Strategy for Wildlife Species of Greatest Conservation Need

Wisconsin

Prepared by

Wisconsin Department of Natural Resources
with Assistance from Conservation Partners

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Wisconsin's Strategy for Wildlife Species of Greatest Conservation Need

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"When one tugs at a single thing in nature, he finds it attached to the rest of the world."
– John Muir

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Cover Photos
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Foreword

"Every industrial nation is consuming its capital and counting on the profit side of the ledger. This is not a sustainable situation over the long term. Our natural capital is our forests, wildlife habitats, fresh water lakes, rivers, ocean, soil, scenic beauty, biodiversity, minerals, etc. We are not just toying with nature; we are compromising the capacity of natural systems to do what they need to do to preserve a livable world." Gaylord Nelson, 2004

A livable world. Our beautiful landscape and our clean water, breathable air, and healthy soil. Our native plants and animals, our free-flowing rivers, and our rich forests and prairies. Do we take these things for granted or will we pause, take stock, and work together to preserve what makes Wisconsin unique?

Wisconsin's Strategy for Wildlife Species of Greatest Conservation Need does just that for wildlife species and the places they call home. The *Strategy* takes a thorough look at the animal species that are part of Wisconsin's natural heritage, identifies those that most need our attention because they are declining or are dependent on places that are declining, and provides a roadmap of conservation actions that we—collectively, as part of the whole conservation community--can take to ensure that Wisconsin's natural capital is preserved. The vast amount of information found in this plan was gathered by our state's leading conservation scientists; it will allow us to use the best available science to make critical decisions about Species of Greatest Conservation Need along with the habitats on which they depend.

The *Strategy* is significant in that it recognizes that conservation is made possible by a partnership of government and citizens. Federal funding for the conservation actions in the *Strategy's* roadmap will be used by all of us—conservation groups, state agencies, Native American tribes—as we accomplish our conservation goals. Here in Wisconsin, we will match these federal funds with our own, along with our hands-on sweat equity. In the end, we'll all benefit by keeping species off of the endangered and threatened species list and by preserving this part of Wisconsin's natural capital.

Every poll conducted in Wisconsin regarding conservation has had the same results: Wisconsinites value wildlife, forests, rivers, water quality, and scenic value. Gaylord Nelson was such an effective leader because he was able to identify our enduring values and focus on the issues that were most fundamental to this state, nation, and world. This includes our environment and all the pieces of it. Every time we pour a glass of water, breathe the air in our cities, swim in our lakes, and enjoy the beauty of Wisconsin's natural heritage, we ought to say thank you to Gaylord Nelson for all that he's given each of us.

This *Strategy* and its road map are the next steps in an important journey to preserve this enduring environment value—Wisconsin's biological diversity.

Governor Jim Doyle
State of Wisconsin
August 1, 2005

Acknowledgments

Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* would not have been developed without the dedicated effort and commitment of the individuals acknowledged below. Through their hard work and expertise, this Strategy will help guide the future conservation of Wisconsin's wildlife species and natural communities. In addition, we extend our appreciation to all of the individuals who provided comments through our Regional Briefings, reviewed the working draft, or assisted in numerous other ways.

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Executive Summary

In 2001, Congress authorized the U.S. Fish & Wildlife Service to implement and fund a new program to help states proactively address the needs of declining wildlife species before they required listing as Endangered or Threatened. The **State Wildlife Grants (SWG)** program provides federal funding to every state and territory to conserve its wildlife resources of greatest conservation need. Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* identifies:

1. which **native wildlife species** with low or declining populations are **most at risk** of no longer being a viable part of Wisconsin's fauna,
2. what **habitats** they are associated with,
3. **where they occur** across the state, and
4. a menu of **conservation actions** to be developed into specific on-the-ground projects to "get them off and keep them off" any Endangered or Threatened lists in the future.

What this *Strategy* Will Do for Wisconsin:

- **Focus efforts** on those native wildlife species that are **most at risk** of becoming Endangered or Threatened, or are already listed as such by either the state or federal government. Wisconsin now has a scientifically-based system to identify our Species of Greatest Conservation Need.

- **Save money** by working to prevent species from becoming listed as Endangered or Threatened. The Strategy identifies **proactive** steps to take now in order to avoid having to implement expensive actions later needed to recover species when their populations have reached dire conditions.

- **Stress** the importance of protecting **habitats** as a means of protecting whole suites of species rather than focusing conservation efforts on individual species.

- Continue efforts to **coordinate and prioritize conservation actions** to benefit the largest number of Species of Greatest Conservation Need, as well as other game and non-game species, by providing information on threats and conservation needs from both habitat and regional perspectives.

- **Provide a reference document** and a dynamic **database** to support agencies, organizations, and individuals in meeting their conservation goals. The *Strategy* can help them identify how their interests match up with the priority conservation needs described in the document.

- **Build partnerships** and encourage collaborative approaches to conserving habitats and species at the local level. With input from partners, the Department will draft an implementation plan identifying which priority conservation actions it is best suited to address and how it can most effectively assist partners in their efforts.

- **Adapt** to changing circumstances. Not only can the database be periodically updated as new data are gathered, but partners and the Department can use the *Strategy* to help react to changing opportunities and threats.

- **Describe ongoing and future opportunities to monitor** Species of Greatest Conservation Need and their habitats as well as establish a process for periodically reviewing and revising the Strategy as new information becomes available.

- **Leverage** past efforts to benefit groups of species without introducing new regulations or constraints, **ensure Wisconsin remains eligible for federal funding** from the State Wildlife Grants Program, and help guide the future allocation of these funds.

Wisconsin's Approach

This *Strategy* was developed through the following science-based steps:

STEP 1: Identify which species are of greatest conservation need (see Section 3.1).

All vertebrate, native wildlife species in Wisconsin were evaluated for their level of risk using the following seven criteria:

Global relative abundance	
Global distribution	State rarity
Global threats	State threats
Global population trend	State population trend

Within each of the **vertebrate** major taxonomic groups (birds, fish, herptiles, and mammals), each species was given a score ranging from 1 to 5 for each of the criteria based on scientific literature and the best professional judgment of a team of experts. These scores were then used to calculate mean risk scores and select the Species of Greatest Conservation Need (SGCN).

Invertebrates (Chapter 4) were assessed using a modified process that incorporated information on the status of knowledge for different invertebrate taxa groups. Although a considerable amount of information has been gathered over the last decade, data on invertebrate species distribution, occurrence, population trend, and life history are insufficient to conduct the type of detailed evaluation that was carried out for vertebrates. For some groups of invertebrates, however, more information does exist. For example, it is known that 51 species of freshwater mussels are found in the state, primarily in warmwater rivers. Of these, 26 (over 50%) are rare or declining and are considered Species of Greatest Conservation Need.

Since little or no distribution data exists for most invertebrate Species of Greatest Conservation Need, it was difficult, if not impossible, to assess their distribution by habitat association (Step 2 below) or broad ecological region (Step 3 below). Further, planning at large scales lacks relevance for most invertebrates, which often have specific microhabitat requirements that cannot be addressed adequately at broader scales.

STEP 2: Identify the habitats required by the Species of Greatest Conservation Need (see Section 3.3).

For each of the **vertebrate** Species of Greatest Conservation Need, the critical habitats needed to support healthy populations within Wisconsin were identified. For terrestrial and wetland habitats, the natural community classification system developed by the DNR's Natural Heritage Inventory program was used. For aquatic habitats, a simplified system of river, stream, and lake communities was developed by DNR fishery researchers. A total of 66 natural communities were used in the analysis.

These 66 natural communities were grouped within eight major habitat categories: northern forest, southern forest, oak savanna, barrens, grassland, wetland, aquatic, and miscellaneous. In addition, one "surrogate" community (surrogate grasslands) was identified.

STEP 3: Identify species distributions within Wisconsin (see Section 3.2).

Each of the vertebrate Species of Greatest Conservation Need was evaluated for its probability of occurring within each of the 16 Ecological Landscapes of Wisconsin. These 16 ecologically similar regions were identified based on climate, soils, existing and historic vegetation, topography, types of aquatic features present, and other factors (Figure 1).

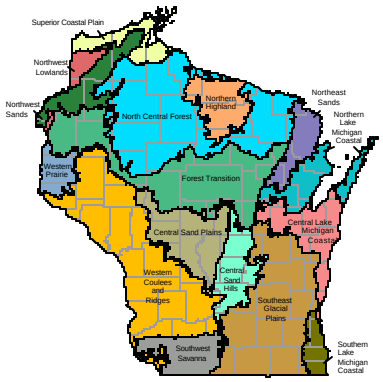


Figure 1. Ecological Landscapes of Wisconsin

Similarly, each Ecological Landscape was evaluated to determine which of the natural communities occurring within it present the best opportunities for management and restoration. For example, in the Southwest Savanna Ecological Landscape, there are major opportunities to sustain and manage oak openings, oak woodlands, and dry, dry-mesic, and mesic prairies.

STEP 4: Identify issues, threats and conservation actions.

The issues and threats facing each of the vertebrate Species of Greatest Conservation Need and the natural communities they inhabit were identified and priority conservation actions to address these problems were described. Many of the threats and conservation actions were related to habitat issues and may be coordinated to simultaneously address the needs of multiple species. Implementing the conservation actions presented in the *Strategy* will significantly improve conditions for these species, but they are not requirements or mandates.

Threats and issues affecting invertebrate populations and related priority conservation actions are also discussed to the extent possible for species groups in the invertebrate chapter (Chapter 4).

STEP 5: Identify priority ecological opportunities.

Figure 2. Ecological Priorities Diagram

The components of the first three steps were then integrated to identify ecological priorities (Figure 2). Thus, for a Species of Greatest Conservation Need, there are lists in Section 3.1 of which Ecological Landscape-natural community combinations are of highest ecological priority. Similarly, for each Ecological Landscape there are lists in Section 3.2 of priority natural community-species opportunities. And finally, for each natural community, there are lists in Section 3.3 of which Ecological Landscapes represent the best management opportunities and which Species of Greatest Conservation Need are most likely to benefit from management actions within those landscapes.

As a result, readers can "enter" the document from either a species, natural community, or Ecological Landscape perspective.

STEP 6: Develop monitoring plans and opportunities to partner with various organizations.

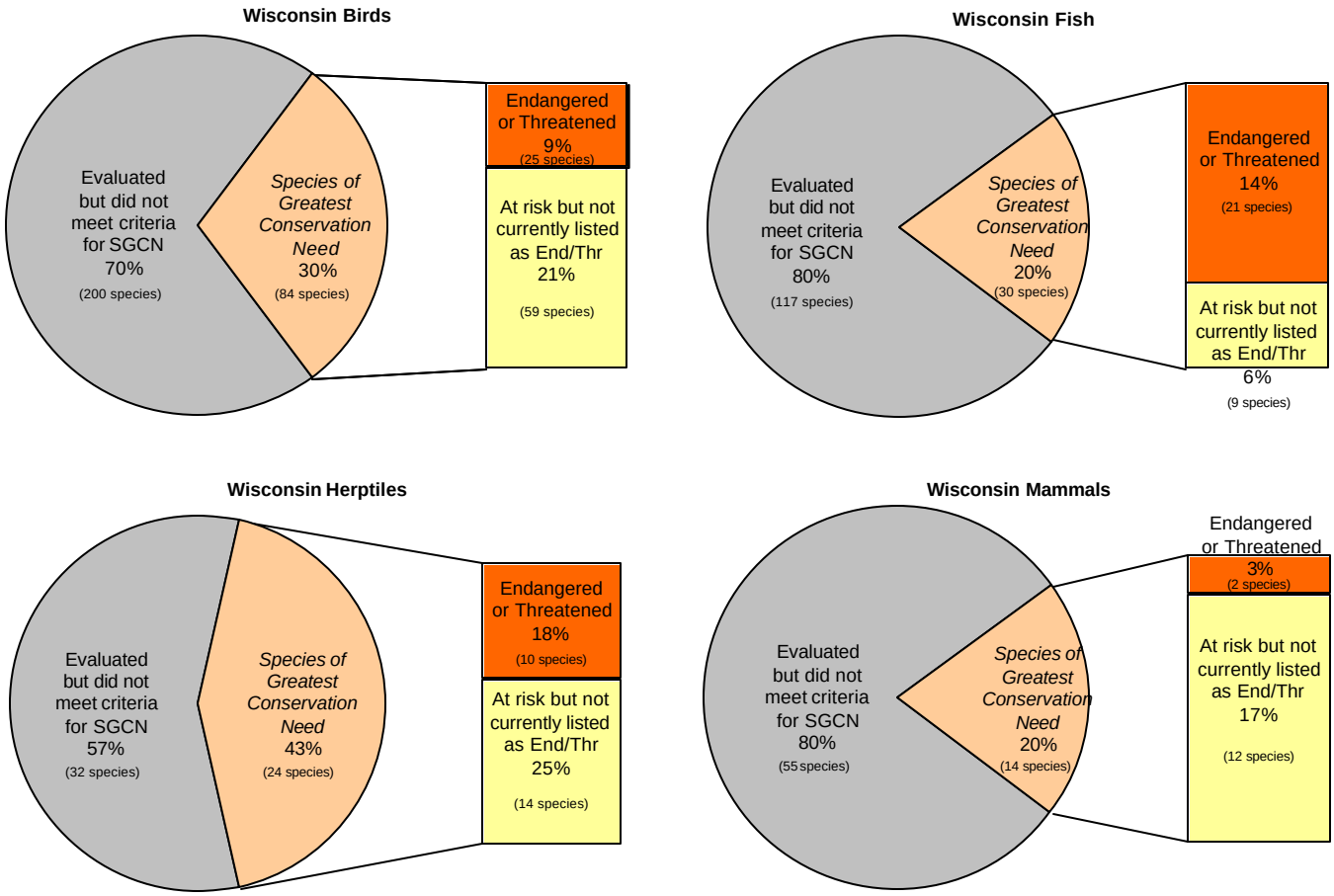
The *Strategy* presents an overview of the wide variety of existing monitoring efforts related to Species of Greatest Conservation Need, potential gaps, and opportunities to measure the implementation of priority conservation actions (Chapter 5). The *Strategy* also describes how conservation partners and the public have been involved in its development, opportunities for continued participation (Chapter 6), and the ways in which the *Strategy* will adapt to new information and changes (Chapter 7).

Summary of Results

By Species

Species of Greatest Conservation Need include both species already listed by either the federal or state government as Endangered or Threatened, as well as species that are at significant risk but not yet on the state or federal Endangered or Threatened species lists.

Because each taxa group was evaluated independently, there is a range in the corresponding number of Species of Greatest Conservation Need within taxa groups. Although some differences can be seen at this coarse level, readers are encouraged to look beyond these "raw numbers" to evaluate the patterns of conservation need that emerge at natural community and Ecological Landscape perspectives. The number and percentage of vertebrate species considered of greatest conservation need within each taxonomic group can be seen in the charts below.



The full list of vertebrate Species of Greatest Conservation Need is presented in the following table. The table is organized taxonomically and includes each species' relative abundance in Wisconsin; that is, how the size and extent of all populations in Wisconsin compare with total size and extent of all populations across the rest of the species' range. The relative abundance categories (high, moderate to low, and very low) were not created to prioritize vertebrate species, but rather as another tool for analysis. These categories are further defined in Section 2.3.

Table 1. Species of Greatest Conservation Need in Wisconsin.

Species Common Name	Relative Abundance	Species Common Name	Relative Abundance	Species Common Name	Relative Abundance
BIRDS					
Horned Grebe	Mod - Low	Upland Sandpiper	Mod - Low	Loggerhead Shrike	Very Low
Red-necked Grebe	Mod - Low	Whimbrel	Mod - Low	Bell's Vireo	Mod - Low
American Bittern	High	Hudsonian Godwit	Mod - Low	Blue-winged Warbler	High
Great Egret	Mod - Low	Marbled Godwit	Very Low	Golden-winged Warbler	High
Snowy Egret	Very Low	Dunlin	Mod - Low	Black-throated Blue Warbler	Mod - Low
Yellow-crowned Night-Heron	Mod - Low	Buff-breasted Sandpiper	Mod - Low	Yellow-throated Warbler	Very Low
Trumpeter Swan	Mod - Low	Short-billed Dowitcher	Mod - Low	Kirtland's Warbler	Very Low
American Black Duck	Mod - Low	American Woodcock	High	Cerulean Warbler	Mod - Low
Blue-winged Teal	Mod - Low	Wilson's Phalarope	Mod - Low	Prothonotary Warbler	Mod - Low
Canvasback	High	Caspian Tern	Mod - Low	Worm-eating Warbler	Mod - Low
Redhead	Mod - Low	Common Tern	Mod - Low	Louisiana Waterthrush	Mod - Low
Lesser Scaup	High	Forster's Tern	Mod - Low	Kentucky Warbler	Mod - Low
Osprey	Mod - Low	Black Tern	Mod - Low	Connecticut Warbler	High
Bald Eagle	High	Black-billed Cuckoo	High	Hooded Warbler	Mod - Low
Northern Harrier	High	Yellow-billed Cuckoo	Mod - Low	Canada Warbler	High
Northern Goshawk	Mod - Low	Barn Owl	Very Low	Dickcissel	Mod - Low
Red-shouldered Hawk	Mod - Low	Short-eared Owl	Mod - Low	Field Sparrow	High
Peregrine Falcon	Mod - Low	Whip-poor-will	Mod - Low	Vesper Sparrow	High
Spruce Grouse	Mod - Low	Red-headed Woodpecker	High	Lark Sparrow	Mod - Low
Greater Prairie-Chicken	Mod - Low	Black-backed Woodpecker	Mod - Low	Grasshopper Sparrow	Mod - Low
Sharp-tailed Grouse	Mod - Low	Olive-sided Flycatcher	Mod - Low	Henslow's Sparrow	High
Northern Bobwhite	Mod - Low	Acadian Flycatcher	Mod - Low	Le Conte's Sparrow	Mod - Low
Yellow Rail	Mod - Low	Willow Flycatcher	High	Nelson's Sharp-tailed Sparrow	Mod - Low
King Rail	Mod - Low	Least Flycatcher	High	Bobolink	High
Whooping Crane	Mod - Low	Boreal Chickadee	Mod - Low	Eastern Meadowlark	High
American Golden Plover	Mod - Low	Veery	High	Western Meadowlark	Mod - Low
Piping Plover	Very Low	Wood Thrush	Mod - Low	Rusty Blackbird	Mod - Low
Solitary Sandpiper	Mod - Low	Brown Thrasher	High	Red Crossbill	Mod - Low

Table 1. Species of Greatest Conservation Need in Wisconsin (cont.)

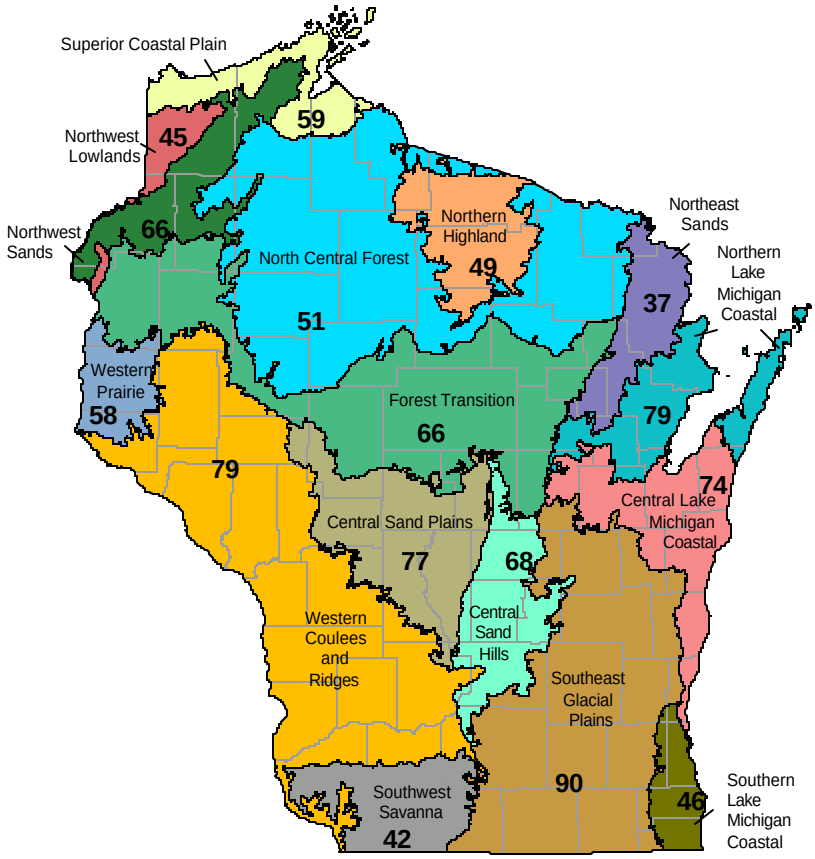
Species Common Name	Relative Abundance	Species Common Name	Relative Abundance	Species Common Name	Relative Abundance
FISHES					
Lake Sturgeon	High	Ozark Minnow	Mod - Low	Greater Redhorse	High
Paddlefish	Mod - Low	Gravel Chub	Mod - Low	Slender Madtom	Mod - Low
American Eel	Very Low	Striped Shiner	Very Low	Banded Killifish	Mod - Low
Skipjack Herring	Very Low	Redfin Shiner	Mod - Low	Starhead Topminnow	Mod - Low
Goldeye	Very Low	Shoal Chub (Speckled Chub)	Mod - Low	Longear Sunfish	Mod - Low
Kiyi	High	Blue Sucker	High	Crystal Darter	High
Shortjaw Cisco	High	Lake Chubsucker	Mod - Low	Western Sand Darter	High
Redside Dace	High	Black Buffalo	Mod - Low	Bluntnose Darter	Very Low
Pallid Shiner	Very Low	River Redhorse	Mod - Low	Least Darter	Mod - Low
Pugnose Shiner	High	Black Redhorse	Mod - Low	Gilt Darter	Mod - Low
HERPTILES					
Four-toed Salamander	Mod - Low	Ornate Box Turtle	Mod - Low	Black Rat Snake	Mod - Low
Mudpuppy	Mod - Low	Midland Smooth Softshell Turtle	Mod - Low	Bullsnake	Mod - Low
Blanchard's Cricket Frog	Mod - Low	Western Slender Glass Lizard	Mod - Low	Queen Snake	Mod - Low
Boreal Chorus Frog	Mod - Low	Northern Prairie Skink	Mod - Low	Butler's Garter Snake	High
Pickerel Frog	Mod - Low	Prairie Racerunner	Mod - Low	Western Ribbon Snake	Very Low
Mink Frog	Mod - Low	Western Worm Snake	Very Low	Northern Ribbon Snake	Mod - Low
Wood Turtle	Mod - Low	Yellow-bellied Racer	Mod - Low	Timber Rattlesnake	Mod - Low
Blanding's Turtle	High	Prairie Ringneck Snake	Mod - Low	Eastern Massasauga Rattlesnake	Mod - Low
MAMMALS					
Water Shrew	Mod - Low	White-tailed Jackrabbit	Very Low	Woodland Jumping Mouse	Mod - Low
Northern Long-eared Bat	Mod - Low	Franklin's Ground Squirrel	Mod - Low	Gray Wolf	Mod - Low
Silver-haired Bat	Mod - Low	Northern Flying Squirrel	Mod - Low	American Marten	Mod - Low
Eastern Red Bat	Mod - Low	Prairie Vole	Mod - Low	Moose	Very Low
Hoary Bat	Mod - Low	Woodland Vole	Mod - Low		

Of the more than 25,000 species of **invertebrates** native to Wisconsin, 530 species in three major taxonomic groups were identified as Species of Greatest Conservation Need. The full list of invertebrate Species of Greatest Conservation Need can be found in Section 4.3.

	Number of Species of Greatest Conservation Need
Non-arthropod invertebrates (e.g., mussels and snails)	58
Non-insect arthropods (e.g., crayfish and spiders)	22
Insects (e.g., butterflies and beetles)	450
Total	**530**

By Ecological Landscape

There is a wide range in the number of vertebrate Species of Greatest Conservation Need occurring in different parts of the state. The map at right shows the number of vertebrate Species of Greatest Conservation Need with a high or moderate degree of probability of occurring in each Ecological Landscape.



There are, of course, many factors that influence this range, including size of the landscape, current and past land uses, diversity of habitats, and patch sizes. Although some species have populations throughout an Ecological Landscape, most are limited to smaller areas of the landscape, particularly in those landscapes that are very large.

By Natural Community

As with Ecological Landscapes, there is a wide range in the number of Species of Greatest Conservation Need associated with each natural community. Some of the reasons for this variation include the community's abundance and geographic extent (both current and historical), the degree of fragmentation of remaining occurrences, loss of certain successional stages, and impacts from invasive species.

The twenty natural communities with the highest number of vertebrate Species of Greatest Conservation Need that are significantly or moderately associated with the natural community are shown in Table 2.

Table 2. Natural communities with the highest number of vertebrate SGCN.

Natural Community	# of vertebrate SGCN significantly or moderately associated with the natural community	Natural Community	# of vertebrate SGCN significantly or moderately associated with the natural community
Warmwater Rivers	40	Submergent Aquatic	27
Dry-Mesic Prairie	39	Surrogate Prairie Grasslands	26
Emergent Aquatic	39	Northern Sedge Meadow	26
Floodplain Forest	35	Open Bog	26
Dry Prairie	31	Mesic Prairie	25
Inland Lakes	29	Oak Opening	25
Oak Barrens	28	Sand Prairie	24
Pine Barrens	28	Southern Mesic Forest	24
Southern Dry-Mesic Forest	27	Southern Tamarack Swamp	24
Shrub-carr	27	Southern Sedge Meadow	24

History of the State Wildlife Grant Program

Historically, both in Wisconsin and nationally, funding for wildlife conservation predominantly has come from hunting and fishing licenses and federal excise taxes on hunting and fishing equipment (Pittman-Robertson Wildlife Restoration Act and Dingell-Johnson Sportfish Restoration Act). Conservation efforts funded by these programs have traditionally focused on the protection and restoration of habitats used by species that are hunted or fished. But, many non-game species, including many rare species, have benefited tremendously from the forests, grasslands and wetlands that have been protected and restored by hunting and fishing organizations and agencies over the years. In fact, the list of rare and declining species would likely be far greater had it not been for the remarkable conservation work conducted throughout the state over the last one hundred years.

In addition to these traditional conservation funding sources, more recently there has been some funding from the federal and state governments to protect and restore Endangered and Threatened species and their habitats. Wisconsin also relies on donations from the public to fund a considerable amount of work on endangered resources. Of course, many game species and other non-game species also benefit from efforts to protect various rare species and their habitats.

Despite the ongoing efforts to maintain wildlife, the Endangered and Threatened species list continues to grow, and maybe more ominously, the number of species not yet listed but with seriously declining populations has grown significantly over the last thirty years. Once species decline to the point where they are classified as Endangered or Threatened, significant funding and staff resources are generally required to protect remaining populations and their habitats and to work to restore both to a healthy, viable state. Indeed, recovery and restoration costs are often much greater than would have been required to prevent the species' decline initially. Recognizing the need to take action to *prevent* wildlife decline, more than 3,000 groups across the country came together as the Teaming With Wildlife coalition. This coalition includes wildlife managers, conservationists, hunters and anglers, businesses, and many others who support the goal of restoring and conserving our nation's wildlife.

To initiate a proactive approach and protect species before serious declines occur, Congress authorized the U.S. Fish & Wildlife Service to implement a new program to fill this funding gap. The **State Wildlife Grants (SWG)** program provides federal funding to every state and territory to conserve its wildlife species of greatest conservation need. It is the only federal program that provides substantial funding to address this issue in every state.

Since the inception of the SWG program in 2001, Wisconsin has received about $1 million each year to fund a variety of conservation initiatives. To remain eligible for continued SWG funding, Wisconsin (and all other states and territories) must submit for approval a Comprehensive Wildlife Conservation Plan/Strategy to the U.S. Fish & Wildlife Service by October 1, 2005.

Partners involved in the development of the Strategy

A large group of experts representing a broad range of conservation interests from throughout the state were invited to participate on an Advisory Team. Twenty individuals representing 18 different organizations (including state and federal agencies, private wildlife conservation organizations, the academic community, Native American Tribes, lake groups, and many others) agreed to be active members of the Advisory Team. In addition over 50 species experts representing a range of organizations provided technical expertise throughout the process.

A User's Guide to the *Strategy*

This document contains an enormous amount of information that can be overwhelming. Although it may seem easy to get lost in the details, readers are encouraged to remain mindful of a couple of issues.

- Use the Strategy to identify how your organization's mission and goals relate to and match up with the priority conservation needs. Some questions to consider include the following: What actions, in what part of the state, could our organization implement? Which actions would provide the most benefits for the greatest number of Species of Greatest Conservation Need?

- Be aware of groups of species with similar needs. Readers are encouraged to use the information in the Strategy as starting points in planning and implementing various conservation efforts. For example, projects focused on a particular species-natural community-Ecological Landscape combination may be able to incorporate the needs of many other Species of Greatest Conservation Need (as well as other species that are not rare or declining) that also occur in that natural community and that Ecological Landscape.

- *Recognize the complexity of habitat management. By its nature, managing habitats will positively affect some species and negatively affect others. This is expected, and land managers have long wrestled with how best to balance the needs of multiple species and habitats for a variety of conservation and economic uses*. For example, managing for older growth forests at a location may benefit some species, but may not benefit (in fact, may displace) others that require forests at earlier successional stages. Similarly, thinning a woodland to create a savanna aspect will likely displace species that require "forest interior" conditions.

  Further complicating habitat management issues is the fact that, in some cases, several Species of Greatest Conservation Need may be associated with a particular natural community, but they may have different management needs or may use the habitat at different times of the year or at different life stages. At times, managing for one or several Species of Greatest Conservation Need may conflict with the needs of other Species of Greatest Conservation Need or other more common species.

  There are neither "right" nor "wrong" ways to manage property – just different ways that result in different outcomes. It is often beneficial to approach this complexity by looking beyond a specific property and examining how it fits into a broader area. This larger scale assessment should incorporate not only ecological opportunities but also economic issues, social needs, and political factors.

- Ecological priorities and priority conservation actions are identified at various scales (species level, natural community, Ecological Landscape). The conservation actions presented here will significantly help the Species of Greatest Conservation Need, but they are not requirements. The actions and priorities are intended to provide a "menu" of opportunities that may or may not be appropriate at any given place or point in time.

- Recognize that the *Strategy* is just that, a strategy to help guide conservation efforts that keep Wisconsin wildlife from being endangered or threatened. It is a guidance document, not a regulatory document. And, as complete and comprehensive as it is, the document is not without limitations. For example, by virtue of federal guidance, it focuses only on animals. Considerable work lies ahead in identifying near- and long-term priorities (both species and their habitats as well as conservation actions). Maybe most importantly, the Department and its partners will need to integrate the findings of this document with the Fish & Wildlife Plan, the Land Legacy Report, the SCORP, the Statewide Forest Plan, and many other plans as we approach our collective work.

Some Examples of Using the Strategy

If you are interested in management of a particular property or area

As an example, if you are developing management plans for a tract of woods in northern Wisconsin, you might be interested to know which habitats represent major opportunities for management and conservation in that part of the state and which Species of Greatest Conservation Need are most likely to occur there. Thus, you might want to "enter" the document through the particular Ecological Landscape of interest (Section 3.2) to find information on the overarching needs and opportunities in the landscape as well as lists of those natural communities which are major and important management opportunities. More detailed information about management considerations for each natural community can be found in Section 3.3. Within your Ecological Landscape you will also find lists of those Species of Greatest Conservation Need with high, moderate, or low degrees of probability of occurring in the landscape. More detailed information about management considerations for these species can then be found in Section 3.1. Together with forest stand data and other economic factors, this set of information can help guide on-the-ground management decisions to benefit a wide range of species – rare and common, game and non-game.

If you are interested in a particular species or taxonomic group

If you are involved with management of a particular species or group of species, you can "enter" the document through a taxonomic group in Section 3.1 and then find information about the specific species of interest to you. For example, if you are interested in reptiles and amphibians (a.k.a. "herptiles") that are of greatest conservation need you can go straight to Section 3.1.4. Here you will find information on the overall taxa group as well as individual descriptions of threats and issues facing each species and the corresponding conservation actions that can help improve conditions for them. In addition, there are listings of the Ecological Landscape-natural community combinations that represent the best ecological opportunities in the state for conservation efforts targeting the species.

From the species-specific information you can then go to Sections 3.2 and 3.3 to find what other species occur in these habitats in particular Ecological Landscapes. This broader habitat-based level of analysis can enable more "bang for the buck" from various conservation actions.

