas to the east of Wisconsin in Michigan, see O'Connor et al. (2009).

Forests occurred most often on slopes and in draws that were afforded some protection from frequent, hot fires. Most of the remnant hardwood forests are dry to dry-mesic and dominated by oaks, but in a few locations there are stands of mesic maple-basswood forest. These mesic hardwood forests tend to occur as isolated islands, and none of them are extensive. The hardwood forests provide habitat for several herbs that reach their northernmost range limits in this ecological landscape. One of these, green violet (*Hybanthus concolor*), is extremely rare and may in fact have been recently extirpated from Wisconsin.

Wetlands are rare and relatively poorly represented in this well-drained unglaciated ecological landscape. Most of the wetlands are small, and many have been degraded by prolonged periods of heavy grazing by domestic livestock, which has led to the replacement of many native plants by the nonnative invasive reed canary grass. In some areas, attempts had been made to cultivate wetlands, either by plowing them up during dry periods or by draining them. Wetland communities that occur in the Southwest Savanna include Emergent Marsh, Southern Sedge Meadow, Wet-mesic Prairie, Shrub-carr, and Floodplain Forest. None of these types are or were common—some are very rare—and they tend to be associated with rivers and streams in valleys. Stands of aquatic macrophytes now occur in some impoundments.

Forests. Historically, most of the forests (and Oak Woodlands) in this ecological landscape burned periodically, though with less frequency and generally less severity than the prairies and savannas. Southern Dry and Southern Dry-mesic forests are oak-dominated communities that were locally common in some areas, and these not only burned periodically but were dependent on fire for their long-term maintenance. Mesic forests were rare (and remain so) and would typically develop and persist only on sites protected

from fire by waterbodies, wetlands, or topographic features such as escarpments, cliffs or steep-sided mounds.

Some stands of oak were thought to have burned frequently but at lower intensities than areas of prairie or oak savanna (Curtis 1959). Recent research (R. Henderson, personal communication, Wisconsin DNR) has shown that the understories of some of these communities, now referred to as "Oak Woodland," are composed of many of the same genera that characterize prairies and savannas (e.g., grasses, composites, and legumes) but with representation by different, somewhat more shade tolerant, species.

Natural stands of conifers, traditionally referred to as ***relicts*** by plant ecologists in Wisconsin, are uncommon and unusual features of interest to botanists, biogeographers, and conservationists in the Southwest Savanna. These are composed mostly of pines (*Pinus* spp.) and are strongly associated with bedrock at or very near the surface (the only habitats in this ecological landscape that support our native pines). A few of the more mesic cliff habitats, usually on cool northern or eastern exposures and sometimes affected by groundwater seepage, support small, linear stands of eastern hemlock, which reaches its southwestern range extremities here. Though the conifer relicts are rare, they are often highly visible, and some are well known due to their association with prominent bluffs and bedrock outcroppings. They are of considerable ecological and biogeographic interest and significance, and many also prize them for their aesthetic beauty.

Savannas. Oak Openings were extensive here, covering parts of the Southwest Savanna that burned frequently but perhaps less intensely than the prairie-dominated areas. In many locations, the Oak Openings were dominated by large open-grown bur or white oaks, but black oak and shagbark hickory (*Carya ovata*) were important components of some stands.

Prairie stream, grasslands, native conifers on fire-protected slope. Eastern white pine is among the forest canopy dominants; eastern hemlock reaches its southernmost range limits here. Iowa County. Photo by Eric Epstein, Wisconsin DNR.

The widespread implementation of fire suppression policies and the conversion of land to crop production led to the loss or significant alteration of almost all of Wisconsin's native oak savannas, especially the more mesic (and productive) Oak Openings, which were historically abundant in this ecological landscape. Trees were removed, and the sites were then plowed and planted to crops, or the remnants grew up into dense stands of forest in the absence of frequent fire. Heavy grazing could maintain savanna structure, but that favored understory species better-adapted to that disturbance regime, such as nonnative cool-season grasses and some spiny or thorny shrubs, which flourished at the expense of many of the native plants. Historically, farmers burned their pastures to improve grazing, whether wooded or not. When cows were removed from the wooded areas (which included oak savannas), the need to burn disappeared as well (Ruffner and Groninger 2006). The result was an increase in shrubs and saplings, creating conditions that were unsuitable for many of the native understory species that thrived under conditions of incomplete canopy closure and filtered shade.

The best savanna restoration opportunities exist where there are relatively large pastures that have retained a partial canopy of open-grown oaks. In some cases, at least a subset of the native understory plants have persisted in such circumstances (either in the seed bank or because they flower and set seed very early and have foliage that consists mostly of ground hugging rosettes of basal leaves or are of low palatability to domestic livestock), and these may increase and thrive under a management regime designed specifically to restore and maintain the savanna community. Under a regime of moderate to heavy grazing many nonnative plants increase. This group includes Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*), smooth brome (*Bromus inermis*), Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), and leafy spurge (*Euphorbia esula*). Weedy native species such as common milkweed (*Asclepias syriaca*) and ragweeds (*Ambrosia* spp.) may also behave as increasers. Most of the native prairie grasses and forbs decrease, and some ultimately disappear, under such management regimes (Weaver 1954).

Shrub Communities. Native shrub communities have received little attention throughout Wisconsin. Owing to current grazing practices and patterns, it's likely that many, perhaps most, existing stands of shrubs have been significantly altered. Shrubs of low palatability to livestock (such as those armed with thorns or spines) may have increased in some upland situations, though grazing has likely altered plant composition and structure in many other ways.

Shrub-carr is a wetland community dominated by tall shrubs such as the dogwoods and willows that sometimes occur along stream and open wetland margins. The widespread implementation of fire suppression policies and wetland drainage may have led, at least temporarily, to an increase in the amount of shrub cover in formerly more open wetland communities such as sedge meadows and lowland prairies.

When patches of shrubs and small trees (e.g., some of the thorny species such as hawthorns) occur within pastures, they can provide critical breeding habitat for rare birds such as the Bell's Vireo (*Vireo bellii*) and Loggerhead Shrike (*Lanius ludovicianus*) and for more common but declining species such as the Willow Flycatcher (*Empidonax traillii*), Field Sparrow (*Spizella pusilla*), and Brown Thrasher (*Toxostoma rufum*). All five of these birds are Species of Greatest Conservation Need (WDNR 2005b). When such species are present, the benefits of shrub removal need to be weighed carefully, at multiple scales, against the habitat the shrubs provide for these and other sensitive species.

Herbaceous Communities. Tallgrass prairies formerly covered large parts of this ecological landscape, especially on broad ridges and rolling uplands lacking natural firebreaks. Mesic Prairie, now virtually eliminated by conversion to cropland, was the characteristic natural community in the more level areas with deep, rich soils (silts, silt loams, and loams). Dry-mesic and Wet-mesic Prairies occurred as site conditions dictated (the latter would have been rare, as wetlands of all types are scarce here). Prairie that was not suitable for conversion to intensive crop production because of steep slopes or thin, rocky soils was often used as pasture.

Tallgrass prairie remnants are all small, and most are now isolated by fields, transportation corridors, and residential developments. Mesic Prairie is especially scarce, and remnants are often confined to rights-of-way that have been maintained since the mid-1800s, when large influxes of Euro-American settlers arrived. A few very small Wet-mesic Prairie remnants may persist in poorly drained lowlands along some of the larger rivers or on the lower slopes of valleys drained by small streams, but these have typically been grazed, and few, if any, are presently in good condition. Dry Prairie remnants occur where soils are shallow, usually where bedrock is at or very close to the surface, or where slopes are steep with hot southern or western exposures. Because the Dry Prairies offer limited opportunities for successful crop production, these remnants have been disproportionately spared from conversion to intensive agricultural use.

This mesic prairie remnant occurs within a long-abandoned railroad right-of-way on the Lafayette-Grant county line. Fertile soils, level topography, and a favorable climate have resulted in the conversion of almost all land in this part of the Southwest Savanna to intensive row crop production. Photo by Eric Epstein, Wisconsin DNR.

In a study that examined nearly 40 years of change in prairie communities at 54 sites originally studied by John Curtis and his students for the publication *The Vegetation of Wisconsin* (Curtis 1959), Leach and Givnish (1996) found that the absolute loss of species per site per year was 0.45% for dry prairie, 0.77% for mesic prairie, and 1.03% for wet prairies. Losses were particularly severe among regionally rare and short-statured species. These results imply that, without active management, half of the native plant species present in remnant wet prairies may be extirpated in less than 50 years and half would be gone from remnant dry prairies in slightly more than a century. Long-term fire suppression, livestock grazing, reduced stand size, fragmentation of prairie habitat and isolation of remnants, and the spread of invasive species are among the important factors that have contributed to these losses. There is a need to collect additional baseline data on vegetation composition and structure from remnants across the Southwest Savanna, as it seems unlikely that such alarming rates of loss will remain constant or improve.

Surrogate grasslands include open lands enrolled in the Conservation Reserve Program (CRP) or Conservation Reserve Enhancement Program (CREP), unplowed "prairie pastures," actively pastured grasslands, fallow fields, old fields, and croplands. Lands dedicated to crop production have relatively low value to the more sensitive grassland species, but they can help to maintain the open aspect of a treeless landscape and potentially increase the effective conservation area for some species (Sample et al. 2003)

This is one of a very small number of ecological landscapes in Wisconsin where the opportunities to manage grasslands at a large scale and the opportunities to protect and restore native prairie remnants with their associated biota come together. Conservation opportunities to manage for tallgrass prairie are best where there are opportunities to embed prairie remnants within extensive surrogate grasslands or where they are adjacent to large pastures, especially where a variety of soil, slope, aspect, and soil moisture conditions are present. Many rare taxa persist in the grasslands of the Southwest Savanna, albeit often in small, isolated populations. Active steps need to be taken if further declines in grassland habitats and in the populations of grassland-dependent sensitive species are to be avoided. To that end, the recently adopted Southwest Wisconsin Grassland and Stream Conservation Area (SWGSCA) project (WDNR 2009a), which includes parts of Dane, Iowa, Lafayette, and Green counties, contains management recommendations for large-scale grassland conservation, primarily through the implementation of Bird Conservation Areas (see "Large-Scale Grassland Management" in "Management Opportunities for Important Ecological Features of the Southwest Savanna" below).

Primary Communities. Primary communities are defined as areas of bare substrate upon which there has been little or no soil development. In the Southwest Savanna the most common examples of such communities are cliffs (vertical exposures of bedrock). Some of the most prominent cliffs occur on slopes undercut by streams.

Most of the cliffs in the Southwest Savanna are dry and represent exposures of Cambrian dolomites or sandstones. A few Moist Cliff communities are known here, and several of these harbor northern "relicts" that support native conifers. Specialized biota may be associated with bedrock habitats, whether dry or moist.

Aquatic Features. These are described more fully in the "Hydrology" section below. This ecological landscape is renowned for its coolwater transitional systems and spring-fed coldwater streams, but warmwater streams are also present. The larger stream systems contain smallmouth bass, channel catfish, northern pike, and even some walleye. The moderately sized tributaries of these systems function as spawning areas and nursery streams for these fish.

Natural lakes are very rare here and are essentially limited to abandoned meander channels of several of the larger rivers (some of these may be briefly reconnected to their former stream channels during significant flood events). Many streams have been impounded by dam construction. These impoundments (artificial lakes) provide habitat for some native plants and animals but reduce or render unsuitable the habitat needed by others.

Forest Habitat Types

The Southwest Savanna Ecological Landscape is dominated by the dry-mesic to mesic habitat type group; however, mesic sites also are quite common (Table 20.1). Habitat types apply only to forests, and as noted previously, much of this ecological landscape was vegetated by prairie and savanna. The prevalent disturbance regime of periodic wildfire limited the development of mesic hardwood forests.

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 white oak and/or northern red oak (*Quercus rubra*). Common associates include black oak, elms (*Ulmus* spp.), aspens (*Populus* spp.), and American basswood (*Tilia americana*). Minor associates include black walnut (*Juglans nigra*), hickories (*Carya* spp.), black cherry (*Prunus serotina*), and sugar maple (*Acer saccharum*). If seed sources are available, potential late-successional dominants are sugar maple and American basswood.

Mesic sites typically are associated with silt loam soils that are well to moderately well drained and nutrient rich. Forest stands are most commonly dominated by white oak and/or northern red oak. Common associates include elms, sugar maple, and American basswood. Minor associates include black oak, hickories, black walnut, and black cherry. If seed sources are available, potential late-successional dominants are sugar maple and American basswood.

Flora

Forty-two plant species on the Wisconsin Natural Heritage Working List have been documented to date in this ecological landscape (WDNR 2009c). Of these 42 species, 8 are listed as Wisconsin Endangered, 14 are Wisconsin Threatened, and 20 are Wisconsin Special Concern.

Prairie bush-clover (*Lespedeza leptostachya*) was listed as U.S. Threatened by the U.S. Fish and Wildlife Service in 1987, and the federal recovery plan that has been written for this species includes Wisconsin sites (USFWS 1988). In Wisconsin, this species is listed as Wisconsin Endangered. Eight of

Table 20.1. *Forest habitat type groups and forest habitat types[a] of the Southwest Savanna Ecological Landscape (SWS EL).*

Southern forest habitat type groups[b]	Southern forest habitat types common within the SWS EL	Southern forest habitat types minor within the SWS EL
Dominant within SWS EL		
Dry-mesic to mesic (includes phases)	ATiCr(O) ATiCr(As)	
Common within SWS EL[b]		
Mesic (includes phases)	ATiH ATiAs(De)	
Minor within SWS EL[b]		
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 20.B ("Forest Habitat Types in the Southwest Savanna Ecological Landscape") at the end of this chapter.

[b]Groups listed in order from most to least common:
Dominant occurrence is an estimated > 50% of forested land area.
Common occurrence is an estimated 10–50% of forested land area.
Minor occurrence is an estimated 1–9% of forested land area.
Present: Other habitat types can occur locally, but each represents < 1% of the forested land area of the ecological landscape.

Wisconsin's 20 documented populations of prairie bush-clover occur in the Southwest Savanna, making this ecological landscape one of our most important places to protect this globally rare plant. A complete list of the rare species tracked by Wisconsin Natural Heritage Inventory (WDNR 2009c) in this ecological landscape may be found in Appendix 20.C.

Glade mallow (Wisconsin Special Concern) is a regional endemic of the north-central U.S., where it grows in sedge meadows and moist prairies. Iowa County. Photo by Eric Epstein, Wisconsin DNR.

While rare plants have been documented in virtually all of the Southwest Savanna's available habitats, species strongly associated with native prairies are especially well represented. Rare prairie plants with at least 25% of their known Wisconsin populations in this ecological landscape include prairie Indian-plantain (*Arnoglossum plantagineum*) (listed as *Cacalia tuberosa* on the Natural Heritage Working List), wild hyacinth (*Camassia scilloides*), Hill's thistle (*Cirsium hillii*), pale-purple coneflower (*Echinacea pallida*), marbleseed (*Onosmodium molle*), American fever-few (*Parthenium integrifolium*), and prairie turnip (*Pediomelum esculentum*).

Glade mallow (*Napaea dioica*), a Wisconsin Special Concern plant that inhabits sedge meadows and wet prairies, is a regional endemic occurring only in the north central United States (Cochrane and Iltis 2000). Twenty-nine of the 80 Wisconsin populations documented in the Natural Heritage Inventory database occur in the Southwest Savanna.

Several species important because of their statewide rarity are strongly associated with oak savannas. Among these are purple milkweed (*Asclepias purpurascens*), yellow giant hyssop (*Agastache nepetoides*), and yellow gentian (*Gentiana alba*). Until recently, oak savannas have been regarded as communities transitional between prairies and forests and

Pale-purple coneflower (Wisconsin Threatened) is limited to native prairie remnants in extreme southern Wisconsin. It has been introduced to many locations where it was not native. Photo by Thomas Meyer, Wisconsin DNR.

In Wisconsin, reflexed trillium (Wisconsin Special Concern) occurs only in rich hardwood forests in the extreme southern part of the state. Photo by Thomas Meyer, Wisconsin DNR.

Significant Flora in the Southwest Savanna Ecological Landscape

- Forty-two rare plant species have been documented in the Southwest Savanna.
- Eight of these rare plant species are listed as Wisconsin Endangered, and 14 are Wisconsin Threatened.
- One Wisconsin Endangered plant, prairie bush-clover, is also U.S. Threatened.
- This ecological landscape is especially important for rare plants associated with prairie and savanna habitats.
- Hardwood forests in the Southwest Savanna support several plants that reach their northern range limits here and that are rare in or absent from other ecological landscapes.
- Native conifers such as eastern white pine and eastern hemlock, along with several "northern" understory associates, reach their southern range limits in the Southwest Savanna; eastern hemlock does not occur naturally farther south or west.

were not generally recognized as harboring distinctive floras. This may have been due to the virtual absence of intact remnants for study and the highly degraded nature of persisting examples. In common with the fate of many of our more sensitive prairie plants, the more specialized savanna species tend to decline or disappear after long periods of fire exclusion (Leach 2008).

Though forests are not common here, several forest herbs are worthy of mention. Fire pink (*Silene virginica*) is known from only a few Wisconsin locations, two of them in rich dry-mesic to mesic hardwood forests in the Southwest Savanna. Other forest plants worth mentioning here are great Indian plantain (*Arnoglossum reniforme*, listed as *Cacalia muehlenbergii* on the Wisconsin Natural Heritage Working List), nodding rattlesnake root (*Prenanthes crepidinea*), reflexed trillium (*Trillium recurvatum*), and the rare saprophytic orchid, nodding pogonia (*Triphora trianthophora*).

In highlighting the rare plant species that are relatively well represented in this ecological landscape, we have relied mostly on the number of populations documented here compared with those occurring elsewhere in the state. To address protection priorities and design effective conservation projects, a

The Wisconsin Endangered fire pink is extremely rare in Wisconsin, where it reaches its northernmost range limits in woodlands of the Southwest Savanna Ecological Landscape. Photo by Thomas Meyer, Wisconsin DNR.

The last Wisconsin observation of green violet was from a rich hardwood forest in Grant County by UW-Madison botanist Hugh Iltis in 1959. Recent searches have failed to relocate historical populations or reveal any new ones. Green violet is currently regarded as extirpated in Wisconsin. Photo by Kitty Kohout.

more thorough analysis is needed, which would include the examination of factors such as population size and viability, the abundance and status of potentially suitable habitat, level of past survey effort, taxonomic uncertainties, and gaps in life history knowledge. The length of time that has elapsed since placement of a species on Wisconsin's rare plant Working List can have a significant impact on the number of records available for review and analysis.

Eastern hemlock, historically a dominant, and still widespread, tree in northern Wisconsin, reaches its southwestern range limits in the Southwest Savanna Ecological Landscape. Here eastern hemlock grows almost exclusively in linear stands on or above cliffs in close proximity to flowing water, most often on slopes with cool, moist eastern or northern aspects. Common associates include species such as eastern white pine (*Pinus strobus*) and yellow birch (*Betula alleghaniensis*) as well as an assemblage of understory species that are much more widely distributed farther north.

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 Southwest Savanna Ecological Landscape. Of those, this review is limited to species that were known to be 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).

The Southwest Savanna was important historically for a number of wildlife species, especially those for which prairies, oak savannas, oak forests, and streams were important habitats. This ecological landscape was particularly important for elk (*Cervus canadensis*), American bison (*Bos bison*), Wild Turkey (*Meleagris gallopavo*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Greater Prairie Chicken (*Tympanuchus cupido*), and Northern Bobwhite (*Colinus virginianus*). In the mid-19th century, the Southwest Savanna was settled by Euro-Americans, and large-scale wildfires were reduced. Farmers still burned their pastures for grazing (even those that were wooded), which maintained open conditions in much of this ecological landscape. However, when cattle were removed from the woods in the 1950s, the need to burn the woods disappeared as well (Ruffner and Groninger 2006), resulting in many open savannas and woodlands succeeding to closed canopy forest. These changes in land use had impacts to wildlife that have persisted to this day.

Elk were found throughout Wisconsin but flourished in prairies, oak openings, and at the prairie-forest borders (Figure 20.7). Since elk ate grasses and sedges to a greater extent than other large herbivorous mammals, they were most numerous and abundant in the southern and western parts of the state (Schorger 1954) and were abundant in the Southwest Savanna. Frederick G. Hollman, who settled at Platteville in 1828, reported that elk and other game were found in "astonishing quantities" at that time (Schorger 1954). Elk disappeared early from this ecological landscape, likely before 1840, due to the influx of miners and early settlers.

American bison occupied the prairie areas of the state prior to Euro-American settlement and were thought to be abundant in the Southwest Savanna Ecological Landscape (Figure 20.8; Schorger 1937). Current theories are that American bison preferred short to mid-grass prairies and were prevented from moving east of the Mississippi River by hunting pressure from early American Indians (R. Henderson, Wisconsin DNR, personal communication). For several centuries (1600–1700s), American Indian populations declined from disease and social disruption following or just prior to the arrival of Euro-Americans. During that time, American bison populations increased and expanded. As more American Indian tribes were forced west by Euro-American settlers relocating from the eastern U.S., the American bison population in Wisconsin came under

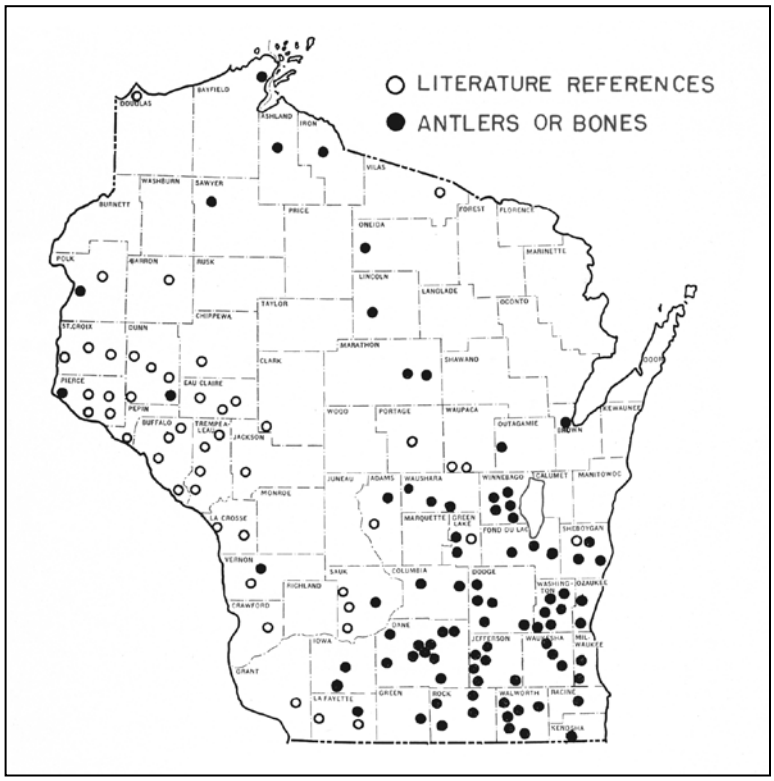

Figure 20.7. *Historical records of elk in Wisconsin. Figure reproduced from Schorger (1954) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

heavy hunting pressure by American Indians for food. The American bison population had been reduced to small numbers before the state was settled. The last two American bison reported shot east of the Mississippi River occurred in 1832. Records of American bison occurring in this ecological landscape are only from Prairie du Chien and Blue Mounds, areas where habitat was likely very suitable for their occurrence. A map of southwestern Wisconsin published by R.W. Chandler in 1829 stated that "not more than a tenth is covered by timber in detached groves, the remainder being prairies" (Schorger 1937), indicating that suitable habitat was present. One problem is that there are no written records for extreme southern Wisconsin before 1800, and bison populations could have been greatly reduced by the time of more recent reports. Schorger (1937) showed that the Southwest Savanna was occupied by American bison, but, like elk, they were likely eliminated early in the 19th century.

