Chapter 22
Western Coulees and Ridges 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): Regal fritillary, photo by Ann Swengel; Prothonotary Warbler, photo by Laura Erickson; plains prickly-pear cactus, photo by Dick Bauer; Cerulean Warbler, photo by Dennis Malueg; snow trillium, photo by Eric Epstein, Wisconsin DNR.

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Cover photos

Top left: *Natural Heritage Inventory zoologist Bill Smith with huge black oak along the Mississippi River, Grant County. Photo by Eric Epstein, Wisconsin DNR.*

Center left: *Exposed cliff of Cambrian sandstone along the Kickapoo River, Vernon County. Photo by Robert H. Read.*

Bottom left: *This extensive series of dry bluff prairies is one of the largest and best examples of such features in the Upper Midwest. Rush Creek Bluffs, Crawford County. Photo by Eric Epstein, Wisconsin DNR.*

Right: *Mature forest dominated by large northern red and white oaks. Note the absence of mesophytic competitors in the stand pictured. Maintaining oaks on mesic and dry-mesic sites in the absence of fire and in the presence of dense growths of shrubs and saplings has been problematic. Driftless Area, Sauk County. Photo by Eric Epstein, Wisconsin DNR.*


Thomas Meyer, WDNR

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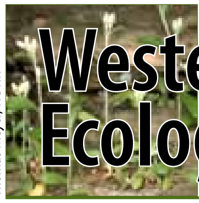

Thomas Meyer, WDNR

Western Coulees and Ridges Ecological Landscape at a Glance

Physical and Biotic Environment

Size
This ecological landscape encompasses 9,642 square miles (6,170,674 acres), over 17% of the state, making it the largest of Wisconsin's 16 ecological landscapes.

Climate
The climate is typical of southern Wisconsin; the mean growing season is 145 days, mean annual temperature is 43.7°F, mean annual precipitation is 32.6 inches, and mean annual snowfall is 43 inches. Because it extends over a considerable latitudinal area, the climate varies from north to south. The climate is favorable for agriculture, but steep slopes limit intensive agricultural uses to broad ridge tops and parts of valleys above floodplains. The climate variability, along with the rugged ridge and coulee (valley) topography, numerous microhabitats, and large rivers with broad, complex floodplains, allows for a high diversity of plants and animals.

Bedrock
The Western Coulees and Ridges Ecological Landscape is mostly underlain by Paleozoic sandstones and dolomites of Cambrian and Ordovician age. Precambrian quartzite occurs in the Baraboo Hills near the eastern edge of the ecological landscape. Thin beds of shale occur with other sedimentary rocks in some areas. Bedrock is exposed as cliffs and, more locally, as talus slopes.

Geology and Landforms
This ecological landscape is characterized by its highly eroded, unglaciated topography with steep sided valleys and ridges, high gradient headwaters streams, and large rivers with extensive, complex floodplains and terraces. Ancient sand dunes occur on some of the broader terraces along the Mississippi and Wisconsin rivers.

Soils
Windblown loess of varying thickness is found throughout the ecological landscape. Alluvium is found in the floodplains. Organic soils, especially peats, are rare.

Hydrology
Dendritic drainage patterns are well developed in this ecological landscape. Natural lakes are restricted to the floodplains of large rivers. Large warmwater rivers are especially important here and include the Wisconsin, Chippewa, and Black. The Mississippi River forms the western boundary of the Western Coulees and Ridges Ecological Landscape. Numerous spring-fed (cold) headwaters streams occur here. Coolwater streams are also common.

Current Land Cover
Vegetation in the Western Coulees and Ridges Ecological Landscape is a mix of forest (41%), agriculture (36%), and grassland (14%) with wetlands (5%) mostly in the river valleys. Primary forest cover is oak-hickory (51%). Maple-basswood forests (28%), dominated by sugar maple, American basswood, and red maple, are common in areas that were not burned frequently before Euro-American settlement. Bottomland hardwoods (10%) dominated by silver maple, swamp white oak, river birch, ashes, elms, and eastern cottonwood are common within the floodplains of the larger rivers. Relict "northern" mesic conifer forests composed of eastern hemlock, eastern white pine, and associated hardwoods such as yellow birch are rare but do occur in areas with cool, moist microclimates. Dry rocky bluffs may support xeric stands of native white pine, sometimes mixed with red or even jack pine. Prairies are now restricted to steep south- or west-facing bluffs, unplowed outwash terraces along the large rivers, and a few other sites. They occupy far less than 1% of the current landscape. Mesic tallgrass prairies are now virtually nonexistent except as very small remnants along rights-of-way or in cemeteries.

Socioeconomic Conditions
The counties included in this socioeconomic region are Buffalo, Crawford, Dunn, Eau Claire, Grant, Iowa, Jackson, La Crosse, Monroe, Pepin, Pierce, Richland, Sauk, Trempealeau, and Vernon counties.

Population
The population in 2010 was 614,553, or 10.8% of the state total.

Population Density
57 persons per square mile

Per Capita Income
$29,363

Important Economic Sectors
Important economic sectors include Government, Tourism-related, Health Care and Social Services, and Retail Trade in 2007, reflecting high government and tourism-related dependence. Agriculture, forestry, and rural residential development affect the natural resources in the ecological landscape most extensively.

Public Ownership
Public ownership in the Western Coulees and Ridges Ecological Landscape is limited (only about 3%), and much of it is associated with the large rivers (i.e., Mississippi, Wisconsin, Chippewa, and Black rivers). The state owns and manages several parks (Wyalusing, Wildcat Mountain, Perrot, Devil's Lake), scattered state wildlife and fishery areas, one experimental state forest (Coulee), one demonstration forest (Douglas Hallock), and some state natural areas (Rush Creek Bluffs, Morgan Coulee, Nelson-Trevino Bottoms, Mount Pisgah Hemlock-Hardwoods). The Wisconsin Department of Tourism owns the Kickapoo Reserve in eastern Vernon County. Federal ownership includes Fort McCoy Military Reservation and two national wildlife refuges: Upper Mississippi River National Wildlife and Fish Refuge and Trempealeau National Wildlife Refuge. A map showing public land ownership (county, state, and federal) and private lands enrolled in the forest tax programs can be found in the maps appendix (see Appendix 22.K at the end of this chapter).

Other Notable Ownerships
The Nature Conservancy owns and manages significant properties in the Baraboo Hills and at several other locations (e.g., Spring Green). Several other nongovernmental conservation organizations (NGOs) are active here, including the Mississippi Valley Conservancy, The Prairie Enthusiasts, and the Wisconsin Society for Ornithology. The Ho-Chunk Nation owns ecologically valuable lands, such as those along the Kickapoo River in Vernon County, between Wildcat Mountain State Park and the Kickapoo Reserve.

Considerations for Planning and Management
Planning and management considerations include developing public-private partnerships and creating additional conservation lands in the ecological landscape's interior; developing reliable and practical methods of regenerating and maintaining the ecological landscape's oak ecosystems (including forests, woodlands, and savannas); broadening the incentives available to private landowners to promote the maintenance and restoration of rare communities such as oak savannas and oak woodlands as well as underrepresented forest patch sizes and shapes and developmental stages (these include large patches, connecting corridors, and older forests); better land management and land use planning for floodplains, watersheds, and headwaters areas; clarifying successional patterns of forest communities affected by dams and the suppression of fire and restore functional dynamics where possible; seeking opportunities to reduce habitat fragmentation and isolation and increase ecological connectivity; incorporating major environmental gradients into conservation projects where possible; and earlier detection and better control of invasive species. (Many are now established in parts of the Western Coulees and Ridges Ecological Landscape, and they must be addressed in survey, management, monitoring, and protection plans. Some of the most heavily visited areas in this ecological landscape are badly overrun by invasive plants, and control or eradication efforts should be priorities here and be a component of all land and water management activities. Such infestations are likely to be spread by tourists and resource professionals alike). Educating the public about the harmful effects of nonnative earthworms and other invasive plants and animals is an outreach priority.

Major dams have been constructed on the Mississippi River, significantly altering and fragmenting aquatic habitats there, but long free-flowing stretches of the Wisconsin, Chippewa, and Black rivers still exist in this ecological landscape.

In many parts of the Western Coulees and Ridges Ecological Landscape, significant developments occur on the relatively level terraces between the floodplains of large rivers and steeply sloping adjacent bluffs. The terraces are intensively used for agriculture and residential development and

An example of a big river with a complex undeveloped floodplain surrounded by agricultural land. La Crosse-Trempealeau counties. Photo by Wisconsin DNR staff.

as sites for railroad, highway, and utility corridors. Cities and villages now occupy many of the broader terraces, especially where tributaries join the Mississippi River, and residential areas continue to expand on such lands. Opportunities to keep uplands and floodplains connected are relatively scarce and should be regarded as conservation priorities. The sand terraces support rare species and imperiled habitats and therefore have high intrinsic values; they also serve as ecologically important connectors across ecosystems and environmental gradients.

Sand mining has increased greatly in recent years (mostly for use in "fracking" elsewhere in North America). Impacts are currently under review, but they could be widespread because Wisconsin has high potential to provide raw materials for this purpose.

This series of dry prairies occupies south-facing bedrock bluffs. Wisconsin has exceptional representation of bluff (or "goat") prairies, which are key habitat for numerous native plants, invertebrates, and herptiles. Note the wooded draws between the more exposed bluffs. Morgan Coulee State Natural Area, Pierce County. Photo by Eric Epstein, Wisconsin DNR.

Management Opportunities

The Western Coulees and Ridges Ecological Landscape offers the best opportunities in the state to maintain many of southern Wisconsin's natural communities. Numerous rare species have been documented here due to the diversity, scale, types, condition, and context of the natural communities present.

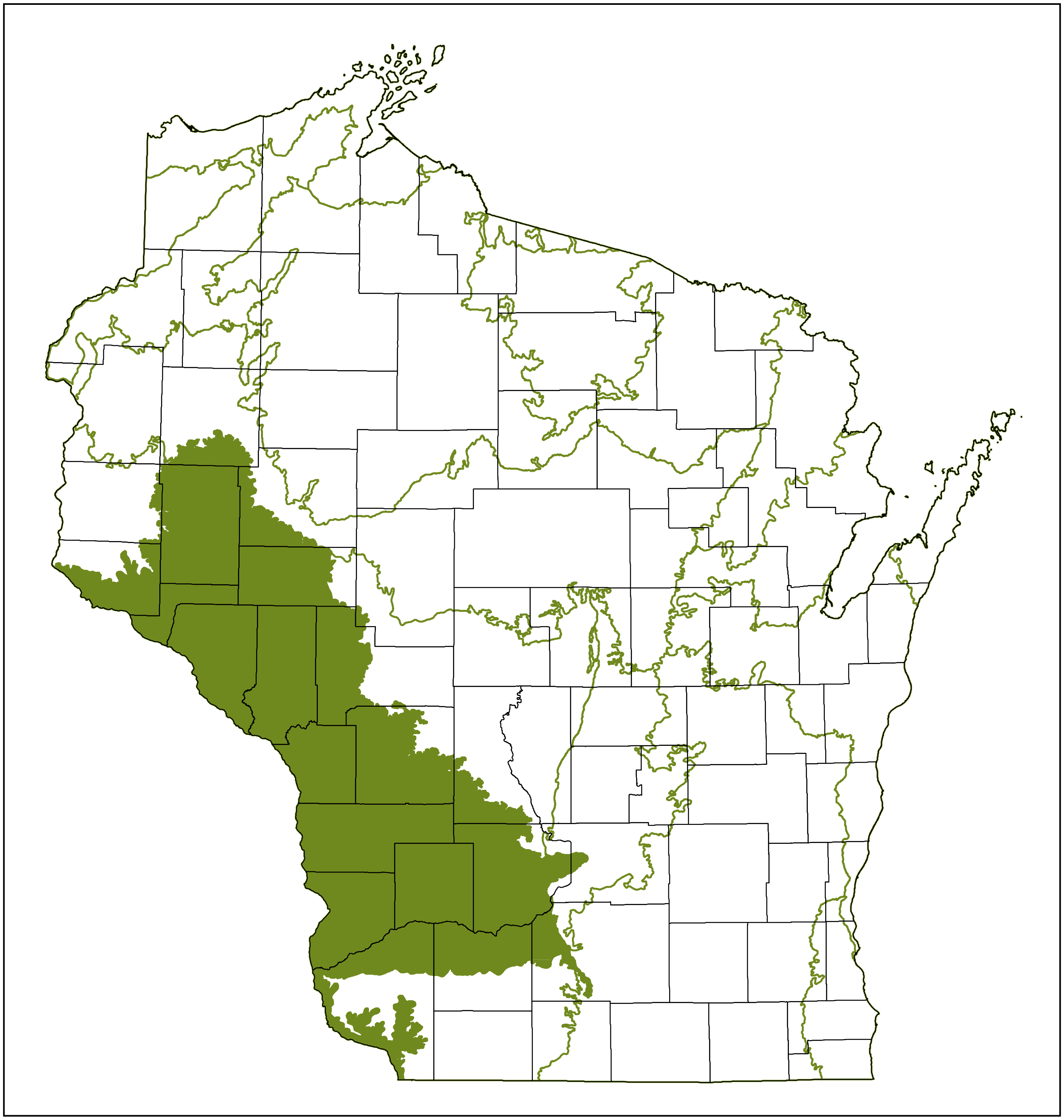
Forests can be managed and conserved in this ecological landscape at virtually all scales, including areas up to hundreds or, in some cases, thousands of acres. Oak forests are more abundant here than in any other ecological landscape. Mesic maple-basswood forests are also widespread, and some of the Upper Midwest's most extensive stands of Floodplain Forest occur here along the major rivers. All of these forest types can and do provide critical breeding and/or migratory habitat for significant populations of native plants and animals. Maintaining large blocks of these forest types, including areas with combinations of these types, is a major opportunity. Since much of the forested acreage is privately owned, there are opportunities to work with private landowners, identifying places to combine efforts, and plan on a much larger scale than an individual property.

Less common natural communities also provide excellent management opportunities in this ecological landscape. Conifer relicts, by definition, are almost entirely restricted to the Western Coulees and Ridges, with a few management opportunities present in the Southwest Savanna Ecological Landscape. Fire-dependent oak ecosystems are well represented here and include oak openings, oak barrens, oak woodland, and dry to mesic oak forests. Bluff prairies and sand prairies are better represented in this ecological landscape than anywhere else in Wisconsin and probably better than anywhere else in the Upper Midwest, given that most of the Driftless Area occurs within Wisconsin. These fire-dependant communities could be managed in a continuum with savanna and forest communities when and wherever that is possible.

Man-made habitats such as "surrogate grasslands" can be important for many species by increasing the effective size and reducing isolation of small remnant prairies or savannas. Large open habitats can be critical for area-sensitive grassland birds and others. Incorporating remnant native grasslands into such management scenarios is critical. Properly sited and managed dredge spoil islands can provide important habitat for herptiles and birds, especially along the Mississippi River, which has been heavily altered by dam construction, diminished water quality, and the impacts of invasive species.

Large warmwater rivers are critical for fish, herptiles, birds, and invertebrates, especially mussels and some aquatic insects. Diverse habitats associated with the large river corridors include the main channels, running sloughs, oxbow lakes and ponds, various floodplain wetland communities, terraces with sand prairies and barrens, and adjoining mesic to xeric forested bluffs. Managing this vegetation mosaic can increase the effective conservation area and protect ecotones and connectivity representing opportunities that are unavailable or limited elsewhere in the state. Other important aquatic features include high concentrations of coldwater and coolwater streams, spring runs, and spring seepages.

Bedrock features are important throughout the Western Coulees and Ridges Ecological Landscape and include cliffs, caves, talus slopes, and Algific Talus Slopes. Some bats and reptiles are dependent on caves, tunnels, and abandoned mines as roost sites and hibernacula.



Western Coulees and Ridges Ecological Landscape

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Western Coulees and Ridges 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 in Wisconsin; a discussion of the changes and trends in Wisconsin ecosystems over time; identification of major current and emerging issues; and identification of the most significant ecological opportunities and the best places to manage important natural resources in the state. Part 1 also contains a chapter describing the natural communities, aquatic features, and selected habitats of Wisconsin. Part 2 of the book, "Ecological Landscape Analyses," of which this chapter is part, provides a detailed assessment of the ecological and socioeconomic conditions for each of the 16 individual ecological landscapes. These chapters identify important considerations when planning management actions in a given ecological landscape and suggest management opportunities that are compatible with the ecology of the ecological landscape. Part 3 of the book, "Supporting Materials," includes appendices, a glossary, literature cited, recommended readings, and acknowledgments that apply to the entire book.

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

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

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

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

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

consideration for land and water managers, especially when Wisconsin supports a large proportion of a species' regional or global population or if a species is socially important. Our hope is that 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 of the book contains a section entitled "Property-level Approach to Ecosystem Management" that suggests how to apply this information to an individual property.

How to Use This Chapter

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

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

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

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

Coordination with Other Land and Water Management Plans

Coordinating objectives from different plans and consolidating monetary and human resources from different programs, where appropriate and feasible, should provide the most efficient, informed, and effective management in each ecological landscape. Several land and water management plans dovetail well with *The Ecological Landscapes of Wisconsin*, including the Wisconsin Wildlife Action Plan; the Fish, Wildlife, and Habitat Management Plan; the Wisconsin Bird Conservation Initiative's (WBCI) All-Bird Conservation Plan and Important Bird Areas program; and the *Wisconsin Land Legacy Report.* Each of these plans addresses natural resources and provides management objectives using ecological landscapes as a framework. Wisconsin DNR ***basin*** plans focus on the aquatic resources of water basins and watersheds but also include land management recommendations referencing ecological landscapes. Each of these plans was prepared for different reasons and has a unique focus, but they overlap in many areas. The ecological management opportunities provided in this book are consistent with the objectives provided in many of these plans. A more thorough discussion of coordinating land and water management plans is provided in Chapter 1, "Principles of Ecosystem and Landscape-scale Management," in Part 1 of this publication.

General Description and Overview

The Western Coulees and Ridges Ecological Landscape in southwestern and west central Wisconsin is characterized by its lack of glacial features. It is part of the region called the "Driftless Area" because it lacks glacial deposits known as "drift" (although glacial outwash materials do occur in river valleys). The topography is unique in the state due to the long periods of erosion that have created dissected ridges, steep-sided valleys, and extensive stream networks with ***dendritic drainage patterns***. The Western Coulees and Ridges Ecological Landscape is more forested than the rest of southern Wisconsin. The Baraboo Range, rugged hills formed primarily of Precambrian Baraboo Quartzite, is located in the eastern part of the ecological landscape. Soils are mostly silt loams (loess) and sandy loams over dolomite and sandstone bedrock. Several large rivers, including the Mississippi, Wisconsin, Chippewa, and Black, flow through or border the ecological landscape.

Historical vegetation consisted of southern hardwood forests of several major types, oak savanna, and prairie, with extensive floodplain forests, sedge meadows, and marshes along the major rivers. With Euro-American settlement, most of the more level lands on ridge tops and in valley bottoms was cleared of native vegetation and converted to agricultural uses. The steep slopes between valley bottom and ridge top, unsuitable for raising crops, either remained in forest or grew up into oak- or maple-dominated forests after the wildfires that were common before Euro-American settlement were suppressed.

Current vegetation is a mix of forest (the largest land cover component, at over 40%), agriculture, and grassland (mostly nonnative), with wetlands restricted almost entirely to the river valleys. The primary forest cover is oak-hickory (51%) dominated by oak species (*Quercus* spp.) and shagbark hickory (*Carya ovata*). Maple-basswood forests (28%), dominated by sugar maple (*Acer saccharum*), American basswood (*Tilia americana*), and red maple (*Acer rubrum*), are common in areas that were not subjected to repeated wildfires prior to Euro-American settlement. Bottomland hardwoods (10%) are common and restricted to the valley bottoms of the larger rivers and are dominated by silver maple (*Acer saccharinum*), ashes (*Fraxinus* spp.), elms (*Ulmus* spp.), and eastern cottonwood (*Populus deltoides*). Coniferous forests are not extensive and include the so-called ***relict*** conifer stands of eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), and (rarely) jack pine (*Pinus banksiana*) on dry sites and mesic stands of eastern hemlock (*Tsuga canadensis*) and yellow birch (*Betula alleghaniensis*) on steep slopes with cool, moist microclimates. In a few locations, there are lowland forests dominated by tamarack (*Larix laricina*) in valleys, though many, if not most, of these are now in serious decline.

The vast majority of natural lakes in the Western Coulees and Ridges Ecological Landscape are associated with the large rivers. Shallow riverine lakes (e.g., oxbows, ponds, backwaters) are common within the floodplains of the larger rivers. There are numerous impoundments throughout the ecological landscape. Water quality in streams varies widely depending on land use factors. Groundwater is more susceptible to pollution here due to extensive areas of porous karst topography (DAI 2012).

The total area for the Western Coulees and Ridges Ecological Landscape is approximately 6.2 million acres, over 17% of Wisconsin's surface, making this the largest of the 16 ecological landscapes. Over 404,000 acres, or almost half of the 834,000-acre Driftless Area, is within Wisconsin's borders. The remaining acreage occurs in adjacent parts of Minnesota, Iowa, and Illinois. Only 3% (roughly 186,000 acres) of this ecological landscape is publicly owned, and much of that public land is concentrated along the major rivers.

Agriculture is a major land use and an important part of the economy in the Western Coulees and Ridges counties. The market value of all agricultural products sold in the Western Coulees and Ridges counties was $1.3 billion (23% of the state total); 25% of this amount came from crop sales, while the remaining 75% was from livestock sales (which includes dairy products). A relatively high proportion of the agricultural land sold is being diverted to other uses.

Wooded slopes are often used for oak sawlog production. Of all ***timberland*** within the Western Coulees and Ridges Ecological Landscape, 91% is owned by private landowners. Recreational resources are abundant. The Western Coulees and Ridges counties have a high number of state parks, forests, and recreation areas and state fishery and wildlife areas as well as several federal wildlife refuges along the Mississippi River.

The population density (57 persons per square mile) is less than that of the state average (105 persons per square mile). The Western Coulees and Ridges counties are traditionally rural but have increasing dependency of their urban centers for the bulk of local economic output. The largely homogeneous white population of Western Coulees and Ridges counties is growing in urban areas, while rural counties lose population and experience decreased economic activity.

Economically, the Western Coulees and Ridges counties support higher levels of government jobs and service jobs compared to the state as a whole. Though unemployment and poverty rates are comparable to the statewide figures, per capita incomes and average wages per job are low in the Western Coulees and Ridges counties, indicating a lack of higher paying jobs.

Environment and Ecology

Physical Environment

Size

The Western Coulees and Ridges Ecological Landscape extends over 9,642 square miles (6,170,674 acres), representing 17.4% of the area of the state of Wisconsin. It is the largest ecological landscape in the state.

Climate

Climate data were analyzed from 22 weather stations within the Western Coulees and Ridges Ecological Landscape (Gays Mills, Genoa Dam, Trempealeau Dam, Lone Rock, Prairie du Chien, Lynxville Dam, La Crosse, Dodge, Alma Dam, Eau Claire, Sparta, Hillsboro, Richland Center, Baraboo, Prairie du Sac, Menomonie, Ridgeland, Dodgeville, Reedsburg, Viroqua, Cashton, and Dubuque Dam; WSCO 2011). The Western Coulees and Ridges Ecological Landscape has a continental climate, with cold winters and warm summers, similar to other southern ecological landscapes (Central Lake Michigan Coastal, Central Sand Plains, Central Sand Hills, Southeast Glacial Plains, Southern Lake Michigan Coastal, Southwest Savanna, 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. Because the Western Coulees and Ridges Ecological Landscape extends over a considerable latitudinal area, the climate varies more than in most ecological landscapes.

The mean growing season in the Western Coulees and Ridges Ecological Landscape is 145 days (base 32°F), seven days less than other southern ecological landscapes (152 days). Only the Central Sand Plains has fewer growing degree day (135 days) of the southern ecological landscapes. There is considerable variation in growing degree days among weather stations within the Western Coulees and Ridges, ranging from 117 to 181 days. Growing season length follows a latitudinal pattern with a longer growing season in the southern part of the ecological landscape and shorter growing season in the northern part.

Mean annual temperature is 43.7°F (41.1–48.2°F), 1.6°F cooler than other southern ecological landscapes. The mean August maximum temperature is 81.2°F, very similar to the other southern ecological landscapes (80.9°F). Mean January minimum temperature is 0.4°F, 3.5°F cooler than other southern ecological landscapes (4.0°F). There is considerable variation in temperatures across the ecological landscape, which follows a latitudinal pattern. The coldest average temperatures in the ecological landscape are recorded at Ridgeland, on the northern edge of the ecological landscape. During the winter months, the average temperature at Ridgeland is 8–9°F lower than temperatures at the Lynxville Dam near the southern end of the ecological landscape. During the rest of the year, Ridgeland has temperatures that are 6–7°F cooler than Lynxville.

There are no Wisconsin weather stations in the far southwestern portion of the ecological landscape that lie along the Mississippi River, but there is a station at Dubuque, Iowa. Data from Dubuque indicate that monthly mean temperatures are at least one degree higher than at La Crosse to the north throughout the year, and January mean temperatures are 3.5°F higher. This southwest corner of the Western Coulees and Ridges Ecological Landscape is somewhat warmer than the rest of the ecological landscape. Species typical of more southerly locations are found here, such as honey locust (*Gleditsia triacanthos*), chinquapin oak (*Quercus muhlenbergii*), and Kentucky coffee-tree (*Gymnocladus dioicus*).

Mean annual precipitation is 32.6 (29.5–36.3) inches, an average value compared with the rest of the southern ecological landscapes (33.1 inches). The mean annual precipitation varied substantially (6.8 inches) among weather stations within this ecological landscape, with the largest differences in the summer months. Dodgeville is the wettest location, with 36.3 inches and Lone Rock the driest at 29.5 inches. Mean annual snowfall is 43 inches (ranging from 25 inches to 60 inches), similar to other southern Wisconsin ecological landscapes (42 inches).

The growing season, temperatures, and precipitation in the Western Coulees and Ridges Ecological Landscape are favorable for agricultural row crops, small grains, and pastures, but the steep topography prevents farming on the hillsides. The variable climate from north to south in this ecological landscape, along with the rough ridge and valley topography and microclimates, allows for a large diversity of plants and animals.

Topography and cold air drainage in the unglaciated Western Coulees and Ridges can produce dense valley fogs while the adjoining ridge tops are in bright sunshine. Monroe County. Photo by Eric Epstein, Wisconsin DNR.

Bedrock Geology

With the exception of the Baraboo Hills, most bedrock underlying the surface of the ecological landscape was deposited during the Cambrian and Ordovician periods, about 500 to 440 million years ago. Precambrian igneous rock lies beneath the Paleozoic sedimentary formations and is important in constraining aquifers, but there are few exposures within the ecological landscape.

Baraboo Hills

The Baraboo Hills are an unusual and significant geologic feature within the ecological landscape. The bedrock here is dominantly Baraboo Quartzite, originating from an extensive marine deposit of quartz sand during Precambrian time at about 1.7 billion years ago. Through cementing and metamorphosis, the sand became sandstone and then quartzite. It has a reddish-purple color due to its iron content and exhibits ***stratification*** and ripple marks typically seen when sand is deposited from oceans (Dott and Attig 2004). These ancient oceans apparently persisted over a long period of time because quartzite at the Baraboo Hills is approximately 4,000 feet thick. It is believed to be of the same origin as bedrock at the Blue Hills in Barron County as well as a deposit in southwestern Minnesota.

The Baraboo Quartzite was severely metamorphosed and deformed by a geologic event, possibly a continental collision, at around 1.65 billion years ago. This event folded the rock into the U-shaped "Baraboo Syncline," lifting the edges of the deformed section while the center was depressed. One uplifted side of the fold forms the South Range of the syncline and the other the North Range of the syncline; between them is the lower-lying center of the syncline where more recent deposits have accumulated and the city of Baraboo is located. The Baraboo Quartzite is a hard rock and resistant to erosion. It is described in three geological units, differing from each other based on inclusions of pebble beds and phyllite (metamorphosed slate), sand grain sizes, and the pattern of cross-bedding in the original sand deposits (Clayton and Attig 1990).

Older rock deposits of rhyolite occur beneath the Baraboo Quartzite, outcropping at the edges of the Baraboo Hills (e.g., the Lower Narrows, Devil's Nose), and there are also a few exposures of granite and diorite in the surrounding area. The rhyolite and granite originate from volcanic activity at around 1.76 billion years ago. At the Lower Narrows, rhyolite is thought to be at least a thousand feet thick (Clayton and Attig 1990). Landtype Association 222Ld05 shows the location of bedrock-controlled, predominantly quartzite areas of the Baraboo Hills. See the "Landtype Associations of the Western Coulees and Ridges Ecological Landscape" map in Appendix 22.K.

Paleozoic Deposits

Paleozoic rock in this ecological landscape is made up of several different formations, dominantly sandstones, limestone, and dolomite, with inclusions of siltstone and shale (Figure 22.1). Cambrian rocks of the Elk Mound, Tunnel City, and Trempealeau groups, mostly made up of poorly cemented sandstones, lie above the Precambrian surface. (Nomenclature used herein is according to the Wisconsin Geological and Natural History Survey Open-File Report *Bedrock Stratigraphic Units in Wisconsin;* WGNHS 2006.) Above these layers are Ordovician limestone and dolomite of the Prairie du Chien, Ancell, and Sinnipee groups.

The Mount Simon Formation is the oldest Cambrian rock above the Precambrian surface but does not occur in all parts of the ecological landscape due to erosion. It is a medium- to coarse-grained, thick-bedded sandstone deposited from a shallow marine environment as Cambrian seas advanced over the area; this bedrock can be up to 1,300 feet thick (Schultz 2004).

The Eau Claire Formation, part of the Elk Mound Group, overlies the Mount Simon at thicknesses up to 200 feet. It was deposited in a quieter marine environment as oceans rose to a greater depth over the area. The Eau Claire Formation is a very fine- to fine-grained, thin- to medium-bedded, yellow or brownish sandstone, fossiliferous and containing a large amount of shale. The Eau Claire bedrock is exposed near the outlet of Neshonoc Lake and along the La Crosse River in La Crosse County (Evans 2003). After this phase of deposition, the seas retreated, and the surface of the Eau Claire was eroded (Schultz 2004).

Above the Eau Claire Formation lies the Wonewoc Formation, part of the Elk Mound Group, formed in nearshore environments as the seas readvanced. It is a fine- to medium-grained, thick-bedded, brownish-yellow to yellow or white sandstone, 140–280 feet thick, likely deposited on broad tidal flats (Thwaites et al. 1922). The Wonewoc sandstone tends to form steep cliffs with near-vertical faces even though it is very poorly cemented, being protected by overlying formations.

The Wonewoc Formation grades gradually into the overlying Lone Rock Formation, part of the Tunnel City Group. The Lone Rock Formation is very fine- to fine-grained glauconitic (i.e., micaceous, containing an iron silicate), thin- to medium-bedded light brown to green-brown sandstone, 100–200 feet thick. Fossils of trilobites and brachiopods can be found locally in this sandstone, indicating marine deposition. Thwaites et al. (1922) noted an abundance of fossils in the vicinity of Coles Peak, south of the Fort McCoy Military Reservation, and around the mouth of Farmer's Valley near the southern edge of Sparta. The Lone Rock Formation forms gentle slopes where it underlies the land surface.

The St. Lawrence Formation, part of the Trempealeau Group, lies above the Lone Rock Formation. It was formed from sand and the shells of marine organisms and includes thin-bedded sandy dolomite, dolomitic sandstone, and dolomitic siltstone; it is less than 30–40 feet thick and has few exposures in La Crosse County (Evans 2003) but is 103 feet thick at Castle Rock near Camp Douglas (Thwaites et al. 1922). Its variable thickness may be due to irregularities of

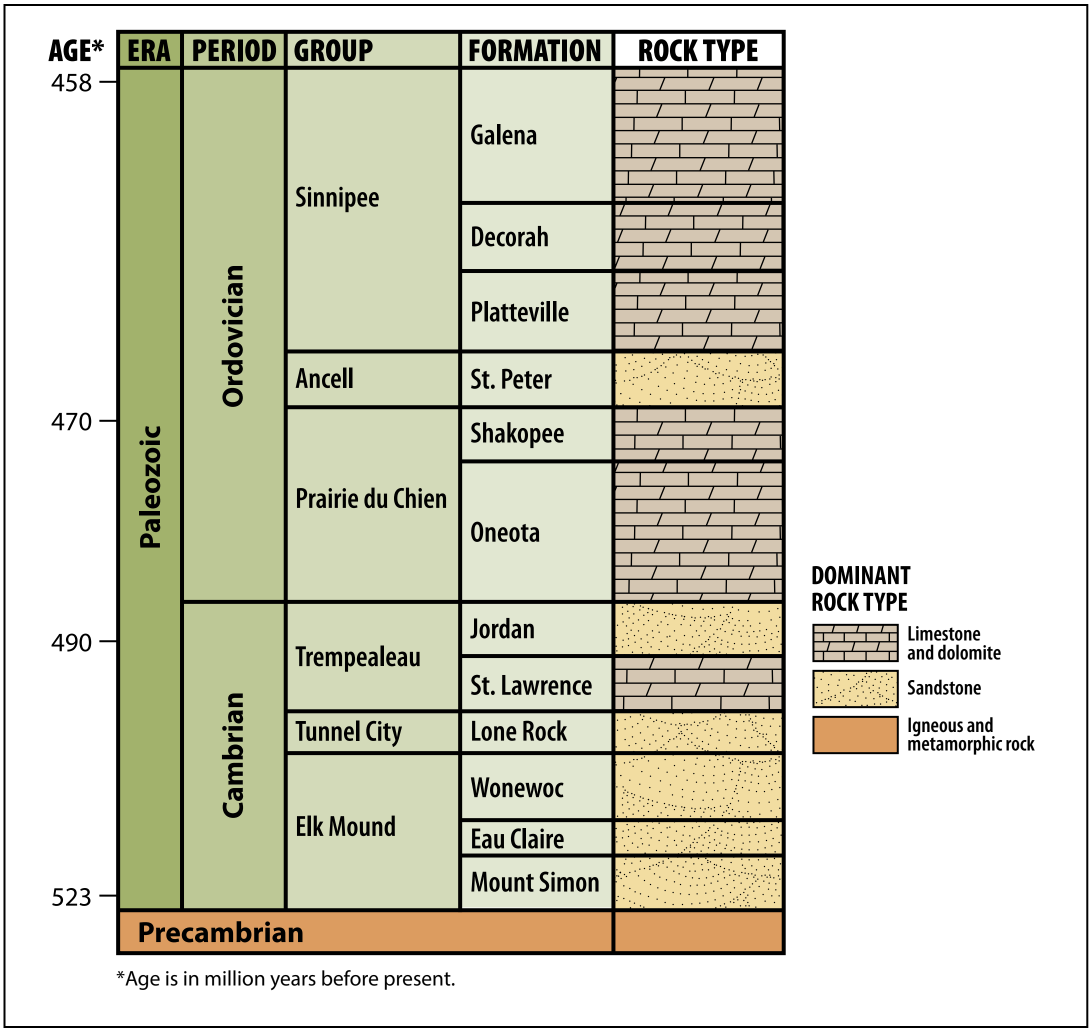


Figure 22.1. *Bedrock strata in the Western Coulees and Ridges Ecological Landscape. Diagram based on WGNHS (2006).*

the underlying surface, variable deposition, or erosion following deposition. Fossils of trilobites and brachiopods can be abundant in the St. Lawrence but are mostly fragmented from transport before deposition. Again, after this phase of deposition, the seas retreated and erosion of the surface occurred.

Jordan Formation sandstone overlies the St. Lawrence Formation. The Jordan Formation also forms near-vertical portions of outcrops and underlies steep slopes. It is medium-to-coarse grained, light brown to brownish-yellow, moderately sorted, quartz sandstone that ranges in thickness from a few feet up to 100–160 feet, thought to be due to uneven deposition (Thwaites et al. 1922, Evans 2003). The Jordan Formation can also be seen at Castle Rock. It is not known to contain fossils, and this, along with the pattern of bedding, indicates that deposition may have occurred on a sand flat covered by water at times, with some material deposited by wind.

The topmost bedrock on most ridges is a resistant dolomite deposited during the Ordovician period in the Prairie du Chien Group, including the Oneota and Shakopee formations. The Oneota Formation consists of fine- to medium-crystalline, thin- to thick-bedded, pale gray to light brownish-gray dolomite, sandy dolomite, and dolomitic sandstone, from 140 to more than 250 feet thick. This dolomite contains cavities in which calcite and quartz has developed, and chert is also abundant. Fossils of algal reefs (Cryptozoa) are common in the dolomite, and other fossils can be found in the chert. Shakopee Formation rocks are relatively thin and contain strata of sandstone, sandy dolomite, and shale.

The Prairie du Chien Group rocks are firm and considerably more resistant to weathering than the underlying sandstone, which is why they often form the tops of ridges, but in a few locations they are overlain by younger rocks of the St. Peter Formation and the Sinnipee Group. Between the Prairie du Chien and the St. Peter, there is a layer of red clay and chert residuum, indicating that weathering occurred for some time before deposition resumed, and the Prairie du Chien's surface is dissected by erosion (Thwaites et al. 1922, Schultz 2004). The St. Peter Formation consists of fine-to-medium grained, white to yellow quartz-rich sandstone with some limestone, shale, and conglomerate. St. Peter rock can be thick but in many areas has been partially or completely eroded.

The Sinnipee Group, made up of the Platteville, Decorah, and Galena formations, represents the most recent bedrock in the ecological landscape; it exists in a few locations in Crawford, Pierce, and St. Croix counties and is common in the far southern portion of the ecological landscape that lies along the Mississippi River in Grant County. Sinnipee Group rocks are firm dolomites with some limestone and shale; they are the predominant bedrock underlying the Southwest Savanna Ecological Landscape.

Karst and Caves

This ecological landscape is notable for its karst topography, created by surface water and groundwater dissolution of carbonate bedrock, primarily Paleozoic dolomite (Day et al. 1989). Some of these cavities are considered caves because 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.

Cave formation has involved sandstone as well as carbonate rocks (limestone and dolomite). Cronon (1970) described the processes of cave formation in sandstone, including the force of stream meanders acting upon sandstone cliffs; exterior erosion by water, wind, or frost acting along joints or bedding planes; erosion by ground water; and collapse. This latter class of cave typically formed when cavities developed in the Ordovician Prairie du Chien dolomite and the overlying St. Peter sandstone gradually collapsed into them. Rubble accumulated on the floors of the dolomite cavities, and the base level of the caves migrated upward till some are now located predominantly within the sandstone layer. Examples include Star Valley Cave near Soldier's Grove and Viroqua City Cave in the town of Viroqua; St. Peter sandstone forms the ceilings of these caves, and there is evidence of the floors having been built up by collapsed rubble. Caves that are now entirely within the overlying sandstone include Jones Cave in Iowa County and Bridgeport Cave northeast of the town of Bridgeport in southern Crawford County (Cronon 1970, Day and Kueny 1999, Schultz 2004).

Some caves formed by dissolution in Cambrian sandstones with relatively high amounts of carbonate, particularly the upper Tunnel City Group and Jordan Formation sandstones. Processes in addition to dissolution that contributed to cave formation in these rocks include undercutting by water, exterior erosion, freeze-thaw cycles, and physical breakdown of sandstone particles. Caves developed in Cambrian sandstones include Anderson's, Grunt, and Hummel's Caves in Richland County. Small caves have also formed in the Jordan sandstone cliffs along the Kickapoo River valley north of Viola, including Mount Nebo Cave (Cronon 1970, Day and Kueny 1999).

Caves open to the public for tours include the Kickapoo Indian Caverns near Wauzeka in Crawford County; Crystal Cave, just west of Spring Valley in Pierce County; Eagle Cave, about 10 miles southwest of Richland Center in Richland County; and Cave of the Mounds, just east of Blue Mounds in Dane County. Many more caves in sandstone, or partially so, have been catalogued by Cronon (1970).

Certain rock formations in the ecological landscape, such as Five-Column Rock (about 2 miles southwest of Readstown, Vernon County), are thought to be remnants of former cave structures (Day and Kueny 1999). Glacial meltwater running through Driftless Area valleys during the Pleistocene is known to have eroded and downcut the landscape, and these erosional processes would have opened many caves and exposed these remnant features.

Mining

A notable lead and zinc mining area existed in southwest Wisconsin from the time of the first Euro-American settlements, and minor ore deposits of copper and barite were also found. The mining area includes the far southern portion of the ecological landscape that lies along the Mississippi River in Grant County and south of the Wisconsin River near Highland in Iowa County. The heyday of mining took place in the 1830s through the mid-1850s, and a zinc mine continued to operate till 1979. Ores occur in the Sinnipee Group dolomites, including the Galena, Decorah, and Platteville formations. The geology of this area has been described by Heyl et al. (1978) and is summarized in Chapter 20, "Southwest Savanna Ecological Landscape." There are active silica sand mines along the Mississippi River in Pierce County.

Other Notable Geologic Features

An intriguing geologic area known as the Rock Elm disturbance is located in Pierce County, south of the village of Rock Elm and near the boundary of the ecological landscape. This is thought to be the site of a meteor impact at about 400–450 million years ago, which resulted in fracturing and displacement of the deeply buried Precambrian bedrock as well as rocks deposited during the Cambrian and Ordovician periods (Dott and Attig 2004, French et al. 2004). The meteor was believed to be 650–700 feet in diameter and struck at a speed possibly as high as 67,500 mph, releasing more than 1,000 megatons of energy. The large crater, said to be Grand Canyon-sized, was filled in over time with sediment, and the site now appears similar to the surrounding landscape except for the rock outcrops. The area is notable as one of only around 200 such meteor impact sites worldwide.

An interesting find occurred near Boaz in 1897 in the southern part of the ecological landscape (Richland County). A fossilized mastodon skeleton was found by boys of the Dosch family after a heavy rainfall eroded a streambank, exposing some very large bones. Local residents assisted in unearthing the remainder of the skeleton, quite a newsworthy event at the time. A spear point was also found at the site, suggesting that Paleo-Indian humans may have killed the mastodon (Palmer and Stoltman 1976). The skeleton is now on display at the University of Wisconsin-Madison Geology Museum, and a historical marker noting the find is located along U.S. Highway 14 just east of Boaz.

Landforms and Surficial Geology

The Western Coulees and Ridges Ecological Landscape is within the unique "Driftless Area" of southwestern and west central Wisconsin (Figure 22.2). The Driftless Area is also found in southeast Minnesota, northeast Iowa, and northwest Illinois, although Wisconsin has almost half of the Driftless area within its borders. No glacial features are found other than outwash sediments carried by rivers from glaciers to the north and east. Glaciers have not been active in this area for at least 2.4 million years, and if any glacial till were deposited prior to that time, it has been removed by erosion. The stream-dissected topography of this eroded landscape is characterized by deeply incised, steep-walled valleys and bedrock controlled ridge tops. Geomorphic processes including sheet wash, soil creep, and soil flowage shaped the hillslopes and transported erosional debris to adjacent streams. These processes were active during the last glacial period when vegetation was absent but have also occurred during the past century due to agricultural practices.

A thin to thick mantle of loess (wind-deposited silty material) covers most of the landscape, with the thickest deposits on the ridges and closer to the Mississippi River, where loess can be up to 16 feet thick (Hole 1976). Much of the loess was moved downslope by erosion and has been incorporated into floodplain deposits. Stream cutting and deposition formed floodplains, terraces, swamps, sloughs, and marshes along rivers on valley floors. Rivers in the ecological landscape carried meltwater from glaciation further to the north, filling some of the major valleys with glacial outwash materials. This is more apparent in the northern part of the ecological landscape in wide river valleys such as the Black and Chippewa but also occurs in the southern part of the ecological landscape in the Wisconsin River valley.

The eastern tip of the Baraboo Hills is the only part of the ecological landscape that was glaciated during the most recent advance of ice sheets during the Wisconsin glaciation. Ice at the westward margin of the Green Bay Lobe rode up over the resistant bedrock of the Baraboo Hills at

Figure 22.2. *Location of the Driftless Area. The Driftless Area refers to those parts of southwestern Wisconsin and adjacent Illinois, Iowa, and Minnesota that were not covered by the Quaternary glaciers. In Wisconsin, the Driftless Area includes all or most of the Southwest Savanna and Western Coulees and Ridges ecological landscapes. Driftless Area boundary courtesy of the Driftless Area Initiative. Basemap © ESRI. All rights reserved.*

about 16,000 years ago. The rise onto higher ground caused the ice sheet to thin and eventually split, flowing out around both sides of the range and blocking a large gap in the hills that is now occupied by Devil's Lake. Prior to this blockage, the gap was an outlet for the early stages of Glacial Lake Wisconsin to the north and was likely scoured by meltwater flow at that time. The glacier built moraines at both ends of the gap near what are now the north and south shores of Devil's Lake, forming effective dams on the former drainage channel. Meltwater flowed from the ice sheet into the gap, forming a lake that was larger and had a surface elevation about 90 feet higher than the present Devil's Lake. The Green Bay Lobe also blocked the southward flowing Wisconsin River. As a result, water ponded in central Wisconsin, forming Glacial Lake Wisconsin, which drained through the Black River (Clayton and Attig 1990). When the glacier melted away, the spectacular Devil's Lake remained, and the scenery here has attracted human visitors for thousands of years. Other glacial features of Devil's Lake State Park are the ***talus slopes***, formed during glaciation when repeated cycles of freezing and thawing loosened pieces of quartzite that tumbled down the cliffs. A variety of geologic formations are visible within the park, making it a popular destination for geology field trips. A booklet, *The Ice Age Geology of Devil's Lake State Park*, (Attig et al. 1990) is a useful general reference for park visitors interested in geology.

Landforms of River Systems

The Wisconsin River and other large rivers in the ecological landscape, including the Black, Chippewa, and Mississippi, have distinctive landforms originating from glacial and riverine processes. All of these river valleys carried large quantities of meltwater along with loads of outwash sand and gravel during the Late Wisconsin glaciation. These glacial drainages cut wider channels than current rivers occupy and built large floodplains from outwash materials. Current river beds are often downcut into the former floodplains. Types of fluvial landforms created by glacial drainages as well as current rivers include terraces at different levels above the river, built by floods of differing height and intensity, as well as meanders, oxbows, sandbars, former channels, and eroding bluffs. Sand dunes were built on wide river terraces following glaciation, when wind redeposited sandy outwash material. A large dune field is located along the Mississippi River near the towns of Trempealeau and New Amsterdam.

Baker and Barnes (1998) correlated forest types with physiographic characteristics for a river in Michigan, including broader scaled geologic features like outwash plains as well as specific fluvial landforms like levees and terraces (Figure 22.3). A river running through an outwash plain supported silver maple and ash on the levee; the "first bottom," or lower terrace, was associated with silver maple forest or alder-willow thicket, while the backswamp was forested with black ash (*Fraxinus nigra*) and silver maple. The slightly higher "second bottom" terrace tended to support swamp white oak (*Quercus bicolor*) and sugar maple. Turner et al. (2004) studied the Wisconsin River floodplain and found that "indicators of physiography and flood regime were particularly important in predicting occurrence, community composition, and abundance of trees," although forest characteristics were also influenced by land use history. Flood-tolerant species occurred closer to the river channel, in lower-lying landscape positions. These included river birch (*Betula nigra*), silver maple, black ash, green ash (*Fraxinus pennsylvanica*), eastern cottonwood, swamp white oak, black willow (*Salix nigra*), and American elm (*Ulmus americana*). Flood-intolerant species, such as northern pin oak (*Quercus ellipsoidalis*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), black cherry (*Prunus serotina*), and quaking aspen (*Populus tremuloides*) were associated with higher landscape positions because soil moisture in floodplains can vary with a slight change in elevation.

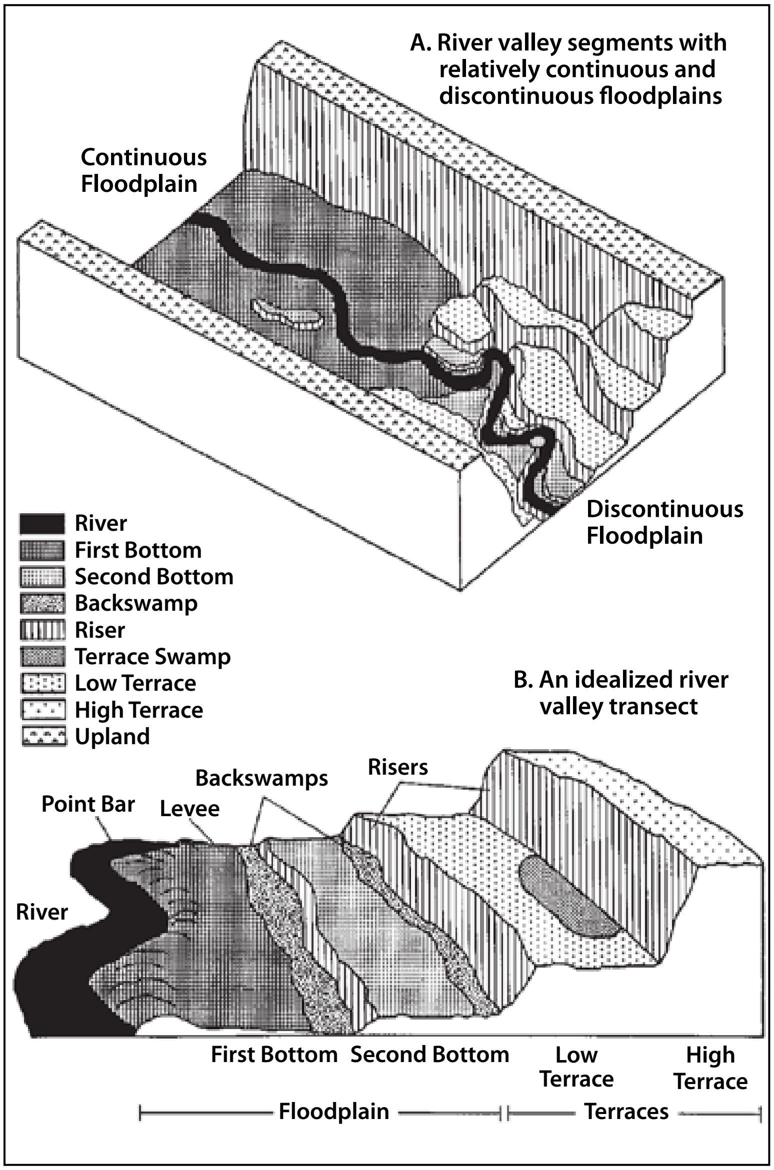


Figure 22.3. *Fluvial landforms of a Michigan river. This figure was reprinted from Baker, M. E. and B. V. Barnes. 1998. Landscape ecosystem diversity of river floodplains in northwest lower Michigan, U.S.A.* Canadian Journal of Forest Research *28:1405-1418. Copyrighted by Canadian Science Publishing or its licensors.*

Floodplain soils are typically stratified with different textural classes deposited by streamflows of different intensity. Soils are often a mixture of organic material, sands, silts, and clays. These locations were favored by American Indian tribes as agricultural sites because the soils were easy to till and very fertile.

The floodplain system functions in mitigating floods and protects water quality by absorbing and filtering runoff. Extreme floods are rare, but these events have the greatest effects on floodplains. Flooding is an important part of the natural disturbance regime of these systems because floods bring in and redistribute sediment and nutrients. A fresh deposit of bare silty soil provides a seed bed necessary for regeneration of several floodplain tree species, notably silver maple. Floods vary in the amount and duration of inundation, affecting nutrient input and decomposition. Tree survival during a flood depends in part on the oxygen content of floodwater, and flowing water contains more oxygen than stagnant water.

A map showing the Landtype Associations (WLTA Project Team 2002) in the Western Coulees and Ridges Ecological Landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 22.K at the end of this chapter.

Topography and Elevation

The Western Coulees and Ridges is a dissected landscape with narrow to broad ridges; narrow sloping shoulders; steep to very steep valley sides, escarpments, and ***pediments***; and narrow to broad valley floors. Elevations range from about 615 feet (200 meters) at Prairie du Chien to 1,594 feet (486 meters) at Sauk Point in the Baraboo Hills.

Soils

Soils on hilltops and sideslopes are formed in loess, loamy to clayey residuum, and loamy colluvium over limestone or sandstone. They range from well drained to moderately well drained and typically have silt loam to sandy loam surface textures, moderate permeability, and moderate available water capacity. Some of the larger valleys, particularly in the northern part of the ecological landscape, contain stream terraces deposited by outflow from glaciation and have soils formed in outwash sands. Soils of the narrower valleys are dominantly silty and loamy residuum and alluvium. These soils range from well drained to very poorly drained and have areas subjected to periodic flooding. Loess deposits are thickest near the Mississippi River; some areas are mapped as having 8–16 feet of aeolian silt, and nearly 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. Organic soils are uncommon throughout the Western Coulees and Ridges.

Hydrology

Basins

Six major basins drain the Western Coulees and Ridges Ecological Landscape. From north to south, these basins are the lower Chippewa, Buffalo-Trempealeau, Black River, Bad Axe-La Crosse, lower Wisconsin, and Grant-Platte river basins. All of these basins drain into the Mississippi River, which forms the western boundary of the ecological landscape. Within these basins, there are 73 watersheds that lie entirely or partially within the Western Coulees and Ridges.

Unlike other parts of Wisconsin, the surface of the Western Coulees and Ridges Ecological Landscape was not shaped by recent glaciation. Consequently, this ecological landscape features a well-developed dendritic drainage system. Natural lakes and most wetlands are associated with the major river corridors. The state's largest rivers, including the Mississippi, Wisconsin, Chippewa, and Black, border or pass through this ecological landscape. Each of these rivers originates in ecological landscapes farther north. The Mississippi has been dammed at ten locations in Wisconsin (Dubuque, Guttenberg, Prairie du Chien, Genoa, La Crosse, Trempealeau, Winona, Whitman, Alma, and Red Wing). Channels to accommodate commercial navigation (mostly freight barges) are maintained along Wisconsin's entire length of the Mississippi by the U.S. Army Corps of Engineers. Dams on the Wisconsin, Chippewa, and Black rivers occur mostly to the east and north of the Western Coulees and Ridges, and long stretches of these ecologically important waterbodies run unimpeded through the ecological landscape. The Federal Energy Regulatory Commission (FERC) relicensing process for operating dams can be used to improve conditions for aquatic organisms, including maintaining minimum flows, reducing flow fluctuations below dams, and reducing late-winter drawdowns.

Inland Lakes

This "unglaciated" area (which includes areas of pre-Wisconsin drift near the northern end of the ecological landscape) is characterized by streams rather than lakes because of the long period of time during which erosion incised the landforms and created a well-developed drainage system. Natural lakes are restricted to large rivers and their floodplains, usually as oxbows, cut-off sloughs, or ponds. According to the Wisconsin DNR's 24K Hydrography Geodatabase, there are 98 named lakes here (some of these are impoundments) (WDNR 2015b). Landsat satellite-derived data from 1992 have been interpreted to show that there are also 10,546 small, unnamed "lakes" in this ecological landscape (WDNR 1993). However, most of these waterbodies are believed to be small areas of open water within or near the extensive, inundated portions of river floodplains, and surrounded by wetland vegetation. There are numerous small check dams creating small lake-like waterbodies in this ecological landscape's interior.

Lake Pepin has a surface area of over 25,000 acres and an average depth of about 18 feet. It is a natural widening of the Mississippi River created by the deposition of sediments from the Chippewa River, which form a natural obstruction across the Mississippi River. Most of the other lake-like widenings on the major rivers were created by dams, constructed

Lake Pepin is a huge natural lake on the Mississippi River created by alluvium deposited by the Chippewa River a short distance downstream. Pepin-Pierce counties. Photo by Eric Epstein, Wisconsin DNR.

mostly during the early part of the 20th century to assist navigation for commercial vessels and provide a measure of flood control. Such waterbodies are referred to as "pools."