If you are interested in a particular habitat

If you are interested in a particular habitat you can "enter" the document through Section 3.3. Here you will find information on the Species of Greatest Conservation Need that are significantly and moderately associated with the habitat as well as the Ecological Landscapes where the best management and restoration opportunities occur for the habitat. For example, if you are interested in native grasslands you can go to Section 3.3.3 and find lists of the vertebrate Species of Greatest Conservation Need significantly or moderately associated with each of the grassland natural communities. You will also find information on which Ecological Landscapes are major or important opportunities for management and restoration of native grasslands. And finally, there is substantial information (from both statewide and Ecological Landscape perspectives) about threats and issues confronting our native grasslands as well as associated conservation actions.

Regardless of how you intend to apply the data (whether for research, education, grant writing, or on-the-ground management decisions) or which way you choose to "enter" the document, you're encouraged to move from one section to another. This approach should help put the ecological priorities listed within each section into a broader perspective and enhance the value, effectiveness and impact of your conservation work.

Chapter 1. Introduction and Purpose

1.1 Background

Today, there are over 1000 species that are listed as federally threatened or endangered. Over 5000 additional species are considered at risk. A comprehensive, strategic direction is needed at the federal and state levels to conserve species with low or declining populations and prevent species that are not currently listed from becoming threatened or endangered. A strategic direction will help allocate future funding resources to ensure that those often-limited resources are used effectively and efficiently.

Nationwide, many state fish and wildlife agencies have traditionally relied on funding for game species conservation through hunting and fishing licenses and federal excise taxes on hunting and fishing equipment (Pittman-Robertson Wildlife Restoration Act and Dingell-Johnson Sport Fish Restoration Act). This funding was responsible for the recovery of many critically imperiled fish and wildlife species, including non-game species, during the last century and continues to form the core of agency budgets.

The Endangered Species Act provides funds for federally listed species, but for state listed species agencies commonly must rely on donations and tax check-off and license plate programs to support conservation programs for rare species. Once a species has declined to the point where it is listed as federally or state Threatened or Endangered, the cost to protect or restore populations and their habitat is often far greater than would have been required to prevent their decline in the first place.

Until recently, the conservation of thousands of native fish and wildlife species that are not hunted or fished and not endangered fell into a federal funding gap. Fortunately, as we move into the 21st century, there is a new opportunity and program before us that has begun to fill this funding gap. This new opportunity is the State Wildlife Grants program – the nation's core program for preventing wildlife from becoming endangered. Wildlife, as defined by this program, is any species of wild, free-ranging fauna including fish and invertebrates. The State Wildlife Grants program provides federal funding to every state to conserve its wildlife resources. It is the only federal program that provides substantial funding to address this issue in every state. Wisconsin's participation in this program positions us to proactively conserve many species of native wildlife and their habitats.

Currently, states receive funds from the State Wildlife Grants program on an annual basis. Funds appropriated are allocated to the states according to a formula that takes into account each state's size and population. Through efforts by Teaming With Wildlife[1], work is being done to ensure that the relatively small amount of funding from State Wildlife Grants might one day grow to be comparable to the amount and stability of federal funds now provided for game species.

The task of conserving declining wildlife is certainly a challenging one, and yet we know that success is possible as we recall our history of wildlife conservation. We know that by starting early and taking proactive steps instead of reacting to crises, we can have a positive impact and avoid risky and expensive recovery efforts. Our nation's leaders believe this and want even clearer strategies put forth; therefore, in order to continue to receive State Wildlife Grants funds, each state is required to develop and submit a *Comprehensive Wildlife Conservation Plan/Strategy* (*Strategy*) to the National Advisory Acceptance Team (NAAT)[2] by October 1, 2005. These state wildlife strategies will provide an essential foundation for the future of wildlife conservation and an opportunity for the states, federal agencies, and other

[1] Teaming With Wildlife is a broad, national bipartisan wildlife conservation coalition that includes more than 3,000 organizations. More information is available at www.teaming.com

[2] The NAAT is comprised of both state and federal Fish and Wildlife Service Administrators that will review *Strategies* and recommend approval, conditional approval, or disapproval to the Director of the Fish and Wildlife Service.

conservation partners to think strategically and act on their individual and coordinated roles within their state and across the nation.

Each state *Strategy* must address eight required elements. Further, the *Strategy* must identify and be focused on the "Species of Greatest Conservation Need" yet address the "full array of wildlife" and wildlife-related issues. While Wisconsin's Department of Natural Resources has the primary responsibility for developing this *Strategy*, you will find that Wisconsin's effort has engaged a broad array of partners, including other government agencies, conservation groups, private landowners, the public, and others who have a stake in fish and wildlife management. The WDNR will continue to work with our conservation partners during the *Strategy's* implementation. The *Strategy* reflects the issues, management needs, and priorities unique to Wisconsin, but we have also worked with neighboring states and others to ensure nationwide consistency and a common focus on targeting resources to prevent wildlife from declining to the point of endangerment.

The Eight Required Elements of the *Strategy*

(1) Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife; and,

(2) Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1); and,

(3) Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats; and,

(4) Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions; and,

(5) Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions; and,

(6) Descriptions of procedures to review the strategy at intervals not to exceed ten years; and,

(7) Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats; and,

(8) Congress also affirmed through this legislation that broad public participation is an essential element of developing and implementing these plans, the projects that are carried out while these plans are developed, and the Species in Greatest Need of Conservation that Congress has indicated such programs and projects are intended to emphasize.

1.2 Overview of Wisconsin's Strategy

Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* was prepared to address the eight required elements and ensure Wisconsin's continued eligibility for State Wildlife Grants. Additionally, the *Strategy* will set priorities for the allocation of State Wildlife Grant funds in Wisconsin and provide guidance and information in support of the conservation efforts of government agencies, tribes, and the full range of public and private partners.

The *Strategy* is organized into the following main sections:

Strategy Approach and Methods (Chapter 2)

- Descriptions of the interactive teams used to develop the *Strategy*.
- Overview of Wisconsin's Ecological Landscapes[3] and natural communities[4].
- Methodology used to identify vertebrate and invertebrate Species of Greatest Conservation Need.
- Methodology used to determine the associations between vertebrate Species of Greatest Conservation Need, Ecological Landscapes, and natural communities.
- Methodology used to identify threats and issues affecting vertebrate and invertebrate Species of Greatest Conservation Need and determine priority conservation actions.

Vertebrate Species of Greatest Conservation of Need Assessment and Conservation Strategies (Chapter 3)

- Results from the analyses presented by individual Species of Greatest Conservation Need, Ecological Landscape, and natural community.
- Additional analyses and summary results based on the association between the species and natural communities; probability the species occurs in each Ecological Landscape; and opportunity each natural community presents for management, protection, or restoration in each Ecological Landscape. These factors were combined to determine ecological priorities (Figure 1-1).
- Information on threats, issues, and priority conservation actions for Species of Greatest Conservation Need and the natural communities with which they are associated.

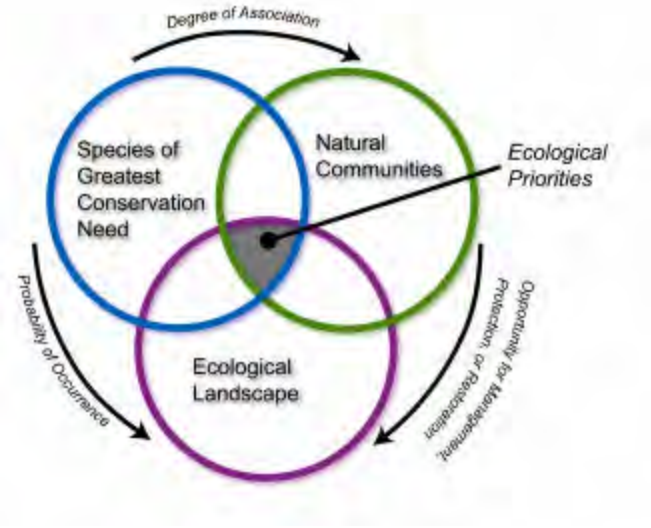


Figure 1-1. Relationship between Species of Greatest Conservation Need, natural communities, Ecological Landscapes, and ecological priorities.

[3] The Ecological Landscape classification system divides Wisconsin into 16 ecologically similar regions. These regions differ from each other in ecological attributes and management opportunities. They have unique combinations of physical and biological characteristics that make up the ecosystem, such as climate, geology, soils, water, or vegetation. They differ in levels of biological productivity, habitat suitability for wildlife, presence of rare species and natural communities, and in many other ways that affect land use and management.

[4] Wisconsin's natural communities are based on the WDNR Natural Heritage Inventory Program classification system; there are eight major natural community groups (aquatic, barrens, grasslands, miscellaneous types, northern forests, oak savanna, southern forests, and wetlands). Within these eight aggregates there are 66 more finely divided community types that are made up of collections of native plants and animals that consistently occur together under similar conditions.

Invertebrate Species of Greatest Conservation Need Assessment and Conservation Strategies (Chapter 4)

- Current state of scientific knowledge regarding Wisconsin invertebrates.
- Threats and issues affecting invertebrates and priority conservation actions.

Monitoring (Chapter 5)

- General purpose and strategy for monitoring the Species of Greatest Conservation Need and their habitats, and approaches for monitoring priority conservation actions.

Public Participation and *Strategy* Coordination (Chapter 6)

- Public involvement process used and coordination efforts with other agencies, tribes, and conservation partners.
- Strategies for the continued coordination and involvement of various conservation partners and interested parties in the implementation, review, and revision of the *Strategy*.

Strategy Review and Revision (Chapter 7)

- Process for updating the *Strategy* in the short-term and long-term using the Adaptive Management Model.
- Topics to address in the long-term *Strategy* revision, including items that this first iteration did not address.

1.3 The Results and Benefits of Wisconsin's *Strategy*

The greatest accomplishment of the *Strategy* is the creation of a dynamic vision for the future conservation of low or declining wildlife in Wisconsin. This is the first ***comprehensive*** opportunity to plan for and fund programs to conserve these species and the habitats they require, both as a state and nation. Wisconsin's *Strategy* is a comprehensive assessment of our wildlife resources, developed with substantial input from experts and partners across the state; we hope that it will be used to help direct and focus future efforts to conserve and manage Wisconsin's Species of Greatest Conservation Need and their habitats.

Results

- Identifies Wisconsin's Species of Greatest Conservation Need using a series of scientific filters and methods applied to the suite of all wildlife species native to the state.
- Provides information on Wisconsin's Species of Greatest Conservation Need, natural communities, and Ecological Landscapes both individually and in combination to assist users in their conservation efforts.
- Identifies ecological priorities and associated priority conservation actions for Species of Greatest Conservation Need and the natural communities that they depend upon.
- Allows flexibility for partners and other *Strategy* users to decide whom, how, and when to implement conservation actions.
- Creates a valuable database of information that can be updated and used to track progress overtime.
-

Benefits

- Helps Wisconsin to proactively conserve wildlife, especially those species which in the past have often "fallen between the cracks" in terms of both funding and conservation attention.
- Encourages a broad conservation perspective implemented through partnerships and creative approaches at local, regional, and statewide levels.
- Builds on valuable information gathered, compiled, and analyzed though past planning efforts without creating new regulations.

- Ensures that Wisconsin remains eligible for federal funding from the State Wildlife Grants Program.
- Begins the process of setting priorities for allocation of State Wildlife Grant funds in Wisconsin.
- Provides guidance and information, including a reference database, for government agencies, tribes, and the full range of public and private partners to use to support their conservation efforts.

Public, private, and individual conservation partners in Wisconsin have made concerted efforts to focus management actions at the habitat level, rather than operating on a species-by-species approach. With the evolution of ecosystem management in recent times, it has become increasingly clear that habitats (i.e., natural communities) are often more appropriate targets for conservation actions than individual species. To adequately protect the structure, function, and biodiversity of natural systems, we need to be wary of efforts that benefit one or a few species at the possible expense of numerous other species. As a result, this *Strategy* truly strives to incorporate habitat-based management, while highlighting Wisconsin's Species of Greatest Conservation Need. Doing this allows us to link species or groups of species to priority habitats that represent the best opportunities for conservation success throughout our state. We hope that Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* will be used as a resource by the WDNR, conservation partners, and interested individuals to help conserve Species of Greatest Conservation Need and their habitats.

Chapter 2. Approach and Methods

2.1 Organizational Structure

Wisconsin's *Strategy* development process was structured in order to encourage participation of individuals at various levels of involvement. Participants were organized into several interactive teams based on their role in the planning process. This approach was selected in an attempt to optimize the efficiency of the process and make the best possible use of the strengths possessed by each participant. A description of each of these teams and their role in the planning process are presented below.

Guidance Team

- Approved broad guidance.
- Approved the final plan prior to acceptance by the Wisconsin Natural Resources Board and USFWS.
- Determined how the plan will influence all Department programs that direct management and funding to Species of Greatest Conservation Need and their habitats.
- Guidance Team members: Todd Ambs, WI DNR Division Administrator-Water Division
  Paul DeLong, WI DNR Division Administrator-Forestry Division
  Tom Hauge, WI DNR Bureau Director-Wildlife Management
  Laurie Osterndorf, WI DNR Division Administrator-Land Division
  Mike Staggs, WI DNR Bureau Director-Fisheries Management and Habitat
  Jack Sullivan, WI DNR Bureau Director-Integrated Science Services
  Darrell Zastrow, WI DNR Bureau Director-Forest Services

Project Sponsor

- Project "champion" and spokesperson to facilitate statewide buy-in.
- Made decisions to forward to Administrators/Bureau Directors and the Natural Resources Board.
- Provided direction and support to the plan Coordination Team.
- Project Sponsor: Signe Holtz, WI DNR Bureau Director-Endangered Resources

Coordination Team

- Synchronized communication among all who need to "own" the first iteration of this statewide plan so that the process is transparent and there is appropriate opportunity for review and feedback at established checkpoints.
- Created communication products that present the plan and its science-based information in ways that meet the needs of intended audiences.
- Organized & implemented the planning process under the direction of the Project Sponsor.
- Coordinated writing and compilation of the plan document.
- Coordination Team members: Jill Mrotek (leader), WI DNR
  Armund Bartz, WI DNR
  Owen Boyle, WI DNR
  Sarah Carter, WI DNR
  Ted Gostomski, WI DNR
  Greg Moeller, WI DNR
  John Pohlman, WI DNR
  Pat Robinson, WI DNR
  Rebecca Schroeder, WI DNR

Advisory Team

- Reviewed federal guidelines and sideboards for developing Wisconsin's *Strategy.*
- Recommended species experts to participate on Species Teams.
- Provided input on criteria to be used to identify Species of Greatest Conservation Need.
- Reviewed and submitted comments on information prepared by Coordination Team, Science Work Team, and Species Teams.
- Served as a liaison to their group or organization to keep members informed about plan development.

Advisory Team *Continued*

- Advisory Team members: Gary Birch, WI DOT
  Susan Borkin, Milwaukee Public Museum
  Lynn Broaddus, Friends of Milwaukee's Rivers
  Gary Casper, Partners for Amphibian & Reptile Conservation and formerly with the Milwaukee Public Museum
  Scott Craven, University of WI-Madison
  Noel Cutright shared responsibilities with Susan Schumacher for WE Energies and with Bill Mueller for Wisconsin Society for Ornithology
  Dan Eklund and Linda Parker shared responsibilities representing USDA Forest Service
  Karen Etter Hale, Madison Audubon Society
  Jon Gilbert, Great Lakes Indian Fish and Wildlife Commission
  Signe Holtz, WI DNR
  Charles Luthin, Natural Resources Foundation
  Colette Matthews and Keith Lane commenced participation on March 11, 2005 as representatives of the WI County Forest Association
  Peter Murray, WI Association of Lakes
  Bob Obma, Trout Unlimited
  Chuck Pils, WI Chapter of the Wildlife Society
  Jim Ruwaldt, US Fish and Wildlife Service
  Joel Trick, US Fish and Wildlife Service
  Robert Weihrouch, USDA Natural Resource Conservation Service
  Rebecca Smith and Paul West (until April, 2005), The Nature Conservancy
  Gary Zimmer, The Ruffed Grouse Society

Science Work Team

- Developed criteria to identify Species of Greatest Conservation Need.
- Identified habitat classification system.
- Provided peer review of draft plan chapters.
- Science Work Team: Jerry Bartelt (co-leader), WI DNR
  Owen Boyle (co-leader), WI DNR
  Armund Bartz, WI DNR
  Tara Bergeson, WI DNR
  Ellen Barth, WI DNR
  Sarah Carter, WI DNR
  Ed Emmons, WI DNR
  Eric Epstein, WI DNR
  Ted Gostomski, WI DNR
  Greg Moeller, WI DNR
  Pat Robinson, WI DNR
  Bill Vander Zouwen, WI DNR

Technical Consultants

- Tim Cooke, WI DNR, logistical support.
- Erin Crain, WI DNR, coordinated development of the monitoring section to address the requirements of Element 5. Assisted by WI DNR staff Loren Ayres, Tara Bergeson, Patrick Campfield, Mariquita Sheehan, and Michelle Washebek.
- Drew Feldkirchner, WI DNR, played a pivotal role in database management.
- Anne Forbes, Partners in Place, LLC, provided process consulting and facilitation.
- Mary Hamel, WI DNR, assisted with the design of the public participation strategy.
- Betty Les, WI DNR, reviewed draft materials and provided insight regarding specific plan details.
- Orion Kiesch and Peggy Peters, WI DNR, webpage development.
- Jill Rosenberg, WI DNR, map development for natural community chapter.
- Bureau of Technology Services, map development for species summary chapter.

Species Teams

- Served as species experts, providing scientific data and peer review to the Science Work Team.
- Determined Species of Greatest Conservation Need for their respective taxa group.
- Identified species' relationship to Ecological Landscapes and natural communities.
- Addressed species threats, issues, and conservation actions.
- Species Teams were organized around five taxa groups. They were:

Bird Species Team

Andy Paulios (leader), WI DNR
Jerry Bartelt, WI DNR
Noel Cutright, Wisconsin Society of Ornithology
Eric Epstein, WI DNR
Kim Grveles, WI DNR
Randy Hoffman, WI DNR
Robert Howe, University of WI-Green Bay
Sumner Matteson, WI DNR
Dave Sample, WI DNR
Tom Will, USFWS

Herptiles (Amphibians & Reptiles)

Bob Hay (co-leader), WI DNR
Gary Casper (co-leader), PARC & fmr. MPM
Tom Anton, The Ecological Consulting Group
Craig Berg, Milwaukee County Zoo
Tara Bergeson, WI DNR
Josh Kapfer, University of WI-Milwaukee
Rori Paloski, WI DNR
Alan Resetar, Field Museum
Richard Sajdak, Pittsford, NY
Eric Wild, University of WI-Stevens Point

Invertebrates

Dreux Watermolen (leader), WI DNR
Susan Borkin, Milwaukee Public Museum
Stanley Dodson, University of WI-Madison
Michael Draney, University of WI-Green Bay
Bob Dubois, WI DNR
Rich Henderson, WI DNR
Joan Jass, Milwaukee Public Museum
Kathy Kirk, WI DNR
Lisie Kitchel, WI DNR
Richard Lillie, WI DNR (retired)
Scott Sauer, WI DNR
Jamie Schlangen, WI DNR
Kurt Schmude, University of WI-Superior
William Smith, WI DNR
Ed Stern, University of WI-Stevens Point
Stan Szczytko, University of WI-Stevens Point
Mark Wetzel, Illinois Natural History Survey
Dan Young, University of WI-Madison

Fish

John Lyons (leader), WI DNR
Philip Cochran, St. Mary's University of Minnesota
Kyle Piller, Southeastern Louisiana University

Mammals

Loren Ayers (leader), WI DNR
Eric Anderson, University of WI-Stevens Point
Richard Bautz, WI DNR
Pat Beringer, WI DNR
Ron Eckstein, WI DNR
Jon Gilbert, Great Lakes Indian Fish & Wildlife Commission
Dennis Haessly, Roche A Cri Research
Paula Holahan, University of WI Zoological Museum
Randy Jurewicz, WI DNR
Charles Long, University of WI-Stevens Point
David Matheys, WI DNR
Mike Mossman, WI DNR
John Olson, WI DNR
David Redell, WI DNR
Robert Rolley, WI DNR
Amber Roth, WI DNR
Maureen Rowe, WI DNR
Joseph Senulis, WI DNR
Douglas Smith, Northland College
Dean Van Doren, WI DNR
James Woodford, WI DNR
Adrian Wydeven, WI DNR
Chris Yahnke, Univ. of WI-Stevens Point
Patrick Zollner, USDA Forest Service

Ecosystem Management Planning Team

- Provided background information regarding Ecological Landscapes and natural communities of Wisconsin.
- Identified opportunities for protection, restoration, and/or management of natural community types within Ecological Landscapes.
- Identified threats and conservation actions on a natural community level.
- The Ecosystem Management Planning Team is independent of the Comprehensive Wildlife Conservation Plan development process. The Ecosystem Management Planning Team is:

Jerry Bartelt (leader), WI DNR	Eunice Padley, WI DNR
Eric Epstein, WI DNR	Jeff Schimpff, WI DNR
Vern Everson, WI DNR	Andy Stoltman, WI DNR
Colleen Matula, WI DNR	Pete Wolter, WI DNR

Conservation Partners

- Were informed about the process at selected intervals during plan development.
- Provided threats, issues, and conservation actions for Species of Greatest Conservation Need.
- Reviewed and commented on the draft plan.
- Once approved, the conservation public will be encouraged to participate in the implementation of the plan. This will include "stepping down" the plan from a strategic plan on a statewide level to an implementation plan on a local level.

2.2 Ecological Framework

This section is intended to provide readers with a general overview of Wisconsin's ecological diversity at both landscape and habitat levels. It describes the different ecological regions of the state and identifies the natural communities that are or have the potential to be associated with those ecological regions.

2.2.1 Overview of the Ecological Landscapes of Wisconsin

The Department of Natural Resources adopted a classification system (based on the system known as the National Hierarchical Framework of Ecological Units which was developed by the US Forest Service and many collaborators) to consistently organize its land-based ecological planning, management, and monitoring activities. This system divides the state into 16 ecologically similar regions, based on climate, soils, existing and pre-settlement vegetation, topography, types of aquatic features present, and other factors (Figure 2-1). Referred to as "Ecological Landscapes," they each have their own "look and feel." They also have unique sets of conservation needs and opportunities. They differ in levels of biological productivity, habitat suitability for wildlife, presence of rare species and natural communities, and in many other ways that affect land use and management.

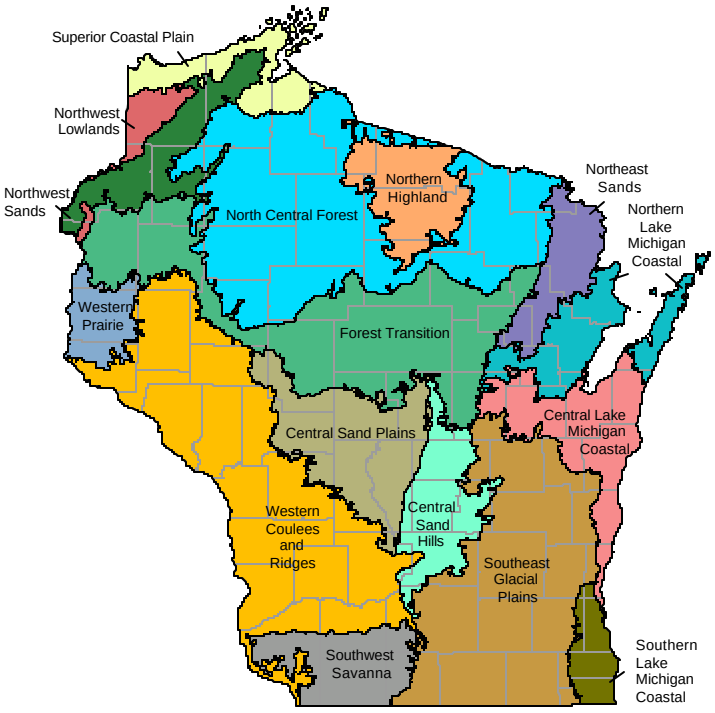


Figure 2-1. Ecological Landscapes of Wisconsin.

The distribution and abundance of plants and animals across the state has been, and continues to be, determined by both natural factors and human-induced disturbance patterns. Historically, many species reached the edge of their range in a narrow band that runs from northwestern to southeastern Wisconsin. This narrow band, known as the "Tension" or "Transition" Zone, separates the northern forest (including the boreal forest) from the southern forest and prairies (Figure 2-2).

Information presented in Section 2.2.3 is taken largely from *Ecological Landscapes of Wisconsin* (Wisconsin DNR 2004a). This web-based resource provides an assessment of each Ecological Landscape, including its ecological, social, and economic characteristics. It also identifies opportunities to manage resources with consideration for long-term ecological and economic sustainability. The information is used by natural resource managers as a reference to help assess the ecological resources and opportunities that exist within the state and in the Ecological Landscapes where they work. This resource was developed collaboratively by DNR staff. It is periodically updated and can be viewed at http://dnr.wi.gov/landscapes/. This web site also contains maps of original vegetation, current land cover, landtype association, public land ownership, and water features for each landscape.

The 16 Ecological Landscapes are described below working from the northwest part of the state to the southeast; first, north of the Tension Zone, and then south. Although many Species of Greatest

Conservation Need tend to be associated with certain areas of the state based on ecological characteristics, only rarely are their ranges concurrent with the Ecological Landscape boundaries described in this chapter. Part of each of the following 16 write-ups are lists of species with high, moderate, or low probabilities of occurring in the Ecological Landscape. This categorization of "probability of occurrence" is not intended to imply that a species occurs throughout the Ecological Landscape, but rather that the species occurs somewhere within it. This is particularly evident in the larger landscapes such as the North Central Forest, Forest Transition, West Central Coulee and Ridges, and Southeast Glacial Plains.

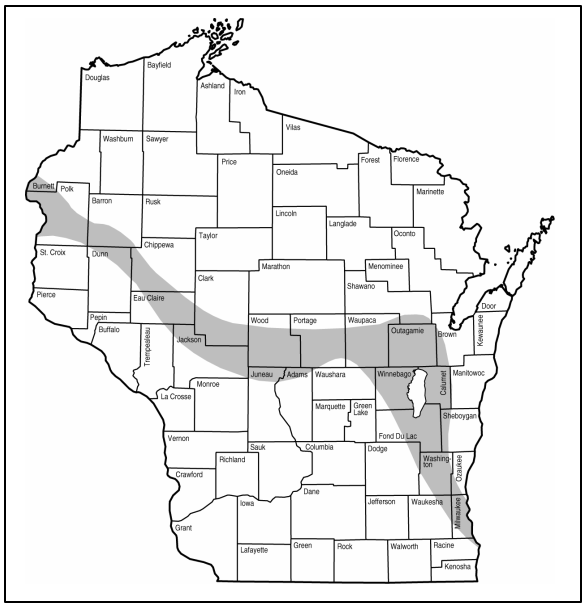


Figure 2-2. Tension Zone in Wisconsin.

2.2.2 Overview of the Natural Communities in Wisconsin

As one travels around the state, it is apparent that Wisconsin harbors a wide variety of terrestrial and aquatic habitats. From the thousands of small lakes in Vilas and Oneida Counties to the steep, wooded valleys and spring creeks of the Driftless Area to the gently rolling, productive farmland along the Rock River, the state contains a remarkable diversity of lands and waters.

Of course, no two places are the same; each forest, wetland, grassland, stream, and lake contains a unique collection of plants and animals. But, based on environmental conditions and ecological processes, similar habitats support similar collections of species. For example, areas of native vegetation in the southern part of the state that are south-facing, have well-drained and reasonably fertile soils, and are subject to frequent fires often harbor scattered bur and white oak trees amidst a variety of native grasses and forbs. Ecologists refer to collections of native plants and animals that consistently occur together under similar conditions as "natural communities." *The Vegetation of Wisconsin* (Curtis 1959) described a novel way to determine natural communities based on plant associations and it remains the foundation from which most ecologists in the state categorize groups of species. Curtis focused on terrestrial and wetland communities, but did not address aquatic systems.

The DNR's Natural Heritage Inventory (NHI) has expanded and refined Curtis' original classification of terrestrial and wetland-related natural communities in Wisconsin. In this report, 58 NHI natural communities, 1 surrogate community (taken from the report, *Managing Habitat for Grassland Birds: A guide for Wisconsin*), and 8 aquatic community types (developed by DNR fishery researchers for use in this plan) are used. They are listed in Table 2-1. *Section 3.3 provides detailed descriptions of these communities as well as listings of the Species of Greatest Conservation Need associated with each.*

Different natural communities occur in different parts of the state and as a result there are different opportunities to sustain these communities in different Ecological Landscapes. "Sustain" means ensuring that a given natural community type will be present and has high potential to maintain its natural composition, structure, and ecological function over a long period of time (e.g., 100 years). Estimating the likely degree of sustainability requires looking at each natural community type from an Ecological Landscape perspective across the state or region to determine whether occurrences of communities are large enough and/or connected enough to support the composition, structure, and ecological function of a community type over time. ***An key objective of sustaining natural communities is to manage for natural community types that historically occurred in a given Ecological Landscape and to have all***

seral stages of a community type represented to accommodate wildlife species that require early and/or late successional habitat stages in order to complete their life history cycle.

This goal of sustainability does not preclude a "working landscape" where both traditional (e.g., forest and agricultural products) and non-traditional (e.g., ginseng, sphagnum moss, etc.) products are extracted from an area. People are dependent on natural resources economically and physically, so to maintain economic sustainability over the long term, natural resources must be sustained. Such a philosophy allows for human use so long as the capacity for self-renewal of natural resources is not compromised. However, removing natural resources in an unsustainable way will diminish natural communities, our economy, and the human population over the long term.

Table 2-2 provides a quick way of identifying which Ecological Landscapes provide the best opportunities for sustaining the natural communities that occur in Wisconsin. It can help guide land and water management activities (including active management for product extraction and recreation, preservation, and restoration of degraded or missing natural communities) to ensure that they are compatible with the local ecology of the Ecological Landscape and also maintain important components of ecological diversity and function. It should help identify the most appropriate community types that could be considered for management activities within each Ecological Landscape. Therefore, this table is intended for broad land and water management applications. This table is not intended to suggest that entire Ecological Landscapes should be restored to historic conditions or that current management regimes are successfully sustaining natural communities. It is intended to illustrate what parts of the state may provide the most effective opportunities to sustain natural communities as landowners and managers strive to meet the needs of both people and diverse sustainable ecosystems.

Opportunities are defined as follows:

Major Opportunity - A major opportunity for sustaining the natural community in the Ecological Landscape exists, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful maintaining the community's composition, structure, and ecological function over a long period of time.

Important Opportunity - Although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several significant occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and there may be a lack of opportunities elsewhere.

Present - The natural community occurs in the Ecological Landscape, but better management opportunities appear to exist in other parts of the state.

Absent - The natural community is not known to occur in the Ecological Landscape.

More information about natural communities in Wisconsin is available at the DNR's web site at http://dnr.wi.gov/org/land/er/communities/.

2.2.3 Ecological Landscape Descriptions

Starting on the following pages are individual descriptions of the 16 Ecological Landscapes in Wisconsin, including lists of the natural communities occurring within each Ecological Landscape. *Section 3.2 contains the lists of Species of Greatest Conservation Need occurring within each Ecological Landscape*

as well as those species-community combinations within each Ecological Landscape that are considered highest ecological priority.

Table 2-1. Natural and surrogate communities in Wisconsin used in this report.

Northern Forest natural communities
Boreal Forest
Northern Dry Forest
Northern Dry-Mesic Forest
Northern Mesic Forest
Northern Wet-Mesic Forest
Northern Wet Forest
Northern Hardwood Swamp

Open and Shrub Wetland natural communities
Alder Thicket
Bog Relict
Boreal Rich Fen
Calcareous Fen
Coastal Plain Marsh
Ephemeral Pond
Great Lakes Coastal Fen
Interdunal Wetland
Northern Sedge Meadow
Open Bog
Shrub Carr
Southern Sedge Meadow

Aquatic natural communities
Emergent Aquatic
Emergent Aquatic-Wild Rice
Submergent Aquatic
Submergent Aquatic-Oligotrophic Marsh

Natural communities based on geologic features
Algific Talus Slope
Alkaline Clay Bluff
Alvar
Bedrock Glade
Dry Cliff
Forested Ridge and Swale
Great Lakes Rockshore
Great Lakes Beach
Great Lakes Dune
Inland Beach
Moist Cliff

Southern Forest natural communities
Hemlock Relict
Pine Relict
Central Sands Pine-Oak Forest
Southern Dry Forest
Southern Dry-Mesic Forest
Southern Mesic Forest
Southern Tamarack Swamp
White Pine-Red Maple Swamp
Floodplain Forest
Southern Hardwood Swamp

Oak Savanna natural communities
Cedar Glade
Oak Opening
Oak Woodland

Oak/Pine Barrens natural communities
Great Lakes Barrens
Oak Barrens
Pine Barrens

Grassland natural communities
Bracken Grassland
Sand Prairie
Dry Prairie
Dry-Mesic Prairie
Mesic Prairie
Wet-Mesic Prairie
Wet Prairie

Hydrologic-based natural communities
Coldwater Streams
Coolwater Streams
Lake Michigan
Lake Superior
Impoundments/Reservoirs
Inland Lakes
Warmwater Rivers
Warmwater Streams

Surrogate communities
Surrogate Grassland (e.g., Conservation Reserve Program, pasture, hay, etc.)