White-tailed deer (*Odocoileus virginianus*) were found throughout the state and were likely more abundant in southern Wisconsin than in the northern part of the state at the time of Euro-American settlement (Schorger 1953). White-tailed deer were reported as plentiful in southwestern Wisconsin in the 1830s; a settler reported seeing 30 feeding together at one time near Platteville. White-tailed deer remained plentiful in the Dodgeville, Mineral Point, and Ridgeway areas as well in the Darlington region during the 1840s and 1850s. However, as settlers arrived in southwestern Wisconsin in subsequent years, they depended on venison for food, and professional market hunters sent tons of venison to the large eastern cities. Subsistence harvest, together with market hunting, likely reduced the white-tailed deer population to its lowest level late in the 19th century.

From 1900 through the 1960s, white-tailed deer populations were low, and white-tailed deer were considered uncommon throughout southwestern Wisconsin. However, since the early 1980s, white-tailed deer populations have increased dramatically in this area and elsewhere in Wisconsin (Figure 20.9), and white-tailed deer are now very abundant in the Southwest Savanna Ecological Landscape. Today the white-tailed deer is a very important animal for recreation but causes crop damage, vehicle accidents, and forest regeneration problems. ***Chronic wasting disease*** (CWD) was discovered in the northeastern part of the Southwest Savanna (in Dane and

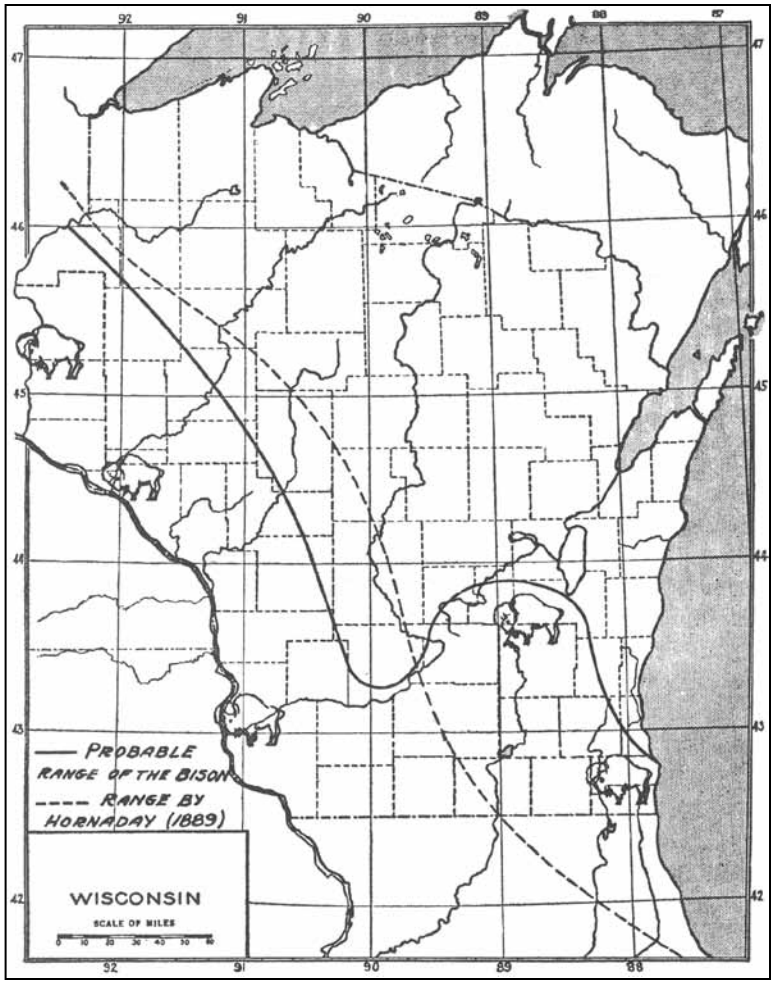

Figure 20.8. *Probable range of the American bison in Wisconsin prior to Euro-American settlement. Figure reproduced from Schorger (1937) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

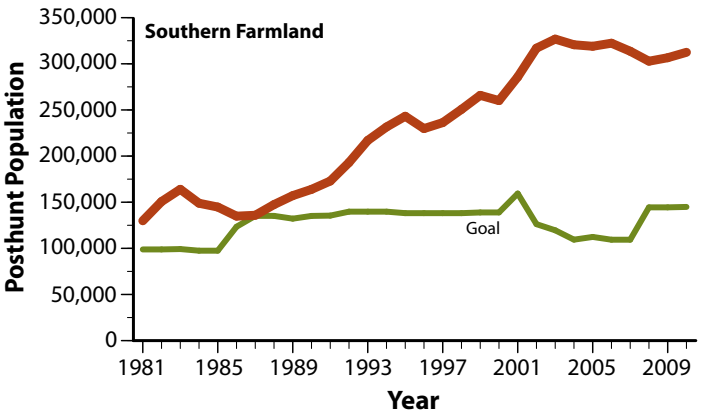

Figure 20.9. *White-tailed deer population size in relation to population goals in the southern farmland deer management region, 1981–2010.*

Iowa counties) in 2002. Since then special hunting seasons and regulations have been implemented to reduce the white-tailed deer herd and thereby contain the disease. Ongoing testing for this disease is occurring to monitor its incidence and spread and to inform hunters of sick white-

tailed deer they may have shot. As of 2015, the incidence of the disease continues to rise, and the geographic location of the disease continues to spread.

The gray wolf (*Canis lupus*) was found throughout the state, including the Southwest Savanna, before widespread Euro-American settlement. The gray wolf declined throughout the state from south to north due to loss of food sources, shooting, trapping, and poisoning. By the early 1960s, they were thought to be extirpated from all of Wisconsin. Since then, gray wolves recolonized the state through northwestern Wisconsin from Minnesota and expanded their populations to the northeast and southeast into central Wisconsin. No gray wolves are resident in the Southwest Savanna at this time.

Prior to Euro-American settlement, the American black bear (*Ursus americanus*) was found throughout this ecological landscape but was probably more abundant in the brushier and more wooded areas. After Euro-American settlement, the range of the American black American black bear shifted to the north. American black bears were extirpated from the Southwest Savanna, with the last record of an American black bear here in the 1870s (Schorger 1947). Today American black bear range is expanding from northern and central Wisconsin to the southern and southwestern parts of the state (Figure 20.10), and there are now occasional sightings reported from the Southwest Savanna again.

The historical range of the Wild Turkey was in southern Wisconsin below a line from Green Bay to Prairie du Chien (Figure 20.11; Schorger 1942). Wild Turkeys were most abundant in southwestern Wisconsin and were very common in the Southwest Savanna Ecological Landscape. In 1828 settler Frederick G. Hollman reported "bear, deer, and wild turkeys being found in astonishing quantities" near Platteville (Schorger 1942). As late as 1856, Wild Turkeys sold in Lancaster for as little as 25 cents each. Due to persistent hunting by settlers for food, changes to habitat, and the severe winter of 1842–43, Wild Turkeys were rare by 1860. Prior to reintroduction in 1976, the last documented Wild Turkey was seen in Lafayette County in 1881. For a discussion of Wild Turkey reintroduction, see Chapter 22, "Western Coulees and Ridges Ecological Landscape." Although the Wild Turkey is now established in every ecological landscape in the state, the Southwest Savanna has high densities of Wild Turkey and affords excellent hunting and wildlife viewing opportunities.

The Sharp-tailed Grouse was considered widely distributed in the state in open and brushy habitats before widespread Euro-American settlement and likely was very common in the Southwest Savanna, primarily occupying the extensive oak savannas, as well as areas with scattered shrubs and thickets of saplings (Schorger 1943). Sharp-tailed Grouse probably increased here for a while as the cessation of fire favored the growth of young trees and brushy habitats but then declined, either due to the succession of oak openings and brushlands into dense forests or because of the expansion of intensive agriculture. The last documented flock of Sharp-tailed Grouse here was seen during the winter of 1939–40 near Blue Mounds. Today no Sharp-tailed Grouse occur in this ecological landscape.

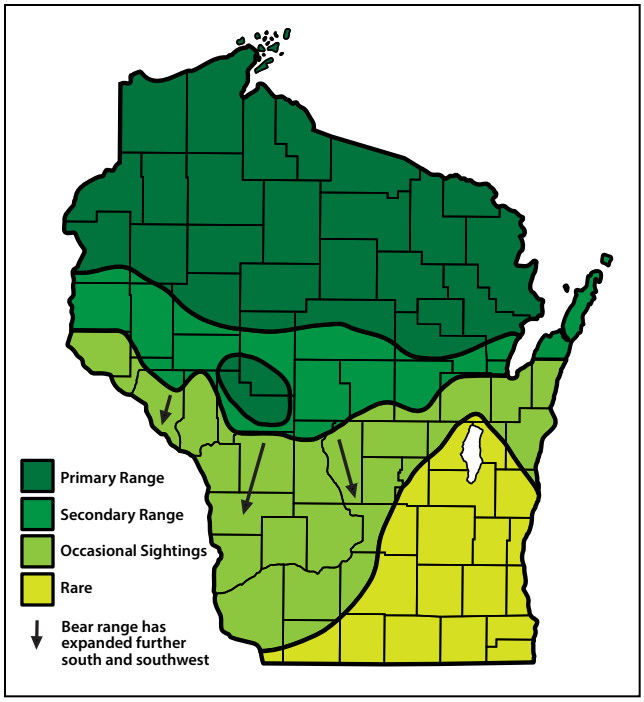

Figure 20.10. *Wisconsin American black bear range.*

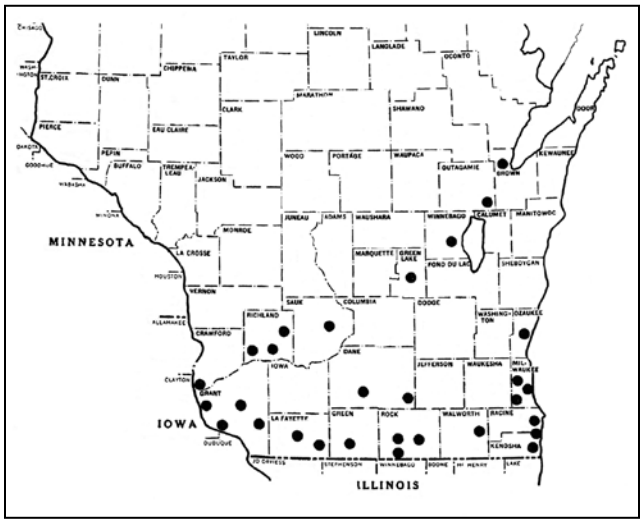

Figure 20.11. *Historical Wild Turkey range in Wisconsin. Figure printed with the written permission of the* Wilson Ornithological Society, *from Schorger (1942).*

The Greater Prairie-Chicken was found throughout southern Wisconsin before widespread Euro-American settlement, although the Sharp-tailed Grouse may have been more abundant (Schorger 1943). The Greater Prairie-Chicken was considered abundant through the 1850s in southern Wisconsin, especially in the Southwest Savanna, but then declined. At first agriculture seemed to cause the Greater Prairie-chicken population to increase, but as agriculture became more intensive

and the prairies disappeared, populations declined. The result is that the range of the Greater Prairie-Chicken was forced north as prairies were plowed for agriculture in the south and forests were cleared in central and northern Wisconsin. As forests grew back in the north, the range of the Prairie-Chicken was constricted to its present extent in the Central Sand Plains and Forest Transition ecological landscapes in central Wisconsin. By 1900 the population was at very low levels. No Greater Prairie-chickens are found in the Southwest Savanna today; the last sighting was in 1941 (Robbins 1991).

The Northern Bobwhite must have been widely distributed throughout the open areas of the state (Figure 20.12; Schorger 1944) and probably made use of shrub habitats. Populations fluctuated depending on winter severity. Northern Bobwhite were especially abundant during a period of mild winters from 1846 to 1857, reaching peak numbers in 1854. During this time "a good shot [could] readily bag 50 to 75 in a day" in Madison (Schorger 1944). The Northern Bobwhite population was much reduced by the fall of 1857 compared to former years. The Northern Bobwhite population recovered through the 1860s but never reached the levels reported in 1854. From 1870 into the 1940s, the Northern Bobwhite population remained relatively stable. Today Northern Bobwhite persists here, and the Southwest Savanna is the second most reliable place in which to find this species in Wisconsin (Cutright et al. 2006). For more detailed discussion of Northern Bobwhite management, see Chapter 22, "Western Coulees and Ridges Ecological Landscape."

The timber rattlesnake (*Crotalus horridus*) was found in the uplands, especially where there were rock outcroppings and rock crevices where they could hibernate. This snake is restricted to southwestern Wisconsin and has never been found east of Madison (Figure 20.13). The timber rattlesnake was abundant in the Southwest Savanna at the time of Euro-American settlement. Although the timber rattlesnake still occurs here, populations have been greatly reduced, and the species is now listed as Wisconsin Special Concern. It is now protected by special harvest regulations.

The eastern massasauga (*Sistrurus catenatus catenatus*) was found in marshy areas, lowland prairies, and along streams. It was found throughout southern and central Wisconsin at the time of Euro-American settlement. In the Southwest Savanna, the eastern massasauga was less abundant than the timber rattlesnake but occurred along streams in lowland prairies. It is unlikely that the eastern massasauga still occurs here. It is currently listed as a Wisconsin Endangered species.

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: rare species, Species of Greatest Conservation

Figure 20.12. *Historical Northern Bobwhite range in southern Wisconsin. Figure reproduced from Schorger (1944) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

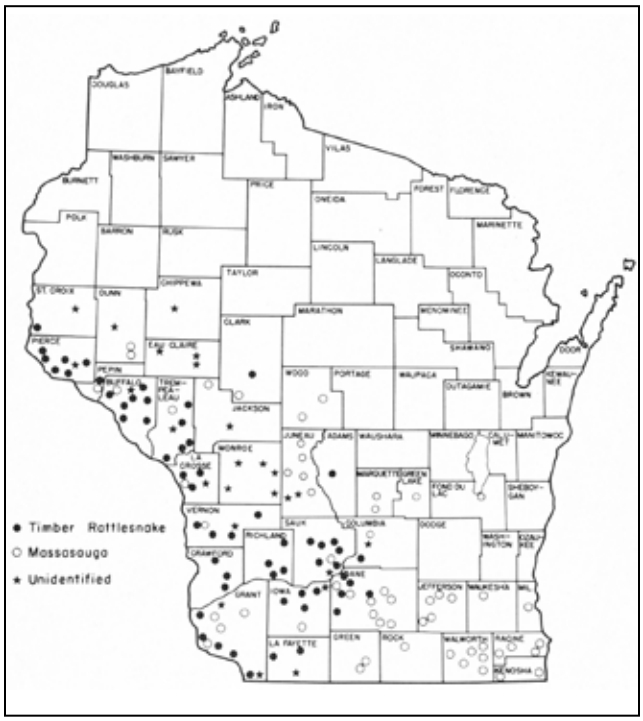

Figure 20.13. *Historical timber and massasauga rattlesnake range in Wisconsin. Figure reproduced from Schorger (1967) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

Need (SGCN), responsibility species, and socially important species (see definitions in text box). Note that the four categories are not exclusive—considerable overlap will occur for some species. As natural communities and habitats are the most efficient way to manage and benefit a majority of species, we also discuss the management of different wildlife habitats in which significant fauna occur.

Rare Species. In this document, "rare" species are those that appear on the Wisconsin Natural Heritage Working List and are classified as "endangered," "threatened," or "special concern" by the state or federal governments (see Appendix 20.C for a comprehensive list of the rare animals known to exist in the Southwest Savanna Ecological Landscape). As of November 2009 (WDNR 2009c), the Natural Heritage Inventory database contained records for 40 rare animal species from the Southwest Savanna: four mammals, nine birds, five herptiles, six fishes, and 16 invertebrates. These include no U.S. Endangered or U.S. Threatened species, six Wisconsin Endangered species, 10 Wisconsin Threatened species, and 24 Wisconsin Special Concern species. See Appendix 20.D for the number of species per major species group in the Southwest Savanna with designations of endangered, threatened, or special concern.

Federally Listed Species: One U.S. Threatened mammal, the northern long-eared bat (*Myotis septentrionalis*) occurs in the Southwest Savanna Ecological Landscape (federally listed in 2015); the U.S. Endangered Indiana bat (*Myotis sodalis*) was found hibernating in an abandoned mine just a few miles west of the Southwest Savanna in the Western Coulees and Ridges Ecological Landscape.

Wisconsin Endangered Species: No Wisconsin Endangered mammals occur in this ecological landscape. One Wisconsin Endangered bird, Loggerhead Shrike, and one Wisconsin Endangered herptile, northern cricket frog (*Acris crepitans*), have been documented here. Two Wisconsin Endangered fish, gravel chub (*Erimystax x-punctatus*) and slender madtom (*Noturus exilis*) are documented in the Wisconsin Natural Heritage Working List for this ecological landscape, but the slender madtom no longer occurs here. Wisconsin Endangered invertebrates are limited to two species: the regal fritillary butterfly (*Speyeria idalia*) and the red-tailed prairie leafhopper (*Aflexia rubranura*).

Wisconsin Threatened Species: No Wisconsin Threatened mammals occur in this ecological landscape.[1] The Wisconsin Natural Heritage Working List documents four Wisconsin Threatened birds: Henslow's Sparrow (*Ammodramus henslowii*), Acadian Flycatcher (*Empidonax virescens*), Hooded Warbler (*Setophaga citrina*, listed as *Wilsonia citrina* on the Natural Heritage Working List), and Bell's Vireo; one Wisconsin Threatened herptile, Blanding's turtle (*Emydoidea blandingii*); two Wisconsin Threatened fish, black buffalo (*Ictiobus niger*) and Ozark minnow (*Notropis nubilus*); one Wisconsin Threatened mussel, the buckhorn (*Tritogonia verrucosa*); and two other Wisconsin Threatened invertebrates, cherrystone drop (*Hendersonia occulta*), and prairie leafhopper (*Polyamia dilata*).

Wisconsin Special Concern Species: Wisconsin Special Concern animals found here include four mammals, four birds, three herptiles, two fish, and 11 invertebrates (WDNR 2009c; see Appendix 20.C for the list of Wisconsin Special Concern species being tracked).

Categories of Significant Wildlife

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

[1] When this material was written, it was based on the 2009 Wisconsin Natural Heritage Working List (WDNR 2009c). On 6/1/2011, four bats were added to the Wisconsin Threatened Species list: northern long-eared bat (*Myotis septentrionalis*) and eastern pipistrelle (*Perimyotis subflavus*), both of which occur in this ecological landscape, and big brown bat (*Eptesicus fuscus*) and little brown bat (*Myotis lucifugus*). This was an emergency listing due to the rapid spread of the often fatal disease known as white-nose syndrome. The four Wisconsin "cave" bats are especially vulnerable because they hibernate over the winter in caves and mines where they can become infected with the fungus that causes white-nose. Some hibernacula have experienced mortality rates greater than 98%.

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 state or federal lists but also include more common species that are declining. There are five mammals, 26 birds, eight herptiles, and two fish species listed as SGCN for the Southwest Savanna (see Appendix 20.E for a complete list of the Species of Greatest Conservation Need in this ecological landscape and the habitats with which they are associated).

Responsibility Species. The Southwest Savanna is especially important because it can provide viable habitat for many grassland animals. It is the best area in the state for Dickcissel (*Spiza americana*), Bell's Vireo, and Western Meadowlark (*Sturnella neglecta*); one of the two best areas for Grasshopper Sparrow (*Ammodramus savannarum*) and Henslow's Sparrow; and one of the three best areas in the state for Upland Sandpiper (*Bartramia longicauda*). This ecological landscape is likely one of the most productive areas in the state for the American badger (*Taxidea taxus*). The prairie vole (*Microtus ochrogaster*) is becoming increasingly uncommon here, and this may be the best place in Wisconsin to manage for it. The Southwest Savanna supports one of the largest and most viable populations of the regal fritillary butterfly east of the Mississippi River.

This ecological landscape offers very good opportunities to provide for Red-headed Woodpecker (*Melanerpes erythrocephalus*), Eastern Bluebird (*Sialia sialis*), Orchard Oriole (*Icterus spurius*), Eastern Whip-poor-will (*Antrostomus vociferus*), gophersnake (*Pituophis catenifer*), and western foxsnake (*Elaphe vulpina*) by restoring and expanding oak savanna habitat. There are warmwater streams containing rare fish, such as the Ozark minnow and gravel chub, that are found primarily in this ecological landscape. In addition, some streams support species of aquatic insects such as stonefly (*Plecoptera* spp.), which indicates good water quality. The Wisconsin Endangered northern cricket frog inhabits cleaner ponds, sloughs, backwaters, and some impounded stretches of rivers in the Southwest Savanna, especially the lower Pecatonica and Platte River systems. This ecological landscape appears to be a stronghold for this frog, which formerly occurred across the southern half of Wisconsin.

Socially Important Fauna. Species such as white-tailed deer, Wild Turkey, the introduced Ring-necked Pheasant (*Phasianus colchicus*), and grassland birds are all important for hunting and wildlife viewing. The Southwest Savanna has an important warmwater fishery that includes some of the state's best smallmouth bass populations. Catfish and northern pike are also found in these streams. Coldwater streams may contain populations of introduced brown trout, although some of these streams also support native brook trout. There are over 70 miles of trout streams in the Southwest Savanna. The premier brook trout (*Salvelinus fontinalis*) stream in the ecological landscape is Steiner Branch. Noteworthy nonnative brown trout (*Salmo trutta*) streams here are Borah Creek (Grant County), Mt. Vernon Creek (Dane County), West Branch Sugar River (Dane County), German Valley Creek (Dane County), and Gordon Creek (Dane and Iowa counties). Other trout streams in the basin include the upper reaches of the Platte River, Austin Branch, Crow Branch, Leggett Creek, the Little Grant River, and a reach of the Little Platte River (WDNR 1980).

Wildlife Habitat and Communities. The Southwest Savanna contains important wildlife species associated with native and

*This northern cricket frog (Wisconsin Endangered) is calling from shallow water covered by lesser duckweed (*Lemna minor*). Each duckweed "frond" is about 2 mm long, which gives a sense of scale for this diminutive amphibian. Photo by Rori Paloski, Wisconsin DNR.*

Significant Wildlife in the Southwest Savanna Ecological Landscape

- Grassland fauna supports many rare birds and insects as well as uncommon mammals.
- Oak savanna associates include Red-headed Woodpecker, Eastern Bluebird, Orchard Oriole, Whip-poor-will, eastern pipistrelle bat, gophersnake, and western fox snake.
- Upland shrub habitats support Loggerhead Shrike, Bell's Vireo, Brown Thrasher, Eastern Towhee, and Field Sparrow.
- Warmwater stream fish (e.g., smallmouth bass) and rare aquatic insects.
- Wisconsin Endangered northern cricket frog occurs in sloughs and other aquatic habitats, backwaters, and some impoundments.

surrogate grasslands, oak savannas, warmwater streams and their associated riparian corridors, and coldwater streams. One Important Bird Area has been designated within the Southwest Savanna (Steele 2007; see the map of "Ecologically Significant Places of the Southwest Savanna Ecological Landscape" in Appendix 20.K).

The Southwest Savanna is considered to have some of the best management potential for upland grassland bird species in Wisconsin (Sample and Mossman 1997). Many of the ridge tops and valleys are pastured, have crops of alfalfa and small grains, or are in the Conservation Reserve Program (CRP) or the Conservation Reserve Enhancement Program (CREP). Pasture land, CRP, and CREP lands function as surrogate grasslands for many native bird species. About 10% of the ecological landscape is classified as grassland (WDNR 1993). However, in some areas here this figure approaches or exceeds 15 to 20%. The growing acceptance of rotational grazing by local farmers has the benefit of providing additional or improved surrogate grassland habitat especially when it is done with ungrazed paddocks and other "bird-friendly" practices (Temple et al. 1999). This ecological landscape is important for grassland birds such as Upland Sandpiper, Short-eared Owl (*Asio flammeus*), Western Meadowlark, Grasshopper Sparrow, and Henslow's Sparrow. Brushy areas provide habitat for Bell's Vireo, Brown Thrasher, Eastern Towhee (*Pipilo erythrophthalmus*), and Field Sparrow. Uncommon mammals such as American badger and prairie vole occur in the grasslands here. Rare Lepidoptera (e.g., regal fritillary butterfly) and rare leafhoppers (e.g., red-tailed prairie leafhopper) occur in remnant prairies on hillsides and ridge tops.