Avoca Lake, Woodman Lake, and Bakkens Pond (partially impounded) are drainage lakes of around 20 acres within the Wisconsin River floodplain. McCartney Lake is a 924-acre lake associated with the Mississippi River. Lakes of this nature are connected to the Wisconsin or Mississippi rivers, at least during high flows, and support diverse communities of ***nongame*** fish, panfish, and game fish as well as herptiles and aquatic invertebrates.

Along the lower Wisconsin River, several of the large sloughs contain biologically important habitats and also offer substantial recreational opportunities. Examples include Cruzon, Bullhead, Jones, and Hill's sloughs. The lakes and running sloughs that occur within river floodplains are extremely important to fish, herptiles, and other aquatic organisms and also to birds and mammals that feed on other aquatic life.

Impoundments

Following Euro-American settlement, rivers and streams were dammed at many locations. This created areas of open standing water, caused the loss of in-stream and wetland habitats, eliminated habitat connectivity, created barriers that prevented the movement of many aquatic organisms, led to increased water temperature and altered flow regimes, and caused local water quality impairments. The new habitats created by the impoundments provided suitable conditions for species that were formerly less common—including new arrivals such as the exotic and highly invasive common carp (*Cyprinus carpio*).

Some of the largest impoundments in Wisconsin are associated with the locks and dams on the Mississippi River. These were constructed to enhance navigability for commercial barge traffic but also facilitate certain types of recreational use (e.g., power boats). They have caused a tremendous loss of wetland habitat (especially emergent marshes and floodplain forest) and have altered the natural processes upon which this vegetation and some of the associated aquatic animals depend. For several decades following construction of these dams in the early part of the 20th century, the pools supported a wealth of fish, wildlife, and aquatic habitat. However, as the artificially high water levels created by the locks and dams caused islands in the lower portion of the pools to erode from wave and ice action, the suitability of these areas as habitat for fish and wildlife declined. Some pools and channels disappeared as sediments carried by the river washed from the eroding islands and nearby uplands into the deep holes and backwaters.

Aquatic plants important to the Mississippi River food web, adapted to the shallow water bordering the islands, were affected by high water and increased turbidity. Many formerly dense and extensive beds of aquatic macrophytes shrank in size or vanished altogether. The loss of this vegetation created open expanses of shallow water above the locks and dams, resulting in a loss of food and shelter and reduced productivity for fish and wildlife.

Federal and state river managers have been rebuilding islands and restoring channels and deep-water areas in an attempt to restore habitat lost to the locks and dams. Even so, plant beds have only partially recovered. Emergent aquatics such as arrowheads (*Sagittaria* spp.), bulrushes (*Schoenoplectus* spp., *Scirpus* spp.), bur-reeds (*Sparganium* spp.), and cat-tails (*Typha* spp.), growing in moist saturated soils and/or in shallow water, often depend on natural seasonal fluctuations in water levels to allow new plants to sprout from seed and to ensure long-term survival of the aquatic plant beds. The relatively stable water levels created by the navigation pools have eliminated many plant beds. Over time, these beds have had little or no opportunity to become reestablished in the absence of normal seasonal decreases in water depth (USGS 2010b). However, efforts at simulating the effects of normal flow variation are under evaluation by federal and state agencies.

Along with the large navigational dams noted above, a large number of smaller streams have been impounded, combining for a total of 1,385 dams listed in Wisconsin DNR records. Forty-one other dams have been formally abandoned. There are also 39 levees to divert floodwaters along the Mississippi in this ecological landscape. The Western Coulees and Ridges has the highest number of dams of any ecological landscape in Wisconsin. This has created a maximum total impounded water volume of more than 828,000 acre-feet (much of that in Wisconsin's share of the Mississippi River navigation pools, which are roughly bisected by the state's boundaries), the second highest total of any ecological landscape, behind the Southeast Glacial Plains (WDNR 2015b).

Thirty one of these dams are classified as erosion check dams installed under agricultural programs to prevent severe gully erosion and to protect streams and are not on perennial streams. These dams on intermittent waterways that do not provide year-around habitat may have few negative impacts.

Lake Menomin, an impounded stretch of the Red Cedar River in the City of Menomonie (Dunn County), is the only documented lake-like waterbody with wild rice (*Zizania* spp.) in this ecological landscape (wild rice also occurs along certain sluggish streams in the western part of the ecological landscape, but it is generally not thriving).

Rivers and Streams

In the absence of glacial impacts, rivers and streams have had a primary role in shaping physical features throughout the Western Coulees and Ridges Ecological Landscape. There are hundreds of named streams here, from small spring-fed coldwater creeks to several of the largest rivers in the Upper Midwest. The Mississippi River, the largest river in the United States, forms the western boundary of the Western Coulees and Ridges.

■ **Warmwater Rivers.** Major warmwater rivers in this ecological landscape include the Mississippi and several of its large tributaries, including the Chippewa, Wisconsin, and Black.

Though the Mississippi has been dammed in ten locations and now exists as a series of impoundments, the other major rivers in this ecological landscape are characterized by long free-flowing stretches, including over 90 miles of the lower Wisconsin River, over 60 miles of the lower Chippewa River, and roughly 55 miles of the lower Black River.

It is important to note that because some large rivers that are tributaries to the Mississippi (such as the Wisconsin, Chippewa, and Black) are less impacted by dams and other developments than the Mississippi itself; these rivers are all interdependent with the Mississippi in maintaining their ecological diversity. Some fish species move from deep pools where they overwinter in the Mississippi to gravelly spawning habitat in these large tributaries, thereby using these different habitat features to complete various stages of their life histories. For example, rare large-river species such as blue sucker (*Cycleptus elongatus*) and paddlefish (*Polyodon spathula*) use the connection between the Mississippi and the lower Chippewa rivers in this manner (Benike and Johnson 2003). Many mussel species also rely on this movement of fish for hosting their larvae and distributing juvenile mussels (L. Kitchel, Wisconsin DNR, personal communication).

The Wisconsin, Chippewa, and Black rivers are among the Upper Midwest's most ecologically important large river systems because of the wealth of aquatic life they support, the many excellent examples of native vegetation (aquatic, wetland, and upland) that are associated with the river corridors, and the numerous populations of rare species that are found in this ecological landscape.

Several warmwater rivers were designated as Conservation Opportunity Areas (COAs) in the Wisconsin Wildlife Action Plan (WDNR 2005b) because they are critical to maintaining populations of various aquatic "Species of Greatest Conservation Need." Warmwater rivers in this ecological landscape of especially high significance to rare or otherwise sensitive aquatic life include the Mississippi, Wisconsin, Chippewa, Black, Buffalo, Trempealeau, Red Cedar, Platte, Bad Axe, and Rush rivers.

■ ***Mississippi River:*** The major rivers, especially the Mississippi, have served as transportation corridors for centuries. Large cities and numerous small towns have been sited along these rivers. Fish and mussels have been harvested commercially. The Mississippi River system has been tremendously altered by the construction of locks and dams in the 1930s. Railroad, highway, and utility corridors now effectively separate much of the river and lower parts of its floodplain from the grasslands, savannas, and forests that occur on the uplands adjoining the floodplain. The land cover of the Mississippi River floodplain has changed dramatically over time. In 1890, the floodplain was about 16% to 20% open water (a main channel and narrow backwaters) and dominated by wet forest and wet shrub habitats. As of 2000, the floodplain cover was about 80% open water, with a large amount of submergent aquatic vegetation (Hendrickson 2010).

Aquatic vegetation in the Mississippi River serves directly as food for some fish and wildlife species and also functions as habitat for many insects and snails that are, in turn, used as food by many species. In general, aquatic vegetation is most abundant in the upstream portions of each pool where sediment loading is lower and has been shown to rebound when islands are reestablished and pool levels are lowered to provide more natural and favorable growing conditions. Eurasian water-milfoil (*Myriophyllum spicatum*) and other exotic invasives are established here, but so far, they have not overwhelmed native aquatic plants in most areas (Hendrickson 2010).

Water level drawdowns of 1.5 feet in Pools 8 (2001–2002) and 5 (2005–2006) were conducted by the U.S. Army Corps of Engineers and analyzed by a team representing numerous state and federal agencies to determine the impacts to plant life of exposing river bottom sediment that had long been covered in water. This test was very successful, producing significant increases in perennial vegetation, especially emergent and submergent plants that provide food and cover that is beneficial to a variety of wildlife. Because mussel populations were found mainly in water more than 1.5 feet deep, they were not adversely impacted by these drawdowns. Likewise, fish die-offs due to warmer water were no more common than in upstream and downstream pools that were not drawn down.

■ ***Lower Wisconsin River:*** The lower Wisconsin flows through an extensive and relatively undisturbed and unbroken corridor of forested and prairie blufflands, sand terraces, floodplain forests, shrub swamps, marshes, and wet meadows. Forest cover is high along some of the Wisconsin's tributaries as well as on some of the surrounding uplands, helping to maintain a viable and diverse range of habitat conditions for many sensitive species within and along this river.

■ ***Lower Chippewa River:*** The lower Chippewa River, with its extensive forested floodplain, is a diverse large warmwater river system, with the lower 60+ miles below the Dells Dam in Eau Claire to its confluence with the Mississippi River constituting some of the last remaining non-impounded large-riverine habitat in the Upper Midwest. This free-running stretch flowing into the Mississippi River supports 70% of all the fish species found across Wisconsin, including 18 species that are threatened or endangered (WDNR 2001, WDNR 2010a). The Upper Chippewa River basin, to the north of this ecological landscape, is heavily forested, contributing to the high water quality and clarity that is maintained even as the Chippewa flows through the more heavily developed Forest Transition and Western Coulees and Ridges ecological landscapes. The Chippewa River tends to have less sand and more gravel substrate than either the Black or the Wisconsin rivers (WDNR 2001), originating from the Cary terminal moraine and the Wissota terrace (Andrews 1965). The large delta at the mouth of the Chippewa River was created by the deposition of glacial sediments. It is composed of sand, gravel, silt, and clay as much as 150 feet deep and has created Lake Pepin, a natural widening of the Mississippi. Broad, sandy terraces are common along the Chippewa from just south of Eau Claire almost to Durand.

■ ***Trempealeau River:*** Among the smaller tributaries to the Mississippi, the Trempealeau River exhibits a naturally sandy substrate common to rivers in this ecological landscape. Unlike the larger rivers such as the Wisconsin, Chippewa, and Black that originate in heavily forested northern Wisconsin, the Trempealeau is almost entirely within an intensively agricultural watershed. This results in a heavy load of soil sediments (silt) deposited over the sand substrate, which renders the Trempealeau much less desirable habitat for sensitive and uncommon sand-burrowing organisms than rivers with cleaner, clearer water (WDNR 2002b).

■ ***Eau Claire River:*** The Eau Claire River is atypical of larger rivers in this ecological landscape as it has a streambed consisting not only of sand but also a large proportion of gravel and bedrock. This rich ***mosaic*** of habitats supports a diverse aquatic invertebrate fauna, more typical of much larger rivers. The watershed of the Eau Claire River is still extensively forested and has few municipal point source discharges, which protects water quality, limits erosion, and benefits pollution intolerant species.

■ **Cold and Coolwater Streams.** Cold, spring-fed headwaters streams are common in many parts of this ecological landscape. A large number of springs have been documented in the Western Coulees and Ridges (see below), and they are critical contributing water sources for many cold- and coolwater stream systems.). These springs help support populations of pollution-intolerant invertebrates, rare nongame fish, and native brook trout. Most of these coldwater streams with suitable habitat are DNR-designated trout streams. They are distributed throughout the ecological landscape, but Dunn County has the greatest concentration. For a list of all trout streams in Wisconsin, see the Wisconsin DNR's web page "Trout Stream Maps" (WDNR 2014). Most of the smaller coolwater rivers and streams have been affected by past and present agricultural practices that have degraded water quality and altered channel and streambank characteristics.

Coldwater inland streams supporting trout of larger size are more plentiful in the Western Coulees and Ridges Ecological Landscape than elsewhere in the state. A representative sampling of these streams includes the upper Rush River and Plum Creek (Pierce County); Elk Creek (Chippewa County); Arkansaw Creek (Pepin County); Waumandee Creek (Buffalo County); Beaver Creek and upper Buffalo River (Trempealeau County); the north and south forks of the Buffalo River, the forks of Hall's Creek, and the upper Trempealeau River (Jackson County); upper Coon Creek, the upper Pine and Willow rivers, and upper Mill Creek (Richland County); Steuben Springs Creek (Crawford County); Big Green River and Blue River, (Grant County); Pompey's Pillar Creek and Otter creek (Iowa County); Coon Creek-Timber Coulee (Vernon County); and Black Earth Creek (Dane County).

Coldwater and coolwater streams and stream corridors especially important for supporting diverse populations of aquatic invertebrates and fish, including some rare species, include the Eau Claire River (upstream of the City of Eau Claire), the upper portion of Hall's Creek, and the lower Baraboo River in this ecological landscape. Other streams are major features within primarily terrestrial Conservation Opportunity Areas (COAs), including Rush Creek (Crawford County), Coon Creek (Vernon County), and the upper and lower portions of the Kickapoo River and several of its spring-fed tributaries (Monroe, Vernon, and Crawford counties). In the Baraboo Hills there are a number of fast, high-gradient coolwater streams, such as Otter Creek, that are very rich in aquatic invertebrates. Though the quartzite substrate of this area is nutrient-poor, the heavy forest cover protects water quality and sensitive habitats that have been lost from other parts of the ecological landscape. As many as 20 invertebrate species found here are found nowhere else in Wisconsin (W.A. Smith, Wisconsin DNR, personal communication).

Undisturbed coldwater stream, Fort McCoy Military Reservation. Monroe County. Photo by Eric Epstein, Wisconsin DNR.

Coldwater stream restoration and rehabilitation projects have tended to focus on development or enhancement of a recreational trout fishery, with the prime beneficiary being the nonnative brown trout (*Salmo trutta*). In parts of the Western Coulees and Ridges (e.g., the Kickapoo River watershed, the Baraboo Hills) where coldwater streams historically flowed through forests, managers have sometimes relied on rip-rap and planting grass as streamside cover. While this can restore certain aspects of coldwater ecosystems (and can have many benefits to streams flowing through intensively used agricultural areas), these grassy streambanks often become dominated by invasive reed canary grass (*Phalaris arundinacea*).

■ **Coldwater to Warmwater Rivers and Streams.** Several streams stand out here because they have both cold headwaters and warmwater lower ***reaches*** that are notable for the diversity of aquatic invertebrates, fish, amphibians, and birds they support across a gradient of stream temperatures. These include the Rush, Red Cedar, La Crosse, and Kickapoo rivers (W.A. Smith, Wisconsin DNR, personal communication).

■ ***Rush River:*** The lower reach of the Rush River (Pierce County) includes a floodplain and delta that has been identified as a Conservation Opportunity Area by the Wisconsin Wildlife Action Plan because it provides habitat for Species of Greatest Conservation Need. The surrounding woods supports many rare breeding birds including the Red-shouldered Hawk (*Buteo lineatus*), Acadian Flycatcher (*Empidonax virescens*), Cerulean Warbler (*Setophaga cerulea* but listed as *Dendroica cerulea* on the Wisconsin Natural Heritage Working List; WDNR 2009), and Prothonotary Warbler (*Protonotaria citrea*). Many of the other coolwater streams here have been too degraded by past and present agricultural practices to provide good habitat diversity.

■ ***Red Cedar River:*** The Red Cedar River originates in a lake district in the Forest Transition Ecological Landscape to the north in the extreme southwestern corner of Sawyer County, entering the Western Coulees and Ridges in southern Barron County. It flows first through an area of colloidal clay, then through heavily farmed watersheds. Despite this, the Red Cedar does contain a diverse fish assemblage due to its connection with the Chippewa River. While it exhibits a diverse bottom structure, it is too silty here to support aquatic species that are intolerant of high turbidity and otherwise degraded water.

■ ***La Crosse River:*** The headwaters of the La Crosse River are mostly within heavily forested Fort McCoy Military Reservation, where there is very little agricultural activity. The upper La Crosse River is fed by springs, seepages, and coldwater streams and supports a number of rare species, including plants, as well as a high diversity of aquatic invertebrates.

■ ***Kickapoo River:*** Past agricultural practices within the Kickapoo River watershed contributed huge quantities of sand, silt, and clay sediments to the river and its floodplain. Conditions for aquatic life are still poor in many areas (especially for invertebrates). However, portions of the upper river flow through an area of relatively extensive forest. Here the river is flanked by series of spectacular sandstone cliffs, which support conifer-dominated plant communities populations of many rare plants and animals. Some of the upper Kickapoo's tributaries are in relatively good condition and support coldwater species. An extensive, mostly forested, floodplain occurs near the Kickapoo's confluence with the Wisconsin River.

Other streams and stream corridors that comprise a mix of warm, cool, and coldwater habitats are also important in the Western and Coulees Ecological Landscape for supporting a diversity of fish and aquatic invertebrate species. These include the Eau Claire River (upstream of the City of Eau Claire), the upper portion of Hall's Creek, and the lower Baraboo River (W.A.Smith, Wisconsin DNR, personal communication). Other streams are major features within primarily terrestrial COAs, including Rush Creek, Coon Creek, and the upper and lower portions of the Kickapoo River and several of its spring-fed tributaries.

Springs

Springs and cold, spring-fed headwaters streams are common in many parts of this ecological landscape. The Western Coulees and Ridges contains at least 4,242 springs, the greatest number of springs documented in any Wisconsin ecological landscape (Macholl 2007). The constant flow of cold, oxygenated waters from these springs is critical to maintaining coldwater stream systems. These springs help support populations of pollution-intolerant invertebrates, rare nongame fish, and native brook trout.

Wetlands

The Western Coulees and Ridges Ecological Landscape contains over 368,000 acres of wetlands (WDNR 2010b), covering almost 6% of this ecological landscape's surface area. Of this wetland acreage, approximately 171,000 acres (47%) are forested, 36,000 (10%) are shrub-dominated, and 110,000 (30%) are herbaceous. No other wetland type makes up more than 3% of the total area of the ecological landscape. Approximately 10% of the wetlands in the Western Coulees and Ridges have been delineated but not classified. Compared with Wisconsin's other ecological landscapes, this is the fifth highest number of wetland acres. However, as a percentage of total acres, the Western Coulees and Ridges ranks 14th out of the 16 ecological landscapes. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information on the Wisconsin Wetlands Inventory.

Most of the wetlands here are associated with the floodplains of the larger rivers. Some of the Upper Midwest's most extensive areas of Floodplain Forest (bottomland hardwoods) occur along the Wisconsin, Chippewa, and Black rivers. Large stands of Floodplain Forest are highly significant to forest-interior birds and other species, especially when they

Old-growth Floodplain Forest borders this running slough through the Tiffany Bottoms, Buffalo County. Photo by Eric Epstein, Wisconsin DNR.

Extensive marsh at confluence of Trempealeau and Mississippi rivers includes beds of American lotus. Trempealeau County. Photo by Eric Epstein, Wisconsin DNR.

contain riverine lakes and ponds and adjoin extensive areas of upland forest.

Marshes are common and sometimes extensive within the large river floodplains. At a few locations, e.g., Trempealeau National Wildlife Refuge, extensive marshes dominated by American lotus-lily (*Nelumbo lutea*) occur. Less abundant but still important wetland communities are Shrub-carr, Southern Sedge Meadow, and Wet Prairie. Uncommon types include Alder Thicket, Southern Hardwood Swamp, and Southern Tamarack Swamp. Peatland communities are generally rare, occurring mostly where cold groundwater seepage creates permanently saturated conditions. Lowland prairies are now very rare. Spring seeps are common, though they are small and highly localized features on the toe slopes along many rivers and streams. These provide not only a source of clean, cold, well-oxygenated water but also provide habitats used by rare plants and animals.

Localized small patch wetlands fed by groundwater seepage are common, though not typically extensive, in the interior of the Western Coulees and Ridges. Common ***cover types*** include skunk cabbage (*Symplocarpus foetidus*), sedges (*Carex* spp.), speckled alder (*Alnus incana*), and sometimes yellow birch and black ash. Minnesota has separated some of these types out as distinct communities (Minnesota DNR 2005). Most stands in Wisconsin, and probably elsewhere in the Driftless Area, have been pastured for many decades.

Major wetland threats include hydrologic disruption, heavy grazing by domestic livestock, and the spread of invasive species. The latter have spread rapidly throughout some of the wetland communities here in recent decades. Reed canary grass has been especially problematic along streams, in some logged stands of lowland hardwood forest, and where marsh, sedge meadow, or prairie vegetation has been artificially drained and/or subjected to prolonged periods of grazing. Sediment- or nutrient-laden runoff can cause or exacerbate problems wetland degradation.

Water Quality

Unlike conditions within the heavily forested ecological landscapes of northern Wisconsin, many rivers and streams here are influenced by agricultural and urban uses. Siltation, loss of adjoining forests and wetlands, erosion of soils from fields of row crops, and urban stormwater runoff all degrade water quality and habitat values.

Outstanding Resource Waters (ORW) and ***Exceptional Resource Waters (ERW)*** are surface waters that have good water quality, support valuable fisheries and wildlife habitat, provide outstanding recreational opportunities, and are not significantly impacted by human activities. Waters with ORW or ERW status warrant additional protection from the effects of pollution. Both designations have regulatory restrictions, with ORWs being the most restricted (see Glossary). These designations are intended to meet federal Clean Water Act obligations and prevent any lowering of water quality or degradation of aquatic habitats in these waters. They are also used to guide land use changes and human activities near these waters. A complete list of ORWs and ERWs in this ecological landscape can be found on the Wisconsin DNR's website (WDNR 2015d).

Waters designated as impaired on the ***U.S. Environmental Protection Agency (EPA) 303(d) list*** exhibit various water quality problems including ***polychlorinated biphenyls*** (PCBs) in fish, sediments contaminated with industrial metals, mercury from atmospheric deposition, bacteria from farm and urban runoff, and habitat degradation. A plan is required by the EPA on how 303(d) designated waters will be improved by the Wisconsin DNR. This designation is used as the basis for obtaining federal funding, planning aquatic management work, and meeting federal water quality regulations. The complete list of 303(d) impaired waters and criteria can be viewed at the Wisconsin DNR's impaired waters web page (WDNR 2015f).

As would be expected in heavily agricultural areas, many impoundments exhibit water quality problems due to the introduction of excessive sediments and nutrients from steep slopes, row cropping, and fertilizer applications For example, Lake Neshonoc (on the La Crosse River) has problems with heavy nuisance algae growth, which causes lowered oxygen levels and foul odors. Fish Trap Lake, a small (4 acres), shallow (6 feet maximum depth) anoxic oxbow lake on the Wisconsin River, drains into Jones Slough where it creates a rusty-orange discoloration.

In the large river systems, water quality remains relatively good. Large, relatively clean and unpolluted rivers often support a high diversity of aquatic organisms, including invertebrates, herptiles, and fish. The Chippewa, Black, and Wisconsin rivers originate in and emerge from heavily forested regions farther north and carry relatively few pollutants into the less forested, more heavily developed Western Coulees and Ridges. Small streams, by contrast, are greatly affected by local land use, and many suffer from excess siltation and nutrient runoff from fields of row crops that may not be well managed or that lack vegetated ***buffers***. Discharges from sewage treatment plants in need of upgrades and urban runoff can also create significant water quality problems.

The Mississippi River has a long geologic history of natural sedimentation, but the conversion of prairies and forests to agricultural land and cities has significantly increased sediment loading since Euro-American settlement. The impoundments created by the dams built in the early decades of the 20th century greatly inhibit the ability of the river to flush sediments, which settle into deeper waters, smothering aquatic vegetation, decreasing habitat diversity, and limiting recreational, commercial, and some wildlife uses. Sedimentation rates worsen below Lake Pepin at times of high stormwater runoff (UMESC 2006).

Many species are intolerant of high levels of suspended sediments or excess nutrient inputs. Lake Pepin is a natural widening of the Mississippi River created when sediments deposited by the Chippewa River just downstream partially blocked the main channel of the Mississippi. Lake Pepin now acts as a settling basin for pollutants, including phosphorous and sediments transported by the Minnesota River from upstream agricultural areas and various cities (Minnesota River Basin Data Center 2001). Many pollutants are now buried in the river sediments here and are not transported farther downstream. For this reason, water quality in the Mississippi River at normal water levels is better for some distance below Lake Pepin and the mouth of the Chippewa River.

Nitrate concentrations in the water are generally highest in spring in response to the application of fertilizers on farmland (especially during rainier springs). In summer and winter, there are problems with critically low oxygen concentration in some of the Wisconsin backwaters of the Mississippi (UMESC 2006).

Water resource problems affecting coldwater streams in this ecological landscape include ***flashy stream*** flows, severe floods accompanied by stream bank erosion and followed by sand or silt deposition, degraded habitat for sensitive aquatic organisms, and disrupted thermal regimes. Heavy pasturing and ditching have negatively impacted small streams in many parts of this ecological landscape. Other problems include manure and fertilizer runoff, cropland erosion, and gullies (Engel and Michalek 2002). As an example, Kettle Hollow Creek in the Rush Creek watershed has high levels of suspended solids, as do several streams in other watersheds.

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

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

According to Finley (1976), the Western Coulees and Ridges Ecological Landscape of the mid-1800s contained Wisconsin's most extensive area of oak forest, oak openings, and oak woodland, with 53% of the ecological landscape forested or partially forested with oak species (Figure 22.4). Maple-basswood forest made up 19% of the vegetation, with upland brush the next largest cover type (10%).

Relative importance values (RIV) from PLS data are available for tree species based on the average of tree species density and ***basal area*** (He et al. 2000). These data indicate that three species of oak comprised almost two-thirds of the ecological landscape's tree species RIV: white oak (*Quercus alba*)

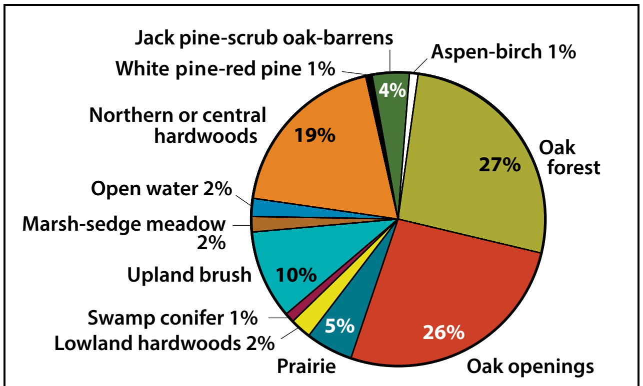


Figure 22.4. *Vegetation of the Western Coulees and Ridges Ecological Landscape during the mid-1800s, as interpreted by Finley (1976) from federal General Land Office public land survey information.*

(33.6%, RIV), bur oak (*Quercus macrocarpa*) (15.9% RIV), and black oak (14.8% RIV). The only other RIV for a species higher than 5% was sugar maple (7.1% RIV). See the map "Vegetation of the Western Coulees and Ridges Ecological Landscape in the Mid-1800s" in Appendix 22.K.

Current Vegetation

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

The Western Coulees and Ridges Ecological Landscape is approximately 6,168,000 acres in size, of which approximately 43% was forested in 1992 (WDNR 1993). WISCLAND data also indicate that 36% of the ecological landscape was in agricultural use and second only to the Southeast Glacial Plains in the total number of acres in agriculture. Grassland covered 14% of the Western Coulees and Ridges, the largest amount of grassland of any ecological landscape (Figure 22.5). Very little of this was native grassland (prairie); most was probably pasture or land in CRP (Conservation Reserve Program).

According to the Wisconsin Wetlands Inventory (WDNR 2010b), wetland cover is uncommon in the Western Coulees and Ridges, comprising less than 5% (approximately 300,000 acres) land cover (note that data are not currently available for Dunn, Jackson, and La Crosse counties). Almost half (49%) of the ecological landscape's wetlands are forested—the vast majority (over 95%) in deciduous hardwoods. Emergent/wet meadow (which in this classification includes emergent marsh and sedge meadow) and shrub/scrub wetland comprise the bulk of the nonforested wetland type, occupying 34% and 13%, respectively, of the total wetland acreage.

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 are discussed in the "Fauna" section below.

According to FIA data summarized in 2004, approximately 39% of the land area in the Western Coulees and Ridges is forested. The predominant forest cover type group is oak (51% of the forested land area), followed by northern or central hardwoods (26%), lowland hardwoods (10%), and aspen (6%) (Figure 22.6). All other forest types each occupy 5% or less of the land area.

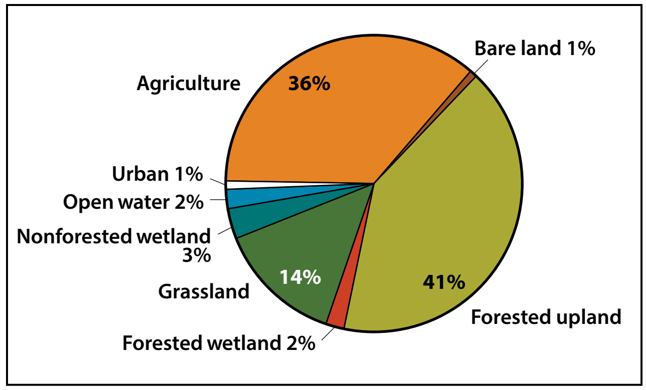


Figure 22.5. *WISCLAND land use/land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery (WDNR 1993) for the Western Coulees and Ridges Ecological Landscape.*

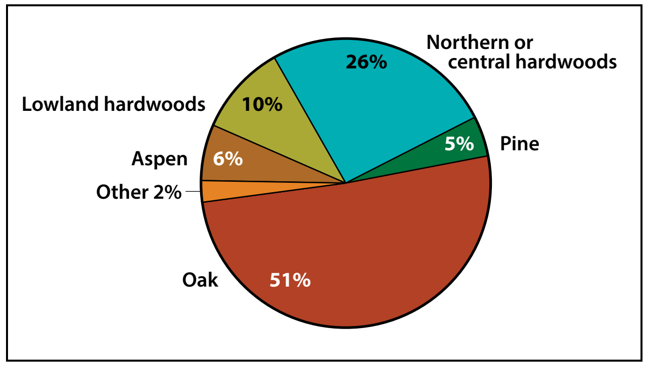


Figure 22.6. *Forest Inventory and Analysis data (USFS 2004) showing land by forest type (greater than 17% crown cover) as a percentage of forested land area for the Western Coulees and Ridges Ecological Landscape. For more information about the FIA data, see Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."*

Changes in Vegetation over Time

The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and communities that are now altered in number, size, or extent or that have been changed functionally (for example, by dam construction or fire suppression). Although data are limited to a specific snapshot in time, they provide valuable insights into Wisconsin's ecological capabilities. Maintaining or restoring some lands to more closely resemble historical systems and including some structural or compositional components of the historical landscape within actively managed lands can help conserve important elements of biological diversity. We do not mean to imply that entire ecological landscapes should be restored to historical conditions, as this is not possible or necessarily desirable within the context of providing for human needs and desires. Information on the methodology, strengths and limitations of the vegetation change data is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials."

Current forest vegetation (based on FIA) is primarily oak species (36% of RIV), northern or central hardwoods (18%), and aspen-birch (11%; Figure 22.7). Aspen RIV has increased from 4.1% to 10.9% of forest cover since Euro-American settlement, while red maple has increased from 0.9% to 8.3%. Hickory (*Carya* spp.) has also increased (from 0.9% of RIV to 6.6%), as has elm (from 4.2% to 7.5% of RIV).

The overall RIV for oaks has decreased from over 70% to 36%, and the RIVs of the individual species within that group have also changed widely (Figure 22.8). The RIVs of black, bur, and white oaks have decreased dramatically, while northern red oak RIV has increased from 2.6% to 12.9%. It should be noted that more recently (since 1983), northern red oak has decreased in total volume by approximately 10% in the Western Coulees and Ridges Ecological Landscape (USFS 2004). This is likely due to market demand for northern red oak, with removals exceeding growth since that time. In addition to overall changes in volume, oak in the Western Coulees and Ridges is likely experiencing losses in the oldest and youngest age classes, based on FIA data. Medium to high nutrient sites supporting the oak-hickory forest-type group in Wisconsin have little acreage in age classes of 100 years and older, and acreage of the oldest and youngest age classes declined between the 1996 and 2004 inventories (USFS 2004). Previous analyses showed a similar loss between the years of 1983 and 1996.

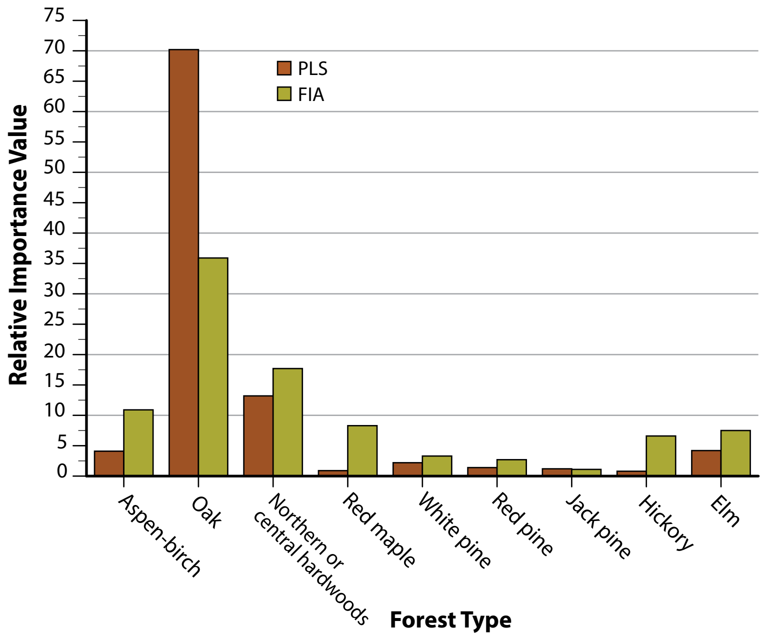


Figure 22.7. *Comparison of tree species' relative importance value (average of relative dominance and relative density) for the Western Coulees and Ridges Ecological Landscape during the mid-1800s, when the federal General Land Office public land survey (PLS) data were collected, with 2004 estimates based on Forest Inventory and Analysis (FIA) data (USFS 2004). Each bar represents the proportion of that forest type in the data set (totals equal 100). Trees of less than 6-inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.*

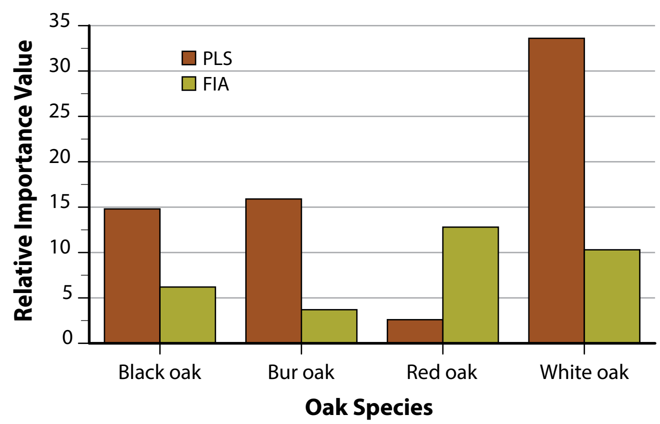


Figure 22.8. *Comparison of oak species relative importance value (average of relative dominance and relative density) during the mid-1800s, when the federal General Land Office public land survey (PLS) data were collected, with 2004 estimates based on Forest Inventory and Analysis (FIA) data (USFS 2004). Trees of less than 6-inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.*

Natural Communities

This section summarizes the abundance and importance of major physiognomic (structural) natural community groups in this ecological landscape. Some of the exceptional opportunities, needs, and actions associated with these groups, or with some of the individual natural communities, are discussed briefly. For details on the composition, structure, and distribution of the specific natural communities found in the Western Coulees and Ridges Ecological Landscape, see Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," in Part 1 of the book and also see Curtis (1959) and Minnesota DNR (2005). Information on invasive species can be found in the "Natural and Human Disturbances" section of this chapter.

■ **Forests.** Hardwood-dominated forests are more extensive here than in other southern Wisconsin ecological landscapes, but they are often highly dissected, interspersed with farm fields and residential areas, and characterized by a great amount of "hard" edge (usually created by adjoining croplands and pastures). In many parts of the ecological landscape, forests now occupy mostly the steeper slopes, while ridge tops and valley bottoms have been cleared and those lands converted to agricultural uses. As is true throughout Wisconsin, the vast majority of forests here have been logged, often repeatedly. In the Western Coulees and Ridges, many stands, perhaps most, have been grazed by domestic livestock.

Dry-mesic and mesic hardwood forests are widespread and well represented in this ecological landscape. Southwestern Wisconsin's abundant oak-dominated upland hardwood forests possess high ecological, economic, aesthetic, and recreational values. Sustainable management of the oak forests, in particular, has proven to be highly problematic. Most, if not all, of the regeneration methods used have had only limited and local success. Because a majority of this ecological landscape is privately owned (especially away from the large rivers), opportunities to work at large scales are challenging. Most upland vegetation in southern Wisconsin, including forests, has been strongly influenced by land use and ownership pattern. Continued research to develop more effective and practical methods of maintaining oaks, at least on dry-mesic sites, is a priority for land managers and conservationists here.

Sugar maple-basswood forests (Southern Mesic Forest, or sometimes simply referred to as "northern hardwoods") may support exceptionally rich understory vegåetation, especially in areas with loess soils, where the forests are underlain by dolomites or limestones and where topography, slope aspect, and rivers did not allow fires to carry unimpeded across vast areas. Mesic hardwood forests support distinctive assemblages of understory species not present in other forest communities. Additional conservation attention for this often overlooked forest community is needed, especially for rich sites that adjoin other forest types. Important concentrations of mesic (and oak-dominated dry-mesic) hardwood forests occur in the Kickapoo River drainage (e.g., especially within a large triangular-shaped area bounded roughly by the Kickapoo, Baraboo, and Wisconsin rivers) and in moist valleys and coves, such as those near the Mississippi River in western Grant and southern Pierce counties. Scattered stands elsewhere should not be overlooked, especially if they can be managed in conjunction with other upland forest communities and with lowland hardwoods. Note that many mesic forests occupy specific topographic settings and occur in complexes of other forest types, especially drier oak forests and more moist lowland forests. In part because of the high importance of the nutrient-rich mesic hardwood forests to the Driftless Area's native flora, these stands have been split out as a distinct natural community by Minnesota DNR (MDNR 2005).

The other major forest community in the Western Coulees and Ridges is Floodplain Forest, comprising much of the floodplains of large rivers and streams. Some of the Upper Midwest's largest stands of this type occur in southwestern Wisconsin. There has been more interest in actively managing this type in recent years, and it will be important for any active management to consider the entire natural community, rather than focusing solely on reproducing commercially valuable trees such as swamp white oak. For example, cottonwood,

Kickapoo River and valley; view south from Wildcat Mountain State Park lookout, Vernon County. Photo by Robert H. Read.

Rich Southern Mesic Forest of sugar maple, American basswood and northern red oak occupies this cove opening to the Kickapoo River in Monroe County. Photo by Eric Epstein, Wisconsin DNR.

river birch, hackberry, and silver maple are important members of floodplain associations and fill unique ecological roles. In addition, the impact of logging on invasive species populations must be considered; for example, in some cases, reed canary grass may be so abundant and become so dominant following timber harvest that tree reproduction may be nearly impossible. Long-term impacts of altered hydrologic regimes caused by the construction of dams have created significant concerns for the future viability, protection, and management of the full spectrum of natural variation inherent in this type. Some of the formerly dominant species associated with early successional forested floodplain systems, such as eastern cottonwood and black willow, have become increasingly scarce and difficult to maintain.

Running slough, extensive mature floodplain forest of silver maple, green ash, river birch, and hackberry. Western Wisconsin. Photo by Eric Epstein, Wisconsin DNR.

Forest communities of limited extent but sometimes high ecological significance, especially when embedded within large areas of other forest types, include the conifer-dominated Pine Relicts and Hemlock Relicts as well as Forested Seeps. Along with Tamarack Swamp, which is naturally rare here, apparently in serious decline, and has been poorly studied, these natural communities provide habitat for distinctive assemblages of plants and animals that would otherwise be scarce and sometimes absent from this ecological landscape.

Opportunities to manage in large blocks are relatively limited in this ecological landscape but should be sought for conservation purposes, especially where stands of individual forest communities are relatively large, where these stands adjoin stands of other forest types, and where important

Large tract of older dry hardwood forest on the South Bluff above Devils Lake. Sauk County. Such sites provide critical habitat for birds requiring interior forest conditions in which to breed successfully. Photo by Eric Epstein, Wisconsin DNR.

Forest of white pine-red pine on sandstone talus. Grant County. Photo by Eric Epstein, Wisconsin DNR.

environmental gradients (e.g., moisture, slope, aspect, soil texture and depth) can be represented. The distribution and habitat affinities of some forest interior taxa are reasonably well known (e.g., birds) and can be helpful in the design of viable conservation areas. We also note that though large block opportunities are relatively few, they are not nonexistent. In addition, forest cover in the Western Coulees and Ridges now is much higher than in any of the other southern Wisconsin landscapes (excepting the very different xeric forests now prevalent in Wisconsin's Central Sands region, which includes the Central Sand Hills and Central Sand Plains ecological landscapes).

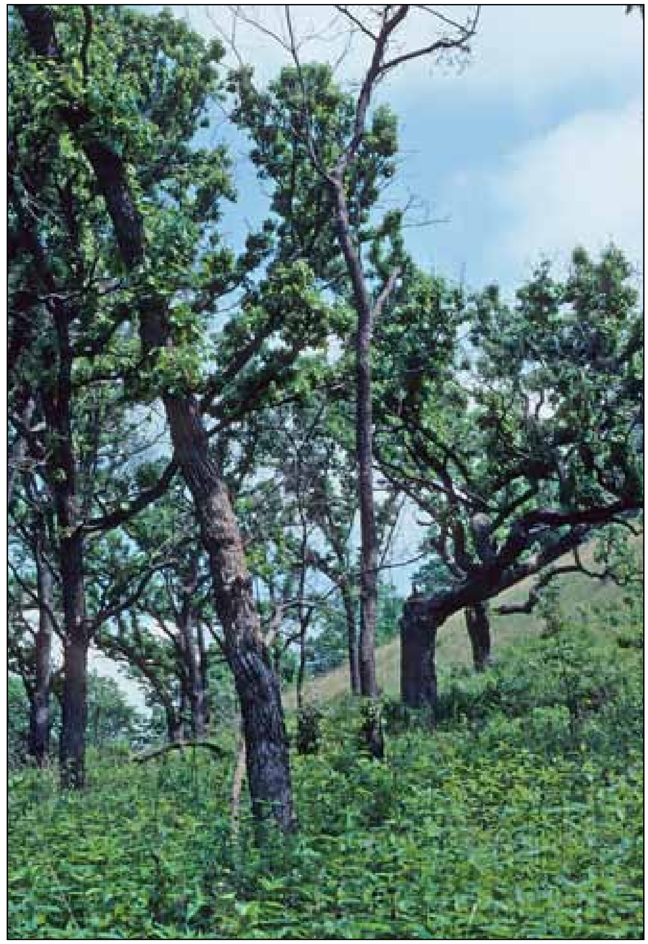
All of the major forest communities found in this ecological landscape are capable of supporting sensitive forest interior species. Even relatively small stands of native conifers may support conifer-dependent area-sensitive specialists (some of them northern disjuncts) if these habitats are embedded within more extensive areas of forest.

When fire was the dominant ecological disturbance affecting southern Wisconsin, forests occurred as part of a mosaic that graded into open Oak Woodland and various savanna communities, especially the widespread bur oak-dominated Oak Openings. Today the border between forest and open land is typically much more abrupt, as the savannas and woodlands have either been destroyed or have grown up into densely canopied forests.

There are sites where it is possible to manage for the full spectrum of oak-dominated natural communities, including closed canopy oak forests, oak woodlands (with their open understories), and oak savannas, which have discontinuous canopies, support many light-demanding understory species, and may grade into treeless prairies. Where feasible, e.g., at Rush Creek ***State Natural Area*** in Crawford County and at several sites within and adjacent to the lower Wisconsin State Riverway, managing for the entire "oak ecosystem" continuum is likely to offer the greatest conservation return for these dynamic fire-driven natural communities over time. All of these communities, including the stands now managed as forests, require some level of disturbance (albeit at varying frequencies and levels of intensities) with periodic prescribed fire arguably the most important and appropriate type of disturbance. Managing these communities as a continuum may also be the most efficient use of management resources and preserve the greatest number of management options over time.

There are also important opportunities to increase conservation value and ecosystem viability by planning at large scales that may include mesic and lowland hardwood forests as well as those historically driven by periodic fire. All three of these major forest types (or groups) represent some of the best and most extensive forest management opportunities in the Upper Midwest south of the ***Tension Zone***.

Invasive plants are serious problems at many locations, and nonnative insects and pathogens are affecting some forests and putting others at risk. For example, Dutch elm disease, caused by the fungus *Ophiostoma ulmi*, has killed most of the large elms, altering forest structure and composition throughout the ecological landscape. Eurasian honeysuckles (*Lonicera tatarica*, *Lonicera* x *bella*, *L. mackii*, *L. morrowii*) and buckthorns (*Rhamnus* spp.) now dominate the tall shrub and sapling layers of many upland forests (especially oak forests), and garlic mustard (*Alliaria petiolata*) has become a serious problem and a dominant plant in the herbaceous layer of many forest communities at numerous locations. Reed canary grass often invades disturbed lowland forests and can inhibit, or even prevent, the regeneration of native trees. Gypsy moth (*Lymantria dispar*) has been found along the eastern edge of this ecological landscape, and the impacts of emerald ash borer (*Agrilus planipennis*) could be devastating to lowland hardwood forests and mesic forests where ashes are important species.



Recently burned white oak-black oak-bur oak woodland on bluff prairie margin. Rush Creek Bluffs, Crawford County. Photo by Eric Epstein, Wisconsin DNR.

Savannas. "Oak Savanna" encompasses both the Oak Openings and Oak Barrens. See Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," for additional information.

All savanna communities are now rare. Active restoration efforts are now aimed at protecting, maintaining, and where feasible, expanding some of the better remnants. Over fifty years ago, University of Wisconsin plant ecologist John Curtis wrote "beyond question, an oak savanna with an intact ground layer is the rarest plant community in Wisconsin today" (Curtis 1959). While one may quibble over the status of several recent additions to Wisconsin's roster of recognized plant communities (WDNR 2009), when placed within the context of referencing the state's major plant communities, his statement is truer today than ever.

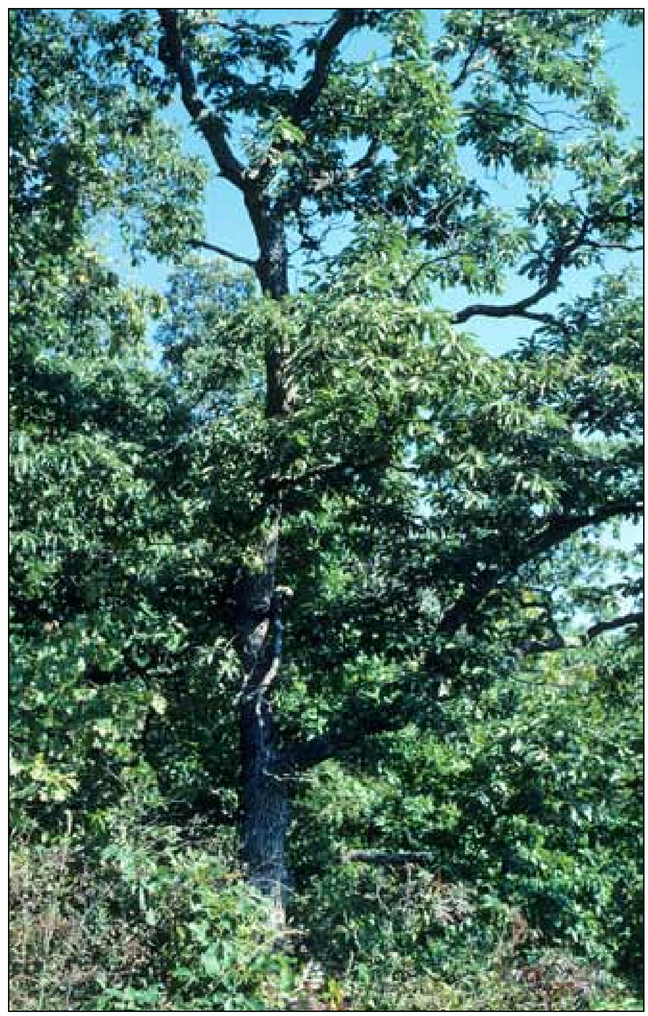
Prior to Euro-American settlement of Wisconsin, Oak Openings were the most common savanna type in southwestern Wisconsin, often occurring as a structurally distinct transitional community between the treeless prairies and closed canopy oak woodlands and hardwood forests. The combined effects of fire suppression, logging, grazing, and conversion to cropland eliminated almost all of the Oak Openings in this ecological landscape as they did almost everywhere else in southern Wisconsin, making conservation of this now globally rare natural community almost entirely a restoration-focused endeavor. The tremendous increase in shrub and sapling density (seldom with any oak component) has created conditions that are unsuitable for many of the native plants and animals adapted to savanna environments. In addition, many of the now abundant shrubs are highly invasive exotic species. Oak Openings are now the rarest savanna community in southern Wisconsin and the Upper Midwest.

Historically, savannas occurred on a wide variety of sites, and soil moisture conditions varied from very dry to wet-mesic. The mesic and wet-mesic savannas (these were Oak Openings) are essentially gone, as are most of the savannas on dry-mesic sites, which quickly succeeded to forest in the absence of frequent fire.

The driest sites include the barrens communities, where the best management opportunities are on the sandy terraces just above the floodplains of the large rivers. Dry savannas also occur on steep south- or west-facing bluffs with shallow, rocky soils on which the dominant trees may be bur oaks. On dolomite bluffs bordering the Mississippi River near the village of Bagley (Grant County), the dominant oak is the chinquapin oak (*Quercus muehlenbergiii*), a geographically limited, rare tree species in Wisconsin (now listed as Wisconsin Special Concern). A significant portion of this site is within Gasner Hollow State Natural Area, where prescribed fire and brush removal are being used to restore this area to savanna and woodland conditions.

Savanna conservation and management require active restoration. The dry sites may offer some of the best short-term opportunities for savanna restoration because successional processes proceed more slowly, and the lands they occupy are not as productive and sought after for commercial forestry or agricultural uses. To represent the full spectrum of structural and compositional diversity associated with the savannas and woodlands, however, much better representation of sites on wet-mesic, mesic, and dry-mesic sites is needed. The Western Coulees and Ridges Ecological Landscape offers some of the

Good quality oak savanna remnant on sandy island in lower Chippewa River. Dunn County. Photo by Eric Epstein, Wisconsin DNR.



Chinquapin oak is the dominant tree in this unusual oak woodland above the Mississippi River near Bagley. Grant County. Photo by Eric Epstein, Wisconsin DNR.

Oak savanna on coarse-textured sands along the lower Chippewa River. Nine Mile Island State Natural Area, Pepin-Dunn counties. Photo by Eric Epstein, Wisconsin DNR.

best savanna restoration opportunities in the Upper Midwest for Oak Openings and Oak Barrens.

Savanna restoration is complex, and there is no simple template for managers to follow. There are few intact examples against which to measure success in reestablishing the desired composition or structure. The unique limb architecture, so characteristic of canopy oaks in the Oak Openings, cannot be reproduced by simply reducing tree density in an existing forest, and the understory composition of pastured stands that have retained their open grown bur or white oaks is difficult to assess until livestock have been removed and (prescribed) fire has been reintroduced. Western Wisconsin's "prairie and savanna pastures," lands grazed by domestic livestock but never plowed, may offer the best practical opportunities for restoration.

The Oak Barrens community was (and is today) limited to sites on level or gently rolling terrain that were characterized by droughty, coarse-textured soils (usually sands) of low nutrient content. The broad sandy terraces that flanked the floodplains of major rivers such as the Mississippi, Wisconsin, Chippewa, and Black historically supported barrens vegetation, sometimes over extensive areas. Excellent remnants still occur on the terraces of each of these rivers. Oak Barrens also occurred in some of the hillier parts of the ecological landscape underlain by sandstone bedrock, where the shallow soils are drought-prone and infertile, wildfires were frequent and, sometimes, catastrophic. Examples are known from northern Dunn County and north central Monroe County (including much of the area now occupied by Fort McCoy Military Reservation). At a few barrens sites, jack pine is the dominant tree, rather than black or northern pin oak, creating outliers of the Pine Barrens community (better known from the sandy, fire-prone portions of the northern and central regions of the state).

All savanna communities are now rare. Good quality remnants have been identified at a number of locations, and active restoration efforts are now focused on protecting, maintaining and, when possible, expanding these occurrences.

Shrub Communities. The native shrub communities of this Western Coulees and Ridges are wetlands, which, in this unglaciated region, are mostly limited to the broader floodplains of the major rivers and larger streams. Shrub communities, of which Shrub-carr is the most common type, tend to occupy a zone between forested lowlands and open wetland communities such as marsh or sedge meadow. They may also form a narrow border along the upper reaches of smaller streams if the gradient and adjacent slopes are not too steep and if local land uses are compatible with maintaining stands of native shrubs. While the willow/dogwood-dominated Shrub-carr community is probably the most common shrub swamp type here (there are no precise summary data for the native shrub cover types), Alder Thicket occurs at some locations and is characteristic of the upper reaches of spring-fed headwaters streams or around areas that experience active and abundant groundwater seepage.

Along with other lowland vegetation in this ecological landscape, many shrub swamps have been cleared or grazed to accommodate agriculture. This is especially true in valleys occupied by smaller streams. In recent years, there has been some interest among resource managers in maintaining or increasing shrub habitat, usually to provide habitat for game species such as the American Woodcock (*Scolopax minor*) or Ruffed Grouse (*Bonasa umbellus*). More documentation of the impacts of the methods used to accomplish alder regeneration is needed because manipulated stands, especially in areas formerly used for agricultural practices (including grazing), can be vulnerable to the rapid invasion and takeover by aggressive weeds such as reed canary grass. Sites that formerly supported lowland forests can be difficult and expensive to maintain in an early successional shrub-dominated stage.

Some activities may lead to a temporary artificial dominance of shrubs and saplings, including lowering the water table of more open wetlands via ditching or excluding fire from sedge meadows and marshes. Such stands seem inherently unstable and will probably require active management to maintain them as either shrublands or more open wetlands.

The thickets of saplings and shrubs that are the result of certain upland logging practices (such as clearcutting) can have benefits for some wildlife species, but in most cases these positive effects will be short-lived, and care should be taken to avoid compromising the integrity of extensive areas of older forest that are in short supply in southern Wisconsin and often support uncommon or rare species. ***Ecological context*** becomes a critical consideration when weighing impacts of this sort of management beyond the stand level.

Herbaceous Communities. The tallgrass prairies (these include the mesic, wet-mesic, and dry-mesic types) that were historically common on broad ridge tops and on some of the larger river terraces are almost gone, destroyed as Euro-American settlers moved into southern Wisconsin and established farms. The most fertile and treeless lands were selected preferentially, and once the steel moldboard plow was available, the tallgrass prairies disappeared quickly. Only very small, often isolated, remnants of these communities persist today.

Dry Prairie (also called "goat prairie," "dry lime prairie," "driftless bluff prairie") is a characteristic plant community that occurs on the upper slopes of steep bluffs, most often with southern or western exposures. On bluffs flanking the valleys carved by the major rivers, series of these prairies sometimes extend for miles where the slope orientation is appropriate. Wisconsin has many good examples of this native grassland community, and they are less prone to succeed to forest because of the extreme site conditions. In the past, sites supporting bluff prairies were relatively secure and of relatively low value for development purposes. Recently, however, the views afforded by such sites have proven to be major attractions to builders of new homes, and many bluff prairies have been compromised by the construction of homes and associated infrastructure.