Table 2-2. Opportunities for sustaining Wisconsin's natural communities by Ecological Landscape.

		Superior Coastal Plain*	Northwest Lowlands	Northwest Sands*	North Central Forest*	Northern Highland*	Forest Transition*	Northeast Sands	Northern Lake Mich.	Central Lake Mich.	Western Prairie	Western Coulee and	Southwest Savanna	Central Sand Plains	Central Sand Hills*	Southeast Glacial Plains	Southern Lake Mich.
Northern Forest Communities	Boreal Forest	3	2		2	1		1	2								
	Northern Dry Forest	2	1	3	1	2		3	2					2	1		
	Northern Dry-Mesic Forest	2	2	3	2	3	2	3	2	2	1	2		2	1	1	
	Northern Hardwood Swamp	2	1	2	3	2	2	2	2	2		1		2	2	3	
	Northern Mesic Forest (1)	2	2	1	3	2	3	2	3	2	1	1		2	1		
	Northern Wet-Mesic Forest	2	2	2	3	2	3	3	3	2		1			1	2	1
	Northern Wet Forest (2)	2	3	3	3	3	3	2	2	2	1	2		3	3	2	2
Southern Forest Communities	Central Sands Pine – Oak Forest													3	3		
	Floodplain Forest	2		1	2	1	2	1	2	2	2	3	1	3	2	3	1
	Hemlock Relict											3	1	1			
	Pine Relict											3	2	1			
	Southern Dry Forest										1	3	2	2	3	3	2
	Southern Dry-Mesic Forest						1			2	2	3	2	3	2	3	2
	Southern Hardwood Swamp									1		1				2	2
	Southern Mesic Forest						1		1	2	2	3	2	2	1	2	2
	Southern Tamarack Swamp											2		2	2	3	2
	White Pine – Red Maple Swamp													3			
Oak Savanna Communities	Cedar Glade								2	1	2	3	1	1	1	2	
	Oak Opening										2	3	3		1	3	2
	Oak Woodland										2	3	3	1	1	3	1
Barrens Communities	Great Lakes Barrens	3							1								
	Oak Barrens											3		3	2		
	Pine Barrens			3		1		3				2		3	2		
Grassland Communities	Bracken Grassland					2		3									
	Dry-Mesic Prairie										2	3	3	2	1	3	1
	Dry Prairie										2	3	3	2	2	3	
	Mesic Prairie										3	2	3	1	1	3	2
	Sand Prairie (3)										2	3	1	3	2	1	
	Wet-Mesic Prairie											2	2	1	3	3	3
	Wet Prairie										1	2	1	1	2	2	2
Open and Shrub Wetland Communities	Alder Thicket	2	2	2	3	2	2	2	1	1	1	2		3	2	2	
	Bog Relict									1		1			2	3	2
	Boreal Rich Fen				2	2		2	3								
	Calcareous Fen (Southern)											1		1	3	3	2
	Coastal Plain Marsh													2	3		
	Ephemeral Pond	1	1		3	2	2	1	2	2	1	2	1		1	2	2
	Interdunal Wetland	3							1	2							
	Northern Sedge Meadow	2	3	3	3	3	2	2	3	2	1	2		3	2	2	
	Open Bog (4)	3	3	3	3	3	2	2	1	1				3	2		
	Shore Fen	3							2								
	Shrub Carr	2	1	1	2	2	2	1	3	2	1	3	1	3	3	3	2
	Southern Sedge Meadow						1		2	2	1	2	1	2	3	3	2

Table 2-2. *Continued.*

		Superior Coastal Plain*	Northwest Lowlands	Northwest Sands*	North Central Forest*	Northern Highland*	Forest Transition*	Northeast Sands	Northern Lake Mich. Coastal*	Central Lake Mich. Coastal*	Western Prairie	Western Coulee and Ridges*	Southwest Savanna	Central Sand Plains	Central Sand Hills*	Southeast Glacial Plains	Southern Lake Mich. Coastal
Aquatic Communities	**Emergent Aquatic**	3	2	3	3	3	2	2	3	2	3	3	1	2	3	3	2
	Emergent Aquatic-Wild Rice	3		3	2	3	1	1	1	1	1	2		1	1	2	
	Submergent Aquatic	3	2	3	3	3	2	2	2	2	2	3	1	2	2	2	1
	Submergent Aquatic-Oligotrophic Marsh			1		3											
Miscellaneous Communities	**Algific Talus Slope**											3					
	Alvar								1	3							
	Bedrock Glade		1		3	1	2		1	2	2	3		1	2		
	Bedrock Shore	2															
	Clay Seepage Bluff	2							2	2							2
	Dry Cliff	3	1		3		2	2	3	3	2	3	2	3	1	3	1
	Forested Ridge and Swale	1							3	3							
	Great Lakes Alkaline Rockshore								3								
	Great Lakes Beach	3							3	3							1
	Great Lakes Dune	3							3	3							2
	Inland Beach			3	1	2		1						1			
	Moist Cliff	3	1		3		2	2	2	2	2	3	2	2	2	2	1
Hydrologic-Based	**Coldwater streams**	3	1	2	3	2	3	3	1	1	3	3	2	2	3	1	
	Coolwater streams	3	2	2	3	3	3	3	2	2	3	3	2	2	2	2	1
	Lake Michigan								3	3							3
	Lake Superior	3			1												
	Impoundments/Reservoirs	1	1	2	3	2	3	2	2	1	2	1	1	3	3	3	2
	Inland lakes	1	1	3	3	3	2	2	2	1	1			1	3	3	2
	Warmwater rivers	2	3	2	3	3	3	3	3	3	3	3	1	2	3	3	2
	Warmwater streams	3	2	3	3	3	3	1	3	3	3	1	3	2	2	3	3

3	**Major Opportunity** - A major opportunity for sustaining the natural community in the Ecological Landscape exists, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful maintaining the community's composition, structure, and ecological function over a long period of time.
2	**Important Opportunity** - Although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several significant occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and there may be a lack of opportunities elsewhere.
1	**Present** - The natural community occurs in the Ecological Landscape, but better management opportunities appear to exist in other parts of the state.
Blank	**Absent** - The natural community is not known to occur in the Ecological Landscape.
*	Indicates that the Ecological Landscape has not been comprehensively inventoried or that additional data are needed and that there is incomplete knowledge of what community types exist in the Ecological Landscape.

2.2 Ecological Framework

This section is intended to provide readers with a general overview of Wisconsin's ecological diversity at both landscape and habitat levels. It describes the different ecological regions of the state and identifies the natural communities that are or have the potential to be associated with those ecological regions.

2.2.1 Overview of the Ecological Landscapes of Wisconsin

The Department of Natural Resources adopted a classification system (based on the system known as the National Hierarchical Framework of Ecological Units which was developed by the US Forest Service and many collaborators) to consistently organize its land-based ecological planning, management, and monitoring activities. This system divides the state into 16 ecologically similar regions, based on climate, soils, existing and pre-settlement vegetation, topography, types of aquatic features present, and other factors (Figure 2-1). Referred to as "Ecological Landscapes," they each have their own "look and feel." They also have unique sets of conservation needs and opportunities. They differ in levels of biological productivity, habitat suitability for wildlife, presence of rare species and natural communities, and in many other ways that affect land use and management.

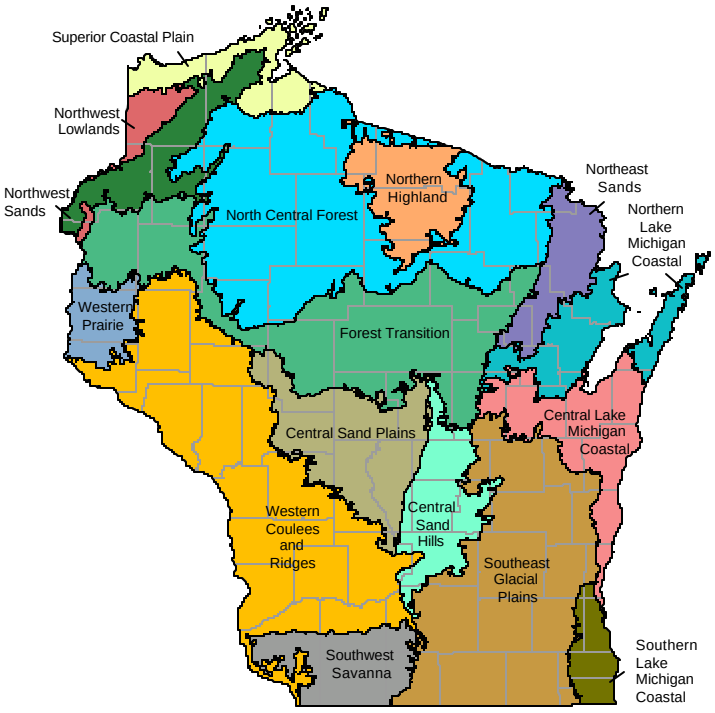


Figure 2-1. Ecological Landscapes of Wisconsin.

The distribution and abundance of plants and animals across the state has been, and continues to be, determined by both natural factors and human-induced disturbance patterns. Historically, many species reached the edge of their range in a narrow band that runs from northwestern to southeastern Wisconsin. This narrow band, known as the "Tension" or "Transition" Zone, separates the northern forest (including the boreal forest) from the southern forest and prairies (Figure 2-2).

Information presented in Section 2.2.3 is taken largely from *Ecological Landscapes of Wisconsin* (Wisconsin DNR 2004a). This web-based resource provides an assessment of each Ecological Landscape, including its ecological, social, and economic characteristics. It also identifies opportunities to manage resources with consideration for long-term ecological and economic sustainability. The information is used by natural resource managers as a reference to help assess the ecological resources and opportunities that exist within the state and in the Ecological Landscapes where they work. This resource was developed collaboratively by DNR staff. It is periodically updated and can be viewed at http://dnr.wi.gov/landscapes/. This web site also contains maps of original vegetation, current land cover, landtype association, public land ownership, and water features for each landscape.

The 16 Ecological Landscapes are described below working from the northwest part of the state to the southeast; first, north of the Tension Zone, and then south. Although many Species of Greatest

Conservation Need tend to be associated with certain areas of the state based on ecological characteristics, only rarely are their ranges concurrent with the Ecological Landscape boundaries described in this chapter. Part of each of the following 16 write-ups are lists of species with high, moderate, or low probabilities of occurring in the Ecological Landscape. This categorization of "probability of occurrence" is not intended to imply that a species occurs throughout the Ecological Landscape, but rather that the species occurs somewhere within it. This is particularly evident in the larger landscapes such as the North Central Forest, Forest Transition, West Central Coulee and Ridges, and Southeast Glacial Plains.

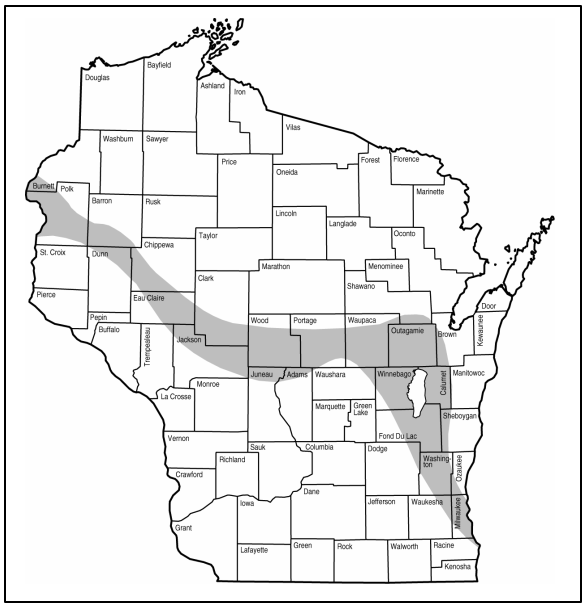


Figure 2-2. Tension Zone in Wisconsin.

2.2.2 Overview of the Natural Communities in Wisconsin

As one travels around the state, it is apparent that Wisconsin harbors a wide variety of terrestrial and aquatic habitats. From the thousands of small lakes in Vilas and Oneida Counties to the steep, wooded valleys and spring creeks of the Driftless Area to the gently rolling, productive farmland along the Rock River, the state contains a remarkable diversity of lands and waters.

Of course, no two places are the same; each forest, wetland, grassland, stream, and lake contains a unique collection of plants and animals. But, based on environmental conditions and ecological processes, similar habitats support similar collections of species. For example, areas of native vegetation in the southern part of the state that are south-facing, have well-drained and reasonably fertile soils, and are subject to frequent fires often harbor scattered bur and white oak trees amidst a variety of native grasses and forbs. Ecologists refer to collections of native plants and animals that consistently occur together under similar conditions as "natural communities." *The Vegetation of Wisconsin* (Curtis 1959) described a novel way to determine natural communities based on plant associations and it remains the foundation from which most ecologists in the state categorize groups of species. Curtis focused on terrestrial and wetland communities, but did not address aquatic systems.

The DNR's Natural Heritage Inventory (NHI) has expanded and refined Curtis' original classification of terrestrial and wetland-related natural communities in Wisconsin. In this report, 58 NHI natural communities, 1 surrogate community (taken from the report, *Managing Habitat for Grassland Birds: A guide for Wisconsin*), and 8 aquatic community types (developed by DNR fishery researchers for use in this plan) are used. They are listed in Table 2-1. *Section 3.3 provides detailed descriptions of these communities as well as listings of the Species of Greatest Conservation Need associated with each.*

Different natural communities occur in different parts of the state and as a result there are different opportunities to sustain these communities in different Ecological Landscapes. "Sustain" means ensuring that a given natural community type will be present and has high potential to maintain its natural composition, structure, and ecological function over a long period of time (e.g., 100 years). Estimating the likely degree of sustainability requires looking at each natural community type from an Ecological Landscape perspective across the state or region to determine whether occurrences of communities are large enough and/or connected enough to support the composition, structure, and ecological function of a community type over time. ***An key objective of sustaining natural communities is to manage for natural community types that historically occurred in a given Ecological Landscape and to have all***

seral stages of a community type represented to accommodate wildlife species that require early and/or late successional habitat stages in order to complete their life history cycle.

This goal of sustainability does not preclude a "working landscape" where both traditional (e.g., forest and agricultural products) and non-traditional (e.g., ginseng, sphagnum moss, etc.) products are extracted from an area. People are dependent on natural resources economically and physically, so to maintain economic sustainability over the long term, natural resources must be sustained. Such a philosophy allows for human use so long as the capacity for self-renewal of natural resources is not compromised. However, removing natural resources in an unsustainable way will diminish natural communities, our economy, and the human population over the long term.

Table 2-2 provides a quick way of identifying which Ecological Landscapes provide the best opportunities for sustaining the natural communities that occur in Wisconsin. It can help guide land and water management activities (including active management for product extraction and recreation, preservation, and restoration of degraded or missing natural communities) to ensure that they are compatible with the local ecology of the Ecological Landscape and also maintain important components of ecological diversity and function. It should help identify the most appropriate community types that could be considered for management activities within each Ecological Landscape. Therefore, this table is intended for broad land and water management applications. This table is not intended to suggest that entire Ecological Landscapes should be restored to historic conditions or that current management regimes are successfully sustaining natural communities. It is intended to illustrate what parts of the state may provide the most effective opportunities to sustain natural communities as landowners and managers strive to meet the needs of both people and diverse sustainable ecosystems.

Opportunities are defined as follows:

Major Opportunity - A major opportunity for sustaining the natural community in the Ecological Landscape exists, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful maintaining the community's composition, structure, and ecological function over a long period of time.

Important Opportunity - Although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several significant occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and there may be a lack of opportunities elsewhere.

Present - The natural community occurs in the Ecological Landscape, but better management opportunities appear to exist in other parts of the state.

Absent - The natural community is not known to occur in the Ecological Landscape.

More information about natural communities in Wisconsin is available at the DNR's web site at http://dnr.wi.gov/org/land/er/communities/.

2.2.3 Ecological Landscape Descriptions

Starting on the following pages are individual descriptions of the 16 Ecological Landscapes in Wisconsin, including lists of the natural communities occurring within each Ecological Landscape. *Section 3.2 contains the lists of Species of Greatest Conservation Need occurring within each Ecological Landscape*

as well as those species-community combinations within each Ecological Landscape that are considered highest ecological priority.

Table 2-1. Natural and surrogate communities in Wisconsin used in this report.

Northern Forest natural communities
Boreal Forest
Northern Dry Forest
Northern Dry-Mesic Forest
Northern Mesic Forest
Northern Wet-Mesic Forest
Northern Wet Forest
Northern Hardwood Swamp

Open and Shrub Wetland natural communities
Alder Thicket
Bog Relict
Boreal Rich Fen
Calcareous Fen
Coastal Plain Marsh
Ephemeral Pond
Great Lakes Coastal Fen
Interdunal Wetland
Northern Sedge Meadow
Open Bog
Shrub Carr
Southern Sedge Meadow

Aquatic natural communities
Emergent Aquatic
Emergent Aquatic-Wild Rice
Submergent Aquatic
Submergent Aquatic-Oligotrophic Marsh

Natural communities based on geologic features
Algific Talus Slope
Alkaline Clay Bluff
Alvar
Bedrock Glade
Dry Cliff
Forested Ridge and Swale
Great Lakes Rockshore
Great Lakes Beach
Great Lakes Dune
Inland Beach
Moist Cliff

Southern Forest natural communities
Hemlock Relict
Pine Relict
Central Sands Pine-Oak Forest
Southern Dry Forest
Southern Dry-Mesic Forest
Southern Mesic Forest
Southern Tamarack Swamp
White Pine-Red Maple Swamp
Floodplain Forest
Southern Hardwood Swamp

Oak Savanna natural communities
Cedar Glade
Oak Opening
Oak Woodland

Oak/Pine Barrens natural communities
Great Lakes Barrens
Oak Barrens
Pine Barrens

Grassland natural communities
Bracken Grassland
Sand Prairie
Dry Prairie
Dry-Mesic Prairie
Mesic Prairie
Wet-Mesic Prairie
Wet Prairie

Hydrologic-based natural communities
Coldwater Streams
Coolwater Streams
Lake Michigan
Lake Superior
Impoundments/Reservoirs
Inland Lakes
Warmwater Rivers
Warmwater Streams

Surrogate communities
Surrogate Grassland (e.g., Conservation Reserve Program, pasture, hay, etc.)

Table 2-2. Opportunities for sustaining Wisconsin's natural communities by Ecological Landscape.

		Superior Coastal Plain*	Northwest Lowlands	Northwest Sands*	North Central Forest*	Northern Highland*	Forest Transition*	Northeast Sands	Northern Lake Mich.	Central Lake Mich.	Western Prairie	Western Coulee and	Southwest Savanna	Central Sand Plains	Central Sand Hills*	Southeast Glacial Plains	Southern Lake Mich.
Northern Forest Communities	Boreal Forest	3	2		2	1		1	2								
	Northern Dry Forest	2	1	3	1	2		3	2					2	1		
	Northern Dry-Mesic Forest	2	2	3	2	3	2	3	2	2	1	2		2	1	1	
	Northern Hardwood Swamp	2	1	2	3	2	2	2	2	2		1		2	2	3	
	Northern Mesic Forest (1)	2	2	1	3	2	3	2	3	2	1	1		2	1		
	Northern Wet-Mesic Forest	2	2	2	3	2	3	3	3	2		1			1	2	1
	Northern Wet Forest (2)	2	3	3	3	3	3	2	2	2	1	2		3	3	2	2
Southern Forest Communities	Central Sands Pine – Oak Forest													3	3		
	Floodplain Forest	2		1	2	1	2	1	2	2	2	3	1	3	2	3	1
	Hemlock Relict											3	1	1			
	Pine Relict											3	2	1			
	Southern Dry Forest										1	3	2	2	3	3	2
	Southern Dry-Mesic Forest						1			2	2	3	2	3	2	3	2
	Southern Hardwood Swamp									1		1				2	2
	Southern Mesic Forest						1		1	2	2	3	2	2	1	2	2
	Southern Tamarack Swamp											2		2	2	3	2
	White Pine – Red Maple Swamp													3			
Oak Savanna Communities	Cedar Glade								2	1	2	3	1	1	1	2	
	Oak Opening										2	3	3		1	3	2
	Oak Woodland										2	3	3	1	1	3	1
Barrens Communities	Great Lakes Barrens	3							1								
	Oak Barrens											3		3	2		
	Pine Barrens			3		1		3				2		3	2		
Grassland Communities	Bracken Grassland					2		3									
	Dry-Mesic Prairie										2	3	3	2	1	3	1
	Dry Prairie										2	3	3	2	2	3	
	Mesic Prairie										3	2	3	1	1	3	2
	Sand Prairie (3)										2	3	1	3	2	1	
	Wet-Mesic Prairie											2	2	1	3	3	3
	Wet Prairie										1	2	1	1	2	2	2
Open and Shrub Wetland Communities	Alder Thicket	2	2	2	3	2	2	2	1	1	1	2		3	2	2	
	Bog Relict									1		1			2	3	2
	Boreal Rich Fen				2	2		2	3								
	Calcareous Fen (Southern)											1		1	3	3	2
	Coastal Plain Marsh													2	3		
	Ephemeral Pond	1	1		3	2	2	1	2	2	1	2	1		1	2	2
	Interdunal Wetland	3							1	2							
	Northern Sedge Meadow	2	3	3	3	3	2	2	3	2	1	2		3	2	2	
	Open Bog (4)	3	3	3	3	3	2	2	1	1				3	2		
	Shore Fen	3							2								
	Shrub Carr	2	1	1	2	2	2	1	3	2	1	3	1	3	3	3	2
	Southern Sedge Meadow						1		2	2	1	2	1	2	3	3	2

Table 2-2. *Continued.*

		Superior Coastal Plain*	Northwest Lowlands	Northwest Sands*	North Central Forest*	Northern Highland*	Forest Transition*	Northeast Sands	Northern Lake Mich. Coastal*	Central Lake Mich. Coastal*	Western Prairie	Western Coulee and Ridges*	Southwest Savanna	Central Sand Plains	Central Sand Hills*	Southeast Glacial Plains	Southern Lake Mich. Coastal
Aquatic Communities	**Emergent Aquatic**	3	2	3	3	3	2	2	3	2	3	3	1	2	3	3	2
	Emergent Aquatic-Wild Rice	3		3	2	3	1	1	1	1	1	2		1	1	2	
	Submergent Aquatic	3	2	3	3	3	2	2	2	2	2	3	1	2	2	2	1
	Submergent Aquatic-Oligotrophic Marsh			1		3											
Miscellaneous Communities	**Algific Talus Slope**											3					
	Alvar								1	3							
	Bedrock Glade		1		3	1	2		1	2	2	3		1	2		
	Bedrock Shore	2															
	Clay Seepage Bluff	2							2	2							2
	Dry Cliff	3	1		3		2	2	3	3	2	3	2	3	1	3	1
	Forested Ridge and Swale	1							3	3							
	Great Lakes Alkaline Rockshore								3								
	Great Lakes Beach	3							3	3							1
	Great Lakes Dune	3							3	3							2
	Inland Beach			3	1	2		1						1			
	Moist Cliff	3	1		3		2	2	2	2	2	3	2	2	2	2	1
Hydrologic-Based	**Coldwater streams**	3	1	2	3	2	3	3	1	1	3	3	2	2	3	1	
	Coolwater streams	3	2	2	3	3	3	3	2	2	3	3	2	2	2	2	1
	Lake Michigan								3	3							3
	Lake Superior	3			1												
	Impoundments/Reservoirs	1	1	2	3	2	3	2	2	1	2	1	1	3	3	3	2
	Inland lakes	1	1	3	3	3	2	2	2	1	1			1	3	3	2
	Warmwater rivers	2	3	2	3	3	3	3	3	3	3	3	1	2	3	3	2
	Warmwater streams	3	2	3	3	3	3	1	3	3	3	1	3	2	2	3	3

3	**Major Opportunity** - A major opportunity for sustaining the natural community in the Ecological Landscape exists, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful maintaining the community's composition, structure, and ecological function over a long period of time.
2	**Important Opportunity** - Although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several significant occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and there may be a lack of opportunities elsewhere.
1	**Present** - The natural community occurs in the Ecological Landscape, but better management opportunities appear to exist in other parts of the state.
Blank	**Absent** - The natural community is not known to occur in the Ecological Landscape.
*	Indicates that the Ecological Landscape has not been comprehensively inventoried or that additional data are needed and that there is incomplete knowledge of what community types exist in the Ecological Landscape.

2.2.3.1 Superior Coastal Plain Ecological Landscape

General Description

The Superior Coastal Plain is Wisconsin's northernmost Ecological Landscape (Figure 2-3), bordered on the north by southwestern Lake Superior and on the south by the Northwest Sands, the Northwest Lowlands, and the North Central Forest. The climate is strongly influenced by Lake Superior, resulting in cooler summers, warmer winters, and greater precipitation compared to more inland locations. Exposed coastal areas are subject to significant disturbance from windstorms, waves, ice, currents, and periodic water level fluctuations. These disturbance regimes play a significant role in determining both the landform and vegetation characteristics of the shoreline ecosystems.

Figure 2-3. Superior Coastal Plain Ecological Landscape.

The major landform in this Ecological Landscape is a nearly level plain of lacustrine clays that slopes gently northward toward Lake Superior. The clay plain is separated into two disjunct segments by the comparatively rugged Bayfield Peninsula. An archipelago of sandstone-cored islands, the Apostles, occurs in Lake Superior just north and east of the Bayfield Peninsula. Wave carved sandstone cliffs bracket stretches of the Peninsula and also occur along the margins of several of the islands. Sand spits are a striking feature of the Lake Superior shoreline, typically separating the waters of the lake from inland lagoons and wetlands. The spits support rare and highly threatened natural communities such as beaches, dunes, interdunal wetlands, and pine barrens, and these in turn are inhabited by specially adapted plants and animals. The mouths of many of the streams entering Lake Superior are submerged, creating freshwater estuaries. A ridge of volcanic igneous rock, primarily basalt, forms the southern boundary of portions of this Ecological Landscape.

Vegetation

Historically the Superior Coastal Plain was almost entirely forested. A distinctive mixture of white pine, white spruce, balsam fir, paper birch, balsam poplar, trembling aspen, and white cedar occurred on the lacustrine clays. White pine was strongly dominant in some areas, according to mid-nineteenth century notes left by surveyors of the US General Land Office. Mesic to dry-mesic forests of northern hardwoods or hemlock hardwoods were more prevalent on the glacial tills of the Bayfield Peninsula and throughout the Apostle Islands.

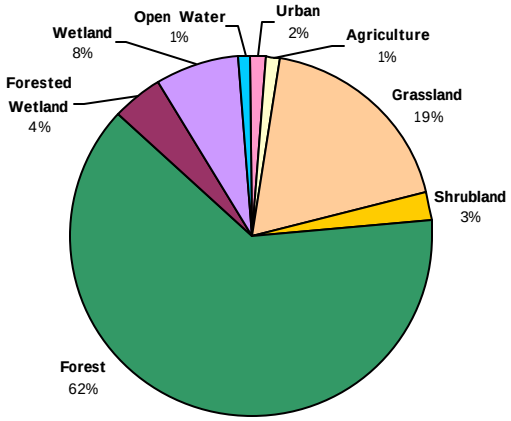


Figure 2-4. Current land cover in the Superior Coastal Plain Ecological Landscape.

Large peatlands occurred along the Lake Superior shoreline, often associated with drowned river mouths and well-developed sand spits. The most extensive of these wetland complexes were on the Bad and St. Louis rivers. A few large peatlands also occurred at inland sites, such as Bibon Swamp, in the upper White River drainage, and Sultz Swamp on the northern Bayfield Peninsula.

The present clay plain forest has been fragmented by agricultural use, and today approximately one-third of this Ecological Landscape is non-forested (Figure 2-4). Most of the open land is in grass cover, having been cleared and then subsequently pastured or plowed. Aspen and birch forests occupy about 40% of the total land area, having increased in prominence over the boreal conifers. On the Bayfield Peninsula, second-growth northern hardwood forests are interspersed among extensive early successional aspen stands. Older forest successional stages are now rare throughout the Superior Clay Plain.

Hydrologic Features

The larger rivers include the St. Louis, Nemadji, Bad, White, Amnicon, Flag, Sand, Raspberry, and Sioux. Smaller streams flowing across the clay plain typically occupy short, relatively straight, steep-sided valleys before emptying into Lake Superior. Other streams originate in the higher elevations of the Bayfield Peninsula and follow meandering courses toward the lake. Inland lakes are rare. Many wetlands still persist, and, collectively, they constitute a regionally significant reservoir of rare plants and animals, intact natural communities, and natural processes. All watersheds have been ranked for groundwater pollution by Wisconsin DNR, and groundwater conditions are among the cleanest in the state. Most watersheds in this Ecological Landscape have not been ranked for watershed, stream, or lake pollution.

Land Use

The total land area for the Superior Coastal Plain Ecological Landscape is approximately 906,000 acres, of which 57% is classified as timberland. Publicly owned lands make up about one-fifth of the area (Figure 2-5); about half of them are county forest, and the remainder are state or federally managed. Two tribal reservations of the Lake Superior Ojibwa -- Red Cliff and Bad River -- are situated along Lake Superior.

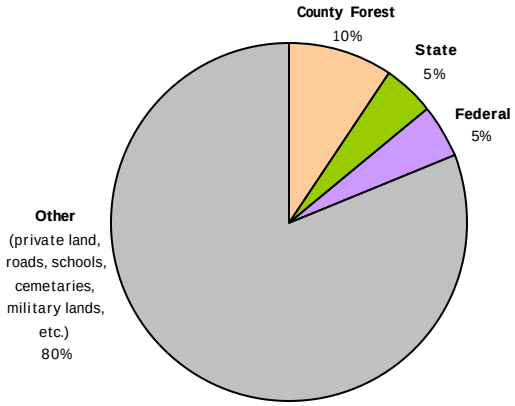


Figure 2-5. Public land ownership in the Superior Coastal Plain Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Ashland, Bayfield, and Douglas ("Superior Coastal Plain Region").

Recreation is an important contributor to the economy of the Superior Coastal Plain Region. The number of state parks, forests, and recreation areas, as well as acreage of federal lands, is quite high. Forest products and processing industries contribute about 9% to the total industrial output of the region. Agriculture is not a major contributor to the economy. This region not only has the third lowest percent of farmland acreage, but the second lowest market value per acre of products sold, and the third lowest per acre production of both milk and corn. Note that farmland is defined as all land under farm ownership, which includes cropland, pastureland, and woodland. It has seen the greatest decrease in both farm numbers and acreage in agricultural land since 1970, and still ranks as one of the regions with highest agricultural land sales.

The Superior Coastal Plain Region has one of the lowest population densities and growth rates (1970-2000) of all the regions in the state. The population density of the region (19 persons/mi^2) is only about one-fifth that of the state as a whole (96 persons/mi^2). Although there are few minorities, this region has the largest percentage of Native Americans. Economically, the counties of the Superior Coastal Plain are not very prosperous. Not only are the per capita income and average wage relatively low, but this region has the highest poverty rates for both adults and children and the second highest rate of unemployment of all the regions. The counties in the Superior Coastal Plain are highly dependent on the service and government job sectors with one of the lowest percentages of manufacturing jobs.