This ecological landscape has excellent potential for oak savanna restoration, which provides habitat for species such as Red-headed Woodpecker, Eastern Bluebird, Orchard Oriole, Eastern Whip-poor-will, the eastern pipistrelle (*Perimyotis subflavus*) and other bats, and the western foxsnake.

Although specific data on distribution and population size of bats here are lacking, the Southwest Savanna Ecological Landscape has habitat that is potentially of high importance for bats (D. Redell, Wisconsin DNR, personal communication). During the summer, important habitat for both tree and cave bats include forests and forest edges within a mile of a waterbody. Wisconsin's largest known population of hibernating eastern pipistrelle bats occurs just to the west of the Southwest Savanna in the Western Coulees and Ridges Ecological Landscape. Eastern pipistrelles do not travel long distances between summer and winter use areas. Summer use of Wisconsin habitat by bats has not been well studied. Based on observations from other states, forests and oak savannas would be expected to have maternity and summer roosts for eastern pipistrelle bats, eastern red bats (*Lasiurus borealis*), and hoary bats (*Lasiurus cinereus*) (pregnant and lactating females have been found in such habitats elsewhere). Additionally, the structure formed by the edges between forests, grasslands, and streams are important for commuting and foraging by resident summer bats. The abandoned mines in this ecological landscape provide hibernacula for bats.

Because of the statewide loss of prairie, the Wisconsin Threatened Henslow's Sparrow is one of many native grassland birds now largely dependent on surrogate grasslands to provide adequate breeding habitat. Photo © Laurie Smaglick Johnson.

Extensive grassland-oak savanna complex in the Southwest Savanna. Such opportunities are limited and dwindling quickly. Photo by Cathy Bleser, Wisconsin DNR.

There are coldwater streams in the Sugar-Pecatonica basin that support populations of native brook trout. These include Big Spring, Syftestad, Whitford, Steiner Branch, and Williams Rewey creeks. Across southeastern Iowa County and eastern Lafayette County, a number of designated trout waters flow

Eastern pipistrelle, one of four species of Wisconsin bats that overwinter in caves and mines, infected with the fungus that causes white-nose syndrome. White-nose syndrome was first detected in Wisconsin in 2014 in Grant County, and either the disease or the fungus that causes it has been found in eight counties as of this writing. Photo by Heather Kaarakka, Wisconsin DNR.

The bat houses at Yellowstone State Park have been found to support up to 4,000 individuals. Photo by Heather Kaarakka, Wisconsin DNR.

through watersheds that also feature strong concentrations of springs (see the "Socially Important Fauna" section above for discussion of trout streams).

Some streams here flow through calcareous bedrock formations (dolomites) that provide high levels of calcium ions to the water. This is beneficial to many aquatic invertebrates, as are the numerous ledge and pool habitats created by erosion and/or solution of the rock. Rountree Branch in the Little Platte River watershed stands out for the rare odanates it supports, including the Wisconsin Special Concern eastern red damselfly (*Amphiagrion saucium*) and highland dancer damselfly. The highland dancer also occurs in the West Fork of the Pecatonica River and in Bull Branch. The larvae of the highland dancer are mobile enough to be able to withstand episodes of heavy sedimentation during high runoff events.

Streams in the Southwest Savanna that contained the Wisconsin Threatened Ozark minnow include the Apple River, Blockhouse Creek, Leggett Creek, and Willow Creek (Amrhein and Ray 2005). They have also been reported in other tributaries of the Galena River, Platte River, and Little Platte River watersheds. Ozark minnows inhabit clear, small-to-medium size streams of low gradient, with gravel to rubble bottoms. They are intolerant of excessive turbidity and siltation.

The Wisconsin Endangered slender madtom had inhabited four streams in the Middle Pecatonica watershed (Fago 1982). However, more intensive agricultural practices led to increased soil erosion and sedimentation and eliminated this species from the Southwest Savanna (Lyons 1996). The mainstem of the Pecatonica River contains small populations of the Wisconsin Endangered gravel chub, the Wisconsin Threatened black buffalo, and the Wisconsin Special Concern silver chub (*Macrhybopsis storeriana*). Some of the tributaries to the Sugar River and the East Branch of the Pecatonica River have historical records of the Wisconsin Special Concern redside dace (*Clinostomus elongatus*). However, increases in brown trout over the last 30 years in many of these streams has been associated with the decline and disappearance of the redside dace. No recent comprehensive surveys have been done, but trends from site-specific studies suggest that few, if any, redside dace populations remain in the Southwest Savanna.

In the 1960s, this region had what was considered one of the best smallmouth bass fisheries in the Midwest (WDNR 2001). Some of the traditionally important smallmouth streams included the Galena, Little Platte, and Sinsinawa rivers. Populations of smallmouth bass and associated species less tolerant of pollution can fluctuate greatly, depending upon changes in land use and water quality. During the 1970s and 1980s, smallmouth bass populations in most streams here declined. These declines were linked to manure runoff, manure spills from feedlots and manure lagoons, and other areas where concentrated wastes can lead to fish kills following major storm and runoff events. Such events carry sediments and nutrients into streams, resulting in significant declines in dissolved oxygen and fish kills (Graczyk 1993, Wang et al. 1996).

Today the smallmouth bass fishery has made a comeback in the streams of the Southwest Savanna Ecological Landscape (WDNR 2015f). Recent monitoring and anecdotal information show that smallmouth bass populations are increasing, and the smallmouth bass fishery of southwestern Wisconsin is now considered among the best in Wisconsin (Lyons et al. 2000). The improvement was attributed to a combination of factors, including fewer spills of manure into streams, more aggressive environmental enforcement, drier weather and less stormwater runoff, better soil conservation and manure management, and, at that time, a reduction in the acreage of row crops. Rotational grazing, riparian buffers, minimum tillage, and enrollment of former cropland into CRP at that time had helped to improve water quality and the fishery. Despite these improvements, there is still a threat to smallmouth bass populations from spills of manure and other pollutants into streams if good conservation practices, such as nutrient and pesticide management and the installation of other ***best management practices***, are not continued (Lyons 2006). By 2008 there was concern that high agricultural commodity prices, influenced at least in part by increased production of corn ethanol, is causing a substantial conversion of non-cropland (grassland) back into more intensive row crop production, with attendant threats to water quality. Between 2006 and 2013, CRP acres declined by more than 40% in Grant, Iowa, Lafayette, and Green counties (D. Sample, Wisconsin DNR personal communication).

Natural and Human Disturbances

Fire, Wind, and Flooding

Fire was the dominant natural disturbance in the uplands of the Southwest Savanna as evidenced by the abundance of fire dependent vegetation found throughout the Southwest Savanna early in the Euro-American settlement period. Prior to Euro-American settlement, the dominant plant communities of the broad ridge tops and gentler slopes were primarily tallgrass prairie and oak savanna. Areas of brush were also present, as were areas of oak grubs where fire had repeatedly top-killed or stunted oak growth. Deciduous forests were more limited in distribution and were often associated with steeper slopes and riparian corridors. The dominance of prairies and oak savannas across the ecological landscape indicates that fires were formerly very frequent. Many fires were set by American Indians (Pyne 1982) to aid hunting, provide habitat for the game animals they depended on and plants they used, and increase the visibility of enemies. Frequent fires prevented the expansion of dense forests and maintained much of the Southwest Savanna in treeless open prairie and oak savanna.

Variable topography and the orientation of major rivers were among the factors that prevented fires from affecting all of the ecological landscape or from affecting vast areas during any one fire event. Mosaics of prairie, savanna, and woodland would have occurred, but some of the individual patches would have been very large. Steeper, cooler, moister slopes (especially those with northern or eastern aspects) did not burn with the frequency or severity of sites in other situations; woody vegetation (woodlands and forests) would have been favored over prairie here.

Prescribed burning has been used successfully to restore and maintain prairie and oak savanna (Nielsen et al. 2003). True prairies probably burned at intervals of less than five years, sometimes annually or semi-annually (Dickmann and Cleland 2002). Oak savannas and oak woodlands probably burned at intervals of one to 15 years. Some of these fires would have been frequent but of relatively low intensity. If the fire interval was longer than 15 years, the communities tended to succeed toward more closed forest conditions.

Windthrow disturbance must have occurred in the historical forests of the Southwest Savanna; however, data on the frequency and severity of such events are lacking. Canham and Loucks (1984) reported that windthrow was not a significant disturbance factor in southern Wisconsin compared with other, more heavily forested areas of Wisconsin. ***Downburst*** thunderstorms and tornadoes occurred here (and still do), and while the effects could be severe, they were, for the most part, localized.

The extent and frequency of flood disturbance prior to Euro-American settlement is undocumented. Stream gradients range from very low along some of the larger rivers to high in the headwaters and upper reaches of small streams. Driftless Area topography, steep slopes, and the presence of bedrock near the surface contribute to the flashy nature of some Southwest Savanna streams. Stream "flashiness" means that water levels increase rapidly after major rainfall or snowmelt events, then decrease rapidly to more normal flow levels (WDNR 2001). Stream flashiness has been exacerbated by intensive agricultural development, which sometimes occurs on slopes and in floodplains. The presence of floodplain forests and other types of wetland vegetation along some of the larger rivers indicates that annual inundation has occurred for a very long time. Many of these lowland corridors still flood every spring, but the amount and duration of inundation has been altered by dams, the elimination of wetlands, agricultural development, and other land uses. Serious floods, causing crop and property damage, still occur periodically on rivers such as the Pecatonica.

Forest Insects and Diseases

Forests in the Southwest Savanna are dominated by oaks, with some central hardwoods, mesic maple-basswood forest, and floodplain forest composed of species such as silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), and river birch (*Betula nigra*). Each of these forest types is associated with particular insects and diseases. There are a number of pest species that periodically affect forests in this ecological landscape.

Gypsy moth (*Lymantria dispar*) is a nonnative insect becoming established in the Southwest Savanna that may periodically affect oak forests. Dry conditions can facilitate gypsy moth population growth, leading to relatively faster

rates of spread and more frequent outbreaks after establishment. The two-lined chestnut borer (*Agrilus bilineatus*) is a bark-boring insect that attacks oaks. Oak wilt is a vascular disease caused by the native fungus *Ceratocystis fagacearum*.

Dutch elm disease is caused by the fungus *Ophiostoma ulmi*, which is transmitted by two species of bark beetles or by root grafting. All of our native elm species are susceptible. Elms have essentially been eliminated as a component of the forest overstory but are still a significant part of the understory and seedling layers in some stands. The life span of an elm is typically now about 30 years before it succumbs to Dutch elm disease. Dutch elm disease has altered several important forest types in this ecological landscape (e.g., Floodplain Forest and Southern Mesic Forest). Elms have almost disappeared from many, if not most, areas in cities, where it was formerly widely planted as a shade tree.

The emerald ash borer (*Agrilus planipennis*), an exotic insect native to Asia, could have an impact on forest structure here, especially in the floodplain forests (though these are discontinuous and of limited extent and size in the Southwest Savanna). Forested floodplains in which green ash is common and can be a canopy codominant, could be dramatically altered if the ashes are killed and not replaced by other trees. Floodplain Forests provide important breeding habitat for a number of rare species and maintain connectivity between forested sites within and between ecological landscapes (especially to the north and west in the Western Coulees and Ridges Ecological Landscape).

This extremely serious forest pest was first discovered in the state near the Milwaukee River in Ozaukee and Washington counties in southeastern Wisconsin in 2008 and has been confirmed in 35 Wisconsin counties as of 2015 (WDATCP 2015), including Grant, Green, and Lafayette counties in the Southwest Savanna. 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. In greenhouse tests, the emerald ash borer has also 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. See the Wisconsin Emerald Ash Borer website (WDATCP 2015) for up-to-date information on its current distribution.

More information about these diseases and insect pests of forest trees can be found at the Wisconsin DNR's Forest Health Protection web page (WDNR 2015b) and at the U.S. Forest Service Northeastern Area Forest Health Protection web page (USFS 2015).

Invasive Species

In grassland communities, problem species include crown vetch (*Coronilla varia*), cut-leaved teasel (*Dipsacus laciniatus*), spotted knapweed (*Centaurea biebersteinii*), leafy spurge, bird's-foot trefoil (*Lotus corniculata*), white and yellow sweet clovers (*Melilotus alba* and *M. officinalis*), Japanese hedge-parsley (*Torilis japonica*), wild parsnip (*Pastinaca sativa*), autumn olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*). Nonnative grasses such as smooth brome, Kentucky bluegrass, and Canada bluegrass can be common in native prairies but in other circumstances (e.g., CRP or lightly grazed pastures) may provide valuable habitat as "surrogate grasslands" for grassland birds and other animals of conservation concern.

In forested communities, glossy and common buckthorn (*Rhamnus frangula* and *R. cathartica*), nonnative honeysuckles (such as *Lonicera tatarica, L. morrowii,* and the hybrid *Lonicera* x *bella*), garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Dame's rocket (*Hesperis matronalis*), Norway maple (*Acer platanoides*), 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.

The vast majority of remnant oak savannas are, or have been, grazed. Such stands may retain their historical structure but either lose most of their characteristic understory species or have them severely reduced. Almost any of the terrestrial invasives mentioned elsewhere in this section can occur in the savannas. Research and experimentation are needed to develop effective methods of recovering missing or suppressed elements of the native savanna flora.

Several native plant species in this area have become (or are perceived to have become) aggressive due to the alteration of disturbance regimes (e.g., suppression of fires, hydrological modifications such as attempted drainage or dam construction, and grazing). These include common prickly-ash (*Zanthoxylum americanum*), red-osier dogwood (*Cornus stolonifera*), box elder (*Acer negundo*), smooth and staghorn sumacs (*Rhus glabra, R. hirta*), poison ivy (*Toxicodendron radicans*), river grapevine (*Vitis riparia*), Virginia creeper (*Parthenocissus quinquefolia*), and wild cucumber (*Echinocystis lobata*). In some cases, these plants may outcompete other native plants and result in ecosystem simplification (Rogers et al. 2008). We emphasize that the primary cause of this has been the disruption of natural disturbance regimes and landscape patterns that formerly maintained the full suite of species associated with any given community or community group.

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

For more information about invasive species in Wisconsin, see the Wisconsin DNR's invasive species web page (WDNR 2015d).

Land Use Impacts

Historical Impacts. There have been dramatic changes in the land use and land cover in the Southwest Savanna. Settlers plowed the prairies to create cropland, cut trees on the slopes to build homes and barns, and then grazed the slopes with livestock. The vegetation rapidly shifted from dominance by extensive prairies and oak savannas at the time of Euro-American settlement to a patchwork of agricultural fields and scrubby, second-growth forests. Statewide, less than 0.1% of Wisconsin's historical acreage of prairie and oak opening remains today.

Runoff has increased here over the last 180 years due to the conversion of prairie, savanna, and wetland cover to agricultural land. Seventy percent of the ecological landscape was classified as "agricultural" in 1992 (WDNR 1993). This has significantly altered structure and condition of prairie streams. A study done in the Platte River and Little Platte River watersheds demonstrated that runoff had almost tripled as a result of the conversion of prairie, savanna, and forest to agricultural land (Knox 1977). The increase in runoff and flood frequency also increased sediment load, resulting in the deposition of as much as 12 feet of sediment in the floodplain of the lower Platte River. The lower Platte River is in the Western Coulees and Ridges Ecological Landscape, but the land use histories have been very similar. Much of this sediment ends up in the in the Mississippi River.

One positive trend was reported in a 1996 report summarizing streamflow characteristics in southwestern Wisconsin's Driftless Area. The study showed that since the 1950s annual low flows, or base flows, of streams have increased, while annual flood peaks have decreased (Gebert and Krug 1996). These data show that streams in southwestern Wisconsin are moving closer to flow conditions that existed at the beginning of Euro-American settlement in the basin. Other research concludes that changes in agricultural practices, such as eliminating or stabilizing gullies through the use of vegetated waterways, vegetation buffers, terracing, and conservation tillage that improve infiltration, account for the improved hydrologic regime (Potter 1991). In addition, positive impacts on stream quality have occurred where uplands in grass (CRP) exceed 20% cover (Marshall et al. 2008). However, with the high price of corn and other farm crops, many agricultural lands are being converted from grass or hay to row crops. Depending upon the agricultural practices landowners choose to employ, this could significantly impact water quality over the next decade.

Current Impacts. Current disturbances in the Southwest Savanna are largely due to human activities such as agriculture, residential expansion, the spread of invasive species, and cessation of fire**.** Human disturbance also includes the long-term conversion of land to houses, roads, agriculture, impoundments, wind power facilities, and utility corridors. Shorter-term disturbances result from logging and recreational pursuits such as ATV use.

Unfragmented grassland landscape slated for development. Photo by Cathy Bleser, Wisconsin DNR.

In addition to direct impacts, human land use changes also indirectly impact ecosystem structure and function by altering natural disturbance regimes. Reduction in the use of fire as a tool to maintain pastures and fire prevention activities have reduced fire frequency and intensity, leading to changes in species composition and landscape patch structure. The absence of periodic fire has allowed habitats such as prairie and oak savanna to succeed to brush or forest.

It is probable that flood disturbance has increased because of the more rapid runoff from crop lands that were historically prairie, savanna, or some other permanent vegetative cover. The characteristics of runoff now are very different from what was carried by historical floods prior to Euro-American settlement because of the greatly increased loads of sediment, nutrients, and other pollutants. The construction of dams on major rivers has disrupted the natural flood regimes of river and stream systems, which will almost certainly lead to changes in plant species composition and structure.

Changes in Hydrology. In the 19th century, many mill pond dams were built on small streams to produce power. Most of these have since been eliminated or are now used for other purposes. Many of the smaller tributaries are fragmented by improperly placed culverts, particularly on town roads, which have collectively resulted in the fragmentation of many miles of stream.

As discussed above, cropping and pasturing on steep slopes has resulted in increased flooding and flood severity of many of the streams here. The characteristics of these streams changed after their beds and floodplains were buried in silt and topsoil washed from adjoining ridge tops and hillsides. Some wetlands in valleys were drained for cropland or grazed, radically changing their vegetative characteristics and water-absorbing capacity.

Agriculture. Agriculture has created a patchwork of farm fields on the ridge tops and in the more level valleys of this ecological landscape. Forests tend to be confined to the steeper slopes or, sometimes, floodplains of the larger rivers. This

Treeless landscape, almost entirely dominated by intensive row crop agriculture. Southern Lafayette County, near the Illinois border. Photo by Cathy Bleser, Wisconsin DNR.

results in a fragmented landscape composed mostly of agricultural fields, with scattered surrogate grasslands and woodlots. This is good for some species like white-tailed deer and Wild Turkey, but it does not provide much habitat for the rarer area-sensitive grassland or forest species or for many of the organisms with more specialized habitat needs. WISCLAND land use/land cover data from 1992 indicate that farming occurred on 70% of land in this ecological landscape at that time (this does not include pastureland, which made up much of the 10% classified as "grassland"; WDNR 1993).

Streams in the basins of the Southwest Savanna are subject to runoff-related nonpoint source pollution from stream bank erosion, soils eroding from cultivated fields, barnyard runoff, and overgrazing. These types of pollution increase the amount of sediment and nutrients in streams, affecting in-stream habitat, water temperature, and fish spawning and has other adverse effects on the biological uses of stream ecosystems (WDNR 2001).

Significant amounts of sediment are still being delivered by the Grant and Platte rivers (mentioned here because some of the headwaters streams of both of these rivers are in the Southwest Savanna) to the Mississippi, where the sediments create and contribute to habitat problems in Pool 11. In addition to this, a federal study points toward excessive sediment and nutrient delivery as factors primarily responsible for the hypoxia (oxygen depletion) problem in the Gulf of Mexico (CENR 2000). Nutrients, particularly nitrogen, that are attached to stream-born sediments from farm fields in the greater Mississippi River basin result in excessive nutrient loading in the Gulf of Mexico at the mouth of the Mississippi River. The excessive nutrients promote accelerated growth of phytoplankton and zooplankton. Decomposition of dead phytoplankton and other organic material use available oxygen faster than it can be replenished. This results in the severe dissolved oxygen depletion problem in the upper Gulf of Mexico affecting marine life there.

Runoff carrying animal wastes from barnyards is the primary cause of the occasional fish kills that occur in some streams within the basins of the Southwest Savanna (Wang 1994). Nonpoint pollution has affected recreational uses of streams here, particularly sport fishing opportunities. The Wisconsin DNR conducted macroinvertebrate monitoring at 22 sites on 13 streams from 1992 to 1996 and has monitored additional sites since then. The data indicate that all of the surveyed streams suffered from some stream perturbations due to excess sediment or nutrient loadings (Marshall 1999). Many agricultural operations use conservation practices these days to prevent or limit soil erosion and loss, but there are still problem areas.

Groundwater contamination via agricultural use can be an issue in the Southwest Savanna because the fractured bedrock of karst formations is often close to the surface, and agricultural chemicals can quickly leach into the groundwater.

Since 1985, the Conservation Reserve Program (CRP) has enrolled thousands of acres in this ecological landscape, taking highly erodible land out of crop production and putting it into more permanent grass cover for a period of ten years via a CRP contract with the federal government. This has increased the cover of grass, benefitting grassland birds and other native species while protecting soil resources and water quality. The number of CRP acres reached a peak in 1993–94 with 710,000 acres enrolled statewide. Since then CRP acres have declined to 460,654 acres in 2009 (S. Hull, Wisconsin DNR, personal communication). Depending on corn and soybean prices, the number of CRP acres could continue to decline and be returned to row crop production.

Recently, new farm startups have been going to grass-based agriculture for financial reasons (D. Undersander, University of Wisconsin, personal communication). Short-term rotational grazing is becoming more popular and prevalent in the Southwest Savanna. This could have an added benefit for grassland birds by providing surrogate grassland pasture for nesting if grazing is timed appropriately to prevent cows from trampling nests of grassland birds or if cattle stocking rates are low enough to allow for necessary amounts of residual cover (Temple et al. 1999). It may also have a benefit by preventing soil loss and improvement of water quality in streams.

In recent years, more farms here are being bought by "hobby farmers" who do not make their entire living from the land. This trend has resulted in more conservation practices being implemented and more land being allowed to return to a semi-natural state. In addition, many hobby farmers are interested in preserving and restoring prairie, oak savanna, and other natural communities. This could have a positive effect on wildlife and fish populations as well as on native plants.

Mining. Many areas in the Southwest Savanna were mined for lead and zinc. These mining operations often left waste piles on the landscape as well as abandoned mine holes and airshafts that have led to water quality problems on streams and groundwater. Two mine waste or "roaster" pile sites near Platteville and New Diggings have been properly treated since 1991 to prevent ground water contamination (WDNR 2001).

Although these remediations have helped improve the quality of some water resources, there are still numerous mining-related features on the landscape. Improperly abandoned mines and mine airshafts and mine waste piles have the potential to negatively impact water quality through the formation of acidic, toxic metal-laden runoff and pose a threat to public health and safety problems. Problem sites need to be identified and their impacts on resources evaluated.

Forest Management. One potential land use change in this ecological landscape is the decline of the oak resource, especially on dry-mesic and mesic sites. Oaks are very important, not only as commercial timber but as the dominant genus of trees for a whole community of plants and animals associated with, and to some degree dependent on, the oaks. Currently we are living on the legacy of past fires that produced and maintained the existing oak-dominated vegetation in this area. With the cessation of fire, the logging of oaks may accelerate the conversion of the stand to another forest type, especially on the richer sites, and even more so when ***high-grading*** is used to preferentially remove the trees (usually the large oaks) with the greatest commercial value. The practice of high grading, for example, when logging oak forests for their largest and most valuable trees, often results in stand conversion to a less desirable (ecologically and economically) species composition. The introduction and spread of invasive species (Eurasian honeysuckles, buckthorns, Japanese barberry, and garlic mustard) is another contributing factor to low levels of oak regeneration. Regeneration of oak in this ecological landscape needs more research to learn techniques that restore not only the oak trees but also maintain the entire oak community. Prescribed fire may be a useful tool to maintain oak and other fire adapted species, but the logistics can be problematic. It should also be noted that in the altered forests from which oaks have been lost or significantly reduced, prescribed fire can be much more difficult to introduce as an effective forest management tool owing in part to the reduced flammability of the litter layer (Abrams 2005).