Dry Sand Prairie occurs on drought-prone terraces that border some of the ecological landscape's larger rivers. Sites are level to rolling, and some have developed on ancient dune fields. Good quality Sand Prairies are very rare, with most of the historical acreage converted to irrigated agricultural fields, red pine plantations, or subdivisions.

Steep west-facing slope of sandstone and dolomite bedrock bluff supports good quality dry prairie. Vernon County. Photo by Eric Epstein, Wisconsin DNR.

Good quality sand prairie remnant on Hill's Island in the lower Chippewa River, Dunn County. Photo by Eric Epstein, Wisconsin DNR.

Lowland (Wet and Wet-mesic) prairies occur at only a few sites now, usually in association with river terrace complexes where sloughs and periodic floods limited access, and cultivation was intrinsically difficult.

Though the aggregate acreage of surrogate grassland is high in the Western Coulees and Ridges, stands are usually less extensive here than in ecological landscapes farther south and east. They can provide important habitat for rare or declining grassland birds that can no longer find native prairies large enough to meet even their minimal habitat needs.

Though most of Wisconsin's remnant prairies are small, isolated, and in need of management attention, the Western Coulees and Ridges harbors Wisconsin's best examples of Dry Prairie and Sand Prairie. Some of the terrace prairies associated with the large rivers contain small patches of the tallgrass types, and remnants are sometimes embedded within surrogate grasslands. Though small, sometimes isolated, and difficult to protect, even small remnants of these rare native prairie communities can act as irreplaceable ***refugia*** for native plants and some animals (e.g., rare invertebrates).

Miscellaneous Communities. Outcroppings of the sedimentary rocks that underlie most of the ecological landscape are common features of the Western Coulees and Ridges. Sandstones and dolomites of Cambrian or Ordovician age make up most of the rock exposures (Paull and Paull 1977). Cliffs are numerous in some areas and sometimes occur in extensive series on the bluffs bordering the larger valleys. The best developed and most dramatic cliffs feature sheer rock faces that, in some areas, are hundreds of feet high. Some of the smaller rivers, such as the Kickapoo, are known for having created ***entrenched meanders***, semi-permanent channels where flowing waters have cut through relatively soft sandstone bedrock.

Cliffs provide habitat for rare plants and animals, including species that are restricted to the Western Coulees and Ridges Ecological Landscape (see the "Fauna" and "Flora" sections for details). For example, cliffs may be used as nest sites by some bird species (including the reintroduced Peregrine Falcon [*Falco peregrinus*]). Updrafts, created where winds hit the bluffs and are deflected upward, are often used by large raptors to help them move efficiently and with minimal expenditure of effort from one location to another. Other important habitats associated with and dependent on bedrock include caves, fissures, talus slopes, and abandoned mines, all of which may be used as roosting areas or hibernacula by bats, reptiles, and some birds.

Algific Talus Slopes are extremely rare geological features known in Wisconsin from only a few sites in the southwestern corner of this ecological landscape. The Algific Talus Slopes are created by and dependent on a unique combination of geological factors. The talus slopes emit cold air throughout the growing season, providing habitat for highly specialized and unusual plants and animals. For details on this natural community, see Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," and also see Frest (1981), Frest (1991), and Meyer (1995).

Although the vast majority of exposed bedrock in this ecological landscape (almost always as cliffs) is Cambrian sandstone or dolomite, much older rock is exposed at a few locations, such as the pre-Cambrian quartzites and conglomerates of the Baraboo Range in Sauk County (Lange 1989). Quartzite talus slopes and boulder fields have created unique habitats for plants and animals that are not replicated by the much more widespread exposures of sedimentary sandstones and dolomites.

Sandbars and mudflats are exposed along the major rivers under certain conditions and at certain times of the year. Exposures of mud, sand, or gravel may be extensive in late summer or during drought years. Such habitats are often ephemeral, unstable, and highly variable in composition from year to year and location to location. Plant cover may be sparse, dense, or entirely absent, but tenure of vegetation is typically short (days, weeks, months, more rarely for a few years). Dominants are often graminoid species (grasses, sedges, rushes), but fast growing shrubs or trees, e.g., sandbar willow (*Salix exigua*), may form thickets if enough time lapses between significant flood events during the growing season. Shorebirds, herptiles, and invertebrates may use such habitats heavily.

Forest Habitat Types

The Western Coulees and Ridges Ecological Landscape is geographically extensive, topographically complex, and ecologically variable. Much of the region is covered by loess (wind-blown silt), but soil depth and underlying materials are highly variable. All major southern habitat type groups are represented (Table 22.1). Common habitat type groups are dry-mesic, dry-mesic to mesic, and mesic. Minor habitat type groups are dry, mesic to wet-mesic, and wet-mesic to wet. Across the region, many different habitat types (including geographic variants and phases) occur, but often only a few habitat types predominate locally.

Dry-mesic sites are typically associated with loamy soils that are well drained and nutrient medium to rich. Forest stands are most commonly dominated by some mix of northern red oak, white oak, black oak, red maple, and aspen (*Populus* spp.). Occasional associates include eastern white pine, white birch (*Betula papyrifera*), shagbark hickory, black cherry, white ash (*Fraxinus americana*), American basswood, and sugar maple. Potential late-successional dominants are red maple, sugar maple, and American basswood.

Dry-mesic to mesic sites are typically associated with silt loam soils that are well drained and nutrient rich. Forest stands are most commonly dominated by some mix of northern red oak, white oak, red maple, shagbark hickory, black cherry, American basswood, sugar maple, and aspen. Potential late-successional dominants are sugar maple and American basswood.

Table 22.1. *Forest habitat type groups and forest habitat types[a] of the Western Coulees and Ridges Ecological Landscape (WCR EL).*

Southern forest habitat type groups[b] common within the WCR EL	Southern forest habitat types common within the WCR EL	Southern forest habitat types minor within the WCR EL
Dry-mesic (DM)	ArCi-Ph	ArDe-V ArCi AArVb
Mesic (M)	ATiSa-De	ATiCa ATiCa-La ATiSa
Dry-mesic to mesic (DM-M) (includes phases)		ATiDe ATiDe(Pr) ATiCr(O)
Southern forest habitat type groups minor within the WCR EL		
Dry (D)		PVCr PVGy
Wet-mesic to wet (WM-W)		Forest lowland (habitat types not defined)
Mesic to wet-mesic (M-WM)		

Source: Kotar and Burger (1996).

[a]Forest habitat types are explained in Appendix 22.B ("Forest Habitat Types in the Western Coulees and Ridges Ecological Landscape") at the end of this chapter.

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

Mesic sites are typically associated with silt loam soils that are well to moderately well drained and nutrient rich. Forest stands are most commonly dominated by some mix of sugar maple, American basswood, northern red oak, white oak, and aspen. Occasional associates include red maple, shagbark hickory, bitternut hickory (*Carya cordiformis*), black cherry, elm, white ash, and white birch. Potential late-successional dominants are sugar maple and American basswood.

Flora

The most comprehensive study of the Western Coulees and Ridges flora was conducted by Thomas Hartley (1962, 1966). Detailed botanical studies of more limited geographic scope, often focused on rare plants, have been conducted in the upper Kickapoo River watershed (Read 1977), the Baraboo Hills (Clark et al. 1993), Fort McCoy Military Reservation, the Badger Army Ammunition Plant (Thompson and Welsh 1993), and at many state-owned properties such as the Coulee Experimental State Forest (WDNR 2008b) and the Lower Wisconsin State Riverway. Relatively complete lists of vascular plants are available for many state natural areas in this ecological landscape. Specific natural communities and habitats, such as prairies, Algific Talus Slopes, and cliffs, have also attracted the attention of botanists here.

The Wisconsin Natural Heritage Working List (WDNR 2009) includes 130 species of vascular plants that have been documented within the Western Coulees and Ridges Ecological Landscape. Of the 130 species, 18 are listed as Wisconsin Endangered, 28 are listed as Wisconsin Threatened, and 84 are listed as Wisconsin Special Concern. See Appendix 22.C at the end of this chapter for a complete list of the rare vascular plant species tracked by the Wisconsin Natural Heritage Inventory in this ecological landscape.

Two plants occurring here, northern wild monkshood (*Aconitum noveboracense*) and prairie bush-clover (*Lespedeza leptostachya*), are listed as threatened at the federal level by the U.S. Fish and Wildlife Service because of their rangewide rarity or jeopardy. Federal recovery plans were completed for northern wild monkshood in 1983 and for prairie bush-clover in 1988. Both plants are also listed as Wisconsin Threatened.

Several plants under consideration for federal listing in the 1980s were the subjects of detailed status surveys conducted by Wisconsin DNR botanists. The target species were three plants endemic to prairies of the Upper Midwest: Hill's thistle (*Cirsium hillii*), glade mallow (*Napaea dioica*), and prairie fame-flower (*Talinum rugospermum*). Following the completion of these surveys, federal listing for these species was not pursued. However, some of the continent's largest and most viable populations of each are located in Wisconsin in the Western Coulees and Ridges Ecological Landscape. Most of the sites harboring extant populations of these plants are unprotected, and many historical populations (known from herbarium collections) could not be relocated during survey efforts in the 1990s and 2000s.

Northern Monkshood is a habitat specialist with a severely limited midwestern distribution. It is listed as "Threatened" by both federal and state governments. Photo by Kitty Kohout.

Each of these plants is now considered globally rare, though at low enough risk to be kept off the federal statutory list for now. Each of these species has a restricted range and a strong association with habitats that are themselves in severe jeopardy, such as prairies and oak savannas. It is prudent and cost effective to plan for the conservation of such species now, rather than waiting until fewer options are available as conditions become increasingly dire.

Among the globally rare plants that are well represented here compared to other parts of Wisconsin are bog bluegrass (*Poa paludigena*), pale false foxglove (*Agalinis skinneriana*), clustered poppy mallow (*Callirhoe triangulata*), Hill's thistle, and glade mallow.

The Western Coulees and Ridges Ecological Landscape supports 21 species of rare vascular plants that have been documented in no other ecological landscape in Wisconsin. These include globally rare species such as northern wild monkshood (18 of 18 documented populations are found here) and clustered poppy mallow (25 of 25 known populations occur here) as well as plants that are more common in other parts of their ranges but represented in Wisconsin by

In Wisconsin, clustered poppy-mallow (Wisconsin Special Concern) occurs at only a few sites, where it is closely associated with sand prairies and oak barrens. Photo by Thomas Meyer, Wisconsin DNR.

single populations, such as the Wisconsin Threatened Carey's sedge (*Carex careyana*) and the Wisconsin Special Concern silvery scurf-pea (*Pediomelum argophyllum*).

An additional 26 plant species have 50% or more (but not all) of their populations in this ecological landscape. Among those with legal protection are the globally rare and Wisconsin Endangered pale false foxglove, Carolina anemone (*Anemone caroliniana*), and purple milkweed (*Asclepias purpurascens*), and the Wisconsin Threatened musk-root (*Adoxa moschatellina*), roundstem foxglove (*Agalinis gattingeri*), drooping sedge (*Carex prasina*), yellow gentian (*Gentiana alba*), and brittle prickly pear (*Opuntia fragilis*). Examples of rare plants listed as Wisconsin Special Concern species and with especially strong representation in the Western Coulees and Ridges Ecological Landscape are great Indian plantain (*Arnoglossum reniforme* but listed as *Cacalia muehlenbergii* on the Wisconsin Natural Heritage Working List), autumn coral-root (*Corallorhiza odontorhiza*), glade fern (*Diplazium pycnocarpon*), prairie fame-flower, and nodding pogonia (*Triphora trianthophora*).

Significant Flora in the Western Coulees and Ridges Ecological Landscape

- Significant components of this ecological landscape's flora include midwestern endemics, northern "relicts," habitat specialists, and some remarkable disjuncts.
- Dry Prairies are characteristic features of steep rocky bluffs and level sandy river terraces. Each of these prairie settings provides habitat for a distinctive group of vascular plants. Dry Prairies are better represented here than in any other ecological landscape.
- Dry hardwood forests and woodlands (i.e., those dominated by oaks) support a subset of herbs that do not occur in more mesic forests. In the past, wildfires reduced shrub and sapling cover, creating relatively open understory conditions.
- Cliffs and talus slopes are common here, and the bedrock exposures provide habitat for many specialists of limited distribution.
- Mesic hardwood forests support a rich complement of native herbs, including many rarities limited to southern Wisconsin.
- Ecological connectivity is higher here than in the glaciated parts of southern Wisconsin. There is the potential to include major environmental gradients (such as soil moisture, slope, and aspect) within lands managed for conservation purposes.
- Fire suppression has altered community composition, structure, and function in prairies, savannas, and oak forests, all of which were adapted to periodic wildfire.
- River and floodplain hydrology have been altered by dam construction and widespread ditching. The long-term impacts of these alterations on floodplain vegetation and aquatic biota need clarification and constitutes an urgent research need.
- The diverse native flora of the Western Coulees and Ridges is highly threatened by the spread and increase of invasive plants and animals.
- Several "southern" plants reach their northern range limits here, including trees such as chinquapin oak, honey locust, Kentucky coffee-tree, and American sycamore (*Platanus occidentalis*).
- Cold, heavily shaded sandstone canyons and gorges can support "relict" communities in which northern species such as eastern hemlock, yellow birch, Canada yew, and a number of herbs are prominent.

Habitat Affinities of Rare Plant Species in the Western Coulees and Ridges Ecological Landscape

Forests. Stands of Southern Mesic Forest that have not been heavily grazed, severely logged, inappropriately burned, or infested with invasive plants are capable of supporting rich assemblages of native herbs. Many of the more conservative and rarer species do not occur in the similar sugar maple-dominated stands of northern Wisconsin (commonly referred to as "northern hardwoods"; this name is also applied to sugar maple-basswood forests in southern Wisconsin). Besides well-known and showy groups such as the spring ephemerals (Curtis 1959), the rare flora of the mesic hardwood forests in the Driftless Area includes Carey's sedge, snow trillium (*Trillium nivale*), nodding pogonia, putty root orchid (*Aplectrum hyemale*), twinleaf (*Jeffersonia diphylla*), glade fern, and heart-leaved skullcap (*Scutellaria ovata ovata*).

Golden seal (*Hydrastis canadensis*) is a rare native herb that is not currently tracked by the Wisconsin Natural Heritage Inventory program. It has been collected (and sometimes sold) by herbalists because it is thought to have medicinal qualities. Small-scale attempts to grow this plant commercially were attempted in the past, but we are not aware of any current efforts to cultivate golden seal at a large scale. It may, however, still receive pressure from collectors who take plants from the wild.

The floristic diversity of the Driftless Area hardwood forests may be boosted significantly when features such as rock outcroppings or spring seeps are present. Seeps may support rare species such as drooping sedge or bog bluegrass. In areas where calcareous bedrock is exposed, the outcroppings may be covered by the unusual walking fern (*Asplenium rhizophyllum*) and jeweled shooting star (*Dodecatheon amethystinum*).

In addition to the disturbances mentioned above, exotic earthworms have had serious negative impacts to the native floras of mesic hardwood forests in parts of northern Wisconsin and may be a concern in the Western Coulees and Ridges Ecological Landscape as well. Documentation of the extent and severity of earthworm-related problems is needed for this ecological landscape.

Snow trillium, putty root orchid, and Dutchman's-breeches in an exceptionally rich stand of mesic maple-basswood forest in southwestern Pierce County. Photo by Eric Epstein, Wisconsin DNR.

Dry and dry-mesic forests of the Western Coulees and Ridges are, or were, often dominated by oaks. The characteristic natural disturbances were fire and drought. Periodic wildfires formerly affected many, if not virtually all, oak forests. Besides facilitating establishment of the oaks, fires reduced the density of shrub and sapling cover and prevented the growth of and dominance by more ***mesophytic*** tree species such as maples (*Acer* spp.), ashes, and American basswood. Native grasses, legumes, and composites may be well represented in oak stands that have not been heavily disturbed by agents other than fire. Among the noteworthy rare plants of the oak forests are autumn coral-root, upland boneset (*Eupatorium sessilifolium* var. *brittonianum*), great Indian plantain, and ginseng (*Panax quinquefolius*).

Floodplain Forest is the most abundant wetland community along the major rivers in the Western Coulees and Ridges Ecological Landscape. The characteristic plants, including the trees, are adapted to periodic inundation and consequently

Jeweled shooting star is a cliff specialist in the Driftless Area, where it grows on shaded outcrops of sedimentary bedrock. Photo by Thomas Meyer, Wisconsin DNR.

constitute a distinctive assemblage of Wisconsin's native plants. This includes the understory, which may include tall shrub buttonbush (*Cephalanthus occidentalis*), the brilliant cardinal flower (*Lobelia cardinalis*), cut-leaved coneflower (*Rudbeckia laciniata*), false dragonhead (*Physostegia virginiana*), and the striking green dragon (*Arisaema dracontium*), a jack-in-the-pulpit relative. Graminoids—grasses and sedges—may dominate the ground layer, especially fairly early in the growing season, but by mid-summer, nettles (*Laportea canadensis* and *Urtica* spp.) and ostrich fern (*Matteucia struthiopteris*) may form nearly solid stands that can exceed several meters in height. The very rare Wisconsin Endangered beak grass (*Diarrhena obovata)* occurs in Floodplain Forest and Forested Seep communities in the Western Coulees and Ridges. Of special interest is the recent discovery of purple rocket (*Iodanthus pinnatifidus*) in lowland hardwood forests along the lower Wisconsin River in Grant and Crawford counties.

Floodplain Forests near the southern edge of the ecological landscape host tree species that are common farther south but that reach their extreme northern range limits in Wisconsin's southernmost counties. These include Kentucky coffeetree, American sycamore, and pin oak (*Quercus palustris*), all Wisconsin Special Concern species, along with honey locust.

Heavily disturbed stands may be invaded by the aggressive reed canary grass. Once established, this weed can become the dominant understory plant and inhibit the growth of native plant species, including trees. Box elder (*Acer negundo*) is often prominent in heavily disturbed floodplain forests that have been affected by persistent ***high grading***, heavy grazing, and ditching. The exotic insect emerald ash borer has been found in some Western Coulees and Ridges counties and could have devastating effects on the lowland forests of this ecological landscape since ashes are among the important canopy trees.

■ Savannas and Woodlands. Savannas are structurally transitional between closed canopy forests and treeless prairies and, historically, frequently formed an ecotone between them. The savannas were often in close proximity to Oak Forest, Oak Woodland, and prairie, and these natural communities have many genera and some species in common. Under a disturbance regime of frequent fire of low intensity (presumed to be how the oak savannas were maintained in regions with heavier soils), the understory was open and supported many native grasses, legumes, mints, and composites, including some species that seldom occur (or fail to attain high population levels) in either the closed canopy forests or in entirely treeless prairies. Rare plants associated with woodland and savanna habitats include yellow giant hyssop (*Agastache nepetoides*), purple milkweed, yellow gentian, violet bush-clover (*Lespedeza violacea*), slender bush-clover (*L. virginica*), and upland boneset.

An interesting puzzle for plant geographers and others is why the globally rare and Wisconsin Threatened kitten's-tails (*Besseya bullii*) has not been found in Wisconsin's Driftless Area. It occurs just to the east of the Western Coulees and Ridges in the Southeast Glacial Plains where it is locally common (though not very widespread) in parts of the Southern Kettle Moraine region, including the Kettle Moraine State Forest – Southern Unit. It is also found just to the north of the Western Coulees and Ridges on semi-open (savanna-like) bluffs above the St. Croix River. Kitten's-tails has been found at several locations in Minnesota's Driftless Area (their "Paleozoic Plateau"), which really adds to the distribution puzzle.

In the absence of frequent ground fires, the savannas rapidly lost their open aspect, and many of the light-demanding plant species declined or disappeared (Leach and Givnish 1999). Some of these plants are now limited to forest edge situations (where they may barely hang on), but such vulnerable habitats are unlikely to offer long-term population viability. Mechanical thinning of the overstory will not be enough to produce suitable environments in which many of the savanna associates will thrive or persist because that can neither create the needed understory structure, nor compensate for the probable loss of many understory species.

It should be emphasized that the concern for plants associated with savannas and woodlands is not limited to rare understory species but includes the dominant oaks as well. Heavy shade can lead to their demise, and the larger trees were (and are) often cut for firewood, lumber, or to reduce shade and improve land for pasture. On sandy or gravelly sites, the oaks (which are often of low commercial value if open-grown or otherwise of "poor" form) have often been removed and sometimes replaced by monotypic plantations of red, white, or Scots (*Pinus sylvestris*) pine.

An excellent source of information on the ecology and distribution of Wisconsin's native prairie and savanna plants is the *Atlas of Wisconsin Prairie and Savanna Flora* (Cochrane and Iltis 2000).

■ Prairies. Most of Wisconsin's prairie flora apparently reached Wisconsin following the glacial retreat from the surrounding parts of Wisconsin, approximately 10,000 years ago. The prairie flora reached Wisconsin from two areas beyond the reach of glaciation, the northern Great Plains and the Ozark Mountains (Curtis 1959). The fertile, highly productive, deep-soil tallgrass prairies have been almost entirely replaced by corn and soybeans over the past one hundred and fifty years. Prairie remnants today are small, isolated, and often weedy. They occur along roadsides, in cemeteries, and within railroad rights-of-way where they are vulnerable to encroachment by invasive plants, herbicide drift, damage due to the use of mechanized grading equipment, and pilferage from those desiring to pick—or dig up—a pretty plant. Rare plants associated with the tallgrass remnants include the Wisconsin Threatened wild quinine (*Parthenium integrifolium*), pale purple coneflower (*Echinacea pallida*), and several Wisconsin Special Concern plants such as the extremely rare silvery scurf pea.

Remnant Sand Prairies are found at a few locations such as the sandy terraces bordering the large rivers. The Wisconsin Special Concern clustered poppy mallow is a globally rare

Plains prickly-pear cactus is adapted to hot, dry drought-prone habitats such as sand prairies and blowouts, oak barrens, and bedrock glades. Photo by Dick Bauer.

plant that is strongly associated with Sand Prairie habitats. All 25 populations of clustered poppy mallow known from Wisconsin occur in the Western Coulees and Ridges Ecological Landscape. Other Sand Prairie specialists include a cactus, plains prickly pear (*Opuntia macrorhiza*), the sclerophyllous shrub false heather (*Hudsonia tomentosa*), and prairie fameflower, a curious plant that produces a rosette of fleshy, tubular leaves and flowers for only brief periods during the late afternoon. Other noteworthy plant species that may occur in sandy prairies are the Wisconsin Endangered hairy wild petunia (*Ruellia humilis*) and Wisconsin Special Concern prairie false-dandelion (*Microseris cuspidata*). Sand Prairies are globally rare, and Wisconsin has exceptional occurrences along the lower Wisconsin, Black, and Chippewa rivers. A major sand prairie/oak barrens restoration project is underway on a Mississippi River terrace at Trempealeau National Wildlife Refuge.

The ecological landscape's steep bluffs offer many opportunities to manage and protect Dry Prairie (aka "driftless bluff prairie," "bedrock bluff prairie," "goat prairie," and "dry lime prairie"). At several locations, there is an excellent opportunity to integrate the management and restoration of bluff prairies (and adjacent or nearby surrogate grasslands) with oak savanna, oak woodland, and oak forest communities. Periodic wildfire is the common denominator shared by these natural communities, all of which are either already rare (prairies and savannas) or in decline (oak forest). The Western Coulees and Ridges contains one of the Upper Midwest's most significant concentrations of Dry Prairies.

■ **Bedrock Habitats (Cliffs, Talus Slopes, and Glades).** The diminutive cliff cudweed (*Gnaphalium saxicola,* listed as *Gnaphalium obtusifolium* var. *saxicola* on the Wisconsin Natural Heritage Working list) is one of a very small number of vascular plants that is endemic to Wisconsin. It occurs in only two ecological landscapes (it is also found just to the east of the Western Coulees and Ridges, in the Central Sand Plains Ecological Landscape, where it has been documented at a few sites in its primary habitat, dry sandstone cliffs).

Cliff cudweed (Wisconsin Threatened) is endemic to Wisconsin, where it is known from dry sandstone cliff habitats in two ecological landscapes. Photo by Thomas Meyer, Wisconsin DNR.

Note that the taxonomic changes proposed previously for this species have been accepted by the scientific community. Cliff cudweed (*Gnaphalium obtusifolium* var. *saxicola*) is now recognized by the University of Wisconsin State Herbarium and other institutions as a fully distinct taxon, *Gnaphalium saxicola*. The legal status remains Wisconsin Threatened.

Shadowy goldenrod (*Solidago sciaphila*) is limited in distribution to the Upper Midwest's Driftless Area, where it inhabits dry sandstone cliffs. Other rare plants highly dependent on driftless cliffs or talus slopes include muskroot and the following Wisconsin Special Concern species: jeweled shooting star, rock club-moss (*Huperzia porophila*), purple-stem cliff-brake (*Pellaea atropurpurea*), and Shinner's three-awned grass (*Aristida dichotoma*).

Disjunct species of special interest to biogeographers include the Wisconsin Special Concern bird's-eye primrose (*Primula mistassinica*), a plant of the far north, which in Wisconsin is known only from the Apostle Islands of Lake Superior, rocky shores along Lake Michigan on the northern Door Peninsula and the Grand Traverse Islands, and cold dripping sandstone cliffs carved by Driftless Area streams.

The Wisconsin Endangered Lapland rosebay, an extreme disjunct from the far north, is known from cool, moist, shaded sandstone cliffs at only two sites in our state. Photo by Thomas Meyer, Wisconsin DNR.

The most extreme example of a disjunct species is offered by one of Wisconsin's two populations of a circumboreal plant and our only native rhododendron, the Wisconsin Endangered Lapland rosebay (*Rhododendron lapponicum*).

Algific Talus Slopes are extraordinarily rare communities restricted to the Driftless Area. In Wisconsin, they have been documented at just a few locations in dissected stream valleys in western Grant County. The biota of these unusual communities is especially notable for its northern disjuncts and ***periglacial relicts***, which are represented here by plants and land snails that were apparently "stranded" in cold microclimates in southwestern Wisconsin thousands of years ago.

Algific Talus Slopes emit cold air throughout the growing season, creating habitat for organisms that otherwise could not exist in southern Wisconsin. One of the most striking examples is the Wisconsin Endangered intermediate sedge (*Carex media*), a boreal species, which in Wisconsin occurs only on the Algific Talus Slopes of western Grant County. The nearest stations for intermediate sedge are in the Upper Peninsula of Michigan, where it has been found on Isle Royale, and on the north end of the Keweenaw Peninsula. Several populations of northern wild monkshood also occur on Algific Talus Slopes.

Miscellaneous Natural Communities and Habitats. Marshes occur almost entirely within the floodplains of the larger rivers. Of special interest are the marshes within the Mississippi River backwaters dominated by American lotus-lily, a "broad-leaved emergent" (the petiole elevates the leaf above the water's surface) that may form extensive stands in shallow protected bays. Wild rice was locally common in some of the sluggish rivers and streams but has virtually disappeared due to hydrological alterations and diminished water quality.

Sedge meadows occur within the saturated, rather than regularly inundated, parts of river floodplains and may also occupy poorly drained lowlands at other sites when hydrologic conditions favor the development and maintenance of meadows rather than marsh, shrub swamp, or lowland forest. Unusual plants that occur in sedge meadow habitats in this ecological landscape include the Wisconsin Endangered nodding rattlesnake-root (*Prenanthes crepidinea*) and the Wisconsin Special Concern upper midwestern endemic glade mallow. The latter also occurs in wet prairies and even degraded wet roadsides, streambanks and trail rights-of-way under open to semi-open tree canopies.

Sand bars and mudflats flats are somewhat ephemeral features that provide habitat for a group of specialized plants (many of them graminoids, i.e., grasses, rushes, and sedges). These habitats can also be of great importance to migrating shorebirds and waterfowl, and to nesting turtles.

Several plants formerly known to occur in Wisconsin were last observed in the Western Coulees and Ridges but are now considered to be extirpated here. Examples include Mead's milkweed (*Asclepias meadii*), a globally rare plant that inhabited mesic prairies, Yerba-de-tajo (*Eclipta prostrata*), an annual that inhabited mudflats within the Mississippi River floodplain, and green-violet (*Hybanthus concolor*), a mesophytic herb last noted in a rich but now heavily grazed maple-basswood forest in Grant County.

The Western Coulees and Ridges is a large ecological landscape (largest of all ecological landscapes in the state) that also supports a diverse flora with a large number of rare vascular plants. Among all of southern Wisconsin's ecological landscapes, it supports some of Wisconsin's best and most extensive examples of rare or declining communities and habitats such as prairies, savannas, southern hardwood forests, disjunct conifer relicts, and cliffs.

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 to have occurred in the Western Coulees and Ridges Ecological Landscape. Of those, this review is limited to species that were known or thought to be especially important here in comparison to other ecological landscapes. For a more complete review of historical wildlife in the state, see a collection of articles written by A.W. Schorger compiled into the volume *Wildlife in Early Wisconsin: A Collection of Works by A.W. Schorger* (Brockman and Dow 1982).

The Western Coulees and Ridges was important historically for a number of wildlife species, especially those using oak savanna and oak openings, oak and floodplain forests, prairies, bluffs, caves and rock outcroppings, and large river systems. This ecological landscape was particularly important for elk (*Cervus canadensis*), American bison (*Bos bison*), Wild Turkey (*Meleagris gallopavo*), Passenger Pigeon (*Ectopistes migratorius*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Greater Prairie-Chicken (*Tympanuchus cupido*), Northern Bobwhite (*Colinus virginianus*), timber rattlesnake (*Crotalus horridus*), and eastern massasauga (*Sistrurus catenatus catenatus*). In the mid-19th century, the ecological landscape was settled by Euro-Americans, wildfires were prevented and controlled, and wildlife populations changed.

Although the distribution of the Passenger Pigeon has been described as covering the eastern half of North America (Schorger 1946), its nesting habitat was limited by the presence and abundance of mast (primarily beech nuts and acorns). Schorger (1946) reported from newspaper accounts and interviews that Passenger Pigeons nested by the millions in Wisconsin. With a large presence of oak, this ecological landscape was undoubtedly an important nesting area for Passenger Pigeons during years of high mast production.

Passenger Pigeons were clubbed, shot, and trapped during the nesting season and squabs taken from nests and shipped to markets in Milwaukee, Chicago, and cities on the east coast by the trainload (Schorger 1939). Since the Passenger Pigeon was thought to lay only one egg each year, nested only in communal roosts, and was dependent on abundant mast for the production of young, the heavy kill of Passenger Pigeon led to its extinction. The last known Passenger Pigeon died in 1914 at the Cincinnati Zoo. See Chapter 10, "Central Sand Plains Ecological Landscape," for a more detailed discussion of the Passenger Pigeon.

Elk were found throughout Wisconsin but flourished in open woodlands, oak openings, and at the border of grasslands and forests. Elk were most numerous and abundant in the southern and western parts of the state (Figure 22.9) and were especially abundant in this ecological landscape. The Chippewa, Kickapoo, Trempealeau, and Mississippi River valleys were often mentioned as having abundant elk populations, and there was a report that elk were "astonishingly abundant" around the Platteville area (Schorger 1954). Elk were still abundant in this ecological landscape during the 1850s but declined rapidly after that. The last reliable report of elk in Wisconsin is from west of Menomonie in 1866. Beginning in 1930s, attempts have been made to restore free-ranging elk in Wisconsin by releasing elk raised from Yellowstone National Park and Jackson Hole, Wyoming (see the "Changes in Fauna" section in Chapter 4, "Changes and Trends in Ecosystems and Landscape Features," for details). Fifteen elk were released in 1932, but by 1948, elk were thought to have again been extirpated from the state. Another attempt was made to reestablish elk in northern Wisconsin in 1995 (see the "Changes in Fauna" section in Chapter 4 for details). Currently, Wisconsin has about 180 elk, all of them from this most recent restoration effort in the North Central Forest Ecological Landscape.

American bison historically occupied the prairie areas of the state and were abundant in this ecological landscape (Figure 22.10). A map of southwestern Wisconsin published in 1829 by R.W. Chandler, a pioneer settler of Galena, Illinois, stated that "not more than a tenth is covered by timber in detached groves, the remainder being prairies" (Schorger 1937). Daniels (1854) estimated that only one third of southwestern Wisconsin was prairie in 1854. He attributed this rapid change from prairie to timber to the cessation of fires and rapid growth of young trees on the open prairie.

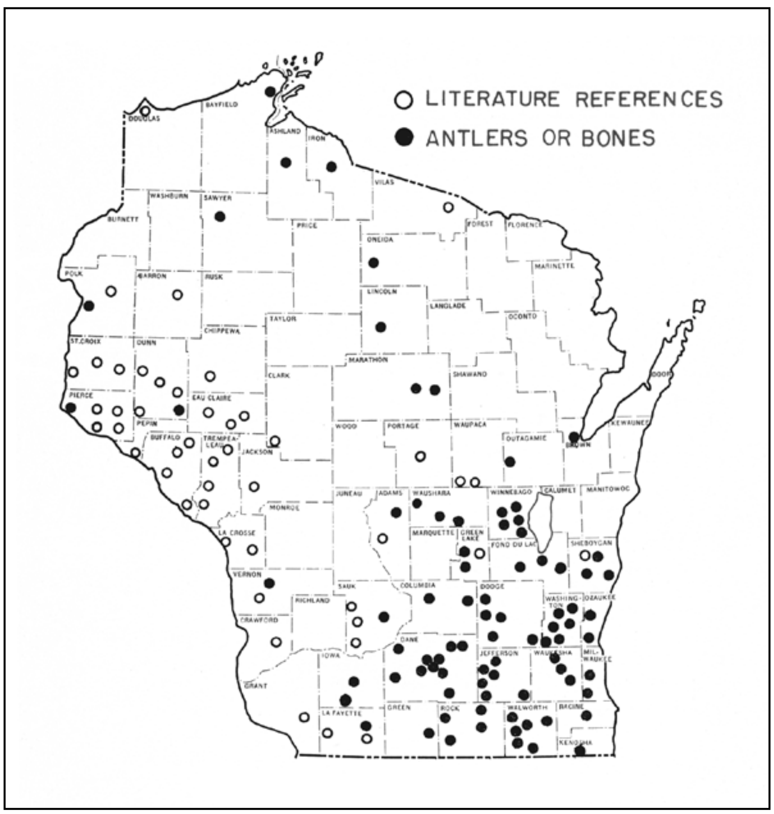


Figure 22.9. *Historical records of elk in Wisconsin. Figure reproduced from Schorger (1954) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

American bison occurred from Racine along Lake Michigan, north to Lake Winnebago, and over to Burnett County in the northwestern part of the state. Both the Wisconsin and Chippewa River valleys are mentioned as having abundant American bison populations (Schorger 1937). The last Wisconsin American bison was killed near the Trempealeau River in 1832.

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). Deer were reported as plentiful in southwestern Wisconsin in the 1830s (Schorger 1953), and Hoffman (1835) reported that he saw "large herds" on the prairies in February 1834. 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. The severe winter of 1856–57 caused many deer to starve or be easily killed by settlers in southwestern Wisconsin (Schorger 1953). Snow 6 feet deep was reported in some places with a thick crust, making movement of deer very difficult. Within a decade, the deer population seemed to recover somewhat, and they were reported to be numerous again in southwestern Wisconsin in the mid-1860s. Subsistence harvest, together with market hunting, likely reduced the deer population to its lowest level late in the 19th century. Deer were considered uncommon throughout southwestern Wisconsin from 1900 through the 1960s. However, since the early 1980s, deer populations have increased dramatically in this ecological landscape (Figure 22.11), and deer are now very abundant. Today the white-tailed deer is an important game species but causes crop damage, vehicle accidents, damage to forest regeneration, and negative impacts to many forest herbs. ***Chronic wasting disease*** (CWD) was discovered in the eastern part of this ecological landscape (Dane and Iowa counties) in 2002. Since then, special hunting seasons and regulations have been implemented to reduce the 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 deer they may have shot (Figure 22.12).

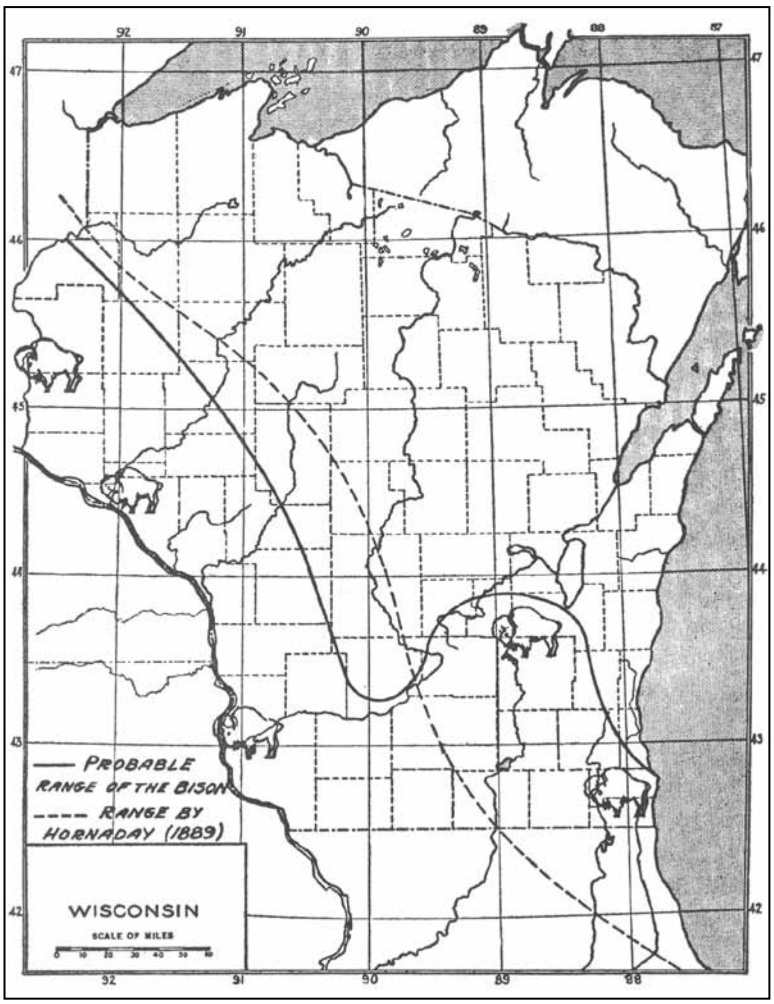


Figure 22.10. *Probable range of the bison in Wisconsin prior to Euro-American settlement. Figure reproduced from Schorger (1937) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

The gray wolf (*Canis lupus*) occurred statewide prior to Euro-American settlement. Wisconsin wolf numbers then declined gradually due to loss of food sources, shooting, trapping, and poisoning. By the early 1960s, they were thought to have been extirpated from the state. The gray wolf population has since reestablished itself and expanded from northwest to northeast and into central Wisconsin. No gray wolves are known to be resident in this ecological landscape at the time of this writing but are sporadically observed here.

American black bears (*Ursus americanus*) were historically found throughout the ecological landscape but were probably more abundant in the heavily wooded areas to the north. The last historical appearance of black bears here was from the early to mid-1900s (Schorger 1949). Today the American black bear range is expanding south and southwest in the state. The northeastern edge of the ecological landscape, in Dunn, Chippewa, and Eau Claire counties, is considered secondary range for the American black bear, and northwestern Jackson County is considered primary range (Figure 22.13). Recent sightings of American black bears have occurred in other parts of the Western Coulees and Ridges.

The historical range of the Wild Turkey was in southern Wisconsin below a line from Green Bay to Prairie du Chien (Figure 22.14; Schorger 1942). However, since the Wild Turkey was at the northernmost part of its range, the number of turkeys close to this line fluctuated in response to severe winters. Wild Turkeys were most abundant in southwestern Wisconsin and

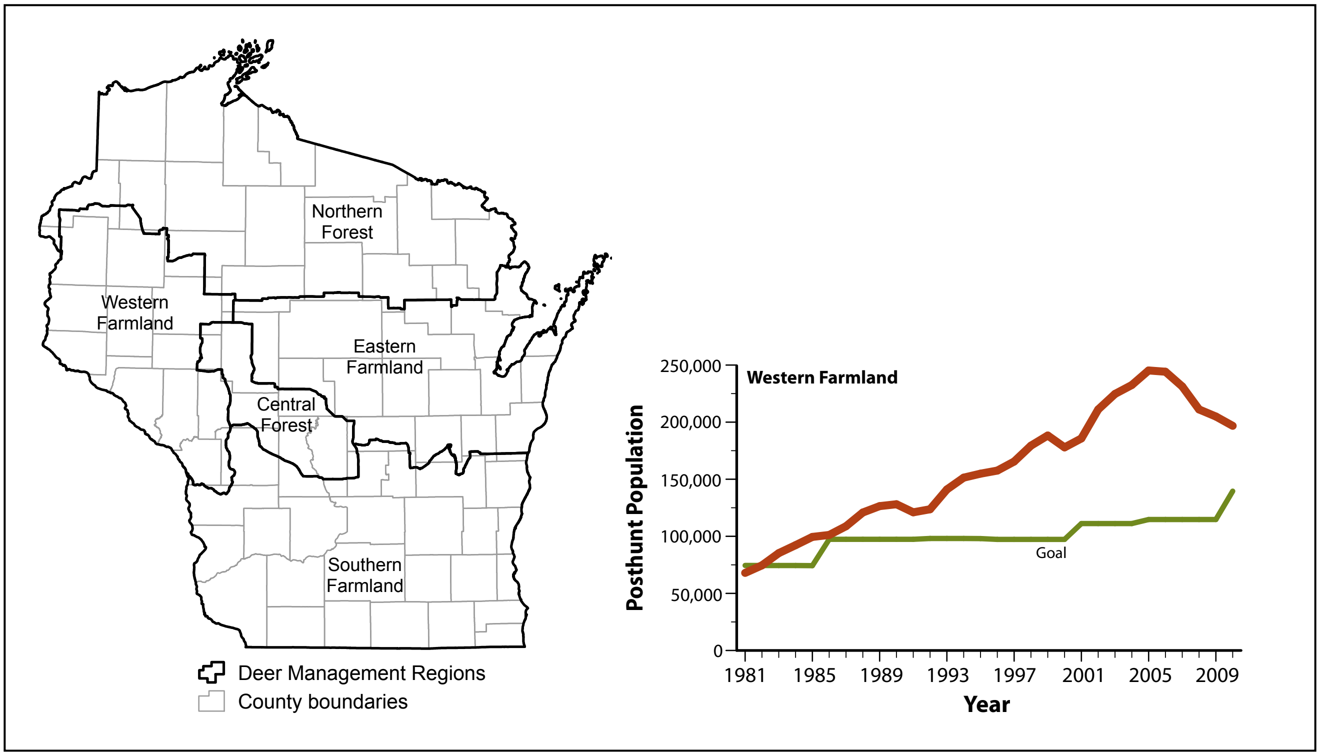


Figure 22.11. *White-tailed deer population size in relation to population goals in the western farmland deer management region, 1981–2010.*

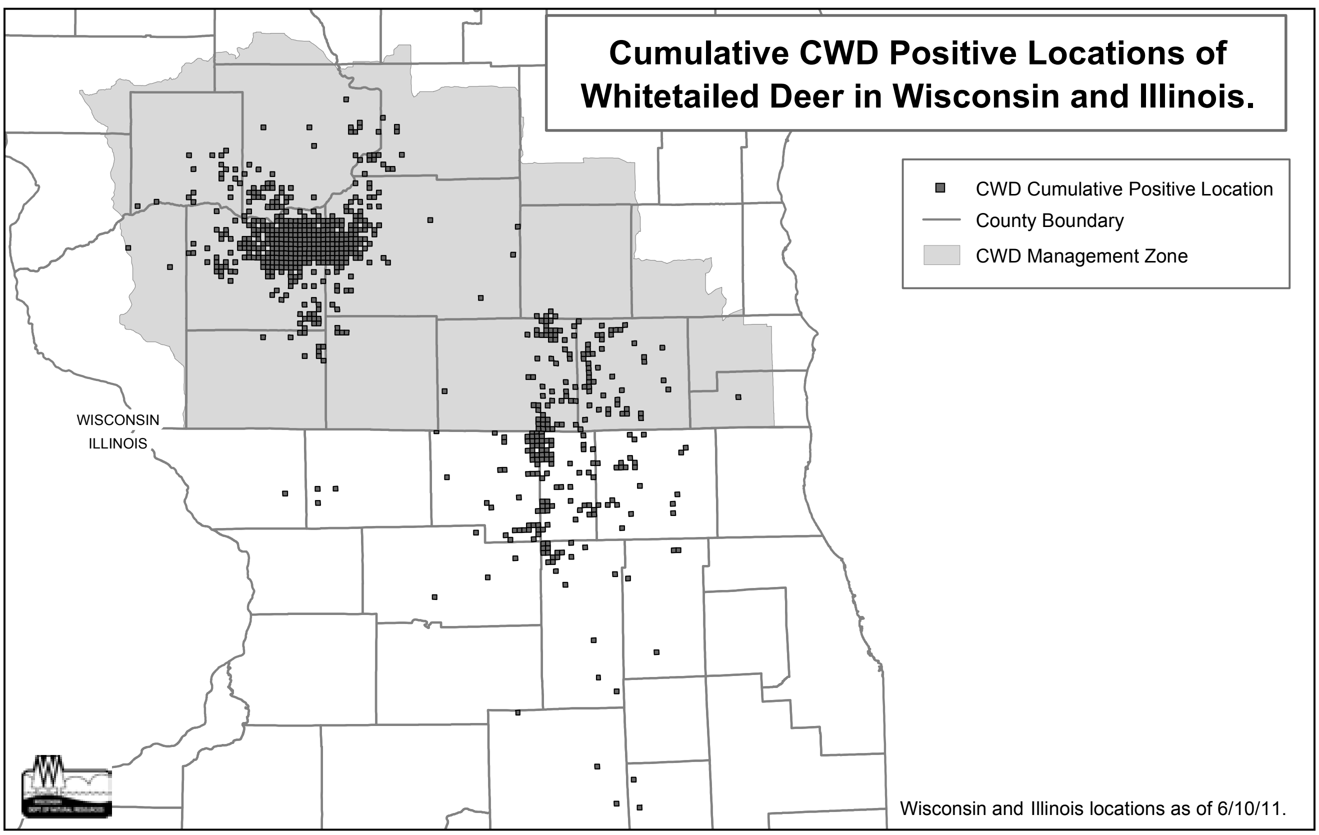


Figure 22.12. *Cumulative locations of CWD-positive deer in Wisconsin and Illinois, 2002–2011.*

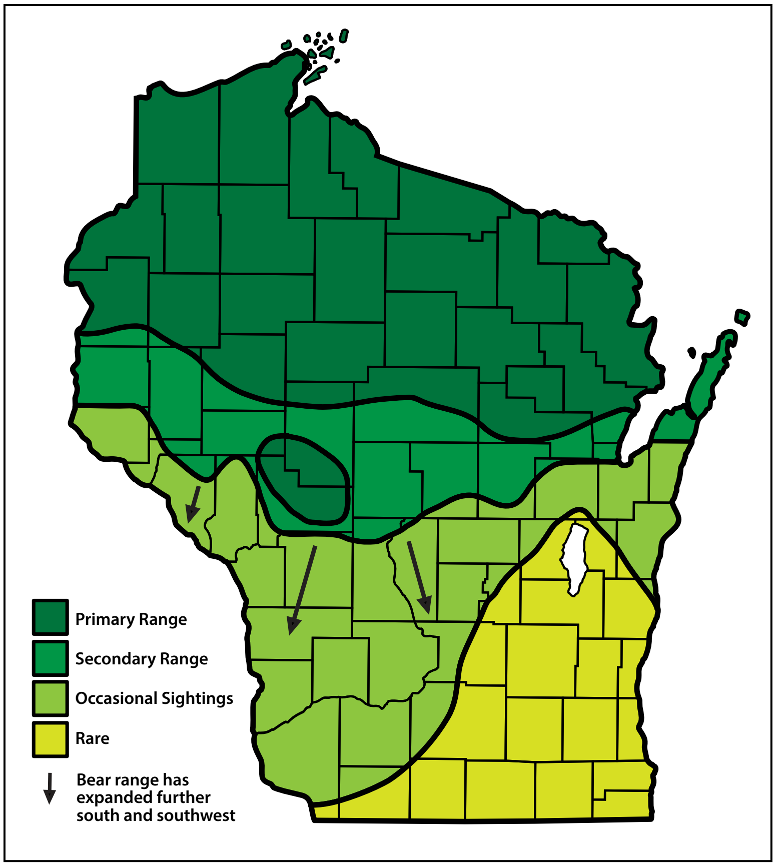


Figure 22.13. *Wisconsin American black bear range in 2008 (Wisconsin DNR unpublished data).*

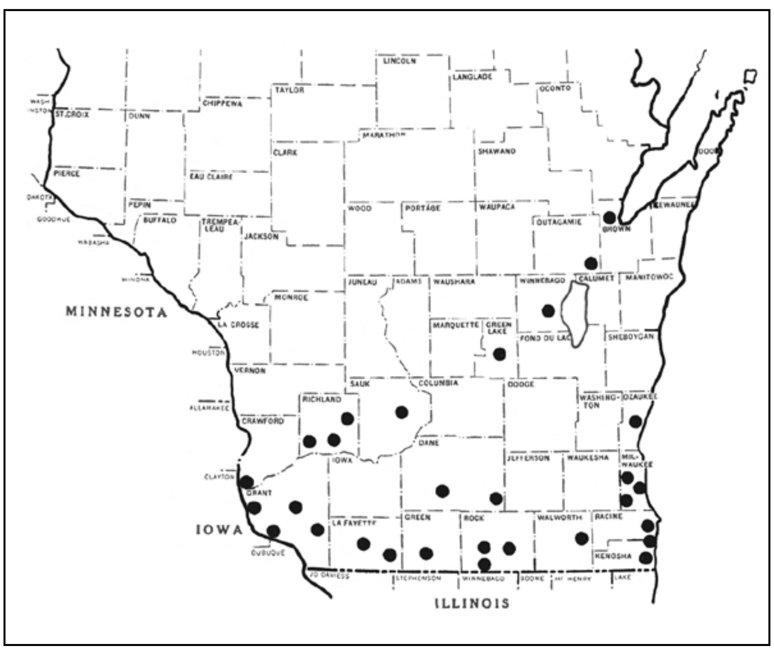


Figure 22.14. *Historical Wild Turkey range in Wisconsin. Figure printed with the written permission of The Wilson Ornithological Society, from Schorger, A.W. 1942. The Wild Turkey in early Wisconsin.* Wilson Bulletin *54:173–182.*

in the southern part of this ecological landscape. In 1816, James Lockwood stated, "It was not an uncommon thing to see a Fox Indian arrive at Prairie du Chien with a hand sled, loaded with twenty to thirty wild turkeys for sale, as they were very plentiful about Cassville, and occasionally killed opposite Prairie du Chien" (Schorger 1942). Due to persistent hunting by settlers for food, changes to habitat, and the severe winter of 1842–43, Wild Turkeys were rare by 1860. The last historical documented Wild Turkey was seen in Lafayette County in 1881.

There were a couple of attempts by private individuals to reintroduce the Wild Turkey into Wisconsin during the late 1800s (Schorger 1942). These flocks persisted until the early 1900s. Between 1929 and 1939, the State of Wisconsin released about 3,000 pen-reared Wild Turkeys in Grant and Sauk counties (Brown and Vander Zouwen 1993). These birds frequented farmyards and were quite tame. They persisted until 1958 when the last Wild Turkey was reported dead near Grand Marsh in Adams County. In the early 1950s, the Wisconsin Conservation Department stocked Wild Turkeys in the Meadow Valley-Necedah Area in the Central Sand Plains region. That flock, a cross between game farm hens and wild gobblers, originated from Pennsylvania. During 1954–57, 827 birds from Pennsylvania were released on the Meadow Valley Wildlife Area-Necedah National Wildlife Refuge. Although this release appeared successful at first, the flock encountered disease and severe winters. The flock persisted but never expanded its range significantly (Brown and Vander Zouwen 1993). It wasn't until 1976 that the Wild Turkey became reestablished in Wisconsin, when 45 Wild Turkeys trapped in Missouri were released in Vernon County. These Wild Turkeys were obtained in a trade for 135 Ruffed Grouse trapped in this ecological landscape. Other reintroductions followed, and a total of 334 Missouri Wild Turkeys were released in Buffalo, Iowa, Sauk, Trempealeau, Jackson, La Crosse, Vernon, Dane, and Lafayette counties. Once established in these areas, the Wisconsin DNR trapped and relocated Wild Turkeys throughout the state. Although the Wild Turkey is now established in all 16 ecological landscapes, the Western Coulees and Ridges Ecological Landscape has the highest densities for this bird in Wisconsin, providing excellent hunting and wildlife viewing opportunities.

The Sharp-tailed Grouse was considered to be widely distributed in the state in open and brushy habitats before Euro-American settlement and was likely common in this ecological landscape, primarily occupying the extensive oak openings and barrens (Schorger 1943). Sharp-tailed Grouse probably expanded into additional areas as dense growths of shrubs and saplings created brushy habitat with the cessation of fire. Sharp-tailed Grouse later declined, as the oak openings grew into dense forests, and agriculture became increasingly intensive. No Sharp-tailed Grouse occur in this ecological landscape today.

The Greater Prairie-Chicken was found throughout southern Wisconsin prior to Euro-American settlement, although the Sharp-tailed Grouse may have been more abundant (Schorger 1943). Through the 1850s, the Greater Prairie-Chicken was considered abundant in southern Wisconsin, but it later declined. The spread of agriculture initially seemed to lead to an increase in the Greater Prairie-Chicken population, but populations declined as farming became more intensive and the prairies disappeared. The Greater Prairie-Chicken was forced north as prairies were plowed for agriculture in the south while forests were cleared in central and northern Wisconsin (Schorger 1943). As forests regrew in the north, the range of the Prairie Chicken contracted to its present location, primarily in the Central Sand Plains Ecological Landscape of central Wisconsin. The Greater Prairie Chicken is not found in this ecological landscape today.

The Northern Bobwhite must have been distributed throughout the open areas of southern Wisconsin (Figure 22.15; Schorger 1944), though populations fluctuated widely depending on winter severity. Northern Bobwhite were especially abundant during a period of mild winters from 1846 to 1857 and reached peak numbers in 1854. During this time, it was said that "a good shot could readily bag 50 to 75 in a day" in Madison (Schorger 1944). Shipments of quail from Beloit to the eastern cities amounted to 12 tons in 1854–55. A shipment of 20,000 quail from Janesville was received in Philadelphia in 1856. Northern Bobwhite declined quickly thereafter due to unregulated trapping and shooting and adverse weather. The winters of 1854–55 and 1855–56 were severe, but trapping continued with "tons of quail and other game hanging in the yard of the Capital House in Madison." The Northern Bobwhite population was much reduced from its former numbers by the fall of 1857. The population recovered through the 1860s but never achieved the 1854 levels. From 1870 to the 1940s, Northern Bobwhite populations remained relatively stable.

At the close of the 19th century, the Northern Bobwhite population increased temporarily in the Mississippi valley. Schorger (1944) noted that "they were abundant in 1896 at Prairie du Chien and more numerous than

The Northern Bobwhite (Wisconsin Special Concern) was formerly common in many parts of southern Wisconsin but has now disappeared from much of its former range. Photo by Jack Bartholmai.