Management Opportunities

- Protection of unique Great Lakes shoreline environments such as the vast Bad River-Kakagon Sloughs; the smaller but biologically rich estuaries at Fish Creek, Sioux River Slough, Sand River, Raspberry Bay, Bark Bay, Lost Creek, Port Wing, Allouez Bay, and the lower St. Louis River; and the wave-carved sandstone cliffs of the northern Bayfield Peninsula.
- Protection of unique geological features and natural communities of the Apostle Islands, including wave-sprayed sandstone cliffs and ledges, tombolos, cuspate forelands, and barrier spits, Great Lakes barrens, and old-growth forest remnants of white cedar, yellow birch, and hemlock.
- Protection, management, and restoration of clay plain boreal forest, a greatly altered and diminished forest community that occurs nowhere else in the state, and is important for maintaining the water quality of the streams that feed Lake Superior.
- Increase conifer cover, forest patch size and connectivity, and late successional forests to counter the effects of fragmentation and re-establish diminished habitats.
- Protection, management, and restoration of stream corridors.
- Maintenance of extensive forest habitat on the Bayfield Peninsula.
- Protection of the Bibon Swamp and White River corridor, which links the extensive forests to the south with the vast Bad River-Kakagon Sloughs on Lake Superior.
- Protection and rehabilitation of the Nemadji River corridor, which harbors ecologically unusual rich mesic hardwood forests, floodplain forests, and marshes.
- Protection of numerous rare plant and animal populations, especially those for which Great Lakes habitats have high significance.
- Protection and management of sites used by large numbers of migratory and colonial nesting birds.
- Protection of critical inland, nearshore, and offshore fish habitats.
- Grassland management is possible and potentially valuable in some former agricultural areas. These efforts will be most beneficial on sites where opportunities to manage and restore extensive clay plain forest are negligible or unfeasible.
- Cooperate with the Bad River and Red Cliff bands of the Lake Superior Ojibwa to ensure effective long-term protection of the highly significant natural features occurring on and near Lake Superior tribal lands.

Natural Communities

The following table (Table 2-3) lists the natural communities occurring in the Superior Coastal Plain arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-3. Natural communities occurring in the Superior Coastal Plain arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Boreal Forest	Northern Dry Forest	Ephemeral Pond
Great Lakes Barrens	Northern Dry-Mesic Forest	Forested Ridge and Swale
Emergent Aquatic	Northern Hardwood Swamp	
Emergent Aquatic-Wild Rice	Northern Mesic Forest	
Submergent Aquatic	Northern Wet-Mesic Forest	
Interdunal Wetland	Northern Wet Forest	
Open Bog	Floodplain Forest	
Shore Fen	Alder Thicket	
Dry Cliff	Northern Sedge Meadow	
Great Lakes Beach	Shrub Carr	
Great Lakes Dune	Bedrock Shore	
Moist Cliff	Clay Seepage Bluff	

2.2.3.2 Northwest Lowlands Ecological Landscape

General Description

The Northwest Lowlands Ecological Landscape forms a triangular wedge in northwestern Wisconsin (Figure 2-6), bounded on the north by the Superior Coastal Plain and on the south and east by the Northwest Sands. The major landforms are ground and end moraines, with drumlins present in the southwestern portion. Topography is gently undulating. Bedrock outcroppings are rare except in association with the basalt ridge that follows the Douglas County fault line and forms part of the northern boundary of the Northwest Lowlands. Maximum local relief is approximately 350'. Waterfalls, cliffs, exposed bedrock glades, and rock-walled gorges are associated with the bedrock features. Local exposures of sandstones and/or conglomerates occur in some of these gorges. Soils are predominantly loams, with significant acreages of peat deposits in the poorly drained lowlands. Significant portions of this Ecological Landscape extend westward into the state of Minnesota.

Figure 2-6. Northwest Lowlands Ecological Landscape.

Vegetation

The historic upland vegetation of this Ecological Landscape was almost entirely forest, composed mostly of paper birch, fir, sugar maple, aspen, and white spruce, with some white and red pine on the drier ridges. The lowlands supported extensive wet forests of black spruce and tamarack, and some white cedar and black ash swamps. The notes made by US General Land Office surveyors during the mid-nineteenth century indicate that overall tree densities were high in this Ecological Landscape; also, the witnessed trees included many large individuals. The Ecological Landscape at that time was likely a mosaic of young, recently disturbed forests interspersed with patches of old-growth forests.

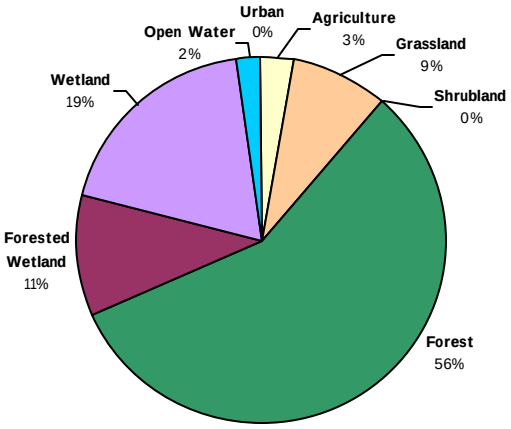


Figure 2-7. Current land cover in the Northwest Lowlands Ecological Landscape.

The present-day forests remain extensive and relatively unbroken, occupying about 67% of the Ecological Landscape (Figure 2-7). Forests consists mainly of aspen, paper birch, sugar maple, basswood, spruce, and fir. Minor amounts of white and red pine and red oak are also present. Older successional stages are currently rare. The large undisturbed peatland complexes are composed of mosaics of black spruce-tamarack swamp, muskeg, open bog, poor fen, shrub swamp, and white cedar swamp. Among the important sensitive species occurring here are the timber wolf, moose, gray jay, lesser purple fritillary, subarctic darner, and bog bluegrass. Many birds and invertebrates with generally boreal ranges are found here. Road density is notably low in the western part of the Ecological Landscape.

Hydrologic Features

This heavily forested Ecological Landscape occupies a major drainage divide, and contains the headwaters of many streams flowing north toward Lake Superior or south toward the St. Croix River system. Among the important rivers are the St. Croix, Black, Tamarack, Spruce, and Amnicon. Lakes are uncommon, and are typically associated with peatland complexes. Rare aquatic species include the river redhorse, gilt darter, and several dragonflies and damselflies. Water quality is relatively good in this area with the third best ranking for overall watershed pollution levels according to Wisconsin DNR.

Land Use

The total land area for the Northwest Lowlands Ecological Landscape is approximately 421,000 acres, of which 74% is classified as timberland. About half of the Ecological Landscape is in public ownership (Figure 2-8), which is mostly managed as county forests; a small portion is also under federal or state management.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis, with counties as the smallest unit. This Ecological Landscape is very small, and the only county included in the socioeconomic region is Douglas County ("Northwest Lowlands Region"). The City of Superior is in Douglas County, but not within the Northwest Lowlands Ecological Landscape. This may cause some discrepancies when analyzing the socioeconomic structure of the Ecological Landscape; however, the social and economic character of the area is expected to be significantly affected by its close proximity to Superior and Duluth, Minnesota.

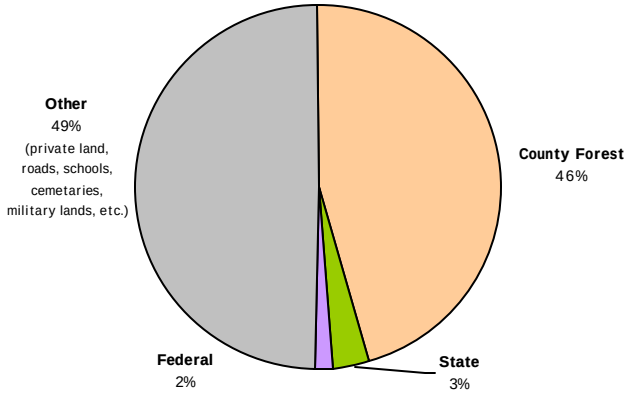


Figure 2-8. Public land ownership in the Northwest Lowlands Ecological Landscape.

The forest products and processing industries are not a major contributor to the economy of the Northwest Lowlands Region (4% of total industrial output); however, this may be due to the influence of the City of Superior on economic measures for Douglas County. The area is heavily forested, and mostly managed by County Forests for wood products. Agriculture is not a major contributor to the economy of the region. The region has the second lowest percent land area in farmland, the lowest market value per acre of products sold, the second lowest milk production per acre, and the third lowest per acre production of corn. Note that farmland includes all land under farm ownership such as cropland, pastureland, and woodland.

The region also has one of the highest percentages of agricultural land sold and diverted to other uses. The number of state parks, forests, and recreation areas, as well as fishery and wildlife areas, are second fewest among the regions. As with farmland, an above average amount of forest land is sold and diverted to other uses in this region. This region has the highest combined percentage of agricultural and forest land sold annually.

Compared to the other regions, the Northwest Lowlands Region is sparsely populated and relatively poor. The population density of the region (32 persons/mi^2) is about one third that of the state as a whole (96 persons/mi^2). It has the lowest population density and the second lowest growth rate (1970-2000) among the regions of the state. Note that the population density of the Northwest Lowlands Region is low, however, the population density of the Ecological Landscape alone would be even lower, since the City of Superior is included in the region, but not in the Ecological Landscape. The population has a very low percentage of young people (less than 18 years old) and is not racially diverse. It has an above average percentage of high school graduates. Although the per capita income is below average, Douglas County has the fourth highest average wage among the regions, and one of the lowest poverty rates for both adults and children.

The largest sector of the Douglas County economy is transportation, communication, and public utilities, which contribute 23% of total industrial output. As for job diversity, this region has the lowest percentage of manufacturing employment and the third lowest proportion of farming jobs. Government service is relatively more important here as a provider of jobs.

Management Opportunities

- This Ecological Landscape is relatively intact with respect to natural landcover and hydrologic patterns, providing opportunities for management of large land areas.
- Protection of extensive, unfragmented forest habitat is especially important here, as large forest blocks are becoming increasingly uncommon statewide.
- Protection of high quality peatland complexes, as these are among the largest and least disturbed examples of their respective types in the state, and constitute critical habitats for many rare and/or range restricted boreal plants and animals.
- Protection of headwaters streams and their associated corridors and watersheds.
- Protection of the ecologically significant St. Croix River system.
- Increase conifer cover, forest patch size and connectivity, and older successional stages where appropriate and feasible.
- Management for large wide-ranging mammals such as timber wolf and moose.
- Maintain existing extensive areas with low road densities, which are perhaps the lowest in the state.
- Work with Minnesota to ensure continued coordinated and compatible management, and to maintain important travel and dispersal corridors between the states.
- Additional data collection is highly desirable and needed to clarify the ecological significance of this little-studied Ecological Landscape.

Natural Communities

The following table (Table 2-4) lists the natural communities occurring in the Northwest Lowlands arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-4. Natural communities occurring in the Northwest Lowlands arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Wet Forest	Boreal Forest	Northern Dry Forest
Northern Sedge Meadow	Northern Dry-Mesic Forest	Northern Hardwood Swamp
Open Bog	Northern Mesic Forest	Ephemeral Pond
	Northern Wet-Mesic Forest	Shrub Carr
	Emergent Aquatic	Bedrock Glade
	Submergent Aquatic	Dry Cliff
	Alder Thicket	Moist Cliff

2.2.3.3 Northwest Sands Ecological Landscape

General Description

The Northwest Sands Ecological Landscape (Figure 2-9) is a large glacial outwash system consisting of two major landforms: flat plains or terraces along glacial meltwater channels, and pitted or "collapsed" outwash plains containing kettle lakes. Soils are deep sands, low in organic material and nutrients.

Figure 2-9. Northwest Sands Ecological Landscape.

Vegetation

Historic vegetation at the time of the General Land Office survey was dominantly jack pine and scrub oak forest and barrens. White and red pine forests were also a sizable component of the Ecological Landscape. Numerous barrens occurred in the southwest half of the Ecological Landscape, and a few large barrens within the northeast half. Most of the trees in the barrens were jack pine, but oak savannas also occurred in the south central part of the Ecological Landscape.

Current vegetation is a mix of forest, agriculture, and grassland with some wetlands in the river valleys. Pine, aspen-birch, and oak equally (27% each) dominate the forested area of the Ecological Landscape (Figure 2-10). The maple-basswood, spruce-fir, and lowland hardwood forest type groups occupy small percentages of the Ecological Landscape. Within the open lands, there is a relatively large proportion of grassland and shrubland, a small but locally significant amount of emergent/wet meadow and open water, and very little row-crop agriculture.

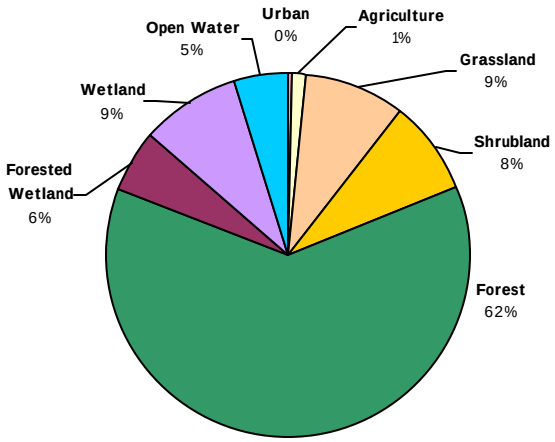


Figure 2-10. Current land cover in the Northwest Sands Ecological Landscape.

Hydrologic Features

Several hundred kettle lakes are found in the pitted outwash plain. The headwaters of the St. Croix-Namekagon and Brule River systems are located here among flat plains, sedge meadows, bog complexes, and major barrens. The overall pollution levels of watersheds, steams, and lakes that have been ranked (6 out of 23) in the Northwest Sands Ecological Landscape are about average according to Wisconsin DNR. Groundwater conditions are among the least polluted and most vulnerable in the state for the 16 watersheds that have been ranked.

Land Use

The total land area of the Northwest Sands Ecological Landscape is approximately 1.2 million acres, of which 64% is classified as timberland. Of timberland within the Ecological Landscape, 49% is under public ownership, while 41% is owned by non-industrial, private landowners. The largest public landowners are the counties and municipalities (21%), followed by federal (12%) and state (5%) governments (Figure 2-11).

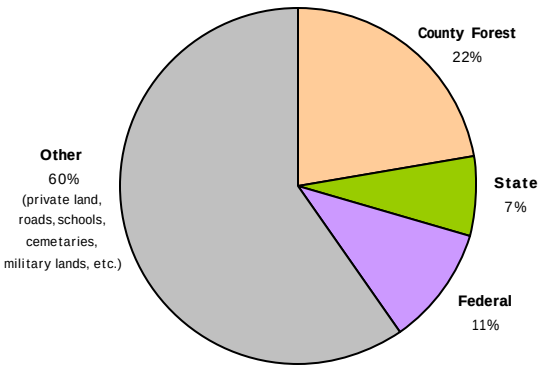


Figure 2-11. Public land ownership in the Northwest Sands Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region").

Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Bayfield, Burnett, Douglas, and Washburn ("Northwest Sands Region").

The Northwest Sands Region has a relatively low population density and an aging population. The population density of the region (20 persons/mi^2) is about one-fifth that of the state as a whole (96 persons/mi^2). It has the second lowest percentage of young people (less than 20 years old), the third highest proportion of elderly (over 65 year old) people, and the second highest median age among the regions of the state. Overall, the percentage of minorities is below average, with the exception of the Native American population.

Economically, the counties of the Northwest Sands are somewhat depressed when compared with the rest of the state. Per capita income and average wage are third lowest and the rates of poverty and unemployment are third and fifth highest, respectively, among the regions. The retail, service, and government sectors are important employers in the region, though the facilities are located outside the Ecological Landscape in Superior.

Hay production is relatively important in the region's agricultural sector. Forest products and dollar value of the processing industries are relatively small, comprising only 5% of the total regional dollar value of industrial output. Agriculture land sold and diverted to other uses resulted in a slightly higher percentage of agricultural land loss in the region than in the state as a whole.

Management Opportunities

- There is ample opportunity for increasing the extent of dry jack pine-northern pin oak forest and white and red pine restoration.
- Large-scale restoration of oak-pine barrens and wetlands (sedge meadows, marshes, and bogs) would benefit many rare birds, herptiles, plants, butterflies and moths, and many other invertebrates found in the Ecological Landscape.
- Other species deserving special management in this Ecological Landscape include wolves and grassland/shrubland birds.
- Maintenance and restoration of St. Croix, Brule (cedar swamp and spring management), and Namekagon river systems, kettle lakes, wild rice lakes, streams, springs or spring creeks, and conifer swamps present additional ecological management opportunities.

Natural Communities

The following table (Table 2-5) lists the natural communities occurring in the Northwest Sands arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-5. Natural communities occurring in the Northwest Sands arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Dry Forest	Northern Hardwood Swamp	Northern Mesic Forest
Northern Dry-Mesic Forest	Northern Wet-Mesic Forest	Floodplain Forest
Northern Wet Forest	Alder Thicket	Submergent Aquatic-Oligotrophic Marsh
Pine Barrens		
Emergent Aquatic		Shrub Carr
Emergent Aquatic-Wild Rice		
Submergent Aquatic		
Northern Sedge Meadow		
Open Bog		
Inland Beach		

2.2.3.4 North Central Forest Ecological Landscape

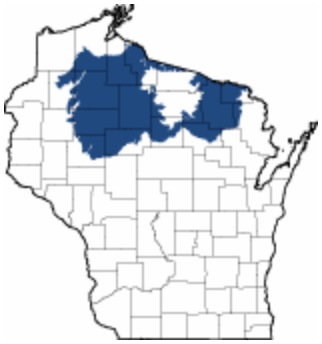


Figure 2-12. North Central Forest Ecological Landscape.

General Description

The North Central Forest Ecological Landscape occupies much of the northern third of Wisconsin (Figure 2-12). Its landforms are characterized by end and ground moraines with some pitted outwash and bedrock controlled areas. Kettle depressions and steep ridges are found in the northern portion. Two prominent areas in this Ecological Landscape are the Penokee-Gogebic Iron Range in the north extending into Michigan, and Timm's Hill, the highest point in Wisconsin (1,951 feet) in the south.

Soils consist of sandy loam, sand, and silts. The vegetation is mainly forest, with many wetlands and some agriculture, though the growing season is not as favorable as it is in southern Wisconsin. Lake Superior greatly influences the northern portion of the Ecological Landscape especially during the winter season, producing greater snowfall than in most areas in Wisconsin.

Vegetation

The historic vegetation was primarily hemlock-hardwood forest dominated by hemlock, sugar maple, and yellow birch. There were some smaller areas of white and red pine forest scattered throughout the Ecological Landscape, and individual white pines trees were a component of the hemlock-hardwood forest. Harvesting hemlock to support the tanneries was common at the turn of the century, and the species soon became a minor component of forests due to over-harvesting and lack of regeneration.

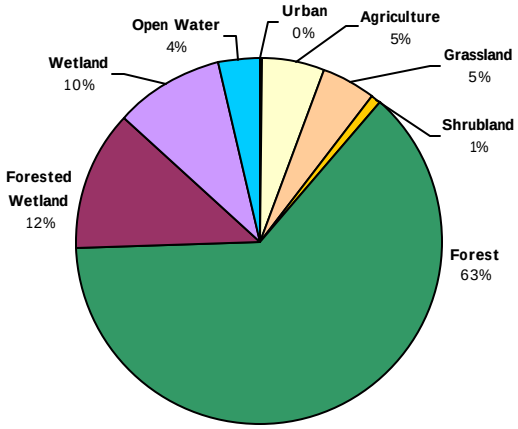


Figure 2-13. Current land cover in the North Central Forest Ecological Landscape

Currently, forests cover approximately 80% of this Ecological Landscape (Figure 2-13). The northern hardwood forest is dominant, made up of sugar maple, basswood, and red maple, and also including some scattered hemlock and white pine pockets within stands. The aspen-birch forest type group is also relatively abundant, followed by spruce-fir. A variety of wetland community types also are present, both forested and non-forested.

Hydrologic Features

Many small drainages and lakes are found throughout this Ecological Landscape. Major rivers include the Chippewa, Flambeau, Wisconsin, Jump, Wolf, Pine, Popple, and Peshtigo. Several man-made flowages exist such as the Turtle-Flambeau, Gile, Pine, and Mondeaux. Although the Ecological Landscape has one of the most favorable ratings by Wisconsin DNR for overall watershed quality, many lakes have mercury levels high enough to warrant a consumption advisory.

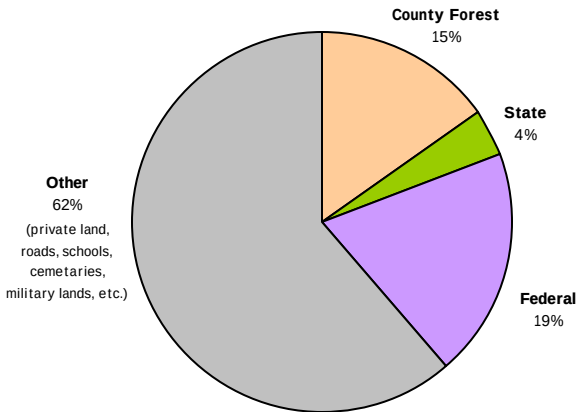


Figure 2-14. Public land ownership in the North Central Forest Ecological Landscape

Land Use

The North Central Forest Ecological Landscape contains 2.1 million acres of total land area and has the highest percentage of land area in

timberland (77%) compared to other Ecological Landscapes. A high percentage (44%) is publicly owned (Figure 2-14), mostly in federal or county management.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Ashland, Bayfield, Chippewa, Florence, Forest, Iron, Langlade, Lincoln, Price, Rusk, Sawyer, Taylor, and Washburn ("North Central Forest Region").

Agriculture is not a major contributor to the economy of the North Central Forest Region. In general, this region has a fairly low per capita income and average wage, as well as the third highest unemployment rate of all the regions. It has a substantial acreage in water, especially lakes, and a large number of fishery and wildlife areas.

Compared to the other regions of the state, the population of the North Central Forest Region is growing rapidly and, on average, is much older, less racially diverse, and less educated. The population density (21 persons/mi^2) is slightly less than one-fourth that of the state as a whole (96 persons/mi^2). Interestingly, it had the fourth fastest-growing population from 1970-2000 with a high percentage of elderly (over 65 years old) and a high median age. This region has the lowest percentage of minorities, with the exception of Native Americans. The percentage of high school and college graduates is below average. Economically, this region is less prosperous than other regions. It has the fourth lowest per capita income and average wage and the third highest rates of unemployment and child and adult poverty. Manufacturing jobs are quite important whereas service jobs are much less important than in other regions.

Management Opportunities

- Landscape scale forest management to retain or restore the compositional, structural, and functional attributes of northern forest ecosystems.
- Restoration of older successional stages and larger forest patches.
- Maintaining larger blocks of northern hardwood forest, especially those in public ownership, is important for forest-interior species such as the black throated-blue warbler, hermit thrush, and many other neotropical migrants.
- Restore the missing or diminished conifer component of forests, especially hemlock, white pine, and white cedar.
- Monitoring and research opportunities exist in areas with significant disturbance events such as windthrow, insect and disease, and other agents.
- Continue efforts to manage for uncommon species such as loons, eagles, ospreys, and wolves, especially since these species have responded favorably to past management attention.
- Management for additional rare or otherwise sensitive species.
- Management and protection of kettle lakes, cedar swamps, and other wetlands that are especially important for their biotic components.
- Increase protection for the major rivers, to enhance water quality and maintain populations of sensitive aquatic organisms.
- Establish ecological linkages within this Ecological Landscape along major river corridors. Some of these can be extended to adjacent Ecological Landscapes.
- Protect the extensive forests of the Penokee Range, and the unusual features associated with them, such as high-gradient, soft headwater streams, and open bedrock glades.

Natural Communities

The following table (Table 2-6) lists the natural communities occurring in the North Central Forest arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-6. Natural communities occurring in the North Central Forest arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Hardwood Swamp	Boreal Forest	Northern Dry Forest
Northern Mesic Forest	Northern Dry-Mesic Forest	Inland Beach
Northern Wet-Mesic Forest	Floodplain Forest	
Northern Wet Forest	Emergent Aquatic-Wild Rice	
Emergent Aquatic	Boreal Rich Fen	
Submergent Aquatic	Shrub Carr	
Alder Thicket		
Ephemeral Pond		
Northern Sedge Meadow		
Open Bog		
Bedrock Glade		
Dry Cliff		
Moist Cliff		

2.2.3.5 Northern Highlands Ecological Landscape

Figure 2-15. Northern Highlands Ecological Landscape.

General Description

The Northern Highlands Ecological Landscape is located in northern central Wisconsin (Figure 2-15). It is known for its pitted outwash plains and kettle lakes mixed with extensive forests and large peatlands. Its landforms are characterized mainly by pitted outwash but also contain some coarse-textured moraines. Soils are acidic and relatively unproductive due to low moisture-holding capacity and lack of organic matter.

Vegetation

Historically, this was Wisconsin's greatest pinery. White and red pine forests largely dominated the vegetation, with some smaller pockets of jack pine. On the more mesic soils, hemlock-hardwood forests were common. Aspen-birch forests occurred in openings formed by disturbance events such as wind or fire.

Current forest vegetation is primarily aspen, with some white, red and jack pine in both natural and plantation form (Figure 2-16). Northern hardwood forests, though reduced in extent, still occur on the more mesic soils. Lowland conifer occupies the many peatlands that are scattered throughout the Ecological Landscape.

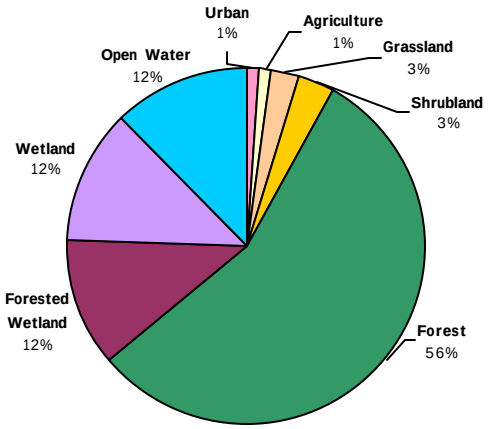


Figure 2-16. Current land cover in the Northern Highland Ecological Landscape

Hydrologic Features

The Northern Highlands is known for having one of the highest concentrations of kettle lakes in the world. The kettles were formed as glaciers melted, when large ice blocks became stranded and outwash materials were deposited over them. As the ice blocks slowly melted and collapsed, kettles were formed. Lakes developed in portions of kettles that were below the level of ground water. The sandy bottoms and shorelines of these lakes make them some of the most desirable areas for water recreation in the state. The Wisconsin and Manitowish are the two main rivers that run through the Ecological Landscape. Wetland types in this area such as open bog, fen, and wild rice marsh contain rare flora and fauna. Watershed pollution is about average for the state according to Wisconsin DNR.

Land Use

The Northern Highland Ecological Landscape comprises approximately 1.4 million acres of which 64% is forested. Almost 30% of the land is in public ownership (Figure 2-17), including the Northern Highland-American Legion State Forest.

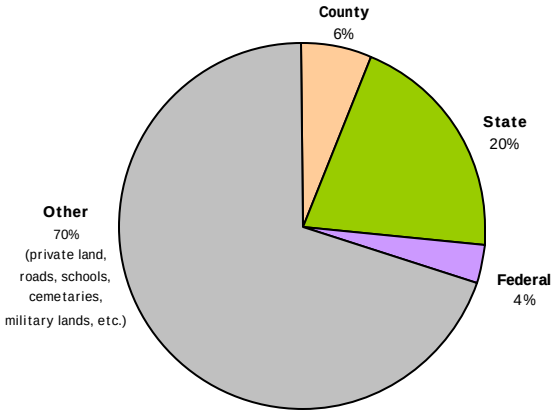


Figure 2-17. Public land ownership in the Northern Highland Ecological Landscape

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Iron, Oneida, and Vilas (Northern Highland Region).

As is common in northern Wisconsin, the timber industry is extremely important in local economies. Much of the land is used for timber and pulp production, made possible by the availability of public land and the ownership of 17% of the timberland by the forest industry. Recreation is also significant in the region, as is typical in northern Wisconsin. Agriculture productivity is low for most crops due to the short growing season and poor quality soils.

The population density of the Northern Highland Region (59 persons/mi^2) is about two-thirds that of the state as a whole (96 persons/mi^2), and its economy is below average. Per capita income for the region is lower than statewide, although it has been increasing for the region. The service sector employed the most people. The regional poverty rates for all people and for children under age 18 were higher than for the state as a whole. The Northern Highland counties each had higher unemployment rates than the state average. Iron, Oneida, and Vilas counties are all service-dependent.

Management Opportunities

- This Ecological Landscape has an abundance of kettle lakes in a forested setting, making it an important area for rare species and wildlife, as well as recreation and tourism. Conflicts exist among competing uses.
- Restoration of dry forest types that are currently aspen or monotypic plantations and conversion to predominately white and red pine.
- Restoration and protection of hemlock-hardwood forest.
- Maintenance of bracken grasslands by prescribed burning.
- Protection of rare biota including calypso orchid (*Calypso bulbosa*), shore sedge (*Carex lenticularis*), red-shouldered hawk (*Buteo lineatus*), yellow rail (*Coturnicops noveboracensis*), and many other species. This Ecological Landscape also harbors a large proportion of rare aquatic and wetland species.
- Continued management emphasis on uncommon, sensitive animals associated with water -- bald eagle, osprey, common loon, and black tern.
- Protection and management of remaining wild lakeshores, wild rice lakes and streams, and extensive peatlands that are under pressure from development.
- The strategic location of this Ecological Landscape within northern Wisconsin provides potential for linking extensive forests to the north, east, and west, and protecting the headwaters and upper portions of our largest river, the Wisconsin.

Natural Communities

The following table (Table 2-7) lists the natural communities occurring in the Northern Highlands arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-7. Natural communities occurring in the Northern Highlands arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Dry-Mesic Forest	Northern Dry Forest	Boreal Forest
Northern Wet Forest	Northern Hardwood Swamp	Floodplain Forest
Emergent Aquatic	Northern Mesic Forest	Pine Barrens
Emergent Aquatic-Wild Rice	Northern Wet-Mesic Forest	Bedrock Glade
Submergent Aquatic	Bracken Grassland	
Submergent Aquatic-Oligotrophic Marsh	Alder Thicket	
	Boreal Rich Fen	
Northern Sedge Meadow	Ephemeral Pond	
Open Bog	Shrub Carr	
	Inland Beach	

2.2.3.6 Forest Transition Ecological Landscape

Figure 2-18. Forest Transition Ecological Landscape.

General Description

The Forest Transition Ecological Landscape lies along the northern border of Wisconsin's Tension Zone, through the central and western part of the state (Figure 2-18), and supports both northern forests and agricultural areas. The central portion of the Forest Transition lies primarily on a glacial till plain deposited by glaciation between 25,000 and 790,000 years ago. The eastern and western portions are on moraines of the Wisconsin glaciation. The growing season in this part of the state is long enough that agriculture is viable, although climatic conditions are not as favorable as in southern Wisconsin. Soils are diverse, ranging from sandy loam to loam or shallow silt loam, and from poorly drained to well drained.

Vegetation

The historic vegetation of the Forest Transition was primarily northern hardwood forest. These northern hardwoods were dominated by sugar maple and hemlock, and contained some yellow birch, red pine, and white pine.

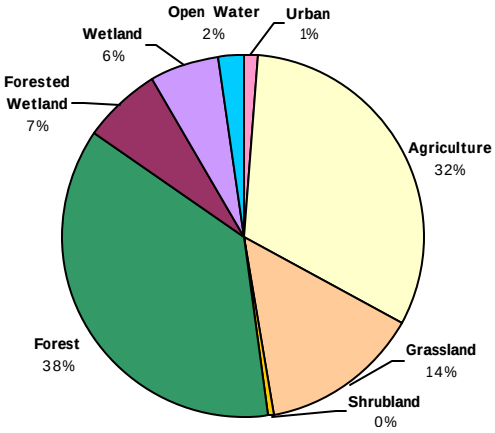


Figure 2-19. Current land cover in the Forest Transition Ecological Landscape.

Currently, over 60% of this Ecological Landscape is non-forested (Figure 2-19). Forested areas consist primarily of northern hardwoods and aspen, with smaller amounts of oak and lowland hardwoods. The eastern portion of the Ecological Landscape differs from the rest of the area in that it remains primarily forested, and includes some ecologically significant areas. Throughout the Ecological Landscape, small areas of conifer swamp are found near the headwaters of streams, and associated with lakes in kettle depressions on moraines. Ground flora show characteristics of both northern and southern Wisconsin, as this Ecological Landscape lies along the Tension Zone.

Hydrologic Features

Small kettle lakes are common on the moraines in the western and eastern parts of the Ecological Landscape, but there are few lakes in the central glacial till plain. Several streams have their headwaters in the moraines. Many small creeks and rivers flow across the plain, in a dendritic pattern; these include the Big Rib, Little Rib, Trappe, St. Croix, and Wisconsin. This Ecological Landscape is near average in levels of watershed pollution, according to Wisconsin DNR rankings.

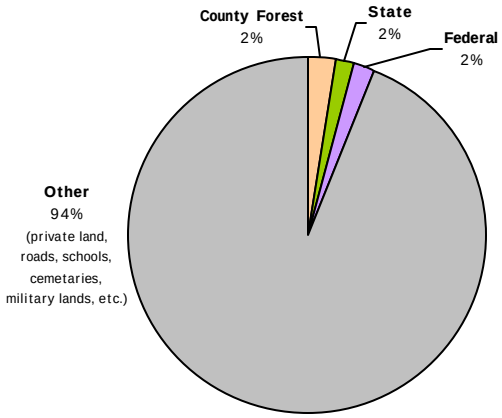


Figure 2-20. Public land ownership in the Forest Transition Ecological Landscape.