Another forest management issue is the grazing of woodlots by cattle, hogs, and sheep (WDNR 2001). Woodlot grazing reduces the supply of acorns and kills oak seedlings and saplings. Woodlot grazing may also result in significant soil erosion, understory damage, the spread and increase in abundance of weeds, and increased runoff as the animals compact the soil, limiting infiltration. Increased landowner participation in "whole farm management plans" (which emphasize natural resource stewardship as an integral part of good farming business practices) and financial incentives offered by federal and state programs can reduce, and in some areas has reduced, the problems created by woodlot grazing. However, the problem has been exacerbated by legislation affecting how agricultural land is assessed for property tax purposes. Woodlots that are not pastured are assessed at a higher rate than are pastured woodlots. This tax incentive to pasture livestock within forests will have an adverse effect on the ecological health of woodlots in southwestern Wisconsin and elsewhere (WDNR 2001).

The Southwest Savanna has the best management opportunities in Wisconsin for large-scale grasslands. Large acreages of CRP exist here, and these benefit many grassland species. In addition, CRP has benefited water quality, stream flow, and fish populations here (Marshall et al. 2008). Planting trees through the CRP program in agricultural areas where grassland restoration is the primary management objective is counter-productive and results in a fragmented landscape in which grassland habitat patches become smaller and increasingly isolated, with reduced suitability for area-sensitive species, for poor dispersers, and other grassland species.

Residential Development. Dispersed residential development is occurring and increasing throughout the Southwest Savanna Ecological Landscape but especially near larger cities (e.g., Madison, New Glarus, Dodgeville areas). Dispersed development results in permanent change and can alter areas. Impacts include habitat fragmentation, isolation, and loss of connectivity between habitats. In some areas, destruction of rare prairie and forest habitats may occur.

Wind Energy Development. An industrial wind facility has been built in the Southwest Savanna because of the magnitude of available wind resources on the open ridge tops. While this is attractive as a source of electricity that does not directly consume fossil fuels or produce greenhouse gasses, bat and bird fatalities have been observed in Wisconsin and elsewhere in the U.S at commercial wind facilities. Bat mortality is often greater than bird mortality at wind facilities (D. Redell, Wisconsin DNR, personal communication). Migratory bat species are generally at greatest risk.

Management Opportunities for Important Ecological Features of the Southwest Savanna

Natural communities, waterbodies, and other significant habitats for native plants and animals have been grouped together as "ecological features" and identified as important 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 but that may not necessarily occur within an individual stand of any one community type;
- 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 those using multiple habitats;
- add habitat diversity that would otherwise not be present or maintained;
- provide economies of scale for land and water managers.

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

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

Significant ecological management opportunities that have been identified for the Southwest Savanna Ecological Landscape include

- large-scale grassland management;
- native prairie remnants;
- oak savanna restoration;
- continuum of fire-adapted vegetation: prairie-savanna-woodland-oak forest and scattered populations of sensitive grassland and savanna species;
- forests (hardwood forests and conifer relicts;)
- warmwater rivers and streams;
- coldwater streams embedded within grasslands; and
- caves and abandoned mines.

Outstanding Ecological Opportunities in the Southwest Savanna Ecological Landscape

- Large-scale grassland management, including pastures, CRP lands, and cropland.
- Many native prairie remnants occur here that should be protected; however, most are small and isolated. Where possible, they should be embedded within other open cover types.
- Oak savanna restoration, perhaps focusing on stands that have never been plowed.
- The entire continuum of fire-adapted vegetation, including prairie, savanna, open woodlands, oak forest.
- Populations of rare and declining grassland and savanna species.
- Forests (oak forests, mesic maple-basswood forests, conifer relicts).
- Warmwater rivers and streams, with associated wetland communities, native plants and animals.
- Spring-fed coldwater streams embedded within open landscapes.
- Caves and abandoned mines are common here and provide critical habitat for bats.

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 20.2. Examples of some locations where these important ecological places occur within the Southwest Savanna are on the "Ecologically Significant Places of the Southwest Savanna Ecological Landscape" map in Appendix 20.K at the end of this chapter.

Large-scale Grassland Management

The Southwest Savanna offers several of Wisconsin's best opportunities to manage and maintain upland grasslands, especially at the larger "landscape" scales needed by some grassland animals. Three Bird Conservation Areas (BCAs) have been proposed for this ecological landscape. Each BCA would be 10,000 acres or more in size, be located in an open landscape of working farms, and have a 2,000-acre core of permanent grass. The BCA would be composed largely of private lands in various forms of grass including programs like CRP (WDNR 2009a) (see Figure 20.14).

Native grasslands are now very rare in the Southwest Savanna Ecological Landscape, as they are throughout all of Wisconsin and most of the upper Midwest (Figure 20.15). In parts of the Southwest Savanna, good quality prairie remnants are embedded within large acreages of CRP, fallow agricultural land, pasture, and cropland. Conservation of these prairie resources is important in the Southwest Savanna

Table 20.2. *Natural communities, aquatic features, and selected habitats associated with each ecological feature within the Southwest Savanna Ecological Landscape.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Large-scale grassland management	Dry Prairie Dry-Mesic Prairie Mesic Prairie Southern Sedge Meadow Surrogate Grassland Wet Prairie Wet-Mesic Prairie
Scattered prairie remnants	Dry Prairie Dry-Mesic Prairie Mesic Prairie Wet Prairie Wet-Mesic Prairie
Oak savanna restoration	Oak Barrens Oak Opening Oak Woodland
Prairie-savanna-woodland-forest continuum	Southern Dry Forest Southern Dry-Mesic Forest Dry Prairie Dry-Mesic Prairie Mesic Prairie Oak Opening Oak Woodland Wet-mesic Prairie Surrogate Grassland
Rare grassland species	See Appendix 20.C, the Natural Heritage Inventory table of rare species and natural community occurrences for the Southwest Savanna.
Forests (hardwoods and conifer relicts)	Southern Dry Forest Southern Dry-Mesic Forest Southern Mesic Forest Pine Relict Dry Cliff Hemlock Relict Wet Cliff
Warmwater rivers and streams	Floodplain Forest Shrub-carr Southern Sedge Meadow Emergent Marsh Submergent Marsh Warmwater River Warmwater Stream
Coldwater and coolwater streams, springs, associated biota	Surrogate Grassland Coldwater Stream Coolwater Stream Springs and Spring Runs

[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.

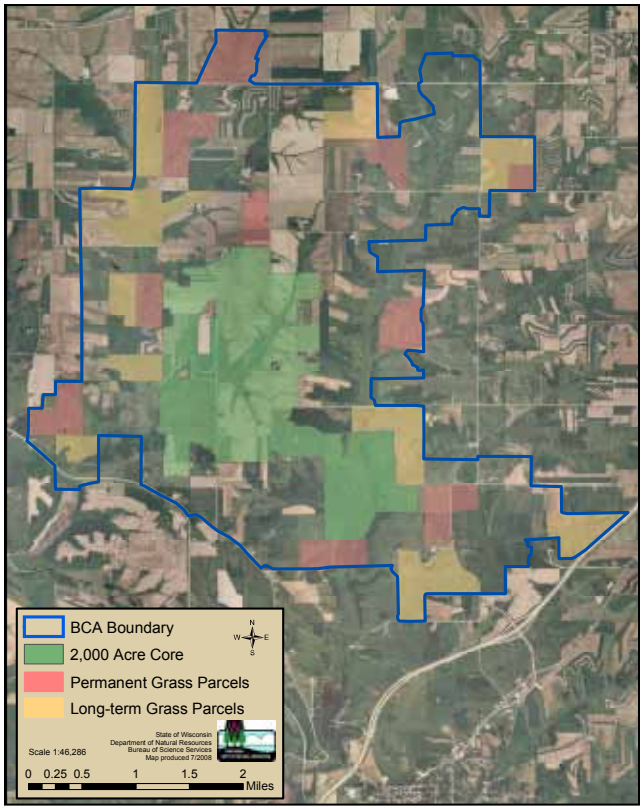

Figure 20.14. *Example of a Bird Conservation Area proposed for the Southwest Wisconsin Grassland and Stream Conservation Area (WDNR 2009a).*

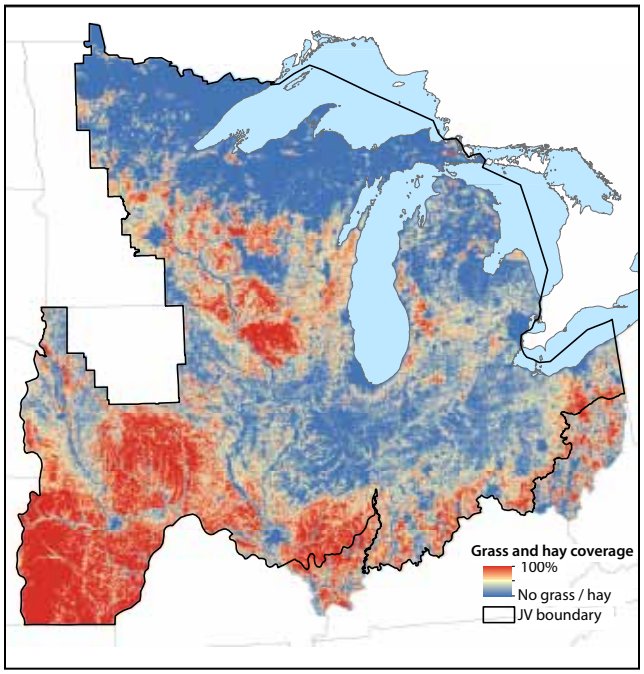

Figure 20.15. *Grass and hay coverage of the upper Midwest. Note that the Southwest Savanna Ecological Landscape stands out as the best opportunity for grassland management in the Great Lakes states. Figure printed with permission from the Upper Mississippi River and Great Lakes Joint Venture Implementation Plan (UMRGLJV 2007).*

region for many reasons, including the unique opportunities offered there compared with other ecological landscapes in Wisconsin. For example, where the terrain is rough or where soils are shallow because the bedrock is near the surface, there are some extensive areas of upland "prairie sod" that have been grazed but never plowed. Such areas may offer exceptional restoration opportunities because they have typically retained more of the native flora, fauna, and soil micro-organisms characteristic of the original native grassland ecosystem, especially at the larger scales, than sites that have been more severely disturbed (Leach and Givnish 1996). Some of these "prairie pastures" are in excess of 2,000 acres in size, affording the chance to design grassland conservation areas that will effectively conserve not only embedded high quality prairie remnants and associated flora and microorganisms but also accommodate some of the more specialized animals, such as those that are area sensitive or impacted negatively by edge effects at smaller sites. When considering such sites for conservation action, it is important to include

Extensive grasslands, some of them never plowed, in southwestern Iowa County. Photo by Eric Epstein, Wisconsin DNR.

Extensive prairie pastures in the Southwest Savanna. York Prairies, Green County. Photo by Cathy Bleser, Wisconsin DNR.

gradients associated with slope, slope aspect, soil type, and soil moisture to better ensure long-term viability and avoid the creation of more static ecosystems that will be less likely to adapt to or endure changing environmental conditions.

Among the other factors to consider when evaluating prairie conservation opportunities for which the Southwest Savanna Ecological Landscape is particularly well suited are geographic location (closer to the grassland ecosystems that were historically prevalent to the south and west of Wisconsin), climate, bedrock geology, soil type and soil depth, landform, native grassland remnants, scattered populations of sensitive grassland plants and animals, and current predominant land uses.

Many of the better remnants support rare plants, invertebrates, herptiles, birds, and other animals. The surrogate grasslands provide the scale needed by area-sensitive species, can in some cases connect now isolated patches of prairie, and may also buffer prairie and savanna remnants from less compatible land uses in the vicinity. The surrogate grasslands may also provide missing environmental gradients, which may be needed to adapt to long-term environmental changes.

The Wisconsin Natural Resources Board approved a significant project that will protect and restore grassland and stream habitats in this ecological landscape (WDNR 2009a): the Southwest Wisconsin Grassland and Stream Conservation Area (SWGSCA). The 474,000-acre project boundary encompasses high-priority grasslands, prairies, and watersheds across southern Iowa, northern Lafayette, southwest Dane, and far northwestern Green counties. In June 2009, the Wisconsin DNR was authorized to acquire in fee or easement 12,000 acres of grassland habitat over the next 15 years. The Wisconsin DNR joins with the long-standing Military Ridge Prairie Heritage Area partnership in the northeastern portions of the SWGSCA to expand upon their grassland and stream protection and management accomplishments and to create three large (≥10,000 acres) grassland Bird Conservation Areas.

Pastured grasslands. Photo by Cathy Bleser, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Follow through on the recommendations found in the many studies conducted by the Wisconsin DNR (multiple programs) and others (including many private partners) that have identified local, statewide, and regional opportunities for grassland management: e.g., Sample and Mossman (1997), the *Wisconsin Land Legacy Report* (WDNR 2006c), Krause and Henderson (1995), The Nature Conservancy's conservation plan for the Prairie-Forest Border ecoregion (TNC 2000), The Nature Conservancy's conservation plan for the Military Ridge Prairie Heritage Area (TNC 2001), the Wisconsin Wildlife Action Plan (WDNR 2005b), and the *Important Bird Areas of Wisconsin* publication (Steele 2007). Address grassland landscapes beyond the SWGSCA boundary, e.g., Grant County, additional areas in Green County.
- Identify and work cooperatively with key partners to protect large areas of upland grass and encourage land use compatibility (WDNR 2009a). Develop effective and acceptable means of managing for sensitive grassland species in a "working" landscape.
- Support the continued success of U.S. Department of Agriculture farm conservation programs that place and maintain grass on the landscape. For example, the current loss of Conservation Reserve Program (CRP) grasslands could be addressed, in part, through promoting State Acres for Wildlife Enhancement (SAFE), Conservation Reserve Enhancement Program (CREP), the Conservation Stewardship Program, Wildlife Habitat Improvement Program (WHIP), and Environmental Quality Improvement Program (EQIP).
- Monitor the response of vegetation in surrogate grasslands to altered management regimes, e.g., reintroduction of fire, brush removal, invasive species control, and modified grazing practices.
- Monitor populations of selected taxa known or thought to be in decline. Include narrow habitat specialists as well as species thought to be sensitive to landscape level environmental changes.
- Develop and provide incentives that protect grasslands and facilitate their management.
- Seek additional funding sources (e.g., private endowments) for land conservation and protection in grassland and savanna ecosystems.

Native Prairie Remnants

Native prairie remnants are scattered throughout the Southwest Savanna. Surveys were underway in 2011 to confirm and document as many of these remnant prairies areas as possible across the SWGSCA. It is likely that the majority of higher quality remnants are small, somewhat degraded, and isolated; however, a large number of unplowed pastures

across the ecological landscape may have good potential for restoration and enhancement. Some occur within transportation or utility rights-of-way or in somewhat similar situations that may make them difficult to protect and manage over the long-term. Many have served as ***refugia*** for sensitive native plants and animals, and the protection of prairies that are diverse, relatively free from invasive species, or that support populations of rare species should remain a conservation priority in this ecological landscape.

Where feasible, remnants chosen for conservation attention should be managed with other grasslands, including those within working landscapes (e.g., where there is an emphasis on row crop, small grain and hay production, and/or grazing). The best sites will allow for management flexibility that afford strong protection to the remnants while encouraging uses that are compatible with maintaining populations of species that require large areas or that tend to move around (for example, as their prey or nectar sources fluctuate locally).

Research is still needed on the impacts of various disturbance regimes (e.g., fire, mowing, grazing) on various taxa, including plants, invertebrates, birds, and small mammals. The configuration and context of individual management units and the timing and frequency of the implementation of management activities also merit additional study.

Management Opportunities, Needs, and Actions

- Compile information from public and private sources on location, size, condition, and ownership of remnants throughout the ecological landscape. In 2011, aerial and ground surveys were being conducted to identify and assess prairie and savanna remnants across the Southwest Savanna Ecological Landscape.
- Work with appropriate agency representatives and landowners to identify and promote alternatives to planting trees in significant grasslands and prairies, either through programs like ***Managed Forest Law*** or the Conservation Reserve Program.
- Work to address property tax barriers to grassland management and protection (e.g., increased property taxes when lands are no longer eligible for agricultural use-value taxation rates) or the Managed Forest Law program. Economic incentives are critical to how private land is managed.
- Prioritize prairie remnants for protection and management based on their size, context, condition, and content.
- Develop a comprehensive management and protection "toolbox" for landowners facing a confusing array of programs and suggested practices (e.g., grazing). Work with landowners using a variety of methods to achieve the degree of protection and management needed.
- Monitor results of various kinds of management on selected community attributes and taxa, especially invertebrates believed to be fire sensitive.
- Develop a list of sensitive taxa and from that select a subset for which to monitor population and/or changes under a variety of site conditions and management regimes.
- Work with local governments and planning commissions to raise awareness of remnants, avoid damaging, destroying, or building on them, and assist with identification.
- Develop a tax break program for prairie remnants, similar to Managed Forest Law, to discourage agricultural use and encourage protection.
- Collect baseline data from selected conservation projects using a combination of satellite images, air photos, and more intensive field-based data collection.

Oak Savanna Restoration

In the Southwest Savanna Ecological Landscape, there are several extensive areas of grazed but never cleared and plowed oak savanna. Characteristic structural attributes of the formerly abundant and widespread Oak Openings community persist. The floristic composition of the ground layer has been altered, but the native flora may not have been entirely destroyed (Leach and Givnish 1998). More investigation is needed to identify those sites that afford the best opportunities at which to restore and manage oak savanna communities, especially the more mesic, now globally rare, Oak Openings, which are (or were) typically dominated by large open-grown bur oak or less commonly, by white oak. Due to the topography in the Southwest Savanna and the past prevalence and behavior of wildfire, open grassland often co-occurred and intermingled with oak savanna. This presents opportunities to manage for both grassland and savanna elements in single, large-scale landscape projects. In 2011 a survey was conducted to find, assess, and map prairie and savanna remnants across large portions of the Southwest Savanna to establish conservation areas for grassland birds (Applied Ecological Services 2011).

Oak Openings are now one of the North America's most imperiled natural communities (Faber-Langendoen 2001). In southern and western Wisconsin, Oak Openings formerly covered 15–20% of the ecological landscape (Curtis 1959), making southern Wisconsin an important and logical place in which to attempt to conserve or restore the type, and the Southwest Savanna is potentially among the most important ecological landscapes anywhere in which to accomplish this.

Intact examples of Oak Openings are unknown, and experimentation is needed to identify those sites that offer the best opportunities for restoration and management. Information useful to managers and conservationists working on savanna restoration may be found in publications such as Pruka (1995), Packard and Mutel (1997), and O'Connor (2006).

Grazing by Scottish Highland cattle was investigated as a management technique to reduce shrub densities and restore overgrown Oak Openings (Harrington and Kathol 2009) at Yellowstone Lake in Lafayette County. Grazing by Scottish

Highland cattle reduced stem densities of blackberries and raspberries (*Rubus* spp.) and some other shrub species, but grazing by these cattle suppressed native forbs in savanna and native grasses in prairie. The authors of the study concluded that managed grazing can be a valuable tool as a supplement to fire in controlling shrubs in degraded savanna systems (see the "Oak Openings" section in Chapter 2, "Assessment of Current Conditions"). In 2011 and 2012, grazing by goats was investigated as a management tool to reduce shrubs and saplings in overgrown Oak Openings at Yellowstone Lake Wildlife Area. To date, results are not yet available. However, in 2014, goats were being used with apparent success to eliminate or suppress unwanted woody growth at weedy, severely overgrown prairie-savanna restoration sites in southwestern Wisconsin (E. Epstein, personal observation).

Management Opportunities, Needs, and Actions

- Identify unplowed savanna pastures across this ecological landscape. In 2011, aerial and ground surveys were conducted to identify and assess prairie and savanna remnants (final report pending).
- Determine the representation of native prairie flora in pastured savannas with a long history of grazing. Develop a search image for sites with the highest restoration potential.
- Develop management agreements with landowners who will permit or participate in research and restoration activities that are designed to promote natural communities (woodlands, savannas, and prairies) and associated native flora and fauna.
- Conduct breeding bird surveys, using standard methods, across remnant savannas of varying sizes and situated in environmental settings representative of this ecological landscape.
- The area sensitivities of savanna-associated species are poorly understood compared to species of forests and grasslands. More study is needed to clarify the area relationships of savanna biota such as Red-Headed Woodpecker or Brown Thrasher.
- Determine histories of remnant savannas from a variety of sources (federal public land survey data, early air photos, soil surveys, tree coring, notes from past naturalists, interviews with long-term residents).
- Because intact remnants are absent, it may be necessary to introduce carefully selected plants and animals into what are thought to be viable savanna habitats. Such species should be tracked with appropriate monitoring protocols.
- Experiment to see which plant species come back unaided when grazing ceases and burning is reintroduced to savanna remnants.

Continuum of Fire-adapted Vegetation: Prairie-Savanna-Woodland-Oak Forest and Associated Populations of Sensitive Grassland and Savanna Species

The Southwest Savanna offers potential opportunities to manage large sites that encompass the full spectrum of fire-driven natural communities that formerly covered much of this part of Wisconsin. Such opportunities are now very rare and appear limited to a few locations in the Southeast Glacial Plains (e.g., the southern Kettle Moraine) and Western Coulees and Ridges ecological landscapes.

All of these natural communities are dynamic, and management for the structural variability (including and emphasizing large habitat patches that are now absent from most grassland and savanna conservation projects) will accommodate more niches and more species than scattered small sites representing only a single vegetation type (Ribic et al. 2009). Such sites may also allow species to move around as conditions change, and give managers more flexibility. Such sites would also offer more recreational opportunities, provided that these are compatible with the basic conservation objectives of a given project.

Populations of rare plants and animals occur at scattered locations across the Southwest Savanna Ecological Landscape. These include large populations of high priority species for conservation action as well as small populations that have persisted at small sites in various locales. As knowledge of the distribution and abundance of these species increases, the ability to select and prioritize the best conservation opportunities will increase.

Leach and Givnish (1996, 1999) offer information on the species traits and environmental factors that affect and govern the distribution and behavior of plants in prairie, savanna, and woodland communities under varying conditions.

This landscape near Barneveld includes surrogate grasslands, prairie, savanna, and woodland remnants. The brushy thickets provide nesting habitat for rare species such as the Bell's Vireo (Wisconsin Threatened). Photo by Eric Epstein, Wisconsin DNR.

American fever-few (Wisconsin Threatened) reaches its northern range extremities in southern Wisconsin, where it inhabits tallgrass prairie remnants. Photo by Thomas Meyer, Wisconsin DNR.

The habitat mosaic afforded by adjacent grasslands, forests (including savannas and open woodlands), and streams is ideal for summer use by some bat species. That bats will occupy such habitats in the Southwest Savanna is attested to by the high rate of occupancy of bat houses placed at Yellowstone Lake State Park in Lafayette County (J. Senulis, Wisconsin DNR, personal communication).

Management Opportunities, Needs, and Actions

- Examine conservation plans for priority project areas and where feasible incorporate considerations for the inclusion of soil, light, slope, aspect, and moisture gradients into the design of those plans.
- Identify and assess sites that offer the best opportunity to manage for the full spectrum of fire-dependent vegetation and develop conservation priorities.
- Identify viable populations of high priority grassland species and work with landowners and managers to secure protection agreements.
- Collect baseline information on the vegetation composition and structure at sites containing representatives of these communities and track changes using satellite imagery, air photos, and plots or transects.
- Identify knowledge gaps on the status of high priority taxa and design surveys to provide information needed to make better conservation decisions.
- Test the idea that sites representing the full continuum of vegetation have a better chance of retaining more of the native species associated with individual communities over time than isolated projects focused on single communities or habitat types. This is important for planners, managers, and researchers and in communications with the public.
- Develop a list of species that can be effectively monitored to assess changes in populations or habitats under a range of management scenarios.
- Continue to build the Natural Heritage Inventory database by designing, coordinating, funding, and participating in needed survey efforts.