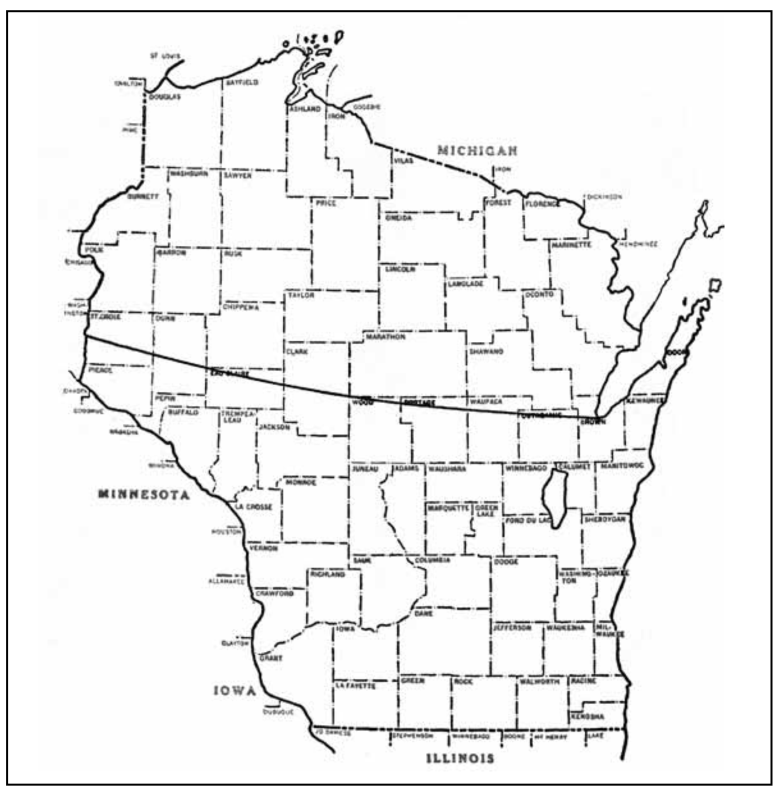


Figure 22.15. *Historical Northern Bobwhite range in southern Wisconsin. Figure reproduced from Schorger (1944) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

usual at Trempealeau ….” The increase continued through 1900, and they “were to be found everywhere in the country districts at Prairie du Chien for the first time in many years.” Northern Bobwhite populations have decreased dramatically since 1900 due to changes in land use and other causes, but this ecological landscape has the best populations remaining in the state. The Wisconsin DNR made an effort to increase Northern Bobwhite habitat and populations here during the 1970s and 1980s by planting hedgerows and winter food plots on private land. These efforts met with little success because habitat was not maintained by private landowners. Up to 60% of annual variability in Northern Bobwhite numbers could be explained by winter severity (Petersen 1997), but long-term declines are due to habitat loss.

Both the timber rattlesnake and eastern massasauga were historically abundant in this ecological landscape (Figure 22.16**).** The timber rattlesnake was found in the uplands, especially where there were rock outcroppings and rock crevices where they could hibernate. Historically, they have been restricted to southwestern Wisconsin and have never been found east of Madison. The eastern massasauga was found in marshy areas, low prairies, and along streams throughout southern and central Wisconsin. Populations of both rattlesnake species have been dramatically reduced by land use changes and continued persecution. The Cooke family killed 150 rattlesnakes during their first year near Gilmanton in 1856 (Cooke 1940). Messeling (1953) stated that he killed a thousand rattlesnakes for their bounty each year. As late as the mid-1960s, Crawford County paid a bounty for 10,000–11,000 rattlesnakes a year. Early settlers also used pigs, which kill and eat snakes, to control rattlesnakes on their farms (Schorger 1967).

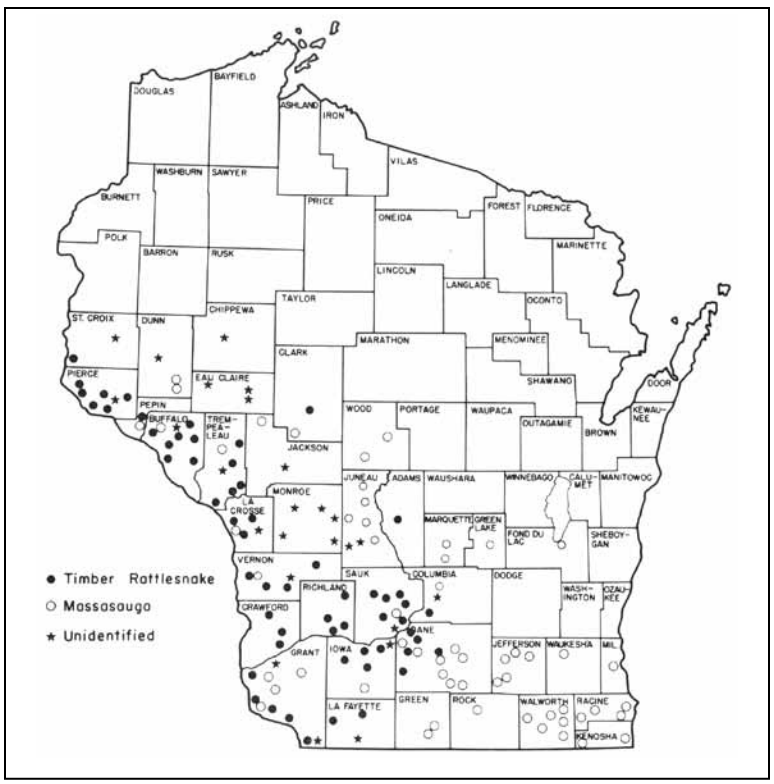


Figure 22.16. *Historical timber and massasauga rattlesnake range in Wisconsin. Figure reproduced from Schorger (1967) by permission of the Wisconsin Academy of Sciences, Arts and Letters.*

The eastern massasauga is more sensitive to habitat changes, is now listed as Wisconsin Endangered, and is a candidate for federal listing. In the Western Coulees and Ridges, it is still occasionally found locally along the Chippewa and Black rivers. Timber rattlesnake populations have also been reduced; this is a Wisconsin Special Concern species and is protected from harvest by State law. As this is the only Wisconsin ecological landscape that has both the timber rattlesnake and eastern massasauga and suitable habitat for them, this is the only place where management for this species can feasibly occur.

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 people of the state. To ensure that all species are maintained in the state, “significant wildlife” includes both common and rare species. Four categories of species are discussed: rare species, Species of Greatest Conservation Need (SGCN), responsibility species, and socially important species (see definitions in text box). Because conservation of wildlife communities and habitats is the most efficient and cost-effective way to manage and benefit a majority of species, we also discuss management of different wildlife habitats in which significant fauna occur.

■ Rare Species. In this book, “rare” animals include those species that appear on the Wisconsin Natural Heritage Working List and are classified as

The timber rattlesnake (Wisconsin Special Concern) is now restricted to rocky bluffs in southwestern Wisconsin. Photo by Rori Paloski, Wisconsin DNR.

"endangered," "threatened," or "special concern" by the Wisconsin or federal governments. (See Appendix 22.C at the end of this chapter for a comprehensive list of rare species known to exist in the Western Coulees and Ridges Ecological Landscape). As of November 2009, the Wisconsin Natural Heritage Working List documented 178 rare species in the Western Coulees and Ridges Ecological Landscape, including 7 mammals, 30 birds, 18 herptiles, 27 fishes, and 96 invertebrates (WDNR 2009). These include three U.S. Endangered species, three candidates for future federal listing, 30 Wisconsin Endangered species, 34 Wisconsin Threatened species, and 114 Wisconsin Special Concern species.

■ ***Federally Listed Species:*** Three U.S. Endangered animals occur in this ecological landscape. One is the Higgins' eye mussel (*Lampsilis higginsii*), which is also listed as Wisconsin Endangered. The second is the Karner blue butterfly (*Lycaeides melissa samuelis*), listed as a Wisconsin Special Concern species and managed under a Habitat Conservation Plan approved by the U.S. Fish and Wildlife Service. The third is the gray wolf, which is occasionally seen in this ecological landscape. The gray wolf was removed from the federal endangered species list in January 2012, granting management authority to the State of Wisconsin. The Wisconsin state legislature passed a law in April 2012 authorizing hunting and trapping seasons for wolves and directed that wolf hunting and trapping seasons be held starting in the fall of 2012. The first hunting and trapping seasons of wolves were conducted during October–December 2012. Wolves are now being managed under a 1999 wolf management plan (WDNR 1999) with addenda in 2006 and 2007, but the plan is being updated to reflect these recent changes in wolf management in Wisconsin. The Bald Eagle (*Haliaeetus leucocephalus)* (formerly U.S. Threatened) is also found here. Since its delisting in 2007, the Bald Eagle remained federally protected with required monitoring for five years to ensure that the population did not decline. The Bald Eagle is protected under the U.S. Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. The Bald Eagle is listed as a Wisconsin Special Concern species.

■ ***Wisconsin Endangered Species:*** No Wisconsin Endangered mammals occur in the Western Coulees and Ridges Ecological Landscape (WDNR 2009). Six Wisconsin Endangered birds occur here, including Yellow-throated Warbler (*Setophaga dominica*, listed as *Dendroica dominica* on the Wisconsin Natural Heritage Working List), Peregrine Falcon, Worm-eating Warbler (*Helmitheros vermivorum*), Loggerhead Shrike (*Lanius ludovicianus*), Forster's Tern (*Sterna forsteri*) and Barn Owl (*Tyto alba*). Five Wisconsin Endangered herptiles are found here, including northern cricket frog (*Acris crepitans*), slender glass lizard (*Ophisaurus attenuatus*), eastern massasauga, ornate box turtle (*Terrapene ornata*), and western ribbon snake (*Thamnophis proximus*). Seven Wisconsin Endangered fish have been recorded here, including bluntnose darter (*Etheostoma chlorosoma*), crystal darter (*Crystallaria asprella*), black redhorse (*Moxostoma duquesnei*), skipjack herring (*Alosa chrysochloris),* starhead topminnow (*Fundulus dispar*), goldeye (*Hiodon alosoides*), and pallid shiner (*Hybopsis amnis*). However, the only verified record of black redhorse from the Western Coulees and Ridges is from the 1920s, and this species is now considered extirpated from Wisconsin waters. It still occurs in some Mississippi River tributaries in Minnesota, opposite Wisconsin. The skipjack herring is also considered "functionally extirpated" in Wisconsin. This species inhabited the Mississippi River but never lived its whole life in Wisconsin waters. Skipjack herring migrated into the state from their more southerly wintering areas in the Missouri/southern Illinois portions of the Mississippi in large numbers each year prior to the dams being built on the Mississippi River in the early 20th century. Once the dam at Keokuk in southern Iowa was closed around 1910, the migrations were blocked, and skipjack herring essentially disappeared. Now they only show up in very small numbers, during or soon after years with major floods, using the high water to make their way through the gauntlet of dams to reach Wisconsin waters.

Eight Wisconsin Endangered mussels occur in this ecological landscape, including spectacle case (*Cumberlandia*

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 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.

Significant Wildlife in the Western Coulees and Ridges Ecological Landscape

- "Southern" hardwood forests: critical bird and other forest interior wildlife.
- Oak Savanna: Oak Openings and Oak Barrens. Mammals, birds, herptiles, invertebrates.
- Grasslands: rare birds, herptiles, invertebrates.
- Sandy terraces bordering large rivers, rare habitats and many rare habitat specialists.
- Large warmwater rivers: exceptionally rich assemblages of fish, turtles, mussels, other invertebrates.
- The Mississippi Flyway: a major continental migration route for waterfowl, raptors, songbirds, and others.
- Major concentrations of migrating Tundra Swans and Canvasbacks on the Mississippi River pools.
- Wintering Bald Eagles on the large rivers.
- Sand, lead, and zinc mines, tunnels, and caves that provide critical habitat for breeding and wintering bats.
- Algific Talus Slopes and rare land snails.
- Disjunct populations of "northern" species associated with conifer relicts.
- Assemblages of fish and insects associated with coldwater and coolwater streams.

The Wisconsin Endangered Worm-eating Warbler is a forest interior specialist restricted to southern Wisconsin where it inhabits large areas of contiguous upland hardwood forest. Photo by Laura Erickson.

monodonta), purple wartyback (*Cyclonaias tuberculata*), butterfly (*Ellipsaria lineolata*), elephant ear (*Elliptio crassidens*), ebony shell (*Fusconaia ebena*), Higgins' eye, yellow and slough sandshells (*Lampsilis teres*), and bullhead (*Plethobasus cyphyus*); eight other Wisconsin Endangered invertebrates also occur in this ecological landscape, including phlox moth (*Schinia indiana*), regal fritillary (*Speyeria idalia*), silphium borer moth (*Papaipema silphii*), Midwest Pleistocene vertigo (*Vertigo hubrichti*), Knobel's riffle beetle (*Stenelmis knobeli*), Pecatonica river mayfly (*Acanthametropus pecatonica*), Wallace's deepwater mayfly (*Spinadis simplex),* and red-tailed prairie leafhopper (*Aflexia rubranura*).

■ ***Wisconsin Threatened Species:*** No Wisconsin Threatened mammals occur in the Western Coulees and Ridges Ecological Landscape (WDNR 2009).[1] Nine Wisconsin Threatened birds occur here, including Henslow's Sparrow (*Ammodramus henslowii*), Great Egret (*Ardea alba*), Red-shouldered Hawk, Cerulean Warbler, Acadian Flycatcher, Yellow-crowned Night-Heron (*Nyctanassa violacea*), Kentucky Warbler (*Geothlypis formosa,* listed as *Oporornis formosus* on the Natural Heritage Working List), Bell's Vireo (*Vireo bellii*), and Hooded Warbler (*Setophaga citrina,* listed as *Wilsonia citrina* on the Working List). Other Wisconsin Threatened species documented within this ecological landscape include two herptiles (wood turtle, *Glyptemys insculpta*, and Blanding's turtle, *Emydoidea blandingii*); nine Wisconsin Threatened fish—blue sucker, black buffalo (*Ictiobus niger*), redfin shiner (*Lythrurus umbratilis*), shoal chub (*Macrhybopsis aestivalis*), river redhorse (*Moxostoma carinatum*), greater redhorse (*Moxostoma valenciennesi*), Ozark minnow (*Notropis nubilus*), gilt darter (*Percina evides*) and paddlefish; five

[1]On 6/1/2011, four bats were added to the Wisconsin Threatened Species list: big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and eastern pipistrelle (*Perimyotis subflavus*). 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%.

The Wisconsin Threatened paddlefish inhabits big warmwater rivers in southern and western Wisconsin. Photo by John Lyons, Wisconsin DNR.

mussels—rock pocketbook, (*Arcidens confragosus*), monkeyface, (*Quadrula metanevra*), wartyback (*Quadrula nodulata*), salamander mussel (*Simpsonaias ambigua*), and buckhorn (*Tritogonia verrucosa*); three insects—frosted elfin (*Callophrys irus*), pygmy Snaketail (*Ophiogomphus howei*), and prairie leafhopper (*Polyamia dilata*); and two snails—wing snaggletooth (*Gastrocopta procera*) and cherrystone drop (*Hendersonia occulta*)—have been documented here.

■ ***Wisconsin Special Concern Species:*** Wisconsin Special Concern species occurring in this ecological landscape include 7 mammals, 15 birds, 11 herptiles, 11 fish, and 70 invertebrate species (see Appendix 22.C at the end of the chapter for a complete list of Wisconsin Special Concern species).

■ **Species of Greatest Conservation Need.** Species of Greatest Conservation Need (SGCN) appear in the Wisconsin Wildlife Action Plan (WDNR 2005b) and include those species already recognized as endangered, threatened, or special concern on Wisconsin or federal lists along with nonlisted species that meet the SGCN criteria. There are 50 birds, 7 mammals, 17 herptiles, and 15 fish species listed as SGCN for the Western Coulees and Ridges Ecological Landscape (see Appendix 22.E at the end of the chapter for a complete list of SGCN in this ecological landscape and the habitats with which they are associated).

■ **Responsibility Species.** The Western Coulees and Ridges provides a rich diversity of habitats for a variety of animals for which this ecological landscape is important. The Mississippi and Wisconsin rivers are important wintering areas for Bald Eagles. The Peregrine Falcon currently nests on bluffs and tall, man-made structures along the Mississippi River. The Mississippi River is an important stopover area for large numbers of migrating Tundra Swans (*Cygnus columbianus)* and Canvasbacks (*Aythya valisineria*). The Prothonotary Warbler, Cerulean Warbler, Acadian Flycatcher, and Red-shouldered Hawk breed in floodplain forests and/or adjoining upland hardwood forests. This ecological landscape is considered to be the best place in the state in which to maintain Red-headed Woodpecker (*Melanerpes erythrocephalus*) populations. Henslow's Sparrow, which is declining significantly, occurs here and has some opportunities to maintain its populations.

The large rivers contain a diverse variety of fish not commonly found elsewhere in the state. Large rivers support the paddlefish, goldeye, silver chub (*Macrhybopsis storeriana*), pallid shiner, shoal chub, weed shiner (*Notropis texanus*), pugnose minnow (*Opsopoeodus emiliae*), blue sucker, black buffalo, pirate perch (*Aphredoderus sayanus*), starhead topminnow, western sand darter (*Ammocrypta clara*), crystal darter, and mud darter (*Etheostoma asprigene*), in addition to over 20 other more common species. Among small streams, coldwater streams are important for brook trout (*Salvelinus fontinalis*) and slimy sculpin (*Cottus cognatus*), coolwater streams for redside dace (*Clinostomus elongatus*) (although other ecological landscapes have more), and warmwater streams for Ozark minnow. The large rivers in this ecological landscape are important to rare mussels such as spectacle case, purple wartyback, butterfly, elephant ear, ebony shell, Higgins' eye, yellow and slough sandshells, bullhead, and winged mapleleaf (*Quadrula fragosa*), rock pocketbook, monkeyface, wartyback, salamander mussel, and buckhorn.

The Wisconsin Threatened Cerulean Warbler breeds in large stands of older, unfragmented deciduous forest, mostly in southern Wisconsin. Photo by Dennis Malueg.

Bedrock outcroppings and dry bluff prairies in this ecological landscape support the timber rattlesnake, and moister woods support the grey ratsnake (*Pantherophis spiloides*). In Wisconsin, both species are found almost exclusively in the Western Coulees and Ridges. The eastern massasauga occurs in its highest statewide abundance here. The ornate box turtle occurs primarily on sand terraces within the lower Wisconsin River basin and at a couple of other sites in southern Wisconsin. The six-lined racerunner (*Aspidoscelis sexlineata*) is found on dry and dry-mesic bluff prairies and in sand prairies on slopes and terraces above large river floodplains in this ecological landscape and a few other places in the state.

The eastern pipistrelle bat (*Perimyotis subflavus*) has its largest hibernating and resident populations in this ecological landscape and does not travel long distances between summer and winter roosts. Summer use of Wisconsin habitats by bats has not been well studied. Based on observations from other states, the forests and remnant oak savannas would be expected to have maternity and summer roosts of eastern pipistrelle bats, northern long-eared bat (*Myotis septentrionalis*), eastern red bats (*Lasiurus borealis*), and hoary bats (*Lasiurus cinereus*) (pregnant and lactating individuals of these species have been found here). Although few silver-haired bats (*Lasionycteris noctivagans*) are residents here, their primary occurrence in this ecological landscape is during migration. Old sand, lead, and zinc mines, abandoned tunnels, and caves are common in parts of the Western Coulees and Ridges and serve as hibernacula for large numbers of bats.

Rare moths, butterflies (e.g., Ottoe skipper [*Hesperia ottoe*], regal fritillary, phlox moth), and leafhoppers as well as dragonflies and mayflies occur within the ecological landscape.

The six-lined racerunner (Wisconsin Special Concern) inhabits bluff prairies and sand prairies. Photo by Armund Bartz, Wisconsin DNR.

The globally rare regal fritillary (Wisconsin Endangered) inhabits native prairies. It is listed as endangered by the State of Wisconsin. Photo by Ann Swengel.

Highly specialized, very rare land snails occur on Algific Talus Slopes, moist cliffs, and dry prairies. The Algific Talus Slopes, and several of the rare species they support, occur in no other ecological landscape (Frest 1991).

■ **Socially Important Fauna.** Species such as white-tailed deer, Wild Turkey, Ruffed Grouse, and American Woodcock are important for hunting and wildlife viewing in the Western Coulees and Ridges Ecological Landscape, as are many other species of birds. The larger rivers support waterfowl and other waterbirds that are popular for hunting and/or wildlife viewing. The warmwater fishery is significant and supports populations of channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), sauger (*Sander canadense*), walleye (*Sander vitreus*), smallmouth bass (*Micropteris dolomieu*), largemouth bass (*Micropterus salmoides*), and white bass (*Morone chrysops*) plus bluegill (*Lepomis macrochirus*), crappie (*Pomoxis* spp.), and other panfish that are sought by anglers. Abundant coldwater streams provide habitat for native brook trout as well as introduced brown trout and rainbow trout (*Oncorhynchus mykiss*). There are important commercial fisheries in the Mississippi River, which harvest a wide variety of species that are sold for food, with emphasis on shovelnose sturgeon (*Scaphirhynchus platorynchus*), common carp, bigmouth buffalo (*Ictiobus cyprinellus*), smallmouth buffalo (*Ictiobus bubalus*), and channel and flathead catfish.

■ **Wildlife Habitat and Communities.** This ecological landscape contains important wildlife species associated with southern hardwood forests, relict forests of eastern hemlock and pine, oak savannas, dry and dry-mesic prairies, surrogate grasslands, large warmwater rivers and their complex floodplain habitats, marshes, and coolwater and coldwater streams. Twelve designated "Important Bird Areas" are located, at least in part, within the Western Coulees and Ridges Ecological Landscape (Steele 2007).

■ ***Upland Forests:*** The Western Coulees and Ridges Ecological Landscape has the largest amount of southern hardwood forest types (dry, dry-mesic, mesic, and lowland) of any ecological landscape in the state, including large unfragmented blocks of forest that are used and needed by many area-sensitive animals. These southern hardwood forest communities are important habitat for rare birds such as Acadian Flycatcher, Worm-eating Warbler, Kentucky Warbler, Louisiana Waterthrush (*Parkesia motacilla*), Cerulean Warbler, and Hooded Warbler as well as for eastern red bats. Notable locations providing these habitats include the Baraboo Hills, the lower Wisconsin River valley, the upper and lower Kickapoo River valley, and the lower Rush Creek drainage of western Crawford County.

Relict stands of eastern hemlock and pine occur on rocky bluffs and gorges, especially in the Baraboo Hills, and along the Kickapoo, Baraboo, and Pine rivers. Most of these coniferous forests occupy niches with either cool or moist microclimates (Hemlock Relicts) or hot and dry microclimates (pine relicts, which sometimes include red or even jack pine). Disjunct populations of northern birds (and plants) are associated with some of these conifer "relicts." Examples of northern birds that breed in the conifer stands of the Western Coulees and Ridges include Black-throated Green Warbler (*Setophaga virens*), Pine Warbler (*Setophaga pinus*), Red-breasted Nuthatch (*Sitta canadensis*), Winter Wren (*Troglodytes hiemalis*), and Hermit Thrush (*Catharus guttatus*).

■ ***Savannas and Grasslands:*** The Western Coulees and Ridges Ecological Landscape has excellent potential for restoration of oak savannas, which provide habitat for species such as Red-headed Woodpecker, Eastern Bluebird (*Sialia sialis*), Orchard Oriole (*Icterus spurius*), Eastern Whip-poor-will (*Antrostomus vociferus*), eastern pipistrelle bat, eastern red bat, gophersnake (*Pituophis catenifer*), and western foxsnake (*Elaphe vulpina*). Brushy areas may support species such as Brown Thrasher (*Toxostoma rufum*), Eastern Towhee (*Pipilo erythrophthalmus*), Blue-winged Warbler (*Vermivora cyanoptera* but listed as *Vermivora pinus* on the Wisconsin Natural Heritage Working List), Bell's Vireo, and, in the past, Loggerhead Shrike.

Fort McCoy Military Reservation has extensive Oak Barrens and Sand Prairie habitats, utilized by many rare and declining grassland birds, including Lark Sparrow (*Chondestes grammacus*), Grasshopper Sparrow (*Ammodramus savannarum*), and Upland Sandpiper (*Bartramia longicauda*); herptiles, including gophersnake, North American racer (*Coluber constrictor*), slender glass lizard, and Blanding's turtle; and insects, including phlox moth, frosted elfin, and the U.S. Endangered Karner blue butterfly. These habitats are also likely to be used by eastern pipistrelle bats, eastern red bats, and hoary bats, though bats have not been well studied at Fort McCoy.

Many ridge tops and valleys are pastured, support crops of alfalfa and small grains, or are in the Conservation Reserve Program, making this ecological landscape important for grassland birds such as Bobolink (*Dolichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*), Western Meadowlark (*Sturnella neglecta*), Northern Harrier (*Circus cyaneus*), Short-eared Owl (*Asio flammeus*), Grasshopper Sparrow, and Henslow's Sparrow. Rare butterflies (regal fritillary), moths (phlox moth), and leafhoppers (red-tailed prairie leafhopper) occur in remnant prairies on ridge tops and in valleys. Ecotones between open and forested areas are important for commuting and foraging by eastern pipistrelle bats as well as by other bat species.

■ ***Large Rivers and their Corridors:*** The corridors created by the large warmwater rivers, their floodplains, and the adjoining uplands are of major importance in the Western Coulees and Ridges. The large rivers include the Mississippi, Wisconsin, Chippewa, and Black. The floodplains, terraces and forested bluffs along these rivers provide nest sites, winter roosting areas, and foraging habitat for Bald Eagles. Cliffs and man-made structures such as bridges and smokestacks provide nesting habitat for Peregrine Falcons along the Mississippi. Prairies on the steep south-and west-facing bluffs above the rivers support rare reptiles such as timber rattlesnake, gophersnake, and six-lined racerunner. Wooded bluffs provide habitat for the gray ratsnake (which in Wisconsin is found only in the Western Coulees and Ridges). Rare natural communities such as Sand Prairie and Oak Barrens occur primarily on sandy terraces in the major river valleys, and these habitats support rare species such as Lark Sparrow, ornate box turtle, and six-lined racerunner. The beaches, sand bars, mudflats, and sand terraces along the large rivers provide important nesting habitat for many turtles, including the Wisconsin Threatened Blanding's turtle, and are stopover sites for migrating shorebirds, waders, and waterfowl. The river corridors and backwaters are important foraging and drinking sites for bat species. Recent acoustic surveys have identified eastern red bat, hoary bat, silver-haired bat, northern long-eared bat, and eastern pipistrelle among the bats using habitats associated with the major river valleys.

Floodplain forests along the Wisconsin, Black, Chippewa and Mississippi rivers provide important breeding habitat for many bird species, including Prothonotary Warbler, Cerulean Warbler, Red-shouldered Hawk, and Yellow-billed Cuckoo (*Coccyzus americanus*). Extensive stands with large living trees and snags are especially important for cavity nesters and raptors. Heron and egret rookeries occur in some of the floodplain forests, especially where the sites are protected by riverine lakes and running sloughs. At a few locations, the floodplains of the large rivers support populations of the Wisconsin Endangered eastern massasauga and also provide habitat for many other rare plants, invertebrates, fish, amphibians, reptiles, and birds.

These large rivers support diverse fish assemblages, including a number of species with limited geographic distribution (see "Responsibility Species," above). The long, barrier-free stretches of these rivers benefit populations of many species, including shovelnose sturgeon, paddlefish, blue sucker, west-

The Wisconsin Threatened Henslow's Sparrow breeds in tallgrass prairie, surrogate grassland, and in some types of sedge meadow. Photo by Tom Schultz.

The Prothonotary Warbler (Wisconsin Special Concern) builds its nest in snags over water within extensive areas of floodplain forest. Photo by Laura Erickson.

ern sand darter, shoal chub, and crystal darter. Commercial fishing still occurs (especially on the Mississippi River) for shovelnose sturgeon, common carp, bigmouth and smallmouth buffalo, and channel and flathead catfish.

The Mississippi, Wisconsin, Chippewa, and Black rivers support a rich mussel fauna, including species that live only in large, warmwater rivers. They provide important habitat for a number of rare invertebrates, including globally rare mussels such as the U.S. Endangered Higgins' eye (see "Responsibility Species" above). The lower stretches of the Wisconsin, Black, and Chippewa rivers all have high ***indices of biotic integrity*** (IBI) (Lyons 1992), indicating high water quality and healthy ecosystems. The IBI scores of these rivers correlate with very diverse and productive communities of aquatic life that indicate low levels of habitat and water quality degradation. However, due to the agricultural land uses that are prevalent in the watersheds of this ecological landscape, many of the larger streams carry enough silt to limit populations of aquatic invertebrates that are intolerant of suspended sediments.

Until 2006, commercial clamming was practiced where there were suitable substrates, especially on the Mississippi River. Other invertebrates, including insects, snails, and worms, form a critical food base for fish and other organisms. The abundance of many of these invertebrates is greatest in river reaches with the lowest suspended sediment concentrations. Overall, the upper stretches of the Mississippi River within the Western Coulees and Ridges (roughly from Alma downstream to Cassville) have better water quality and greater densities of aquatic invertebrates than downstream stretches (see the "Water Quality" section above).

Mississippi River and Its Corridor. Despite extreme changes that have occurred along the Mississippi River due to dam construction, channelization, clay silt from urban and agricultural development, and discharge of large volumes of treated wastewater with harmful levels of ammonia, the river's sheer size and the variety of remaining habitats support a fairly wide variety of aquatic invertebrates. Based on 2011 data, the Mississippi River supports at least 15 Wisconsin listed invertebrate species and 106 total aquatic invertebrate taxa. However, this total ranks the Mississippi as only 17th among all rivers and streams in the state in aquatic invertebrate species richness, with only one-third the number of taxa as the Wolf River (W.A. Smith, Wisconsin DNR, personal communication).

Nearly all of the fish species that existed in the early 1900s in the Upper Mississippi River System (the stretch of the Mississippi River bordered by Minnesota, Wisconsin, Iowa, Illinois, and Missouri) continue to inhabit the river (more than 125 species), but nonnative common carp and other introduced species are now present. Thirty-nine rare, threatened, or endangered species of fish have been found in the Upper Mississippi River System since 1993, as were 11 nonnative fish species. Some native fish would benefit from managing the river in a way that attempts to at least partially mimic its historical flood regime but only if suitable habitat diversity and abundance exists to harbor significant numbers of fry and fingerlings (UMESC 2006).

Of the 119 species of fish inhabiting the Wisconsin stretch of the Mississippi River (from Prescott downstream to the Illinois state line), 22 fish species are considered rare and are included on the Wisconsin Natural Heritage Working List (WDNR 2009). Examples of these rare fish include the paddlefish, goldeye, silver chub, pallid shiner, shoal chub, weed shiner, pugnose minnow, blue sucker, black buffalo, pirate perch, western sand darter, crystal darter, and mud darter.

Open water and marshes along the Mississippi River provide habitat for breeding and migrating waterfowl, and many other waterbirds. Some of the largest concentrations of Canvasbacks, Lesser Scaup (*Aythya affinis*), and Tundra Swans in the Midwest occur on the Mississippi River (e.g., on Lake Pepin) during their migration periods. Great Blue Heron (*Ardea herodias*) and Great Egret have rookeries at locations along the Mississippi River. Many other waterbirds, such as Black Terns (*Chlidonias niger*), American White Pelicans (*Pelecanus erythrorhynchos*), and Green Herons (*Butorides virescens*), are commonly found along the Mississippi River.

Lower Wisconsin River and Its Corridor. Terraces and forested bluffs along the lower Wisconsin River provide diverse habitats for many species, as do the numerous sandbars and mudflats that develop as water levels drop following high spring runoff flows. The sandbars and mudflats provide important, if somewhat ephemeral, habitat for turtles, birds, and insects.

The lower Wisconsin River has 98 of the 147 native fish species in the state, ranging from common and iconic warm river species such as flathead catfish and channel catfish to very rare species. Large-river species such as shovelnose sturgeon, lake sturgeon, sauger, and smallmouth buffalo are supported by the diverse habitat structure of the Wisconsin River. Rare species

The Wisconsin Threatened Great Egret nests in rookeries, often in forested portions of large river floodplains. Photo by Steve Hillebrand, courtesy U.S. Fish and Wildlife Service.

such as western sand darter, paddlefish, black buffalo, crystal darter, and shoal chub are also found in the river (WDNR 2011). Through recent sampling, significant populations of fish species sensitive to degraded water-quality have been found in spring-fed floodplain lakes. Examples include pirate perch, least darter (*Etheostoma microperca*), mud darter, starhead topminnow, and weed shiner (Marshall and Lyons 2008).

The lower Wisconsin River is considered one of the most significant areas in the state for herptiles (G. Casper, personal communication) as it provides diverse and extensive habitats of good quality, including the main river channel and its backwaters, floodplain lakes, many types of wetlands, terraces with sand prairie and barrens remnants, and forested bluffs, bluff prairies, and cliffs. Many species of turtles (e.g., Blanding's turtle, northern map turtle [*Graptemys geographica*], Ouachita map turtle [*Graptemys ouachitensis*], false map turtle [*Graptemys pseudogeographica*], midland smooth softshell turtle [*Apalone muticus*], spiny softshell turtle [*Apalone spinifera*]) use the river and its corridor.

There are many mussels, including the wartyback, ellipse (*Venustaconcha ellipsiformis*), and slippershell (*Alasmidonta viridis*), found in the lower Wisconsin River. Some of these species are rare or of limited distribution and found in few other places in the state. The U.S. Endangered Higgins' eye mussel occurs in the lower Wisconsin River, and an attempt to reintroduce this species to additional locations within the lower Wisconsin is underway. The "Orion Mussel Bed" is a state natural area established by the Wisconsin DNR in 1996 along a 3-mile stretch of the lower Wisconsin River in Richland County. This area is intended to protect habitat for an especially diverse invertebrate fauna, which includes at least 15 rare species (among them mussels, insects, and fish). The bottom substrate here is composed of gravel, rubble, and sandstone bedrock "shelves," very unlike the shifting sandy bottoms that are predominant in many stretches of this river.

The lower Wisconsin River, while affected by sediment and nutrient loading from many of its tributaries, maintains the greatest diversity of invertebrate species of any river in this ecological landscape, with 454 total taxa recorded to date. A recent discovery was made here of the Hine's emerald, a Wisconsin and U.S. Endangered dragonfly (W.A. Smith, Wisconsin DNR, personal communication). The globally rare and Wisconsin Endangered Pecatonica River mayfly, despite its name, is now known only from large rivers of the Western Coulees and Ridges, including the lower Wisconsin, Black, and Chippewa.

The Chippewa River and Its Corridor. The lower Chippewa River is another highly significant large river, with an extensive forested floodplain, excellent barrens and sand prairies remnants, and forested bluffs. Recent surveys by Wisconsin DNR fish managers found 65 fish species, including 18 species listed as Wisconsin Endangered, Threatened, or Special Concern. Among the rare species found here were the blue sucker, greater redhorse, river redhorse, shovelnose sturgeon, lake sturgeon, paddlefish, and crystal darter (Benike and Johnson 2003, Wisconsin DNR 2010a). The fish community composition in the lower Chippewa River makes it an important stronghold for large river fishes in the Upper Midwest.

The Chippewa River's aquatic invertebrate biota includes 20 Wisconsin Endangered, Threatened, Special Concern, or Watch List species (mussels, dragonflies, and mayflies). Two mussels are currently candidates for federal listing as endangered or threatened: the spectacle case and purple wartyback. A third, the salamander mussel, is being considered for candidate status under the federal Endangered Species Act.

The Black River and Its Corridor. The Black River originates in northern Wisconsin within the Chequamegon-Nicolet National Forest and enters the Western Coulees and Ridges Ecological Landscape at Black River Falls. The Black is free-flowing from the Black River Falls Dam to the Mississippi River, a distance of roughly 55 miles. Relatively little development has occurred along this stretch of river. Vegetation includes extensive forests of lowland hardwoods in the river's floodplain and oak on the adjoining uplands. Sand terraces support good quality oak barrens and sand prairie remnants. Sandstone cliffs, some with "relict" pine stands, occur within the river corridor between Black River Falls and North Bend. Near its confluence with the Mississippi, the floodplain of the Black River becomes quite broad. Besides the large stands of floodplain forest, the wetland communities include large marshes, along with sedge meadow, shrub swamp, potentially restorable alluvial savanna (now extremely rare), and wet prairie (now limited to a few very small remnants). Numerous rare species have been documented along the Black, especially along its lowermost reaches, but in general, this river system is not as well known as the Mississippi, Wisconsin, or Chippewa. More study is needed, and certainly warranted, because the Black River corridor contains major management and protection opportunities. The lower Black River attracts many recreationists (especially canoeists, fishers, birders, and hunters), and there are excellent opportunities to implement land and water protection efforts here.

The Kickapoo River and Its Corridor. The Kickapoo River is a medium-sized stream. Unlike the large rivers discussed above, the Kickapoo originates and is entirely contained within the Western Coulees and Ridges Ecological Landscape. Extensive mesic and dry-mesic upland forests, composed mostly of deciduous trees, but including stands of eastern hemlock and pine (mostly eastern white, with small amounts of red), occur along the upper Kickapoo River in Vernon and Monroe counties. Along the lower river, all the way down to the village of Wauzeka where the Kickapoo joins the Wisconsin, extensive hardwood forests comprise the predominant vegetation. The larger blocks of forest provide important breeding habitat for many forest interior birds, including rare species such as Worm-eating, Kentucky, Hooded, and Cerulean warblers, Acadian Flycatcher, and Red-shouldered Hawk. The upper Kickapoo River is known for its many sharp meanders, entrenched in Cambrian sandstone bedrock. The river has carved spectacular cliffs, which provide habitat for many rare plants and invertebrates. Water quality in the Kickapoo is generally poor, due to excessive sediment and nutrient inputs. In addition, the Kickapoo is notorious for the severe flooding it experiences following rapid snowmelt or heavy rain events. Additional improvements to water quality and floodplain management are needed.

■ *Coldwater Streams:* The Western Coulees and Ridges Ecological Landscape is one of the most important ecological landscapes in the state for high-gradient coldwater and coolwater streams that originate in and drain the deeply dissected valleys. These provide important habitat for native brook trout and introduced brown trout. These small streams also contain rare fish, such as redside dace, and support rare dragonflies and mayflies. See "Rivers and Streams" in the "Hydrology" section for a discussion of physical properties and why they support certain fauna.

■ *Rare Communities and Geologic Features:* This is the only ecological landscape in the state that has Algific Talus Slopes. Algific Talus Slopes support rare land snails, such as the Wisconsin Endangered Midwest Pleistocene vertigo (Frest 1991), and many rare plants (e.g., the Wisconsin and U.S. Threatened northern wild monkshood). The wing snaggletooth, a Wisconsin Threatened species, is a land snail that in Wisconsin occurs only in the Western Coulees and Ridges. It is a calciphile and occurs on calcareous hill or "goat" prairies with southern or western exposures on bluffs in western Wisconsin. Populations may exist in areas of only a few square meters. In Wisconsin, it is restricted to open sites that warm early enough in the spring to provide a growing season of at least 160 frost-free days, typical for the western Wisconsin hill prairies and glades.

Cracks, caves, and crevices associated with bedrock outcrops on bluffs provide hibernacula for snakes, including timber rattlesnake and grey ratsnake, as well as bats, including the eastern pipistrelle and northern long-eared bat. They also may provide summer roosts for male and nonparous female bats, including northern long-eared bat. Old sand mines in Pierce County are used as hibernacula for large numbers of bats. There is one documented occurrence here of the Indiana bat (*Myotis sodalis),* a U.S. Endangered mammal, from the Atkinson Mine near Beetown in Grant County on November 7, 1954 (Davis and Lidicker 1955).

Natural and Human Disturbances

Fire, Wind, and Flooding

Fire was the most common and dominant natural disturbance in the uplands of the Western Coulees and Ridges Ecological Landscape, as evidenced by the fire-dependent vegetation found throughout the ecological landscape early in the Euro-American settlement period. The dominance of prairies, oak savannas, oak barrens, and oak forests indicate that fire was formerly the major vegetation driver in much of the ecological landscape.

Before Euro-American settlement, the ecological landscape was affected by the activities of American Indians. Various tribes have occupied the Western Coulees and Ridges since the last glacial period, utilizing the abundant food resources of the area, cultivating crops on the fertile floodplains, and constructing settlements and travel routes on higher areas. Fires were set by American Indians to aid in hunting and to provide habitat for the game they desired and plants they used. These fires prevented forests from expanding and kept much of the ecological landscape in prairie, oak savanna, oak woodland, and oak forest. After Euro-American settlers arrived in the early to mid-1800s, fires were suppressed, and forests quickly expanded.

The orientation of the major rivers, along with the highly variable topography, were factors that likely limited the extent of fires and prevented fires from affecting some portions of the ecological landscape. For example, a large triangular area roughly bounded by the Wisconsin, Baraboo, and Kickapoo rivers in Richland, Vernon, Crawford, and Monroe counties, was historically dominated by extensive hardwood forest, with a large component of mesic maple-basswood forest and relatively little prairie and savanna. The past vegetation suggests that this area burned infrequently (or at some locations, not at all) prior to Euro-American settlement. In general, the cool, moist, north- and east-facing slopes likely did not burn frequently or at high temperatures, allowing more mesic vegetation to become established and to persist. Some ridge tops and south- and west-facing slopes may have burned more frequently, resulting in local mosaics of mesic hardwood forest, with fire-dependent prairie, oak savanna, oak woodland, and oak forest vegetation.

True prairies probably burned at intervals of less than five years, sometimes burning annually or semi-annually, while

Prescribed fire is an important tool for managing and maintaining oak ecosystems, including oak savanna, oak woodland, and oak forest. Photo by Armund Bartz, Wisconsin DNR.

oak savannas and oak openings are thought to have burned at intervals of one to 15 years (Dickmann and Cleland 2002). If the fire interval was longer than 15 years, these communities tended toward closed forest. Some savannas and woodlands burned frequently but at low intensities.

Prescribed burning has been used successfully in the ecological landscape to restore prairie, oak savanna, and oak barrens (Nielsen et al. 2003). Managers often attempt to regenerate oak forests through clearcutting or shelterwood cutting, which partially resembles the effects of fire in that the site is opened to full or nearly full sunlight. However, fire is different from clearcutting in that it temporarily reduces the density of saplings, shrubs, and herbaceous litter, providing a competitive advantage for regenerating oaks. Fire also mineralizes organic material, making nutrients available for plant uptake or leaching, whereas logging removes a proportion of the site nutrients. Prescribed fire also promotes native understory vegetation that evolved with fire and is part of the oak plant community. Currently, excessive deer browse is also impacting the ability of oak to regenerate in many areas. Oak regeneration remains a serious management challenge in this ecological landscape, especially on dry-mesic and mesic sites.

Windthrow disturbance certainly occurred in historical forests of the Western Coulees and Ridges Ecological Landscape; however, data on frequency and severity are lacking. Canham and Loucks (1984) reported that windthrow was less important than fire as a disturbance factor in southern Wisconsin. Windthrow likely occurred in the lowland forests along rivers and streams where the high water table limited tree root depths. Significant windthrow now occurs every year in the bottoms along the Mississippi, Wisconsin, Chippewa, and Black rivers. Thunderstorm ***downbursts*** and tornadoes historically affected forests, woodlands, and savannas, but their documented impacts were apparently not extensive.

The extent and frequency of flood disturbance prior to Euro-American settlement is unknown. However, the major rivers, such as the Wisconsin, Chippewa, and Mississippi, must have flooded annually. The presence of landforms associated with floods and floodplain forests in the river valleys indicate frequent (probably annual) inundation. These rivers still flood each spring following snowmelt (and sometimes following major rain events at other seasons), but the frequency and severity of inundation has been altered by dams and dikes, elimination of wetlands, and other human activities. The flood regime needed to maintain and regenerate floodplain forests is poorly known and needs additional study.

Following Euro-American settlement and the advent of agriculture, flash floods and soil erosion became the norm in this ecological landscape for almost 80 years (see "Land Use Impacts" section for details). With ridge tops cleared for farming and the often steep side slopes grazed by livestock, soil erosion and flooding occurred after almost every major rain event. It wasn't until the 1930s, when contour farming and other soil conservation practices were initiated, that flash flooding was partially diminished. However, some streams

This red pine plantation was flattened by straight line winds during a severe storm in Monroe County. Photo by Eric Epstein, Wisconsin DNR.

This mid-summer storm generated winds of over 50 mph and dropped several inches of hail on local roads, including Interstate 90-94. Juneau County. Photo by Eric Epstein, Wisconsin DNR.

Following Euro-American settlement, chronic flooding in the Kickapoo River valley led to land use changes, and several highways, businesses, and one village were moved up and out of the river's floodplain. Looking toward the village of Ontario, Wisconsin from Wisconsin Highway 33, Vernon County. Photo by Robert H. Read.

and rivers still flood today, causing erosion and property damage. Many small dams have been constructed for flood control, and in one case, significant portions of a small village (Soldiers Grove) were moved to higher ground out of the floodplain. One of the largest attempts at flood control in the interior of this ecological landscape was a proposal to build a dam across the Kickapoo River, which has experienced many devastating floods, near the village of La Farge. This effort was abandoned after it was realized that water quality in the resulting lake would be poor, the economic benefits of the project would not equal the costs, environmental damage would occur, and political support wavered. The upper Mississippi River has been impounded since the first half of the 20th century by a series of dams. The lock and dam system (there are ten dams on the Mississippi River in this ecological landscape) is maintained by the U.S. Army Corps of Engineers and provides for a 9-foot navigation channel that handles a large amount of commercial barge traffic as well as recreational craft. The dams also function as flood control structures.

Forest Insects and Diseases

Forests of the Western Coulees and Ridges are dominated by oaks, maples, ashes, birches (*Betula* spp.), cherries (*Prunus* spp.), elms, basswood, and others. There are a number of pest species that periodically affect forests in this ecological landscape, and each of forest type or tree is associated with particular insects and diseases.

Oaks can be attacked by several organisms. Gypsy moth, a nonnative insect, is becoming established in this ecological landscape and will periodically affect oak and aspen forests. Dry conditions (due to site characteristics or drought) that exist in parts of the ecological landscape 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*. Aspens can be impacted by forest tent caterpillar (*Malacosoma disstria*), aspen heart rot fungus (*Phellinus tremulae*), and aspen Hypoxylon canker fungus (*Hypoxylon mammatum*).

Dutch elm disease is caused by the fungus *Ophiostoma ulmi*, which is transmitted by two species of bark beetles or by root grafting. American elm is more seriously affected than other elm species, but all of our native elms are somewhat susceptible, as is the nonnative Siberian elm (*Ulmus pumila*). American elm has essentially been eliminated as a component of the forest overstory but is still a significant part of the subcanopy, sapling, and seedling layers. Its life span is typically now about 30 years before it succumbs to Dutch elm disease. The loss of American elm as a ***supercanopy*** or dominant tree has impacts on associated wildlife species, such as Wood Duck (*Aix sponsa*). Dutch elm disease, along with subsequent invasion by reed canary grass as the canopy is opened (which can prevent tree seedling establishment), are factors currently encountered in bottomland forests. Dutch elm disease and reed canary grass have altered several major forest types in the Western Coulees and Ridges (e.g., Floodplain Forest and Southern Hardwood Swamp).

The emerald ash borer is an exotic insect native to Asia. This extremely serious forest pest was first discovered in the state near the Milwaukee River in Ozaukee and Washington counties in 2008 and has been confirmed in 35 Wisconsin counties as of 2015 (WDATCP 2015). In the Western Coulees and Ridges Ecological Landscape, the emerald ash borer has been confirmed in Buffalo, Crawford, Grant, Jackson, La Crosse, Monroe, Richland, Sauk, Trempealeau, and Vernon counties. 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. In the Western Coulees and Ridges, Iowa County has also been placed under quarantine because of its proximity to infestations in neighboring counties.

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

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

Invasive Species

In forested community types, glossy and common buckthorn (*Rhamnus frangula* and *R. cathartica*), nonnative honeysuckles, garlic mustard, Japanese barberry (*Berberis thunbergii*), Dame's rocket (*Hesperis matronalis*), multiflora rose (*Rosa multiflora*), 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.

In grassland and barrens communities, problem species include nonnative grasses such as smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), and Canada bluegrass (*Poa compressa*); other invasives are crown vetch (*Coronilla varia*), spotted knapweed (*Centaurea biebersteinii*), cut-leaved teasel (*Dipsacus laciniatus*), bird's-foot trefoil (*Lotus corniculata*), white and yellow sweet clovers (*Melilotus alba* and *M. officinalis*), wild parsnip (*Pastinaca sativa*), autumn olive (*Elaeagnus umbellata*), and multiflora rose.

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., hydrological modifications such as attempted drainage, the introduction of livestock into relatively confined areas, and suppression of fire). These include prickly ash (*Zanthoxylum americanum*), red-osier dogwood (*Cornus stolonifera*), 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. In at least some, if not most, instances, such problems result from a prior disruption (such as heavy grazing, drainage, fire suppression), which needs attention if the unwanted situation is to be corrected.

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

For more information on invasive species, see the Wisconsin DNR's invasive species web page (WDNR 2015c).

In this heavily grazed woodlot, Japanese barberry now dominates the understory of this dry-mesic oak forest. Forage value for livestock is minimal, and after repeated high-grading for oak sawlogs, most of the timber value is gone. Monroe County. Photo by Eric Epstein, Wisconsin DNR.

Land Use Impacts

Historical impacts. There have been dramatic changes in the land use and land cover of the Western Coulees and Ridges since the mid-1800s (WDNR 2002a). Settlers plowed ridge top prairies and cleared valleys for farmland, cut trees on the steep slopes for building homes and barns, and allowed cattle to graze whatever wasn't planted to crops. The landscape changed from treeless prairies, oak savanna, and dense forests at the time of Euro-American settlement to the current patchwork of agricultural fields on the ridges and valleys and second-growth forests on the steeper slopes and in the river floodplains. Less than 0.1% of the prairies and oak savannas present prior to Euro-American settlement remains today.

During and after settlement most of the area was farmed, resulting in severe and extensive soil erosion and numerous flash flood events (WDNR 2002a). Crop fields in this highly dissected landscape were mostly rectangular, and plowing was often conducted straight up and down slopes. Steep wooded slopes that could not be farmed were grazed by cows, compacting the soil and removing understory plants that limited runoff. Millions of tons of topsoil moved from hilltops and hillsides to valley floors. In the Bad Axe-La Crosse River basin, an average of 12 to 15 feet of topsoil was deposited in the valley bottoms, burying wetlands, fields, roads and bridges. Deep gullies (Figure 22.17) where water eroded away the soil were common. By the 1930s, after nearly eighty years of cultivation and grazing, virtually every rainstorm resulted in flash floods. By this time, farming in the Bad Axe-La Crosse River basin developed into a frustrating venture, with every new rainstorm washing away valuable crops, pasture,

Reed canary grass has taken over the wetlands bordering this ditched and channelized headwaters creek. The spoilbank adjoining the creek has been colonized by a dense growth of the native but weedy box elder. Juneau County. Photo by Eric Epstein, Wisconsin DNR.

and soil. The once crystal clear streams that held brook trout became shallow, wide, warm, and full of silt. The tons of sediment that reached the valley floor buried springs and seeps, causing many perennially flowing headwaters streams to become intermittent, flowing only after rainstorms. Streams became braided meanders, with their main channels lost to the massive amounts of sediment now in the valley. In-stream fish habitat was damaged or destroyed, and the cold water brook trout were replaced by warmwater species such as suckers, carp, and other minnows.

In 1934, the Federal Soil Erosion Service launched the Coon Valley Erosion Project in the Coon Creek watershed (WDNR 2002a). Men from the newly founded Civilian Conservation Corps (CCC) planted trees, fenced livestock off of steep slopes, reconfigured fields to follow the hills' contours, planted grassed waterways, and stabilized gullies. Efforts to restore streams were also attempted by adding wood and rock deflectors to force floodwaters away from streambanks toward the stream's center and by planting vegetation on streambanks. These land management practices were successfully adopted and are still in use today.

Even though these conservation measures were implemented, the ecological landscape was degregated, and flash floods continued to damage land and property (WDNR 2002a). From the 1940s to the 1960s, farms on marginal land failed, and the land reverted back to more natural conditions. In the 1970s, many farming operations went deeply into debt, overvalued land prices fell, and interest rates remained high. In the early to mid-1980s, many farmers were forced to financially dissolve their farms. Large amounts of farmland were purchased by landowners who were not interested in raising livestock or growing crops as their source of income, and these farms reverted to more natural vegetation.

The Food Security Act of 1985 required compliance with farm-specific conservation plans in order to receive any kind of government subsidy (WDNR 2002a). From 1983 to 1988, land under conservation tillage in the area increased over 700%. The Conservation Reserve Program (CRP) was an incentive to remove highly erodible land from crop rotation and replace it with perennial vegetative cover. Conditions have improved with these conservation actions. Infiltration of rain and snowmelt into the soil has reduced runoff. Conservation practices such as contour farming have reduced soil erosion. CRP took highly erodible land out of crop production, but many acres of CRP-enrolled lands have been put back into production recently. Streams are recovering, many once again becoming narrow, deep, and cold. This ecological landscape has the highest percentage of cover of southern forest types in the state and also has many rare and ecologically significant features. However, the landscape is dramatically altered from its original condition as millions of tons of soil were permanently moved from ridge tops and hillsides to valley floors and floodplains and deposited downslope and downstream.

Figure 22.17. *Gullies were common around southwestern Wisconsin in the 1920s. Note rider on horseback. Photo courtesy of U.S. Department of Agriculture Soil Conservation Service.*

Current Impacts. Current disturbances in the ecological landscape are largely due to human activities such as agriculture, residential development, timber production, impoundment construction, and cessation of fire. Some of these disturbances, such as the construction of homes, roads, and related infrastructure, result in essentially permanent changes. Other disturbances, such as those associated with certain types of logging or recreational activities (e.g., inappropriate use of ATVs), may also result in long-term effects.

In addition to direct impacts, human land use changes also indirectly impact ecosystem composition, structure, and function by altering natural disturbance regimes. Widespread (universal) fire suppression has accelerated and exacerbated the loss of native grassland and savanna to forest. It is probable that the severity and frequency of flood disturbance has been increased by converting lands that were in permanent vegetative cover to tilled cropland. Construction of dams has disrupted the natural flood regimes of river and stream systems that maintained floodplain vegetation, and allowed for the free movement of aquatic organisms. Over time, the areas behind dams fill with sediment, creating the need for periodic dredging to maintain their effectiveness as navigation aids, generators of hydroelectric power, flood control structures, and recreational areas. If the sediments are polluted, disposal problems arise and can be difficult and expensive to remedy.

Fire suppression activities have reduced or eliminated fire frequency and intensity, leading to changes in species composition and stand structure. Fire suppression has allowed communities such as prairie and oak savanna to succeed to forest. Oak forests, in turn, are becoming increasingly dominated by mesophytic species (maples, ashes, American basswood).

Changes in Hydrology. In the 1930s, the U.S. Army Corps of Engineers began a massive project to construct a series of locks and dams on the Mississippi River to improve navigation on the river for commercial barge traffic. Ten of these locks and dams (at Dubuque, Guttenberg, Prairie du Chien, Genoa, La Crosse, Trempealeau, Winona, Whitman, Alma, and Red Wing) impound the waters of the Mississippi River (along Wisconsin reaches shared with Minnesota and Iowa) to permit barge traffic to reach Minneapolis-St. Paul.

While providing a significant benefit to commerce as well as to energy conservation (compared to shipping by truck or even rail) (USDOT 1994), the locks and dams on the Mississippi river exact a devastating toll on the habitat necessary to sustain fish and wildlife populations. Higher water levels and waves from storms and boat traffic erode natural islands and convert shallow marshes with abundant beds of emergent vegetation into areas of open water with relatively low habitat value for wildlife.

Pollution from industries, municipalities, and agriculture along the Mississippi River and its tributaries degraded water and sediment quality along significant reaches of the river. In response to citizen concerns about the health of the river, the U.S. Congress established a program to assess the condition of the Mississippi. As a result, the ecology and hydrology of the Mississippi River have been studied and documented extensively in a comprehensive research program since 1986 (Bartels et al. 2004). A Long Term Resource Monitoring Program (LTRMP) has since 1986 targeted six characteristics of the river and its physical and biological characteristics: fish, invertebrates, aquatic vegetation, water quality, sedimentation, and land cover.