Land Use

The Ecological Landscape's total land area is approximately 4.7 million acres, of which 43% is classified as timberland. About 6% of the Ecological Landscape is public land (Figure 2-20), including county, state, and federally managed areas.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Barron, Chippewa, Clark, Langlade, Lincoln, Marathon, Menominee, Polk, Portage, Shawano, Taylor, Washburn, Waupaca, and Wood ("Forest Transition Region").

The counties are quite diverse. Agriculturally, several counties stand out as top producers. Clark and Marathon lead in milk production. Portage leads in potato, pea, and snap bean production. This region has the third highest number of fishery and wildlife areas compared with others in the state. Less timberland is sold or diverted to other uses as compared with the average for other regions in the state.

There is a fairly high per capita water use, mostly for industrial and thermoelectric power generation. Population density of the region is slightly less than half (44 persons/mi^2) than that of the state as a whole (96 persons/mi^2). The population is younger on average, less racially diverse, and less educated compared other regions. It has the second lowest percentage of high school and college graduates. Economically, it ranks near average for all indicators. The manufacturing sector has a relatively more important role, while the percentage of service and government jobs is somewhat below average.

Management Opportunities

- Although this Ecological Landscape is not rich in rare natural communities, there are some significant opportunities to restore and preserve examples of natural community types that are relatively common but often occur in a degraded condition.
- Restoration and management of northern hardwood forests for age classes and structural diversity.
- Reforestation of marginal agricultural lands to reduce forest fragmentation, increase forested habitat, provide protection from erosion, and increase socioeconomic value.
- Preservation of Eastern hemlock on the western extent of its range, where it may have unusual genetic factors.
- Protection of the quartzite outcrop at Rib Mountain, which represents one of only a few such features in the state.
- Sustainable management of the Menominee Forest.
- Non-indigenous invasive plants are a particular problem in this Ecological Landscape due to the interspersion of land uses. They impact natural areas, wildlife forage, and forest regeneration.
- Wetland restoration.
- Preservation of lakes in the Lakewood area.
- Preservation and management of the St. Croix, Wolf, Chippewa, and Black Rivers; all of which run through this Ecological Landscape.
- Prevention of nonpoint pollution in the river systems listed above.
- Management of the Wisconsin River corridor for movement of plant, animal, and aquatic species, which could be increasingly important in an era of climatic change. Consider restoration and dam removals.

Natural Communities

The following table (Table 2-8) lists the natural communities occurring in the Forest Transition arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-8. Natural communities occurring in the Forest Transition arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Mesic Forest	Northern Dry-Mesic Forest	Southern Dry-Mesic Forest
Northern Wet-Mesic Forest	Northern Hardwood Swamp	Southern Mesic Forest
Northern Wet Forest	Floodplain Forest	Emergent Aquatic-Wild Rice
	Emergent Aquatic	Southern Sedge Meadow
	Submergent Aquatic	
	Alder Thicket	
	Ephemeral Pond	
	Northern Sedge Meadow	
	Open Bog	
	Shrub Carr	
	Bedrock Glade	
	Dry Cliff	
	Moist Cliff	

2.2.3.7 Northeast Sands Ecological Landscape

Figure 2-21. Northeast Sands Ecological Landscape.

General Description

The Northeast Sands Ecological Landscape occupies a relatively narrow, vertical band of land in northeast Wisconsin (Figure 2-21). This Ecological Landscape, formed in glacial outwash sand plains (some of them pitted), has steep outcropping Precambrian bedrock knolls of basalt, rhyolite, or granite. Sandy ground moraines and end moraines are also interspersed in the landscape.

Vegetation

Historically, extensive oak/jack pine barrens and jack pine forests were found in the outwash sand portions of this Ecological Landscape. Moraines supported forests of hardwoods, red pine, and white pine. Outwash plains often contained pitted depressions, resulting in numerous wetlands and kettle lakes.

Most of this Ecological Landscape is still forested; aspen predominates, followed by northern hardwoods (Figure 2-22). Jack pine remains on the outwash plains along with northern pin oak. There are several important occurrences of jack pine/oak barren communities. A small percentage of this Ecological Landscape contains spruce-fir-cedar forest and lowland hardwood forest. The Brazeau Swamp is one of the best representations of large cedar swamp forests in northern Wisconsin.

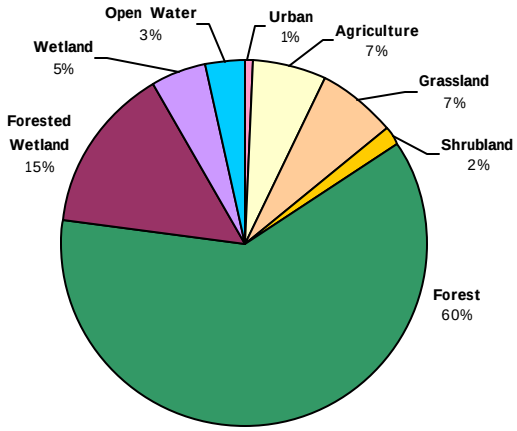


Figure 2-22. Current land cover in the Northeast Sands Ecological Landscape.

Hydrologic Features

The Northeast Sands contains several important river systems as well as extensive wetlands. The Menominee is the largest, located on the Michigan-Wisconsin border. Several wild rivers in Landscape are the Wolf, Pine, Popple, and Pike. The Upper Peshtigo River runs through the Landscape's center and includes the Caldron Falls Flowage and the High Falls Reservoir. Extensive wetlands, including the Peshtigo Brook State Wildlife Area, are found here. This Ecological Landscape has high levels of watershed pollution, according to Wisconsin DNR, with three of five watersheds classified as highly polluted. Its lakes, though few, ranked second worst in pollution levels among the Ecological Landscapes.

Land Use

The total land area of the Northeast Sands Ecological Landscape is approximately 987,000 acres, of which 77% is classified as timberland. About a third of the Ecological Landscape is publicly owned (Figure 2-23), mostly by counties.

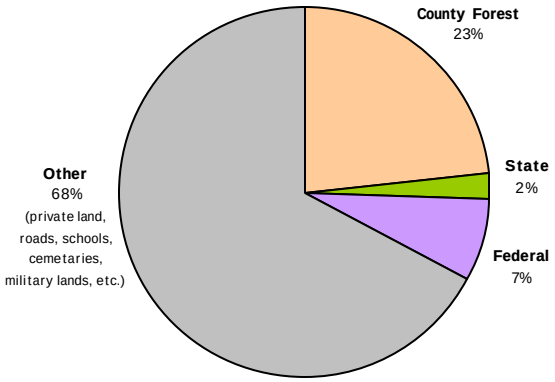


Figure 2-23. Public land ownership in the Northeast Sands Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties

as the smallest unit. The counties included in this socioeconomic region are Florence, Marinette, Menominee, and Oconto ("Northeast Sands Region").
The economy of the Northeast Sands Region is largely dependent on forest industry. The forest products and processing industries contribute 24% to the region's total industrial output. Compared with other regions, the Northeast Sands is not heavily agricultural or recreational. It has below-average percentages of acreage in farmland (only 14%) and acreage per farm, and it ranks below the mean in milk and corn production per acre. Note that farmland includes all land under farm ownership, such as cropland, pastureland, and woodland. Acreage in lakes and rivers is relatively low but has important recreation value. Although there are relatively few state parks, forests, recreation areas, or fishery and wildlife areas, a significant portion of the Nicolet National Forest is located within this region. Relatively little of the forested or agricultural land is sold or diverted to other uses. The region has a fairly low per capita water usage, with industrial needs accounting for over 50% of total water use.

The Northeast Sands Region is sparsely populated and has a somewhat elderly population. It has fewer African Americans than any other region, but the percentage of Native Americans is second highest. The area is economically depressed, with the second lowest per capita income, the highest rate of unemployment, and the second highest rate of adult poverty. The percentage of manufacturing jobs is the highest in this region, and the proportion of service jobs the lowest.

Management Opportunities

- Restoration of oak-pine barrens and bracken grasslands (Dunbar Barrens, Spread Eagle Barrens, Athelstane Barrens), and associated grassland/shrub birds.
- Maintenance of jack pine forests on outwash plains.
- Restoration and maintenance of areas proximal to outwash for restoration and management of white pine and red pine forests.
- Protection of unusual communities found on rock outcrops.
- Protection of cedar forests in Brazeau Swamp and elsewhere.
- Preservation and management of the Pine and Popple River corridors, and the Wolf River corridor.
- Preservation and management of the Menominee River corridor, including the adjoining rock outcrops and extensive forests within the corridor.
- Lake and wetland protection.
- Sustainable forest management and demonstration areas in the recently purchased Peshtigo River State Forest.

Natural Communities

The following table (2-9) lists the natural communities occurring in the Northeast Sands arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-9. Natural communities occurring in the Northeast Sands arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Dry Forest	Northern Hardwood Swamp	Boreal Forest
Northern Dry-Mesic Forest	Northern Mesic Forest	Floodplain Forest
Northern Wet-Mesic Forest	Northern Wet Forest	Emergent Aquatic-Wild Rice
Pine Barrens	Emergent Aquatic	Ephemeral Pond
Bracken Grassland	Submergent Aquatic	Shrub Carr
	Alder Thicket	Inland Beach
	Boreal Rich Fen	
	Northern Sedge Meadow	
	Open Bog	
	Dry Cliff	
	Moist Cliff	

2.2.3.8 Northern Lake Michigan Coastal Ecological Landscape

Figure 2-24. Northern Lake Michigan Coastal Ecological Landscape.

General Description

This Ecological Landscape is located in northeastern Wisconsin (Figure 2-24), and includes Green Bay and the northern part of the Door Peninsula. Its landforms consist of the Niagara escarpment, a prominent dolomite outcropping along the east side of Green Bay, a lacustrine plain along the west side of Green Bay, and ground moraine elsewhere. Low sand dunes and beach ridges that support Great Lakes endemics and many other rare species are found along the Great Lakes shoreline. The influence of Lake Michigan moderates extreme temperatures. Soils are very diverse; in some areas, lacustrine sands are found overlying clays or bedrock within only a few feet of the surface. In the Door Peninsula, soils are typically stony loamy sands to loams. Poorly drained sands are common in the lake plain or in depressions between dunes and beach ridges. On the western side of Green Bay, the ground moraine is composed mostly of moderately well drained, rocky sandy loams, interspersed with lacustrine sands and clays, and peat and muck also common.

Vegetation

Historic vegetation included maple-basswood-beech forest, hemlock-hardwood forest, northern white cedar swamp, hardwood-conifer swamp, wet meadows, and coastal marshes. Conifer dominated upland forests that resemble the boreal forest were present along Lake Michigan; they contain a significant component of white spruce and balsam fir. Cliffs, sinkholes, and dolomite ledges are associated with the Niagara Escarpment.

Current vegetation consists of more than 60% non-forested land, most of which is in agricultural crops, with smaller amounts of grassland, wetland, shrubland, and urbanized areas (Figure 2-25). Forested lands are dominated by maple-basswood, with smaller amounts of lowland hardwoods, aspen-birch, and lowland conifers. High quality areas of exposed alkaline bedrock beach occur on the northern Door Peninsula, providing habitat for many rare plants. Several islands lie off the Door Peninsula and these also provide critical habitat for rare species and colonially nesting birds.

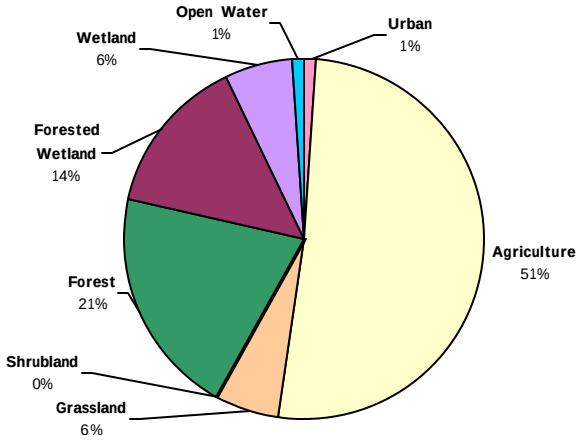


Figure 2-25. Current land cover in the Northern Lake Michigan Coastal Ecological Landscape.

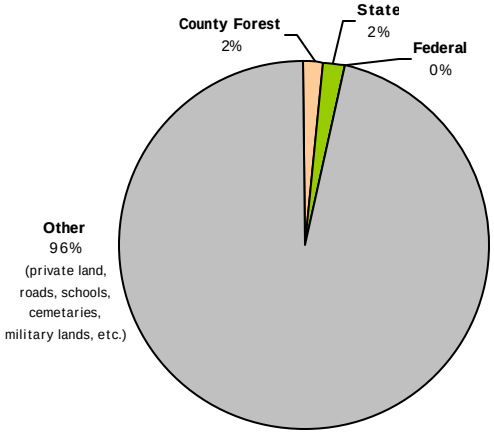


Figure 2-26. Public land ownership in the Northern Lake Michigan Coastal Ecological Landscape

Hydrologic Features

This Ecological Landscape has an extensive shoreline along Green Bay, on the west coast of Lake Michigan. Many small rivers and creeks drain the numerous linear wetlands on the west side of Green Bay that trend southwest to northeast. Large rivers that flow through the Ecological Landscape are the Oconto, Peshtigo, and Menominee Rivers. There are no large inland lakes, but lakes that do occur have relatively high pollution levels. Lakes in four out of six watersheds are classified by Wisconsin DNR as highly polluted.

Land Use

The total land area for the Northern Lake Michigan Coastal Ecological Landscape is approximately 1.3 million acres, of which 37% is classified as timberland. About 3.5% of the Ecological Landscape is public land (Figure 2-26).

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Door, Marinette, Oconto, and Shawano ("Northern Lake Michigan Coastal Region").

Recreation is a major economic contributor to the Northern Lake Michigan Coastal Region, especially in Door County, with an above average number of state parks, forests, and recreation areas. Agriculture, however, is not a large contributor to the economy of the region. Farm acreage accounts for only 36% of the land base of the region and total market value per acre of agricultural products is below average compared to other regions.

Population in the Northern Lake Michigan Coastal Region has been growing relatively rapidly since 1970, especially for elderly people. The population density of the region (35 persons/mi^2) is slightly less than half that of the state as a whole (96 persons/mi^2). It has the second highest percentage of elderly (over 65 years old) and the third highest median age. It has the third lowest percentage of minorities and the fourth lowest percentages of high school and college graduates. Economically, it is near average with slightly lower than average rates of unemployment and poverty. The percentage of farming jobs is second highest in this region, whereas the proportion of government jobs is fourth lowest.

Management Opportunities

- This Ecological Landscape has many rare and endemic natural communities along Lake Michigan.
- Protection of key stretches of the Niagara Escarpment that are important for rare species.
- Protection and management of coastal ridge and swale forest, and the beaches, dunes, and boreal forest in Door County, which are unique to the Great Lakes shoreline.
- Reforestation of marginal lands on the Door Peninsula is desirable to reduce adverse edge effects and accommodate rare area-sensitive animals.
- Forest interior species management is possible in the northern part of the Ecological Landscape.
- Within the interior of this Ecological Landscape there are opportunities for management of large conifer and hardwood swamps.
- There are opportunities for the restoration and management of lakeshore marshes, sedge meadows, and wet forests along the west shore of Green Bay.
- Lake Michigan shoreline endemic species require protection of alkaline rock shores, coastal estuaries, boreal forests, and alvar, beach, and dune communities.
- Most of the coastline in this Ecological Landscape is important for migratory birds.
- Protection of islands off the coast of this Ecological Landscape, which are important for colonial nesting birds and are not significantly impacted by deer or human development.
- Colonial waterbird island rookeries occur along the Lake Michigan coast in Green Bay and the Grand Traverse Islands. These rookeries will need protection, monitoring, and management. Improving the water quality in lower Green Bay will reduce the negative impacts of pollutants.
- Maintenance of migratory corridors, resting, and feeding areas for migratory birds, including raptors, songbirds, and waterfowl is important throughout the Ecological Landscape.
- The Menominee River corridor is located in this Ecological Landscape, affording management opportunities for floodplain forests.
- Protection of the Wolf, Oconto, and Peshtigo rivers should be considered.
- Green Bay and reefs in the Bailey's Harbor area of Door County are significant fish spawning areas.

Natural Communities

The following table (2-10) lists the natural communities occurring in the Northern Lake Michigan Coastal arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-10. Natural communities occurring in the Northern Lake Michigan Coastal arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Mesic Forest	Boreal Forest	Southern Mesic Forest
Northern Wet-Mesic Forest	Northern Dry Forest	Great Lakes Barrens
Emergent Aquatic	Northern Dry-Mesic Forest	Emergent Aquatic-Wild Rice
Boreal Rich Fen	Northern Hardwood Swamp	Alder Thicket
Northern Sedge Meadow	Northern Wet Forest	Interdunal Wetland
Shrub Carr	Floodplain Forest	Open Bog
Dry Cliff	Cedar Glade	Alvar
Forested Ridge and Swale	Submergent Aquatic	Bedrock Glade
Great Lakes Alkaline Rockshore	Ephemeral Pond	
Great Lakes Beach	Shore Fen	
Great Lakes Dune	Southern Sedge Meadow	
	Clay Seepage Bluff	
	Moist Cliff	

2.2.3.9 Central Lake Michigan Coastal Ecological Landscape

Figure 2-27. Central Lake Michigan Coastal Ecological Landscape.

General Description

The Central Lake Michigan Coastal Ecological Landscape stretches from southern Door County west across Green Bay to the Wolf River drainage, then southward in a narrowing strip along the Lake Michigan shore to central Milwaukee County (Figure 2-27). Owing to the influence of Lake Michigan in the eastern part of this Ecological Landscape, summers are cooler, winters are warmer, and precipitation levels are greater than at locations farther inland.

Dolomites and shales underlie the glacial deposits that blanket virtually all of the Central Lake Michigan Coastal Ecological Landscape. The dolomite Niagara Escarpment is the major bedrock feature, running across the entire landscape from northeast to southwest. Series of dolomite cliffs provide critical habitat for rare terrestrial snails, bats, and specialized plants. The primary glacial landforms are ground moraine, outwash, and lakeplain. The topography is generally rolling where the surface is underlain by ground moraine, variable over areas of outwash, and nearly level where lacustrine deposits are present. Important soils include clays, loams, sands, and gravels. Certain landforms, such as sand spits, clay bluffs, beach and dune complexes, and ridge and swale systems, are associated only with the shorelines of Lake Michigan and Green Bay.

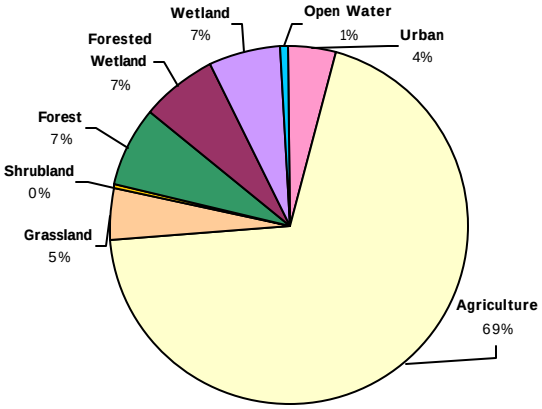


Figure 2-28. Current land cover in the Central Lake Michigan Coastal Ecological Lands cape.

Vegetation

Historically, most of this Ecological Landscape was vegetated with mesic hardwood forest composed primarily of sugar maple, basswood, and beech. Hemlock and white pine were locally important, but hemlock was generally restricted to cool moist sites near Lake Michigan. Areas of poorly drained glacial lakeplain supported wet forests of tamarack, white cedar, black ash, red maple, and elm, while the Wolf and Embarrass Rivers flowed through extensive floodplain forests of silver maple, green ash, and swamp white oak. Emergent marshes and wet meadows were common in and adjacent to lower Green Bay, while Lake Michigan shoreline areas featured beaches, dunes, interdunal wetlands, marshes, and highly diverse ridge and swale vegetation. Small patches of prairie and oak savanna were present in the southwestern portion of this landscape.

Most of the upland forest has been removed over the past 150 years as the land was converted to agricultural, residential, and industrial uses. Today approximately 84% of this Ecological Landscape is non-forested (Figure 2-28). The remaining forest consists mainly of mesic maple-basswood or maple-beech types, or lowland hardwoods composed of soft maples, ashes, and elms. Fragmentation of upland habitats is severe throughout this Ecological Landscape. Invasive species have become a major concern in both terrestrial and aquatic habitats. Reed canary grass, giant reed, purple loosestrife, garlic mustard, Eurasian buckthorns and honeysuckles, and carp are especially troublesome. Significant wetlands are still present, but most have been affected to some degree by hydrologic disruption, pollution, sedimentation, and the encroachment of invasive species. Large acreages of marsh in Lower Green Bay have been filled to accommodate urban development.

Hydrologic Features

The biota is especially noteworthy for the rare regional endemic plants and animals associated with Lake Michigan shoreline habitats, and the highly specialized animals inhabiting the Niagara Escarpment. The

coastal areas annually host significant concentrations of migratory birds, especially during the spring migration period. The waters of Lake Michigan and Green Bay, and the Wolf-Embarrass River corridors, provide seasonally critical habitat for numerous animals. Lakes are uncommon and most of them have been at least partially developed. The Central Lake Michigan Coastal Ecological Landscape has the worst relative pollution ratings for watersheds and streams. Thirty of the 31 watersheds in the Ecological Landscape are more highly polluted than most other watersheds in the state, according to rankings by the Wisconsin DNR.

Land Use

The total land area for the Central Lake Michigan Coastal Ecological Landscape is approximately 1.8 million acres, of which only 16% is classified as timberland (Figure 2-29). Public lands make up less than 3% of this Landscape, but include several notable and heavily-visited state properties such as Harrington Beach and Kohler-Andrae State Parks, Point Beach State Forest, and Collins Marsh State Wildlife Area.

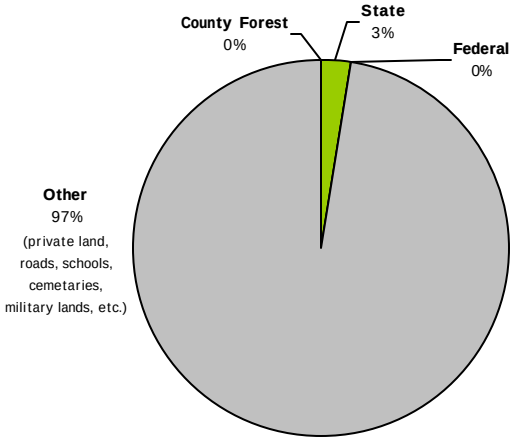


Figure 2-29. Public land ownership in the Central Lake Michigan Coastal Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Brown, Calumet, Kewaunee, Manitowoc, Outagamie, Ozaukee, Sheboygan, and Waupaca ("Central Lake Michigan Coastal Region").

Agriculturally, the Central Lake Michigan Coastal Region is very productive. It has the third highest percentage of farmland acreage, the highest milk production per acre and the second highest per acre market value of agricultural products among all of the state regions. In terms of water usage, over 92% in the Central Lake Michigan Coastal Region is used for thermoelectric power generation. Manitowoc County alone accounts for 45% of water usage in the region, almost entirely for this purpose. Note that farmland is defined as all land under farm ownership, which includes cropland, pastureland, woodland, and other.

Compared to other state regions, the Central Lake Michigan Coastal Region is very densely populated with a young, well-educated and racially diverse population. The population density of the region (184 persons/mi^2) is about twice that of the state as a whole (96 persons/mi^2). Among state regions, the Central Lake Michigan Coastal Region has the second highest percentage of people under 20 years old and a below-average proportion of elderly (over 65 years old). In addition, this region has the fourth highest nonwhite population, mostly due to the presence of a large number of Hispanics. It also has a slightly higher percentage of both high school and college graduates.

Economically, the region is relatively prosperous. The Central Lake Michigan Coastal Region has the state's highest per capita income, the second highest average wage, and the second lowest rates of unemployment and adult and child poverty. The economy depends heavily on manufacturing and much less on the government sector. Both the agriculture and service sectors have below-average representation in the job market in this region.

Management Opportunities

- Protect unique Great Lakes coastal features such as beach and dune systems, forested ridge and swale complexes, Great Lakes marshes, and alvar (a rare community characterized by thin soil over limestone).
- Protect sensitive stretches of the Niagara Escarpment, a globally significant geologic feature that supports many rare and specialized organisms.
- Expand protection for Lake Michigan shoreline habitats, especially those areas receiving heavy use by migratory birds, fish, and colonial birds.
- Expand protection for the Wolf and Embarrass River corridors.
- Connect habitat remnants where possible, especially along shorelines and stream corridors.

Natural Communities

The following table (Table 2-11) lists the natural communities occurring in the Central Lake Michigan Coastal arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-11. Natural communities occurring in the Central Lake Michigan Coastal arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Alvar	Northern Dry-Mesic Forest	Southern Hardwood Swamp
	Northern Hardwood Swamp	Cedar Glade
	Northern Mesic Forest	Emergent Aquatic-Wild Rice
	Northern Wet-Mesic Forest	Alder Thicket
	Northern Wet Forest	Bog Relict
	Floodplain Forest	Open Bog
	Southern Dry-Mesic Forest	
	Southern Mesic Forest	
	Emergent Aquatic	
	Submergent Aquatic	
	Ephemeral Pond	
	Interdunal Wetland	
	Northern Sedge Meadow	
	Shrub Carr	
	Southern Sedge Meadow	
	Bedrock Glade	
	Clay Seepage Bluff	
	Moist Cliff	

2.2.3.10 Western Prairie Ecological Landscape

Figure 2-30. Western Prairie Ecological Landscape.

General Description

The Western Prairie Ecological Landscape is located on the far western edge of the state (Figure 2-30) just south of the Tension Zone. It contains the only true representative prairie potholes in the state. It is characterized by its glaciated, rolling topography and a primarily open landscape with rich prairie soils and pothole lakes, ponds, and wet depressions, except for forested areas along the St. Croix River. The climate and growing season are favorable for agricultural crops. Sandstone underlies a mosaic of soils. Silty loams that can be shallow and stony cover most of the area. Alluvial sands and peats are found in stream valleys.

Vegetation

Historic vegetation was comprised of dry to mesic prairie grasses in the rolling areas and wet prairies in the broad depressions. Open oak savannas and barrens were found on the hilly topography, with small inclusions of sugar maple-basswood forest in small steep sites. Prairie pothole type wetlands were mainly found in St. Croix and Polk counties. Barrens were found along the river terraces of the St. Croix River.

Almost half of the current vegetation is agricultural crops and almost a third of the area is grasslands, with smaller areas of open water, open wetlands, and urban areas (Figure 2-30). The major forest types are maple-basswood and oak-hickory, with smaller amounts of lowland hardwoods and lowland conifer.

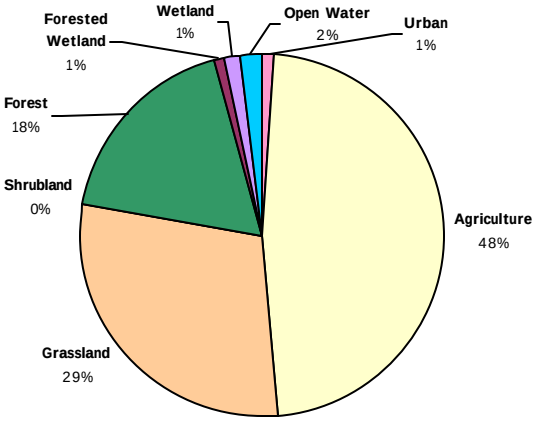


Figure 2-31. Current land cover in the Western Prairie Ecological Landscape.

Hydrologic Features

Two major rivers flow through this Ecological Landscape, the Mississippi and the St. Croix. The St. Croix is a National Scenic River. The Apple and Kinnikinnic are two important secondary streams. This area seems to have an unusual hydrology with greatly fluctuating water levels. The water quality is relatively poor compared with the rest of the state. It has the second poorest rankings for both watersheds overall (11 out of 12 are rated as highly polluted) and groundwater pollution and the worst rankings of any Ecological Landscape for both lake and stream pollution, according to Wisconsin DNR.

Land Use

The total land area for the Western Prairie Ecological Landscape is approximately 698,000 acres, of which 16% is classified as timberland. Less than 3% of the land is in public ownership (Figure 2-32).

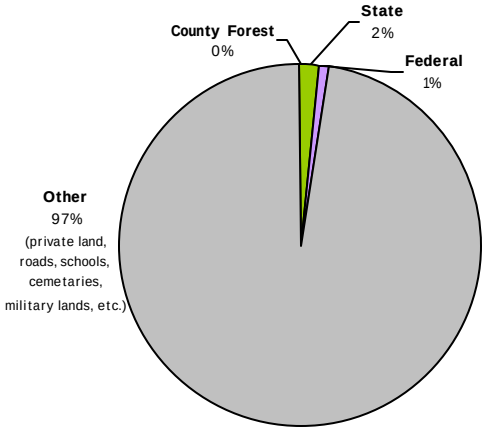


Figure 2-32. Public land ownership in the Western Prairie Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Pierce and St. Croix ("Western Prairie Region").

The Western Prairie Region is highly dependent on agriculture. It has the second highest percentage of total acreage in farmland. Note that farmland is defined as all land under farm ownership, which includes cropland, pastureland, and woodland. Compared to the other regions, these counties are third highest in corn production per acre and fourth in milk production per acre. The region has the highest percentage of both agricultural and forest land acreage sold, and the second highest percentage diverted to nonagricultural and non-forest uses. Overall acreage in lakes is low in this region. Per capita water usage in the region is the lowest of all regions in the state.

Although the population density of this region is not high, it does have the fastest growth rate since 1970 and the lowest median age. The population density (108 persons/mi^2) is slightly higher than that of the state as a whole (96 persons/mi^2). The population is fairly young, not racially diverse, and very well educated, on average. Economically, people in the region are quite prosperous with a high per capita income and the lowest rates of child and adult poverty and unemployment. Agriculture is important with a higher percentage of jobs in agriculture than any other region.

Management Opportunities

- Opportunities for restoring wetland and grassland communities are prevalent in this Ecological Landscape.
- Restoration of wetland/grassland communities throughout this Ecological Landscape with a special focus on grassland birds.
- Maintenance of the St. Croix River corridor including floodplain, goat prairies, oak/pine cliffs, islands, and prairie remnants along the river.
- Protection of the Apple River canyon.
- Protection of the Kinnickinic River watershed and corridor, which contains many rare plants and significant geological features.
- The Star Prairie/Western Habitat Restoration should continue to receive management emphasis.
- This Ecological Landscape is an important breeding area for the rare loggerhead shrike.
- Continued restoration and maintenance of prairie pothole/wetland complexes and other wetland communities for waterfowl and other wetland wildlife, including the US Fish and Wildlife Service's Waterfowl Production Areas.

Natural Communities

The following table (Table 2-12) lists the natural communities occurring in the Western Prairie arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-12. Natural communities occurring in the Western Prairie arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Mesic Prairie	Floodplain Forest	Northern Dry-Mesic Forest
Emergent Aquatic	Southern Dry-Mesic Forest	Northern Mesic Forest
	Southern Mesic Forest	Northern Wet Forest
	Cedar Glade	Southern Dry Forest
	Oak Opening	Emergent Aquatic-Wild Rice
	Oak Woodland	Alder Thicket
	Dry-Mesic Prairie	Ephemeral Pond
	Dry Prairie	Northern Sedge Meadow
	Sand Prairie	Shrub Carr
	Submergent Aquatic	Southern Sedge Meadow
	Bedrock Glade	Wet Prairie
	Dry Cliff	
	Moist Cliff	

2.2.3.11 Western Coulee and Ridges Ecological Landscape

Figure 2-33. Western Coulee and Ridges Ecological Landscape.

General Description

The Western Coulee and Ridges Ecological Landscape in southwestern and west central Wisconsin (Figure 2-33) is characterized by its highly eroded, driftless topography and relatively extensive forested landscape. Soils are silt loams (loess) and sandy loams over sandstone residuum over dolomite. Several large rivers including the Wisconsin, Mississippi, Chippewa, Kickapoo, and Black flow through or border the Ecological Landscape.

Vegetation

Historical vegetation consisted of southern hardwood forests, oak savanna, scattered prairies, and floodplain forests and marshes along the major rivers. With Euro-American settlement, most of the land on ridgetops and valley bottoms was cleared of oak savanna, prairie, and level forest for agriculture. The steep slopes between valley bottom and ridgetop, unsuitable for raising crops, grew into oak-dominated forests after the ubiquitous presettlement wildfires were suppressed.