Forests

Hardwood forests are most frequent on sites that were afforded some protection from wildfire by natural firebreaks. Dry and dry-mesic forests were dominated by oaks and occurred on slopes that either burned infrequently or with low intensity. Mesic maple-basswood forests were rare and local, occurring only at sites that had a high degree of protection from fire. Conifer relicts are dominated by species that are highly restricted in distribution and abundance this far south in Wisconsin. They are very rare but of significant biogeographic interest. The conifer relicts also offer opportunities to monitor response to climate change as the dominant species and some of the understory plants typically occur to the north of the Southwest Savanna. Dry Pine Relicts dominated by eastern white pine and more mesic, extremely rare Hemlock Relicts, dominated by mixtures of eastern hemlock and eastern white pine, are present here.

Management Opportunities, Needs, and Actions

- Identify opportunities to manage for or restore oak forests as part of the continuum of fire-adapted vegetation (oak forest-oak woodland-oak savanna-prairie).
- Where appropriate, maintain and regenerate oak forests. Several landowners have been experimenting with the use of prescribed fire as a management tool in oak forests. Such efforts may yield results with geographically broader implications for successful oak management.
- Better documentation of the values that forests here have for sensitive native plants and animals is needed.
- Many of the forests in this ecological landscape occur as small, isolated patches. Some of these occurred in similar settings historically. Data are needed on the changing

floras of such stands, especially for those containing species thought to be sensitive to current disturbances such as fire suppression, logging, the spread of invasive plants and exotic earthworms, and excessive browse pressure from white-tailed deer.

- Additional searches for rare forest herbs such as green violet and fire pink are needed.
- Conifer relicts should be mapped and monitored. Historical sources of information should be consulted to determine their former extent. Their linear configuration and adjacent land uses make them especially vulnerable to infestation by invasive plants.
- The viability of conifer relicts, especially those in which eastern hemlock is important, is unknown and needs further investigation and monitoring.
- Garlic mustard is widespread and sometimes abundant in the forests of this ecological landscape. Coordinated control efforts by multiple jurisdictions are needed, especially for sites that are currently lightly infested. "New" infestations should be eradicated as quickly as possible.

Warmwater Rivers and Streams

Warmwater rivers and streams support native fish, herptiles, and invertebrates, including rare species. Wetlands associated with riparian corridors are most extensive along the largest rivers (the Pecatonica, East Branch of the Pecatonica, and Galena) and include examples of native plant communities, some of which in turn support additional rare or otherwise sensitive species. Few of these wetlands are currently in good condition due to past land and water use practices, and several wetland restoration projects are underway to remedy this situation, refine cost-effective techniques for private landowners, and increase the ability of these riparian ecosystems to maintain and facilitate the dispersal of assemblages of native plants and animals.

There is a need to improve water quality and reduce nonpoint pollution in many parts of the Southwest Savanna. Nonpoint pollution is a significant problem here. Sediments from erodible soils, and runoff from pesticides, fertilizers, metals and various chemicals, are carried into surface waters by storm waters and snowmelt. These pollutants can also negatively impact groundwater and contaminate aquifers used as sources of drinking water. In the future, large animal operations will need to be sited in ways that will not impair water quality or diminish water quantity and undo conservation gains made over the past three decades. Modification of land use practices is the key to reducing nonpoint source impacts. Among the methods that have had some success are the promotion of CRP enrollment in erosion-prone areas, the installation of vegetation buffers between cropland and streams, and the restoration of functionality to wetlands in riparian corridors by protecting or planting perennial native cover (Marshall et al. 2008).

The Wisconsin Buffer Initiative (WBI) and a subsequent more comprehensive project is addressing agricultural fields with the highest phosphorus loss within a subwatershed. These studies are investigating if best management practices (BMPs) are applied intensively within a small area (20 square miles or less), will they yield water quality benefits (UW-Madison 2005). Waters that would respond favorably and significantly to changes in water quality were identified and landowners were contacted to determine their level of interest in installation of BMPs and cooperation with monitoring the landscape thereafter. Soil tests were taken on fields to determine the number of pounds of phosphorus lost per acre, depending on phosphorus concentration in the soil, potential erosiveness of the soil, crop rotation, and farming practices. Fields with the highest phosphorus loss were targeted first, followed by fields with lower phosphorus loss. In the Southwest Savanna Ecological Landscape, there were three multi-year projects: BMPs are being established in the Pleasant and Kittleson Valley (southwestern Dane County) and the Silver Spring Branch (southeast Lafayette County) watersheds, with the Smith-Conley Branch (central Iowa County) watershed serving as a control (University of Wisconsin-Madison 2005). All three of these streams have the potential to be trout waters, but are on the state's list of impaired waters due to habitat degradation caused by excessive sediment loss. Landowners in these watersheds were encouraged to consider not only the effects of their land management practices on water quality but also on wildlife in the area. Putting highly erosive land into "set aside" programs (e.g., buffers or CRP) would have the benefit of lowering the phosphorus run off from agricultural fields and enhancing bird and small mammal habitat. Results reported as of 2014 have been very encouraging, resulting in significant improvements in overall habitat values as measured by ***index of biotic integrity*** (IBI) scores, when both stream corridor buffers and upland erosion control improvements are established (Amrhein 2014, TNC 2014).

Free-flowing stream, bordered by oak savanna and prairie pastures. Photo by Cathy Bleser, Wisconsin DNR.

Partnerships involving the Wisconsin DNR, Natural Resources Conservation Service, local municipalities, University of Wisconsin-Extension, Grant and Lafayette counties, local conservation organizations, and interested citizens could drastically reduce the amount of nonpoint pollution here. The restoration of riparian and in-stream habitats will improve overall water quality and stream health. Habitat conditions can be improved for many native organisms, including smallmouth bass, an important source of recreation in the Southwest Savanna (Lyons et al. 1988).

Management Opportunities, Needs, and Actions

- Focus protection and restoration efforts on rivers and streams that are in relatively good condition and are known to support sensitive aquatic species. Focus areas should include consideration of nearby upland habitat protection projects and areas where infiltration occurs.
- Identify opportunities to merge terrestrial and aquatic conservation projects.
- Work with counties and other local governmental units to implement best management practices to reduce nonpoint source pollution, including sediments from soil erosion, stormwater runoff, and excess nutrient inputs.
- Work with county and Natural Resources Conservation Service staff to implement the Conservation Reserve Enhancement Program (CREP) and the Wisconsin State Rules for runoff management (NR 151).
- Secure funding via appropriate grants to encourage the implementation of best management practices. Examples might include state targeted runoff management (TRM) grants or federal environmental quality improvement programs (EQIP).
- Encourage municipalities to practice water conservation measures and implement wellhead protection programs.
- Ensure that the siting and operation of large animal enterprises will not impair ground or surface water quality.
- Continue to develop partnerships among governmental agencies, local conservation organizations, farm groups, and private landowners to protect or restore riparian habitats. Such partnerships are especially critical in areas such as the Southwest Savanna where there is little public land and agriculture is the dominant land use.
- The Wisconsin DNR and all basin partners should support the activities of the University of Wisconsin-Extension basin educators by providing financial, technical and teaching aid for activities such as volunteer stream monitoring, pasture improvement projects, building and maintaining the Water Education Library, and coordinating and conducting basin-wide seminars to provide educational and informational opportunities to local residents to learn more about watershed ecology and stream protection and restoration techniques (UW-Extension 2015).

Coldwater Streams Embedded within Grasslands

Coldwater ecosystems are well represented in the headwaters and upper reaches of many streams in the Southwest Savanna Ecological Landscape. The 2,549 mapped springs in this ecological landscape (Macholl 2007) are critical to the maintenance of coldwater and coolwater systems by providing clean, cold, highly oxygenated water. These sources of groundwater discharge need protection from all forms of degradation, including reduced flow, increases in temperature, and contamination from polluted runoff or infiltration.

Wisconsin's groundwater protection law applies to only about 3% of springs statewide because many ***high capacity wells*** don't meet the criteria for regulation (to qualify for protection, they must be within 1,200 feet of a groundwater protection area, be near a spring with a flow of 1 cubic foot per second for 80% of the year, or be in a basin with high consumptive water use). Advocates of stream and groundwater protection will want to continue efforts to strength this law so that it protects the majority of springs in the Southwest Savanna and throughout the state (Macholl 2007). Within the recharge areas of springs, land uses that limit nonpoint pollution runoff, groundwater withdrawal, and timber harvest and promote restoration of grassy or other permanent vegetative cover will help protect these critical natural features and the streams they nourish.

Groundwater contamination can affect springs here, which in turn can affect streams into which these springs discharge. Therefore, it is important to identify and address groundwater contamination by removing it at the source. Partners within the Southwest Savanna Ecological Landscape, including Wisconsin DNR, should promote nutrient and pesticide management throughout the basin in an effort to reduce the amount of groundwater contamination that results from those sources. Former mining and mine processing sites that are potential pollution sources should be identified and prioritized for cleanup.

Management Opportunities, Needs, and Actions

- Identify and protect coldwater and coolwater systems with representative assemblages of native species, including associated rare or declining sensitive species, and use these streams as reference areas.
- The Wisconsin DNR, in partnership with county agencies, local governments, local conservation organizations, and private citizens, should reestablish "native" fisheries in streams with suitable habitat where water quality protection has broad support and is most assured.
- Work with county and Natural Resources Conservation staff to implement the Conservation Reserve Enhancement Program (CREP) and the Wisconsin State rules for runoff management (NR 151).

- Continue to provide assistance to those creating or proposing local development plans and advocate for measures that minimize peak flow and adverse nutrient and temperature impacts to coldwater streams.
- Work with county zoning officials, local communities, and other organizations to develop effective protection standards for resources that fall under the classification of Exceptional Resource Waters (ERW) or Outstanding Resource Waters (ORW).
- Assess trout habitat improvements on overall stream ecology on state-owned and state-eased properties to clarify effects on other aquatic taxa and streamside vegetation.
- Improve coldwater stream conditions by developing and providing guidelines to change land use practices where these have been problematic. Encourage installation of riparian buffers and the enrollment of erodible land in CRP, CREP, or other programs with somewhat parallel goals.

Caves, Abandoned Mines, and Other Subterranean Habitats

Abandoned mines, caves, and other subterranean features are common in parts of the Southwest Savanna. While poorly handled mine waste has resulted in water quality problems, the diggings, along with some natural underground cavities, are being used by bats, including several species that have recently been listed as threatened by the State of Wisconsin. The severe threat posed by the spread of white-nose syndrome, an often fatal fungal disease that has already killed millions of bats in the eastern United States, makes it imperative that sites used by bats now are identified and protected while wildlife health specialists search for and develop effective treatments. It is likely that other, poorly documented species (e.g., certain invertebrates), also use, and are perhaps dependent on, subterranean habitats. These habitats need further survey and study.

Management Opportunities, Needs, and Actions

- Survey mines and caves and identify sites used by bats. Determine species and numbers involved and monitor population trends and mortality.
- Prioritize subterranean sites for additional conservation action, based in part on factors such as the species involved, population sizes, vulnerability to disease, and ability to control access.
- Develop or refine use and access guidelines applicable to all occupied or potentially occupied mines and caves and disseminate this information via various outreach programs.
- Convene experts and develop a list of organisms for which subterranean habitats are potentially important while assessing critical knowledge gaps.
- Design and implement surveys for accessible sites that are thought to have the highest potential for supporting organisms using and depending on these habitats.

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 Southwest Savanna Ecological Landscape is called the Southwest Savanna counties. The counties included are Iowa, Grant, Lafayette, and Green because at least 25% of each county lies within the ecological landscape boundary (Figure 20.16).

History of Human Settlement and Resource Use

American Indian Settlement

As the glaciers receded from Wisconsin, Paleo-Indians entered Wisconsin from a generally southern direction, with southwestern Wisconsin showing evidence of some of the earliest habitation (Mason 1997). The Southwest Savanna Ecological Landscape shows evidence of being inhabited from those earliest pioneers until the present day. Several rock shelters in this ecological landscape have evidence of use during the middle archaic period (Stoltman 1997). Rock art is associated with a number of these rock shelters as well as on the bluffs and areas of exposed bedrock in the area. Evidence of increasingly intensive agriculture and the use of pottery of different types is also well documented during the Woodland phase in this ecological landscape (Stevenson et al. 1997). See the "History of Human Settlement and Resource Use" section in Chapter 2, "Assessment of Current Conditions," for more information on the phases of American Indian cultures.

Figure 20.16. *Southwest Savanna counties.*

While there are currently no tribal lands or American Indian populations in the area, a wide variety of tribes inhabited this region during the turbulent 17th century, including the Ho-Chunk, Potawatomi, Kickapoo, Illini (Illinois), and Miami. The Iroquois Wars of this era made Wisconsin home to many tribes on their journey farther west.

Euro-American Contact and Settlement

During the 17th century, French fur traders, soldiers, and missionaries began arriving here. As a result of Euro-American contact with American Indian tribes, trading posts, missions, and forts along river routes and lakes were established throughout the region. During the 1800s, American Indian tribes began ceding large areas of land to the U.S. government, and permanent Euro-American settlement began in earnest.

Swiss began settling in the Southwest Savanna area in the mid-1800s, primarily from German-speaking parts of Switzerland. With 2,336 farms in 1850, this region eventually became an important agricultural area (ICPSR 2007).

Early Agriculture

Permanent Euro-American settlement began in the Southwest Savanna counties well before 1850. The Southwest Savanna counties were among the first established in the state. Iowa County was founded in 1829, followed by Grant and Green counties in 1836, and Lafayette County in 1846 (NACO 2010). Agriculture became a critical component of local economies in the Southwest Savanna counties shortly after their establishment as political units. In 1850 there were 2,336 established farms in the Southwest Savanna counties (ICPSR 2007) (Figure 20.17). By 1860 the number of farms in the Southwest Savanna counties had grown to 8,132 farms and by 1870 had peaked at 12,064 farms. Thereafter, the number of farms in the Southwest Savanna counties followed a general trend of slow decrease. Although the onset of the Great Depression caused farm numbers to plummet throughout much of the state, farms in the Southwest Savanna counties were much more resilient through the 1930s and early 1940s.

Following World War II, a combination of the failure of many smaller, marginal farms, subsequent consolidation, and mechanization increased the average size of farms and reduced the number of farms throughout the state but to a lesser degree in the Southwest Savanna counties. Farm size in the Southwest Savanna counties followed a trend of much larger acreages than in the state as a whole. In 1950 the average Southwest Savanna County farm was 181 acres compared to 138 acres statewide (Figure 20.18).

Total value of all crops in the first half of the 20th century indicates the extreme influence of the Great Depression on agriculture. In 1910 all crops harvested in the Southwest Savanna counties had an estimated total value of $13.4 million, which had nearly tripled by 1920 ($36.5 million). However, total value of all crops in the Southwest Savanna counties plummeted in 1930 ($17.7 million) and fell further by 1940 ($14.1 million) (ICPSR 2007).

Farms in the Southwest Savanna counties tended to grow more "cereal" crops (small grains, such as wheat, rye, barley, and oats) and less "hay and forage" crops than the state as a whole. The 1910 federal agricultural census listed "cereals" as 59.7% of the total value of all crops harvested in the Southwest Savanna counties, compared to 49.3% statewide (ICPSR 2007). Cereals fell to 46.8% of total crop values in 1930, but recovered to 54.6% by 1940. Meanwhile, "hay and forage," associated with livestock farming, was only 31.2% of total value of crops harvested in the Southwest Savanna counties in 1910, rose to 46% of total crop value by 1930, then fell to 39.4% of total crop value by 1940, compared to 44.6% statewide in 1940.

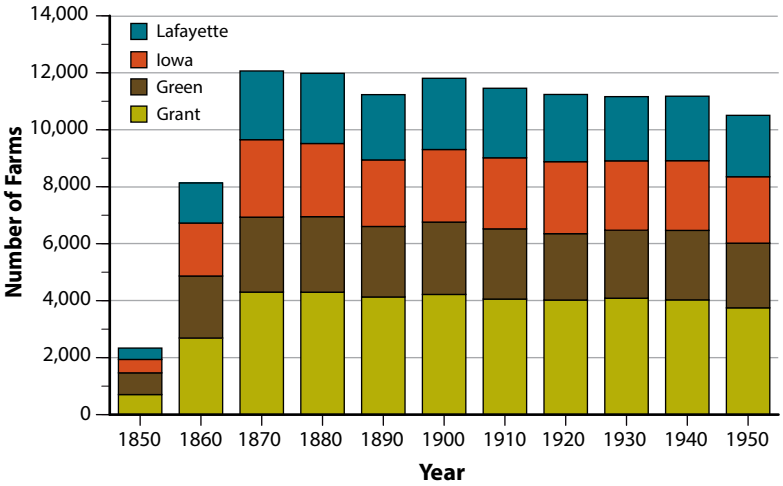

Figure 20.17. *Number of farms in Southwest Savanna counties between 1850 and 1950 (ICPSR 2007).*

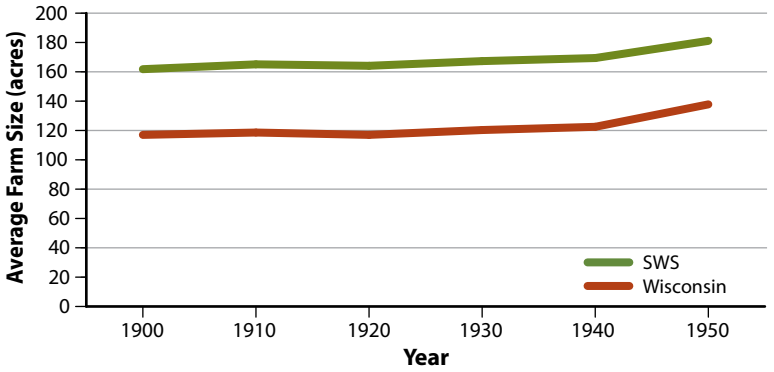

Figure 20.18. *Average farm size in Southwest Savanna counties between 1900 and 1950 (ICPSR 2007).*

Early Mining

The French began mining this area during the late 17th and throughout the 18th century, specifically Nicolas Perrot during the 1680s and Julien Dubuque during the 1780s (The Wisconsin Cartographer's Guild 1998). American Indians took over mining this region once the French had left the area, but by the early 1800s this region had become one of the world's leading mining centers. Iron and copper, among other minerals and metals, drew large groups of settlers to Wisconsin during the 19th and early 20th centuries. Both Cornish and Finnish immigrants, possessing extensive mining experience from work in Europe, were among the first to be recruited. Extensive mining of lead, and later zinc, occurred in this ecological landscape, which made up a large part of Wisconsin's lead district or "the diggings" as it later came to be called.

The majority of the lead extracted from this region was found in the unglaciated or driftless area, usually deposited in crevices and bedding planes of a Paleozoic magnesium limestone (Ostergren and Vale 1997). Despite a sudden lead mining depression from 1829 to 1831, as a result of the increased production from the new Fever (Galena) River lead district in northern Illinois, by the 1840s this region was producing more than 23,000 tons of lead each year). The market demand for lead paint, bullets, pipes, lead sheeting and printer's type, among others, created a booming local economy, and by 1844, Grant County had as many miners as farmers.

With lead ore quantities depleted, zinc became a more prevalent mining product during the mid-19th century. New technology during the 1850s made zinc extraction in the lead region possible, and Mineral Point soon had the world's largest zinc smelter. The zinc industry continued on a limited scale through the late 1970s (The Wisconsin Cartographer's Guild 1998).

Early Transportation and Access

In the early 19th century, an extensive network of American Indian trails already existed throughout southern Wisconsin.

Old mine shaft, Grant County. Photo by Drew Feldkirchner, Wisconsin DNR.

These trails were widened into roads suitable for ox carts and wagons due to the rapid increase in settlement during the 1830s (Davis 1947). A system of military roads was developed in Wisconsin around the same time, connecting key cities and forts with one another. One such road terminated in Sinipee on the Mississippi River after beginning at Fort Crawford on Lake Winnebago. By 1870, however, the importance of railroads had caused these relatively primitive roadways to become of secondary value. One of the first railroad lines to reach the Mississippi River was the Milwaukee and Mississippi, which reached Prairie du Chien (in the Western Coulees and Ridges Ecological Landscape) from Milwaukee in 1857.

Early Logging Era

The lumbering industry in Wisconsin grew with the Euro-American pioneers as they moved into the newly opened agricultural frontier. The treaties of 1837 with the Dakota and Ojibwe made timberlands available for cutting. Mills in the Southwest Savanna Ecological Landscape harvested stands of southern hardwood forest and oak savanna (The Wisconsin Cartographer's Guild 1998).

Resource Characterization and Use[2]

The Southwest Savanna Ecological Landscape has almost 2,000 square miles of land but less than 4 square miles of water. This ecological landscape ranks the lowest of all 16 ecological landscapes in terms of surface area of water and in the number of lakes.

A low percentage of area in both surface water and forest detracts from the ability of the Southwest Savanna to support significant recreational activity. This ecological landscape has the lowest percentage of public land in the state (2%, or 24,600 acres). In addition, it has both the lowest density of campgrounds and of multi-purpose trails. Acreage in ***state natural areas*** and the number of Land Legacy sites are lower than in other ecological landscapes.

Agriculture is a very important factor to the economy of the Southwest Savanna Ecological Landscape. It has the highest percentage of land area in agriculture (70%) of any Wisconsin ecological landscape. Both corn and milk production are significant. Forestry, on the other hand, is not nearly as important to the economy. The Southwest Savanna Ecological Landscape is close to the bottom in terms of the percentage of land in forests (17%) as well as in volume of timber and the amount of wood removed.

The Southwest Savanna Ecological Landscape has one of the lowest densities of roads, railroads, and airport runways. In fact, this region has the lowest railroad density in the state. It has only three airports and no shipping ports.

[2]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."

Energy use in the Southwest Savanna Ecological Landscape is relatively low, and it is not a major producer of either hydroelectric power or woody biomass. There are areas of significant wind potential in this ecological landscape; as of 2013, there was one commercial wind facility in this ecological landscape. There are currently no ethanol plants in the Southwest Savanna counties.

The Land

Of the 1.25 million acres of land that make up the Southwest Savanna Ecological Landscape, only 17% is forested. About 97% of all forested land is privately owned while 3% belongs to the state, counties, or municipalities (USDFS 2009).

Minerals

Three of the four Southwest Savanna counties are currently engaged in some type of mineral extraction. Green and Grant counties are involved in the production of nonmetallic minerals. In 2007 there were six mining establishments in the Southwest Savanna counties. Due to limited participation in mining, employment and earnings information is not disclosed (WDWD 2009). Due to confidential disclosure rules, much of this information is limited to summary data.

Water (Ground and Surface)

Water Supply

The data in this section are based on Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015c), which are the same as the data reported in the "Hydrology" section. However, the data are categorized differently here so the numbers differ slightly. Surface water covers 2,513 acres (0.2% of total area) of the Southwest Savanna. The 112 lakes (over 1 acre in size) total 965 acres, 38% of the surface water here (WDNR 2009b). There are no lakes over 500 acres in size. Yellowstone Lake (an impoundment) is the largest at 453 acres. There are 1,492 acres of streams and rivers, the largest of which are the Pecatonica, the East Branch of the Pecatonica, and the Galena rivers. There are 180 dams in place across perennial and intermittent streams, which impound 1,160 acres of water. The land area is described within the estimated geophysical boundaries of the ecological landscape, not by county delineation.