Findings of the LTRMP as of 2006 indicated a number of trends, both encouraging and troubling. While nearly all the fish species present in the early 1900s are still here a century later, about 50% of the fish biomass consists of nonnative invasive carp species, and there is great concern over the potential for Asian carp to continue spreading upriver. Invertebrates such as mayflies, midges, and fingernail clams have remained at population levels equal to those found in 1952. However, researchers believe that populations of many of these species could increase if land use improvements could achieve a decrease in the siltation rate along the river bottom. Important aquatic vegetation has increased in areas where artificial islands were constructed, in conjunction with lowering water levels. Water quality in the reaches below Lake Pepin is better than upstream because the lake acts to settle out pollutants entering via the Minnesota River. Backwaters oxygen levels sometime drop to low levels, and these areas experience seasonal blooms of nuisance levels of blue-green algae. Excessive sedimentation continues to occur in places, suppressing populations of fish, invertebrates, and plants and impeding navigation. Open water continues to replace deepwater marsh vegetation, although where water levels have been lowered for periods of time, vegetative restoration has been somewhat successful.

Oil spill in the Mississippi River, Buffalo County. Photo by Dean Tvedt.

Dams were built on the Chippewa River creating Dell Pond and Lakes Wissota and Altoona. On the Black River, Lake Arbutus was created. Dams on the Wisconsin River upstream from the Western Coulees and Ridges Ecological Landscape affect the lower Wisconsin River and its floodplain by controlling water levels and flooding to some extent. Many mill pond dams built on small streams in the 19th century for power production have been removed. As discussed above, cropping ridge tops and pasturing steep slopes resulted in periodic flooding of many of the streams in the ecological landscape. Many of these streams were altered and damaged when their channels and valleys were filled with soil washed from the uplands. Wetlands in some of the major river valleys were drained for farming or grazing, changing their vegetative cover and reducing their capacity to store floodwaters.

Many warmwater streams in the Western Coulees and Ridges Ecological Landscape may have been coolwater streams prior to the extensive removal of permanent vegetative cover and subsequent agricultural development. Loss of topsoil due to poor agricultural practices was tremendous during the 19th and early 20th centuries prior to the development of effective soil conservation techniques. Impacts to streams were devastating because original stream channels and valleys were sometimes filled with as much as 30 feet of sediment (see Figure 22.17).

The Rush River in central Pierce County is a prime example of the impacts that coldwater streams have experienced in the Western Coulees and Ridges. As late as 1869, it was still one of the best trout streams in the Mississippi River basin (Engel and Michalek 2002). The watershed of the Rush River was mostly forested and contained numerous cold, spring-fed headwaters streams that supported native brook trout populations. Land use changes along the Rush and its tributaries led to a dramatic transformation. From the late 1800s through the early 1900s, stream habitat and water quality were severely degraded by deforestation, logging and milling dams, agricultural activities, and discharge of wastewater effluent. Flooding and erosion were rampant, and the Rush River became dependent on stocking to support a sport fishery.

Conservation practices that began around the 1930s, including soil erosion and flood control programs, natural reforestation, and wastewater treatment, have resulted in major improvements in stream water quality and habitat (Engel and Michalek 2002). These factors, along with improved farming practices, enabled stocking of nonnative trout populations to redevelop by the 1960s. Watershed conditions, infiltration rates, and coldwater base flow have improved to the point that natural reproduction of trout is now common in the tributaries and upper portions of the main stem of the Rush River.

Agriculture. Currently, farming occurs on over half of the land area of this ecological landscape. Conservation practices are often used to prevent or limit soil erosion and loss, which is a notable improvement over conditions that prevailed earlier. However, contamination from runoff and leaching associated with agricultural use can still be an issue here. The highly permeable bedrock is often close to the surface, allowing agricultural chemicals to quickly leach into the groundwater. Atrazine was identified as a problem in the groundwater in some areas in the early 1990s, and its use is now prohibited in parts of most counties in the Western Coulees and Ridges Ecological Landscape (WDATCP 2009).

Since 1985, the Conservation Reserve Program has enrolled thousands of acres in this ecological landscape, taking highly erodible land out of crop production and establishing permanent grass cover. The increased grass cover benefits grassland birds and protects soil and water quality. However, the policy of using the same grassland management practices across the country has limited the program's effectiveness in some cases. The current desire for corn ethanol and resulting higher prices for corn potentially threaten to reduce the amount of acres in CRP in favor of corn or other biofuel production. Biofuel is another emerging area where there will need to be coordination between cover, harvest, and the needs of grassland wildlife (this will also apply to forested lands).

Recently, new farm startups have been going to grass-based agriculture for financial reasons, especially in this ecological landscape. Short-term rotational grazing is becoming more popular and prevalent. 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 stocking rates are low enough to maintain residual cover. It may also have a benefit by preventing soil loss and improving water quality. Because confined domestic livestock graze differently than free-ranging native grassland ungulates, grazing of native prairies, sedge meadows, and fens should not be encouraged, at least not at the present time. More must be learned about grazing methods and impacts to "prairie pastures" (unplowed grasslands) by domestic livestock before it can be promoted without cautions as a benign, beneficial, and cost-effective practice.

Recently, more farms are being bought by "hobby farmers" that do not make their entire living from the land. This has resulted in some lands reverting to a more natural state. In addition, many hobby farmers are interested in preserving and restoring prairie, oak savanna, and oak openings and other natural communities on land. This could have a positive effect on terrestrial and aquatic fauna as well as rare plants. Challenges include how to maintain such practices at particular locations over time (this can be a very substantial investment) and how to match incentives with ecological and socioeconomic need.

Forest Management. One potential land use change in this ecological landscape is the decline of oak in upland habitats, especially on dry-mesic and mesic sites. In the absence of fire and under pressure from unsustainable logging practices, grazing, deer herbivory, the increase in woody competitors, and the spread of invasive species, oaks and oak forests are declining. Oaks are important not only as a source of commercial timber but also because they are the dominant organisms in an interdependent community of plants and animals. Currently, many of the oaks we see are the legacy of fires that occurred more than a hundred years ago, which produced suitable conditions for the germination, growth, and maintenance of oak savannas, woodlands, and forests. With the suppression of fire, when oak is logged today, the conversion of the stand to another forest type is often accelerated, especially on the richer, moister sites. "High-grading," the practice of preferentially removing the trees with the greatest commercial value (usually the large oaks, and at the present time, the largest red oaks in particular), can further accelerate the decline of oak in these stands and lead to a conversion to ecologically and economically less desirable forest types. The introduction and spread of invasive species (such as Eurasian honeysuckles and buckthorns and Japanese barberry) is preventing oak from regenerating in many areas. Overabundant deer populations can also contribute to reduced oak regeneration because of excessive browsing. More research is needed to develop effective techniques that will not only restore and regenerate the oak trees but will also maintain entire oak-dominated forest communities. More mesophytic native trees (maples, cherries, ironwood [*Ostrya virginiana*]) now dominate the understories of many oak stands. Use of more prescribed fire may be productive, but the logistics can be problematic, and there is a lack of experience in using fire in forested ecosystems on an operational scale in Wisconsin. 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 significant land use change has occurred because of hydrologic modifications such as dam construction. This alters the historical annual flood regimes of rivers and their floodplains and can result in poor regeneration of many floodplain species, including some of the now dominant trees. Some of the largest and most intact floodplain forests in the Upper Midwest exist in the Western Coulees and Ridges, and they are being changed in ways that are not now well understood, at least from a management perspective. The disruption of hydrologic regimes, introduction of invasive species, cascading effects from the loss of American elm as an overstory tree, and potential damage from the emerald ash borer may make future regeneration and maintenance of floodplain ecosystems, and especially the forests, difficult. In some heavily disturbed stands, reed canary grass and species of low value such as box elder are now dominant. Better management and conservation guidelines on how to prevent or reverse such situations are needed very soon.

Both forests and grasslands represent significant management opportunities in the Western Coulees and Ridges Ecological Landscape. The planting of trees through the CRP program in areas designated by Wisconsin DNR as "grassland restoration areas" to restore grasslands at large scales is counter productive. The use of limited resources to promote management that results in the increased fragmentation of now scarce large patches of grassland or forest habitats benefits neither area sensitive grassland or forest species. Increased cooperation and coordination within and among agencies and NGOs is needed to restore and maintain habitats, especially at the larger scales, that fit the ecology of a given area and are appropriate for the habitats and species that are most in need of management attention.

High-grading, especially for large diameter oaks, remains a common practice in western Wisconsin. Because this site is pastured, successful oak regeneration is unlikely to occur. Monroe County. Photo by Eric Epstein, Wisconsin DNR.

This large sand prairie on a Mississippi River terrace has been planted to a red pine monotype. Pierce County. Photo by Eric Epstein, Wisconsin DNR.

Fragmentation. Fragmentation is a term that describes certain types of landscape structure. It can be an end result and a process. Fragmentation occurs when contiguous habitats are broken into separate, disconnected pieces. These fragments may be permanently separated, e.g., by road, homes, agricultural fields, or other developments or temporarily separated, which may occur following certain management activities, such as some timber sales or even the use of prescribed fire.

This ecological landscape has high levels of both permanent and more temporary fragmentation. One of the most common and widespread habitat mosaics in the Western Coulees and Ridges is the interspersion of small to medium-sized patches of agricultural fields, pastures, and woodlots. This is often dictated by the relatively rugged topography, which limits land use potential and results in characteristic land use patterns that are repeated throughout much of the ecological landscape. Farmlands occur mostly on ridge tops, in valley bottoms, and sometimes on gentler slopes. Steeper slopes are usually forested, and sometimes, especially on very steep slopes with southern or western exposures, support remnant woodlands, savannas, or prairies. The typical land-use pattern results in habitat patches that are highly dissected and characterized by a great deal of high-contrast edge (i.e., there is an abrupt change from open land to dense forest with little or no transition). This is very unlike the classic "checkerboard" pattern created by the mix of agricultural lands and woodlots in the more extensively farmed landscapes in the glaciated parts of southern Wisconsin.

Large patches of contiguous forest or uncultivated grass are now scarce (there are no large native prairies remaining anywhere in Wisconsin, though there are a few areas where it may be possible to manage for grasslands and grassland-dependent wildlife and include prairie remnants or sites with high restoration potential). In many areas they are absent. Landscapes with high levels of fragmentation have relatively large amounts of edge. This pattern favors some species like white-tailed deer and Wild Turkey (almost all of the species favored by this landscape pattern are common and widespread), but it does not provide the larger patches of contiguous, relatively homogeneous habitats needed by many sensitive grassland or forest species. We still have a few opportunities to provide these, and better accommodate rare or declining species, without appreciably sacrificing habitat for deer or turkey. See Wilson (2008) for background and some preliminary ideas on how large blocks of forest interior habitat and area-sensitive forest wildlife might be managed in the Driftless Area.

■ **Residential Development.** Dispersed residential development has occurred and is increasing throughout the ecological landscape, especially near larger cities (e.g., Madison, La Crosse, Eau Claire areas). Dispersed development creates permanent land cover and land use changes that can alter large parts of the landscape, resulting in habitat fragmentation and loss of habitat connectivity. Destruction and isolation of prairie remnants and patches of forest are among the significant threats from this sort of development. On the positive side, many residents who move to the country are interested in the natural world and may be able and willing to convert cropland to more natural habitats.

■ **Military Sites.** Fort McCoy is located in the Western Coulees and Ridges in northern Monroe County. Good examples of Oak Barrens and Sand Prairie occur on this 60,000-acre property. There are also extensive forests of oak, stands of native pine (mostly eastern white pine and jack pine), and wetlands. The absence of agriculture has protected native streamside vegetation and seepages along the upper reaches of several coldwater streams, and these riparian areas support native coldwater fish communities (which include brook trout) as well as rare plants, invertebrates, herptiles, and birds. Military training at Fort McCoy, including troop exercises, tank and heavy weapons training, and low level flights by aircraft, may disturb plants and wildlife at certain times of the year. Conversely, bombing and strafing practice sometimes results in fires, and these have played an important role in preserving some of the fire-dependent prairie and savanna communities at Fort McCoy.

■ **Underground Mining.** Abandoned lead and zinc mines in the southern part of the ecological landscape provide habitat for hibernating bats. At the same time, these mines typically intersect the water table and provide ready access for agricultural runoff and illegal dumping. The mines, as well as the natural crevices and openings in the host rock for the mine, enable rapid transport of contaminants to wells using that groundwater. The sand mines in the northwestern part of the ecological landscape are among the largest bat hibernacula in the state. Abandoned railroad and other tunnels may also provide habitat for hibernating bats. The Norwalk Tunnel on the Elroy-Sparta state bike trail contains many hundreds of hibernating bats, with the site being made suitable because of the doors that close the tunnel to the outside during the winter. These sites need to be kept open for use by bats and protected from large amounts of human disturbance.

■ **Wind Farms.** Commercial wind facilities are operational in parts of Wisconsin, including two wind farms in the Western Coulees and Ridges Ecological Landscape, and more are being planned. While this source of energy is attractive because it isn't directly powered by fossil fuels, there are risks to bats, birds, and perhaps other wildlife, especially if siting is not done with adequate study and great care. Fatalities among bats and birds have been documented at wind power installations in Wisconsin, and at many other locations across the globe. In some areas, migratory bats have suffered the greatest mortality, which is often caused by barotrauma, changes in barometric pressure when the bats come close to the spinning blades, causing their lungs to burst (Baerwald et al. 2008). Detailed siting guidelines are needed to protect vulnerable species, and for other reasons.

Newer homes in rural areas often come with large lawns and exotic plantings. Impacts depend in part on previous land cover and land use. In some cases there are opportunities to work with landowners of such sites to make them more friendly to native plants and animals. Monroe County. Photo by Eric Epstein, Wisconsin DNR.

Abandoned mines in the Driftless Area provide important habitat for Wisconsin's bats. Here, the entrance has been modified above the door to allow bat movement, and instruments are counting bats moving in and out. Photo by Dave Redell, Wisconsin DNR.

Management Opportunities for Important Ecological Features of the Western Coulees and Ridges

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

- occur together in close proximity, especially in repeatable patterns representative of a particular ecological landscape or group of ecological landscapes;
- offer compositional, structural, and functional attributes that are important for a variety of reasons and that may not necessarily be represented in a single stand;
- represent outstanding examples of natural features characteristic of a given ecological landscape;
- are adapted to and somewhat dependent on similar disturbance regimes;
- share hydrological linkage;
- increase the effective conservation area of a planning area or management unit, reduce excessive edge or other negative impacts, and/or connect otherwise isolated patches of similar habitat;
- potentially increase ecological viability when environmental or land use changes occur by including environmental gradients and connectivity among other important management considerations;
- accommodate species needing large areas or those requiring more than one type of habitat;
- add habitat diversity that would otherwise not be present or maintained; and
- provide economies of scale 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 communities, habitats, and species that are present, may provide the most benefits over the longest period of time. This does not imply that all of the communities and habitats associated with a given opportunity should be managed in the same way, at the same time, or at the same scale. We, instead, 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 management opportunities were determined.

Outstanding Ecological Opportunities in the Western Coulees and Ridges Ecological Landscape

- "Southern" hardwood forest communities of oak, maple-basswood, and bottomland hardwood types are extensive, offering some of the best opportunities in the Upper Midwest for management and protection.
- The full continuum of fire-dependent "oak ecosystem" communities of oak forest, oak woodland, and oak savanna is present, offering exceptional management opportunities at multiple scales.
- Research on oak-dominated ecosystems is needed to develop more effective and affordable methods of maintaining and, where possible, restoring oaks as dominant species.
- Large warmwater rivers, complex floodplains, terraces, and associated blufflands support a wealth of plant and animal diversity and should be conservation focal points.
- Several of the Upper Midwest's most extensive forested floodplains occur along the Wisconsin, Chippewa, and Black rivers.
- Sand terraces flanking the major river floodplains support rare plant communities such as Oak Barrens and Sand Prairie, upon which many rare species depend. The terrace ecosystems are highly threatened by outright destruction by conversion to pine plantations, irrigated row crop agriculture, and residential development and are degraded by fragmentation and fire suppression.
- The Mississippi River corridor constitutes a continentally significant "flyway" for migratory birds.
- Dry Prairies are common on bluffs with southwestern exposures, especially along large rivers such as the Mississippi, Wisconsin, and Chippewa.
- Bedrock features are common and widespread and include cliffs, gorges, talus slopes, glades, caves, and mines.
- All Wisconsin occurrences of the globally rare Algific Talus Slope community occur here.
- Caves and abandoned mines host some of the state's most important bat and herptile hibernacula.
- Dredge spoil islands can provide benefits to nesting turtles and birds when managed and sited properly.
- Spring-fed coldwater and coolwater streams are common and can provide both ecological and economic benefits.
- Surrogate grasslands can provide critical habitat for rare and declining grassland birds. Such grasslands occur on broad ridge tops and on sand terraces.
- Conifer relicts are concentrated in drainages with abundant cliff or talus habitat, such as the upper Kickapoo River valley and the Baraboo Hills.
- Larger blocks of conservation land are needed within the interior of this ecological landscape.

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 Western Coulees and Ridges Ecological Landscape include

- extensive hardwood forests: oak, maple-basswood, Floodplain Forest;
- oak ecosystem continuum: oak forest, oak woodland, and oak savanna;
- grasslands: native prairie and surrogate grassland;
- geologic features: cliffs, talus slopes, and caves;
- large warmwater rivers, complex floodplains, and terraces;
- spring-fed coldwater and coolwater streams;
- Mississippi Flyway; and
- miscellaneous opportunities: scattered natural communities, habitats, and rare species populations.

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 22.2. Examples of locations where these important ecological features be found are on the "Ecologically Significant Places within the Western Coulees and Ridges Ecological Landscape" map in Appendix 22.K.

Extensive Hardwood Forests: Oak, Maple-Basswood, and Floodplain Forests

The Western Coulees and Ridges Ecological Landscape offers Wisconsin's best opportunities to manage for "southern" forest types. These are hardwood-dominated forest ecosystems that may be grouped into three major categories: Oak forests (Southern Dry-mesic and Southern Dry Forests); mesic maple-basswood forests (Southern Mesic Forest); and bottomland hardwoods (Floodplain Forest). At some locations offering the best opportunities to manage and conserve these forest communities, all three groups may occur adjacent to one another.

Oak forests are more widespread and abundant here than in any other ecological landscape, especially on dry-mesic and mesic sites. Northern red and white oaks are of great importance to many species and are among the forest community dominants. Their maintenance is, or should be, a priority concern for ecological and economic reasons. Many decades of fire suppression and several other factors have led to a shift in dominance to more mesophytic species. The heavy shade created by dense subcanopies of maples, cherries, ashes,

Extensive hardwood forests occur along the Lower Chippewa River in Buffalo and Pepin counties. Photo by Eric Epstein, Wisconsin DNR.

American basswood, and ironwood produces unfavorable conditions for the growth of oak seedlings and saplings.

Mesic maple-basswood forests are widespread in the Western Coulees and Ridges. Floodplain Forests are the prevalent vegetation type along southwestern Wisconsin's major river corridors. Some of the Upper Midwest's most extensive stands of this forest community occur here, and all of these support a distinctive assemblage of animals.

Though the lower reaches of the Wisconsin, Chippewa, and Black rivers are free-flowing for long distances, upstream dams have affected flood regimes in this ecological landscape, and the long-term effects on composition and successional trajectories are not well understood.

Among the key management considerations for the major forest types in this ecological landscape are overcoming the negative impacts of fire suppression and "mesophication" (Nowacki and Abrahms 2008); understanding the impacts dams will have on composition, structure, and function of future floodplain forests; protecting floristically rich sugar maple-basswood forest; effectively combating successive waves of invasive species; and designing management and protection projects that include major ecological gradients such as slope, aspect, soil texture, and soil moisture. For all of the forest types occurring in this ecological landscape, invasive species already pose serious threats. Enhancing and maintaining connectivity is more feasible in the Western Coulees and Ridges than in the forested parts of glaciated southern Wisconsin farther east because of the large rivers and their relatively unbroken stands of forested floodplain.

There are also opportunities to manage for less abundant but ecologically significant forest types such as the conifer-dominated Pine Relicts and Hemlock Relicts, Forested Seeps, and Tamarack Swamps. The latter are now very rare in the Western Coulees and Ridges, and many stands appear to be declining due to hydrological disruption, succession, insect attack, climate change, or combinations of these factors. These will have the highest conservation value and greatest

Table 22.2. *Natural communities, aquatic features, and selected habitats associated with each ecological feature within the Western Coulees and Ridges Ecological Landscape.*

Ecological features[a]	Natural communities,[b] aquatic features, and selected habitats
Extensive hardwood forests	Southern Dry Forest Southern Dry-mesic Forest Southern Mesic Forest Southern Hardwood Swamp Floodplain Forest Forested Seep
Oak ecosystem: Oak Forest, Oak Woodland; Oak Opening	Southern Dry Forest Southern Dry-Mesic Forest Oak Barrens Oak Opening Oak Woodland
Grasslands: native prairie and surrogate grasslands	Dry (Bluff) Prairie Sand Prairie Dry-Mesic Prairie Mesic Prairie Wet-Mesic Prairie Wet Prairie Surrogate Grassland
Geologic features: cliffs, gorges, talus slopes, caves	Algific Talus Slope Bedrock Glade Dry Cliff Moist Cliff Caves Hibernacula Mine
Spring-fed cold- and coolwater streams	Alder Thicket Spring Seepage Coldwater Stream Coolwater Stream
Large rivers, complex floodplains, and terraces	Floodplain Forest Shrub-carr Emergent Marsh Wild Rice Marsh Submergent Marsh Impoundments Warmwater River
The Mississippi River bird flyway	Floodplain Forest and all adjacent upland forest and savanna communities Shrub-carr Dry Cliff Emergent Marsh Wild Rice Marsh Submergent Marsh Warmwater River Riverine Lakes Pools

Continued on next page

Table 22.2, *continued.*

Ecological features[a]	Natural communities[b] aquatic features, and selected habitats
Miscellaneous opportunities	Hemlock Relict Pine Relict Talus Forest Southern Tamarack Swamp Cedar Glade

[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.

viability when embedded within extensive forests of other types, such as the hardwood groups mentioned above.

Large blocks of forest provide critical habitat for forest interior species, including many birds that are wholly or somewhat limited in distribution to forests south of the Tension Zone.

Management Opportunities, Needs, and Actions

- Identify large forest blocks that have the greatest potential to support forest interior processes and sensitive species. These may consist of a single forest community but ideally will include several community types. The probability that multiple owners will be involved is high as public lands are limited in extent here, especially in the interior of the Western Coulees and Ridges.
- Keeping stands of various forest types connected will increase effective forest block size for some species but is also likely to add microhabitats that support specialists and provide for the representation of important environmental gradients that will better ensure the long-term viability of a given management project.
- The best opportunities in Wisconsin to manage for extensive dry-mesic oak forests are found here. Because of the past and present abundance of oak and its ecological, aesthetic, and economic values, the protection and management of oak forests is of special importance here.
- Oak management on more mesic sites has been highly problematic, and oak forests are declining in many parts of their continental range. More research and the development of more reliable methods of regenerating oak forests on dry-mesic and mesic sites are ecosystem management priorities here.
- The most extensive areas of Floodplain Forest in Wisconsin occur along the lower Wisconsin, Chippewa, and Black rivers. Such forests provide critical habitat for a number of vertebrates, some of which are found only or primarily within this type.
- Large blocks of contiguous maple-basswood forest are uncommon anywhere in southern Wisconsin. In the Western Coulees and Ridges, there are areas in which mesic hardwood forests are embedded within more extensive stands of other types, such as oak or floodplain forests, forming a large, contiguous habitat.
- Intact maple-basswood forests can be rich repositories of native flora not found in other forest communities. There are unique values associated with this forest type, which plays a critical role in maintaining diversity in our state. At the right scale and in the right context, mesic hardwood forests are also capable of supporting forest interior birds, northern long-eared bats and eastern red bats, and other sensitive animals.
- Diverse, uneven-aged forests provide trees and snags with cracks, crevices, loose bark, as well as larger scale structure such as diverse tree heights and canopy closures that are important for summer bat roosts.
- ***Old-growth forest*** management guidelines are available for "northern hardwoods" (which partially covers Southern Mesic Forest) and "bottomland hardwoods" in the Wisconsin DNR's *Old-Growth and Old Forest Handbook* (WDNR 2006a) and should be among the references consulted when planning active management in stands of these forest types. Old-growth management guidelines are not yet available for oak forests, but these will be forthcoming in the near future. Old-growth forests contain compositional, structural, and functional elements lacking or diminished in younger forests and are needed to ensure that the range of natural variability in successional stages is represented somewhere on the landscape. Other reasons for establishing old-growth "benchmarks" may be found in the *Old-Growth and Old Forest Handbook.*
- Relict stands of conifers are scattered across parts of the Western Coulees and Ridges. These are concentrated in the Baraboo Hills, the upper Kickapoo, Baraboo, and Pine rivers and in some areas south of the Wisconsin River. Many of the more intact sites support disjunct populations of "northern" biota. Almost all relicts are associated with bedrock exposures (cliffs, talus slopes).

- Species associated with these northern outliers or variants may be important for the genetic variation they harbor.
- Impacts of conducting prescribed burns in floristically rich mesic hardwood forests in the spring, especially on steep slopes, need review and documentation.

Oak Ecosystem Continuum: Oak Forest, Oak Woodland, and Oak Savanna

The full continuum of oak-dominated natural communities, from closed canopy oak forests, to open understory oak woodland, to oak savanna (Oak Openings and Oak Barrens are both treated as savanna communities) occurs or could potentially be restored here. Savannas and woodlands have almost been eliminated by fire suppression and various land uses over the past one and half centuries. Oak forests have also undergone significant alterations due to these same changes and are in serious decline in some areas (to the point where it may not be inappropriate to refer to them as "relicts," at least on nutrient-rich mesic and dry-mesic sites). The longevity of the trees somewhat masks the threat.

Management Opportunities, Needs, and Actions

- The opportunities to manage for and maintain oak on dry-mesic and mesic sites in this ecological landscape are better than anywhere else in the state. Regeneration of oak stands has proven to be challenging, especially in the absence of fire, a natural disturbance to which the oaks are adapted.
- Maintaining and managing for large patches of forest or savanna should not be regarded as mutually exclusive. In many cases it will be possible—and desirable—to do both. In all cases, landscape factors such as the amount and distribution of both forest and savanna needed should be assessed before management decisions are made. For an example, see "Managing "Dry Forest/Savanna Mosaic" in Chapter 1, "Principles of Ecosystem and Landscape-scale Management."
- The scope of oak management needs to be broadened to encompass savannas and woodlands as well as forests.
- Because the regeneration of oak has proven so difficult on many sites, research, experimental management, and solid data remain high priorities. This is especially so for those sites that have now been converted to the so-called "central hardwoods" type due to the loss of oak.
- Unsustainable harvest of oak ***sawtimber*** (e.g., high-grading) is having negative impacts on present and future forests and needs to be discouraged and, where possible, eliminated.
- The methods required to attempt oak regeneration may involve expenses and intrusions that are unsustainable and uneconomical compared to the return. Other options for managing oak stands (especially northern red oak on mesic sites) should be weighed carefully as the costs of both maintaining or losing oak can be high.

Oak Barrens and Sand Prairie on ancient sand dunes. Trempealeau National Wildlife Refuge, Trempealeau County. Note "goat" prairie ("Dry Prairie") on steep, south-facing slope of forested bluff in background. Photo by Eric Epstein, Wisconsin DNR.

Woodland of mixed oaks maintained with prescribed fire. Rush Creek Bluffs. Photo by Eric Epstein, Wisconsin DNR.

- Methods of restoring oak to "central hardwoods" stands that have high management potential need to be explored more fully. Long-term, this is desirable ecologically and economically, especially in areas that formerly supported extensive forests of oak. In the short-term, it may require greater effort and investment than is feasible, especially to individual private landowners. In part, this is an institutional problem—DNR and other resource management agencies have the responsibility for making decisions that may not provide the greatest immediate benefits. Additional outreach, and probably incentives, will be needed.
- Landscape-scale considerations are important when making management decisions. The conservation of oak forests should include the continuum of communities that comprise the oak ecosystem. A more integrated approach to managing oak-dominated communities is needed because interests are often broader than considerations based only on short-term economics.
- The Nature Conservancy and the U.S. Environmental Protection Agency published a Midwest Oak Ecosystem Recovery Plan (Botts et al. 1994) that should be consulted by those interested in and responsible for management of Wisconsin's oak savannas, woodlands, and forests.
- Multiple private ownerships and the lack of public lands create a need for incentives to private landowners to manage for oak savanna and prairie; potentially conflicting management goals are important forest management challenges in this ecological landscape (Wilson 2008).
- Fire was the historical disturbance factor that drove and maintained all of the upland oak-dominated communities. Increase the use of prescribed fire as a practical means by which some management and restoration goals may be achieved.
- A more integrated approach to the management of oak ecosystems is needed. Expand the methods used to manage components of the oak ecosystem to develop practical and reliable means of maintaining and increasing oak where appropriate. Prescribed fire, planting (or, in some cases, underplanting) desirable species, herbicides, and the mechanical control of unwanted brush should be considered as additional methods to augment existing silvicultural tools.
- Reduce hard edges where ecologically appropriate (e.g., where former savanna vegetation adjoins grasslands).
- Maximizing forest cover is a valid goal where savanna restoration is impractical, where savanna opportunities are deemed poor by qualified biologists, and/or where there are feasible opportunities to maintain or create connections with or between large patches of contiguous forest. Such habitats are needed by forest interior species and are critical for those strongly associated with southern Wisconsin's forest communities.

Grasslands: Native Prairie and Surrogate Grassland

The bluffs characterizing much of this ecological landscape offer by far the best opportunities in the state to manage for Dry Prairie, especially along major rivers such as the Mississippi, Wisconsin, Chippewa, and Black. Opportunities also exist to manage for Sand Prairie on the broad terraces along some of these same rivers. Both of these prairie types are best represented in the Western Coulees and Ridges and in those parts of the Driftless Area in adjoining states. In part because more of the Driftless Area occurs in Wisconsin than any other state, both opportunity and responsibility to conserve these rare native grassland communities are especially high here.

On more mesic sites, such as the broad ridge tops away from the major river valleys, surrogate grasslands can increase the effective conservation size of remnant prairies, many of which are small and isolated, so that they can better support area-sensitive grassland species and connect grassland patches that would otherwise be separated by relatively inhospitable intervening land cover. Surrogate grasslands can also serve as effective buffers between fragile prairie remnants and more intensively used agricultural or residential lands.

Management Opportunities, Needs, and Actions

- Dry Prairies ("driftless bluff," "dry lime," or "goat" prairies) are better represented here than in any other Wisconsin ecological landscape.
- Better protection for unprotected bluffs has been talked about for decades. Such protection needs to be implemented if the prairie and savanna remnants and their associated sensitive species are to be effectively conserved.
- Integrate bluff prairie management with management of adjoining savannas, woodlands, and forests. This is now occurring at places like Rush Creek State Natural Area in western Crawford County and at several locations along

This surrogate grassland occupies a ridge top and supports a number of sensitive nesting birds, including Henslow's Sparrow, Eastern Meadowlark, and Bobolink. Monroe County. Photo by Eric Epstein, Wisconsin DNR.

Extensive sand prairie grades into oak barrens and then dry oak forest. Numerous rare species depend on this and several similar sites. Fort McCoy Military Reservation, Monroe County. Photo by Eric Epstein, Wisconsin DNR.

the lower Wisconsin River. It could be done elsewhere, for example in the watershed of the lower Rush River in Pierce County where there are excellent examples of prairie, restorable oak savanna, oak forest, and floristically rich mesic forest.

- Sand Prairies and Oak Barrens are now rare features that occur mostly on the level to gently rolling terraces associated with the Mississippi, Wisconsin, Chippewa, and Black rivers. Wherever feasible, phasing out and removing the pine plantations on such sites would not only enlarge openings but would also create restoration opportunities and travel corridors between remnant patches.
- Irrespective of the presence or absence of prairie remnants, undeveloped terraces are highly threatened by uses such as residential development and the construction of new roads, which can create or extend permanent habitat breaks between the river floodplains and the adjoining bluffs.
- Important management opportunities for grassland vertebrates and invertebrates may be offered by remnant Sand Prairie and Oak Barrens communities bordering various types of surrogate grassland.
- Because of the widespread loss and continuing decline of Sand Prairie and Oak Barrens communities, surveys to locate and evaluate both remnants and the best restoration opportunities may still be worthwhile. The most intact and potentially viable examples should be brought into conservation management and, where feasible, connected with one another.
- Few tallgrass prairie remnants have persisted on the more mesic sites characterizing many of the broader ridge tops within the Western Coulees and Ridges. Intact remnant prairies, even when small and isolated, may still merit protection and management attention, but opportunities to embed these within surrogate grasslands such as CRP or lightly grazed pastures could greatly enhance the viability of these remnants and increase their capacity to support additional native grassland species that require more grassland area than the remnants alone can provide.

Geologic Features: Cliffs, Talus Slopes, and Caves

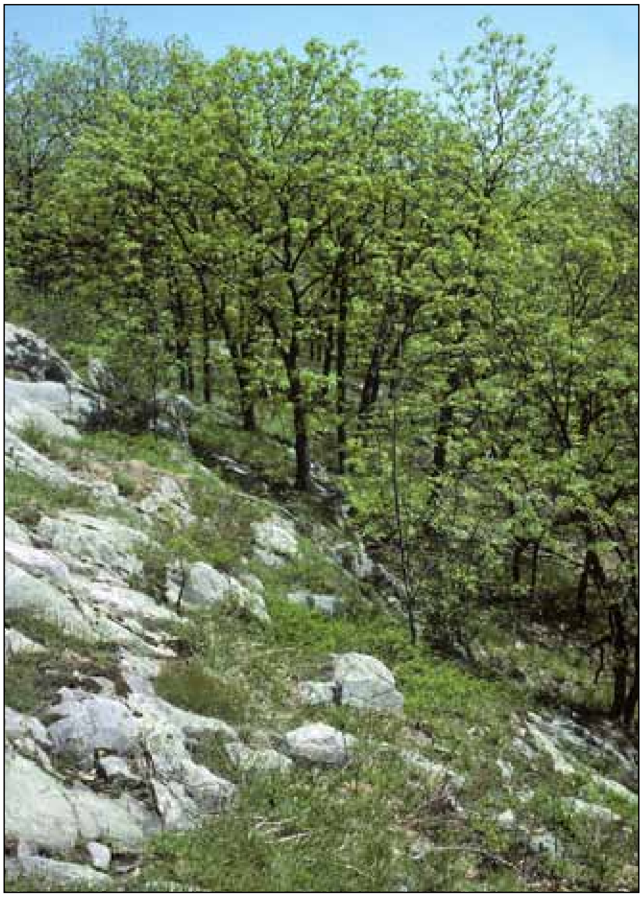
The Western Coulees and Ridges Ecological Landscape was not buried under recent glacial deposits as most of Wisconsin was. Erosion of the underlying bedrock has shaped the landforms and created dendritic drainage patterns. Cliffs are vertical exposures of the rock and are characteristic and locally common features of this ecological landscape. They provide habitat for many highly specialized plants and animals, some of them quite rare. Some bats and herptiles are dependent on caves, tunnels, and abandoned mines as roost sites and hibernacula. Ridge tops with shallow soils that have prevented or limited attempts at cultivation have sometimes served as refugia for species formerly associated with prairie or savanna habitats. Some of these have disappeared completely from areas characterized by intensive land use.

Talus slopes are prominent features in a few places, including the Baraboo Hills. Algific Talus Slopes are highly distinctive and ecologically significant geological features that occur in no other ecological landscape in Wisconsin. Globally, they are apparently unique to a few locations in the Driftless Area of Wisconsin, Iowa, and Minnesota. Algific Talus Slopes are very rare natural communities that, in turn, support numerous rare species. Some of these are known as ***periglacial relicts,*** and a subset of these species are now globally rare (Frest 1991). "Maderate cliffs" are related geological features that have been described in Minnesota but are not yet documented in Wisconsin. The Minnesota DNR's *Field Guide to the Native Communities of Minnesota: The Eastern Broadleaf Forest Province* (2005) provides useful descriptive information of such cliffs as well as the environmental settings in which they occur.

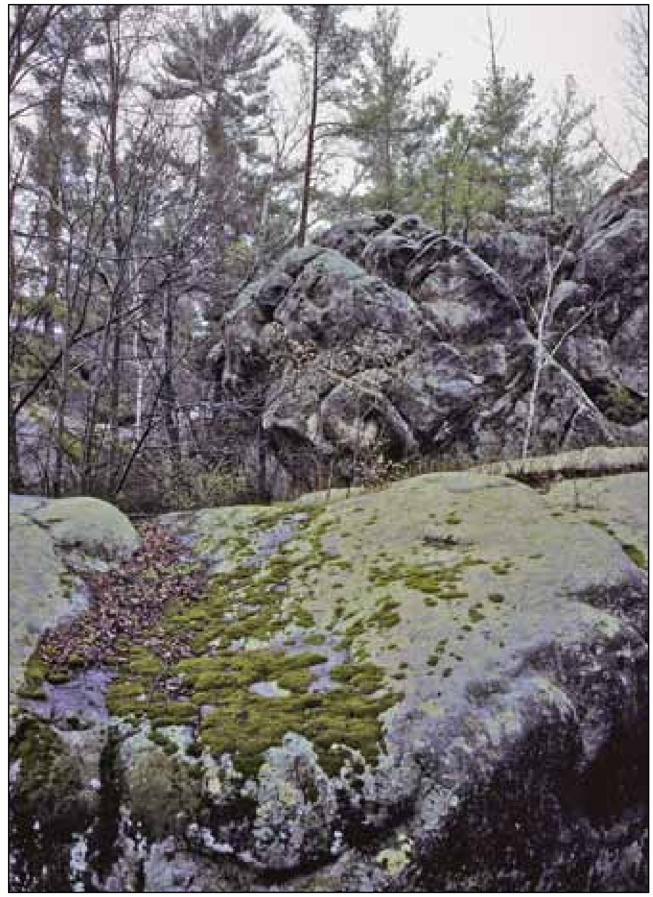
The majority of cliffs in the Western Coulees and Ridges are formed of relatively horizontal beds of sedimentary sandstones and dolomites of Paleozoic age (this is why, in some literature, the Driftless Area is referred to as the "Paleozoic Plateau"). At some locations, such as the Baraboo Hills, much older exposures of bedrock occur, and these are of quartzite and conglomerate.

Management Opportunities, Needs, and Actions

- Identify cliff habitats that support rare plants, provide hibernacula for herptiles and bats, and are used by nesting and roosting birds of conservation concern.
- Design biological surveys that will enable conservation planners, researchers, and resource managers to better characterize and evaluate cliffs and related surface bedrock features. This may require biologists with special skills (e.g., rappelling) and expertise with poorly known taxa, such as nonvascular plants and rock-dwelling invertebrates.



Bedrock Glade on the eastern limb of the Baraboo Range. Open areas with exposed bedrock grade into a sparse bur oak woodland. Columbia County. Photo by Eric Epstein, Wisconsin DNR.



Impressive talus slope, with thin canopy of eastern white pine. Grant County. Photo by Eric Epstein, Wisconsin DNR.

- Special surveys are needed to search for additional Algific Talus Slopes and to attempt to locate and identify maderate cliffs.
- Surveys of caves, tunnels, and abandoned mines are needed to document and assess use by bats and other fauna associated with subterranean habitats.
- Work with owners of caves, tunnels, and mines to protect sites of high ecological value, e.g., those used by hibernating bats and herptiles.
- Incorporate bedrock features into conservation plans that may have initially been designed to protect prairies or forests. At the very least, inclusion of such features will provide habitat for specialists that otherwise would not occur within some areas managed for conservation purposes.
- Bedrock features should be given consideration at the planning stage during forest management activities, especially if the cliffs or glades are known to harbor rare species with relatively high moisture requirements (terrestrial land snails and some of the rare plants mentioned in the "Flora" section are examples) or species that need structural features provided by living and dead trees.

Exposure of Paleozoic sandstones. Near Elroy, Juneau County. Photo by J.B. Meyer.

Large Warmwater Rivers, Complex Floodplains, and Terraces

The lower portions of several of Wisconsin's largest rivers flow through the Western Coulees and Ridges Ecological Landscape before joining the Mississippi. Many rare fish, mussels, and aquatic insects occur in these rivers, and some of these rare species are limited to the habitats provided primarily by large rivers. Important aquatic habitats include the main channels, areas with gravel, rubble, or bedrock bottom substrate, and the riverine (backwater) lakes. The riverine lakes tend to be less developed than lakes elsewhere in southern Wisconsin and are bordered by vegetation that buffers them from the habitat loss demonstrated in more developed riparian and lacustrine environments.

The large rivers often feature broad, complex floodplains, with extensive stands of Floodplain Forest and, less frequently, marshes, sedge meadows, wet prairies, and shrub swamps. Bird use of the floodplain habitats is heavy, and some of the characteristic birds, such as the Prothonotary Warbler are either quite rare and/or highly specialized. On the Wisconsin River, forests within the floodplain corridor are becoming more connected, less isolated, and include large contiguous forest patches. This is contrary to trends exhibited in forest areas elsewhere in the state, particularly in southern Wisconsin. See Turner et al. (2008) for a discussion of changes to the Wisconsin River floodplain since Euro-American settlement.

The uppermost terraces that parallel the floodplains are often intensively used for agricultural or silvicultural purposes. However, some terraces contain remnant Sand Prairie and Oak Barrens communities as well as important microhabitats such as sand blows. The river corridors are flanked by bluffs, which often support extensive hardwood forests. Cliffs are frequent, and Dry Prairies are locally common on steeper slopes with southern or western exposures. Many of the former prairie areas have been heavily invaded by eastern red-cedar (*Juniperus virginiana*), and historically open areas may now have the appearance of dense thickets of evergreens.

Maintaining or restoring good water quality in the hundreds of streams tributary to the major rivers is a key to protecting water quality and habitat values in the large rivers, including the extremely important riverine lakes in the backwaters. Some of the tributaries, such as the Kickapoo (which joins the Wisconsin near Wauzeka), have poor water quality, experience severe floods, and will require significant attention at the watershed scale if conditions are to improve or not deteriorate further. It is crucial to evaluate management projects in watersheds in the Western Coulees and Ridges Ecological Landscape, so the Wisconsin DNR should implement a long-term comprehensive wadeable stream monitoring program to detect changes that show improvement or decline in resources in these tributaries.

The lower reaches of the Black, Chippewa, and Wisconsin rivers each present important opportunities to restore and maintain large river ecosystems with complex floodplains.

Riverine lake and running slough within the Mississippi River floodplain. The large marsh is dominated by American lotus. Much of the floodplain is forested, and the adjoining terraces and bluffs support hardwood forests with scattered savanna and prairie fragments. A part of this site is now a conservation project led by the Mississippi Valley Conservancy and various partners. Grant County. Photo by Eric Epstein, Wisconsin DNR.

The partly open area just above the river in the photo's center is a remnant Sand Prairie-Oak Barrens complex, now surrounded by conifer plantations and cropland. Sites where the river floodplain and adjoining bluffs are still connected are very rare, as the level sandy terraces are often the locations of intensive development. Lower Wisconsin River. Photo by Cathy Bleser, Wisconsin DNR.

Each of these rivers supports rare fish, herptiles, mussels, and aquatic insects. These rivers represent some of the last strongholds for large river fishes (Marshall and Lyons 2008) and many mussels in the Upper Midwest. The complex floodplains contain exceptional stands of bottomland hardwoods, marsh, and at a few locations, lowland prairie and savanna (e.g., at Avoca (Iowa County) and at several sites on the lower Chippewa and Black rivers). These floodplain-associated habitats in turn support many rare species, including birds and mammals.

Though the major river corridors mentioned above share features with one another, each has its own complement of species, natural communities, and habitats. Even where these attributes are shared, they occur in varying proportions,

Lower Black River floodplain and Van Loon State Wildlife Area. La Crosse-Trempealeau counties. Photo by Wisconsin DNR staff.

have been subjected to somewhat different uses, and present different management challenges and opportunities. It is important to remember that all of the large river systems mentioned above were formerly linked, and that they constituted key parts of the Upper Mississippi River System. Conserving as much of the diversity formerly associated with the Upper Mississippi as possible will require the protection of and responsible management for as many components as possible, beginning with those tributary rivers and associated habitats that are most intact and functional. At a continental scale, comparable opportunities do not appear to exist.

Management Opportunities, Needs, and Actions

- A landscape approach is desirable to highlight the importance of managing and protecting not only lengthy river corridors but also watersheds. Effective conservation planning for river systems should encompass the entire river corridor and adjacent uplands to ensure that representative and rare communities and species are preserved somewhere. Once management has been planned for the entire corridor so that all species and community types will be preserved, breaking the area into smaller management units to accomplish specific objectives is feasible. Focusing on stand level management without first identifying and considering all of the resource needs in the area often leads to management that has a single benefit and the loss of other important resources and values. Breaking up the system into mini-management units (stand level management) should be considered last, rather than first, as is often the case. An exception is for features or species that might be lost unless they receive protection and management attention in the short-term.
- Identify critical habitats for sensitive species, especially area-sensitive animals and habitat specialists, that could be lost if their niches were damaged or destroyed. This should include aquatic habitats.
- Identify and plan to conserve large and small patch communities within and adjacent to river floodplains at scales appropriate to their abundance, ecological significance, and the needs of the species they support. This includes in-stream habitats, all plant communities within complex river floodplains, adjacent terraces above the floodplain, other significant upland habitats, and viable populations of sensitive species.
- Identify vegetation types and habitats associated with river corridors that are at greatest risk of loss and degradation. Examples include mussel beds, oxbow lakes and backwater sloughs, and rare plant communities such as oak barrens and sand prairies that occupy terraces between bluffs and floodplains. Dredge spoil islands, when sited and managed properly, can provide habitat for turtles and birds, and perhaps other species.
- The long, free-flowing stretches of the Wisconsin, Chippewa, and Black rivers support exceptionally diverse assemblages of fish, mussels, herptiles, and other aquatic organisms. Maintain free-flowing conditions, improve water quality, and identify needs and opportunities to construct fish passage structures at existing dam sites.
- Establish refuges for sensitive organisms, including nongame fish, herptiles, mussels, and other invertebrates.
- Long-term monitoring of the Mississippi River by the U.S. Geological Survey's Upper Midwest Environmental Sciences Center has identified many projects that state and federal agencies and industries need to undertake to restore the ecological health and beauty of the Mississippi River system For more information, see the Upper Midwest Environmental Sciences Center website (UMESC 2013).
- One of the primary needs is to alter management of the river's flow regime to more closely mimic the natural flows prior to dam construction that maintained both aquatic and floodplain plant and animal diversity and abundance over millennia. This also applies to the lower Wisconsin River. The need to restore more natural flow regimes should be further investigated for the Chippewa and Black rivers.
- Expand upon the success of water level lowering projects to many other pools on the Mississippi River to enable shallow-water aquatic plants to reestablish themselves. Devise ways to use high flows to maintain the effects of natural channel scour. Continue to design, coordinate, and implement plans for additional islands and shallow backwaters that support wild celery and other plants, which collectively benefit fish, herptiles, birds, and invertebrates.
- Carefully study the need for and potential impacts of additional proposed capacity expansion of the lock and dam system on the Mississippi River, especially in light of recent trends toward shipping more grain from West Coast ports to Asia, rather than down the Mississippi to Gulf area ports.

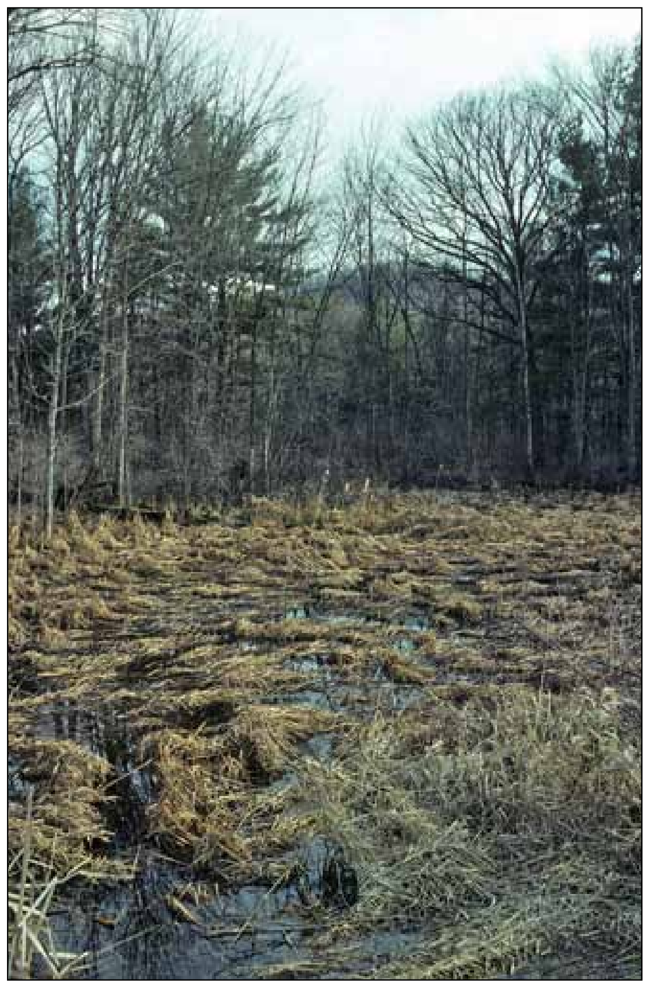
- Overall, improving conditions on the Mississippi River will also benefit the other major and minor rivers and streams tributary to it. Many organisms move between river systems in response to changing flow, temperature, and physical habit conditions.
- The Wisconsin DNR should work with county land conservation offices and the local National Resources Conservation Service (NRCS) office to obtain streambank buffers through the Conservation Reserve Environmental Program (CREP) on select streams throughout the watershed. In addition, the DNR's waters program should support restoration of wetlands and uplands in the headwaters of the tributary watersheds through projects such as the Western Prairie Habitat Restoration Area (WPHRA). The DNR should work with these county conservation offices and the local NRCS office to install ***best management practices*** (BMPs) that reduce flooding, upland soil erosion, and nutrient runoff, while improving infiltration of storm water from upland agricultural areas, factory farms, commercial and urban development areas. Such activities will help prevent sedimentation of waterways, protect and improve coldwater discharge, water quality, fish, and aquatic life.
- Impacts of groundwater withdrawals of floodplain lakes and sloughs adjacent to the rivers where irrigation-based agriculture is expanding on sand and gravel terraces (e.g., along stretches of the lower Wisconsin River) need additional study and assessment.
- Support opportunities to restore habitat along the lower Chippewa, Wisconsin, Black, and other large rivers. Such projects could consist of spot-treatment bank stabilization, boulder clusters, incorporating woody-debris and snags (long-term, this can and should be accomplished primarily via forest management), and, especially, the restoration of native shoreline plant communities.
- Water quality improvements are also needed on some rivers. Large industry is responsible for many point source discharges to the Wisconsin River. Although efforts in the past 20 years have resulted in better water quality, monitoring and study of the Wisconsin River and its tributaries is needed to determine the need for additional water quality improvements. Potential funding sources to protect water quality should be identified in consultation with partners. Continue to protect sensitive or critical ***shoreland*** habitats through easements or acquisition.

Cold and Cool Spring-Fed Streams

The porous sandstones of the Western Coulees and Ridges Ecological Landscape hold large amounts of water, which is released at many locations via springs and seepages. Headwaters and the upper reaches of streams will maintain constant flows of cold, clear, oxygenated water if they have not been seriously damaged or compromised by channelization, heavy grazing, the removal of forest or prairie cover, and excess sedimentation from row crop agriculture or construction activities.

Many of the more than 4,000 springs documented here contribute to the coldwater streams and their biota. These vital sources of groundwater discharge need to be protected from degradation, including loss of flow, increases in temperature, and contamination by excess nutrients and sediments. At this time, Wisconsin's groundwater protection law applies to only about 3% of springs statewide, so advocates of stream and groundwater protection will want to continue efforts to strengthen this law and make it more effective (Macholl 2007).

In recent years, a more integrated approach to trout stream management has provided increased benefits to nongame animals and streamside vegetation (Wisconsin Trout Unlimited 2011). This approach needs to be strongly encouraged and expanded among both public and private partners. Documentation of these benefits (to species, habitats, and



This undisturbed seepage marsh is bordered by alder, bur oak, and eastern white pine and provides important habitat for native plants, invertebrates, amphibians, reptiles, and birds. Vernon County. Photo by Eric Epstein, Wisconsin DNR.

expenditures) is an important follow-through item. Native streamside habitats of high value to some of these species as well as many others include lowland forest, alder thicket, sedge meadow, dense patches of scouring rush (*Equisteum* spp.) and brambles (*Rubus* spp.), wet prairie, emergent marsh, cliffs, vertical banks suitable for excavations by cavity nesters, and patches of exposed soil that provide nesting habitat for turtles.

Among the sensitive species associated with these streams are the Louisiana Waterthrush (forested areas), wood turtle (areas with dense shrub/herb cover), northern cricket frog, Bank Swallow (*Riparia riparia*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), and Belted Kingfisher (*Megaceryle alcyon*).

Management Opportunities, Needs, and Actions

- Where appropriate and feasible, design stream management and rehabilitation projects to benefit sensitive species and maintain or restore important native and surrogate habitats associated with coldwater and coolwater streams.
- Assess status of nontarget fish and aquatic invertebrate species; determine the need to manage assemblages of coldwater and coolwater species, rather than maximizing short-term benefits to sport fish exclusively. A landscape approach, rather than managing streams ***segment*** by segment, would be helpful here.
- Establish refuges to ensure that viable populations of nongame fish associated with these stream types are conserved in perpetuity and monitor populations of declining and/or vulnerable species.
- Encourage landowners to implement BMPs to maintain or improve water quality.

Small seepages and spring runs such as those pictured here are important sources of water for coldwater systems in the Western Coulees and Ridges. Such sites merit protection as they provide not only a reliable source of clean, cold, oxygenated water but also habitat for many native plants and animals. Moore's Creek, Monroe County. Photo by Eric Epstein, Wisconsin DNR.

- Incentives are needed to protect streambanks and keep livestock out of springs, seepages, and stream headwaters areas.
- Continue to provide input to local development plans, advocating for measures that minimize flow diversion, nutrient, and temperature impacts to coldwater streams.
- Work with county zoning officials, lake management districts, local communities, and other organizations to develop higher protection standards for resources that fall under the classification of Exceptional Resource Waters (ERW) or Outstanding Resource Waters (ORW).
- Evaluate impacts to water quality from nonmetallic mining through permit compliance monitoring.
- Assess trout habitat improvements and maintenance on state-owned and easement properties at local and landscape scales.
- Proper management of spring recharge areas is needed to effectively protect coldwater and coolwater streams. Monitor and develop management guidelines on land uses, such as groundwater withdrawal, grazing, and timber harvest, within the recharge areas of springs.
- Monitor success of groundwater withdrawal agreements to protect flows in impacted streams.
- Continue to monitor and assess consumptive uses and their impacts on groundwater, surface water, and aquatic life. Work with local communities and other partners to reduce or eliminate negative impacts. Encourage water conservation measures.
- Encourage landowners in priority watersheds to apply for nonpoint source grants to install pollution abatement techniques. Assess impacts of existing dams on waterways and ditches. Where negative impacts are occurring, encourage the removal of dams and oppose the construction of new dams. Give special attention to impaired waterbodies on the 303(d) list of impaired waters. Continue to encourage municipal water systems to practice water conservation measures and implement wellhead protection programs.
- Stream management by the Wisconsin DNR and others in parts of the Western Coulees and Ridges Ecological Landscape has successfully curbed erosion, lowered water temperature, and created a popular sport fishery, especially for the introduced brown trout.
- Assess the impacts of stocking nonnative brown trout on other native stream biota such as nongame fish and aquatic invertebrates.

The Mississippi Flyway

The Mississippi Flyway (the river and associated wetlands, terraces, and blufflands) is used by enormous numbers of migratory birds during the spring and fall of each year. The Upper Mississippi River Wildlife and Fish Refuge extends for a distance of over 260 miles along the Mississippi from the

Chippewa River downstream into Illinois at the mouth of the Rock River. See Green (1984) for a description and history of the "Great River Refuge."