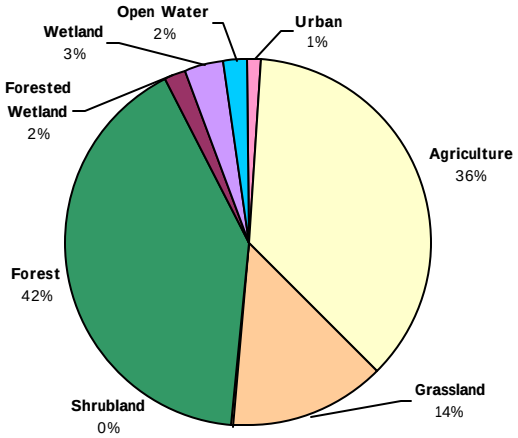


Figure 2-34. Current land cover in the Western Coulee and Ridges Ecological Landscape.

Current vegetation is a mix of forest (40%), agriculture, and grassland with some wetlands in the river valleys (Figure 2-34). The primary forest cover is oak-hickory (51%) dominated by oak species and shagbark hickory. Maple-basswood forests (28%), dominated by sugar maple, basswood, and red maple, are common in areas that were not subjected to repeated presettlement wildfires. Bottomland hardwoods (10%) are common in the valley bottoms of major rivers and are dominated by silver maple, ashes, elms, cottonwood, and red maple. Relict conifer forests including white pine, hemlock, and yellow birch are a rarer natural community in the cooler, steep, north slope microclimates.

Hydrologic Features

There are no natural lakes in this Ecological Landscape, but there are a number of impoundments. Levels of stream and groundwater pollution are worse than average, according to Wisconsin DNR watershed rankings.

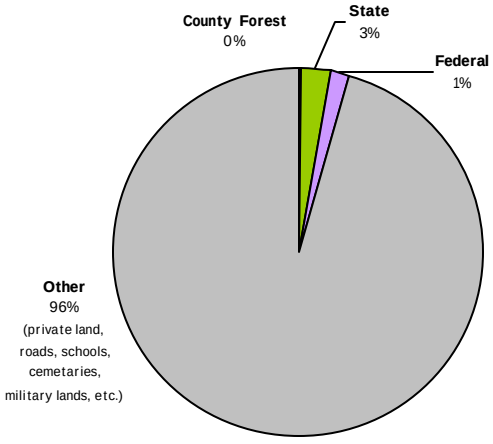


Figure 2-35. Public land ownership in the Western Coulee and Ridges Ecological Landscape.

Land Use

The total land area for the Western Coulees and Ridges Ecological Landscape is approximately 2.2 million acres, of which 38% is classified as timberland. Public land ownership includes only 3% of this Ecological Landscape (Figure 2-35) .

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this

socioeconomic region are Buffalo, Crawford, Dane, Dunn, Eau Claire, Grant, Iowa, Jackson, LaCrosse, Monroe, Pepin, Pierce, Richland, Sauk, Trempeleau, and Vernon ("Western Coulees and Ridges Region"). Although less than 25% of Dane County and none of the Madison Metropolitan area lies within this Ecological Landscape, it was included in the socioeconomic region. Including Dane County may cause some discrepancies when analyzing the socioeconomic structure, however, the social and economic character of the Ecological Landscape and its residents may be significantly impacted by Madison's proximity.

Agriculture is an important part of the economy in the Western Coulees and Ridges Region. Compared to the other regions, it has the second highest percent of farmland acreage and ranks relatively high in both milk and corn production per acre. Note that farmland is defined as all land under farm ownership, which includes cropland, pastureland and woodland. Agriculture is primarily dairy and beef farms; pastures and Conservation Reserve Program areas are common.

Wooded slopes are often managed for oak saw log production. Recreational resources are abundant. The counties of the Western Coulees and Ridges Region have the highest number of state parks, forests, and recreation areas, and the second highest number of state fishery and wildlife areas, as well as several federal wildlife refuges along the Mississippi River. Although it has the lowest percentage of timberland sold or diverted to other uses, a relatively high proportion of the agricultural land sold is being diverted to other uses.

The population density (76 persons/mi^2) is less than that of the state as a whole (96 persons/mi^2). Its population is decidedly young with the second lowest percentage elderly (over 65 years old) and racially diverse with the third highest percentage of African Americans and Asians. Economically, this Ecological Landscape is about average with relatively low unemployment. The proportion of government jobs in this region is second highest in the state with a below-average number of manufacturing jobs. (The demographic and economic information for this region is significantly impacted by including Dane County.)

Management Opportunities

- Restoration and maintenance of red and white oak as a cover type.
- Protection and maintenance of relict hemlock stands.
- Goat prairie restoration and maintenance.
- Grassland wildlife management.
- Preservation of cliff communities, along with cave and bat hibernacula.
- Management of floodplain forests and large southern upland forest tracts.
- Oak savanna restoration.
- Sand prairie and oak barrens restoration and maintenance (on terraces associated with the major rivers).
- Reforestation of marginal agricultural land to facilitate management of large forest blocks compared to other areas in southern Wisconsin.
- Protection of rare features found only in the Driftless Area, such as Algific Talus Slopes.
- Big river protection and maintenance. Some of these streams support especially rich or otherwise significant assemblages of fish, herptiles and aquatic invertebrates.
- Restoration and protection of spring-fed cold water streams.

Natural Communities

The following table (Table 2-13) lists the natural communities occurring in the Western Coulee and Ridges arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-13. Natural communities occurring in the Western Coulee and Ridges arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Floodplain Forest	Northern Dry-Mesic Forest	Northern Hardwood Swamp
Hemlock Relict	Northern Wet Forest	Northern Mesic Forest
Pine Relict	Southern Tamarack Swamp	Northern Wet-Mesic Forest
Southern Dry Forest	Pine Barrens	Southern Hardwood Swamp
Southern Dry-Mesic Forest	Mesic Prairie	Bog Relict
Southern Mesic Forest	Emergent Aquatic-Wild Rice	Calcareous Fen (Southern)
Cedar Glade	Alder Thicket	
Oak Opening	Ephemeral Pond	
Oak Woodland	Northern Sedge Meadow	
Oak Barrens	Southern Sedge Meadow	
Dry-Mesic Prairie	Wet-Mesic Prairie	
Dry Prairie	Wet Prairie	
Sand Prairie		
Emergent Aquatic		
Submergent Aquatic		
Shrub Carr		
Algific Talus Slope		
Bedrock Glade		
Dry Cliff		
Moist Cliff		

2.2.3.12 Southwest Savanna Ecological Landscape

Figure 2-36. Southwest Savanna Ecological Landscape.

General Description

The Southwest Savanna Ecological Landscape is located in the far southwestern part of the state (Figure 2-36). It is characterized by deeply dissected topography, unglaciated for the last 2.4 million years, with broad open hilltops and river valleys, and steep wooded slopes. The climate is favorable for agriculture but the steep slopes limit it to the hilltops and valley bottoms. Soils are underlain with calcareous bedrock. Soils on hilltops are silty loams, sometimes of shallow depth over exposed bedrock and stony red clay subsoil. Some valley soils are alluvial sands, loams, and peats. Some hilltops are almost treeless due to the thin soil while others have a deep silt loam cap.

Vegetation

Historic vegetation consisted of tall prairie grasses and forbs with oak savannas and some wooded slopes of oak.

Almost three-quarters of the current vegetation is agricultural crops with lesser amounts of grasslands, barrens, and urban areas (Figure 2-37). The major forest types are oak-hickory and maple-basswood. High-quality prairie remnants occur on rocky hilltops and slopes that are not farmed. Some prairie pastures and oak savannas still exist. The grassland areas harbor many rare grassland birds, invertebrates, and other grassland species. Relict stands of pine occur on bedrock outcroppings along some stream systems.

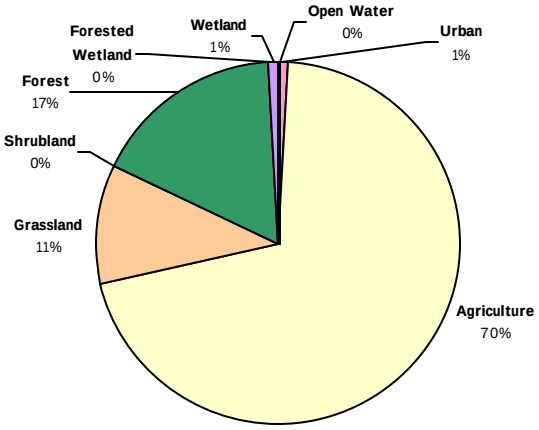


Figure 2-37. Current land cover in the Southwest Savanna Ecological Landscape.

Hydrologic Features

Warm-water streams flow throughout this Ecological Landscape and include the Pecatonica and Galena Rivers. Some contain rare aquatic species. No natural lakes occur in the Ecological Landscape.

Although the lakes that are present are the cleanest in the state, the watersheds and streams are ranked as relatively polluted according to the Wisconsin DNR.

Land Use

The total land area for the Southwest Savanna Ecological Landscape is approximately 1.2 million acres, of which only 11% is classified as timberland. Less than 1% of the Ecological Landscape is in public ownership (Figure 2-38).

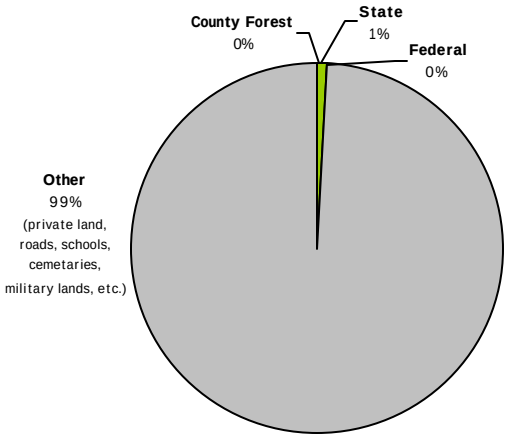


Figure 2-38. Public land ownership in the Southwest Savanna Ecological Landscape .

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Dane, Grant, Green, Iowa, and Lafayette ("Southwest Savanna Region"). Although less than 25% of Dane County and none of the Madison Metropolitan area lies within this Ecological Landscape, it was included in the socioeconomic region.

This may cause some discrepancies when analyzing the socioeconomic structure of the Ecological Landscape. However, the social and economic character of the Ecological Landscape and its residents may be significantly impacted by Madison's proximity.

This region is highly dependent on agriculture. It has a greater percentage of farmland than any other region and the highest market value per acre of agricultural products sold. Note that farmland includes all land under farm ownership such as cropland, pastureland, and woodland. The counties of the Southwest Savanna Region rank second in milk production per acre and first in corn production per acre. Although much of the land is in agriculture, it is somewhat less intensive than in other parts of the state, including large pastures and many Conservation Reserve Program lands. Compared to other Ecological Landscapes, the acreage in lakes is low, as is the number of fisheries and wildlife areas. The percentage of timberland being sold and diverted to other uses is higher than in any other region. Wooded slopes are often managed for oak-hardwood production. In some cases oak forest is being replaced with cherry, red maple, and hickory due to fire suppression, harvest methods, and invasive shrub competition.

The population of the Southwest Savanna Region is racially diverse and well educated. The population density (100 persons/mi^2) is slightly greater than that of the state as a whole (96 persons/mi^2). Of all the regions, it has the smallest percentage of elderly (over 65 years old) and the second highest percentage of nonwhites (African-American, Hispanic, and Asian). The number of high school and college graduates is second highest in the state. There is a relatively high per capita income and low rates of both poverty and unemployment. The government sector is stronger in this region than any other part of the state and manufacturing is not a strong employer. (The demographic and economic information for this region is significantly impacted by including Dane County.)

Management Opportunities

- This Ecological Landscape has many opportunities for restoring rare grassland and oak savanna communities.
- Large-scale restoration of prairies and oak savanna is possible throughout most of the Ecological Landscape including protection of prairie remnants.
- There are major opportunities for grassland bird management.
- Opportunities for rare prairie species restoration and management include the Henslow's sparrow, loggerhead shrike, Bell's vireo, prairie bush clover, regal fritillary butterfly, other rare invertebrates, and the Blanchard's cricket frog.
- There are management opportunities for aquatic resources such as restoration and preservation of high quality warmwater streams and smallmouth bass fisheries as well as trout stream management.
- Opportunities to manage for rare fish species including the slender madtom and the Ozark minnow.
- Protection and management of the Pecatonica and Sugar Rivers, to maintain the ecologically significant component of southern species which are at the edge of their ranges. The floodplains and adjacent communities represent one of the few places in the Ecological Landscape with extensive forest cover, and include remnant prairies, fens, and savannas as well as floodplain forests. These areas provide habitat for certain rare plants and invertebrates.
- Protection of some pine relicts may be possible.

Natural Communities

The following table (Table 2-14) lists the natural communities occurring in the Southwest Savanna arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-14. Natural communities occurring in the Southwest Savanna arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Oak Opening	Pine Relict	Floodplain Forest
Oak Woodland	Southern Dry Forest	Hemlock Relict
Dry-Mesic Prairie	Southern Dry-Mesic Forest	Cedar Glade
Dry Prairie	Southern Mesic Forest	Sand Prairie
Mesic Prairie	Wet-Mesic Prairie	Emergent Aquatic
	Dry Cliff	Submergent Aquatic
	Moist Cliff	Ephemeral Pond
		Shrub Carr
		Southern Sedge Meadow
		Wet Prairie

2.2.3.13 Central Sand Plains Ecological Landscape

Figure 2-39. Central Sand Plains Ecological Landscape.

General Description

The Central Sand Plains Ecological Landscape, located in central Wisconsin (Figure 2-39), occurs on a flat, sandy lake plain, and supports agriculture, forestry, recreation, and wildlife management. The Ecological Landscape formed in and around what was once Glacial Lake Wisconsin, which contained glacial meltwater extending over 1.1 million acres at its highest stage. Soils are primarily sandy lake deposits, some with silt-loam loess caps. Sandstone buttes carved by rapid drainage of the glacial lake, or by wave action when they existed as islands in the lake, are distinctive features of this landscape.

Vegetation

The historic vegetation of the area included extensive wetlands of many types, including open bogs, shrub swamps, and sedge meadows. Prairies, oak forests, savannas, and barrens also occurred in the Ecological Landscape. An area of more mesic forest with white pine and hemlock was found in the northwest portion, including a significant pinery in eastern Jackson County.

Today, nearly half of the Ecological Landscape is nonforested, in agriculture and grassland (Figure 2-40). Most of the historic wetlands were drained early in the 1900s and are now used for vegetable cropping. The forested portion is mostly oak-dominated forest, followed by aspen and pines. A minor portion is maple-basswood forest and lowland hardwoods.

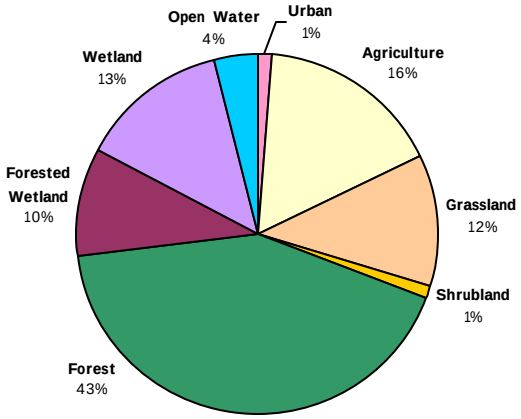


Figure 2-40. Current land cover in the Central Sand Plains Ecological Landscape.

Hydrologic Features

The Wisconsin River is the largest river that flows through the Ecological Landscape; other significant river corridors include the Black River, East Fork of Black River, Yellow River, and Lower Lemonweir River. There are no large, naturally-occurring lakes. The lakes and rivers of the Ecological Landscape are relatively unpolluted. Groundwater rankings by the Wisconsin DNR indicate that this Ecological Landscape is quite polluted as compared with other areas of Wisconsin. Only the Central Sand Hills has a more severe groundwater pollution ranking.

Land Use

The total land area for the Central Sand Plains Ecological Landscape is approximately 2 million acres, of which 56% is classified as timberland. Approximately one-quarter of the Ecological Landscape is publicly owned (Figure 2-41). Most of these lands are in county and municipal ownership, but they also include the Black River State Forest and the Necedah National Wildlife Refuge.

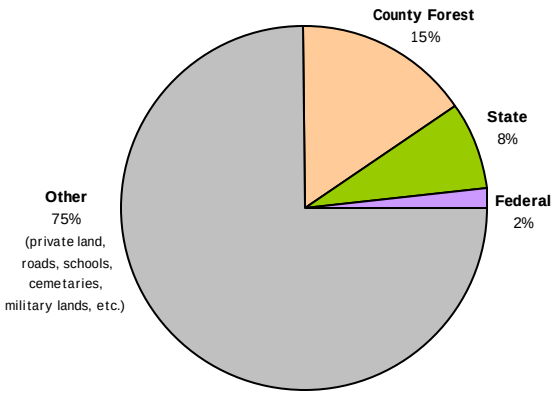


Figure 2-41. Public land ownership in the Central Sand Plains Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Adams, Clark, Jackson, Juneau, Monroe, Portage, and Wood ("Central Sands Region").

The principal land uses within this region are agriculture, cranberry production, and timber production. Three counties are top producers of several crops and together produce half the state's potatoes. Jackson and Wood counties are the top cranberry producers in the state. Agriculture is relatively important compared with other regions, and the forest products and processing industries account for 17% of the region's industrial output compared to 8% statewide.

Compared to other regions in the state the Central Sand Plains Region is nearly average in most socioeconomic indicators with some exceptions. The population density is slightly less than half (44 persons/mi^2) that of the state as a whole (96 persons/mi^2). Its population is comparatively younger and less racially diverse than the other regions, and it has the second lowest number of high school and college graduates. Economically, most of the indicators are around the statewide averages with a somewhat below-average per capita income.

Management Opportunities

- Protection of sandstone buttes and cliffs of geological importance.
- Large-scale barrens, savanna, and prairie restoration, and management of associated grassland and shrubland birds (such as that at Buena Vista Marsh, Meadow Valley, and Necedah).
- Potential habitat exists for Karner blue butterfly management and many other rare barrens-associated species.
- Public lands are extensive enough to support management for animals that are wide-ranging or have large home range requirements, such as wolves, black bear, elk, and bobcat.
- Management to maintain and enhance whooping and sandhill crane habitat, and to restore habitat for migratory waterfowl.
- Management for rare herptiles including the Eastern massasauga rattlesnake and Blanding's turtle.
- Restoration of pine forests, including natural red pine areas.
- Creation of large habitat patches including forests, barrens, and wetlands for species with specific area and community needs.
- Restoration of wetlands such as bogs, large peatlands, sedge meadows, and spruce-tamarack swamps.
- Restoration and management of the Dells of the Wisconsin River.
- Remaining small streams with headwaters in non-agricultural areas are rare and present an opportunity for protection.
- River corridors, including the Black River, East Fork of Black River, Yellow River, and Lower Lemonweir River are potential areas for protection and restoration and/or acquisition.
- Management and protection of wintering bald eagles and eagle migration areas along the Wisconsin River corridor.

Natural Communities

The following table (Table 2-15) lists the natural communities occurring in the Central Sand Plains arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-15. Natural communities occurring in the Central Sand Plains arranged by the levelof opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Wet Forest	Northern Dry Forest	Hemlock Relict
Central Sands Pine-Oak Forest	Northern Dry-Mesic Forest	Pine Relict
Floodplain Forest	Northern Hardwood Swamp	Cedar Glade
Southern Dry-Mesic Forest	Northern Mesic Forest	Oak Woodland
White Pine-Red Maple Swamp	Southern Dry Forest	Mesic Prairie
Oak Barrens	Southern Mesic Forest	Emergent Aquatic-Wild Rice
Pine Barrens	Southern Tamarack Swamp	Calcareous Fen (Southern)
Sand Prairie	Dry-Mesic Prairie	Wet-Mesic Prairie
Alder Thicket	Dry Prairie	Wet Prairie
Northern Sedge Meadow	Emergent Aquatic	Bedrock Glade
Open Bog	Submergent Aquatic	Inland Beach
Shrub Carr	Coastal Plain Marsh	
Dry Cliff	Southern Sedge Meadow	
	Moist Cliff	

2.2.3.14 Central Sand Hills Ecological Landscape

Figure 2-42. Central Sand Hills Ecological Landscape.

General Description

The Central Sand Hills Ecological Landscape is located in central Wisconsin (Figure 2-42) at the eastern edge of what was once Glacial Lake Wisconsin. The landforms in this Ecological Landscape are a series of glacial moraines that were later partially covered by glacial outwash. The area is characterized by a mixture of farmland, woodlots, wetlands, small kettle lakes, and cold water streams, all on sandy soils. The mosiac of glacial moraine and pitted outwash throughout this Ecological Landscape has given rise to extensive wetlands in the outwash areas, and the headwaters of coldwater streams that originate in glacial moraines. The growing season is long enough for agriculture but the sandy soils limit agricultural productivity somewhat.

Vegetation

Historic upland vegetation consisted of oak-forest, oak savanna, and tallgrass prairie. Fens were common in this Ecological Landscape and occurred along with wet-mesic prairie, wet prairie, and rare coastal plain marshes.

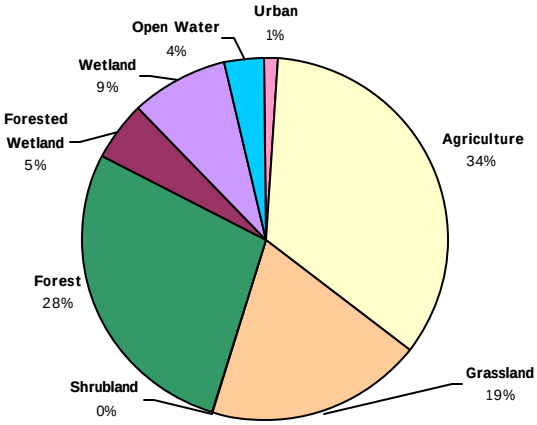


Figure 2-43. Current land cover in the Central Sand Hills Ecological Landscape.

Current vegetation is composed of more than one-third agricultural crops, and almost 20% grasslands with smaller amounts of open wetland, open water, shrubs, barren, and urban areas (Figure 2-43). The major forested type is oak-hickory, with smaller amounts of white-red-jack pine, maple-basswood, lowland hardwoods, aspen-birch, and spruce-fir.

Hydrologic Features

There are numerous small kettle lakes and ponds associated with the glacial outwash. There are many softwater lakes with a firm bottom that are being developed for recreational uses. Although the lakes and rivers of the Ecological Landscape are fairly clean, it has the poorest groundwater rating of all the Ecological Landscapes according to Wisconsin DNR.

Land Use

The total land area for the Central Sand Hills Ecological Landscape is approximately 1.4 million acres, of which 28% is classified as timberland. Only about 4% of the Ecological Landscape is public land (Figure 2-44).

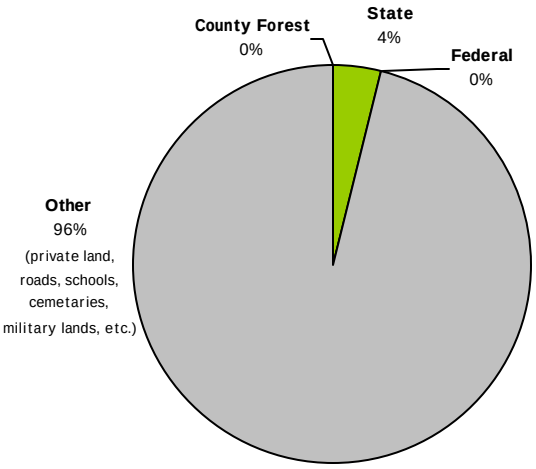


Figure 2-44. Public land ownership in the Central Sand Hills Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Columbia, Green Lake, Marquette, Portage, and Waushara ("Central Sand Hills Region").

Although soils are predominantly dry and sandy, the counties of the Central Sand Hills Region are primarily agricultural. Agriculture is successful in this sandy area with use of irrigation mostly in the production of potatoes, sweet corn, peas, and snap beans but there is a considerable amount of marginal and idle agricultural land. There are no state parks, recreation areas, state forests, or federal lands in the Ecological Landscape, though there are 24 fishery and wildlife areas.

The Central Sand Hills Region is nearly average for most socioeconomic indicators. The population density of the region (54 persons/mi^2) is slightly more than half that of the state as a whole (96 persons/mi^2). The region has shown an above average population growth rate since 1970, especially for the elderly (over 65 years old) population. The number of nonwhites, especially Native Americans is quite low. Although average wage and per capita income are well below the state average, these indicators are intermediate compared to other regions. In addition, the rates of poverty and unemployment are well below average when compared to the other regions. The agricultural and government sectors have a more influential role in the number of employees in the region, whereas manufacturing and the service sector are less important than elsewhere in the state.

Management Opportunities

- This Ecological Landscape has many opportunities for the restoration and preservation of natural communities.
- It is the best place in the state to manage for the coastal plain marsh community type and associated rare species.
- There are opportunities for using prescribed fire to restore oak savanna that provides important Karner blue butterfly habitat.
- It is the best place in the state to maintain and restore the Central Sands Pine-Oak forest community type.
- There are opportunities to preserve and manage for extensive emergent marsh, southern sedge meadows, and calcareous fens (e.g., White River Marsh, Germania and Comstock Marshes, and the Fox River corridor) as well as wet-mesic prairie (e.g., Puchyan Marsh) and relict tamarack swamps.
- There are many unique aquatic features in this Ecological Landscape such as the preservation and management of cold water streams, many of which are important to aquatic invertebrates and cold water fishes.
- Important places in this Ecological Landscape to consider for management are the Lower Baraboo River, Gumz Marsh, the Leopold Reserve, Pine Island Wildlife Area, and the White, Puchyan, and Fox River systems.

Natural Communities

The following table (Table 2-16) lists the natural communities occurring in the Central Sand Hills arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-12. Natural communities occurring in the Central Sand Hills arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Wet Forest	Northern Hardwood Swamp	Northern Dry Forest
Central Sands Pine – Oak Forest	Floodplain Forest	Northern Dry-Mesic Forest
Southern Dry Forest	Southern Dry-Mesic Forest	Northern Mesic Forest
Emergent Aquatic	Southern Tamarack Swamp	Northern Wet-Mesic Forest
Calcareous Fen (Southern)	Oak Barrens	Southern Mesic Forest
Coastal Plain Marsh	Pine Barrens	Cedar Glade
Shrub Carr	Dry Prairie	Oak Opening
Southern Sedge Meadow	Sand Prairie	Oak Woodland
Wet-Mesic Prairie	Submergent Aquatic	Dry-Mesic Prairie
	Alder Thicket	Mesic Prairie
	Bog Relict	Emergent Aquatic-Wild Rice
	Northern Sedge Meadow	Ephemeral Pond
	Open Bog (4)	Dry Cliff
	Wet Prairie	
	Bedrock Glade	
	Moist Cliff	

2.2.3.15 Southeast Glacial Plains Ecological Landscape

General Description

The Southeast Glacial Plains Ecological Landscape makes up the bulk of the non-coastal land area in southeast Wisconsin (Figure 2-45). This Ecological Landscape is made up of glacial till plains and moraines. Most of this Ecological Landscape is composed of glacial materials deposited during the Wisconsin Ice Age, but the southwest portion consists of older, pre-Wisconsin till with a more dissected topography. Soils are lime-rich tills overlain in most areas by a silt-loam loess cap. Agricultural and residential interests throughout the landscape have significantly altered the historical vegetation. Most of the rare natural communities that remain are associated with large moraines or in areas where the Niagara Escarpment occurs close to the surface.

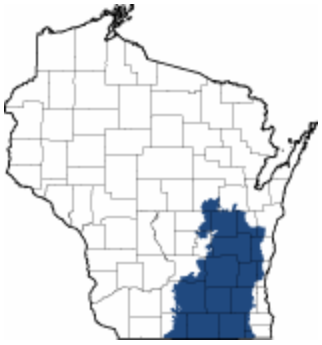


Figure 2-45. Southeast Glacial Plains Ecological Landscape.

Vegetation

Historically, vegetation in the Southeast Glacial Plains consisted of a mix of prairie, oak forests and savanna, and maple-basswood forests. Wet-mesic prairies, southern sedge meadows, emergent marshes, and calcareous fens were found in lower portions of the Landscape. End moraines and drumlins supported savannas and forests.

Agricultural and urban land use practices have drastically changed the land cover of the Southeast Glacial Plains since Euro-American settlement. The current vegetation is primarily agricultural cropland (Figure 2-46). Remaining forests occupy only about 10% of the land area and consist of maple-basswood, lowland hardwoods, and oak. No large mesic forests exist today except on the Kettle Interlobate Moraine which has topography too rugged for agriculture. Some existing forest patches that were formerly savannas have succeeded to hardwood forest due to fire suppression.

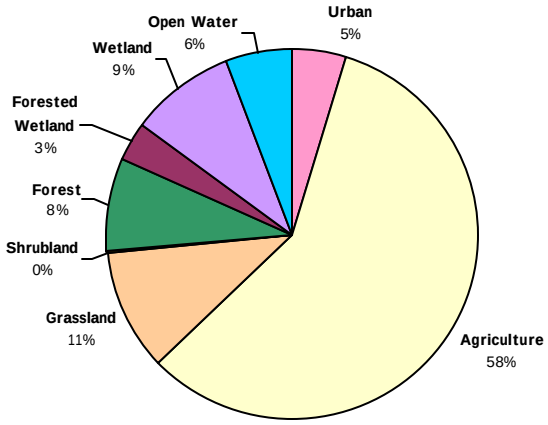


Figure 2-46. Current land cover in the Southeast Glacial Plain Ecological Landscape.

Hydrologic Features

The Southeast Glacial Plains has the highest aquatic productivity for plants, insects, invertebrates, and fish of any Ecological Landscape in the state. Significant river systems include the Mukwonago, Wolf, Sheboygan, Milwaukee, Rock, Sugar, and Fox. Most riparian zones have been degraded through forest clearing, urban development, and intensive agricultural practices. The Ecological Landscape contains several large lakes, including those in the Madison area and in the Lake Winnebago Pool system. These lakes are important to many aquatic species including the lake sturgeon. Kettle lakes are common on end moraines and in outwash channels. In addition to Horicon Marsh, this Ecological Landscape contains important fens, tamarack swamp, wet prairies, and wet-mesic prairies that contain rare plants and animals. However, most wetlands have experienced widespread ditching, grazing, and infestation by invasive plants. Watershed

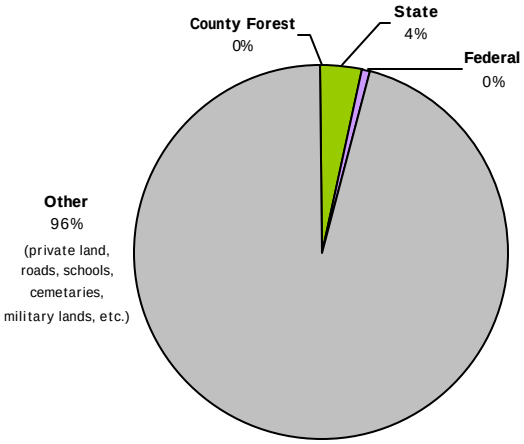


Figure 2-47. Public land ownership in the Southeast Glacial Plain Ecological Landscape.

pollution in the Ecological Landscape is about average according to rankings by Wisconsin DNR, but groundwater pollution is worse than average compared to the rest of the state.

Land Use

The total land area for the Ecological Landscape is approximately 4.9 million acres, of which only 10% is classified as timberland. Only about 4% of the area of this Ecological Landscape is publicly owned (Figure 2-47). Many of these are the least developed areas in southeastern Wisconsin, and the Kettle Moraine represents the largest contiguous patch of undeveloped land.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Calumet, Columbia, Dane, Dodge, Fond du Lac, Green, Green Lake, Jefferson, Ozaukee, Rock, Sheboygan, Walworth, Washington, Waukesha, Waupaca, and Winnebago ("Southeast Glacial Plains Region").

Although the Southeast Glacial Plains Region is quite urban compared to other state areas, agriculture is very important. Among the regions it ranks third in percent of acreage in farmland, market value of agricultural products per acre, and milk production per acre; it ranks second in corn production. Note that farmland includes all land under farm ownership such as cropland, pastureland, and woodland.) The percentage of agricultural land sold and diverted to other uses is below average. Recreation is also important in this region. It has the highest number of fishery and wildlife areas, the second highest number of state parks and forests, and one of the highest ratios of water to land surface area. Per capita water use is near average.