Water Use

Each day about 290 million gallons of ground and surface water are withdrawn in the four Southwest Savanna counties (Table 20.3). About 89% of the withdrawals are from surface water. Of the 128,573 people that reside in these counties, 58% are served by public water sources and 42% are served by ***private wells***. Grant County is the largest user of water (91% of the Southwest Savanna counties), and thermoelectric power generation accounts for the largest withdrawals (88%) (USGS 2010).

Recreation

Recreation Resources

Land use patterns, land cover, and ownership partly determine the types of outdoor recreation that are available to the public. For instance, the Southwest Savanna Ecological Landscape has the highest percentage of agricultural land and the lowest percentages of wetlands and surface water among ecological landscapes (see Chapter 3, "Comparison of Ecological Landscapes," and the map of "WISCLAND Land Cover (1992) of the Southwest Savanna" in Appendix 20.K).The percentage of forest is also very low. Although there is not much water, the majority is in rivers rather than lakes or reservoirs.

The Southwest Savanna Ecological Landscape has the lowest percentage of public land (2%) of any ecological landscape in the state. In addition, this ecological landscape has both the lowest density of campgrounds and of multi-purpose trails. The number of visitors to state lands is also low. Acreage in state natural areas and the number of Land Legacy sites are much lower than average. Interestingly, 25% of the Land Legacy sites are rated as having high recreation potential.

Supply

Land and Water. The Southwest Savanna Ecological Landscape comprises 3.6% of Wisconsin's total land area but only 0.2% of the state's acreage in water (see Chapter 3, "Comparison of Ecological Landscapes," for comparison of ecological landscape sizes). There are 169,413 acres of ***forestland***, or 1% of the total forest acreage in the state (USFS 2009). Streams and rivers make up 61% of the surface water area of the Southwest Savanna Ecological Landscape, and lakes

Table 20.3. *Water use (millions of gallons/day) in the Southwest Savanna counties.*

County	Ground-water	Surface water	Public supply	Domestic[a]	Agriculture[b]	Irrigation	Industrial	Mining	Thermo-electric	Total
Grant	7.8	256.6	3.2	0.8	3.4	0.4	0.3	0.3	256.0	264.4
Green	10.7	0.3	2.7	0.8	1.8	5.0	0.6	0.1	–	11.0
Iowa	10.1	0.4	1.3	0.5	1.7	6.8	0.2	0.0	–	10.5
Lafayette	3.3	0.4	0.8	0.4	2.2	0.2	–	0.1	–	3.7
Total	**31.9**	**257.7**	**8.0**	**2.5**	**9.1**	**12.4**	**1.1**	**0.5**	**256.0**	**289.6**
Percent of total	**11%**	**89%**	**3%**	**1%**	**3%**	**4%**	**0%**	**0%**	**88%**	

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 reservoirs make up over 39% of the surface water area (WDNR 2015c). The largest river is the Pecatonica.

Public Lands. Public access to recreational lands is vital to many types of recreational activity. In the Southwest Savanna Ecological Landscape, almost 24,600 acres, or 2% of all land and water, is publicly owned, mostly by the state (WDNR 2005a). This is significantly less than the statewide average of 19.5%, ranking the Southwest Savanna lowest of the 16 ecological landscapes in the porportion of land in public ownership. State-owned lands and facilities are important to recreation in the Southwest Savanna Ecological Landscape, with over 3,300 acres in parks and recreation areas, including Blue Mounds, New Glarus Woods, Belmont Mound, and Yellowstone Lake state parks and the Browntown-Cadiz Springs Recreational Area. In addition, there are 758 acres of state trails, including the Military Ridge and Pecatonica trails. Fisheries and wildlife management lands cover about 17,000 acres. The largest of these, Yellowstone Wildlife Area and the Galena River Fisheries Area, each provide over 4,000 acres of recreational land.

Trails. Although the Southwest Savanna counties have over 1,000 miles of recreational trails (Table 20.4), they rank 16th (out of 16 ecological landscapes) in terms of trail density (miles of trail per 100 square miles of land). The density of trails is below average for the state for all trail types (Wisconsin DNR unpublished data).

Campgrounds. There are 43 public and privately owned campgrounds that provide about 2,989 campsites in the Southwest Savanna counties (Wisconsin DNR unpublished data). With 3% of the state's campgrounds, this ecological landscape ranks 13th (out of 16 ecological landscapes) in terms of the number of campgrounds and 16th in campground density (campgrounds per square mile of land).

Land Legacy Sites. The Land Legacy project identified over 300 places of significant ecological and recreational importance in Wisconsin, and eight are either partially or totally located within the Southwest Savanna Ecological Landscape (WDNR 2006c). Two of them, the Blue Mound–Blanchardville Prairie and Savanna and the Monroe-Muralt Prairie, are rated as having the highest conservation significance.

State Natural Areas. The Southwest Savanna Ecological Landscape also contains 1,440 acres of state natural areas (either partially or totally located within the ecological landscape), of which 62% are publicly owned (including government and educational institutions), and 38% are owned by private interests and NGOs (Wisconsin DNR unpublished data). The largest state natural areas in this ecological landscape (several are within other state-owned lands) include Barneveld Prairie (673 acres, Dane and Iowa counties), Yellowstone Savanna (198 acres, Lafayette County), Olson Oak Woods (193 acres, Dane County), Hard Scrabble Prairie (161 acres, Grant and Lafayette counties), and York Prairie (145 acres, Green County). For more information on Wisconsin state natural areas, see Wisconsin DNR (2015e).

Demand

Visitors to State Lands. In 2006 there were an estimated 780,000 visitors to state recreation areas and parks in the Southwest Savanna Ecological Landscape (Wisconsin DNR unpublished data). The majority, 92%, visited the state parks, especially Yellowstone Lake and Blue Mounds state parks.

Fishing and Hunting License Sales. Of all license sales, the highest revenue producers for the Southwest Savanna counties were resident hunting licenses (50% of total sales) and resident fishing licenses (29% of total sales) (Wisconsin DNR unpublished data). Table 20.5 shows a breakdown of various licenses sold in the Southwest Savanna counties in 2007. Grant County accounts for both the highest number of licenses sold and the highest revenue from sales. The Southwest Savanna Ecological Landscape county approximation accounts for about 2% of total license sales in the state. However, persons buying licenses in the Southwest Savanna counties may travel to other parts of the state to use them.

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

Table 20.4. *Miles of trails and trail density in the Southwest Savanna counties compared to the whole state.*

Trail type	Southwest Savanna (miles)	Southwest Savanna (miles/100 mi^2)	Wisconsin (miles/100 mi^2)
Hiking	26	0.6	2.8
Road biking	125	2.9	4.8
Mountain biking	36	0.8	1.9
ATV: summer & winter	36	0.8	9.3
Cross-country skiing	206	4.8	7.2
Snowmobile	612	14.2	31.2

Source: Wisconsin DNR unpublished data.

Table 20.5. *Fishing and hunting licenses and stamps sold in the Southwest Savanna counties.*

County	Resident fishing	Nonresident fishing	Misc. fishing	Resident hunting	Nonresident hunting	Stamps	Total
Green	4,283	576	103	7,168	241	2,310	14,681
Grant	8,081	1,034	174	14,899	440	3,418	28,046
Iowa	4,425	737	244	6,337	111	2,239	14,093
Lafayette	1,720	460	122	3,347	104	866	6,619
Total	**18,509**	**2,807**	**643**	**31,751**	**896**	**8,833**	**63,439**
Sales	**$417,876**	**$114,061**	**$13,097**	**$861,699**	**$129,955**	**$69,205**	**$1,605,893**

Source: Wisconsin DNR unpublished data, 2007.

county is characterized by high levels of tourism, recreation, entertainment, and seasonal housing. None of the Southwest Savanna counties are categorized as nonmetro recreation.

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 2006b). 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 most or many regions of the state.

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

Timber Harvesting. A high percentage of statewide residents are concerned about timber harvesting in areas where they recreate (WDNR 2006b). Their greatest concern about timber harvesting is large-scale visual changes (i.e., large openings) in the forest landscape. Forest thinning and harvesting that creates small openings is more acceptable. Silent-sport enthusiasts are the most concerned about the visual impacts of harvesting, while hunters and motorized users are somewhat less concerned. The limited acreage of forest and the lack of public lands makes this issue somewhat less acute here than in other areas of the state, but it does exist. From a broader ecological perspective covering the entire ecological landscape, the loss, degradation, and fragmentation of grasslands (including the planting of trees in some areas) is also controversial.

Loss of Access to Lands and Waters. In many parts of Wisconsin, increased shoreline development has fragmented, altered, and sometimes led to degradation of lands bordering streams and impoundments. This has sometimes meant lower water quality and less access to water resources. Compared with parts of the state with more abundant water resources, this may be a more localized problem in the Southwest Savanna. Another element that may play into the perception of reduced access is a lack of information about where to go for recreational opportunities. In a statewide survey, this element was highly ranked as a barrier to increased outdoor recreation in a statewide survey (WDNR 2006b).

Agriculture

Farm numbers in the Southwest Savanna counties have decreased 18% since 1970. There were approximately 8,350 farms in 1970 and 6,871 in 2002 (USDA NASS 2004). Between 1970 and 2002, average farm size increased slightly from 227 acres to 238 acres, higher than the statewide average of 201 acres. The overall land in farms has steadily decreased since the 1970s (Figure 20.19). In 1970 there were about 1.9 million acres of farmland, and by 2002 acreage was down to 1.6 million acres, a decrease of 14%.

For the four counties, the percentage of land in farms ranges from 75% to 84%, averaging 80%. The counties with the highest percentage of farmland are Lafayette County with 84%, Green County with 82%, and Grant County with 80%.

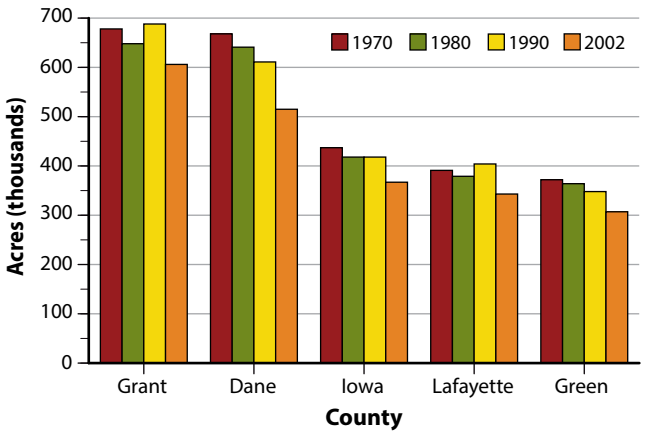

Figure 20.19. *Acreage of farmland in the Southwest Savanna counties by county and year (USDA NASS 2004).*

Agriculture is an important part of the economy of the Southwest Savanna counties. In 2002 net cash farm income totaled $132 million, or an average of $81 per agricultural acre, lower than the statewide average of $90 per acre (USDA NASS 2004). The market value of all agriculture products sold in the Southwest Savanna counties was $552 million (6.7% of the state total); 24% of this amount came from crop sales, while the remaining 76% was from livestock sales. The Southwest Savanna counties rank second in milk production per acre and first in corn production per acre in Wisconsin.

In 2007, 15,510 acres of farmland had been sold, of which 94% stayed in agricultural use at an average selling price of $3,858, and 6% was diverted to other uses at an average sale price of $4,352 per acre (USDA NASS 2009).

Timber

Timber Supply

Based on 2007 Forest Inventory and Analysis data (USFS 2007), 14% (178,773 acres) of the total land area for the Southwest Savanna Ecological Landscape is forested. This is only 1% of Wisconsin's total forested acreage (USFS 2009). Forestland is defined by Forest Inventory and Analysis as any land with more than 17% canopy cover. (Note that this includes vegetation that plant ecologists would consider "savanna," not forest.)

Timber Ownership. Of all timberland within the ecological landscape, 97% is owned by private landowners. The remaining 3% is owned by state and local governments (USFS 2009; Figure 20.20). 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.

Growing Stock and Sawtimber Volume. There was approximately 204 million cubic feet of ***growing stock*** volume in the Southwest Savanna Ecological Landscape in 2007, or 1% of the total volume in the state (USFS 2009). Most of this volume, 99%, was in hardwoods, much higher than the proportion of hardwoods statewide, which was 74% of total growing stock volume. Hardwoods made up a similar percentage of sawtimber volume, 98%, in the Southwest Savanna Ecological Landscape. In comparison, statewide hardwood volume was 67% of total volume.

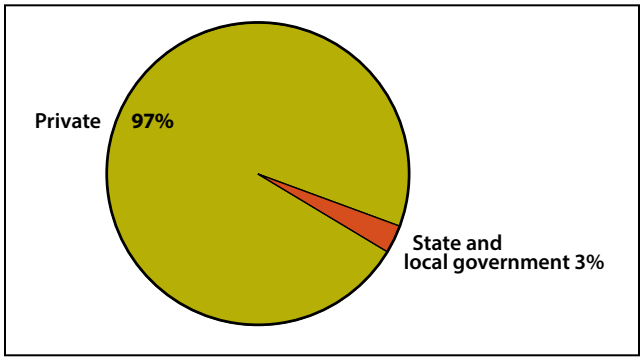

Figure 20.20. *Timberland ownership in the Southwest Savanna Ecological Landscape (USFS 2009).*

Annual Growing Stock and Sawtimber Growth. Between 1996 and 2007, the timber resource in the Southwest Savanna increased by 57 million cubic feet, or 39% (USFS 2009). All of this increase occurred in hardwood volume. Sawtimber volume increased by 265 million ***board feet***, or 54%, again entirely in hardwoods. This change was partly a result of a 21% increase in timberland acreage from 139,348 acres in 1996 to 168,038 acres in 2007. Statewide, timberland acreage increased by 3% during the same time period. Where this increase has occurred has not been explored in this publication. Due to the opportunities for grassland and savanna management in this ecological landscape, the increase in timberland here should be investigated by type and location to determine whether or not it is compatible with (or if it is hindering) a more ecologically appropriate emphasis on grassland and savanna management.

Timber Forest Types. According to Forest Inventory and Analysis data (USFS 2009), the predominant forest type groups in terms of acreage are oak-hickory (65%) and maple-basswood (24%), with smaller amounts of bottomland hardwoods, aspen-birch, and oak-pine. Acreage is predominantly in the sawtimber size class (68%), with only 21% in the pole size class and 10% in seedling and sapling classes (Table 20.6). Also see Appendix H, "Forest Types That Were Combined into Forest Type Groups Based on Forest Inventory and Analysis (FIA) Data," in Part 3, "Supporting Materials."

Timber Demand

Removals from Growing Stock. The Southwest Savanna Ecological Landscape has about 1% of the total growing stock volume on timberland in Wisconsin. Average annual removals from growing stock for the ecological landscape were 1 million cubic feet, or about 0.3% of total statewide removals (349 million cubic feet) between 2002 and 2007 (USFS 2009). (See the "Socioeconomic Characteristics" section in Chapter 3, "Comparison of Ecological Landscapes.") Average annual removals to growth ratios vary by species (only major species shown) as can be seen in Figure 20.21. Removals exceed growth for white oak and American elm (American elm negative growth is likely due to Dutch elm disease).

Removals from Sawtimber. The Southwest Savanna Ecological Landscape has about 1.3% of the total sawtimber volume on timberland in Wisconsin. Average annual removals from sawtimber were about 4 million board feet, or 0.3% of total statewide removals (1.1 billion board feet) between 2002 and 2007 (USFS 2009). Average annual removals to growth ratios vary by species as can be seen in Figure 20.22 (only major species shown). Sawtimber removals exceeded growth for white oak and American elm.

Table 20.6. *Acreage of timberland in the Southwest Savanna Ecological Landscape by forest type and stand size.*

Forest type[a]	Seedling/sapling	Pole-size	Sawtimber	Total
White oak-red oak-hickory	9,216	13,916	35,623	58,755
Hard maple-basswood	–	–	20,890	20,890
Mixed upland hardwoods	–	5,799	7,531	13,330
Black walnut	–	5,707	6,370	12,077
White oak	–	–	11,995	11,995
Sugarberry-hackberry-elm-green ash	5,506	2,588	3,811	11,906
Sugar maple-beech-yellow birch	–	652	,268	9,920
Bur oak	–	–	9,144	9,144
Elm-ash-locust	2,023	3,020	3,864	8,907
Post oak-blackjack oak	–	457	3,123	3,580
Aspen	–	2,760	–	2,760
White pine-red oak-white ash	–	–	2,013	2,013
Nonstocked[b]	–	–	–	1,561
Black cherry	547	652	–	1,200
Total	**17,293**	**35,553**	**113,632**	**168,038**

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

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

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

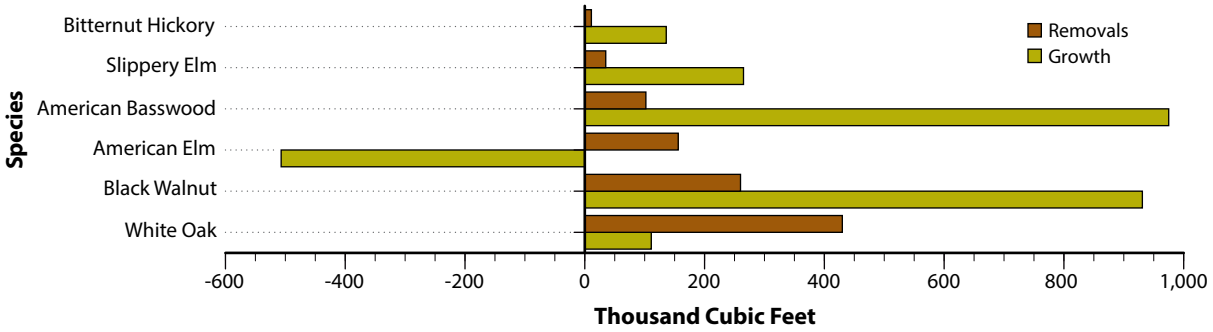

Figure 20.21. *Growing stock growth and removals (selected species) on timberland in the Southwest Savanna Ecological Landscape (USFS 2009).*

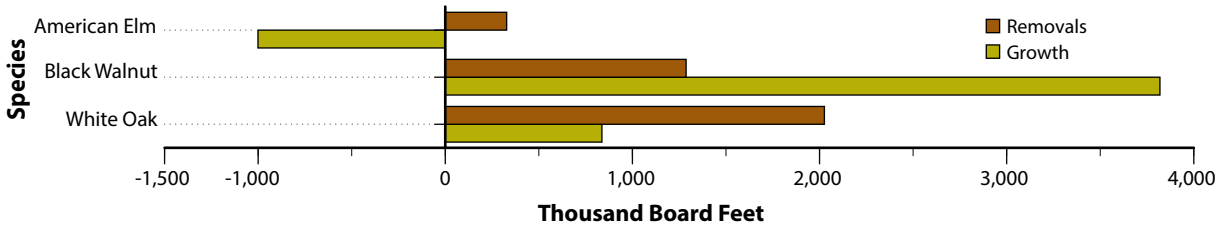

Figure 20.22. *Sawtimber growth and removals (selected species) on timberland in the Southwest Savanna Ecological Landscape (USFS 2009).*

Price Trends

In the Southwest Savanna counties, black walnut, black cherry, northern red oak, and sugar maple were the highest priced hardwood sawtimber species in 2013 (WDNR 2013). Spruce and eastern white pine were the most valuable softwood timber species (note that no spruces are native to the Southwest Savanna, and the amount of eastern white pine growing here is extremely limited). Sawtimber prices for 2013 were generally about average for softwoods and similar for hardwoods compared to the rest of the state according to ***stumpage*** rates calculated for the Managed Forest Law program.

This ecological landscape does not support a significant pulp industry, but for the limited amount of pulpwood harvested, red pine is the most valuable (there are a few red pine plantations here, but red pine is extremely rare in the Southwest Savanna). Pulpwood values in the Southwest Savanna counties were generally much lower for hardwoods compared to the statewide average according to stumpage rates calculated for the Managed Forest Law program (WDNR 2013).

Infrastructure

Transportation

The transportation infrastructure of the Southwest Savanna Ecological Landscape is much less developed than the rest of the state. For instance, road mile density is 9% lower (WDOT 2000), railroad density is 71% lower (WDOT 1998), and airport runway density is 48% lower (WDOT 2010) than the state as a whole. There are three airports in the Southwest Savanna Ecological Landscape, none of which are primary regional airports. There are no shipping ports here (WCPA 2010) (Table 20.7).

Renewable Energy

Hydroelectric and wind turbine power are the only renewable energy sources quantified by county in the Wisconsin energy statistics produced by the Wisconsin Department of Administration (WDOA 2006). Some general inferences can be drawn from other sources regarding the potential for renewable energy production in the Southwest Savanna counties. The Southwest Savanna Ecological Landscape has the potential to produce a significant amount of renewable energy using corn-based ethanol and wind power.

Biomass. Woody biomass is Wisconsin's most-used renewable energy resource, and the Southwest Savanna Ecological Landscape produces 26.1 million oven-dry tons of biomass, or 2.6% of total production in the state (USFS 2009). The forested land base, at only 14%, increased by 28,700 acres, or 21%, in the last decade, indicating some potential for energy production from woody biomass in this part of the state, though given the extent of cropland in this ecological landscape, potential for agricultural-based biomass is much higher.

Hydroelectric. There are no hydroelectric power sites in the Southwest Savanna Ecological Landscape (WDOA 2006).

Ethanol. The Southwest Savanna counties produced 51.2 million bushels of corn in 2002, or 12.5% of total corn production in the state (USDA NASS 2004). Acreage in agriculture currently at 80% of the land base (some woodland is counted as agriculture by this source), decreased by 14% between 1970 and 2002. There are currently no ethanol plants in this ecological landscape (Renewable Fuels Association 2014).

Wind. There is one wind facility in the Southwest Savanna Ecological Landscape in Iowa County (WWIC 2015). This site produces about 30 MW (megawatts) of energy. Mean annual power densities are generally between 100 and 300 W/m^2 (watts/square meter), with some areas having power densities of 300–400 W/m^2 (USDE 2015). For this reason, the potential for increasing wind generation in this part of the state is good.

Table 20.7. *Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of ports in the Southwest Savanna Ecological Landscape.*

	Southwest Savanna	State total	% of state total
Total road length (miles)[a]	6,107	185,487	3%
Road density[b]	3.1	3.4	–
Miles of railroads	54	5,232	1%
Railroad density[c]	2.8	9.7	–
Airports	3	128	2%
Miles of runway	1.8	95.7	2%
Runway density[d]	0.9	1.8	–
Total land area (square miles)	1,946	54,087	4%
Number of ports[e]	–	14	0%

[a]Includes primary and secondary highways, roads, and urban streets.
[b]Miles of road per square mile of land. Data from Wisconsin Roads 2000 TIGER line files (data set) (WDOT 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 2009–2010 web page (WDOT 2010).
[e]Data from Wisconsin Commercial Ports Association (WCPA 2010).

Current Socioeconomic Conditions

The Southwest Savanna counties are mostly rural, with the lowest population and housing densities in the southern half of the state. The average age of the adult population in the Southwest Savannas counties is rising. At the same time, a relatively large portion of the population is under 25, indicating high local birth rates. Education attainment is lower in Southwest Savanna counties than other parts of the state. Housing values and growth are low in Southwest Savanna counties. In general, Green and Iowa counties have demographic characteristics more favorable to economic growth than do more isolated Grant and Lafayette counties in the southwestern corner of the ecological landscape.

Demography

Population Distribution

According to the 2010 federal census, the combined population of the four Southwest Savanna counties was 128,573, or 2.3% of the state total population (USCB 2012b). Much of that population consists of rural or small town residents. Grant County, with an estimated population of 51,208 in 2010, was the most populous of the Southwest Savanna counties. Lafayette County, with 16,836 people, had the smallest population. The Southwest Savanna counties is the only ecological landscape county approximation in the southern portion of the state with over 70% of its population characterized as rural, compared to 31.7% statewide.