The Trempealeau National Wildlife Refuge and a number of state properties have also been established to provide habitat for resident and migratory birds and to protect rare habitats and scenic beauty.

Important bird groups using the Mississippi Flyway include, but are not limited to, waterfowl, shorebirds, herons and egrets, gulls and terns, raptors, and passerines. The Mississippi River valley is an important migratory area from any birds (see image below).

Management Opportunities, Needs, and Actions

- Continue to document bird use: species, numbers, use of locations and specific habitats, timing, and activity. Process and analyze raw data, identify data gaps and important questions, make plans to address those gaps and answer those questions, and contact public and private partners.
- Identify critical habitats that are uncommon or declining or that are unavailable within existing conservation lands such as national wildlife refuges and state wildlife areas.
- Maintain and, where possible, increase connectivity between important habitats and identify future actions that would mitigate problems due to fragmented, isolated, or otherwise vulnerable habitats.
- Identify hazards. Communications towers, transmission lines, aerial cables, rights-of-way used to transport hazardous materials, wind turbines, and walls of glass are all existing or potential causes of significant bird mortality. Future installations of these structures should be sited with great care, and measures to effectively address existing problems will be needed in areas known to receive heavy use by birds and other vulnerable organisms (e.g., bats).
- Bluffs bordering the river corridor have been proposed as areas on which to site industrial wind power facilities. Impacts on birds, bats, other animals, and important habitats such as bluff prairies, cliffs, and hardwood forests need study if future problems are to be avoided. Retrofitting adequate safeguards will be difficult and expensive once such plants are up and running.
- Monitor key habitats and taxa at sites such as national wildlife refuges, state wildlife areas, and Important Bird Areas. Key habitats might include marshes, lowland forests, and wooded bluffs bordering the river.

*The Mississippi Flyway is used by enormous numbers of migrating birds, including waterfowl, waders, gulls, terns, shorebirds, raptors, and songbirds. Depicted here is a flock of Dunlins (*Calidris alpina*), a small shorebird that nests in the Arctic and winters on the Atlantic and Pacific coasts of the southern United States and Central America. Photo by Brian Collins.*

Active nest of the Wisconsin Threatened Red-shouldered Hawk in a large northern red oak. Photo by Rich Staffen, Wisconsin DNR.

Miscellaneous Opportunities to Protect Scattered Natural Communities, Selected Habitats, and Populations of Rare Species

Only about 3% of this ecological landscape is in public ownership, much of it associated with the larger rivers. Other agencies, NGOs, and private citizens will play major roles in achieving conservation goals, and overcoming jurisdictional boundaries will be one of the biggest challenges faced by governmental agencies.

The Western Coulees and Ridges supports more rare species (WDNR 2009) than any other ecological landscape in Wisconsin. Many (probably most) of these will occur within one the management opportunities discussed above. There will be exceptions. Isolated rare species populations need to be assessed on a case-by-case basis, considering factors such as state and global ranks, number of protected (not just existing) populations, adequacy of past survey efforts to determine status, and habitat viability. From a landscape perspective, some future project priorities to consider are listed below.

Management Opportunities, Needs, and Actions

- Identify and prioritize conservation values of lands in the interior of the Western Coulees and Ridges Ecological Landscape, for example, where there are opportunities to protect and manage characteristic and rare vegetation types, aquatic features, geologic features, rare species hotspots, and representative populations of native plants and animals.
- Identify appropriate organizations or individuals to lead high priority conservation projects.
- Protection of undeveloped terraces between river floodplains and forested bluffs is badly needed. The highest priorities would be for sites that connect natural communities, that connect conservation properties along major rivers, and that contain remnant Sand Prairie or Oak Barrens communities. Surrogate grassland habitats can also have high conservation value for some taxa.

Nodding pogonia is a rare though easily overlooked orchid that occurs sporadically in southwestern Wisconsin where its preferred habitat is moist upland forest. Photo by Thomas Meyer, Wisconsin DNR.

- The corridor of the Black River from Jackson County down to Lake Onalaska (La Crosse County) and the confluence with the Mississippi River is relatively undeveloped and offers an excellent opportunity to protect a major river, extensive river floodplain, terrace prairies and barrens, sandstone cliffs with relict pine stands, and extensive forests of oak, maple, and other hardwoods. The river runs free from the Black River State Forest just south of Black River Falls all the way to the Mississippi at Van Loon State Wildlife Area, a distance of roughly 55 miles. Most of the land between the Black River State Forest and Van Loon is private, the major exception being the state wildlife area near North Bend.
- Other opportunities to protect stream corridors may be associated with the middle Kickapoo, Buffalo, Rush, and Trempealeau rivers, among others.
- Protect sites containing viable high-quality examples of natural communities that are not well represented in the State Natural Area system. An example would be the floristically rich hardwood forests (Southern Mesic Forest) that cover the steep east-facing bluffs along the lower Rush River in Pierce County. Such sites might be especially appropriate for local NGOs with mission statements that are compatible with this type of forest protection.
- Sites that contain outstanding examples (formerly called "exemplary stands" within state heritage programs) of natural communities characteristic of this ecological landscape are high priorities for protection.
- Sites that support viable populations of rare species are potentially high protection priorities.
- Lands that increase the effective area of sites known to support area-sensitive species are priorities for some projects, especially where they can help meet multiple ecological objectives.
- Lands that increase the ability to manage existing conservation lands (e.g., by increasing connectivity, adding important microhabitats, or reducing edge) would potentially be high priority conservation projects.
- Better soil and water management is still needed in parts of the Western Coulees and Ridges Ecological Landscape, such as the Kickapoo River watershed. This would complement many socioeconomic and conservation goals, such as protection of wetlands and other floodplain habitats, reduction of property damage, and improvement of water quality. Severe floods in the Kickapoo River watershed in recent years may have created opportunities for additional protection of floodplain and flood-prone habitats. There is more widespread recognition that functional floodplains mitigate floods and provide important fish and wildlife habitat, while reducing damage to crops, structures, roads, and water quality.

Figure 22.18. *Western Coulees and Ridges counties.*

Socioeconomic Characteristics

Socioeconomic information is summarized within county boundaries that approximate ecological landscapes unless specifically noted as being based on other factors. Economic data are available only on a political unit basis, generally with counties as the smallest unit. Demographic data are presented on a county approximation basis as well since they are often closely associated with economic data. The multi-county area used for the approximation of the Western Coulees and Ridges Ecological Landscape is called the Western Coulees and Ridges counties (Figure 22.18). The counties included in this socioeconomic region are Buffalo, Crawford, Dunn, Eau Claire, Grant, Iowa, Jackson, La Crosse, Monroe, Pepin, Pierce, Richland, Sauk, Trempealeau, and Vernon counties because at least 25% of each county lies within the ecological landscape boundary.

History of Human Settlement and Resource Use

American Indian Settlement

The Western Coulees and Ridges Ecological Landscape has long been inhabited by native peoples and is home to some of the most interesting archaeological sites in Wisconsin. Silver Mound in Jackson County is a quarry site, well known for orthoquartzite (Hixton silicified sandstone) that was used extensively in making the fluted points that help define the Paleo-Indian tradition as early as 11,000 years ago (Mason 1997). Points made with Silver Mound orthoquartzite have been found not only all over Wisconsin and the Upper Midwest, Ontario, and in the Dakotas but also as far south as Mammoth Cave, Kentucky (MVAC 2013). Orthoquartzite from Silver Mound was used to make a variety of stone tools all the way into the historical period, although the heaviest use was during the Paleo-Indian and Woodland Traditions (Behm 1997). A related Paleo-Indian site was discovered near Boaz in Richland County in 1897 when farm boys stumbled across a mastodon skeleton in an eroding stream bank, along with an associated fluted point made from Silver Mound orthoquartzite (Mason 1997). This was the best evidence for human hunting of Pleistocene elephants until the late 1980s or early 1990s when several sites in Kenosha County were excavated, showing solid evidence of this activity. The Boaz mastodon skeleton now resides in the geology museum at the University of Wisconsin-Madison.

The terrain of the Western Coulees and Ridges contains many natural rock shelters that have been used since at least the Archaic Tradition, approximately 10,000 years ago (Stoltman 1997). The Raddatz Rockshelter in Sauk County located within Natural Bridge State Park is an important example of the use of rockshelters by early inhabitants. The earliest deposits date to between 9,000 and 8,000 years ago, and extend through the Archaic period (Theler and Boszhardt 2003). There is clear evidence of white-tailed deer and elk hunting and butchering at this site, with the condition of the bones indicating that middle archaic peoples relied heavily on deer in the fall and winter months (Theler and Boszhardt 2003). Other rockshelters in this ecological landscape, occupied during the archaic period and later, include Governor Dodge (Iowa County), Durst (Sauk County), and Brogley (Grant County), to name a few.

With the advent of agriculture, a diagnostic factor of the Woodland Tradition, native peoples used rock shelters less and began to have more semi-permanent habitations often closely associated with the rivers systems of the Driftless Area. There are many sites in the Western Coulees and Ridges that exhibit Woodland Tradition characteristics. One important Woodland site is the Tillmont site (Crawford County), occurring on Island 166 in the Mississippi River just north of Prairie du Chien. The stratigraphy of the site was intact because the island had never been plowed, and sediments left by river floods created layers protecting the successive occupations. Tillmont's earliest occupations date to the late Archaic, but its most extensive occupation was in the Middle Woodland period. A wealth of ceramic, stone, and bone artifacts were found there, as was a mass grave or crypt that is unique in Wisconsin. At least 29 individuals were buried there, with indications that this was not a one-time burial but was used over and over during this occupation. Crypts like this are not unknown in the Mississippi valley but are most often associated with a mound, which is not the case at Tillmont (Stoltman 2005).

Mound building is also associated with the Woodland Tradition, starting initially as conical mounds, progressing to linear mounds, and by the Late Woodland, into effigy mounds shaped like birds, mammals, fanciful creatures, and people.

Many mound groups have been found in and along the river valleys of the Western Coulees and Ridges Ecological Landscape, often at high points with panoramic vistas.

Platform mounds associated with the Mississippian Tradition have also been found in the Western Coulees and Ridges Ecological Landscape. The Mississippian Tradition has clear cultural association with Cahokia, the large city-state located in southern Illinois, which reached its heyday from approximately 1000 AD until 1200 AD. A notable example of platform mounds in the Western Coulees and Ridges is a group of three mounds on a bluff overlooking the modern Village of Trempealeau (Trempealeau County) (Green 1997). Perhaps the best evidence in Wisconsin of the association with Mississippian culture outside of Aztalan (in the Southeast Glacial Plains Ecological Landscape) is at the Fred Edwards site in Grant County (Finney and Stoltman 1991).

Rock art in the form of petroglyphs, or carved figures in a rock face, and pictographs, figures painted on rock faces, are common throughout the Western Coulees and Ridges. Due to the amount of exposed rock and the numbers of prehistoric peoples in this area, the Western Coulees and Ridges have the most and best examples of rock art in the state. It is difficult to date rock art with certainty, and in many cases to connect rock art with a specific tradition. Much of the rock art has been damaged or destroyed, but a few notable extant examples include Roche a Cri State Park (Adams County), Gottshcall Rockshelter (Iowa County), and Tainter Cave (Crawford County) (Theler and Boszhardt 2003).

While there are currently no significant tribal lands or American Indian populations in the Western Coulees and Ridges, a wide variety of tribes inhabited this region during the turbulent 17th century including the Ho-Chunk, Kickapoo, and Huron (Wyandot). The Iroquois Wars of this era made Wisconsin home to many on their journey further west.

Historically, the Ho-Chunk people made their home in this region. The Ho-Chunk were at Green Bay in the mid-1600s but had gradually moved inland to Lake Winnebago by 1700 A.D. They also inhabited villages in western Wisconsin. This tribe gradually rebuilt their economy through the fur trade of the 1600s (The Wisconsin Cartographer's Guild 1998). Today the Ho-Chunk Nation owns lands in Vernon County between Wildcat Mountain State Park and up to and including parts of the Kickapoo Valley Reserve. For more information on Ho-Chunk Indians, see "History of Human Settlement and Resource Use" in Chapter 2, "Assessment of Current Conditions."

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 the American Indian tribes, trading posts, missions, and forts along river routes and lakes were established. During the 1800s, however, the tribes began ceding large areas of land to the U.S. government, and permanent Euro-American settlement began in earnest.

Croatian, Slovene, French, Italian, Latvian and Polish immigrants settled in small groups in this region of the state. Norwegians proved to be the most populous group, however, with over 44,000 settlers in Wisconsin by 1860 (The Wisconsin Cartographer's Guild 1998). Norwegian settlers typically lived in one-room huts and hunted very little, preferring to spend more time and energy farming. In 1850, this region of the state had only 2,813 farms, but by 1890, this number had swelled to 44,074 (ICPSR 2007).

Early Agriculture

Permanent Euro-American settlement began in Western Coulees and Ridges counties well before 1850, when the first agriculture census data became available. Several Western Coulees and Ridges counties were among the first established in the state. Crawford County was founded in 1818, Iowa County in 1829, Grant County in 1836, and Richland County in 1842 (NACO 2010). By 1860 all 15 Western Coulees and Ridges counties were settled. Agriculture has been a prominent component of local economies in Western Coulees and Ridges counties since their inception. In 1850, there were only 1,312 established farms in Western Coulees and Ridges counties, mostly in Grant and Iowa counties. A decade later, the number of farms in Western Coulees and Ridges counties had greatly expanded, totaling 12,583 farms. The number of farms in Western Coulees and Ridges counties reached its maximum in 1900, with 42,871 farms. This was a quarter of all farms statewide. Meanwhile, population had reached 377,149. Farm numbers gradually declined after the turn of the century, as some smaller, marginal farms were driven out of production or incorporated into larger farms (Figure 22.19) (ICPSR 2007).

Farms in Western Coulees and Ridges counties tended to have larger acreages than farms in the state as a whole. In 1950, the average Western Coulees and Ridges county farm was 163.5 acres in size, as compared to 137.8 acres statewide. Following World War II, a combination of the failure of many smaller marginal farms, subsequent consolidation, and mechanization increased the average size of farms in Western Coulees and Ridges counties, much as it did in the state as a whole (Figure 22.20). That trend continued throughout much of the remaining 20th century.

Total value of all crops indicates the extreme influence of the Great Depression on agriculture. In 1910, all crops harvested in Western Coulees and Ridges counties had an estimated total value of $34.0 million, which had tripled by 1920 ($102.9 million) (ICPSR 2007). However, total value of all crops in Western Coulees and Ridges counties plummeted in 1930 ($49.5 million) and fell further in 1940 ($35.7 million). Western Coulees and Ridges counties are generally agricultural but include many marginal farms with relatively low productivity. Total values of crops in Western Coulees and Ridges counties comprised 21.3% of total crop value in the state in 1940, but these crops came from farms comprising 25.9% of all Wisconsin farm acreage.

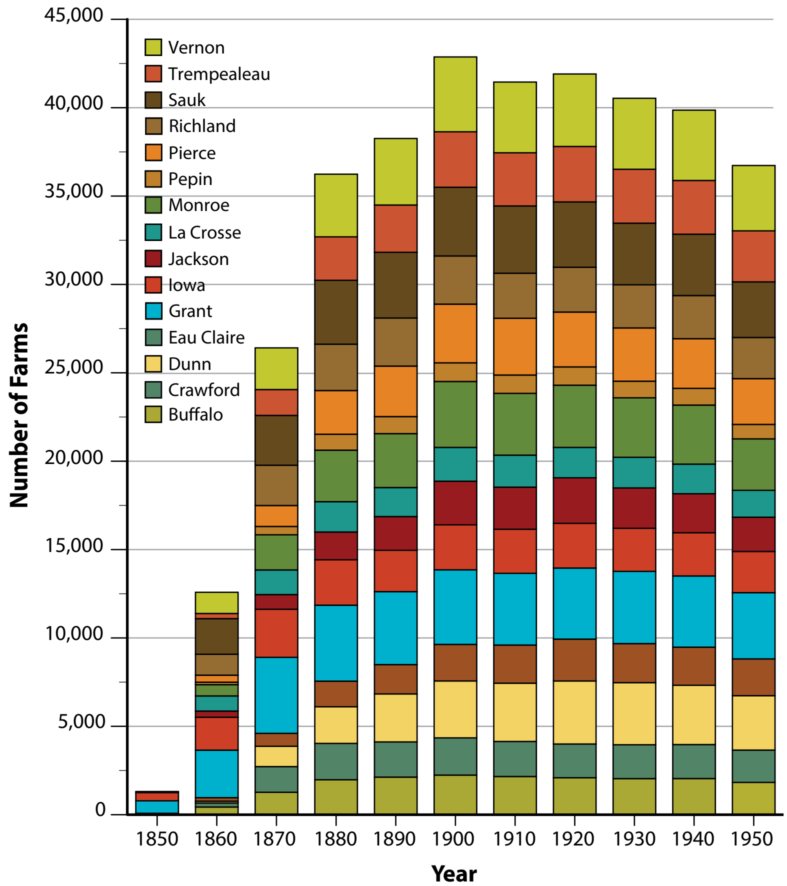


Figure 22.19. *Number of farms in the Western Coulees and Ridges counties between 1850 and 1950 (ICPSR 2007).*

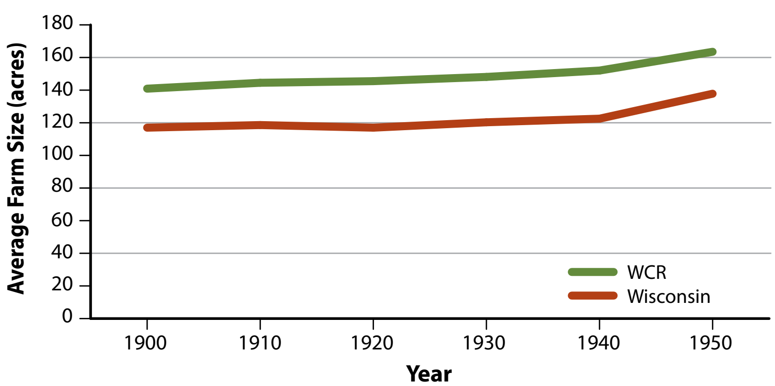


Figure 22.20. *Average farm size in Western Coulees and Ridges counties between 1900 and 1950 (ICPSR 2007).*

Over the early part of the 20th century, the type of farming underwent some fundamental shifts as Wisconsin became a national leader in the newly established dairy industry. As farms matured, they increasingly grew hay and forage crops and fewer cereal crops. Nevertheless, cereal crops remained a greater proportion of crop value in Western Coulees and Ridges counties than in the state as a whole. The 1910 federal agricultural census listed "cereals" as 54.5% of the total value of all crops harvested in Western Coulees and Ridges counties, but cereals comprised as little as 39.9% of total crop values in 1930, recovering to 42.1% by 1940 (ICPSR 2007). Hay and forage, associated with livestock farming, was only 26.9% of total value of crops harvested in Western Coulees and Ridges counties in 1910, but had risen to 40.9% of total crop value by 1940.

Early Mining

The French began mining this area for lead in particular 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 the region once the French had left the area, but by the early 1800s, the region had become one of the world's leading mining centers, and the Euro-American population of the area virtually exploded overnight.

Lead, 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 iron, lead, and later zinc occurred in this region of the state, 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 (e.g., Driftless Area), usually deposited in crevices and bedding planes of a Paleozoic dolomite which was 100 to 275 feet thick (Ostergren and Vale 1997).

Despite a sudden lead mining depression from 1829 to 1831 because of the increased production from the new Fever (Galena) River lead district, by the 1840s this region was producing more than 23,000 tons of lead each year (Ostergren and Vale 1997). The market demand for lead paint, bullets, pipes, lead sheeting, and printer's type, among others, created a booming local economy.

Early Transportation and Access

In the early 19th century, an extensive network of American Indian trails existed throughout the territory. These trails were widened into roads suitable for ox carts and wagons to accommodate the rapid growth in Euro-American 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. By 1870, however, the importance of railroads had caused these relatively primitive roadways to become of secondary value.

Among the first railroad lines to reach the Western Coulees and Ridges area of the state was the La Crosse and Milwaukee, reaching La Crosse in 1858 (Austin 1948). Another line stretched from Milwaukee to Prairie du Chien on the Mississippi and the Baraboo Air Line connected Madison with Lodi, Baraboo, Elroy, and La Crosse.

Early Logging Era

Sawmills were first built along rivers in areas containing large stands of timber. Where the river made it difficult to float logs, lumbermen built mills as close to the cutting area as possible, while on easier rivers, sawmills were generally more centralized (Ostergren and Vale 1997). Wisconsin also had the advantage of an extensive network of waterways flowing south from the northern timber region and several major rivers carried logs through the Western Coulees and Ridges. Wisconsin lumber production reached its peak at more than 4 billion ***board feet*** in 1892 (The Wisconsin Cartographer's Guild 1998). Sawmills caused towns to spring up all over the state. The more prominent mills in the Western Coulees and Ridges area of the state were located in Eau Claire, La Crosse, and Menomonie and utilized mainly southern Wisconsin hardwood forest and oak savanna stands of timber.

Roth (1898) surveyed forest conditions in some of the northern Wisconsin counties at the close of the 19th century, including Dunn and Jackson counties (the other counties in the Western Coulees and Ridges were not included in the survey). Roth reported that nearly all of the pine in Dunn County had been cut, with scattered remaining patchy stands amounting to only several million feet. Much of the hardwood forest had been culled or even cut clean as well, leaving isolated tracts yielding about 4,000 board feet per acre, with total volume estimated at 400 million board feet. Oak comprised a quarter, while maple and basswood made up another half of all hardwoods harvested. Northeastern Dunn County was covered in jack pine interspersed with "bare waste land," and the swamps were unproductive (Roth 1898). By comparison, today there are 82 million board feet of pine and 611 million board feet of hardwood sawtimber in Dunn County forests (USFS 2009).

After considerable production of pine during the Cutover, Jackson County had only an estimated 100 million board feet of pine timber at the time of Roth's writing. The remaining bare expanses were beginning to regenerate in pine saplings and jack pine in the wake of repeated fires. Oak openings dominated the western half of Jackson County, but quality hardwoods only existed on patches of heavier soils and were not a component of the county's eastern pine and swamp forests. Jackson County swamps had formerly been stocked with tamarack and other wetland species but were decimated by the extensive fires (Roth 1898). By comparison, today there are 462 million board feet of pine and 504 million board feet of hardwood sawtimber in Jackson County forests (USFS 2009).

Resource Characterization and Use[2]

The Western Coulees and Ridges Ecological Landscape is the largest ecological landscape in Wisconsin, with almost 9,400 square miles of land and 242 square miles of water. Its population of over one million people is third highest in the state, and the population density is fairly high, at about 105 people per square mile. The Western Coulees and Ridges Ecological Landscape ranks fourth in terms of surface area in water with the highest percentage of this water, 66% in rivers.

In terms of current and potential recreational use, there is less public land in the Western Coulees and Ridges Ecological Landscape compared to the rest of Wisconsin. Both the number of Land Legacy sites as well as the number of Land Legacy sites with significant recreation potential are second highest of any ecological landscape.

Agriculture is very important to the economy of the Western Coulees and Ridges Ecological Landscape. It ranks third among ecological landscapes in terms of the percentage of land area in agriculture but has a slightly below average income per farmed acre. Both total corn and milk production are among the highest in the state.

The forest products industry, on the other hand, is not as important to the economy. The Western Coulees and Ridges Ecological Landscape ranks near the bottom statewide in terms of the percentage of land in forests and below average in timber volume per acre. However, the percentage of total timber volume that is harvested in this ecological landscape ranks second in the state.

Although it has a high population, the density of roads and railroads in the Western Coulees and Ridges Ecological Landscape are below average. It ranks near the top for the number of airports, 20, and has two major river ports.

The population of the Western Coulees and Ridges Ecological Landscape uses a significant amount of energy. This region is also a major producer of energy, ranking third in hydroelectric generation and woody biomass production. This ecological landscape produces 19% of total hydroelectric generation and 12% of total woody biomass production in the state. There are two wind farms in the ecological landscape (in Iowa and Monroe counties), and there are others being proposed.

The Land

Of the 6.17 million acres of land that make up the Western Coulees and Ridges Ecological Landscape, 42% is forested. About 91% of all forested land is privately owned while 6.6% belongs to the state, counties, or municipalities, and 2.6% is federal land (USFS 2009).

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[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."

Minerals

Of the 15 Western Coulees and Ridges counties, only five have full disclosure of mining revenues. Seven counties are currently engaged in some type of mineral extraction. Grant County is involved in the production of nonmetallic minerals. In 2007, there were 32 mining establishments in the Western Coulees and Ridges counties (WDWD 2009).

Frac sand mining is increasing dramatically in the Western Coulees and Ridges Ecological Landscape due to the increased use in oil and gas extraction. As of October 2013, there were 141 frac mine facilities in the state, with the majority of them being in the Western Coulees and Ridges (WCIJ 2013).

Water (Ground and Surface)

Water Supply

The data in this section are based on the Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2015b), which are the same as the data reported in the "Hydrology" section of this chapter; however, the data are categorized differently here so the numbers will differ slightly. Of the 6.17 million acres that make up the Western Coulees and Ridges Ecological Landscape, there are almost 155,000 acres (2.6%) of surface water. There are over 2,514 lakes and reservoirs that are at least one acre in size, totaling almost 53,000 acres or 33% of total surface water. Of the nine lakes that cover over 1,000 acres in size, the largest are Long Lake, Wigwam Slough and several other parts of the Mississippi River, Tainter Lake and Lake Menomin on the Red Cedar River, North Lake, and Cedar Lake. There are 1,385 dams that impound over 180,439 acres of water.

Water Use

Each day, 1.2 billion gallons of ground and surface water are withdrawn in the 15 Western Coulees and Ridges counties (Table 22.3). About 87% of the withdrawals are from surface water. Of the 610,395 people that reside in these counties, 58% are served by public water sources and 42% are served by ***private wells*** (USGS 2010a). Buffalo County accounts for 44% of all water usage. Grant and Vernon counties account for another 40%, with the other 12 counties using the remaining 16%. The majority of withdrawals, 86%, are used for thermoelectric once-through power generation, with Buffalo, Dunn and Vernon counties using 96% of this.

Recreation

Recreation Resources

Land use patterns partly determine the type of recreation available to the public. For instance, in the Western Coulees and Ridges Ecological Landscape, there is a higher percentage of agricultural and grass land and a lower proportion of wetland compared to the rest of the state (see the "WISCLAND Land Cover of the Western Coulees and Ridges Ecological Landscape" map in Appendix 22.K). The surface area in water is about average, but the proportion of that water in rivers as opposed to lakes is the highest in the state (Wisconsin DNR unpublished data).There is less public land in the Western Coulees and Ridges Ecological Landscape compared to other ecological landscapes. Although the density of both campgrounds and multi-purpose trails is second lowest (out of 16 ecological landscapes), the number of visitors to state properties in 2004 was second highest (WDNR 2006b). Acreage in state natural areas is the highest in the state.

Table 22.3. *Water use (millions of gallons/day) in the Western Coulees and Ridges counties.*

County	Ground-water	Surface Water	Public Supply	Domestic[a]	Agriculture[b]	Irrigation	Industrial	Mining	Thermo-electric	Total
Buffalo	5.5	532.8	0.5	0.4	1.4	2.3	0.4	–	533.0	538.2
Crawford	3.3	0.4	1.7	0.5	0.7	0.3	0.4	0.1	–	3.7
Dunn	31.4	0.5	2.3	1.0	1.7	26.0	0.9	0.0	–	31.9
Eau Claire	15.5	3.4	10.3	1.4	0.7	3.0	3.3	0.2	–	18.9
Grant	7.8	256.6	3.2	0.8	3.4	0.4	0.3	0.3	256.0	264.4
Iowa	10.1	0.4	1.3	0.5	1.7	6.8	0.2	0.0	–	10.5
Jackson	7.3	0.2	1.0	0.5	0.8	4.6	0.1	0.4	–	7.5
La Crosse	26.6	43.3	15.7	2.2	2.3	0.6	4.6	1.8	43.0	69.9
Monroe	9.8	0.5	2.6	1.1	1.6	3.8	0.7	0.4	–	10.3
Pepin	1.7	1.4	0.4	0.3	0.5	0.6	1.3	–	–	3.0
Pierce	4.6	0.3	1.9	0.7	1.1	0.3	0.7	0.3	–	4.9
Richland	4.4	1.1	1.2	0.6	0.9	2.5	0.3	0.1	–	5.5
Sauk	13.9	3.7	4.5	2.2	3.5	4.4	1.1	1.1	1.0	17.7
Trempealeau	10.9	0.4	2.6	0.7	1.6	6.0	0.2	0.2	–	11.3
Vernon	4.9	210.3	1.1	0.8	3.0	0.3	0.0	0.0	210.0	215.2
Total	**157.6**	**1,055.0**	**50.3**	**13.7**	**25.0**	**61.8**	**14.6**	**4.7**	**1,042.5**	**1,212.6**
Percent of total	**13%**	**87%**	**4%**	**1%**	**2%**	**5%**	**1%**	**0%**	**86%**	

Source: Based on 2005 data from the U.S. Geological survey on water uses in Wisconsin counties (USGS 2010a).

[a]Domestic self-supply wells.

[b]Includes aquaculture and water for livestock.

Supply

Land and Water. The Western Coulees and Ridges Ecological Landscape accounts for 17.4% of Wisconsin's total land area but only 12.5% of the state's acreage in water (see Chapter 3, "Comparison of Ecological Landscapes," for comparison of ecological landscape sizes). There are 2.5 million acres of ***forestland*** in the Western Coulees and Ridges Ecological Landscape, 15.5% of the total acreage in the state (USFS 2009). Streams and rivers account for 65% of the surface water area of the Western Coulees and Ridges Ecological Landscape, and lakes and reservoirs make up 34% of the area (WDNR 2015b). The largest rivers are the Mississippi, Wisconsin, Chippewa, and Black. The largest lakes are Long Lake, Wigwam Slough, and several backwater reservoirs on the Mississippi River.

Public Lands. Public access to recreational lands is vital to all types of recreational activity. In the Western Coulees and Ridges Ecological Landscape, about 465,000 acres, or 7.5% of all land and water, is publicly owned (WDNR 2005a). This is far less than the statewide average of 19.9% public ownership.

State-owned facilities are especially important to recreation in the Western Coulees and Ridges. There are approximately 5,500 acres of state forest (Coulee Experimental State Forest and the Black River State Forest), 26,000 acres in parks and recreation areas, and 117,830 acres managed for wildlife and fisheries (WDNR 2005a). The largest state parks are Governor Dodge State Park with 5,456 acres and Wyalusing State Park with 2,214 acres. In addition, there are 7,500 acres of state trails, including the Elroy-Sparta, Buffalo River, Red Cedar, 400 State Trail, La Crosse River and Chippewa River trails, and 44,400 acres of wild rivers, mainly the Lower Wisconsin State Riverway. The Western Coulees and Ridges also contains 46,027 acres of state natural areas.

Trails. Although the Western Coulees and Ridges counties have over 4,000 miles of recreational trails (Table 22.4), they rank 15th (out of 16 ecological landscapes) in terms of trail density (miles of trail per 100 square miles of land). Compared to the rest of the state, there is a lower density of all trail types (Wisconsin DNR unpublished data).

Land Legacy Sites. The Land Legacy project has identified over 300 places of significant ecological and recreational importance in Wisconsin, and 37 are either partially or totally located within the Western Coulees and Ridges Ecological Landscape (WDNR 2006c). Five of them, the Baraboo Hills, the Kickapoo River, the lower Wisconsin River, the Upper Mississippi River National Fish and Wildlife Refuge, and Wyalusing State Park, are rated as having both the highest recreation and conservation significance. In addition, Black Earth Creek has the highest rating for recreation significance. Six other sites, the Black River, the Cassville to Bagley Bluffs, Ft. McCoy, the Lower Chippewa River and Prairies, Rush Creek, and Spring Green Prairie are rated as having the highest conservation potential.

Campgrounds. There are 204 public and privately owned campgrounds that provide about 15,100 campsites in the Western Coulees and Ridges counties (Wisconsin DNR unpublished data). With 11% of the state's campgrounds, this ecological landscape ranks third (out of 16 ecological landscapes) in the number of campgrounds but 15th in campground density (campgrounds per square mile of land).

State Natural Areas. The Western Coulees and Ridges Ecological Landscape has about 46,027 acres of state natural areas, of which 77% is publicly owned (including government and educational institutions), 20% is owned by private interests (including nongovernmental organizations, or NGOs) and 3% is owned by joint public-private entities (Wisconsin DNR unpublished data). The largest state natural areas in this ecological landscape include Baxter's Hollow (4,131 acres, Sauk County), Kickapoo Valley Reserve (3,680 acres, Vernon County), the Nelson-Trevino Bottoms (3,608 acres, Buffalo County), South Bluff/Devil's Nose (3,459 acres, Sauk County), and Rush Creek (2,691 acres, Crawford County). For more information regarding state natural areas, see the Wisconsin DNR's state natural areas web page (WDNR 2015e).

Demand

Visitors to State Lands. In 2006, there were an estimated 2.2 million visitors to state recreation areas and parks in the Western Coulees and Ridges Ecological Landscape (Wisconsin DNR unpublished data). The vast majority visited the state parks, especially Devil's Lake, Governor Dodge, Perrot and Wildcat Mountain State Parks.

Table 22.4. *Miles of trails and trail density in the Western Coulees and Ridges counties compared to the whole state.*

Trail type	Western Coulees and Ridges (miles)	Western Coulees and Ridges (miles/100 mi^2)	Wisconsin (miles/100 mi^2)
Hiking	178	1.5	2.8
Road biking	397	3.3	4.8
Mountain biking	180	1.5	1.9
ATV: summer and winter	164	1.4	9.3
Cross-country skiing	452	3.8	7.2
Snowmobile	2,806	23.5	31.2

Source: Wisconsin DNR unpublished data.

Fishing and Hunting License Sales. Of all license sales, the highest revenue producers for the Western Coulees and Ridges counties were resident hunting licenses (49% of total sales), resident fishing licenses (28% of total sales), and nonresident fishing (6% of total sales) (Wisconsin DNR unpublished data). Table 22.5 shows a breakdown of various licenses sold in the Western Coulees and Ridges counties in 2007. La Crosse County accounts for both the highest number of licenses sold and the highest revenue from sales, followed by Sauk and Eau Claire counties. This ecological landscape accounts for about 11% of total license sales in the state. However, persons buying licenses in the Western Coulees and Ridges counties may travel to other parts of the state to use them.

Metropolitan Versus Nonmetropolitan Recreation Counties. A research study (Johnson and Beale 2002) classified Wisconsin counties according to their dominant characteristics. One classification is "nonmetro recreation county." This type of county is characterized by high levels of tourism, recreation, entertainment, and seasonal housing. Sauk County is the only Western Coulees and Ridges county that is categorized as a nonmetro recreation county.

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 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. Many ATV riders feel there is a distinct lack of ATV trails and are looking primarily to public lands for places to expand their riding opportunities.

Timber Harvesting. A high percentage of state residents are concerned about timber harvesting in areas where they recreate (WDNR 2006b). Their greatest concern is large-scale visual changes (i.e., large openings) in the forest landscape. Forest thinning and harvesting that create 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.

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

Table 22.5. *Fishing and hunting licenses and stamps sold in the Western Coulees and Ridges counties.*

County	Resident fishing	Nonresident fishing	Misc. fishing	Resident hunting	Nonresident hunting	Stamps	Total
Buffalo	3,030	890	92	6,037	797	1,777	12,623
Crawford	5,612	2,789	106	8,267	596	2,399	19,769
Dunn	8,852	1,004	288	15,834	567	5,045	31,590
Eau Claire	16,648	1,773	707	28,742	613	7,613	56,096
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
Jackson	4,642	823	157	9,789	357	2,791	18,559
La Crosse	19,985	2,698	465	32,144	1,070	9,963	66,325
Monroe	8,475	952	275	17,265	394	5,456	32,817
Pepin	2,136	312	145	4,467	189	1,070	8,319
Pierce	5,084	1,860	225	9,401	720	5,025	22,315
Richland	3,745	317	140	7,625	241	2,264	14,332
Sauk	16,261	9,206	694	22,768	480	7,451	56,860
Trempealeau	4,905	391	99	11,264	307	3,328	20,294
Vernon	4,191	1,039	72	8,604	225	3,135	17,266
Total	**116,072**	**25,825**	**3,883**	**203,443**	**7,107**	**62,974**	**419,304**
Sales	**$2,633,158**	**$999,000**	**$80,847**	**$5,430,421**	**$1,041,633**	**$503,330**	**$10,688,389**

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

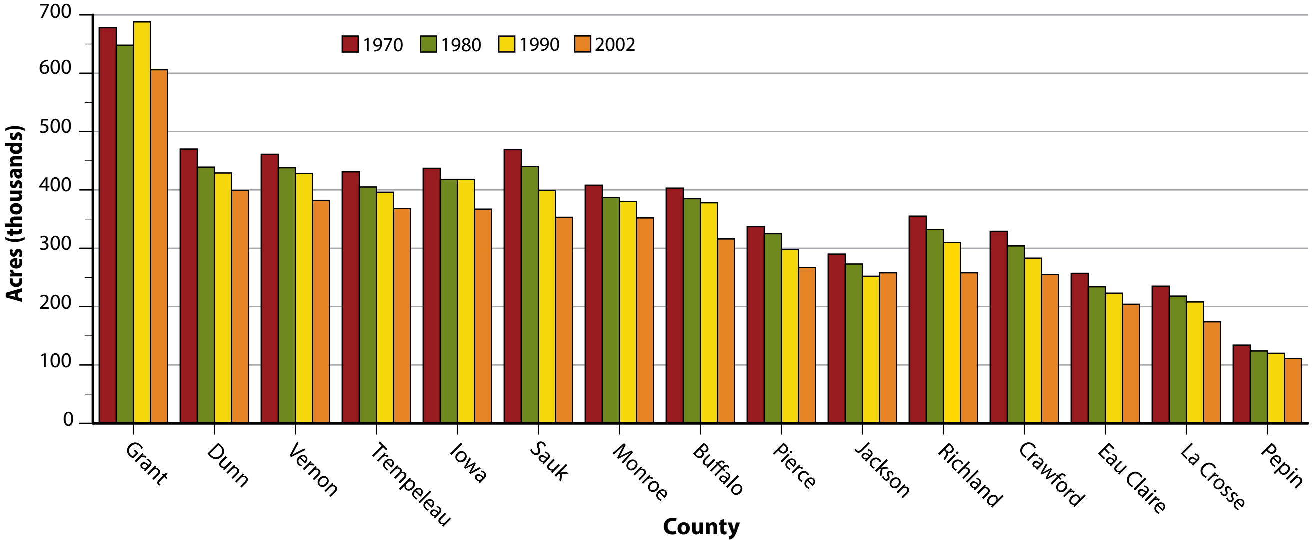

Figure 22.21. *Acreage of farmland in the Western Coulees and Ridges counties by county and year (USDA NASS 2004).*

Agriculture

Farm numbers in the Western Coulees and Ridges counties have decreased 17% since 1970. There were approximately 26,840 farms in 1970 and 22,175 in 2002 (USDA NASS 2004). Between 1970 and 2002, average farm size actually decreased from 216 acres to 210 acres, about equal to the statewide average of 201 acres. The overall land in farms has steadily decreased since the 1970s (Figure 22.21). In 1970, farmland occupied about 5.7 million acres, but by 2002, acreage had declined to 4.7 million acres, a decrease of 18%. For the 15 counties, the percentage of land in farms ranges from 40% to 80%, averaging 66%. Grant, Iowa, Trempealeau, Buffalo, Vernon, Pierce, Pepin, and Dunn counties all have at least 70% of their land in farms.

Agriculture is a very important part of the economy of the Western Coulees and Ridges counties. In 2002, net cash farm income totaled $300 million or an average of $64 per agricultural acre, far less than the statewide average of $90 per acre. The market value of all agriculture products sold in the Western Coulees and Ridges counties was $1.3 billion (23% of the state total); 25% of this amount came from crop sales, while the remaining 75% was from livestock sales (USDA NASS 2004). During 2007, 34,222 acres of farmland were sold, of which 88% remained in agricultural use at an average selling price of $3,093 per acre. The other 12% of farmland was diverted to other uses, selling for a higher average price of $4,025 per acre (USDA NASS 2009).

Timber

Timber Supply

Based on 2009 Forest Inventory and Analysis (FIA) data, 42% (2,549,900 acres) of the total land (includes non-census water) area for the Western Coulees and Ridges Ecological Landscape is forested (USFS 2009). This is 15.5% of Wisconsin's total forest acreage.

■ **Timber Ownership.** According to Forest Inventory and Analysis (FIA) data (USFS 2009), of all timberland within the Western Coulees and Ridges Ecological Landscape, 91% is owned by private landowners, 7% is owned by state and local governments, and 3% is federally owned (Figure 22.22). Timberland is defined as forestland capable of producing 20 cubic feet of industrial wood per acre per year that is not withdrawn from timber utilization (see the glossary in Part 3, "Supporting Materials," for more detailed description of "timberland").

■ **Growing Stock and Sawtimber Volume.** There were approximately 3.2 billion cubic feet of ***growing stock*** volume in the Western Coulees and Ridges Ecological Landscape in 2007, or 15.4% of total growing stock volume in the state. Most of this volume (92%) was in hardwoods, a much higher percentage than hardwoods statewide (74% of total growing stock volume) (USFS 2009). Hardwoods made up a similar percentage of sawtimber volume (90%) in the Western Coulees and Ridges Ecological Landscape. By comparison, statewide in Wisconsin, hardwoods accounted for 67% of total sawtimber volume.

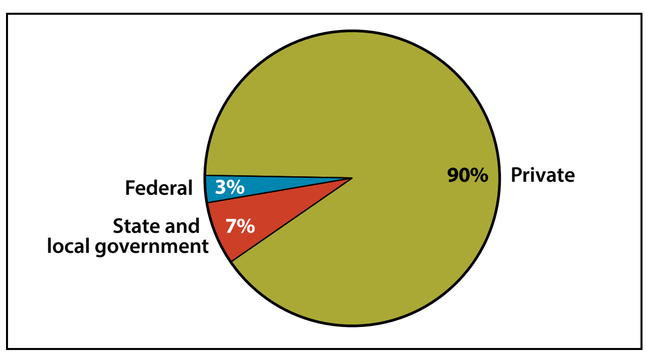

Figure 22.22. *Timberland ownership in the Western Coulees and Ridges Ecological Landscape (USFS 2009).*

Annual Growing Stock and Sawtimber Growth. Between 1996 and 2007, the timber resource in the Western Coulees and Ridges Ecological Landscape increased by 478 million cubic feet, or 18% (USFS 2009). Approximately 76% of this increase occurred in hardwood volume. Sawtimber volume increased by 2.1 billion board feet, or 26%, again mostly in hardwoods. This change was partly a result of a 6% increase in timberland acreage from 2,378,938 acres in 1996 to 2,509,973 acres in 2007 (Table 22.6). Statewide, timberland acreage increased by 3% during the same time period.

Timber Forest Types. According to FIA (USFS 2009), the predominant forest type groups (see Appendix H, "Forest Types That Were Combined into Forest Type Groups Based on Forest Inventory and Analysis Data," in Part 3, "Supporting Materials") in terms of acreage are oak-hickory (55%), maple-basswood (20%), and bottomland hardwoods (10%), with smaller amounts of aspen-birch, white, red and jack pines, and oak-pine. Acreage is predominantly in the sawtimber and pole size classes (58% and 30%, respectively) with only 10% in seedling and sapling classes. Table 22.6 shows acreages for the forest types that make up forest type groups.

Table 22.6. *Acreage of timberland in the Western Coulees and Ridges Ecological Landscape by forest type and size class.*

Forest type[a]	Seedling/sapling	Pole-size	Sawtimber	Total
White oak-red oak-hickory	47,871	277,595	545,526	870,992
Sugar maple-beech-yellow birch	29,018	76,262	130,232	235,511
Hard maple-basswood	3,105	44,824	141,155	189,085
Northern red oak	662	13,147	144,014	157,824
Sugarberry-hackberry-elm-green ash	40,221	33,754	50,555	124,530
White birch	14,075	59,060	12,939	86,074
Mixed upland hardwoods	11,056	23,451	50,664	85,171
Post oak-blackjack oak	9,843	28,979	43,463	82,284
Aspen	12,000	34,883	30,717	77,600
White oak	–	8,251	60,316	68,567
Silver maple-American elm	–	2,801	63,438	66,240
Red pine	2,550	28,337	17,308	48,195
Eastern white pine	14,095	7,359	26,190	47,643
Red maple-oak	2,960	16,547	15,021	34,528
Black ash-American elm-red maple	4,065	8,234	19,186	31,486
Black walnut	4,889	7,142	19,347	31,379
Elm-ash-locust	6,073	17,076	6,789	29,938
Other pine-hardwood	5,581	11,118	11,991	28,690
Chestnut oak-black oak-scarlet oak	9,765	2,467	14,222	26,454
Nonstocked[b]	–	–	–	22,199
Red maple - upland	11,434	4,385	6,105	21,924
Jack pine	9,138	4,583	7,838	21,559
Cherry-ash-yellow-poplar	10,157	7,028	3,440	20,626
Bur oak	1,168	7,324	10,328	18,819
White pine-red oak-white ash	3,535	3,546	10,421	17,501
Black cherry	4,321	10,510	359	15,190
Eastern red-cedar-hardwood	718	4,511	5,914	11,143
Exotic softwoods and hardwoods	–	–	–	9,894
Cottonwood	–	–	8,493	8,493
Cottonwood-willow	516	–	5,242	5,758
White spruce	662	2,690	–	3,353
River birch-sycamore	–	–	3,307	3,307
Willow	2,853	–	–	2,853
Black locust	–	2,171	–	2,171
Sycamore-pecan-American elm	757	1,102	–	1,858
Red maple - lowland	–	470	662	1,133
Total	**263,090**	**749,608**	**1,465,181**	**2,509,973**

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.

Timber Demand

■ **Removals from Growing Stock.** The Western Coulees and Ridges Ecological Landscape has about 15.4% of the total growing stock volume on timberland in Wisconsin (see the "Socioeconomic Characteristics" section in Chapter 3, "Comparison of Ecological Landscapes"). Average annual removals from growing stock were 59 million cubic feet, or about 17% of total statewide removals (349 million cubic feet) between 2002 and 2007. Average annual removals to growth ratios vary by species as can be seen in Figure 22.23 (only major species shown). Removals exceed growth for silver maple, black oak, quaking aspen, elm, jack pine, and white birch.

■ **Removals from Sawtimber.** The Western Coulees and Ridges Ecological Landscape has about 17% of the total sawtimber volume on timberland in Wisconsin. Average annual removals from sawtimber were about 245 million board feet, or 23.3% of total statewide removals (1.1 billion board feet) between 2002 and 2007. Average annual removals to growth ratios vary by species as can be seen in Figure 22.24 (only major species shown). Sawtimber removals exceeded growth for silver maple, black oak, jack pine, and elm.

Price Trends

In the counties of the Western Coulees and Ridges Ecological Landscape, black walnut (*Juglans nigra*), black cherry, sugar maple, and northern red oak were the highest priced hardwood sawtimber species in 2007. Northern white-cedar (*Thuja occidentalis*), eastern white pine, and red pine were the most valuable softwood timber. Sawtimber prices for 2007 were generally much lower for both softwoods and hardwoods compared to the rest of the state (WDNR 2008a). For pulpwood, white spruce (*Picea glauca*) is the most valuable. Pulpwood values in the Western Coulees and Ridges counties were similar for hardwoods and softwoods compared to the statewide average (WDNR 2008a).

Infrastructure

Transportation

The transportation infrastructure of the Western Coulees and Ridges Ecological Landscape is somewhat less developed than the rest of the state. For instance, road mile density is 7% lower (WDOA 2000), railroad density is 17% lower (WDOT 1998) and airport runway density is 2% lower than the state as a whole (WDOT 2012).

There are 20 airports, two of which (Chippewa Valley Regional in Eau Claire and La Crosse Municipal Airport) are primary regional airports. Together they handle 3% of the passenger boardings for the state (WDOT 2012). The Western Coulees and Ridges Ecological Landscape has two gateway shipping ports, one in La Crosse and the other in Prairie du Chien (WCPA 2010) (see Table 22.7).

Renewable Energy

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

The Western Coulees and Ridges Ecological Landscape has significant potential to produce several types of renewable energy, including hydroelectric, woody biomass, and corn-based ethanol. Western Coulees and Ridges counties have 13.4% of the state's population and, by inference, 13.4% of the state's energy use. The Western Coulees and Ridges Ecological Landscape has 11.7% of all above-ground woody biomass in Wisconsin. Western Coulees and Ridges counties generated 18.8% of hydroelectric power and produced 22.5% of the state's corn crop in 2002. The Western Coulees and Ridges counties have one ethanol plant and two sited wind farms (Renewable Fuels Association 2013, WWIC 2013).

Table 22.7. *Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of ports in the Western Coulees and Ridges Ecological Landscape.*

	Western Coulees and Ridges	State total	% of state total
Total road length (miles)[a]	29,890	185,487	16%
Road density[b]	3.2	3.4	–
Miles of railroads	752	5,232	14%
Railroad density[c]	8.0	9.7	–
Airports	20	128	16%
Miles of runway	16.3	95.7	17%
Runway density[d]	1.7	1.8	–
Total land area (square miles)	9,393	54,087	17%
Number of ports[e]	2	14	14%

[a]Includes primary and secondary highways, roads, and urban streets.

[b]Miles of road per square mile of land. Data from Wisconsin Roads 2000 TIGER line files (data set) (WDOA 2000).

[c]Miles of railroad per 100 square miles of land. Data from 1:100,000-scale Rails Chain Database (WDOT 1998).

[d]Miles of airport runway per 1,000 square miles of land. Data from Wisconsin Airport Directory 2011–2012 web page (WDOT 2012).

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

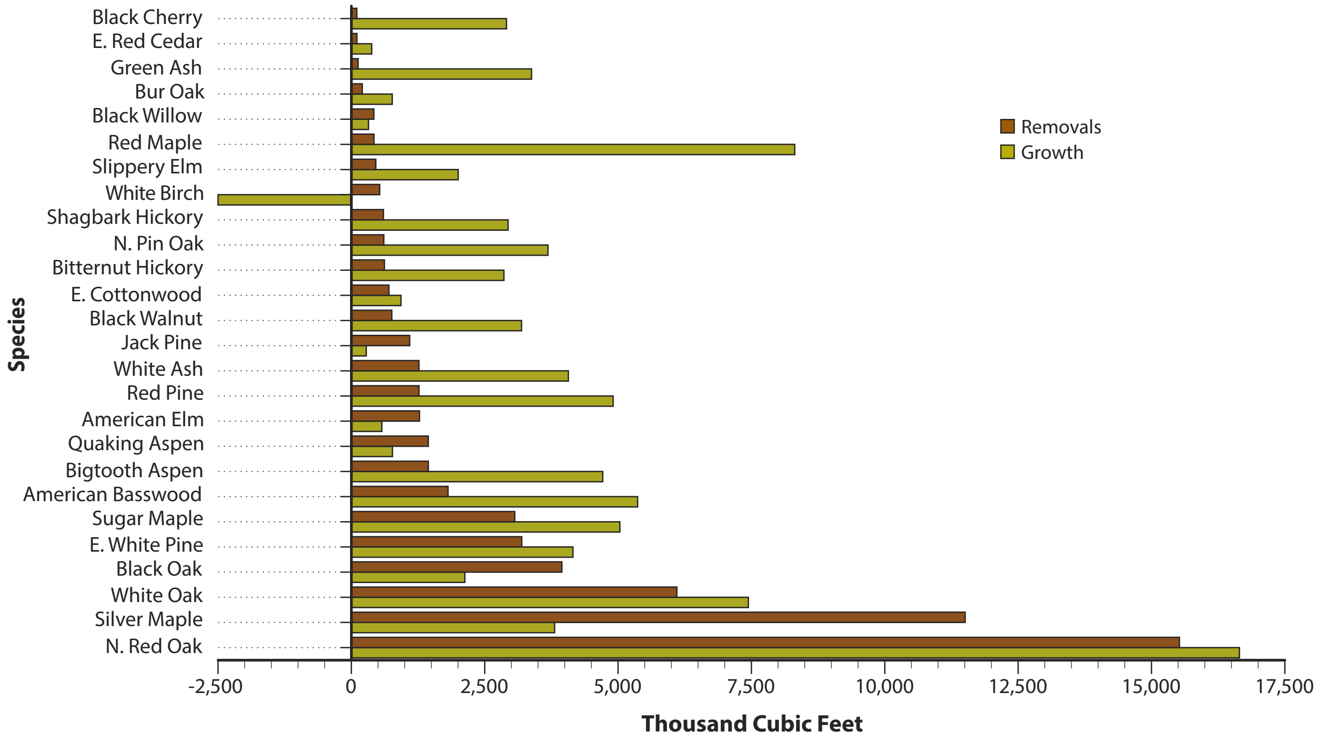

Figure 22.23. *Growing stock growth and removals (selected species) on timberland in the Western Coulees and Ridges Ecological Landscape (USFS 2009).*

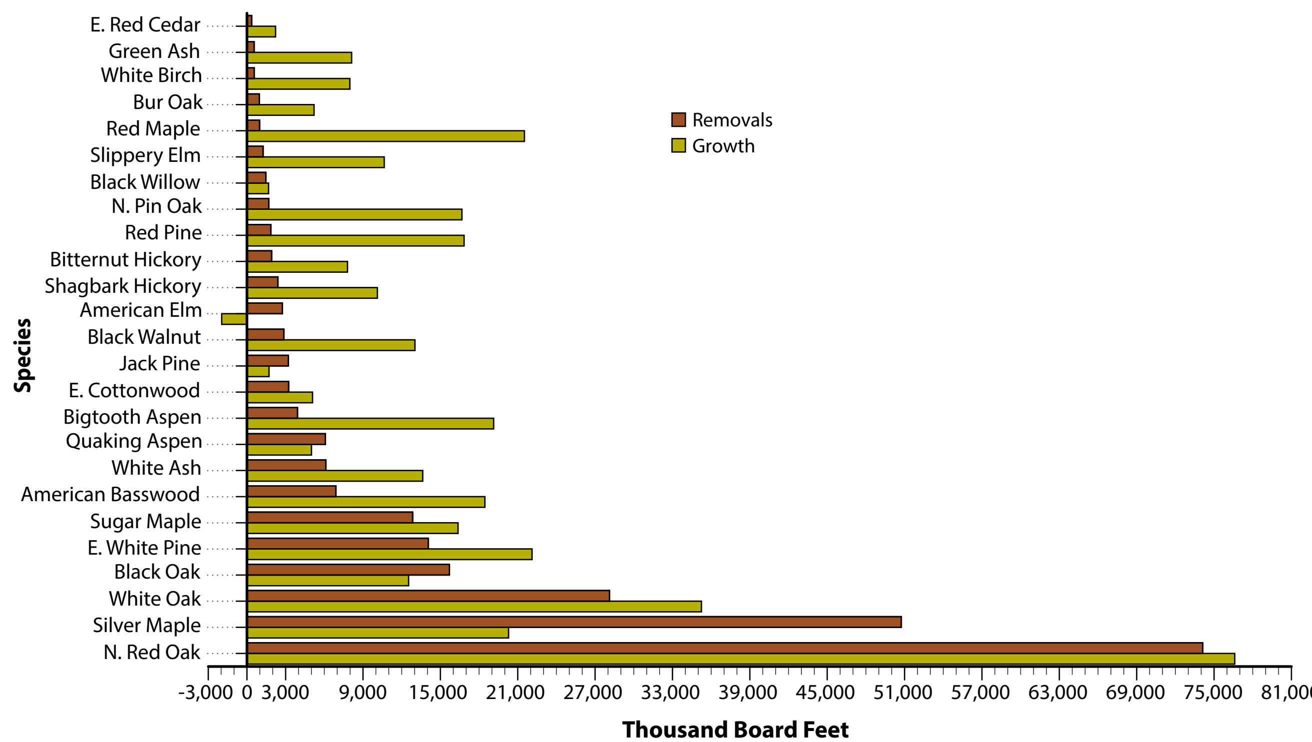

Figure 22.24. *Sawtimber growth and removals (selected species) on timberland in the Western Coulees and Ridges Ecological Landscape (USFS 2009).*

Biomass. The Western Coulees and Ridges Ecological Landscape produces 116.3 million oven-dry tons of woody biomass annually, or 11.7% of the statewide total (USFS 2009).