The Southeast Glacial Plains Region is economically prosperous with a well-educated and racially diverse population. The population density (188 persons/ mi^2) is about twice that of the state as a whole (96 persons/ mi^2), the second highest population density among the regions. This region has the third lowest population of elderly (over 65 years old) while the proportion of nonwhites, especially Hispanics and African Americans, is one of the highest. The per capita income, average wage, and number of high school and college graduates are all third highest, while the rates of poverty and unemployment are both third lowest among the regions. The manufacturing sector is relatively strong, whereas farming, though very productive, does not provide a large percentage of jobs.

Management Opportunities

- Protection of the Niagara Escarpment, glacial eskers and drumlin fields, that are unique and, in some cases world-renowned, features.
- In the Kettle Moraine area, opportunities exist to restore large-scale oak forests and savannas, as well as to manage for forest interior species and rare fen plants.
- Throughout the Ecological Landscape, there are opportunities for linking scattered woodlots and for controlling invasive exotic species.
- Scattered tamarack swamps support unusual assemblages of species and many are in need of restoration, management, and protection.
- There are many opportunities for restoration and management of wetlands such as Horicon Marsh, shallow water lakes (e.g., Lake Winnebago Pools, Rush Lake, and Koshkonong), and larger lakes that support fisheries (e.g., Madison area lakes, Waukesha County lakes). Cedarburg Bog warrants hydrologic restoration as well as reconnection to its formerly linked wetland systems.
- Many rivers are in need of restoration and protection particularly the Mukwanago, which supports exceptional aquatic diversity, and also the Genesse, upper Milwaukee, and Bark rivers.
- Water quality in many watersheds within the Ecological Landscape needs improvement.

- Non-indigenous invasive species are a particular problem in this Ecological Landscape due to the high level of development and disturbance, and, for aquatic species, the connection of many river systems to Lake Michigan.
- Floodplain forests on the Sugar River and the lower Wolf River are unique communities that support rare or otherwise significant species. These areas warrant further protection and restoration.
- Riparian zones throughout the Ecological Landscape present an opportunity for restoration.
- There is potential for increasing public land ownership to accommodate recreation needs and ecological functions.

Natural Communities

The following table (Table 2-17) lists the natural communities occurring in the Southeast Glacial Plains arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-17. Natural communities occurring in the Southeast Glacial Plains arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Northern Hardwood Swamp	Northern Wet-Mesic Forest	Northern Dry-Mesic Forest
Floodplain Forest	Northern Wet Forest	Sand Prairie
Southern Dry Forest	Southern Hardwood Swamp	
Southern Dry-Mesic Forest	Southern Mesic Forest	
Southern Tamarack Swamp	Cedar Glade	
Oak Opening	Emergent Aquatic-Wild Rice	
Oak Woodland	Submergent Aquatic	
Dry-Mesic Prairie	Alder Thicket	
Dry Prairie	Ephemeral Pond	
Mesic Prairie	Northern Sedge Meadow	
Emergent Aquatic	Wet Prairie	
Bog Relict	Moist Cliff	
Calcareous Fen (Southern)		
Shrub Carr		
Southern Sedge Meadow		
Wet-Mesic Prairie		
Dry Cliff		

2.2.3.16 Southern Lake Michigan Coastal Ecological Landscape

Figure 2-48. Southern Lake Michigan Coastal Ecological Landscape.

General Description

The Southern Lake Michigan Coastal Ecological Landscape is located in the southeastern corner of Wisconsin along Lake Michigan (Figure 2-48). The landforms in this Ecological Landscape are characteristic of glacial lake influence, with ridge and swale topography, clay bluffs, and lake plain along Lake Michigan. Further inland, ground moraine is the dominant landform. Soils typically have a silt-loam surface overlying loamy and clayey tills.

Vegetation

The historic vegetation in the northern part of this Ecological Landscape was dominated by sugar maple-basswood-beech forests with some oak while the southern part was dominated by oak forest, oak savanna, and prairies. Wet, wet-mesic, and lake plain prairies were common in this area. Black ash and relict cedar and tamarack swamps were found in this Ecological Landscape.

Today, most of the area is dominated by dairy and cash grain agriculture and intense urban development (Figure 2-49). Only about 8% of the Ecological Landscape is forested. Maple-beech forests are about half of the remaining forest types with the remainder split equally between oak-hickory and lowland hardwood forest types. There are some areas of wet-mesic and wet prairie but only small preserves remain since the landscape is heavily disturbed and fragmented. Because of this isolation, fragmentation, and high level of disturbance, non-native plants are abundant.

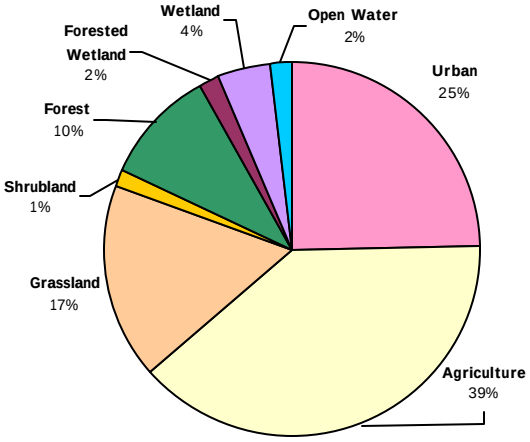


Figure 2-49. Current land cover in the Southern Lake Michigan Coastal Ecological Landscape.

Hydrologic Features

Several rivers cross the Ecological Landscape near Lake Michigan including the Root, Des Plaines, and Pike. The Lake Michigan shoreline is an important ecological area, especially for migratory birds. The watersheds, streams, and lakes of this Ecological Landscape rank as the third most polluted, according to rankings by the Wisconsin DNR.

Land Use

The total land area for the Southern Lake Michigan Coastal Ecological Landscape is 539,824 acres. It has the lowest percent acreage in timberland (8%) of all the Ecological Landscapes. Only 1% is public land (Figure 2-50).

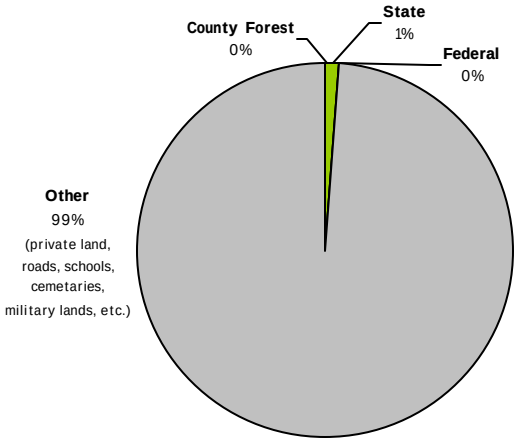


Figure 2-50. Public land ownership in the Southern Lake Michigan Coastal Ecological Landscape.

Socioeconomics

Socioeconomic data are summarized based on county-level approximations of the Ecological Landscape (referred to as a "region"). Economic data are available only on a political unit basis with counties as the smallest unit. The counties included in this socioeconomic region are Kenosha, Milwaukee, and Racine ("Southern Lake Michigan Coastal Region").

The counties of the Southern Lake Michigan Coastal Region are highly urbanized. In spite of this, they have very productive agriculture on farms that are comparatively smaller than the other regions. This region is fourth in total market value of agricultural products and leads in market value per acre of farmland. Unfortunately, the amount of farmland is decreasing rapidly. The region has the highest percentage of farmland sold and diverted to other uses, primarily residential construction. As with agricultural lands, a fairly high percentage of forest land is sold and diverted to other uses each year. The region has low acreage in inland water bodies, as well as the second lowest number of fishery and wildlife areas. Per capita water use is very high in this region.

The Southern Lake Michigan Coastal Region stands out from the other regions for several socioeconomic indicators, especially population attributes and income. Among all the regions, it has the highest population density but has lost the largest percentage of its population since 1970, especially in Milwaukee County. The population density (1,655 persons/mi^2) is much higher than that of the state as a whole (96 persons/mi^2). It has the highest percentage of people under 18 years old and the second lowest median age. The population of nonwhites, especially African American and Hispanic, is higher in this region than elsewhere in the state. Economically, the Southern Lake Michigan Coastal Region is prosperous for most people. Although the average wage is the highest in the state, the per capita income second highest, and the unemployment rates relatively low, the rates of poverty, especially for children, are quite high. In terms of job distribution, the service sector provides more jobs than in any other region. The relative importance of the agriculture and government sector is close to the lowest of all the regions.

Management Opportunities

- Restoration of the Lake Michigan ridge and swale systems to preserve coastal communities such as lake plain prairies, dunes, and fens that harbor significant concentrations of rare species, including globally rare plants such as those found in the Chiwaukee Prairie.
- Protection of bird migration and wintering habitat along or in Lake Michigan.
- Other communities needing management attention include mesic prairies, bog relicts, the black ash, white cedar, and tamarack swamps of the Germantown Swamp, and the Root River corridor in Milwaukee and Racine counties.
- Urban planning is needed to reduce pressure on important biotic communities and provide the most favorable outcomes for humans to coexist with the natural environment.

Natural Communities

The following table (2-18) lists the natural communities occurring in the Southern Lake Michigan Coastal arranged by the level of opportunity to sustain and manage the community type in this Ecological Landscape. For further explanation of natural communities and opportunities to sustain them, see Section 3.3.

Table 2-18. Natural communities occurring in the Southern Lake Michigan Coastal arranged by the level of opportunity to sustain and manage the natural community type in this Ecological Landscape.

Major Opportunity	Important Opportunity	Present
Wet-Mesic Prairie	Northern Wet Forest	Northern Wet-Mesic Forest
	Southern Dry Forest	Floodplain Forest
	Southern Dry-Mesic Forest	Oak Woodland
	Southern Hardwood Swamp	Dry-Mesic Prairie
	Southern Mesic Forest	Submergent Aquatic
	Southern Tamarack Swamp	Dry Cliff
	Oak Opening	Great Lakes Beach
	Mesic Prairie	Moist Cliff
	Emergent Aquatic	
	Bog Relict	
	Calcareous Fen (Southern)	
	Ephemeral Pond	
	Shrub Carr	
	Southern Sedge Meadow	
	Wet Prairie	
	Clay Seepage Bluff	
	Great Lakes Dune	

2.3 Methodology for Determining Species of Greatest Conservation Need

Several of the interactive planning teams mentioned in the first section of this chapter worked collectively to develop a process to identify Species of Greatest Conservation Need for Wisconsin. This analysis included all **native** wildlife species in Wisconsin. Wildlife species considered included birds, mammals, herptiles, fish, and invertebrates including mussels, butterflies, moths, etc.

The approach used to identify Species of Greatest Conservation Need focused on:

- Using existing data;
- Including taxa for which good data currently exist and documenting the rationale used to select the taxa/species;
- Simple approaches that could be easily explained to non-technical audiences, readily replicated for plan updates over time, and could be completed within the established deadline;
- Methods that were objective and scientifically defensible;
- Encouraging simple and efficient peer review;
- Allowing consideration of habitat at a broad scale in order to provide benefits to multiple species;
- Considering multiple categories of Species of Greatest Conservation Need.

Various methods were suggested to identify Wisconsin's Species of Greatest Conservation Need. Examples of problems recognized early in the process when using/testing several alternative methods include:

- Identifying species found in vulnerable or declining habitats (e.g., wetlands, etc.) does not filter out enough species and also includes species that are not rare or declining that can be found in those habitats;
- Unique life history considerations are often subjective;
- Area of Importance should not be used to exclude species that could be considered Species of Greatest Conservation Need because this may eliminate edge-of-range species;
- Using Global Abundance, Global Distribution, Global Threats, State Threats, Global Population Trend, State Population Trend, and Area of Importance as the seven criteria used to rank species biases against state criteria in favor of global criteria;
- Rather than using State Rank (measure of rarity based on number of occurrences in Wisconsin), rounded State Rank should be used for the determination of State Rarity values because rounded State Rank is more conservative;
- Presenting Species of Greatest Conservation need in "tiers" conveys a sense that one tier of species is more important than another tier. Tiers were not used in order to eliminate any perception that one category of Species of Greatest Conservation Need should be viewed as more important than another.

Two separate approaches were developed in order to meet the federal requirements as they relate to the development of Wisconsin's Comprehensive Wildlife Conservation Plan. Vertebrate Species (birds, fish, herptiles, and mammals) of Greatest Conservation Need were identified using the approach that is explained in detail in Section 2.3.1. Invertebrate Species of Greatest Conservation Need were determined through a separate process detailed in Section 2.3.2. A list of the species that appear in this document, but where not evaluated for their potential to be invertebrate or vertebrate Species of Greatest Conservation Need appears in Appendix A. These species were not evaluated because they do not meet the process criteria explained in the following sections (i.e., exotics) or they are not wildlife species (i.e., plants).

2.3.1 Methodology for Determining Vertebrate Species of Greatest Conservation Need

2.3.1.1 General Introduction

Wisconsin's list of vertebrate Species of Greatest Conservation Need was finalized after more than a year of analysis, discussion, and evaluation by teams of species experts and others. The agreed upon approach that led to the list of Wisconsin's vertebrate Species of Greatest Conservation Need is presented below. This process used the best available data and considered the most relevant ecological factors in assessing need for conservation of each species.

2.3.1.2 Method Used to Identify Vertebrate Species of Greatest Conservation Need in Wisconsin

The vertebrate species that were considered during this process came from a master list including all vertebrate species known to occur in Wisconsin (Bleser 2002), which was cross-referenced with other Wisconsin vertebrate species lists (Wisconsin Natural Heritage Program 2004a, Watermolen and Murrell 2001). Exotic species (e.g., ring-necked pheasant), extinct species (e.g., blackfin cisco), and those species that are considered extralimital or accidental (e.g., northern mockingbird) were removed from consideration. These species did not make it past the first "filter" because they did not meet the requirements set forth by the Comprehensive Wildlife Conservation Plan Advisory Team which established that exotic and extinct species as well as extralimital or accidental species should not be identified as Species of Greatest Conservation Need. A couple of edge-of-range species (e.g., Kirtland's warbler) were kept on the list to be considered because they are so rare throughout their entire range.

The vertebrate Species Teams evaluated each native vertebrate species upon seven criteria that helped define the risk and conservation need of each native species. The criteria considered were: state rarity, state threats, state population trend, global abundance, global distribution, global threats, and global population trend. These criteria are ecological factors that affect the dynamics of populations. Each criterion provided a measure of a species' vulnerability and was scored on a scale of 1 to 5. A description of the species assessment scores and their associated descriptions are provided following the explanation of how this information was used.

Vertebrate Species Teams comprised of the species experts identified in Section 2.1 utilized literature sources, databases, communication with colleges, and personal knowledge to assign scores to each of the assessment criteria. For example, species experts consulted the Natural Heritage Inventory Database (BIOTICS), Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), U.S. Shorebird Conservation Plan (Brown et al. 2001), Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan (Kushlan et al. 2002), Wisconsin Fishes 2000: Status and Distribution (Lyons et al. 2000), Geographic distributions of the amphibians and reptiles of Wisconsin (Casper 1996), Mammals of Wisconsin (Jackson 1961), and Mammals of the Great Lakes Region (Kurta 1995). Additional literature sources consulted during the planning process are provided in the Bibliography of this document.

Quantitative data were used to assign scores whenever possible. However, there are many species for which data are lacking or little or no knowledge exists. For those species, qualitative information based on best professional judgment was used. Species assessment scores for all native vertebrate species considered will be made available in CD format. These data may be obtained by contacting the Bureau of Endangered Resources at (608) 266-7012.

The mean of the species assessment scores, referred to in this document as "Mean Risk Score," was used to identify the vertebrate Species of Greatest Conservation Need. The Mean Risk Score of each species was obtained by summing the vertebrate species assessment scores of each species and dividing the

summed value by the number of criteria scored. Note that for a small number of vertebrate species, all seven criteria could not be scored due to a lack of population data. Vertebrate species were sorted by their Mean Risk Score from high to low within each vertebrate taxa group.

A cut-off was established for each vertebrate taxa group by the respective vertebrate Species Team in order to identify those vertebrate species that should be considered vertebrate Species of Greatest Conservation Need based on the distribution of Mean Risk Scores. Each cut-off was assigned using a "natural breakpoint" in the data. The cut-off assigned to each of the vertebrate species taxa groups is as follows: Birds = 3.14, Fish = 3.42, Herptiles = 3.29, and Mammals = 3.00. Vertebrate species possessing a Mean Risk Score at or above the cut-off were considered vertebrate Species of Greatest Conservation Need. Those that fell below the cut-off were not. In addition, all federal and state listed vertebrate species whose presence in Wisconsin is not considered accidental were automatically added to the list of vertebrate Species of Greatest Conservation Need whether they fell above or below the cut-off.

The seven species assessment criteria used to determine Mean Risk Scores are as follows:

State Rarity

State Rarity is a measure of the relative abundance of breeding individuals of a species within the state relative to the abundance of breeding individuals of other species. This process assumes that species that are rare or uncommon in the state are more vulnerable to decline or extinction from the state than species that are more common. State Rarity was quantified using a parameter developed from State Ranks, which are a measure of species' rarity based on their number of occurrences in Wisconsin (Wisconsin Natural Heritage Program 2004b).

State Rarity Score	Definition
1	Demonstrably secure in Wisconsin
2	Apparently secure in Wisconsin, with many occurrences
3	Rare or uncommon in Wisconsin (21-100 occurrences)
4	Imperiled in Wisconsin because of extreme rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making the species very vulnerable to extirpation from the state
5	Critically imperiled in Wisconsin because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factors(s) making the species especially vulnerable to extirpation from the state

State Threats

This factor reflects the effects of current and future extrinsic conditions on the ability of a species to maintain healthy populations through successful reproduction in the state. Threats to suitable breeding conditions are defined as any extrinsic factor that reduces the likelihood of the persistence of a population and can include predation, poaching, parasitism, poisoning from pesticides or other environmental contaminants, habitat fragmentation, deterioration, or loss, hybridization, collisions with power lines or other hazards, and other extrinsic factors that reduce the suitability of breeding conditions.

State Threats Score	Definition
1	Future conditions for breeding populations are expected to be enhanced by human activities or land-uses; potentially a "problem" species
2	Future conditions for breeding populations are expected to remain stable; no known threats
3	Slight to moderate decline in the future suitability of breeding conditions is expected
4	Severe deterioration in the future suitability of breeding conditions is expected
5	Extreme deterioration in the future suitability of breeding conditions is expected; species is in danger of regional extirpation or major range contraction, or has a low probability of successful reintroduction where already extirpated

State Population Trend

State Population Trend is an indicator of vulnerability and represents the direction and magnitude of changes in the state population size over the past 30 years. This process assumes that state population decreases are an indication of species' vulnerability in Wisconsin.

State Population Trend Score	Definition
1	Large population increase over the past 30 years
2	Possible or moderate population increase, or population stable over the past 30 years
3	Uncertain population trend over the past 30 years
4	Possible or moderate population decrease over the past 30 years
5	Large population decrease over the past 30 years

Global Relative Abundance

This is a measure of the global relative abundance of breeding individuals of a species within its range relative to other species. Interpretation of this score is based on the assumption that species that are rare or uncommon are more vulnerable to decline or extinction than species that are more common.

Global Relative Abundance Score	Definition
1	Occurs in highest relative abundance
2	Occurs in high relative abundance
3	Occurs in moderate relative abundance
4	Occurs in low relative abundance
5	Occurs in lowest relative abundance

Global Distribution

This factor represents global distribution of breeding individuals of a species during the breeding season. Interpretation of this score is based on the assumption that species with a narrowly distributed breeding population are more vulnerable than species with a widely distributed breeding population.

Global Distribution Score	Definition
1	Distribution area occupied is most of the continent
2	Distribution area occupied is ¾ of continent
3	Distribution area occupied is half the continent
4	Distribution area occupied is ¼ of the continent
5	Distribution area occupied is very restricted, covering only a small part of the continent

Global Threats

This factor reflects the effects of current and future extrinsic conditions on the ability of a species to maintain healthy populations through successful reproduction. Threats to suitable breeding conditions are defined as any extrinsic factor that reduces the likelihood of the persistence of a population, and can include predation, poaching, parasitism, poisoning from pesticides or other environmental contaminants, habitat fragmentation, deterioration, or loss, hybridization, collisions with power lines or other hazards, and other extrinsic factors that reduce the suitability of breeding conditions.

Global Threats Score	Definition
1	Future conditions for breeding populations are expected to be enhanced by human activities or land-uses; potentially a " problem" species
2	Future conditions for breeding populations are expected to remain stable; no known threats
3	Slight to moderate decline in the future suitability of breeding conditions is expected
4	Severe deterioration in the future suitability of breeding conditions is expected
5	Extreme deterioration in the future suitability of breeding conditions is expected; species is in danger of regional extirpation or major range contraction, or has a low probability of successful reintroduction where already extirpated

Global Population Trend

This factor reflects the direction and magnitude of changes in the global population size over the past 30 years. This process assumes that global population decreases are an indication of species' vulnerability.

Global Population Trend Score	Definition
1	Large population increase over the past 30 years
2	Possible or moderate population increase, or population stable over the past 30 years
3	Uncertain population trend over the past 30 years
4	Possible or moderate population decrease over the past 30 years
5	Large population decrease over the past 30 years

Vertebrate Species Team members reviewed the resulting list of Species of Greatest Conservation Need. Species Team members were given guidance that they could use their best professional judgment to add or remove species from the list on a case-by-case basis, if warranted. Minor adjustments to the list of

vertebrate Species of Greatest Conservation Need were made by the species experts to correct for species they perceived not to be characterized accurately. All changes were documented and are provided below.

The Mammal Species Team experts opted to remove least shrew, Indiana bat, wolverine, eastern spotted skunk, Canada lynx, mountain lion (cougar), woodland caribou, and bison from the list of vertebrate Species of Greatest Conservation Need. They believed these species would be more accurately represented on the information needed list, which is described in Section 2.3.1.4. These eight species were all identified as exhibiting an uncertain State Population Trend.

Bird species were both added and removed from the list of vertebrate Species of Greatest Conservation Need by the Bird Species Team. Seven of the ten bird species (northern harrier, red crossbill, blue-winged teal, wood thrush, blue-winged warbler, black-throated blue warbler, and northern goshawk) were added for a variety of reasons, while three bird species (least flycatcher, veery, and brown thrasher) were added for the same reason (see Table 2-19).

Table 2-19. Justification for Addition of Individual Bird Species to the List of Vertebrate Species of Greatest Conservation Need.

Species Name	Justification
Northern harrier	Area sensitive grassland/wetland bird that is widely distributed throughout the state, but is declining in many grassland areas south of the Tension Zone.
Red crossbill	New research suggests nine different species. Regional experts suggest a decline based on lack of mature upland conifers. If the scores would have been for each distinct species, it is likely that one or more of the species would have made the list due to restricted ranges and low State Rank (high State Rarity) scores.
Blue-winged teal	Neotropical migrant grassland nesting waterfowl. Requires juxtaposition of both upland grasslands for nesting cover and wetland complexes for brood rearing. Declining throughout eastern part of its range.
Wood thrush	Partners in Flight Continental Watch List species
Blue-winged warbler	Partners in Flight Continental Watch List Species
Black-throated blue warbler	Area sensitive, interior gap specialist, may be sensitive to high white-tailed deer populations and needs large blocks of older forest.
Northern goshawk	Area sensitive, occupies older forests, due to listing concerns in other portions of its range there is a need for a WI status assessment both for managers and conservationists.
Least flycatcher, veery and brown thrasher	Highest relative abundance in Wisconsin compared to their overall range. These species are declining both globally and in the state, but were not included in the original list of vertebrate Species of Greatest Conservation Need because they are not state or federally listed and other criteria contributing to their mean species assessment score were not high enough to generate a mean species assessment score above the cut line.

The Bird Species Team decided to remove the prairie warbler, black rail, red knot, and bay-breasted warbler from the list of vertebrate Species of Greatest Conservation Need. Justification for removal of these species is provided in Table 2-20.

Table 2-20. Justification for Removal of Individual Bird Species from the list of Vertebrate Species of Greatest Conservation Need.

Species Name	Justification
Prairie warbler	Breeding males do not occur in Wisconsin on a consistent basis.
Bay-breasted warbler	Common migrant, no confirmed breeding records in the Breeding Bird Atlas. If it is determined that Wisconsin is limiting during migration, successive iterations of this plan can be revised accordingly.
Black rail	Breeding males do not occur in Wisconsin on a consistent basis.
Red knot	Wisconsin is too far on the edge of its range for any serious conservation action to take place

The Herptile Species Team decided to add four species to the list of vertebrate Species of Greatest Conservation Need: northern prairie skink, mudpuppy, ring-neck snake, and boreal chorus frog. Justification for addition of these species is provided in Table 2-21.

Table 2-21. Justification for Addition of Individual Herptile Species to the List of Vertebrate Species of Greatest Conservation Need.

Species Name	Justification
Northern prairie skink	This species is colonial, which makes it vulnerable to localized disturbance and natural succession. Its habitat has been reduced by pine plantings and development and almost no scientific data exist on its status.
Mudpuppy	The status of the mudpuppy has been compromised by instream habitat degradation and the use of lamprecides in many tributaries to the Great Lakes. Lamprecide impacts have been documented in Ohio and should apply in Wisconsin. Needed baseline data do not exist for this species. This species may also have been affected by the biological supply trade that existed in an unregulated fashion until 2000. One supplier in Wisconsin is purchasing over 11,000 mudpuppies annually from Minnesota, so there is still a market for them, and they can be legally commercialized here under a license, but without limits.
Ring-neck snake	This species is colonial and vulnerable to localized disturbances and natural succession. It has already experienced habitat loss due to these two factors and therefore its status may mimic what has happened to the other prairie-dependent snakes in Wisconsin, all of which are included above the cut line. No baseline data exist for the species. It is listed as special concern in Wisconsin.
Boreal chorus Frog	There are very few data on the population status and extant range in Wisconsin. Historically the species had a very limited range in northwestern Wisconsin, but surveys to date (frog and toad survey exclusively) do not differentiate this species from the western chorus frog. The boreal chorus frog has recently been recognized as a distinct species and warrants Species of Greatest Conservation Need status.

A total of 556 vertebrate species were evaluated for consideration as vertebrate Species of Greatest Conservation Need. The final list of vertebrate Species of Greatest Conservation Need includes 152 species: 84 birds, 30 fish, 24 herptiles, and 14 mammals. Lists of these species, by taxa, are presented in Chapter 3 as well as in Appendix B. The number of vertebrate Species of Greatest Conservation Need selected equates to approximately 27% of the native vertebrate species that were considered during this process.

2.3.1.3 Selected Method for Categorizing Vertebrate Species of Greatest Conservation Need in Wisconsin

Area of Importance was used to divide vertebrate Species of Greatest Conservation Need into categories. **These categories were not created in order to prioritize vertebrate species, but rather as another level of analysis for individuals who will be implementing this plan.** Area of Importance reflects the

relative importance of the state to a species and its conservation, based on the abundance of the species in the state relative to other areas within its range.

Area of Importance Score	Definition
1	Does not occur in manageable numbers; could include species of accidental or sporadic occurrence
2	Present in low relative abundance, but occurs in manageable numbers in at least part of the state
3	Present in moderate relative abundance, relative to other parts of a species' range
4	Present in high relative abundance, relative to other parts of a species' range
5	Present in highest relative abundance within a species' range

The reasoning behind the Area of Importance concept is that conservation measures for species are likely to be most effective if enacted in core areas of the species' population rather than on the periphery. However, it is not a measure of ecological importance of conservation measures.

Vertebrate Species of Greatest Conservation Need were divided into three categories. Vertebrate Species of Greatest Conservation Need with an Area of Importance score of 4 or 5 were considered to be species that have high relative abundance in Wisconsin compared to the rest of their range. Vertebrate Species of Greatest Conservation Need with an Area of Importance score of 2 or 3 were determined to have moderate to low abundance in Wisconsin compared to the rest of their range. Vertebrate Species of Greatest Conservation Need with an Area of Importance Score of 1 were those species believed to occur in very low numbers in Wisconsin compared to the rest of their range.

2.3.1.4 Vertebrate Species Not Identified as Vertebrate Species of Greatest Conservation Need in Wisconsin

Two additional groups of vertebrate species were also identified for which research/conservation attention may be needed. These species are not considered vertebrate Species of Greatest Conservation Need because they did not meet the established criteria, and therefore they are not addressed further in this plan. Neither list is mutually exclusive, meaning that one or multiple species could appear on either of these lists. The first of these groups identifies vertebrate species for which additional information (inventory and monitoring) is needed. These species are presented in Appendix B. These species are not on the vertebrate Species of Greatest Conservation Need list, but they do have an uncertain Global or State Population Trend. More information is needed to assess the status of these species. The Bird, Fish, and Mammal Species Teams used an objective selection criteria to determine the species that would be identified in this group. They selected all species that were assigned a Global or State Population Trend of 3. In addition, several species were removed from the list of Species of Greatest Conservation Need and placed in this group based on best professional judgment of the Species Team members. An explanation of the basis for this decision and the species to which it applies appear in the preceding section.

The Herptile Species Team took a more subjective look at those species for which additional information is needed. They chose to specifically identify the species not considered vertebrate Species of Greatest Conservation Need for which additional inventory and monitoring is needed (Table 2-22). They believed this approach would result in more focused inventory and monitoring efforts where there is a justifiable need for more data.

Table 2-22. Herptile Species for which Additional Inventory and Monitoring is Needed.

Species Name	Justification
Northern ringneck snake	Very few data exist for this state special concern species. Detection methods have yet to be developed and warrant testing to help scientists better determine its range, habitat parameters, and population health.
False map turtle	Questions exist about the status of this species, as it is primarily restricted to the Mississippi River. It is a species of special concern in Wisconsin and may have been out-competed by the Ouachita map turtle in several pools in the Mississippi River and in the lower Wisconsin River, where it appears to be extremely rare.
Plains gartersnake	This species has recently become a concern to state herptile experts, as it appears to have disappeared from a number of localities from which voucher specimens were previously collected. No efforts have ever been undertaken to provide even a crude baseline for this species. It is currently intergrading with the state threatened Butler's gartersnake (Thamnophis butleri) in southeastern Wisconsin and may have been out-competed by the common gartersnake (Thamnophis sirtalis) through much of southern Wisconsin.
Spotted salamander	Very limited data exist for this species. Monitoring is warranted to determine the long-term impacts of silviculture. This species prefers older mature hardwood or hardwood/conifer forests where cooler microhabitats and high humidity prevails. It is hypothesized that this species has declined in density because the quality of its habitat has been compromised.
Painted turtle	Populations of this species have declined, but population status is still unclear. Monitoring to evaluate nesting success is warranted, as this appears to be one of the factors influencing populations. This is one species that could possibly be monitored using a basking turtle survey.
Five-lined skink	This prairie, savanna, and barrens species has never been inventoried in Wisconsin. Inventory of this species is warranted because of habitat loss caused by several factors including succession, development, and forestry (e.g., planting sand prairie to pine plantations).
Snapping turtle	This species has been impacted in several areas of the state by commercial trapping and may also be experiencing declines statewide related to low nesting success (heavy nest predation). It would be useful to establish baseline population levels for several representative waterbodies that would be monitored over time to look at trends. This information could guide future management of the species, including harvest regulations.
Common musk turtle	Few data exist on the population status of this turtle, although it is known to occupy numerous lakes that have experienced significant development, particularly in southeastern Wisconsin. This species may be declining because of low nesting success.
Bullfrog	The bullfrog is a state special concern species that is not statistically well represented in the annual frog and toad survey, in part due to its scattered distribution. Its status is currently unclear, but its harvest has been regulated in one Wisconsin county that experienced heavy commercialization by the biological supply industry. This species is still subject to limited harvest for frog legs.

The Herptile Species Team's reasons for not selecting all of the herptile species with a Global or State Population Trend of 3 are as follows:

1. The annual Frog and Toad Survey provides sufficient data on the status of the frogs and toads. Additional efforts are unwarranted for species for which an inventory or monitoring need has not been identified. The Herptile Species Team recommended that this survey be maintained into the foreseeable future.

2. The status of most of the other herptile species for which additional inventory and monitoring activities could be undertaken are clearly secure due to known range and abundance information despite a lack of baseline data to evaluate trends.
3. There are a few herptile species (e.g., central newt and northern water snake) for which it is hypothesized that declines have occurred, but additional information is not warranted at this time as these species are still known to be relatively abundant.

The second group of vertebrate species for which research/conservation attention may be directed are those species that are not currently considered to be at risk but for which Wisconsin is important to their future existence because it contains a large part of the population or continental range of these species. These are species that were assigned an Area of Importance value of 5; they are listed in Appendix B. Although these are not vertebrate Species of Greatest Conservation Need and their populations may not be at immediate risk, it is important for Wisconsin to consider these "responsibility" species in any management plan.