Southwest Savanna counties population centers (defined by the U.S. Census Bureau as cities with a population over 2,500) include the cities of Platteville (with a 2007 estimated population 9,645), Dodgeville (4,502), Lancaster (3,869), and Mineral Point (2,538) (USCB 2009). Two population centers that are located in the Southwest Savanna counties but not within the actual boundaries of the ecological landscape are Monroe (10,512) and Boscobel (3,119). Conversely, the Southwest Savanna Ecological Landscape includes the southwest corner of Dane County, whose considerable urban influence is not considered in this analysis but surely influences the population dynamics and local economies of the Southwest Savanna counties.

Population Density

The population density in 2010 of the Southwest Savanna counties (41 persons per square mile) was less than half that for Wisconsin as a whole (105 persons per square mile). Among Southwest Savanna counties, Green County (63.1 persons per square mile) has the highest population density, followed by Grant (44.7), Iowa (31.1), and Lafayette (26.6) counties (USCB 2012b).

Population Structure

Age. The population age structure structure of Southwest Savanna counties shows egress of the younger workforce to urban centers such as nearby Madison, while retirement age population is relatively high. The population in Southwest Savanna counties is similar to the state's population under age 25 but is composed of fewer people aged 25–49 years (34.7% in Southwest Savanna counties compared to 36.9% statewide) and more people aged over 65 years (14.8% in Southwest Savanna counties compared to 13.1% statewide) (USCB 2009). The median age is higher than the statewide figure of 36 years old in three Southwest Savanna counties, ranging from 37.1 years in Iowa County to 38.1 years in Lafayette County. Grant County has a median age of 35.9 years but has an unusually low population aged 25-49 years (31.6%), which is sixth-lowest statewide and indicates pronounced loss of its young workforce.

Minorities. The Southwest Savanna counties combined are the least racially diverse ecological landscape in the state. Ninety-seven percent of the 2010 population in Southwest Savanna counties was white, non-Hispanic, compared to 86.2% statewide (USCB 2012b).

Education. According to the 2010 federal census, 88.7% of Southwest Savanna counties residents 25 years of age or older had graduated from high school, similar to 89.4% statewide (USCB 2012b). Southwest Savanna counties' residents had lower attainment rates for higher education than the statewide average (19.3% of Southwest Savanna counties residents had received a bachelor's degree or higher, compared to 25.8% statewide). Iowa County (with 91.9% of residents graduated from high school and 22.3% having attained at least a bachelor's degree) leads Southwest Savanna counties in education attainment.

Population Trends

Trends in population change of Southwest Savanna counties reflect the changes to agriculture-dependent communities and movement of people to urban centers beginning in the 1980s. Over the extended period from 1950 to 2006, Southwest Savanna counties' combined population grew at a slower rate (19.7% population growth) than statewide population growth (62%) (USCB 2009). During that period, only Green County experienced population growth (46%) approaching the statewide average. Iowa County experienced low relative population growth over the past half-century (20%) but showed positive growth in the past two decades. Grant County (18% population growth from 1950 to 2006) experienced the opposite growth pattern, growing at steady rates for three decades, then showing net population loss since 1980. Lafayette County, heavily dependent on family farms, had lost 12% of its 1950 population by 2006. Southwest Savanna counties combined matched statewide population growth only in the 1970s (6.3% growth compared to 6.5% growth statewide), which was followed by the Southwest Savanna counties' lone decade of net population loss in the agricultural decline during the 1980s (-2.6% compared to 4% statewide growth).

Housing

Housing Density. The Southwest Savanna counties' combined housing density in 2010 (17.7 housing units per square mile of land) was well below the state's housing density (48.5 units per square mile) (USCB 2012a). Similar to population density, the Southwest Savanna counties' housing density was highest in Green County (27.2 units per square mile), followed by Grant (18.8), Iowa (14.1), and Lafayette (11.4) counties.

Seasonal Homes. Seasonal and recreational homes made up only 3.0% of housing stock in the Southwest Savanna counties in 2010, compared to the statewide average of 6.3% (USCB 2012a). Among Southwest Savanna counties, Iowa County had the greatest percentage of seasonal housing (only 4.6%), moderately affected by proximity to both Madison and the Driftless Region, though much of this effect likely exists in the northern portion of the county toward the Wisconsin River, outside of the Southwest Savanna Ecological Landscape in the Western Coulees and Ridges Ecological Landscape.

Housing Growth. Over the last half century, Southwest Savanna counties' combined housing growth has consistently been well below statewide averages. However, Iowa and Green counties have been close to statewide average housing growth in recent decades, while rural and more isolated Grant and Lafayette counties have continued to have relatively slow housing growth. For the decades of the 1950s, 1960s, and 1970s, Grant County had the highest housing growth figures among Southwest Savanna counties (USCB 2009). However, as statewide growth plummeted in the 1980s (to 14.9% from 30.3% in the 1970s), Iowa County actually exceeded statewide housing growth (16% in the 1980s). In the 1990s, Iowa County (21.3%) again was the only Southwest Savanna County to exceed statewide housing growth (20.2%). From 2000 to 2007, both Green and Iowa counties exceeded statewide housing growth, while Grant and Lafayette counties remained well below those figures.

Housing Values. Southwest Savanna counties each had 2006–2010 median housing values below the statewide median housing value of $169,000: Iowa ($155,500), Green ($150,300), Grant ($118,300), and Lafayette ($117,700) (USCB 2012b).

The Economy

The local economies of Southwest Savanna counties are concentrated in the Government and Retail trade sectors and are particularly dependent upon the Agricultural sector. While no other ecological landscape county approximation in the state can match the Southwest Savanna counties' proportion of farming production, dependence on farming tends to be inversely related with economic well-being. For nearly all economic metrics, the Southwest Savanna Ecological Landscape is divided among Iowa and Green counties, which are near the metropolitan area of Madison, with Lafayette and Grant counties farther away from Madison. Per capita income and average wages per job are low in the Southwest Savanna counties. Though in relative terms and by many common measures, the Southwest Savanna counties' economies are not highly productive; they do not suffer from common indicators of local economies in crisis, such as high unemployment or poverty rates. Property values are relatively low in Southwest Savanna counties and vary among Southwest Savanna counties to the degree that they are isolated from urban centers.

Income

Per Capita Income. Total personal income for Southwest Savanna counties in 2006 was $3.56 billion (1.9% of the state total), with Grant County ($1.31 billion) and Green County ($1.12 billion) contributing the majority of income in Southwest Savanna counties, followed by Iowa County ($0.72 billion) and Lafayette County ($0.40 billion) (USDC BEA 2006). Per capita income in Southwest Savanna counties in 2006 ($28,795) was well below the statewide average of $34,405. In a trend that carries across many metrics, Green and Iowa counties have per capita incomes considerably higher than Grant and Lafayette counties (Table 20.8).

Household Income. Among Southwest Savanna counties, median household income follows a similar trend as per capita income. But Green (2005 median household income of $47,584) and Iowa (50,338) counties not only fared better than their neighbors but exceeded the statewide figure ($47,141), according to U.S. Census Bureau estimates (USCB 2009). Lafayette ($43,413) and Grant ($39,896) counties were only somewhat below the statewide figure, indicating that Southwest Savanna counties have more households with two wage earners than much of the state.

Earnings Per Job. Southwest Savanna counties had average earnings per job in 2006 ($27,803) much lower than the statewide average ($36,142) (USDC BEA 2006). Iowa County ($30,566) had the highest earnings per job among Southwest Savanna counties, with the lowest in Lafayette County ($25,123) (Table 20.8). Among the three measures of income, Southwest Savanna counties fared most poorly in terms of earnings per job, indicating that while jobs in the region tend to be low paying, relatively few are part-time or seasonal.

Unemployment

The Southwest Savanna counties had a combined 2006 unemployment rate of 4.4%, which compares favorably to statewide unemployment rates (4.7%). All four Southwest Savanna counties had unemployment rates below the statewide average, ranging from 4.1% in Lafayette to 4.5% in Grant County (USDL BLS 2006; Table 20.8). Despite the prevalence of relatively low-paying jobs in Southwest Savanna counties, citizens tend to hold jobs at rates comparable to or even better than

Table 20.8. *Economic indicators for the Southwest Savanna 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%**
Grant	$26,923	$26,458	4.5%	12.3%
Green	$31,761	$28,223	4.4%	7.0%
Iowa	$30,685	$30,566	4.3%	6.8%
Lafayette	$25,169	$25,123	4.1%	8.4%
Southwest Savanna counties	**$28,795**	**$27,803**	**4.4%**	**8.9%**

[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.

more prosperous areas of the state. Unemployment rates were much higher throughout the state after 2008 but have become lower again.

Poverty

Poverty Rates. Southwest Savanna counties fare surprisingly well in terms of poverty within their populations. The U.S. Census Bureau estimated the Southwest Savanna counties' combined 2005 poverty rate for all people at 8.9%, compared to 10.2% for the state as a whole (USCB 2009). Iowa County (6.8%) had the lowest poverty rate among Southwest Savanna counties. Only Grant County (12.3%) had a higher poverty rate than the state as a whole (Table 20.8).

Child Poverty Rates. Compared to the statewide average (14%), 2005 estimates of poverty rates for people under age 18 in Southwest Savanna counties were lower in all four counties (USCB 2009). Child poverty rates in Iowa (8.7%) and Green (9.2%) counties compared more favorably than in Grant (13.5%) and Lafayette (13.7%) counties, pointing again to the split between the Southwest Savanna counties.

Residential Property Values

Average residential property value per housing unit in 2006 in the combined Southwest Savanna counties ($86,167) was much lower than the statewide average ($134,021) (Table 20.9). Residential property values are another measure which splits the two pairs of Southwest Savanna counties. Green ($109,785) and Iowa ($101,509) counties had comparably much higher residential property values than Grant ($68,791) and Lafayette ($63,378) counties. This effect is driven by proximity to urban centers; Iowa and Green counties border Dane County, with the influence of the Madison metropolitan area correlated with higher property values.

Important Economic Sectors

Southwest Savanna counties together provided an estimated 69,561 jobs in 2007, or 2.0% of the total employment in the state. (Table 20.10; MIG 2009) Jobs in Southwest Savanna counties are relatively concentrated in just a few economic sectors, with the relative abundance of agriculture-related jobs defining the region's economy. The principal employer in Southwest Savanna counties is the Retail Trade sector (15.2% of their total employment). For definitions of economic sectors, see the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013). Government sector jobs are the second most prevalent in Southwest Savanna counties (14.0% of employment) with their proximity to the state capital in Madison. Most notable in Southwest Savanna counties is the prevalence of Agriculture, Fishing and Hunting sector jobs (13.8% of jobs in the region). In Lafayette County, the farming sector is extraordinarily important. Agriculture is the leading employer, representing over 26% of all jobs and also produces over a quarter of Lafayette County's industrial output. Manufacturing (9.1%), Health Care and Social Services (9.0%), and Tourism-related (8.8%) are other sectors with considerable employment in Southwest Savanna counties.

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

When compared with the rest of the state, the Southwest Savanna counties had only six sectors of employment with quotients higher than 1.0, demonstrating a relative lack of diversity and the prominence of agriculture in the local economy (Figure 20.23, Appendix 20.I). The Southwest Savanna

Table 20.9. *Property values for the Southwest Savanna 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**
Grant	$1,452,930,500	21,121	$68,791
Green	$1,701,565,400	15,499	$109,785
Iowa	$1,067,160,700	10,513	$101,509
Lafayette	$445,989,000	7,037	$63,378
Southwest savanna counties	**$4,667,645,600**	**54,170**	**$86,167**

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

Table 20.10. *Total and percentage of jobs in 2007 in each economic sector within the Southwest Savanna (SWS) counties. The economic sectors providing the highest percentage of jobs in the Southwest Savanna counties are highlighted in blue.*

Industry sector	WI employment	% of WI total	SWS counties employment	% of SWS counties total
Agriculture, Fishing & Hunting	110,408	3.1%	9,628	13.8%
Forest Products & Processing	88,089	2.5%	782	1.1%
Mining	3,780	0.1%	46	0.1%
Utilities	11,182	0.3%	177	0.3%
Construction	200,794	5.6%	3,833	5.5%
Manufacturing (non-wood)	417,139	11.7%	6,354	9.1%
Wholesale Trade	131,751	3.7%	2,306	3.3%
Retail Trade	320,954	9.0%	10,588	15.2%
Tourism-related	399,054	11.2%	6,113	8.8%
Transportation & Warehousing	108,919	3.1%	1,567	2.3%
Information	57,081	1.6%	1,213	1.7%
Finance & Insurance	168,412	4.7%	2,133	3.1%
Real Estate, Rental & Leasing	106,215	3.0%	985	1.4%
Professional, Science & Tech Services	166,353	4.7%	1,607	2.3%
Management	43,009	1.2%	64	0.1%
Administrative and Support Services	166,405	4.7%	1,902	2.7%
Private Education	57,373	1.6%	97	0.1%
Health Care & Social Services	379,538	10.7%	6,244	9.0%
Other Services	187,939	5.3%	4,188	6.0%
Government	430,767	12.1%	9,734	14.0%
Totals	**3,555,161**		**69,561**	**2.0%**

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

counties' Agriculture, Fishing and Hunting sector has the highest quotient of all ecological landscapes in the state, with agricultural employment representing more than four times as many jobs locally as it does statewide. Similarly, the Southwest Savanna counties' Retail Trade sector has the highest quotient of all ecological landscape county approximations in the state, representing a relatively large portion of jobs in the Southwest Savanna counties. Other sectors with relatively high location quotients, in order of their relative portion are Government, Other Services, and Information.

The Other Services sector consists primarily of equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, and providing dry-cleaning and laundry services, personal care services, death care services, pet care services, photo finishing services, and temporary parking services (Marcouiller and Xia 2008). The Tourism-related sector includes relevant subsectors within Retail Trade; Passenger Transportation; and Arts, entertainment, and recreation. The Tourism-related sector also includes all Accommodation and Food Services.

Urban Influence

The U.S. Department of Agriculture's Economic Research Service (USDA ERS) divides counties into 12 groups on a continuum of urban influence, with 1 representing large metropolitan areas, 2 representing smaller metropolitan areas, and remaining

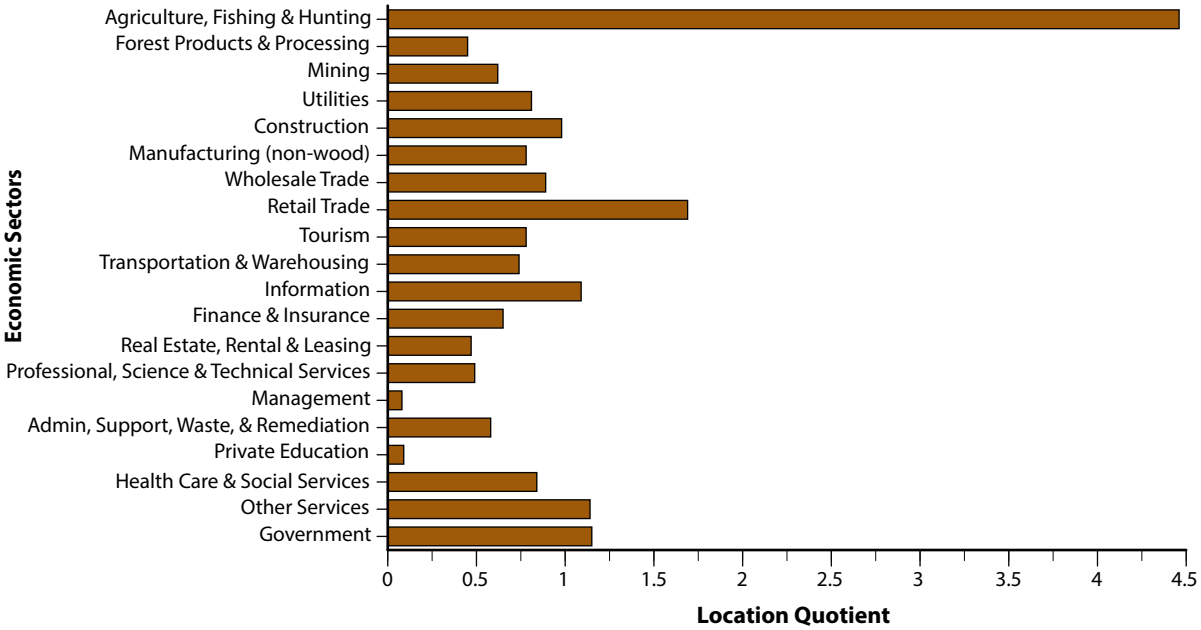

Figure 20.23. *Importance of economic sectors within the Southwest Savanna counties compared to the rest of the state. If the location quotient is greater than 1.0, the Southwest Savanna counties are contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the Southwest Savanna counties are contributing fewer jobs to that economic sector than the state average.*

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 that population size, urbanization, and access to larger adjacent economies are crucial elements in evaluating potential of local economies. Iowa County, with its proximity to the Madison area, is considered a metropolitan county and categorized as a class 2 smaller metropolitan area county. Green and Grant counties are classified as class 5 counties (micropolitan areas adjacent to small metropolitan areas). Lafayette County is relatively isolated and is classified as a class 7 county.

Economic Types

Based on the assumption that knowledge and understanding of different types of rural economies and their distinctive economic and sociodemographic profiles can aid rural policymaking, the USDA ERS 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). Lafayette County is categorized as farming-dependent, Iowa County is service-Dependent, and Green and Grant counties are nonspecialized counties.

Policy Types

The USDA ERS also classifies counties according to "policy types" deemed especially relevant to rural development policy (USDA ERS 2012a). In 2004 none of the Southwest Savanna counties was labeled with any of these classifications.

Integrated Opportunities for Management

Use of natural resources for human needs within the constraints of maintaining sustainable ecosystems is an integral part of ecosystem management. Integrating ecological management with socioeconomic programs or activities can result in efficiencies in land use, tax revenues, and private capital. This type of integration can also help generate broader and deeper support for sustainable ecosystem management. However, any human modification or use of natural communities has trade-offs that benefit some species and harm others. Even relatively benign activities such as ecotourism will have impacts on the ecology of an area. Trade-offs caused by management actions need to be carefully weighed and monitored when planning management to ensure that some species are not being irreparably harmed. Maintaining healthy, sustainable ecosystems provides many benefits to people and our economy. The development of ecologically sound management plans should save money and sustain natural resources in the long run.

The principles of integrating natural resources and socioeconomic activities are similar across 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 when planning the management of natural resources within a given area.

Appendices

Appendix 20.A. *Watershed water quality summary for the Southwest Savanna Ecological Landscape.*

Watershed number	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
GP01	Galena River	154,776	Poor to Good; barnyard runoff, streambank grazing; old mining waste; CAFO threats; stream buffers needed
GP02	Platte River	126,552	Fair to Good; soil loss; streambank grazing; agr nutrients
GP03	Little Platte River	99,163	Fair to Very Good; agr nutrient & soil runoff; streambank grazing
GP04	Lower Grant River	83,042	Poor to Fair; very heavy agr sediment runoff; low D.O.
GP05	Middle Grant River	51,110	Poor to Good; stormwater; sediment, agr runoff
GP06	Upper Grant River	67,900	Fair to Good; rapid runoff from barnyards and farm fields
GP07	Mississippi River	70,700	Fair to Good; sed; high pH; dams; habitat degradation
LW01[b]	Millville Creek	77,937	Fair to Good; nonpoint runoff; ditching; erosion; atrazine
LW07[b]	Green River and Crooked Creek	80,455	Good; nonpoint and atrazine concerns
LW09	Blue River	138,363	Fair to Very Good; barnyard runoff; bank grazing; low D.O.; atrazine
LW11[b]	Otter and Morrey creeks	127,159	Fair to Excellent; low flows; small dams; culverts; NPS
LW15[b]	Mill and Blue Mounds Creek	119,511	Fair to Good/ORW; NPS pollution; urbanization; flood control structures; atrazine; manure pit overtopping
SP02	Jordan and Skinner creeks	60,196	Unknown; probable polluted agr runoff due to land use
SP03	Lower East Branch Pecatonica rivers	92,671	Fair to Good; polluted runoff harms feeder trout streams
SP04	Yellowstone River	36,772	Fair; sed and agr nutrient loading
SP05	Gordon Creek	49,213	Poor to Good; intense grazing, exposed and eroding banks and runoff from cultivated fields and barnyards
SP06	Upper East Branch Pecatonica River	89,713	Good; sed; eroding banks; cattle on banks
SP07	Lower Pecatonica River	85,906	Unknown; high quality wetlands may buffer agr land uses
SP08	Middle Pecatonica River	119,311	Unknown; endangered slender madtom in four tributaries
SP09	Mineral Point and Sudan branches	69,286	Good; NPS runoff from agr; listed Ozark mudminnow
SP10	Upper West Branch Pecatonica River	49,762	Fair; polluted agr runoff remains a problem
SP13	Allen Creek and Middle Sugar River	98,566	Unknown; four tributaries are ERW
SP14	Little Sugar River	85,134	Good – ERW; some NPS pollution sources
SP15	Upper Sugar River	67,816	Good in Sugar; Fair to Good in tribs; threats are urban GW diversions and NPS pollutants
SP16	West Branch Sugar River/ Mt. Vernon Creek	42,714	Fair in West Branch Sugar River; Good ORW to Poor in tribs; polluted runoff

Source: Wisconsin DNR Bureau of Watershed Management data.

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

[b]Only a small fraction of this watershed lies within the Northwest Lowlands, 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.
CAFO = Concentrated animal feeding operations.
D.O. = Dissolved oxygen.
ERW = Exceptional Resource Water (very good to excellent water quality, with point source discharges).
GW = Groundwater (without modifiers, indicates high nitrates, radon, manganese or other negative use condition).
ORW = Outstanding Resource Water (very good to excellent water quality, with no point source discharges).
NPS = Nonpoint source pollutants, such as farm or parking lot runoff, or septic system leakage.
PS = Point source pollutants, such as treated municipal and industrial wastewater.
Sed = Excess sedimentation.
Tribs = Streams that are tributary to the stream(s) after which the watershed is named.

Appendix 20.B. *Forest habitat types in the Southwest Savanna 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 Southwest Savanna Ecological Landscape
ATiAs(De)	*Acer saccharum-Tilia americana/Arisaema, Desmodium* variant Sugar maple-Basswood/Jack-in-the-pulpit, Tick trefoil variant
ATiH	*Acer saccharum-Tilia americana/Hydrophyllum* Sugar maple-Basswood/Virginia waterleaf
ATiCr(As)	*Acer saccharum-Tilia americana/Cornus racemosa, Arisaema* variant Sugar maple-Basswood/Gray dogwood, Jack-in-the-pulpit variant
ATiCr(O)	*Acer saccharum-Tilia americana/Cornus racemosa, Osmorhiza* variant Sugar maple-Basswood/Gray dogwood, Sweet cicely variant

Source: Kotar and Burger (1996).