Hydroelectric. There are five hydroelectric power sites in the Western Coulees and Ridges counties, generating a total of 272.9 million kilowatt hours (kWh) (WDOA 2006). In the entire state, there are 68 sites, owned either by utility companies or privately owned, which generate a total of 1,462 million kilowatt hours.

Ethanol. The Western Coulees and Ridges counties produced 108.5 million bushels of corn in 2002, or 28.2% of total production in the state (USDA NASS 2004). Acreage in agriculture, at 64% of the land base in the Western Coulees and Ridges counties (some woodland is counted as agriculture by this source), decreased by 18% between 1970 and 2002. Increasing ethanol production will depend on converting land to corn. There is one ethanol plant, which is located in Boyceville in Dunn County (Renewable Fuels Association 2013). It produces 40 million gallons per year, or 8% of the state's total ethanol production.

Wind. There are currently two sited wind farms in the Western Coulees and Ridges Ecological Landscape, in Iowa and Monroe counties (WWIC 2013). There are proposed wind facilities in Vernon and Grant counties. Mean annual power densities are generally between 100 and 300 W/m^2 (watts/square meter) in this part of the state, indicating that there is potential for wind generation in certain areas (USDE 2013).

Current Socioeconomic Conditions

The Western Coulees and Ridges counties are traditionally rural but have increasing dependency on their urban centers for the bulk of local economic output. The largely homogenous white population of Western Coulees and Ridges counties is growing in urban areas, while rural counties are losing population and economic activity is declining. To varying degrees by county, earnings lag behind statewide averages. This is especially true among rural counties. Both home values and property values are relatively low in most Western Coulees and Ridges counties.

Demography

Population Distribution

The U.S. Census Bureau estimated the 2010 population of the 15 Western Coulees and Ridges counties to be 614,553, or 10.8% of the state total population (USCB 2012c). The population is classified as 51.7% rural, compared to 31.7% statewide. Of the 15 Western Coulees and Ridges counties, only Eau Claire and La Crosse counties have greater than half their population living in metropolitan areas. Four counties were classified as metropolitan by the U.S. Department of Agriculture's Economic Research Service in 2004: Eau Claire County with the city of Eau Claire, Iowa County influenced by the neighboring Madison metropolitan area, La Crosse County with the city of La Crosse, and Pierce County influenced by the neighboring Twin Cities metropolitan area (USDA ERS 2012b). Of 22 urban centers (defined as cities with at least 2,500 inhabitants) in Western Coulees and Ridges counties, Eau Claire (population was 65,883 in 2010 U.S. Census Bureau estimates) and La Crosse (population was 51,320) are the largest cities (USCB 2012c).

Population Density

Reflecting the region's rural character, the population density of the Western Coulees and Ridges counties is relatively low in all but La Crosse County (253.8 persons per square miles) and Eau Claire County (154.8). Buffalo County (20.2) and Jackson County (20.7) have the lowest population densities among the 15 counties. On average, there are 57 persons per square mile in the Western Coulees and Ridges counties, compared to 105 persons per square mile in Wisconsin as a whole (USCB 2012c).

Population Structure

Age. Western Coulees and Ridges counties had a population age structure similar to the entire state in 2010. The counties have slightly lower percentages of their population in the under 18 years of age range (22.6% as compared to 23.6% statewide) and the slightly more persons over 65 years of age (14.2% as compared to 13.7% statewide) (USCB 2012c). Western Coulees and Ridges counties have a lower proportion of their population in the 25–49 age group (34.4%) compared to statewide (36.9%) in 2007. Compared to the statewide median age of 36 years, four counties are comparably lower: Dunn (30.6), Pierce (32.1), Eau Claire (32.4), and La Crosse (33.5). The other 11 counties, with more rural populations, have higher median ages ranging from 35.9 years in Grant County to 39.2 in Buffalo and Richland counties (USCB 2009).

Minorities. The Western Coulees and Ridges counties are less racially diverse than the state as a whole. Ninety-five percent of the 2010 population in Western Coulees and Ridges counties was white, non-Hispanic, as compared to 86.2% statewide (USCB 2012c).

Education. Residents of Western Coulees and Ridges counties 25 years of age or older have educational levels comparable to the state as a whole but stratified between metropolitan and rural counties. More populated counties, including Eau Claire, La Crosse, and Pierce, have among the best educational attainment levels in the state, while the more rural counties tend to lag behind, especially in terms of higher education. According to the 2010 census, 89.9% of Western Coulees and Ridges counties residents 25 or older have graduated from high school, similar to 89.4% statewide (USCB 2012c). Western Coulees and Ridges counties residents lag slightly behind in terms of higher education: 22.7% of Western Coulees and

Ridges counties residents have received a bachelor's degree or higher, compared to 25.8% statewide.

Population Trends

Over the extended period from 1950 to 2006, Western Coulees and Ridges counties' combined population has grown at a slower rate (39% population growth) than has the state's population (62%) (USCB 2009). However, population trends in Western Coulees and Ridges counties have changed over time and are stratified according to their urban influence. Urban counties within the Western Coulees and Ridges counties have experienced population growth at similar or greater rates compared with statewide figures. In the extended period from 1950 to 2006, only Pierce (84% population growth), Eau Claire (78%), and La Crosse (63%) counties have met or exceeded statewide population growth. Meanwhile, rural counties have experienced slower population change to varying degrees, to the point of actual population loss in Buffalo (-6% population change), Richland (-6%), Crawford (-3.9%), and Pepin (-1.3%) counties from 1950 to 2006.

From 1950 to 1960, Western Coulees and Ridges counties endured stagnant population change (0.6%), highlighted by population losses in each of the ten most rural Western Coulees and Ridges counties, as small farms and communities were abandoned for greater opportunities in larger urban centers (USCB 2009). From 1960 to 1970, Western Coulees and Ridges counties' population growth (6.5%) continued to lag behind statewide numbers (11.8%). By the period from 1970 to 1980, population growth in Western Coulees and Ridges counties (11.2%) had closed the gap with statewide population change and has maintained trends similar to the entire state since then. From 1980 to 1990, population leveled in Western Coulees and Ridges counties (3.2% growth, compared to 4% statewide). From 1990 to 2000, population growth in the Western Coulees and Ridges counties followed the statewide trend (9.4% and 9.6%, respectively), and from 2000 to 2010, the Western Coulees and Ridges counties continued to reflect statewide population growth (5.9% and 6.02%, respectively) (USCB 2012a).

Housing

Housing Density. The Western Coulees and Ridges counties' average housing density (25.2 housing units per square mile of land) is about half the average housing density of the state (48.5 units per square mile) (USCB 2012b). Housing density is much higher in the more metropolitan counties, with La Crosse at 107.2 units per square mile and Eau Claire at 66.1. The remaining counties have comparatively low housing densities ranging from Sauk County's 35.8 units per square mile to Jackson County's 9.8 units per square mile.

Seasonal Homes. Seasonal and recreational homes make up only 3.8% of housing stock in the Western Coulees and Ridges counties. Only Crawford County has a percentage of seasonal homes considerably higher (14.9%) than the statewide average of 6.3% (USCB 2012b). Counties with lower percentages of seasonal housing range from Richland County (8.1%) to La Crosse County (0.6%).

Housing Growth. Housing growth from 1950 to 1960 was 26.1%, a lower rate than the statewide average (40.4%), but the Western Coulees and Ridges counties drew closer to statewide rates during the 1960s (22.6%, as compared with 27.2% statewide) and surpassed it in the 1970s (34.8%, as compared with 30.3% statewide) (USCB 2009). Since then, housing growth in the Western Coulees and Ridges counties has approximated that of the state as a whole. Housing development in the Western Coulees and Ridges counties reflects the dynamics of change in rural areas from exclusively farming-dependent to more diversified residency.

Housing Values. Pierce County, which has seen considerable growth in housing influenced by the neighboring Twin Cities metropolitan area, is the only Western Coulees and Ridges county with median housing values in 2005–2009 that were higher than the statewide median ($203,200 as compared with statewide median of $169,000) (USCB 2012b). The remaining counties can be divided into two groups in terms of housing values, reflecting their relative access to enhanced economic opportunities of metropolitan areas. Five Western Coulees and Ridges counties with higher levels of urbanization have median housing values ranging from Sauk County's $161,100 to La Crosse County's $144,600. The nine most rural counties have relatively low housing values, ranging from Crawford County's $111,700 to Pepin County's 137,900.

The Economy

Western Coulees and Ridges counties support higher levels of government jobs and service jobs compared to the state as a whole. Wages in the service sector tend to be lower than high technology and manufacturing sectors, which are relatively underrepresented in the Western Coulees and Ridges counties. Rural counties especially are experiencing a net in-migration of retirement age adults and out-migration of young adults, with negative implications for the available workforce. Though unemployment and poverty rates are comparable to statewide figures, per capita incomes and average wages per job are low in the Western Coulees and Ridges counties, indicating a lack of higher paying jobs.

Income

Per Capita Income. Total personal income for the 15 Western Coulees and Ridges counties in 2006 was $17.43 billion (9.1% of the state total) (USDC BEA 2006). La Crosse County ($3.49 billion) and Eau Claire County ($3.02 billion) contributed over a third of all income in these counties. Average per capita income in the Western Coulees and Ridges counties in 2006 ($29,363) was lower than the statewide average of $34,405 (Table 22.8). Only Buffalo County ($34,255) approached the statewide average per capita income. Per capita income in

Table 22.8. *Economic indicators for the Western Coulees and Ridges 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%**
Buffalo	$ 34,255	$ 33,627	4.0%	8.8%
Crawford	$ 25,073	$ 24,845	4.9%	11.4%
Dunn	$ 25,748	$ 29,409	4.6%	12.0%
Eau Claire	$ 31,314	$ 31,775	4.0%	11.9%
Grant	$ 26,923	$ 26,458	4.5%	12.3%
Iowa	$ 30,685	$ 30,566	4.3%	6.8%
Jackson	$ 27,623	$ 30,448	5.5%	10.1%
La Crosse	$ 31,640	$ 32,023	3.8%	12.6%
Monroe	$ 26,883	$ 29,805	4.3%	11.0%
Pepin	$ 28,151	$ 26,734	4.7%	9.0%
Pierce	$ 30,068	$ 27,673	4.2%	7.3%
Richland	$ 25,139	$ 26,982	4.7%	12.0%
Sauk	$ 32,998	$ 29,278	4.5%	7.8%
Trempealeau	$ 27,993	$ 29,362	4.3%	9.4%
Vernon	$ 23,510	$ 25,347	4.8%	15.8%
Western Coulees & Ridges counties	**$ 29,363**	**$ 30,057**	**4.3%**	**10.5%**

[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.

the remaining counties ranged from average in Sauk County ($32,998) to very low in Vernon County ($23,510).

Household Income. Estimates of median household income in 2005 in Pierce County ($54,796) and Iowa County ($50,338) exceeded the statewide median household income ($47,141) (USCB 2009). Median household incomes in the remaining Western Coulees and Ridges counties were lower than statewide, ranging from $46,500 in Sauk County to $36,892 in Vernon County.

Earnings Per Job. Similar to per capita income, 2006 average earnings per job in Western Coulees and Ridges counties ($30,057) were lower than the statewide average ($36,142) (Table 22.8). Earnings per job in the Western Coulees and Ridges counties ranged from quite low in Crawford County ($24,845) to moderately low in Buffalo County ($33,627).

Unemployment

Western Coulees and Ridges counties had a combined 2006 unemployment rate of 4.3%, comparatively lower than the state average (4.7%). Jackson County (5.5%) had the highest unemployment rate among the 15 counties, while La Crosse (3.8%), Eau Claire (4.0%), and Buffalo (4.0%) counties had the lowest unemployment rates (Table 22.8). Unemployment rates became much higher after 2008 throughout the state but have become lower again.

Poverty

Poverty Rates. The U.S. Census Bureau estimated the Western Coulees and Ridges counties' average 2005 poverty rate for all people (10.5%) was only slightly higher than for the state as a whole (10.2%) (Table 22.8). Notably, the 2005 poverty rate for all people in Vernon County (15.8%) was third highest among Wisconsin counties. Eight other Western Coulees and Ridges counties had relatively high poverty rates ranging from 11.0% in Monroe County to 12.6% in La Crosse County. Conversely, 2005 poverty rates were especially low in Iowa (6.8%), Pierce (7.3%), and Sauk (7.8%) counties.

Child Poverty Rates. Compared to the statewide average (14%), 2005 estimates of poverty rates for people under age 18 in the Western Coulees and Ridges counties followed similar trends as with overall poverty rates. Child poverty rates were very low in Pierce (6.3%) and Iowa (8.7%) counties but very high in Vernon County (25.5%) (USCB 2009). Child poverty rates in the remaining counties approximated the state average.

Residential Property Values

Average residential property value in the Western Coulees and Ridges counties ($96,264 per housing unit) was much lower than the statewide average ($134,021) (Table 22.9). However, residential property values were highly variable among counties, similar to housing values. Pierce County ($163,807) was the one county with residential property values higher than the state average. Sauk County ($131,956) was just under the state average. A group of five counties was clustered with property values between $104,722 (Pepin County) and $99,468 (Dunn County). The eight counties with the lowest-ranking residential property values were clustered between Crawford County ($57,288), the state's lowest-ranking county,

Table 22.9. *Property values for the Western Coulees and Ridges 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**
Buffalo	$490,708,000	6,590	$74,463
Crawford	$517,827,900	9,039	$57,288
Dunn	$1,718,804,800	17,280	$99,468
Eau Claire	$4,160,427,700	41,081	$101,274
Grant	$1,452,930,500	21,121	$68,791
Iowa	$1,067,160,700	10,513	$101,509
Jackson	$647,692,400	8,883	$72,914
La Crosse	$4,719,296,700	46,538	$101,407
Monroe	$1,373,182,800	18,703	$73,420
Pepin	$349,144,800	3,334	$104,722
Pierce	$2,516,735,900	15,364	$163,807
Richland	$552,891,600	8,601	$64,282
Sauk	$3,735,543,900	28,309	$131,956
Trempealeau	$967,887,500	12,462	$77,667
Vernon	$895,586,400	13,607	$65,818
Western Coulees & Ridges counties	**$25,165,821,600**	**261,425**	**$96,264**

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.

and Trempealeau County ($77,667). The Western Coulees and Ridges counties' low residential property values indicated both their rural character and the lack of recreational demand in much of the ecological landscape.

Important Economic Sectors

Western Coulees and Ridges counties together provided 379,495 jobs in 2007, about 10.7% of the total employment in Wisconsin (Table 22.10; MIG 2009). La Crosse County (81,193 jobs), Eau Claire County (72,167), and Sauk County (47,707) together provided over half of all employment in these counties. Other counties provided employment that ranged from 26,250 jobs in Grant County to 3,300 jobs in Pepin County. The Government sector is the leading source of employment (13.8%) in the Western Coulees and Ridges counties, followed by Tourism-related (12.1%), Health Care and Social Services (11.7%), and Retail Trade (10.0%) Other important economic sectors providing employment are Manufacturing (non-wood) (9.1% of Western Coulees and Ridges employment) and Agriculture, Fishing and Hunting (7.3%). For definitions of economic sectors, see the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

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

When compared with the rest of the state, the Western Coulees and Ridges counties had eight sectors of employment with location quotients higher than 1.0 (Figure 22.25, Appendix 22.I). The Agriculture, Fishing and Hunting sector, providing jobs at more than twice the rate in Western Coulees and Ridges counties compared to statewide, has by far the highest location quotient among sectors in these counties. Though it contributes relatively few real jobs, the sector's high location quotient is an indicator of the relative dependence upon agriculture. Other sectors providing a percentage of jobs higher than the state average, listed in order of their relative employment contribution, are: Transportation and Warehousing, Utilities, Government, Retail Trade, Health Care and Social Services, Tourism-related, and Construction.

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 (Marcouiller and Xia 2008). The Forest Products and Processing sector includes sectors in logging, pulp and paper manufacturing, primary wood manufacturing (e.g., sawmills), and secondary wood manufacturing (e.g., furniture manufacturing).

Table 22.10. *Total and percentage of jobs in 2007 in each economic sector within the Western Coulees and Ridges (WCR) counties. The economic sectors providing the highest percentage of jobs in the Western Coulees and Ridges counties are highlighted in blue.*

Industry sector	WI employment	% of WI total	WCR counties employment	% of WCR counties total
Agriculture, Fishing & Hunting	110,408	3.1%	27,797	7.3%
Forest Products & Processing	88,089	2.5%	8,995	2.4%
Mining	3,780	0.1%	309	0.1%
Utilities	11,182	0.3%	1,426	0.4%
Construction	200,794	5.6%	22,017	5.8%
Manufacturing (non-wood)	417,139	11.7%	34,461	9.1%
Wholesale Trade	131,751	3.7%	11,740	3.1%
Retail Trade	320,954	9.0%	38,075	10.0%
Tourism-related	399,054	11.2%	45,830	12.1%
Transportation & Warehousing	108,919	3.1%	16,194	4.3%
Information	57,081	1.6%	3,765	1.0%
Finance & Insurance	168,412	4.7%	12,619	3.3%
Real Estate, Rental & Leasing	106,215	3.0%	9,850	2.6%
Professional, Science & Tech Services	166,353	4.7%	11,233	3.0%
Management	43,009	1.2%	4,013	1.1%
Administrative and Support Services	166,405	4.7%	12,405	3.3%
Private Education	57,373	1.6%	4,180	1.1%
Health Care & Social Services	379,538	10.7%	44,214	11.7%
Other Services	187,939	5.3%	18,181	4.8%
Government	430,767	12.1%	52,193	13.8%
Totals	**3,555,161**		**379,495**	**10.7%**

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

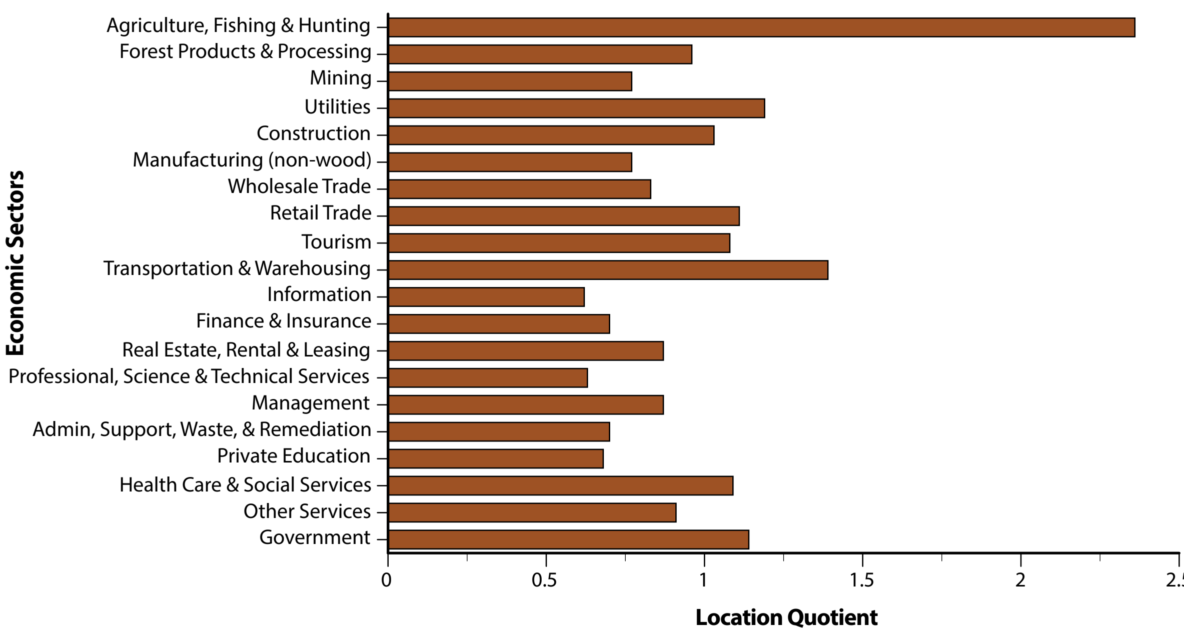

Figure 22.25. *Importance of economic sectors within the Western Coulees and Ridges counties when compared to the rest of the state. If the location quotient is greater than 1.0, the Western Coulees and Ridges counties are contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the Western Coulees and Ridges counties are contributing fewer jobs to that economic sector than the state average.*

The broad terraces flanking the major river floodplains in the Western Coulees and Ridges Ecological Landscape historically supported prairie, oak savanna, and forest vegetation. Now they have been intensively developed and are the landscape features where agriculture, transportation corridors, and urban-industrial complexes are concentrated. Though not pictured here, larger cities such as La Crosse, Onalaska, Prairie du Chien, Winona, and others have all been sited on the terraces. In most of this ecological landscape, these developed areas now break ecological connections between the bluffs and the floodplain. Photo by George Howe, Mississippi Valley Conservancy.

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 the remaining classes from 3 to 12 representing nonmetropolitan counties that are 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. Pierce County is classified as a large metropolitan area (class 1), and Eau Claire, Iowa, and La Crosse counties are classified as smaller metropolitan areas (class 2). The remaining Western Coulees and Ridges counties are composed of nonmetropolitan (rural) counties with varying degrees of "influence" from adjacent urban areas. Dunn, Grant, and Sauk counties are in class 5. Buffalo, Jackson, Monroe, Richland, and Vernon counties are in class 6 counties. Pepin and Trempealeau counties are in class 7. Crawford County (class 9) has the least urban influence.

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 policy making, the USDA Economic Research Service classifies counties in one of six mutually exclusive categories: Farming-dependent counties, Mining-dependent counties, Manufacturing-dependent counties, Government-dependent counties, Service-dependent counties, and nonspecialized counties (USDA ERS 2012a). Three Western Coulees and Ridges counties (Crawford, Richland, and Trempealeau) were classified as manufacturing-dependent in 2004 according to the Economic Research Service's economic specialization definitions. Eau Claire and Iowa counties were classified as service-dependent, and Monroe county was classified as government-dependent. The remaining nine Western Coulees and Ridges counties were classified as nonspecialized.

Policy Types

The USDA Economic Research Service also classifies counties according to "policy types" deemed especially relevant to rural development policy (USDA ERS 2012a). In 2004, Sauk County was classified as a "nonmetro recreation" county (rural counties classified using a combination of factors, including share of employment or share of earnings in recreation-related industries in 1999, share of seasonal or occasional use housing units in 2000, and per capita receipts from motels and hotels in 1997), indicating economic dependence especially upon an influx of tourism and recreational dollars. No other special policy types were identified among the Western Coulees and Ridges counties.

Integrated Opportunities for Management

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

The principles of integrating natural resources and socioeconomic activities are similar across the state. A discussion of "Integrated Ecological and Socioeconomic Opportunities" can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management." 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 22.A. *Watershed water quality summary for the Western Coulees and Ridges Ecological Landscape.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
BL01	Rush Creek	154,479	Fair to V Good; 50% agr/50% forest; Agr NPS; rural home stormwater; steep flashy streams > Hab; small dams; no lakes
BL02	Bad Axe River	125, 112	Fair to V Good; Agr NPS; rural home stormwater/streambank pasturing/gulley erosion > Hab/Temp; flood control dams; turbidity; spring fish kills; impoundments: eutrophic
BL03	Coon Creek	152,451	Fair to Excellent; historic severe soil erosion/gulleying > CCC/ private erosion controls; Agr NPS/rural home stormwater > Temp; streambank pasturing > Sed; high P/coliform
BL04	Lower La Crosse River	93,096	Fair to V Good; Agr/urban/golf course NPS > P; stormwater > coliform/Temp/Hab; Muni PS; ditching; streambank pasturing > Sed; impoundments/carp > Hg/algae
BL05	Little La Crosse River	154,104	Fair to V Good; Agr/barnyard/urban NPS > nutrients/bacteria; streambank pasturing > erosion/Sed; dams > fish barrier; ditching > Hab
BL06	Upper La Crosse River	80,716	Fair to Good; cranberries > flux/Temp; NPS; impoundments on trout streams > Sed/Hg/Temp; flashy flows
BR01	Lower Black River	121,486	Poor to Fair; streambank pasturing > NPS nutrients/erosion > low D.O./Sed; impoundments > eutrophic
BR02	Beaver Creek & Lake Marinuka	102,601	Fair to V Good (several ERW); NPS/streambank/cropland erosion > Sed/Hab/Temp
BR03	Big & Douglas creeks	134,608	Fair to V Good (several ERW); Agr NPS/Sed > Hab/low D.O.
BR04	Trout Run & Robinson creeks	138,833	Fair to V Good; cranberry marshes; channel mod; NPS; Hab; Flux; some ERW streams; borderline eutrophic impoundments
BR06	Halls Creek	73,685	Good to V Good; several ERW: channel mod; Hab; some lakes eutrophic from NPS
BR08	Fivemile & Wedges creeks[b]	91,632	Fair to Good; streambank pasturing; beaver dams; Hab; Sed; thermal impacts; (only one lake)
BT01	Lower Trempealeau River	113,345	Fair to Good; Agr/urban NPS > Flux/Temp/Hab/Sed; streambank pasturing > erosion; gravel mining > Hab
BT02	Middle Trempealeau River	131,498	Poor to Fair; streambank pasturing/erosion> Sed/Hab/Temp/ low D.O.
BT03	Elk Creek	72,289	Fair; streambank pasturing/erosion > Sed/Hab/Temp/low D.O.; lakes: NPS/Sed
BT04	Pigeon Creek	59,618	Fair to Good; Agr NPS; streambank pasturing/erosion> Sed/ Hab/Temp/low D.O.
BT05	Upper Trempealeau River	112,349	Fair to Good; streambank pasturing/erosion > Sed/Hab/Temp/ low D.O; gravel mine > Hab; lakes: NPS/Sed
BT06	Waumandee Creek	142,060	Poor to Good; streambank pasturing/erosion > Sed/Hab/Temp/ low D.O
BT07	Lower Buffalo River	176,278	Fair to Good; NPS; ditching; bank erosion; streambank pasturing/erosion > Sed/Hab/Temp/low D.O; lakes: NPS/Sed
BT08	Upper Buffalo River	124,390	Fair to V Good (Several ERW); streambank grazing > Hab/Sed; beaver dams > Sed/Temp; lakes: NPS/Sediment
GP01	Galena River[b]	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 VG; Ag nutrient & soil runoff; streambank grazing
GP04	Lower Grant River	83,042	Poor to Fair; very heavy agr sediment runoff; low D.O.

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Appendix 22.A, *continued.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
GP05	Upper Grant River	67,900	Poor to Good; stormwater; sediment, agr runoff
GP07	Mississippi River	70,700	Fair to Good; sedimentation; high pH; dams; habitat degradation
LC01	Bear Creek	112,995	Poor to Fair; cropland erosion; streambank grazing > Sed/Hab/Temp/Flux; dams > fish obstruction
LC02	Plum Creek	89,976	Good; Agr erosion; overgrazing
LC03	Eau Galle River	171,440	Fair to Good; NPS nutrients; lack of streambank cover; erosion & turbidity; Eau Galle Lake: eutrophic
LC04	Wilson Creek	156,639	Fair to Very Good; NPS & PS; agr sediment ; forest loss, streambank pasturing
LC05	Hay River	185,343	Fair to Good; streambank grazing > Sed/Hab/Temp; beaver dams; lake NPS > algae
LC06	South Fork Hay River	116,472	Fair to Excellent; high IBI; streambank pasturing & erosion; agr sediment ; some dam & drainage impacts
LC07	Pine Creek & Red Cedar River	184,248	Fair to V Good; streambank pasturing/NPS/beaver dams > Sed/Hab/Temp; Dallas Flowage: eutrophic
LC08	Lake Chetek	135,683	Fair to V Good; woodlot/streambank pasturing > streambed erosion/Hab/Sed/Temp; lakes: meso- to eutrophic; weedy
LC09	Yellow River	153,183	Fair to Excellent; streambank pasturing/urban & Agr NPS > Sed/Hab/Temp/bacteria/erosion; lakes: meso- to eutrophic
LC13	Muddy & Elk creeks	152,279	Fair to V Good; Agr/urban stormwater/ditching/streambank pasturing/cropland erosion > Sed/Hab/Temp/erosion; dams > fish obstruction; lakes: eutrophic
LC14	Lower Eau Claire River	138,438	Fair to V Good; dams/streambank grazing > Hab/Sed; impoundments eutrophic: weeds/algae
LC15	Black & Hay creeks	102,328	Fair to Good; Dams > Sed; Temp; Hab; eutrophic impoundments
LC18	Duncan Creek	122,522	Fair to Excellent; streambank grazing > low D.O./Flux/Sed; lakes: urban NPS > Sed/algae/weedy
LC22	Rush River	185,326	IBI = Fair to Good (a few Excellent); habitat = Fair to Good; manure runoff; crop erosion; Hab sedimentation
LC23	Trimbelle River & Isabelle Creek	141,699	Poor to Very Good; urban & agr NPS; sedimentation; 303(d) tribs
LC24	Lowes & Rock creeks	140,266	Fair to V Good; Agr/urban stormwater/ditching/streambank pasturing/cropland erosion > Sed/Hab/Temp/erosion; dams > fish obstruction; lake: low D.O.
LC25	Otter Creek	45,133	Fair to V Good; Agr/urban stormwater/ditching/streambank pasturing/cropland erosion > Sed/Hab/Temp/erosion; dams > fish obstruction
LW01	Millville Creek	77,937	Fair to good; nonpoint runoff; ditching; erosion; atrazine
LW02	Lower Kickapoo River	96,134	Fair to V Good; 48% forest/40% Agr; Agr NPS; Hab; beaver dams/streambank pasturing > silt/sediment/streambank erosion; flux; GW: atrazine in wells
LW03	Reads & Tainter creeks	86,843	Fair to V Good; 40% forest/45% Agr; ditching/streambank grazing/NPS > Sed/Hab; flux; dams > fish obstruction
LW04	West Fork Kickapoo River	75,547	Good to V Good; 35% forest/53% Agr; Agr NPS; Hab; beaver dams/streambank pasturing > silt/sediment/erosion; flux; dams > fish obstruction/algae; GW: quarry; atrazine in wells
LW05	Middle Kickapoo River	157,779	Good to Excellent (many ORW/ERW); 46% forest/38% Agr; Agr NPS; streambank pasturing > bank erosion; proliferation of dug spring ponds
LW06	Upper Kickapoo River	75,092	Fair to Good; 47% forest/36% Agr; Agr NPS/streambank pasturing > Sed/nutrients/erosion; open valleys > Temp; impoundment: eutrophic

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Appendix 22.A, *continued.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
LW07	Green River & Crooked Creek	80,455	Good; nonpoint & atrazine concerns
LW08	Knapp Creek	101,532	Fair to V Good; 46% Forest/37% Agr; ditching/overgrazing > Hab/streambank erosion; cropland NPS > Sed/nutrients; carp > turbidity; GW: atrazine in wells
LW09	Blue River	138,363	Fair to Good; barnyard runoff; bank grazing; low D.O.; GW: atrazine in wells
LW10	Mill & Indian creeks	83,403	Fair to V Good (Many ORW/ERW); 39% forest/46% Agr; ditching/overgrazing> Hab/bank erosion; barnyard/hog CAFO/cropland NPS > Sed/nutrients/Temp; dams > fish obstruction; GW: atrazine in wells
LW11	Otter & Morey creeks	127,159	Fair to Excellent; low flows; small dams; culverts; NPS
LW12	Willow Creek	97,9974	Poor to Excellent (several ERW); 42% forest/40% Agr; Agr NPS; overgrazing/ditching > Hab; cropland NPS > Sed/nutrients/ Temp; GW: atrazine in wells
LW13	Upper Pine River	115,186	Poor to V Good (several ERW); 37% forest/43% Agr; overgrazing/ditching> Hab; Agr NPS/cropland/streambank erosion/barnyard runoff > Sed/nutrients
LW14	Bear Creek	87,386	Good to Fair; 43% forest/31% agr; cropland/feedlot/barnyard NPS > low D.O. in shallow lakes; ditching > hab/Temp/Sed; GW: atrazine in wells
LW15	Mill & Blue Mounds Creek	119,511	Fair to V Good (ORW); NPS pollution; urbanization; flood control structures; manure pit overtopping; GW: atrazine; manure pit overtopping
LW16	Honey Creek	139,379	Fair to V Good 38% forest/43% Agr; Agr NPS > Silt/Sed; over-grazing/ditching > Hab/Sed; manure pit/barnyard NPS > excess nutrients; GW: atrazine in wells
LW17	Black Earth Creek	67,325	Poor to V Good; 37% forest/43% Agr; Agr NPS > Sed/nutrients/ fishkill; exurban encroachment > construction erosion/loss of groundwater infiltration/stormwater/Temp; gravel mine; lakes: eutrophic; GW: atrazine in wells
LW18	Roxbury Creek	45,513	Fair to Good; NPS, ditching; stream grazing; loosestrife
LW19	Lake Wisconsin	137,576	Fair to Excellent; NPS; stream channelization; atrazine; excess nutrients; PCBs
LW21	Lower Baraboo River	90,173	Fair to V Good; 32% Forest/29% agr; muck farms > ditching > nutrients/sed; streambank pasturing > erosion/NPS > turbidity/ hab; lakes: oligo- to eutroophic; GW: atrazine in wells
LW22	Narrows Creek & Baraboo River	96,344	Fair to Good; 31% forest:49% Agr; barnyard & land-spread NPS; ditching; Hab; GW pesticide/nitrate ; Impoundments eutrophic
LW23	Crossman Creek & Little Baraboo River	136,831	Poor to Good; 30% Forest/47%; ditching/streambank pasturing > severe erosion> Agr NPS/Sed/P > impoundment algae/Eurasian water-milfoil; GW: atrazine in wells
LW24	Seymour Creek & Upper Baraboo River	109,904	Fair; 29% forest/53% Agr; heavy soil erosion/NPS/manure runoff > siltation/nutrients > low D.O.; flashy flows > hab; impoundment: eutrophic/algae/low D.O./temp
LW26	Dell Creek	85,588	Poor to V Good; 45% forest:34% agr; urban & rural NPS; dams/ ditching > temp/sed/hab; GW pesticide/nitrate; impoundments: eutrophic
LW27	Lower Lemonweir River	134,159	Fair to V Good; 40% forest:34% agr; cranberries; streambank grazing > erosion/hab/sed; agr/urban NPS; GW pesticide/ nitrate; impoundment: eutrophic
LW28	Beaver Creek (Monroe Co.)[b]	180,973	Fair to V Good; 42% wetland:36% forest; cranberry ditching/ impoundments > temp/low D.O./hab

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Appendix 22.A, *continued.*

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors[a] (Range = Very Poor/Poor/Fair/Good/Very Good/Excellent)
LW29	Little Lemonweir River	139,524	Good to V Good; 31% forest:38% agr; barnyard NPS; streambank grazing > erosion/temp; ditching; coliform; Lake Tomah: eutrophic; GW pesticide; springs
SP13	Allen Creek & Middle Sugar River[b]	98,566	Poor to V Good; Agr NPS; need updated water quality data
SP15	Upper Sugar River	67,816	Fair to Good; Urban/Agr NPS> Sed/coliform; wetland loss > Hab; dam; UW golf herbicide threatens rare lotus; GW diversions > drawdown

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 this ecological landscape, so overall impacts of land uses within the landscape are unlikely to impact water quality within the watershed to any appreciable degree.

Abbreviations:
Agr = Agricultural.
CAFO = Concentrated animal feeding operation.
D.O. = Dissolved oxygen.
d.s. = Downstream of this ecological landscape.
ERW = Exceptional Resource Water (very good to excellent water quality, with point source discharges).
Flux = Abnormal highs and lows in stream flow fluctuation due to lack of groundwater infiltration, etc., often due to loss of forest cover or creation of excessive impermeable surface.
GW = Groundwater (without modifiers, indicates high nitrates, radon, manganese, or other negative use condition).
Hab = Stream habitat damage.
Hg = Mercury contamination of fish, mainly deposited by coal combustion, or sometimes by industry.
HR = Habitat rating, a measure of habitat quality and/or quantity available for fish within a stream.
IBI = Coldwater Index of Biotic Integrity, a measurement of habitat values required by native trout populations.
Mod = Modification of stream channel, habitat structure, or other aquatic feature.
Muni = Municipal.
NPS = Nonpoint source pollutants, such as farm or parking lot runoff, or septic system leakage.
ORW = Outstanding Resource Water (very good to excellent water quality, with no point source discharges).
P = Phosphorous in excessive amounts, reducing oxygen concentration in a water body.
PAH = Polycyclic aromatic hydrocarbon contamination, often with other toxic substances.
PCBs = Polychlorinated biphenyl industrial pollutants in sediment and aquatic life.
PS = Point source pollutants, such as treated municipal and industrial wastewater.
Sed = Excess sedimentation.
Temp = Elevated temperatures in some stream reaches.
TSI = Trophic state index (indication of impacts of excess nutrients).
Tribs = Streams that are tributary to the stream(s) after which the watershed is named.
u.s. = Upstream of this ecological landscape.
UW = University of Wisconsin.
303(d) = A water listed as impaired under Section 303(d) of the federal Clean Water Act.
> = Yields, creates, or results in (the listed impacts).

Appendix 22.B. *Forest habitat types in the Western Coulees and Ridges 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 Western Coulees and Ridges Ecological Landscape**
ArCi-Ph	*Acer rubrum/Circaea, Phryma* variant Red maple/enchanters nightshade, lopseed variant
ATiSa-De	*Acer saccharum-Tilia americana/Sanguinaria*, *Desmodium* variant Sugar maple-basswood/bloodroot, pointed-leaf tick trefoil variant
ArDe-V	*Acer rubrum/Desmodium*, *Vaccinium* variant Red maple/pointed-leaf tick trefoil, blueberry variant
ArCi	*Acer rubrum/Circaea* Red maple/enchanters nightshade
AArVb	*Acer saccharum-Acer rubrum/Viburnum acerifolium* Sugar maple-red maple/maple-leaf viburnum
ATiCa	*Acer saccharum-Tilia americana/Caulophyllum*, *Laportea* variant Sugar maple-basswood/blue cohosh
ATiCa-La	*Acer saccharum-Tilia americana/Caulophyllum*, *Laportea* variant Sugar maple-basswood/blue cohosh, wood nettle variant
ATiSa	*Acer saccharum-Tilia americana/Sanguinaria* Sugar maple-basswood/bloodroot
ATiDe	*Acer saccharum-Tilia americana/Desmodium* Sugar maple-basswood/tick trefoil
ATiDe(Pr)	*Acer saccharum-Tilia americana/Desmodium*, *Prunus serotina* phase Sugar maple-basswood/tick trefoil, black cherry phase
ATiCr(O)	*Acer saccharum*-Tilia *americana/Cornus racemosa*, *Osmorhiza* variant Sugar maple-basswood/gray dogwood, sweet cicely phase
PVCr	*Pinus strobus/Vaccinium-Cornus racemosa* White pine/blueberry-gray dogwood
PVGy	*Pinus strobus/Vaccinium-Gaylussacia* White pine/blueberry-huckleberry

Source: Kotar and Burger (1996).

Appendix 22.C. *The Natural Heritage Inventory (NHI) table of rare species and natural community occurrences (plus miscellaneous features tracked by the NHI program) for the Western Coulees and Ridges (WCR) Ecological Landscape in November 2009. See the Wisconsin Natural Heritage Working List online for the current status (http://dnr.wi.gov, keyword "NHI").*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
MAMMALS								
Canis lupus (gray wolf)	2008	3	204	1%	S2	G4	SC/FL	LE
Microtus ochrogaster (prairie vole)	1998	9	19	47%	S1S2	G5	SC/N	
Myotis septentrionalis (northern long-eared bat)[b]	2001	5	9	56%	S3	G4	SC/N	
Pipistrellus subflavus (eastern pipistrelle)[b]	2005	6	7	86%	S3S4	G5	SC/N	
Reithrodontomys megalotis (western harvest mouse)	1998	5	11	45%	S3	G5	SC/N	
Sorex arcticus (arctic shrew)	2005	2	31	6%	S3S4	G5	SC/N	
Sorex hoyi (pygmy shrew)	2005	1	39	3%	S3S4	G5	SC/N	
BIRDS[c]								
Ammodramus henslowii (Henslow's Sparrow)	2008	14	82	17%	S3B	G4	THR	
Ammodramus nelsoni (Nelson's Sparrow)	1989	1	6	17%	S1B	G5	SC/M	
Ardea alba (Great Egret)	2001	5	14	36%	S2B	G5	THR	
Bartramia longicauda (Upland Sandpiper)	2004	4	54	7%	S2B	G5	SC/M	
Botaurus lentiginosus (American Bittern)	2008	2	41	5%	S3B	G4	SC/M	
Buteo lineatus (Red-shouldered Hawk)	2009	80	301	27%	S3S4B,S1N	G5	THR	
Chlidonias niger (Black Tern)	1992	1	60	2%	S2B	G4	SC/M	
Chondestes grammacus (Lark Sparrow)	2008	5	6	83%	S2B	G5	SC/M	
Coccyzus americanus (Yellow-billed Cuckoo)	2009	18	39	46%	S3B	G5	SC/M	
Colinus virginianus (Northern Bobwhite)	2007	1	2	50%	S3B	G5	SC/M	
Dendroica cerulea (Cerulean Warbler)[d]	2009	33	92	36%	S2S3B	G4	THR	
Dendroica dominica (Yellow-throated Warbler)[d]	2006	1	2	50%	S1B	G5	END	
Empidonax virescens (Acadian Flycatcher)	2008	26	47	55%	S3B	G5	THR	
Falco peregrinus (Peregrine Falcon)	2007	11	23	48%	S1S2B	G4	END	
Haliaeetus leucocephalus (Bald Eagle)	2008	149	1286	12%	S4B,S2N	G5	SC/P	
Helmitheros vermivorus (Worm-eating Warbler)[d]	2008	9	11	82%	S1B	G5	END	
Ixobrychus exilis (Least Bittern)	2008	3	23	13%	S3B	G5	SC/M	
Lanius ludovicianus (Loggerhead Shrike)	2001	7	31	23%	S1B	G4	END	
Nyctanassa violacea (Yellow-crowned Night-heron)	1985	2	7	29%	S1B	G5	THR	
Oporornis formosus (Kentucky Warbler)[d]	2008	24	31	77%	S1S2B	G5	THR	
Pandion haliaetus (Osprey)	2006	5	733	1%	S4B	G5	SC/M	
Protonotaria citrea (Prothonotary Warbler)	2009	6	40	15%	S3B	G5	SC/M	
Rallus elegans (King Rail)	1993	1	6	17%	S1B	G4	SC/M	
Seiurus motacilla (Louisiana Waterthrush)	2006	15	34	44%	S3B	G5	SC/M	
Spiza americana (Dickcissel)	2007	5	46	11%	S3B	G5	SC/M	
Sterna forsteri (Forster's Tern)	1977	3	31	10%	S1B	G5	END	
Sturnella neglecta (Western Meadowlark)	2007	6	39	15%	S2B	G5	SC/M	
Tyto alba (Barn Owl)	1999	5	29	17%	S1B,S1N	G5	END	
Vireo bellii (Bell's Vireo)	2008	21	43	49%	S2B	G5	THR	
Wilsonia citrina (Hooded Warbler)[d]	2008	18	32	56%	S2S3B	G5	THR	
HERPTILES								
Acris crepitans (northern cricket frog)	2006	29	102	28%	S1	G5	END	
Apalone mutica (smooth softshell)	1973	2	5	40%	S3	G5	SC/H	
Aspidoscelis sexlineata (six-lined racerunner)	2009	6	6	100%	S3	G5	SC/H	
Carphophis vermis (western wormsnake)	2006	2	2	100%	S1	G5	SC/H	
Coluber constrictor (North American racer)	2008	10	14	71%	S2	G5	SC/P	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Crotalus horridus (timber rattlesnake)	2008	58	61	95%	S2S3	G4	SC/P	
Diadophis punctatus arnyi (prairie ring-necked snake)	2008	4	4	100%	S3	G5T5	SC/H	
Diadophis punctatus edwardsii (Northern Ring-necked snake)	1997	2	22	9%	S3?	G5T5	SC/H	
Emydoidea blandingii (Blanding's turtle)	2008	39	316	12%	S3	G4	THR	
Glyptemys insculpta (wood turtle)	2008	40	262	15%	S2	G4	THR	
Hemidactylium scutatum (four-toed salamander)	2008	8	63	13%	S3	G5	SC/H	
Lithobates catesbeianus (American bullfrog)	2005	4	70	6%	S3	G5	SC/H	
Ophisaurus attenuatus (slender glass lizard)	2006	21	67	31%	S1	G5	END	
Pantherophis spiloides (gray ratsnake)	2008	21	21	100%	S2S3	G5T5	SC/P	
Pituophis catenifer (gophersnake)	2008	25	29	86%	S2S3	G5	SC/P	
Sistrurus catenatus catenatus (eastern massasauga)	2007	4	13	31%	S1	G3G4T3T4Q	END	C
Terrapene ornata (ornate box turtle)	2009	18	29	62%	S1	G5	END	
Thamnophis proximus (western ribbonsnake)	1975	1	2	50%	S1	G5	END	
FISHES								
Acipenser fulvescens (lake sturgeon)	1994	9	99	9%	S3	G3G4	SC/H	
Alosa chrysochloris (skipjack herring)	1993	3	4	75%	S1	G5	END	
Anguilla rostrata (American eel)	1985	11	24	46%	S2	G4	SC/N	
Aphredoderus sayanus (pirate perch)	2008	26	39	67%	S3	G5	SC/N	
Clinostomus elongatus (redside dace)	1993	30	96	31%	S3	G3G4	SC/N	
Crystallaria asprella (crystal darter)	2008	10	11	91%	S1	G3	END	
Cycleptus elongatus (blue sucker)	2008	6	8	75%	S2	G3G4	THR	
Erimyzon sucetta (lake chubsucker)	2008	8	85	9%	S3	G5	SC/N	
Etheostoma asprigene (mud darter)	2008	36	36	100%	S3	G4G5	SC/N	
Etheostoma chlorosoma (bluntnose darter)	1996	1	1	100%	S1	G5	END	
Etheostoma clarum (western sand darter)	1995	5	11	45%	S3	G3	SC/N	
Etheostoma microperca (Least darter)	2004	2	83	2%	S3	G5	SC/N	
Fundulus dispar (starhead topminnow)	2008	26	33	79%	S2	G4	END	
Hiodon alosoides (goldeye)	1994	8	8	100%	S2	G5	END	
Ictiobus niger (black buffalo)	2000	8	11	73%	S2	G5	THR	
Lythrurus umbratilis (redfin shiner)	1976	1	37	3%	S2	G5	THR	
Macrhybopsis aestivalis (shoal chub)	1994	8	10	80%	S2	G5	THR	
Macrhybopsis storeriana (silver chub)	1993	9	13	69%	S3	G5	SC/N	
Moxostoma carinatum (river redhorse)	2008	15	43	35%	S2	G4	THR	
Moxostoma duquesnei (black redhorse)	1993	3	6	50%	S1	G5	END	
Moxostoma valenciennesi (greater redhorse)	1994	3	56	5%	S3	G4	THR	
Notropis amnis (pallid shiner)	1994	1	1	100%	S2	G4	END	
Notropis nubilus (ozark minnow)	2007	7	24	29%	S2	G5	THR	
Notropis texanus (weed shiner)	2008	17	45	38%	S3	G5	SC/N	
Opsopoeodus emiliae (pugnose minnow)	2004	15	31	48%	S3	G5	SC/N	
Percina evides (gilt darter)	1979	2	26	8%	S2	G4	THR	
Polyodon spathula (paddlefish)	2003	10	11	91%	S2	G4	THR	
MUSSELS/CLAMS								
Alasmidonta marginata (elktoe)	2008	4	44	9%	S4	G4	SC/P	
Anodonta suborbiculata (flat floater)	1988	1	1	100%	S1S2	G5	SC/P	
Arcidens confragosus (rock pocketbook)	1997	5	5	100%	S1S2	G4	THR	
Cumberlandia monodonta (spectacle case)[e]	1989	3	5	60%	S1	G3	END	C

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Cyclonaias tuberculata (purple wartyback)	1989	3	16	19%	S1S2	G5	END	
Ellipsaria lineolata (butterfly)	2001	4	5	80%	S2	G4	END	
Elliptio crassidens (elephant ear)	1982	1	2	50%	S1	G5	END	
Fusconaia ebena (ebony shell)	1988	5	6	83%	S1	G4G5	END	
Lampsilis higginsii (Higgins' eye)	2008	6	7	86%	S1	G1	END	LE
Lampsilis teres (yellow & slough sandshells)	1988	1	1	100%	S1	G5	END	
Megalonaias nervosa (washboard)	1979	2	3	67%	S3	G5	SC/P	
Plethobasus cyphyus (bullhead/sheepnose)[e]	1988	2	5	40%	S1	G3	END	C
Pleurobema sintoxia (round pigtoe)	1998	6	50	12%	S3	G4G5	SC/P	
Quadrula metanevra (monkeyface)	1988	7	11	64%	S2	G4	THR	
Quadrula nodulata (wartyback)	1988	4	5	80%	S1S2	G4	THR	
Simpsonaias ambigua (salamander mussel)	2002	26	51	51%	S2S3	G3	THR	
Tritogonia verrucosa (buckhorn)	1998	7	12	58%	S2	G4G5	THR	
MISCELLANEOUS INVERTEBRATES								
Gastrocopta procera (wing snaggletooth)	1987	15	15	100%	S3	G5	THR	
Helicodiscus singleyanus (smooth coil)	1987	12	12	100%	S3	G5	SC/N	
Hendersonia occulta (cherrystone drop)	1998	13	53	25%	S3	G4	THR	
Palaemonetes kadiakensis (Mississippi grass shrimp)	2008	2	2	100%	S1	G5	SC/N	
Vertigo hubrichti (Midwest Pleistocene vertigo)	1998	8	47	17%	S1	G3	END	
Zonitoides limatulus (dull gloss)	1991	3	3	100%	S1	G4G5	SC/N	
BUTTERFLIES/MOTHS								
Atrytonopsis hianna (dusted skipper)	1996	4	31	13%	S3	G4G5	SC/N	
Callophrys gryneus (juniper hairstreak)	1991	6	8	75%	S3	G5	SC/N	
Callophrys irus (frosted elfin)	1997	1	17	6%	S1	G3	THR	
Catocala abbreviatella (abbreviated underwing moth)	1998	5	8	63%	S3	G4	SC/N	
Catocala whitneyi (Whitney's underwing moth)	1997	6	10	60%	S3	G3G4	SC/N	
Chlosyne gorgone (gorgone checker spot)	1997	14	40	35%	S3	G5	SC/N	
Erynnis baptisiae (wild indigo dusky wing)	1995	4	4	100%	S2S3	G5	SC/N	
Erynnis lucilius (columbine dusky wing)	1997	8	11	73%	S2	G4	SC/N	
Erynnis persius (persius dusky wing)	1993	4	26	15%	S2	G5	SC/N	
Euchlaena milnei (a looper moth)	1987	2	2	100%	S1S2	G2G4	SC/N	
Euphyes bimacula (two-spotted skipper)	1990	2	17	12%	S3	G4	SC/N	
Grammia phyllira (phyllira tiger moth)	2001	8	14	57%	S2	G4	SC/N	
Hesperia leonardus (Leonard's skipper)	2002	9	29	31%	S3	G4	SC/N	
Hesperia metea (cobweb skipper)	1990	2	12	17%	S2	G4G5	SC/N	
Hesperia ottoe (ottoe skipper)	2008	13	16	81%	S2	G3G4	SC/N	
Lycaeides melissa samuelis (Karner blue)	2005	34	316	11%	S3	G5T2	SC/FL	LE
Lycaena dione (gray copper)	1991	3	14	21%	S2	G5	SC/N	
Papaipema silphii (silphium borer moth)	2008	1	15	7%	S2	G3G4	END	
Phyciodes batesii lakota (Lakota crescent)	1992	1	24	4%	S3	G4T4	SC/N	
Poanes massasoit (mulberry wing)	2003	4	56	7%	S3	G4	SC/N	
Pompeius verna (little glassy wing)	1997	2	7	29%	S1?	G5	SC/N	
Problema byssus (byssus skipper)	1996	1	1	100%	S1?	G3G4	SC/N	
Schinia indiana (phlox moth)	2004	16	31	52%	S2S3	G2G4	END	
Speyeria idalia (regal fritillary)	2008	7	24	29%	S1	G3	END	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
DRAGONFLIES/DAMSELFLIES								
Archilestes grandis (great spreadwing)	1983	1	3	33%	S2	G5	SC/N	
Argia plana (Highland dancer)	1986	1	4	25%	S2	G5	SC/N	
Arigomphus submedianus (jade clubtail)	2004	1	4	25%	S2	G5	SC/N	
Epiaeschna heros (swamp darner)	1991	1	4	25%	S1?	G5	SC/N	
Gomphurus externus (plains clubtail)	1992	4	6	67%	S2	G5	SC/N	
Ischnura posita (fragile forktail)	1989	2	6	33%	S2S3	G5	SC/N	
Libellula cyanea (white-spangled skimmer)	1988	1	2	50%	S1	G5	SC/N	
Macromia taeniolata (royal river cruiser)	1989	1	1	100%	S1	G5	SC/N	
Nasiaeschna pentacantha (cyrano darner)	1992	4	14	29%	S3	G5	SC/N	
Neurocordulia molesta (smoky shadowfly)	1998	5	9	56%	S2S3	G4	SC/N	
Ophiogomphus howei (pygmy snaketail)	1999	1	33	3%	S4	G3	THR	
Ophiogomphus smithi (sand snaketail)	1998	7	28	25%	S2	G2G3	SC/N	
Somatochlora tenebrosa (clamp-tipped emerald)	1989	2	6	33%	S1S2	G5	SC/N	
Stylurus plagiatus (russet-tipped clubtail)	1992	2	8	25%	S2	G5	SC/N	
BEETLES								
Cicindela lepida (little white tiger beetle)	2001	5	13	38%	S2	G3G4	SC/N	
Cicindela macra (a tiger beetle)	2001	2	3	67%	S1S2	G5	SC/N	
Cicindela patruela huberi (a tiger beetle)	2000	15	84	18%	S3	G3T3	SC/N	
Cicindela patruela patruela (a tiger beetle)	1999	2	26	8%	S2	G3T3	SC/N	
Collops vicarius (a melyrid beetle)	1999	1	1	100%	S1	GNR	SC/N	
Hydroporus pseudovilis (a predaceous diving beetle)	1998	1	4	25%	S1S2	GNR	SC/N	
Liodessus cantralli (Cantrall's bog beetle)	1990	1	4	25%	S1S2	GNR	SC/N	
Lioporeus triangularis (a predaceous diving beetle)	1985	1	4	25%	S1S2	GNR	SC/N	
Megacephala virginica (Virginia big-headed tiger beetle)	2003	2	2	100%	S1	G5	SC/N	
Stenelmis knobeli (Knobel's riffle beetle)	1992	1	1	100%	S1	G1G3	END	
Xyloryctes jamaicensis (rhinoceros beetle)	1973	1	1	100%	S1?	GNR	SC/N	
MISCELLANEOUS INSECTS/SPIDERS								
Acanthametropus pecatonica (Pecatonica River mayfly)	1998	3	3	100%	S1	G2G4	END	
Aeropedellus clavatus (club-horned grasshopper)	2004	1	3	33%	S2	G5	SC/N	
Aflexia rubranura (red-tailed prairie leafhopper)	2006	8	25	32%	S2	G2	END	
Arphia conspersa (speckled rangeland grasshopper)	1997	1	8	13%	S2	G5	SC/N	
Attenuipyga vanduzeei (a leafhopper)	2009	4	4	100%	S1	GNR	SC/N	
Dichromorpha viridis (short-winged grasshopper)	1998	1	4	25%	S3?	G5	SC/N	
Eritettix simplex (velvet-striped grasshopper)	1996	1	1	100%	S2S3	G5	SC/N	
Homoeoneuria ammophila (a brush-legged mayfly)	1991	1	3	33%	S1S2	G4	SC/N	
Laevicephalus vannus (a leafhopper)	1996	1	2	50%	S1?	GNR	SC/N	
Lepidostoma libum (a lepidostomatid caddisfly)	1981	1	5	20%	S1?	G3G4	SC/N	
Macdunnoa persimplex (a flat-headed mayfly)	1995	2	3	67%	S1?	G4	SC/N	
Melanoplus flavidus (blue-legged grasshopper)	1996	1	2	50%	S2S3	G4	SC/N	
Mermiria bivittata (mermiria grasshopper)	2005	1	1	100%	S2	G5	SC/N	
Metretopus borealis (a cleft-footed minnow mayfly)	1993	3	3	100%	S1?	G5	SC/N	
Orphulella pelidna (spotted-winged grasshopper)	1998	1	7	14%	S2S3	G5	SC/N	
Paracloeodes minutus (a small minnow mayfly)	1995	1	4	25%	S1?	G5	SC/N	
Paraphlepsius maculosus (a leafhopper)	1997	1	1	100%	S1	GNR	SC/N	
Polyamia dilata (prairie leafhopper)	2009	16	20	80%	S2	GNR	THR	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Prairiana cinerea (a leafhopper)	1995	2	6	33%	S2S3	GNR	SC/N	
Pseudiron centralis (a flat-headed mayfly)	1992	6	10	60%	S3	G5	SC/N	
Psinidia fenestralis (sand locust)	1998	1	4	25%	S3?	G5	SC/N	
Spinadis simplex (Wallace's deepwater mayfly)	1990	3	4	75%	S1	G2G4	END	
Trimerotropis maritima (seaside grasshopper)	1998	1	3	33%	S2S3	G5	SC/N	
Zealeuctra narfi (a rolled-winged winter stonefly)	1992	1	1	100%	S1	G4	SC/N	
PLANTS								
Aconitum noveboracense (northern wild monkshood)	2009	18	18	100%	S2	G3	THR	LT
Adlumia fungosa (climbing fumitory)	1995	1	29	3%	S2	G4	SC	
Adoxa moschatellina (musk-root)	2002	12	13	92%	S2	G5	THR	
Agalinis gattingeri (roundstem foxglove)	1999	19	23	83%	S3	G4	THR	
Agalinis skinneriana (pale false foxglove)	2001	7	8	88%	S2	G3G4	END	
Agastache nepetoides (yellow giant hyssop)	2009	12	30	40%	S3	G5	THR	
Anemone caroliniana (Carolina anemone)	1999	2	4	50%	S1	G5	END	
Aplectrum hyemale (putty root)	2009	12	17	71%	S2S3	G5	SC	
Arabis shortii (Short's rock-cress)	2008	2	11	18%	S2	G5	SC	
Aristida dichotoma (Shinners' three-awned grass)	1991	3	3	100%	S1	G5	SC	
Artemisia dracunculus (dragon wormwood)	2003	4	5	80%	S2	G5	SC	
Artemisia frigida (prairie sagebrush)	2003	5	5	100%	S2	G5	SC	
Asclepias lanuginosa (woolly milkweed)	1998	3	16	19%	S1	G4?	THR	
Asclepias ovalifolia (dwarf milkweed)	1998	6	60	10%	S3	G5?	THR	
Asclepias purpurascens (purple milkweed)	2009	25	39	64%	S3	G5?	END	
Asclepias sullivantii (prairie milkweed)	1993	1	23	4%	S2S3	G5	THR	
Asplenium pinnatifidum (lobed spleenwort)	1992	4	4	100%	S1	G4	THR	
Asplenium trichomanes (maidenhair spleenwort)	1992	4	27	15%	S3	G5	SC	
Astragalus crassicarpus (ground-plum)	2003	2	12	17%	S2	G5	END	
Bartonia virginica (yellow screwstem)	1986	1	81	1%	S3	G5	SC	
Besseya bullii (kitten tails)	1976	1	98	1%	S3	G3	THR	
Cacalia muehlenbergii (great Indian-plantain)	1996	15	25	60%	S2S3	G4	SC	
Cacalia suaveolens (sweet-scented Indian-plantain)	2008	16	28	57%	S3	G4	SC	
Cacalia tuberosa (prairie Indian plantain)	2009	20	62	32%	S3	G4G5	THR	
Callirhoe triangulata (clustered poppy-mallow)	2008	22	22	100%	S3	G3	SC	
Callitriche heterophylla (large water-starwort)	1977	2	3	67%	S1	G5	THR	
Calylophus serrulatus (yellow evening primrose)	1986	2	9	22%	S2	G5	SC	
Camassia scilloides (wild hyacinth)	1995	1	8	13%	S2	G4G5	END	
Carex artitecta (dry woods sedge)	1981	1	1	100%	S1	G5	SC	
Carex assiniboinensis (Assiniboine sedge)	1992	1	33	3%	S3	G4G5	SC	
Carex backii (Rocky Mountain sedge)	1993	2	4	50%	S1	G4	SC	
Carex careyana (Carey's sedge)	1982	1	1	100%	S1	G4G5	THR	
Carex folliculata (long sedge)	2004	8	69	12%	S3	G4G5	SC	
Carex laevivaginata (smooth-sheath sedge)	2000	2	3	67%	S1	G5	END	
Carex media (intermediate sedge)	2008	5	5	100%	S2	G5T5?	END	
Carex prasina (drooping sedge)	1996	26	31	84%	S3	G4	THR	
Carex richardsonii (Richardson's sedge)	2008	7	24	29%	S2	G4	SC	
Chaerophyllum procumbens (spreading chervil)	1993	2	4	50%	S1	G5	SC	
Cirsium hillii (Hill's thistle)	2003	25	58	43%	S3	G3	THR	
Commelina erecta var. *deamiana* (narrow-leaved dayflower)	2003	5	5	100%	S1	G5T5	SC	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Corallorhiza odontorhiza (autumn coral-root)	2006	22	36	61%	S3	G5	SC	
Crotalaria sagittalis (arrow-headed rattle-box)	1992	1	2	50%	S1	G5	SC	
Cypripedium candidum (small white lady's-slipper)	1986	1	47	2%	S3	G4	THR	
Cypripedium parviflorum var. *makasin* (northern yellow lady's-slipper)	1991	1	78	1%	S3	G5T4Q	SC	
Cypripedium reginae (showy lady's-slipper)	1986	1	99	1%	S3	G4	SC	
Cystopteris laurentiana (laurentian bladder fern)	1977	1	11	9%	S2	G3	SC	
Dalea villosa var. *villosa* (silky prairie-clover)	1996	3	18	17%	S2	G5	SC	
Desmodium canescens (hoary tick-trefoil)	2000	3	3	100%	S1	G5	SC	
Diarrhena obovata (beak grass)	2008	5	11	45%	S2	G4G5	END	
Didiplis diandra (water-purslane)	1970	1	4	25%	S1	G5	SC	
Diodia teres var. *teres* (buttonweed)	2008	3	4	75%	S1	G5T5	SC	
Diplazium pycnocarpon (glade fern)	1992	9	12	75%	S2	G5	SC	
Dodecatheon amethystinum (jewelled shooting star)	2008	5	5	100%	S2	G4	SC	
Echinacea pallida (pale-purple coneflower)	2002	6	54	11%	S3	G4	THR	
Eleocharis engelmannii (Engelmann's spike-rush)	1972	1	4	25%	S1	G4G5Q	SC	
Eleocharis robbinsii (Robbins' spike-rush)	1991	1	28	4%	S3	G4G5	SC	
Epilobium palustre (marsh willow-herb)	1976	1	37	3%	S3	G5	SC	
Equisetum palustre (marsh horsetail)	1976	1	21	5%	S2	G5	SC	
Eupatorium sessilifolium var. *brittonianum* (upland boneset)	2008	37	40	93%	S3	G5T3T5	SC	
Gentiana alba (yellow gentian)	2008	48	80	60%	S3	G4	THR	
Gentianopsis procera (lesser fringed gentian)	1986	1	66	2%	S3	G5	SC	
Glycyrrhiza lepidota (wild licorice)	2002	1	6	17%	S1S2	G5	SC	
Gnaphalium obtusifolium var. *saxicola* (cliff cudweed)	2001	4	10	40%	S2	G5T2	THR	
Gymnocarpium robertianum (limestone oak fern)	1985	2	8	25%	S2	G5	SC	
Gymnocladus dioicus (Kentucky coffee-tree)	2009	4	9	44%	S2	G5	SC	
Houstonia caerulea (innocence)	1992	1	8	13%	S2	G5	SC	
Huperzia porophila (rock clubmoss)	1996	13	22	59%	S3	G4	SC	
Hydrophyllum appendiculatum (great water-leaf)	2008	3	3	100%	S2S3	G5	SC	
Hypericum sphaerocarpum (roundfruit St. John's-wort)	1972	2	6	33%	S1S2	G5	THR	
Jeffersonia diphylla (twinleaf)	2006	10	23	43%	S3	G5	SC	
Lespedeza leptostachya (prairie bush-clover)	2008	3	22	14%	S2	G3	END	LT
Lespedeza violacea (violet bush-clover)	1998	15	15	100%	S2	G5	SC	
Lespedeza virginica (slender bush-clover)	2001	13	13	100%	S2	G5	THR	
Lesquerella ludoviciana (silver bladderpod)	2002	1	1	100%	S1	G5	THR	
Liatris punctata var. *nebraskana* (dotted blazing star)	1989	3	20	15%	S2S3	G5T3T5	END	
Lithospermum latifolium (American gromwell)	1990	2	62	3%	S3	G4	SC	
Microseris cuspidata (prairie false-dandelion)	1998	9	15	60%	S2	G5	SC	
Myosotis laxa (small forget-me-not)	2008	6	9	67%	S2	G5	SC	
Napaea dioica (glade mallow)	2007	26	79	33%	S3	G4	SC	
Onosmodium molle (marbleseed)	1997	11	42	26%	S3	G4G5	SC	
Ophioglossum pusillum (Adder's-tongue)	2001	1	12	8%	S2	G5	SC	
Opuntia fragilis (brittle prickly-pear)	2002	19	36	53%	S3	G4G5	THR	
Orobanche uniflora (one-flowered broomrape)	2008	16	30	53%	S3	G5	SC	
Parthenium integrifolium (American fever-few)	2008	17	83	20%	S3	G5	THR	
Pediomelum argophyllum (silvery scurf pea)	2000	2	2	100%	S1	G5	SC	
Pediomelum esculentum (prairie turnip)	2003	17	47	36%	S3	G5	SC	
Pellaea atropurpurea (purple-stem cliff-brake)	2008	12	16	75%	S2	G5	SC	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Penstemon pallidus (pale beardtongue)	1971	2	2	100%	S1	G5	SC	
Phegopteris hexagonoptera (broad beech fern)	2008	12	17	71%	S2	G5	SC	
Phlox bifida (cleft phlox)	1993	1	1	100%	S1	G5?	SC	
Platanthera flava var. *herbiola* (pale green orchid)	1993	3	20	15%	S2	G4T4Q	THR	
Platanthera hookeri (Hooker's orchid)	1985	5	20	25%	S2S3	G4	SC	
Platanthera orbiculata (large roundleaf orchid)	1972	2	78	3%	S3	G5	SC	
Platanus occidentalis (sycamore)	1985	3	7	43%	S2	G5	SC	
Poa paludigena (bog bluegrass)	1992	9	41	22%	S3	G3	THR	
Poa wolfii (Wolf's bluegrass)	1991	1	1	100%	S1	G4	SC	
Polygala cruciata (crossleaf milkwort)	1991	2	83	2%	S3	G5	SC	
Polygala incarnata (pink milkwort)	2007	2	4	50%	S1	G5	END	
Polystichum acrostichoides (Christmas fern)	2000	3	13	23%	S2	G5	SC	
Polytaenia nuttallii (prairie parsley)	2004	10	26	38%	S3	G5	THR	
Potamogeton vaseyi (Vasey's pondweed)	1974	1	19	5%	S2	G4	SC	
Prenanthes aspera (rough rattlesnake-root)	2004	4	10	40%	S2	G4?	END	
Prenanthes crepidinea (nodding rattlesnake-root)	2001	2	3	67%	S1	G4	END	
Primula mistassinica (bird's-eye primrose)	1996	17	42	40%	S3	G5	SC	
Ptelea trifoliata (wafer-ash)	1994	2	14	14%	S2	G5	SC	
Quercus muehlenbergii (chinquapin oak)	2009	4	6	67%	S1S2	G5	SC	
Quercus palustris (pin oak)	1993	2	2	100%	S1	G5	SC	
Rhamnus lanceolata var. *glabrata* (lanced-leaved buckthorn)	2008	7	7	100%	S1	G5T4T5	SC	
Rhexia virginica (Virginia meadow-beauty)	2001	1	22	5%	S3	G5	SC	
Rhododendron lapponicum (Lapland azalea)	1996	1	2	50%	S1	G5	END	
Ruellia humilis (hairy wild-petunia)	2008	4	13	31%	S2	G5	END	
Scleria triglomerata (whip nutrush)	2001	6	17	35%	S2S3	G5	SC	
Scutellaria ovata (heart-leaved skullcap)	2008	7	16	44%	S3	G5	SC	
Scutellaria parvula var. *parvula* (small skullcap)	1989	1	3	33%	S1	G4T4	END	
Senecio plattensis (prairie ragwort)	2008	8	10	80%	S3	G5	SC	
Senna marilandica (Maryland senna)	1973	1	1	100%	S1	G5	SC	
Silene nivea (snowy campion)	1986	4	6	67%	S2	G4?	THR	
Silene regia (wild pink)	2005	1	1	100%	SU	G3	SC	
Solidago sciaphila (shadowy goldenrod)	2009	36	57	63%	S3	G3G4	SC	
Spiranthes ovalis var. *erostellata* (october lady's-tresses)	2007	3	3	100%	S1	G5?T4?	SC	
Strophostyles leiosperma (small-flowered woolly bean)	1989	2	6	33%	S2	G5	SC	
Talinum rugospermum (prairie fame-flower)	2008	30	54	56%	S3	G3G4	SC	
Thaspium barbinode (hairy-jointed meadow-parsnip)	2000	3	3	100%	S1	G5	END	
Thelypteris simulata (bog fern)	2000	6	72	8%	S3	G4G5	SC	
Trillium nivale (snow trillium)	2008	12	34	35%	S3	G4	THR	
Triphora trianthophora (nodding pogonia)	2002	14	16	88%	S2	G3G4	SC	
Utricularia geminiscapa (hidden-fruited bladderwort)	1975	1	95	1%	S3	G4G5	SC	
Viola fimbriatula (sand violet)	1997	1	17	6%	S2	G5T5	END	
Woodsia oregana ssp. *cathcartiana* (Oregon woodsia [tetraploid])	1978	1	2	50%	S1	G5T5	SC	
Zigadenus elegans var. *glaucus* (white camas)	2008	3	4	75%	S2S3	G5T4T5	SC	
COMMUNITIES								
Alder Thicket	1997	15	106	14%	S4	G4	NA	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Algific Talus Slope	1988	8	8	100%	S1	G2	NA	
Bedrock Glade	1993	2	20	10%	S3	G2	NA	
Calcareous Fen	1984	2	84	2%	S3	G3	NA	
Cedar Glade	1984	10	16	63%	S4	GNR	NA	
Dry Cliff	2008	50	88	57%	S4	G4G5	NA	
Dry Prairie	2008	89	146	61%	S3	G3	NA	
Dry-mesic Prairie	2004	9	37	24%	S2	G3	NA	
Emergent Marsh	2008	49	272	18%	S4	G4	NA	
Ephemeral Pond	1978	3	11	27%	SU	GNRQ	NA	
Floodplain Forest	2008	66	182	36%	S3	G3?	NA	
Forested Seep	2001	5	15	33%	S2	GNR	NA	
Glaciere Talus	1998	1	6	17%	S2	G2G3	NA	
Hardwood Swamp	1993	1	53	2%	S3	G4	NA	
Hemlock Relict	2003	24	32	75%	S2	G2Q	NA	
Lake—Oxbow	1981	6	14	43%	SU	GNR	NA	
Lake—Shallow, Hard, Drainage	1985	4	35	11%	SU	GNR	NA	
Lake—Shallow, Soft, Seepage	1979	1	87	1%	S4	GNR	NA	
Lake—Spring	1983	1	13	8%	S3	GNR	NA	
Lake—Unique	1981	1	7	14%	SU	GNR	NA	
Mesic Prairie	1976	2	44	5%	S1	G2	NA	
Moist Cliff	2008	101	176	57%	S4	GNR	NA	
Moist Sandy Meadow	2007	1	3	33%	SU	GNR	NA	
Northern Dry Forest	1982	2	63	3%	S3	G3?	NA	
Northern Dry-mesic Forest	1998	17	284	6%	S3	G4	NA	
Northern Mesic Forest	1993	5	383	1%	S4	G4	NA	
Northern Sedge Meadow	1985	4	231	2%	S3	G4	NA	
Northern Wet Forest	1986	8	322	2%	S4	G4	NA	
Northern Wet-mesic Forest	2004	2	243	1%	S3S4	G3?	NA	
Oak Barrens	2008	16	38	42%	S2	G2?	NA	
Oak Opening	1997	7	25	28%	S1	G1	NA	
Oak Woodland	2004	4	10	40%	S1?	GNR	NA	
Pine Barrens	2003	9	56	16%	S2	G2	NA	
Pine Relict	2008	47	61	77%	S2	G4	NA	
Sand Barrens	2002	21	29	72%	SU	GNR	NA	
Sand Prairie	2008	18	28	64%	S2	GNR	NA	
Shrub-carr	2007	27	143	19%	S4	G5	NA	
Southern Dry Forest	2006	40	97	41%	S3	G4	NA	
Southern Dry-mesic Forest	2006	122	293	42%	S3	G4	NA	
Southern Hardwood Swamp	1993	1	30	3%	S2	G4?	NA	
Southern Mesic Forest	2008	81	221	37%	S3	G3?	NA	
Southern Sedge Meadow	2007	47	182	26%	S3	G4?	NA	
Southern Tamarack Swamp (Rich)	2007	3	32	9%	S3	G3	NA	
Springs and Spring Runs, Hard	1984	9	71	13%	S4	GNR	NA	
Springs and Spring Runs, Soft	1981	2	12	17%	SU	GNR	NA	
Stream—Fast, Hard, Cold	2000	10	98	10%	S4	GNR	NA	
Stream—Fast, Hard, Warm	1980	1	10	10%	SU	GNR	NA	
Stream—Fast, Soft, Cold	1991	4	15	27%	SU	GNR	NA	
Stream—Fast, Soft, Warm	1976	1	5	20%	SU	GNR	NA	
Stream—Slow, Hard, Cold	1985	3	22	14%	SU	GNR	NA	

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Appendix 22.C, *continued.*

Scientific name (common name)	Lastobs date	EOs[a] in WCR	EOs in WI	Percent in WCR	State rank	Global rank	State status	Federal status
Stream—Slow, Hard, Warm	1981	1	20	5%	SU	GNR	NA	
Stream—Slow, Soft, Cold	1982	1	8	13%	SU	GNR	NA	
Wet Prairie	1981	3	22	14%	SU	G3	NA	
Wet-mesic Prairie	1990	3	81	4%	S2	G2	NA	
White Pine-Red Maple Swamp	2004	3	21	14%	S2	G3G4	NA	
OTHER ELEMENTS								
Bat hibernaculum	2005	32	43	74%	S3	GNR	SC	
Bird rookery	2009	11	54	20%	SU	G5	SC	
Herptile hibernaculum	2008	11	14	79%	SU	GNR	SC	
Migratory bird concentration site	1999	1	8	13%	SU	G3	SC	
Mussel bed	1988	26	27	96%	S3?	G3	SC	

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

[b]Northern long-eared (*Myotis septentrionalis*) and eastern pipistrelle (*Perimyotis subflavus*) bats were listed as Wisconsin Threatened in 2011. Northern long-eared bat was listed as U.S. Threatened in 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 these warblers as Cerulean Warbler (*Setophaga cerulea*), Hooded Warbler (*Setophaga citrina*), Kentucky Warbler (*Geothlypis formosa*), Worm-eating Warbler (*Helmitheros vermivorum*), and Yellow-throated Warbler (*Setophaga dominica*).

[e]Spectacle case (*Cumberlandia monodonta*) and bullhead (sheepnose) (*Plethobasus cyphyus*) mussels were listed as U.S. Endangered in 2012.

STATUS AND RANKING DEFINITIONS

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

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

State Status—Protection category designated by the Wisconsin DNR:

END = Endangered. Endangered species means any species whose continued existence as a viable component of this state's wild animals or wild plants is determined by the Wisconsin DNR to be in jeopardy on the basis of scientific evidence.
THR = Threatened species means any species of wild animals or wild plants that appears likely, within the foreseeable future, on the basis of scientific evidence to become endangered.
SC = Special Concern. Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proven. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

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

SC/P = fully protected.
SC/N = no laws regulating use, possession, or harvesting.
SC/H = take regulated by establishment of open closed seasons.
SC/FL = federally protected as endangered or threatened but not so designated by Wisconsin DNR.
SC/M = fully protected by federal and state laws under the Migratory Bird Act.

Global Element Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factor(s) making it vulnerable to extinction throughout its range; typically 21-100 occurrences.
G4 = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery) and usually widespread. Typically > 100 occurrences.
G5 = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery). Not vulnerable in most of its range.
GH = Known only from historical occurrence throughout its range, with the expectation that it may be rediscovered.
GNR = Not ranked. Replaced G? rank and some GU ranks.
GU = Currently unrankable due to lack of data or substantially conflicting data on status or trends. Possibly in peril range-wide, but status is uncertain.
GX = Presumed to be extinct throughout its range (e.g., Passenger pigeon) with virtually no likelihood that it will be rediscovered.

Status and ranking definitions continued on next page

Appendix 22.C, *continued.*

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 22.D. *Number of species with special designations documented within the Western Coulees and Ridges Ecological Landscape, 2009.*

Listing status[a]	Taxa					Total fauna	Total flora	Total listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
U.S. Endangered	1	0	0	0	2	3	0	3
U.S. Threatened	0	0	0	0	0	0	2	2
U.S. Candidate	0	0	1	0	2	3	0	3
Wisconsin Endangered	0	6	5	7	16	34	18	52
Wisconsin Threatened	0	9	2	9	10	30	28	58
Wisconsin Special Concern	7	15	11	11	70	114	84	198
Natural Heritage Inventory total	**7**	**30**	**18**	**27**	**96**	**178**	**130**	**308**

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

[a]Eastern pipistrelle (*Perimyotis subflavus*) and northern long-eared (*Myotis septentrionalis*) bats were listed as Wisconsin Threatened in 2011, and northern long-eared bat was listed as U.S. Threatened in 2015. Spectacle case (*Cumberlandia monodonta*) and bullhead/sheepose (*Plethobasus cyphyus*) mussels were listed as U.S. Endangered in 2012. These species are not included in the numbers above.

Appendix 22.E. *Species of Greatest Conservation Need (SGCN) found in the Western Coulees and Ridges Ecological Landscape.*

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

Canvasback. Photo by Herbert Lange.

	MAJOR																							IMPORTANT												
	Bedrock Glade	Cedar Glade	Coldwater streams	Coolwater streams	Dry Cliff	Dry Prairie	Dry-mesic Prairie	Emergent Marsh	Floodplain Forest	Hemlock Relict	Moist Cliff	Oak Barrens	Oak Opening	Oak Woodland	Pine Relict	Sand Prairie	Shrub-carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Mesic Forest	Submergent Marsh	Surrogate Grasslands	Warmwater rivers	Alder Thicket	Emergent Marsh – Wild Rice	Ephemeral Pond	Mesic Prairie	Northern Dry-mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Pine Barrens	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Wet Prairie	Wet-mesic Prairie	White Pine - Red Maple Swamp
Species That Are Significantly Associated with the Western Coulees and Ridges Ecological Landscape																																				
MAMMALS																																				
Northern long-eared bat			H	H				M	M	M		M		M			M	M	M	M	M		M	M		H		M	M							
BIRDS[a]																																				
Acadian Flycatcher									M										H	H																
American Woodcock																	H							H									M			
Bald Eagle																					M		H													
Bell's Vireo						M	M									M	M					M												M	M	
Black-billed Cuckoo									M			M					H							H							M		M			
Blue-winged Teal							M	H	M												M	M			M		M		M			M		M	M	
Blue-winged Warbler	M								M				M	M			M	M	M	M													M			
Bobolink							H															H					H		H			M		H	H	
Brown Thrasher						M	M					H	H			H						M									H					
Canvasback																					H		H		M											
Cerulean Warbler									H					M					H	M																
Dickcissel							H															H					H									
Eastern Meadowlark						M	H						M			M						H					H					M			M	
Field Sparrow		H				H	M					M	H			H						M					M				M				M	
Grasshopper Sparrow						H	H					M				H						H														
Great Egret								H	M												M		M													
Henslow's Sparrow							H						M									H					H							M	M	
Hooded Warbler																			H	H																
Kentucky Warbler									H										M	H																
Lark Sparrow		H				M						H				H															M					
Least Flycatcher									M																			M								
Lesser Scaup																					H		M		M											

Continued on next page

Appendix 22.E, *continued.*

Ornate box turtle.
Photo by Wisconsin DNR staff.

	MAJOR																							IMPORTANT												
	Bedrock Glade	Cedar Glade	Coldwater streams	Coolwater streams	Dry Cliff	Dry Prairie	Dry-mesic Prairie	Emergent Marsh	Floodplain Forest	Hemlock Relict	Moist Cliff	Oak Barrens	Oak Opening	Oak Woodland	Pine Relict	Sand Prairie	Shrub-carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Mesic Forest	Submergent Marsh	Surrogate Grasslands	Warmwater rivers	Alder Thicket	Emergent Marsh – Wild Rice	Ephemeral Pond	Mesic Prairie	Northern Dry-mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Pine Barrens	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Wet Prairie	Wet-mesic Prairie	White Pine - Red Maple Swamp
Louisiana Waterthrush			H	H															H	H																
Northern Bobwhite						M	M						M									H					M								M	
Northern Harrier						M	M					M										H					H		H		M	M		M	H	
Peregrine Falcon					H																															
Prothonotary Warbler									H																											
Red-headed Woodpecker									M			M	H	H				M	M																	
Red-shouldered Hawk									H										M	M						H		M								M
Rusty Blackbird								M	H								M							M		M							M			
Short-billed Dowitcher								H																												
Veery									M	M					M		H		M	M				H				M		M						H
Vesper Sparrow						H	M					H	M			H															H					
Western Meadowlark						M	H					M				M						H														
Whip-poor-will	M											M		H	M			H	H									M			M					
Willow Flycatcher							M										H					M					M					M		M	M	
Wood Thrush									M					M				M	H	H																
Worm-eating Warbler																		M	H	M																
Yellow-billed Cuckoo									H								M		M	M																
Yellow-crowned Night-heron								M	H								M				M		M			H										
HERPTILES																																				
Black rat snake		H			H	H	M		M				M	H	H			H	H	H							M									
Blanchard's cricket frog			H	H				H													H		H									H				
Blanding's turtle		M	M	M		H	M	H	M			H	H	M		H	M		M	M	H		M	M	H	H	M		M		H	M				
Bullsnake	H	H			H	H	H					H	H	H	M	H		M	M	M							M				H					
Eastern massasauga rattlesnake						H	H	H	H			H				H	H							H		H	H				H					
Four-toed salamander			M	M				H	H								H			H				H		H			M	M						
Midland smooth softshell turtle																							H													
Northern prairie skink	H	H			M	H	M					H	H	M		H		M	M									M			H					
Ornate box turtle		H				H	M						H	H		H		H	H	M																
Pickerel frog			H	H				H	M								M			M	H		H	M		H	M		H	M						
Prairie racerunner	M	H				H						H	H			H																				
Prairie ringneck snake	H	H				H	H					M	H	M		M		M	M																	
Timber rattlesnake	M	H			H	H	M		M				H	H	H	H		H	H	H							M									
Western slender glass lizard						H	H					H	M			H															H					
Western worm snake		H				H												M	M																	
Wood turtle			H	H		H	M		H			H	M	M		H	H			M	H		H	H		M			M	M	H					
Yellow-bellied racer		H			M	H	M					M				H		M	M												M					
FISH																																				
Black buffalo																							M													
Blue sucker																							H													
Bluntnose darter																							H													

Continued on next page

Appendix 22.E, *continued.*

Osprey. Photo by Herbert Lange.

	MAJOR																							IMPORTANT												
	Bedrock Glade	Cedar Glade	Coldwater streams	Coolwater streams	Dry Cliff	Dry Prairie	Dry-mesic Prairie	Emergent Marsh	Floodplain Forest	Hemlock Relict	Moist Cliff	Oak Barrens	Oak Opening	Oak Woodland	Pine Relict	Sand Prairie	Shrub-carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Mesic Forest	Submergent Marsh	Surrogate Grasslands	Warmwater rivers	Alder Thicket	Emergent Marsh – Wild Rice	Ephemeral Pond	Mesic Prairie	Northern Dry-mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Pine Barrens	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Wet Prairie	Wet-mesic Prairie	White Pine - Red Maple Swamp
Crystal darter																							H													
Goldeye																							M													
Lake sturgeon																							H													
Paddlefish																							M													
Pallid shiner																							H													
Redside dace			M	M																																
River redhorse																							M													
Shoal chub (speckled chub)																							H													
Starhead topminnow																							H													
Western sand darter																							M													
Species That Are Moderately Associated with the Western Coulees and Ridges Ecological Landscape																																				
MAMMALS																																				
Franklin’s ground squirrel							H					H	H	M		H						M					M				H					
Eastern red bat			H	H				M	M	M		M	M	M	M		M	M	M	M	M		M	M		H		M	M	M						
Hoary bat			H	H				M	M	M					M		M				M		M	M		H		M	M	M		M				
Prairie vole						H	H					M	M			H						M					M					M				
Silver-haired bat			H	H				M	M	M							M				M		M	M		H		M	M	M		M				
Woodland vole													H	H				H	H																	
BIRDS																																				
American Golden Plover							M	M														M					M							M	M	
Black Tern								H													M				M				M							
Buff-breasted Sandpiper							M	M														M												M	M	
King Rail								H																												
Osprey																							H													
Short-eared Owl						M	M										M					H					H		M			M				
Solitary Sandpiper			M	M				H	H																	H										
Upland Sandpiper						H	H					M				M						H					M				M					
Whooping Crane								H													H								M			M				
Yellow-throated Warbler									H										M													M			M
FISH																																				
Gilt darter																							H													

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

Appendix 22.F. *Natural communities[a] for which there are management opportunities in the Western Coulees and Ridges Ecological Landscape.*

Major opportunity[b]	Important opportunity[c]	Present[d]
Southern Dry Forest	Northern Dry-mesic Forest	Northern Mesic Forest
Southern Dry-mesic Forest	Northern Wet Forest	Northern Wet-mesic Forest
Southern Mesic Forest		Northern Hardwood Swamp
Floodplain Forest	White Pine – Red Maple Swamp	
Hemlock Relict	Southern Tamarack Swamp	Southern Hardwood Swamp
Pine Relict		
	Pine Barrens	Bog Relict
Oak Openings		
Oak Woodland	Alder Thicket	Calcareous Fen
Cedar Glade		
Oak Barrens	Mesic Prairie	Impoundment/Reservoir
	Wet-mesic Prairie	Warmwater Stream
Shrub-carr	Wet Prairie	
	Northern Sedge Meadow	
Dry Prairie	Southern Sedge Meadow	
Sand Prairie (includes Sand Barrens)		
Dry-mesic Prairie	Emergent Marsh – Wild Rice	
Surrogate Grasslands	Ephemeral Pond	
Emergent Marsh		
Submergent Marsh		
Algific Talus Slope		
Bedrock Glade		
Dry Cliff (Curtis' s Exposed Cliff)		
Moist Cliff (Curtis's Shaded Cliff)		
Coldwater Stream		
Coolwater Stream		
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 22.G. *Public conservation lands in the Western Coulees and Ridges Ecological Landscape, 2005.*

Property name	Size (acres)[a]
STATE	
Augusta State Wildlife Area[b]	1,750
Battle Bluff State Natural Area	250
Bear Creek State Fishery Area	750
Big Creek State Fishery Area	1,440
Big Swamp State Wildlife Area	755
Black Earth Creek State Fishery Area	370
Black River State Forest[b]	1,520
Blackhawk Lake State Recreation Area	2,050
Blue Mound State Park[b]	190
Borst Valley State Wildlife Area	1,160
Buffalo River State Fishery Area	1,700
Chimney Rock State Wildlife Area	610
Coon Creek State Fishery Area	1,070
Coulee Experimental Forest	2,940
Dell Creek State Wildlife Area[b]	1,370
Devil's Lake State Park[b]	8,700
Dunnville State Wildlife Area	3,620
Elk Creek State Fishery Area	500
Governor Dodge State Park	5,070
Half Moon Lake State Fishery Area	120
Halls (Stockwell) Creek State Fishery Area	850
Hoffman Hills State Recreation Area	710
Kickapoo State Wildlife Area	6,960
Kickapoo Valley Reserve	8,500
Knapp Creek State Wildlife Area	1,620
La Crosse Area Comprehensive State Fishery Area	1,790
La Crosse River State Fishery Area	460
Lakes Coulee State Wildlife Area	580
Lower Wisconsin State Riverway[b]	44,260
Merrick State Park	300
Mill Bluff State Park[b]	120
Muddy Creek State Wildlife Area	3,210
Natural Bridge State Park	540
Nelson Dewey State Park	750
New Auburn State Wildlife Area[b]	140
Nine Mile Island State Natural Area	1,430
North Bend Bottoms State Wildlife Area	1,590
North Branch Trempealeau River State Fishery Area	270
Otter Creek State Wildlife Area	240
Parfrey's Glen State Natural Area	470
Perrot State Park	1,230
Pierce County Islands State Wildlife Area	1,070
Ridgeway Pine Relict State Natural Area	190
Rush Creek State Natural Area	1,850
Rush River Delta State Natural Area	325
Sand Creek State Fishery Area[b]	160
Snow Bottom State Natural Area	200
South Beaver Creek State Wildlife Area	1,120
Tamarack Creek State Wildlife Area	560
Tank Creek State Fishery Area	500
Tiffany State Wildlife Area	12,940
Trempealeau Lakes State Fishery Area	180
Trout Creek Fishery State Area – Iowa County	880
Van Loon State Wildlife Area	3,800

Continued on next page

Appendix 22.G, *continued.*

Property name	Size (acres)[a]
Whitman Dam State Wildlife Area	2,070
Wildcat Mountain State Park	3,580
Willow Creek State Fishery Area	475
Wyalusing State Park	2,620
Miscellaneous lands[c]	28,890
FEDERAL	
Upper Mississippi River Wildlife and Fish Refuge[b]	71,810
Waterfowl Production Areas	980
COUNTY[d]	
Barron County Forest[b]	260
Eau Claire County Forest[b]	10,510
Jackson County Forest[b]	370
Juneau County Forest[b]	320
Monroe County Forest[b]	3,200
TOTAL	**252,315**

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 22.H. *Land Legacy places in the Western Coulees and Ridges Ecological Landscape and their ecological and recreational significance.*

The *Wisconsin Land Legacy Report* (WDNR 2006c) identified 38 places in the Western Coulees and Ridges 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]
BX	Bad Axe River	Medium	Limited	Substantial	xxx	xxx
BN	Badlands	Small	Limited	Moderate	xx	xx
BA	Badger Army Ammunition Plant	Medium	Substantial	Limited	xxxx	xxxxx
BH	Baraboo Hills	Large	Substantial	Substantial	xxxxx	xxxxx
BO	Baraboo River	Large	Moderate	Moderate	xxxx	xxxx
BT	Battle Bluff	Small	Substantial	Limited	xx	x
BE	Black Earth Creek	Large	Moderate	Substantial	xxx	xxxxx
BR	Black River	Large	Limited	Substantial	xxxxx	xxxx
BU	Buffalo River	Large	Limited	Substantial	xxx	xx
CV	Cassville to Bagley Bluffs	Medium	Moderate	Substantial	xxxxx	x
CY	Cochrane City Bluffs	Small	Limited	Substantial	xx	x
CZ	Copper Creek to Lynxville Hollows	Medium	Limited	Substantial	xxx	xxx
CO	Coulees Coldwater Riparian Resources	Large	Substantial	Moderate	xxxx	xxxx
CE	Coulees Experimental Forest	Small	Substantial	Limited	xx	xx
FM	Fort McCoy	Large	Substantial	Limited	xxxxx	x
GR	Grant and Rattlesnake Rivers	Medium	Limited	Moderate	xxx	xxx
GC	Greensand Cuesta	Medium	Limited	Moderate	xxx	xxx
HR	Hay River	Medium	Moderate	Substantial	xxx	xxxx
KR	Kickapoo River	Large	Substantial	Substantial	xxxxx	xxxxx
LX	La Crosse River	Medium	Moderate	Moderate	xx	xxx
LE	Little and Big Green Rivers	Medium	Moderate	Limited	xx	xxx
LC	Lower Chippewa River and Prairies	Large	Moderate	Moderate	xxxxx	xxxx
LW	Lower Wisconsin River	Large	Substantial	Limited	xxxxx	xxxxx
ML	Mill Creek	Small	Moderate	Limited	xx	xx
NP	North Prairie Du Chien Savanna	Small	Moderate	Substantial	xxxx	xx
PN	Pine River	Medium	Moderate	Moderate	xxx	xxx
PL	Platte River	Medium	Limited	Moderate	xxx	xxx
RU	Rush Creek	Medium	Moderate	Substantial	xxxxx	xxx
RR	Rush River	Medium	Limited	Substantial	xxxx	xxx
SW	Snow Bottom – Blue River Valley	Medium	Moderate	Moderate	xxxx	xxx
SP	Spring Green Prairie	Small	Substantial	Limited	xxxxx	x
TV	Thompson Valley Savanna	Small	Limited	Substantial	xxx	xxx
TR	Trempealeau River	Medium	Limited	Substantial	xxx	xxx
TD	Trempealeau River Delta	Small	Moderate	Substantial	xxxx	xxx
TB	Trimbelle River	Medium	Limited	Substantial	xx	xxx
UM	Upper Mississippi River National Wildlife and Fish Refuge	Large	Substantial	Limited	xxxxx	xxxxx
UD	Upper Red Cedar River	Medium	Limited	Substantial	xxxx	xxxx
WY	Wyalusing State Park	Small	Substantial	Limited	xxxxx	xxxxx

[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.

Appendix 22.H, *continued.*

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 22.I. *Importance of economic sectors within the Western Coulees and Ridges 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 22.J. *Scientific names of species mentioned in the text.*

Common name	Scientific name
Acadian Flycatcher[a]	*Empidonax virescens*
American basswood	*Tilia americana*
American bison	*Bos bison*
American black bear	*Ursus americanus*
American elm	*Ulmus americana*
American lotus-lily	*Nelumbo lutea*
American sycamore	*Platanus occidentalis*
American White Pelican	*Pelecanus erythrorhynchos*
American Woodcock	*Scolopax minor*
Arrowheads	*Sagittaria* spp.
Ashes	*Fraxinus* spp.
Aspens	*Populus* spp.
Aspen heart rot fungus	*Phellinus tremulae*
Aspen Hypoxylon canker fungus	*Hypoxylon mammatum*
Autumn coral-root	*Corallorhiza odontorhiza*
Autumn olive	*Elaeagnus umbellata*
Bald Eagle	*Haliaeetus leucocephalus*
Bank Swallow	*Riparia riparia*
Barn Owl	*Tyto alba*
Beak grass	*Diarrhena obovata*
Bell's Vireo	*Vireo bellii*
Belted Kingfisher	*Megaceryle alcyon*
Bigmouth buffalo	*Ictiobus cyprinellus*
Bird's-eye primrose	*Primula mistassinica*
Bird's-foot trefoil	*Lotus corniculata*
Bitternut hickory	*Carya cordiformis*
Black ash	*Fraxinus nigra*
Black buffalo	*Ictiobus niger*
Black cherry	*Prunus serotina*
Black locust	*Robinia pseudoacacia*
Black oak	*Quercus velutina*
Black redhorse	*Moxostoma duquesnei*
Black Tern	*Chlidonias niger*
Black walnut	*Juglans nigra*
Black willow	*Salix nigra*
Black-throated Green Warbler	*Setophaga virens*
Blanding's turtle	*Emydoidea blandingii*
Blue sucker	*Cycleptus elongatus*
Bluegill	*Lepomis macrochirus*
Blue-winged Warbler	*Vermivora cyanoptera*, listed as *Vermivora pinus* on the Wisconsin Natural Heritage Working List
Bluntnose darter	*Etheostoma chlorosoma*
Bobolink	*Dolichonyx oryzivorus*
Bog bluegrass	*Poa paludigena*
Box elder	*Acer negundo*
Brambles	*Rubus* spp.
Brittle prickly pear	*Opuntia fragilis*
Brook trout	*Salvelinus fontinalis*
Brown Thrasher	*Toxostoma rufum*
Brown trout	*Salmo trutta*
Buckhorn	*Tritogonia verrucosa*
Buckthorns (nonnative)	*Rhamnus* spp.
Bullhead (sheepnose)	*Plethobasus cyphyus*
Bulrushes	*Schoenoplectus* spp., *Scirpus* spp.
Bur oak	*Quercus macrocarpa*

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Appendix 22.J, *continued.*

Common name	Scientific name
Bur-reeds	*Scirpus* spp., *Sparganium* spp.
Butterfly mussel	*Ellipsaria lineolata*
Buttonbush	*Cephalanthus occidentalis*
Canada bluegrass	*Poa compressa*
Canvasback	*Aythya valisineria*
Cardinal flower	*Lobelia cardinalis*
Carey's sedge	*Carex careyana*
Carolina anemone	*Anemone caroliniana*
Cat-tails	*Typha* spp.
Cerulean Warbler	*Setophaga cerulea*, listed as *Dendroica cerulea* on the Wisconsin Natural Heritage Working List
Channel catfish	*Ictalurus punctatus*
Cherries	*Prunus* spp.
Cherrystone drop	*Hendersonia occulta*
Chinquapin oak	*Quercus muehlenbergii*
Cliff cudweed	*Gnaphalium saxicola,* listed as *Gnaphalium obtusifolium* var. *saxicola* on the Wisconsin Natural Heritage Working List
Clustered poppy mallow	*Callirhoe triangulata*
Common buckthorn	*Rhamnus cathartica*
Common carp	*Cyprinus carpio*
Common reed	*Phragmites australis*
Crappie	*Pomoxis* spp.
Crown vetch	*Coronilla varia*
Crystal darter	*Crystallaria asprella*
Curly pondweed	*Potamogeton crispus*
Cut-leaved coneflower	*Rudbeckia laciniata*
Cut-leaved teasel	*Dipsacus laciniatus*
Dame's rocket	*Hesperis matronalis*
Drooping sedge	*Carex prasina*
Dunlin	*Calidris alpina*
Dutch elm disease fungus	*Ophiostoma ulmi*
Eastern Bluebird	*Sialia sialis*
Eastern cottonwood	*Populus deltoides*
Eastern hemlock	*Tsuga canadensis*
Eastern massasauga	*Sistrurus catenatus catenatus*
Eastern Meadowlark	*Sturnella magna*
Eastern pipistrelle	*Perimyotis subflavus*
Eastern red bat	*Lasiurus borealis*
Eastern red-cedar	*Juniperus virginiana*
Eastern Towhee	*Pipilo erythrophthalmus*
Eastern Whip-poor-will	*Antrostomus vociferus*
Eastern white pine	*Pinus strobus*
Ebony shell	*Fusconaia ebena*
Elephant ear mussel	*Elliptio crassidens*
Elk	*Cervus canadensis*
Ellipse	*Venustaconcha ellipsiformis*
Elms	*Ulmus* spp.
Emerald ash borer	*Agrilus planipennis*
Eurasian honeysuckles	*Lonicera tatarica*, *Lonicera* x *bella*, *L. mackii, L. morrowii*
Eurasian water-milfoil	*Myriophyllum spicatum*
False dragonhead	*Physostegia virginiana*
false heather	*Hudsonia tomentosa*
False map turtle	*Graptemys pseudogeographica*
Flathead catfish	*Pylodictis olivaris*
Forest tent caterpillar	*Malacosoma disstria*

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Appendix 22.J, *continued.*

Common name	Scientific name
Forster's Tern	*Sterna forsteri*
Frosted elfin	*Callophrys irus*
Garlic mustard	*Alliaria petiolata*
Gilt darter	*Percina evides*
Ginseng	*Panax quinquefolius*
Glade fern	*Diplazium pycnocarpon*
Glade mallow	*Napaea dioica*
Glossy buckthorn	*Rhamnus frangula*
Golden seal	*Hydrastis canadensis*
Goldeye	*Hiodon alosoides*
Gophersnake	*Pituophis catenifer*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray ratsnake	*Pantherophis spiloides*
Gray wolf	*Canis lupus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Great Indian plantain	*Arnoglossum reniforme,* listed as *Cacalia muehlenbergii* on the Wisconsin Natural Heritage Working List
Greater Prairie-Chicken	*Tympanuchus cupido*
Greater redhorse	*Moxostoma valenciennesi*
Green ash	*Fraxinus pennsylvanica*
Green dragon	*Arisaema dracontium*
Green Heron	*Butorides virescens*
Green-violet	*Hybanthus concolor*
Gypsy moth	*Lymantria dispar*
Hairy wild petunia	*Ruellia humilis*
Heart-leaved skullcap	*Scutellaria ovata ovata*
Henslow's Sparrow	*Ammodramus henslowii*
Hermit Thrush	*Catharus guttatus*
Hickory	*Carya* spp.
Higgin's eye	*Lampsilis higginsii*
Hill's thistle	*Cirsium hillii*
Hoary bat	*Lasiurus cinereus*
Honey locust	*Gleditsia triacanthos*
Hooded Warbler	*Setophaga citrina,* listed as *Wilsonia citrina* on the Wisconsin Natural Heritage Working List
Indiana bat	*Myotis sodalis*
Intermediate sedge	*Carex media*
Ironwood	*Ostrya virginiana*
Jack pine	*Pinus banksiana*
Japanese barberry	*Berberis thunbergii*
Jeweled shooting star	*Dodecatheon amethystinum*
Karner blue butterfly	*Lycaeides melissa samuelis*
Kentucky bluegrass	*Poa pratensis*
Kentucky coffee-tree	*Gymnocladus dioicus*
Kentucky Warbler	*Geothlypis formosa,* listed as *Oporornis formosus* on the Wisconsin Natural Heritage Working List
Kitten's-tails	*Besseya bullii*
Knobel's riffle beetle	*Stenelmis knobeli*
Lapland rosebay	*Rhododendron lapponicum*
Largemouth bass	*Micropterus salmoides*
Lark Sparrow	*Chondestes grammacus*
Least darter	*Etheostoma microperca*
Lesser Scaup	*Aythya affinis*
Lilacs	*Syringa* spp.

Continued on next page

Appendix 22.J, *continued.*

Common name	Scientific name
Loggerhead Shrike	*Lanius ludovicianus*
Louisiana Waterthrush	*Parkesia motacilla*
Maples	*Acer* spp.
Mead's milkweed	*Asclepias meadii*
Midland smooth softshell turtle	*Apalone muticus*
Midwest Pleistocene vertigo	*Vertigo hubrichti*
Monkeyface	*Quadrula metanevra*
Mud darter	*Etheostoma asprigene*
Multiflora rose	*Rosa multiflora*
Musk-root	*Adoxa moschatellina*
Nettles	*Laportea canadensis* and *Urtica* spp.
Nodding pogonia	*Triphora trianthophora*
Nodding rattlesnake-root	*Prenanthes crepidinea*
North American racer	*Coluber constrictor*
Northern Bobwhite	*Colinus virginianus*
Northern cricket frog	*Acris crepitans*
Northern Harrier	*Circus cyaneus*
Northern long-eared bat	*Myotis septentrionalis*
Northern map turtle	*Graptemys geographica*
Northern pin oak	*Quercus ellipsoidalis*
Northern red oak	*Quercus rubra*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Northern white-cedar	*Thuja occidentalis*
Northern wild monkshood	*Aconitum noveboracense*
Norway maple	*Acer platanoides*
Oaks	*Quercus* spp.
Oak wilt fungus	*Ceratocystis fagacearum*
Orchard Oriole	*Icterus spurius*
Ornate box turtle	*Terrapene ornata*
Ostrich fern	*Matteucia struthiopteris*
Ottoe skipper	*Hesperia ottoe*
Ouachita map turtle	*Graptemys ouachitensis*
Ozark minnow	*Notropis nubilus*
Paddlefish	*Polyodon spathula*
Pale false foxglove	*Agalinis skinneriana*
Pale purple coneflower	*Echinacea pallida*
Pallid shiner	*Hybopsis amnis*
Passenger Pigeon	*Ectopistes migratorius*
Pecatonica river mayfly	*Acanthametropus pecatonica*
Peregrine Falcon	*Falco peregrinus*
Phlox moth	*Schinia indiana*
Pin oak	*Quercus palustris*
Pine Warbler	*Setophaga pinus*
Pirate perch	*Aphredoderus sayanus*
Plains prickly pear	*Opuntia macrorhiza*
Poison ivy	*Toxicodendron radicans*
Prairie bush-clover	*Lespedeza leptostachya*
Prairie false-dandelion	*Microseris cuspidata*
Prairie fame-flower	*Talinum rugospermum*
Prairie leafhopper	*Polyamia dilata*
Prickly ash	*Zanthoxylum americanum*
Privets	*Ligustrum* spp.
Prothonotary Warbler	*Protonotaria citrea*
Pugnose minnow	*Opsopoeodus emiliae*
Purple loosestrife	*Lythrum salicaria*

Continued on next page

Appendix 22.J, *continued.*

Common name	Scientific name
Purple milkweed	*Asclepias purpurascens*
Purple rocket	*Iodanthus pinnatifidus*
Purple wartyback	*Cyclonaias tuberculata*
Purple-stem cliff-brake	*Pellaea atropurpurea*
Putty root orchid	*Aplectrum hyemale*
Pygmy snaketail	*Ophiogomphus howei*
Quaking aspen	*Populus tremuloides*
Rainbow trout	*Oncorhynchus mykiss*
Red maple	*Acer rubrum*
Red pine	*Pinus resinosa*
Red-breasted Nuthatch	*Sitta canadensis*
Redfin shiner	*Lythrurus umbratilis*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-osier dogwood	*Cornus stolonifera*
Red-shouldered Hawk	*Buteo lineatus*
Redside dace	*Clinostomus elongatus*
Red-tailed prairie leafhopper	*Aflexia rubranura*
Reed canary grass	*Phalaris arundinacea*
Regal fritillary	*Speyeria idalia*
River birch	*Betula nigra*
River grapevine	*Vitis riparia*
River redhorse	*Moxostoma carinatum*
Rock club-moss	*Huperzia porophila*
Rock pocketbook	*Arcidens confragosus*
Roundstem foxglove	*Agalinis gattingeri*
Ruffed Grouse	*Bonasa umbellus*
Rusty crayfish	*Orconectes rusticus*
Salamander mussel	*Simpsonaias ambigua*
Sandbar willow	*Salix exigua*
Sauger	*Sander canadense*
Scots pine	*Pinus sylvestris*
Scouring rush	*Equisteum* spp.
Sedges	*Carex* spp.
Shadowy goldenrod	*Solidago sciaphila*
Shagbark hickory	*Carya ovata*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Shinner's three-awned grass	*Aristida dichotoma*
Shoal chub	*Macrhybopsis aestivalis*
Short-eared Owl	*Asio flammeus*
Shovelnose sturgeon	*Scaphirhynchus platorynchus*
Siberian elm	*Ulmus pumila*
Silphium borer moth	*Papaipema silphii*
Silver chub	*Macrhybopsis storeriana*
Silver maple	*Acer saccharinum*
Silver-haired bat	*Lasionycteris noctivagans*
Silvery scurf-pea	*Pediomelum argophyllum*
Six-lined racerunner	*Aspidoscelis sexlineata*
Skipjack herring	*Alosa chrysochloris*
Skunk cabbage	*Symplocarpus foetidus*
Slender bush-clover	*Lespedeza virginica*
Slender glass lizard	*Ophisaurus attenuatus*
Slimy sculpin	*Cottus cognatus*
Slippershell	*Alasmidonta viridis*
Smallmouth bass	*Micropteris dolomieu*
Smallmouth buffalo	*Ictiobus bubalus*
Smooth brome	*Bromus inermis*

Continued on next page

Appendix 22.J, *continued.*

Common name	Scientific name
Smooth sumac	*Rhus glabra*
Snow trillium	*Trillium nivale*
Speckled alder	*Alnus incana*
Spectacle case	*Cumberlandia monodonta*
Spiny softshell turtle	*Apalone spinifera*
Spotted knapweed	*Centaurea biebersteinii*
Staghorn sumac	*Rhus hirta*
Starhead topminnow	*Fundulus dispar*
Sugar maple	*Acer saccharum*
Swamp white oak	*Quercus bicolor*
Tamarack	*Larix laricina*
Timber rattlesnake	*Crotalus horridus*
Tundra Swan	*Cygnus columbianus*
Twinleaf	*Jeffersonia diphylla*
Two-lined chestnut borer	*Agrilus bilineatus*
Upland boneset	*Eupatorium sessilifolium* var. *brittonianum*
Upland Sandpiper	*Bartramia longicauda*
Violet bush-clover	*Lespedeza violacea*
Virginia creeper	*Parthenocissus quinquefolia*
Walking fern	*Asplenium rhizophyllum*
Wallace's deepwater mayfly	*Spinadis simplex*
Walleye	*Sander vitreus*
Wartyback	*Quadrula nodulata*
Weed shiner	*Notropis texanus*
Western foxsnake	*Elaphe vulpina*
Western Meadowlark	*Sturnella neglecta*
Western ribbonsnake	*Thamnophis proximus*
Western sand darter	*Ammocrypta clara*
White ash	*Fraxinus americana*
White bass	*Morone chrysops*
White birch	*Betula papyrifera*
White oak	*Quercus alba*
White spruce	*Picea glauca*
White sweet clover	*Melilotus alba*
White-tailed deer	*Odocoileus virginianus*
Wild cucumber	*Echinocystis lobata*
Wild parsnip	*Pastinaca sativa*
Wild quinine	*Parthenium integrifolium*
Wild rice	*Zizania* spp.
Wild Turkey	*Meleagris gallopavo*
Wing snaggletooth	*Gastrocopta procera*
Winged mapleleaf	*Quadrula fragosa*
Winter Wren	*Troglodytes hiemalis*
Wood Duck	*Aix sponsa*
Wood turtle	*Glyptemys insculpta*
Worm-eating Warbler	*Helmitheros vermivorum*
Yellow & slough sandshell mussels	*Lampsilis teres*
Yellow birch	*Betula alleghaniensis*
Yellow gentian	*Gentiana alba*
Yellow giant hyssop	*Agastache nepetoides*
Yellow sweet clover	*Melilotus officinalis*
Yellow-billed Cuckoo	*Coccyzus americanus*
Yellow-crowned Night-Heron	*Nyctanassa violacea*
Yellow-throated Warbler	*Setophaga dominica,* listed as *Dendroica dominica* on the Wisconsin Natural Heritage Working List
Yerba-de-tajo	*Eclipta prostrata*

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

Appendix 22.K. *Maps of important physical, ecological, and aquatic features within the Western Coulees and Ridges Ecological Landscape.*

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

Note: *Go to http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=4 and click the "maps" tab.*

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