Appendix 20.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 Southwest Savanna (SWS) 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 SWS	EOs in WI	Percent in SWS	State rank	Global rank	State status	Federal status
MAMMALS[b]								
Microtus ochrogaster (prairie vole)	1998	1	19	5%	S1S2	G5	SC/N	
Pipistrellus subflavus (eastern pipistrelle)	1999	1	7	14%	S3S4	G5	SC/N	
Reithrodontomys megalotis (western harvest mouse)	1998	3	11	27%	S3	G5	SC/N	
Spermophilus franklinii (Franklin's ground squirrel)	1987	1	12	8%	S2	G5	SC/N	
BIRDS[c]								
Ammodramus henslowii (Henslow's Sparrow)	2007	31	82	38%	S3B	G4	THR	
Bartramia longicauda (Upland Sandpiper)	2005	10	54	19%	S2B	G5	SC/M	
Empidonax virescens (Acadian Flycatcher)	2006	2	47	4%	S3B	G5	THR	
Haliaeetus leucocephalus (Bald Eagle)	2008	5	1286	0%	S4B,S2N	G5	SC/P	
Lanius ludovicianus (Loggerhead Shrike)	1992	2	31	6%	S1B	G4	END	
Spiza americana (Dickcissel)	2005	14	46	30%	S3B	G5	SC/M	
Sturnella neglecta (Western Meadowlark)	2004	4	39	10%	S2B	G5	SC/M	
Vireo bellii (Bell's Vireo)	2007	13	43	30%	S2B	G5	THR	
Wilsonia citrina (Hooded Warbler)[d]	2006	1	32	3%	S2S3B	G5	THR	
HERPTILES								
Acris crepitans (northern cricket frog)	2007	43	102	42%	S1	G5	END	
Coluber constrictor (North American racer)	2007	1	14	7%	S2	G5	SC/P	
Emydoidea blandingii (Blanding's turtle)	2008	7	316	2%	S3	G4	THR	
Lithobates catesbeianus (American bullfrog)	2006	2	70	3%	S3	G5	SC/H	
Pituophis catenifer (Gophersnake)	2004	2	29	7%	S2S3	G5	SC/P	
FISHES								
Clinostomus elongatus (redside dace)	2002	11	96	11%	S3	G3G4	SC/N	
Erimystax x-punctatus (gravel chub)	1986	1	4	25%	S1	G4	END	
Ictiobus niger (black buffalo)	2006	2	11	18%	S2	G5	THR	
Macrhybopsis storeriana (silver chub)	1976	2	13	15%	S3	G5	SC/N	
Notropis nubilus (Ozark minnow)	2007	7	24	29%	S2	G5	THR	
Noturus exilis (slender madtom)	1976	10	18	56%	S1	G5	END	
MUSSELS/CLAMS								
Tritogonia verrucosa (buckhorn)	1993	1	12	8%	S2	G4G5	THR	
MISCELLANEOUS INVERTEBRATES								
Hendersonia occulta (cherrystone drop)	2006	1	53	2%	S3	G4	THR	
BUTTERFLIES/MOTHS								
Chlosyne gorgone (gorgone checker spot)	1994	2	40	5%	S3	G5	SC/N	
Hesperia leonardus (Leonard's skipper)	1996	1	29	3%	S3	G4	SC/N	
Hesperia ottoe (ottoe skipper)	1987	1	16	6%	S2	G3G4	SC/N	
Speyeria idalia (regal fritillary)	2008	5	24	21%	S1	G3	END	
DRAGONFLIES/DAMSELFLIES								
Archilestes grandis (great spreadwing)	1986	1	3	33%	S2	G5	SC/N	
Argia plana (highland dancer)	1987	2	4	50%	S2	G5	SC/N	
Stylurus plagiatus (russet-tipped clubtail)	1992	1	8	13%	S2	G5	SC/N	
MISCELLANEOUS INSECTS/SPIDERS								
Aflexia rubranura (red-tailed prairie leafhopper)	2006	7	25	28%	S2	G2	END	
Amplicephalus kansiensis (a leafhopper)	1997	1	3	33%	S1?	GNR	SC/N	

Continued on next page

Appendix 20.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in SWS	EOs in WI	Percent in SWS	State rank	Global rank	State status	Federal status
Dichromorpha viridis (short-winged grasshopper)	1999	1	4	25%	S3?	G5	SC/N	
Laevicephalus vannus (a leafhopper)	1999	1	2	50%	S1?	GNR	SC/N	
Pentagenia vittigera (a common burrower mayfly)	1991	1	3	33%	S1S2	G5	SC/N	
Polyamia dilata (prairie leafhopper)	1997	1	20	5%	S2	GNR	THR	
Prairiana cinerea (a leafhopper)	1996	1	6	17%	S2S3	GNR	SC/N	
PLANTS								
Agalinis gattingeri (roundstem foxglove)	1997	1	23	4%	S3	G4	THR	
Agastache nepetoides (yellow giant hyssop)	1987	1	30	3%	S3	G5	THR	
Aplectrum hyemale (putty root)	1972	1	17	6%	S2S3	G5	SC	
Arabis shortii (Short's rock-cress)	2003	1	11	9%	S2	G5	SC	
Asclepias lanuginosa (woolly milkweed)	2007	5	16	31%	S1	G4?	THR	
Asclepias purpurascens (purple milkweed)	1987	3	39	8%	S3	G5?	END	
Baptisia tinctoria (yellow wild-indigo)	1986	1	2	50%	S1	G5	SC	
Besseya bullii (kitten tails)	1998	1	98	1%	S3	G3	THR	
Botrychium campestre (prairie dunewort)	2006	1	4	25%	S1	G3G4	END	
Cacalia muehlenbergii (great Indian-plantain)	2004	7	25	28%	S2S3	G4	SC	
Cacalia tuberosa (prairie Indian plantain)	2007	15	62	24%	S3	G4G5	THR	
Camassia scilloides (wild hyacinth)	2008	5	8	63%	S2	G4G5	END	
Carex laevivaginata (smooth-sheath sedge)	2005	1	3	33%	S1	G5	END	
Carex prasina (drooping sedge)	1993	1	31	3%	S3	G4	THR	
Carex richardsonii (Richardson sedge)	2004	5	24	21%	S2	G4	SC	
Cirsium hillii (Hill's Thistle)	2006	17	58	29%	S3	G3	THR	
Cypripedium candidum (small white lady's-slipper)	1999	1	47	2%	S3	G4	THR	
Diarrhena obovata (beak grass)	2001	4	11	36%	S2	G4G5	END	
Echinacea pallida (pale-purple coneflower)	1996	23	54	43%	S3	G4	THR	
Gentiana alba (yellow gentian)	2001	7	80	9%	S3	G4	THR	
Gymnocarpium robertianum (limestone oak fern)	1972	1	8	13%	S2	G5	SC	
Huperzia porophila (rock clubmoss)	1974	1	22	5%	S3	G4	SC	
Jeffersonia diphylla (twinleaf)	2006	4	23	17%	S3	G5	SC	
Lespedeza leptostachya (prairie bush-clover)	2009	8	22	36%	S2	G3	END	LT
Lithospermum latifolium (American gromwell)	2003	8	62	13%	S3	G4	SC	
Napaea dioica (glade mallow)	2005	30	79	38%	S3	G4	SC	
Nuphar advena (yellow water lily)	1972	1	2	50%	S1	G5T5	SC	
Onosmodium molle (marbleseed)	2006	24	42	57%	S3	G4G5	SC	
Orobanche uniflora (one-flowered broomrape)	1999	3	30	10%	S3	G5	SC	
Parthenium integrifolium (American fever-few)	2001	55	83	66%	S3	G5	THR	
Pediomelum esculentum (prairie turnip)	2007	19	47	40%	S3	G5	SC	
Platanthera flava var. *herbiola* (pale green orchid)	2000	1	20	5%	S2	G4T4Q	THR	
Poa sylvestris (woodland bluegrass)	2001	1	3	33%	S1	G5	SC	
Polytaenia nuttallii (prairie parsley)	1995	2	26	8%	S3	G5	THR	
Prenanthes crepidinea (nodding rattlesnake-root)	2008	1	3	33%	S1	G4	END	
Scutellaria ovata (heart-leaved skullcap)	2001	3	16	19%	S3	G5	SC	
Silene nivea (snowy campion)	1994	1	6	17%	S2	G4?	THR	
Silene virginica (fire pink)	2003	1	2	50%	S1	G5	END	
Talinum rugospermum (prairie fame-flower)	2001	2	54	4%	S3	G3G4	SC	
Thaspium trifoliatum var. *flavum* (purple meadow-parsnip)	1989	3	6	50%	S2	G5T5	SC	
Trillium recurvatum (reflexed trillium)	1990	3	58	5%	S3	G5	SC	
Triphora trianthophora (nodding pogonia)	2002	2	16	13%	S2	G3G4	SC	

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Appendix 20.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in SWS	EOs in WI	Percent in SWS	State rank	Global rank	State status	Federal status
COMMUNITIES								
Dry Cliff	1976	3	88	3%	S4	G4G5	NA	
Dry Prairie	2001	14	146	10%	S3	G3	NA	
Dry-mesic Prairie	1987	3	37	8%	S2	G3	NA	
Emergent Marsh	1973	3	272	1%	S4	G4	NA	
Floodplain Forest	1973	3	182	2%	S3	G3?	NA	
Hemlock Relict	2000	3	32	9%	S2	G2Q	NA	
Lake—Oxbow	1973	2	14	14%	SU	GNR	NA	
Mesic Prairie	1996	6	44	14%	S1	G2	NA	
Moist Cliff	1984	6	176	3%	S4	GNR	NA	
Oak Woodland	1999	1	10	10%	S1?	GNR	NA	
Pine Relict	1987	8	61	13%	S2	G4	NA	
Southern Dry Forest	1989	11	97	11%	S3	G4	NA	
Southern Dry-mesic Forest	1992	21	293	7%	S3	G4	NA	
Southern Mesic Forest	1990	8	221	4%	S3	G3?	NA	
Southern Sedge Meadow	2003	5	182	3%	S3	G4?	NA	
OTHER ELEMENTS								
Bat hibernaculum	1999	5	43	12%	S3	GNR	SC	
Bird rookery	1987	1	54	2%	SU	G5	SC	

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

[b]The eastern pipistrelle bat (*Perimyotis subflavus*) and northern long-eared bat (*Myotis septentrionalis*) were listed as Wisconsin Threatened on 6/01/2011, and the northern long-eared bat was listed as U.S. Threatened on 5/04/2015.

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

[d]The American Ornithologist's Union lists the Hooded Warbler as *Setophaga citrina*.

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.

Status and ranking definitions continued on next page

Appendix 20.C, *continued.*

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 20.D. *Number of species with special designations documented within the Southwest Savanna Ecological Landscape, 2009.*

Listing status[a]	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	0	0	0	0	0	0
Wisconsin Endangered	0	1	1	2	2	6	8	14
Wisconsin Threatened	0	4	1	2	3	10	14	24
Wisconsin Special Concern	4	4	3	2	11	24	20	44
Natural Heritage Inventory total	**4**	**9**	**5**	**6**	**16**	**40**	**42**	**82**

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

[a]The eastern pipistrelle (*Perimyotis subflavus*) and northern long-eared (*Myotis septentrionalis*) bats were listed as Wisconsin Threatened in 2011, and the northern long-eared bat was listed as U.S. Threatened in 2015. These species are not included in the numbers above.

Appendix 20.E. *Species of Greatest Conservation Need (SGCN) found in the Southwest Savanna 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.


Bell's Vireo.
Photo by Brian Collins

	MAJOR							IMPORTANT								
	Dry Prairie	Dry-mesic Prairie	Mesic Prairie	Oak Opening	Oak Woodland	Surrogate Grasslands	Warmwater Streams	Coldwater Streams	Coolwater Streams	Dry Cliff	Hemlock Relict	Pine Relict	Southern Dry Forest	Southern Dry-mesic Forest	Southern Mesic Forest	Wet-mesic Prairie
Species that are Significantly Associated with the Southwest Savanna Ecological Landscape																
BIRDS[a]																
Bell's Vireo	M	M				M										M
Bobolink		H	H			H										H
Brown Thrasher	M	M		H		M										
Dickcissel		H	H			H										
Eastern Meadowlark	M	H	H	M		H										M
Field Sparrow	H	M	M	H		M										M
Grasshopper Sparrow	H	H				H										
Henslow's Sparrow		H	H	M		H										M
Northern Bobwhite	M	M	M	M		H										M
Red-headed Woodpecker				H	H								M	M		
Short-eared Owl	M	M	H			H										H
Upland Sandpiper	H	H	M			H										M
Vesper Sparrow	H	M		M												
Western Meadowlark	M	H				H										
Willow Flycatcher		M	M			M										M
HERPTILES																
Blanchard's cricket frog							H	H	H							
Blanding's turtle	H	M	M	H	M		M	M	M					M	M	M
Ornate box turtle	H	M		H	H								H	H	M	
Pickerel frog			M				H	H	H						M	H
Prairie ring-necked snake	H	H		H	M								M	M		
Yellow-bellied racer	H	M								M			M	M		
FISH																
Slender madtom							H									

Continued on next page

Appendix 20.E, *continued.*


Cricket frog.
Photo by Tyler Brandt, Wisconsin DNR.

	MAJOR							IMPORTANT								
	Dry Prairie	Dry-mesic Prairie	Mesic Prairie	Oak Opening	Oak Woodland	Surrogate Grasslands	Warmwater Streams	Coldwater Streams	Coolwater Streams	Dry Cliff	Hemlock Relict	Pine Relict	Southern Dry Forest	Southern Dry-mesic Forest	Southern Mesic Forest	Wet-mesic Prairie
Species That Are Moderately Associated with the Southwest Savanna Ecological Landscape																
MAMMALS																
Eastern red bat				M	M		M	H	H		M	M	M	M	M	
Franklin's ground squirrel		H	M	H	M	M										M
Northern long-eared bat					M		M	H	H		M		M	M	M	
Prairie vole	H	H	M	M		M										
Woodland vole				H	H								H	H		
BIRDS																
American Golden Plover		M	M			M										M
Black-billed Cuckoo																
Blue-winged Teal		M	M			M										M
Blue-winged Warbler				M	M								M	M	M	
Buff-breasted Sandpiper		M				M										M
Loggerhead Shrike	M	M				H										
Northern Harrier	M	M	H			H										H
Solitary Sandpiper							M	M	M							
Wood Thrush					M								M	H	H	
Yellow-billed Cuckoo														M	M	
HERPTILES																
Gophersnake	H	H	M	H	H					H		M	M	M	M	
Timber rattlesnake	H	M	M	H	H					H		H	H	H	H	
FISH																
Ozark minnow							H									

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

Appendix 20.F. *Natural communities[a] for which there are management opportunities in the Southwest Savanna Ecological Landscape.*

Major opportunity[b]	Important opportunity[c]	Present[d]
Oak Opening	Southern Dry Forest	Floodplain Forest
Oak Woodland	Southern Dry-Mesic Forest	Cedar Glade
	Southern Mesic Forest	
Dry Prairie	Hemlock Relict	Shrub-carr
Dry-Mesic Prairie	Pine Relict	Sand Prairie
Mesic Prairie		
Surrogate Grasslands	Wet-Mesic Prairie	Wet Prairie
		Southern Sedge Meadow
Warmwater Stream	Dry Cliff (Curtis' Exposed Cliff)	
	Moist Cliff (Curtis' Shaded Cliff)	Emergent Marsh
		Submergent Marsh
	Coldwater Stream	Ephemeral Pond
	Coolwater Stream	
		Impoundment/Reservoir
		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 20.G. *Public conservation lands in the Southwest Savanna Ecological Landscape, 2005.*

Property name	Size (acres)[a]
STATE	
Belmont Mound State Park	250
Blue Mound State Park[b]	970
Browntown-Cadiz Springs State Recreation Area	640
Hardscrabble Prairie State Natural Area	160
Mount Vernon Creek State Fishery Area	370
New Glarus Woods State Park	390
Yellowstone Lake State Park	730
Yellowstone Lake State Wildlife Area	4,210
Miscellaneous Lands[c]	1,935
FEDERAL	
None	
COUNTY FOREST[d]	
None	
TOTAL	**9,655**

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

[a]Actual acres owned in this ecological landscape.

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

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

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

Appendix 20.H. *Land Legacy places in the Southwest Savanna Ecological Landscape and their ecological and recreational significance.*

The *Wisconsin Land Legacy Report* (WDNR 2006c) identified 8 places in the Southwest Savanna Ecological Landscape that merit conservation action based upon a combination of ecological significance and recreational potential.

Map code	Place name	Size	Protection initiated	Protection remaining	Conservation significance[a]	Recreation potential[b]
BV	Blue Mound – Blanchardville Prairie and Savanna	Large	Moderate	Substantial	xxxxx	xxxxx
BP	Blue Mound State Park	Small	Substantial	Limited	xxxx	xxxxx
FH	Fever River – Hardscrabble Prairie	Medium	Limited	Substantial	xxx	xx
GR	Grant and Rattlesnake Rivers	Medium	Limited	Moderate	xx	xx
MM	Monroe – Muralt Prairie	Medium	Limited	Substantial	xxxxx	xxx
PC	Pecatonica River and Grasslands	Large	Limited	Substantial	xxxx	xxx
PL	Platte River	Medium	Limited	Moderate	xx	xx
YL	Yellowstone Lake	Small	Substantial	Limited	x	xxxx

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

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

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

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

Appendix 20.I. *Importance of economic sectors (based on the number of jobs) within the Southwest Savanna 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 20.J. *Scientific names of species mentioned in the text.*

Common name	Scientific name
Acadian Flycatcher[a]	*Empidonax virescens*
American badger	*Taxidea taxus*
American basswood	*Tilia americana*
American bison	*Bos bison*
American black bear	*Ursus americanus*
American fever-few	*Parthenium integrifolium*
Aspens	*Populus* spp.
Autumn olive	*Elaeagnus umbellata*
Bell's Vireo	*Vireo bellii*
Bird's-foot trefoil	*Lotus corniculata*
Black buffalo	*Ictiobus niger*
Black cherry	*Prunus serotina*
Black locust	*Robinia pseudoacacia*
Black oak	*Quercus velutina*
Black walnut	*Juglans nigra*
Blackberries	*Rubus* spp.
Blanding's turtle	*Emydoidea blandingii*
Box elder	*Acer negundo*
Brook trout	*Salvelinus fontinalis*
Brown thrasher	*Toxostoma rufum*
Brown trout	*Salmo trutta*
Buckhorn mussel	*Tritogonia verrucosa*
Bull thistle	*Cirsium vulgare*
Bur oak	*Quercus macrocarpa*
Canada bluegrass	*Poa compressa*
Canada thistle	*Cirsium arvense*
Channel catfish	*Ictalurus punctatus*
Cherrystone drop terrestrial snail	*Hendersonia occulta*
Common buckthorn	*Rhamnus cathartica*
Common carp	*Cyprinus carpio*
Common milkweed	*Asclepias syriaca*
Common prickly-ash	*Zanthoxylum americanum*
Crown vetch	*Coronilla varia*
Curly pondweed	*Potamogeton crispus*
Cut-leaved teasel	*Dipsacus laciniatus*
Dame's rocket	*Hesperis matronalis*
Dickcissel	*Spiza americana*
Dogwoods	*Cornus* spp.
Dutch elm disease fungus	*Ophiostoma ulmi*
Eastern Bluebird	*Sialia sialis*
Eastern hemlock	*Tsuga canadensis*
Eastern massasauga	*Sistrurus catenatus catenatus*
Eastern pipistrelle bat	*Perimyotis subflavus*
Eastern red bat	*Lasiurus borealis*
Eastern red damselfly	*Amphiagrion saucium*
Eastern Towhee	*Pipilo erythrophthalmus*
Eastern Whip-poor-will	*Antrostomus vociferus*
Eastern white pine	*Pinus strobus*
Elk	*Cervus canadensis*
Elms	*Ulmus* spp.
Emerald ash borer	*Agrilus planipennis*
Eurasian honeysuckles	*Lonicera tatarica*, *Lonicera* x *bella,* and *Lonicera morrowii*
Eurasian water-milfoil	*Myriophyllum spicatum*
Field Sparrow	*Spizella pusilla*
Fire pink	*Silene virginica*

Continued on next page

Appendix 20.J, *continued.*

Common name	Scientific name
Garlic mustard	*Alliaria petiolata*
Glade mallow	*Napaea dioica*
Glossy buckthorn	*Rhamnus frangula*
Gophersnake	*Pituophis catenifer*
Grasshopper Sparrow	*Ammodramus savannarum*
Gravel chub	*Erimystax x-punctatus*
Gray wolf	*Canis lupus*
Great Indian plantain	*Arnoglossum reniforme,* listed as *Cacalia muehlenbergii* on the Wisconsin Natural Heritage Working List
Greater Prairie-Chicken	*Tympanuchus cupido*
Green ash	*Fraxinus pennsylvanica*
Green violet	*Hybanthus concolor*
Gypsy moth	*Lymantria dispar*
Hazelnut	*Corylus* spp.
Henslow's Sparrow	*Ammodramus henslowii*
Hickories	*Carya* spp.
Highland dancer	*Argia plana*
Hill's thistle	*Cirsium hillii*
Hoary bat	*Lasiurus cinereus*
Hooded Warbler	*Setophaga citrina,* listed as *Wilsonia citrina* on the Wisconsin Natural Heritage Inventory Working List
Indiana bat	*Myotis sodalis*
Japanese barberry	*Berberis thunbergii*
Japanese hedge-parsley	*Torilis japonica*
Kentucky bluegrass	*Poa pratensis*
Kentucky coffee-tree	*Gymnocladus dioicus*
Leafy spurge	*Euphorbia esula*
Lesser duckweed	*Lemna minor*
Lilacs	*Syringa* spp.
Loggerhead Shrike	*Lanius ludovicianus*
Marble-seed	*Onosmodium molle*
Multiflora rose	*Rosa multiflora*
Nodding pogonia	*Triphora trianthophora*
Nodding rattlesnake root	*Prenanthes crepidinea*
Northern Bobwhite	*Colinus virginianus*
Northern cricket frog	*Acris crepitans*
Northern pike	*Esox lucius*
Northern red oak	*Quercus rubra*
Norway maple	*Acer platanoides*
Oak wilt fungus	*Ceratocystis fagacearum*
Orchard Oriole	*Icterus spurius*
Ozark minnow	*Notropis nubilus*
Pale purple coneflower	*Echinacea pallida*
Pines	*Pinus* spp.
Poison ivy	*Toxicodendron radicans*
Prairie bush-clover	*Lespedeza leptostachya*
Prairie Indian-plantain	*Arnoglossum atriplicifolium,* listed as *Cacalia tuberosa* on the Wisconsin Natural Heritage Working List
Prairie leafhopper	*Polyamia dilata*
Prairie turnip	*Pediomelum esculentum*
Prairie vole	*Microtus ochrogaster*
Prickly ash	*Zanthoxylum americanum*
Privets	*Ligustrum* spp.
Purple loosestrife	*Lythrum salicaria*
Purple milkweed	*Asclepias purpurascens*

Continued on next page

Appendix 20.J, *continued.*

Common name	Scientific name
Ragweeds	*Ambrosia* spp.
Raspberries	*Rubus* spp.
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-osier dogwood	*Cornus stolonifera*
Redside dace	*Clinostomus elongatus*
Red-tailed prairie leafhopper	*Aflexia rubranura*
Reed canary grass	*Phalaris arundinacea*
Reflexed trillium	*Trillium recurvatum*
Regal fritillary	*Speyeria idalia*
Ring-necked Pheasant	*Phasianus colchicus*
River birch	*Betula nigra*
River grapevine	*Vitis riparia*
Rusty crayfish	*Orconectes rusticus*
Shagbark hickory	*Carya ovata*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Short-eared Owl	*Asio flammeus*
Silver chub	*Macrhybopsis storeriana*
Silver maple	*Acer saccharinum*
Slender madtom	*Noturus exilis*
Smallmouth bass	*Micropteris dolomieu*
Smooth brome	*Bromus inermis*
Smooth sumac	*Rhus glabra*
Spotted knapweed	*Centaurea biebersteinii*
Staghorn sumac	*Rhus hirta*
Stoneflies	*Plecoptera* spp.
Sugar maple	*Acer saccharum*
Timber rattlesnake	*Crotalus horridus*
Two-lined chestnut borer	*Agrilus bilineatus*
Upland Sandpiper	*Bartramia longicauda*
Virginia creeper	*Parthenocissus quinquefolia*
Walleye	*Sander vitreus*
Western foxsnake	*Elaphe vulpina*
Western Meadowlark	*Sturnella neglecta*
White oak	*Quercus alba*
White sweet clover	*Melilotus alba*
White-tailed deer	*Odocoileus virginianus*
Wild cucumber	*Echinocystis lobata*
Wild hyacinth	*Camassia scilloides*
Wild parsnip	*Pastinaca sativa*
Wild Turkey	*Meleagris gallopavo*
Willow Flycatcher	*Empidonax traillii*
Yellow birch	*Betula alleghaniensis*
Yellow gentian	*Gentiana alba*
Yellow giant hyssop	*Agastache nepetoides*
Yellow sweet clover	*Melilotus officinalis*

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

Appendix 20.K. *Maps of important physical, ecological, and aquatic features within the Southwest Savanna Ecological Landscape.*

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

Note: *Go to http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=1 and click the "maps" tab.*

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