A final vertebrate species list (Appendix B) contains a collection of those vertebrate species that did not meet any of the selection criteria for the three previously mentioned lists: 1) vertebrate Species of Greatest Conservation Need, 2) vertebrate species not identified as Species of Greatest Conservation Need for which additional information is needed, and 3) vertebrate species not identified as Species of Greatest Conservation Need that are not currently considered to be at risk for which Wisconsin contains a large part of the population or continental range. Similar to lists 2 and 3 discussed directly above, these vertebrate species are not the focus of Wisconsin's Strategy for Species of Greatest Conservation Need.

The four lists of vertebrate species that resulted from this process should be viewed as dynamic. A strategy for reviewing and revising these lists has been developed and is presented in Chapter 7. The species lists will be adjusted as additional data become available or state rarity, state threats, state population trends, global relative abundance, global distributions, global threats, or global population trends of species change in response to natural or non-natural influences.

2.3.2 Methodology for Determining Invertebrate Species of Greatest Conservation Need

2.3.2.1 General Introduction

Almost 97 percent of all described animal species and more than three out of four species of all living plants and animals combined are invertebrates. Yet, with the exception of a few basic qualities shared by all living things, invertebrates fail to demonstrate a single trait in common. Rather, invertebrates are characterized by what they are not (e.g., they are *not* vertebrates) and thus are lumped into one vast and heterogeneous assemblage of organisms (Barth and Broshears 1982). This enormous invertebrate diversity is clearly and dramatically reflected in their numerical preponderance, innumerable adaptations, and ecological variability and opportunism (Lutz 1986). Approximately 950,000 of the described invertebrate species are insects. The remainder fall into a variety of phyla encompassing the range of diversity from sponges to mollusks to echinoderms.

A basic understanding of ecosystems and their component parts (e.g., species, communities, etc.) forms the foundation for dealing with practical natural resource problems. Although often overlooked and misunderstood, invertebrates play integral roles in every biotic community. Without invertebrates, all ecosystem-level biological processes (e.g., energy flow, decomposition, pollination, trophic organization, biological control) would collapse rapidly (Wilson 1987). Indeed, it has been argued that if invertebrates disappeared, loss of all other life forms would soon follow (Wilson 1987, 1992). Attempts to ensure ecosystem sustainability across a wide range of temporal and spatial scales will not be successful if they do not rely heavily on conservation and protection of invertebrate communities.

The remainder of this section is divided into five sections. The first section (2.3.2.2) discusses what is currently known (and not known) about invertebrates in Wisconsin. The following section (2.3.2.3) identifies those invertebrate species groups considered and not considered in the current Comprehensive Wildlife Conservation Plan planning effort. The third section (2.3.2.4) identifies some of the principal data sources used in preparing the list of invertebrate Species of Greatest Conservation Need. The next section (2.3.2.5) details how invertebrate species were categorized for conservation planning during preparation of the Comprehensive Wildlife Conservation Plan. The fifth section (2.3.2.6) details the rationale for inclusion of taxa on the list of invertebrate Species of Greatest Conservation Need. References cited in the text are listed in the Bibliography.

2.3.3.2 State of Scientific Knowledge and Process Used to Identify Invertebrate Species of Greatest Conservation Need

In order to effectively encompass the tremendous diversity of invertebrates (and the range of experts that work with invertebrates), invertebrate taxa were divided into three categories to simplify review and discussion. The three categories are:

1. Nonarthropod invertebrates.
2. Noninsect arthropods.
3. Insects.

While biologically these categories are somewhat artificial, they were chosen for practical reasons. First, in the case of the insects and the noninsect arthropods, the included taxa are biologically related and often studied together. Second, experts that work on a particular taxon often maintain at least a general familiarity with related or similar taxa (e.g., scientists working with spiders often are familiar with other arachnid groups, those working with cladocerans often are familiar with copepods and clam shrimp, etc.).

As an initial step in the process to identify invertebrate Species of Greatest Conservation Need, an assessment of the state of scientific knowledge regarding invertebrates in Wisconsin was conducted. This was done by using three questions believed to be keys to successful conservation planning:

1. What invertebrate species occur in Wisconsin?
2. How are these invertebrate species distributed in space and time?
3. What factors cause the observed distributions in Wisconsin?

Tables 2-23, 2-24, and 2-25 present the results of this exercise. In these tables, an asterisk (*) indicates that the question can be answered completely or almost completely (e.g., for question 1, survey work has been completed and a state checklist is available or could be compiled relatively easily to indicate what species occur in Wisconsin). A plus sign (+) indicates that a partial, but by no means complete, answer to the question is available (e.g., for question 2, a fair amount may be known about the distribution of some families or species, but not most others in the group). Finally, a minus sign (-) indicates that little or no progress has been made in obtaining answers to the questions (e.g., little or no survey work has been completed or basic taxonomy is in such a state of disarray that comprehensive surveys remain impractical).

Wisconsin DNR (WDNR) biologists prepared initial drafts of the tables based on an extensive review of available taxonomic and ecological literature. The tables were then shared with twenty-two experts throughout the state who are familiar with the various taxa. Experts included academic scientists and museum curatorial staff, as well as additional WDNR biologists. Nine individuals responded to the peer review opportunity. The tables were modified to address input received in this peer review process. It was not always possible (or appropriate) to use a single symbol when completing the tables. For example, an asterisk/plus (*/+) marking indicates that considerable work has been completed on the taxa and a comprehensive species list is available, but additional species will likely be found in the state with additional survey work. This is sometimes the case because only limited habitats have been surveyed (e.g., grasshoppers have not been surveyed extensively in forests).

Due to time constraints associated with the overall Comprehensive Wildlife Conservation Plan process and the lack of active investigators working on Wisconsin invertebrate fauna, it was not feasible to contact experts on every invertebrate species group included in the tables. Thus, this assessment should be reviewed by additional experts and revised as necessary and appropriate.

The following tables demonstrate that basic information is lacking, e.g., species lists, for most Wisconsin invertebrate groups. From a conservation biology standpoint, the single greatest difficulty researchers and managers face is the lack of readily available, easy-to-use keys for the accurate identification of invertebrate species. This is confounded by the unstable taxonomy in many groups and the lack of investigators working on others. Most taxonomists spend years, even decades, learning the organisms, the literature, and the ecosystems in which the organisms are found. In most cases this, unfortunately, is not a science that can be performed by amateurs. Incorrect identification leads to confusion, poor interpretation of inventory data, and ultimately, poor decisions regarding resource protection and management.

A note on nomenclature

When dealing with invertebrates, it is often necessary to reconcile conflicts in the scientific nomenclature used by different researchers. Such conflicts result from advances in the description and documentation of previously undescribed invertebrate species and a changing understanding of evolutionary relationships.

> *Correct identification is vital to the protection of our natural resources, our health, and our environment. Furthermore, identification of pests and diseases must be accurate and timely if we are to sustain the mainstay of our economy – that is our forest, fisheries, and agricultural resources.*
> - Ian Efford, *Systematics: An Impending Crisis* (1995)

To ensure the most up-to-date taxonomic labels, scientific names from the Tree of Life Web Project (The University of Arizona 2004) were used. The Tree of Life is a collaborative effort of biologists from around the world. On more than 3,000 Internet web pages, the project provides information about the diversity of organisms on Earth, their evolutionary history, and characteristics. Each page contains information about a particular group of organisms. Tree of Life pages are linked to each other hierarchically, in the form of an evolutionary tree of life that illustrates the genetic connections between living things. Visitors to the Tree of Life web site can download the entire structure of the phylogenetic tree to examine relationships between organisms. These data are updated weekly to reflect current taxonomic understanding. This information can be accessed at http://tolweb.org/tree/phylogeny.html.

Standardized common names for invertebrate species included on the list of Species of Greatest Conservation Need were used as much as possible. Many invertebrates, however, do not have common names. NatureServe's database (NatureServe 2004) was used as a source of common names. Common names of some groups of species were updated using standard references (e.g., Stark 1998).

Table 2-23. Nonarthropod Invertebrates - Assessment of Progress Toward Answering Three Questions Key to Conservation Planning.

(*) = The question can be answered completely or almost completely (e.g., for question 1, a checklist is available or could be compiled relatively easily to indicate what species occur in Wisconsin).
(+) = A partial, but by no means complete, answer is available (e.g., for question 2, scientists have a general sense of the species distributions in Wisconsin).
(-) = Little or no progress has been made in obtaining an answer to the question (e.g., relatively little attention has been paid to the Wisconsin fauna).

Taxa	Key Questions		
	1. What species occur in Wisconsin?	2. How are the species distributed in space and time?	3. What factors cause the observed distributions in Wisconsin?
Porifera (sponges)	*	+	+
Cnidaria (hydra and "jellyfish")	-	-	-
Platyhelminthes: Turbellaria (flatworms)	-	-	-
Platyhelminthes: Trematoda (flukes)	+	-	-
Platyhelminthes: Cestoidea (tapeworms)	+	-	-
Nemertea (ribbon worms)	+	-	-
Nematoda (round worms)	+	+	-
Nematomorpha (horsehair worms)	*	-	-
Acanthocephala (spiny headed worms)	*	+	-
Gastrotricha (gastrotrichs)	-	-	-
Rotifera (rotifers)	+	+	-
Annelida: Oligochaeta (earthworms)	+	-	-
Annelida: Hirudinea (leeches)	*	+	+
Annelida: Branchiobdellida (crayfish worms)	+	-	-
Annelida: Aphanoneura (suction-feeding worms)	-	-	-
Annelida: Polychaeta (polychaete worms)	*	+	-
Entoprocta (*Urnatella*)	*	-	-
Ectoprocta (bryozoans)	+	-	-
Mollusca: Gastropoda (snails and slugs)	*	-	-
Mollusca: Pelecypoda (fingernail clams and freshwater mussels)	*	+	+

Table 2-24. Noninsect Arthropods - Assessment of Progress Toward Answering Three Questions Key to Conservation Planning.

(*) = The question can be answered completely or almost completely (e.g., for question 1, a checklist is available or could be compiled relatively easily to indicate what species occur in Wisconsin).

(+) = A partial, but by no means complete, answer is available (e.g., for question 2, scientists have a general sense of the species distributions in Wisconsin).

(-) = Little or no progress has been made in obtaining an answer to the question (e.g., relatively little attention has been paid to the Wisconsin fauna).

Taxa	Key Questions		
	1. What species occur in Wisconsin?	2. How are the species distributed in space and time?	3. What factors cause the observed distributions in Wisconsin?
Crustacea: Anostraca (fairy shrimp)	*	+	-
Crustacea: Notostraca (tadpole shrimp)	+	-	-
Crustacea: Laevicaudata and Spinicaudata (clam shrimp)	+	-	-
Crustacea: Cladocera (water fleas)	*	-	-
Crustacea: Ostracoda (seed shrimp)	+	+	-
Crustacea: Copepoda (copepods)	*/+	+	-
Crustacea: Branchiura (fish lice)	+	+/-	-
Crustacea: Mysidacea (opossum shrimp)	*	-	-
Crustacea: Isopoda (sow bugs)	*	+	-
Crustacea: Amphipoda (scuds)	*	+	-
Crustacea: Decapoda (crayfish, freshwater shrimp)	*	*	+
Dipopoda (millipedes)	+	-	-
Paurapoda (paurapods)	-	-	-
Chilopoda (centipedes)	+	-	-
Symphyla (symphylans)	-	-	-
Arachnida: Psuedoscorpiones (pseudoscorpions)	+	-	-
Arachnida: Opiliones (daddy-long legs)	*	-	-
Arachnida: Araneae (spiders)	+	+	-
Arachnida: Acari (mites, ticks)	+	-	-
Pentastomida (tongue worms)	-	-	-
Tardigrada (water bears)	-	-	-

Table 2-25. Insects and Related Hexapoda – Assessment of Progress Toward Answering Three Questions Key to Conservation Planning.

(*) = The question can be answered completely or almost completely (e.g., for question 1, a checklist is available or could be compiled relatively easily to indicate what species occur in Wisconsin).

(+) = A partial, but by no means complete, answer is available (e.g., for question 2, scientists have a general sense of the species distributions in Wisconsin).

(-) = Little or no progress has been made in obtaining an answer to the question (e.g., relatively little attention has been paid to the Wisconsin fauna).

Taxa	Key Questions		
	1. What species occur in Wisconsin?	2. How are the species distributed in space and time?	3. What factors cause the observed distributions in Wisconsin?
Hexapoda: Protura (proturans)	+	-	-
Hexapoda: Collembola (spring tails)	+	-	-
Hexapoda: Diplura (diplurans)	-	-	-
Insecta: Archaeognatha (bristletails)	-	-	-
Insecta: Thysanura (silverfish, fire brats)	*	-	-
Insecta: Ephemeroptera (mayflies)	*	+	+/-
Insecta: Odonata (dragonflies, damselflies)	*	+	+/-
Insecta: Plecoptera (stoneflies)	*	+	+/-
Insecta: Phasmida (stick and leaf insects)	+	-	-
Insecta: Orthoptera (grasshoppers, crickets, etc.)	+	+	-
Insecta: Dermaptera (earwigs)	*	+	-
Insecta: Dictyoptera (cockroaches, termites, mantids)	*	+	+/-
Insecta: Psocoptera (book lice, bark lice)			
Insecta: Phthiraptera (lice)	*	+	+/-
Insecta: Hemiptera (true bugs)	+	+/-	+/-
Insecta: Thysanoptera (thrips)	+	-	-
Insecta: Megaloptera (alderflies, dobsonflies, fishflies)	*	+	-
Insecta: Neuroptera (lacewings, ant lions, owlflies)	+	-	-
Insecta: Coleoptera (beetles)	+	+/-	+/-
Insecta: Strepsiptera (twisted-winged insects)	+	-	-
Insecta: Mecoptera (scorpionflies, hangingflies)	-	-	-
Insecta: Trichoptera (caddisflies)	*	+/-	+/-
Insecta: Lepidoptera (butterflies, moths)	+	+	+/-
Insecta: Diptera (flies)	+	+	+/-
Insecta: Siphonaptera (fleas)	+	+	-
Insecta: Hymenoptera (wasps, bees, ants, etc.)	*/+	+	+/

2.3.2.3 Invertebrate Taxa Considered/Not Considered in the Current Strategy

The state of scientific knowledge assessment was used to focus attention on groups for which there appeared to be adequate knowledge to be able to identify invertebrate Species of Greatest Conservation Need. Specifically, attention was first directed toward those groups in Tables 2-23, 2-24, and 2-25 that have two or three plus [+] signs indicating sufficient progress has been made in answering the basic biological questions.

There are several taxa for which basic taxonomic and life history information remains lacking. These groups have two or three minus [-] signs in Tables 2-23, 2-24, and 2-25, indicating little progress has been made in answering the three basic conservation questions (e.g., cnidarians, gastrotrichs, etc.). Biologists know a fair amount about the biology and distribution of some other groups (e.g., sponges, leeches), but current status and survey information remains inadequate for determining Species of Greatest Conservation Need. Some taxa include mostly exotic, accidental, or migrant species. For example, most terrestrial earthworms are known to be introduced exotic species. Relatively little, however, is known about the native earthworms and some of these may be of conservation concern. Sufficient information to assess the status of these organisms in Wisconsin is simply just not available, as more is known about the exotics than the native species. Similarly, while a fair number of parasitologists have worked on the Wisconsin fauna, most parasitic taxa (e.g., flatworms, horsehair worms) remain poorly known. It is possible that conservation of vertebrate hosts will contribute to the conservation of their parasites. As a result of these uncertainties, invertebrate species within these groups were not evaluated to determine if any could be considered Species of Greatest Conservation Need. Invertebrate taxa not considered as part of this planning effort to identify Species of Greatest Conservation Need are listed in Table 2-22.

Table 2-26. Invertebrate Taxa Not Reviewed for Species of Greatest Conservation Need Status in Current Planning Effort.

Porifera (sponges)	Cnidaria (hydra and "jellyfish")	Platyhelminthes (flatworms, flukes, tapeworms)
Nemertea (ribbon worms)	Nematoda (round worms)	Nematomorpha (horsehair worms)
Acanthocephala (spiny headed worms)	Gastroticha (gastrotrichs)	Rotifera (rotifers)
Annelida (segmented worms)	Entoprocta (*Urnatella*)	Ectoprocta (bryozoans)
Crustacea: Notostraca (tadpole shrimp)	Crustacea: Branchiura (fish lice)	Diplopoda (millipedes)
Chilopoda (centipedes)	Paurapoda (paurapods)	Symphyla (symphylans)
Arachnida: Pseudoscorpiones (pseudoscorpions)	Arachnida: Opiliones (daddy-long legs)	Arachnida: Acari (mites, ticks)
Pentastomida (tongue worms)	Tardigrada (water bears)	Hexapoda: Protura (proturans)
Hexapoda: Collembola (springtails)	Hexapoda: Diplura (diplurans)	Insecta: Archaeognatha (bristletails)
Insecta: Thysanura (silverfish, fire brats)	Insecta: Phasmida (stick and leaf insects)	Insecta: Dermaptera (earwigs)
Insecta: Dictyoptera (cockroaches, termites, mantids)	Insecta: Psocoptera (book lice, bark lice)	Insecta: Phthiraptera (lice)
Insecta: Thysanoptera (thrips)	Insecta: Neuroptera (lacewings, ant lions, owlflies)	Insecta: Strepsiptera (twisted-winged insects)
Insecta: Mecoptera (scorpionflies, hangingflies)	Insecta: Siphonaptera (fleas)	Hymenoptera (bees, ants, etc.)

Biologists have studied one or more individual species of some invertebrate groups and a fair amount is known about the biology and distribution of some families or species groups within larger taxa. For example, tiger beetles and aquatic beetles are comparatively well known, but most other groups of beetles remain poorly known. Similarly, recent work in Wisconsin grasslands has yielded information about the biology, distribution, and status of certain hemipterans and orthopterans. Surveys also have provided a considerable amount of data on the distribution and status of butterflies and larger moths, but most microlepidopterans remain unknown in the state. Similarly, in aquatic ecosystems, much is known about the distribution of mussels, but little is known about the occurrence of fingernail clams. In addition, the invertebrate team and outside experts reviewed one group, the Megaloptera, and found no species to be Species of Greatest Conservation Need. Therefore, this group is not considered elsewhere in this plan. Table 2-27 presents those taxa for which only certain families or species groups were reviewed for Species of Greatest Conservation Need status during the current planning effort.

Table 2-27. Invertebrate Taxa for which Only Certain Families or Species Groups were Reviewed for Species of Greatest Conservation Need Status During the Current Planning Effort.

Mollusca: Pelecypoda (fingernail clams)	Crustacea: Copepoda (copepods)	Crustracea: Isopoda (sow bugs)
Crustacea: Amphipoda (scuds)	Arachnida: Araneae (spiders)	Insecta: Orthoptera (grasshoppers, crickets, etc.)
Insecta: Hemiptera (true bugs)	Insecta: Coleoptera (beetles)	Insecta: Lepidoptera (butterflies and moths)
Insecta: Diptera (flies)		

Many of the taxa listed in Tables 2-26 and 2-27 are considered to be invertebrate species or species groups of unknown conservation need ("Category 2", see Section 2.3.2.5 below).

2.3.2.4 Important Invertebrate Data Sources

The Comprehensive Wildlife Conservation Plan Invertebrate Species Team consulted the Natural Heritage Inventory Database (BIOTICS) as a primary source of information on invertebrates for which occurrence data has been collected and compiled previously. The Invertebrate Species Team also relied heavily on consultation with the experts who previously contributed information to BIOTICS and an extensive review of literature related to the various invertebrate taxa occurring in Wisconsin.

Besides BIOTICS, other important sources used for this effort included the Wisconsin Macroinvertebrate Database, a special database maintained by the Natural Heritage Inventory program. The Wisconsin Macroinvertebrate Database includes the "Biomonitoring Database" maintained by Dr. Stan Szczytko, University of Wisconsin-Stevens Point under contract with WDNR for assessment of wadeable streams (Lillie et al. 2003). The Wisconsin Macroinvertebrate Database uses the same general database structure, but also includes aquatic invertebrate species occurrence data from:

- biotic inventories conducted by Natural Heritage Inventory staff on WDNR's larger properties as part of property master planning efforts,
- inventory work conducted as part of the Lake Superior Basin Coastal Wetland Evaluation,
- several mayfly and dragonfly status surveys, including those for Hine's emerald dragonfly, stream dragonflies, and mayflies under review for federal listing, and the U.S. Forest Service's "Sensitive Species" in Wisconsin,
- WDNR's ongoing Odonate Atlas Pilot Project,
- inventory work completed as part of the WDNR's Bureau of Endangered Resources' Peatlands Project,

- Environmental Review assessments and monitoring conducted for proposed mines, wastewater treatment facilities, etc.,
- reports from peer reviewed literature,
- reliable reports from unpublished "gray" literature,
- museum log data (Odonata only), and
- some agency mussel surveys (mussel data are managed in a separate database maintained by WDNR).

Currently, the Wisconsin Macroinvertebrate Database documents around 20,000 collection efforts in aquatic or wetland habitats with about 286,000 invertebrate species occurrence records representing approximately 4,000 different taxa. The Wisconsin Macroinvertebrate Database serves as the main data-handling tool for all aquatic macroinvertebrate species and some terrestrial invertebrates addressed by the Natural Heritage Inventory. The Natural Heritage Inventory (rare species) database coverage of macroinvertebrates is largely derived by periodically querying the Wisconsin Macroinvertebrate Database.

A long-term project lead by WDNR biologists Rich Henderson and Scott Sauer has been documenting invertebrate species, primarily insects, within grassland habitats. The study has produced a large volume of terrestrial insect occurrences. Between 1992 and 2004, the study made or documented well over 2,000 site visits on approximately 370 sites yielding about 1,900 taxa and nearly 30,000 specimens. Periodically, project biologists have provided the Natural Heritage Inventory program with recommendations of potentially rare species. The Natural Heritage Inventory so far has tracked only obligate grassland species that are probably rare globally and may be sensitive to certain management practices. The Invertebrate Species Team consulted project biologists and considered their complete data set in developing the list of Species of Greatest Conservation Need.

The Invertebrate Species Team also consulted several on-line databases maintained by the Milwaukee Public Museum. The Wisconsin Crustaceans Homepage (Milwaukee Public Museum 2004a) is based on Milwaukee Public Museum crustacean collections and research. The internet web site (http://www.mpm.edu/collect/invert/jass/Default.asp) primarily focuses on crayfish, with images and data from the book *The Crayfishes and Shrimp of Wisconsin* (Hobbs and Jass 1998). It also includes data on fairy shrimp, amphipods, and isopods, as well as other crustaceans. Similarly, the Milwaukee Public Museum's Mathiak Collection of Freshwater Mussels of Wisconsin (Milwaukee Public Museum 2004b) contains significant holdings from Wisconsin, a major portion being mussels collected by Harold A. Mathiak, who surveyed 251 rivers and creeks across Wisconsin (641 sites) during the 1970s. Voucher specimens (7000+) with the pertinent date, stream, county, and township/range/section data were donated to six institutions including the Milwaukee Public Museum. The Mathiak Collection provides a good source of material for addressing various research and conservation questions. The Milwaukee Public Museum Mollusk Collection web site offers a searchable, composite database of this collection. It can be accessed at http://www.mpm.edu/collect/invert/mussels/default.asp.

2.3.2.5 Categorizing Invertebrate Species of Greatest Conservation Need

After the initial step of developing the state of scientific knowledge tables (Section 2.3.2.2), the next step was to take a look at the subset of invertebrate groups for which it was determined there was adequate knowledge to allow for analysis in this first iteration of the Comprehensive Wildlife Conservation Plan. Unlike the vertebrate groups, there was not the same breadth or depth of data and information to draw from in determining what invertebrate species are of greatest conservation need. That said, criteria were written to parallel the vertebrate process. Staff and partner invertebrate experts statewide were enlisted to develop the list of 530 invertebrate Species of Greatest Conservation Need. These species span 19

groups, of which 58 invertebrate species are non-arthropod invertebrates, 22 are non-insect arthropods, and 450 are insects.

With the list of 19 groups that were going to be addressed in the plan, a letter was sent out to various invertebrate species experts inside and outside the WDNR. The letter explained the criteria for identifying invertebrate Species of Greatest Conservation Need. Invertebrate species were identified as such if they were:

1. state and/or federally listed,
2. of special concern and having a Natural Heritage Inventory State Rank of S1 or S2 and/or Global Rank of G1-G3, or
3. nominated by a species expert and accepted by the Invertebrate Species Team.

State Ranks and Global Ranks provide basic information on the relative imperilment or vulnerability of a species within the specified geographic ranges based on a five-point heriarchical scale, ranging from critically imperiled (S1, G1) to demonstrably widespread, abundant and secure (S5, G5) (NatureServe, 2002).

Rationale for nomination and acceptance in this category considered whether the species is declining; endemic; disjunct; with small, localized "at-risk" populations; with limited dispersal; with fragmented or isolated populations; *and/or* species of special or conservation concern (in addition to S1 or S2 and/or G1-G3).

Draft lists of species for many groups were provided to experts based on the first two criteria. Experts were asked to nominate species they thought also merited consideration given the rationales listed in criteria 3. The Invertebrate Species Team then considered the nominations for the final list of invertebrate Species of Greatest Conservation Need. Similar to the vertebrate process, there is a continuum of knowledge on invertebrate species in the state. In addition to invertebrate Species of Greatest Conservation Need (Category 1), three other categories of invertebrates (Category 2, 3, and 4) were created to describe the varying degrees of information available about these other species or groups of species.

Category 2 describes invertebrate species or species groups of unknown conservation need. This group was divided into three subgroups, which were:

1. Species or species groups for which basic taxonomy and/or life history research is needed;
2. Species or species groups for which taxonomy and life history are relatively certain, but their status is unknown; and
3. Species that are not listed as endangered or threatened in Wisconsin, but are listed as state threatened or endangered in an adjacent state (Illinois, Iowa, Michigan, or Minnesota). This category will be comprised of invertebrate species that may not be rare or declining in Wisconsin, but have been recognized as rare or declining elsewhere.

This category includes all of the taxa listed in Table 2-26 and not considered during the current planning effort.

Category 3 describes invertebrate species or species groups not identified as Species of Greatest Conservation Need of which a large portion of their continental population resides in Wisconsin. These will be invertebrate species that may not be rare or declining in Wisconsin, but species for which it should be noted that Wisconsin plays a significant role in their continued existence. This category could include many additional species currently included in Category 2. Further refinement of this third category remains underway and the list will evolve as knowledge of the various taxa increases.

Category 4 describes invertebrate species or species groups that are not of conservation need at this time. Species in this category include species with stable or growing populations, pest species, and introduced non-native species. As with Category 3, work to develop this fourth category more fully remains underway and the

list will evolve as knowledge of the various taxa increases. In addition, this category could include many additional species currently included in Category 2.

2.3.2.6. Rationale for Inclusion of Invertebrate Species as Species of Greatest Conservation Need

The following list by taxonomic group indicates the rationale for including species in each group on the list of Species of Greatest Conservation Need and the databases, literature, and experts consulted in the current planning process. Species groups are presented in taxonomic order.

Mollusca: Gastropoda (Snails)

The list of Species of Greatest Conservation Need includes 31 land snails. Numerous other snails are tracked as part of the Natural Heritage Inventory Working List (Natural Heritage Inventory 2004a). All snails included on the list of Species of Greatest Conservation Need are either state and/or federally listed or are considered of special concern and have a Natural Heritage Inventory State Rank of S1 or S2 and/or a Global Rank of G1, G2, or G3. The Invertebrate Species Team also considered the published works of invertebrate zoologist Joan P. Jass, Milwaukee Public Museum, Dr. Jeffery Nekola, University of Wisconsin-Green Bay, Dr. James Theler, University of Wisconsin-La Crosse, and Dr. Terrence Frest, a private consultant and snail expert. Information on the distribution and habitats of listed snail species is available in *The Endangered and Threatened Invertebrates of Wisconsin* (Wisconsin DNR 1999d).

Mollusca: Pelecypoda (Mussels)

The list of Species of Greatest Conservation Need includes 26 mussels. All mussels included on the list of Species of Greatest Conservation Need are either state and/or federally listed or are considered of special concern and have a Natural Heritage Inventory State Rank of S1 or S2 and/or a Global Rank of G1, G2, or G3. In addition to surveys conducted by the Natural Heritage Inventory Program, the Invertebrate Species Team considered works of and previous input from mussel experts Frank Baker, Harold Matthiak, David Heath, Marian Havlik, Sam Fuller, Thomas Doolittle, Mark Hove, and others. Important Museum collections accessed during preparation of the Natural Heritage Inventory working list included the Milwaukee Public Museum, the Bell Museum of Natural History, University of Wisconsin-Stevens Point, and the University of Wisconsin-Madison's Zoology Museum. Information on the distribution and habitats of listed mussels is available in *The Endangered and Threatened Invertebrates of Wisconsin* (Wisconsin DNR 1999d).

Annelida: Polychaeta (Annelid Worms)

The list of Species of Greatest Conservation Need includes one polychaete worm, *Manayunkia speciosa.* The inclusion of this annelid on the list of Species of Greatest Conservation Need is based on recommendations from Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, based on his recent analysis of available data. Dr. Schmude has worked statewide for the past 10 years conducting aquatic invertebrate surveys for various resource agencies, including WDNR, and is currently relied on extensively for expertise by the Natural Heritage Inventory Program. In spite of extensive aquatic invertebrate sampling throughout the state, fewer than 250 specimens of this polychaete have been collected from only two counties in extreme northern Wisconsin and Lake Superior. The Invertebrate Species Team also consulted with Mark J. Wetzel, Illinois Natural History Survey, regarding annelids occurring in Wisconsin. Mr. Wetzel is a well-respected annelid taxonomist.

Crustacea: Anostraca (Fairy Shrimp)

The list of Species of Greatest Conservation Need includes all three of Wisconsin's fairy shrimp species. The inclusion of these species on the list is based on recommendations of zooplankton ecologist Dr. Stanley Dodson, University of Wisconsin, and invertebrate biologist Dr. Ed Stern, University of Wisconsin-Stevens Point, as well as the published works of invertebrate zoologist Joan P. Jass, Milwaukee Public Museum. Dr. Dodson and his colleagues have investigated zooplankton communities in the Great Lakes, small inland lakes, wetlands, and restored wetlands throughout the state for many years. Dr. Stern has spent many years investigating the fauna of Wisconsin's aquatic communities. Ms. Jass is a recognized expert on Wisconsin crustaceans. She and her colleagues published the first comprehensive treatments of Wisconsin fairy shrimp in the early 2000s. Wisconsin's fairy shrimp occur sporadically on the landscape and are dependent on ephemeral ponds, a habitat that is easily disturbed or destroyed.

Crustacea: Isopoda (Isopods, Sow Bugs)

The list of Species of Greatest Conservation Need includes one aquatic isopod, *Lirceus lineatus*. The inclusion of this sow bug on the list of Species of Greatest Conservation Need is based on recommendations from Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior. Dr. Schmude has worked statewide for the past 10 years conducting aquatic invertebrate surveys for various resource agencies, including WDNR, and is currently relied on extensively for expertise by the Natural Heritage Inventory Program. Biologists have collected fewer than 100 specimens of this species from only two Wisconsin counties (Ashland and Door). The Invertebrate Species Team also considered the published works of invertebrate zoologist Joan P. Jass, Milwaukee Public Museum, when assessing the isopods for Species of Greatest Conservation Need.

Crustacea: Amphipoda (Amphipods)

The list of Species of Greatest Conservation Need includes three amphipods. The Wisconsin well amphipod (*Stygobromus putealis*) is endemic to Wisconsin, occupies subterranean groundwater, and is known from only four wells and a spring in Dodge, Fond du Lac, and Green Lake counties in central Wisconsin. The inclusion of this amphipod on the list of Species of Greatest Conservation Need was based on current recommendations of Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, and prior recommendations of invertebrate zoologist Joan P. Jass, Milwaukee Public Museum. Dr. Schmude has worked statewide for the past 10 years conducting aquatic invertebrate surveys for various resource agencies, including WDNR, and is currently relied on extensively for expertise by the Natural Heritage Inventory Program. Ms. Jass is an expert on Wisconsin crustaceans and is responsible for most of the recent publications on the group. Dr. Schmude also recommended inclusion of the other two amphipods. These two species appear to be extremely rare in the state and have been collected only sporadically.

Crustacea: Laevicaudata (Clam Shrimp)

The list of Species of Greatest Conservation Need includes one clam shrimp, *Lynceus brachyurus*, for which very few Wisconsin records are available. The inclusion of this clam shrimp on the list of Species of Greatest Conservation Need is based on recommendations from Dr. Stanley Dodson, University of Wisconsin, and Dreux Watermolen, WDNR. Dr. Dodson, a zooplankton ecologist, and his colleagues have investigated zooplankton communities in the

Great Lakes, small inland lakes, and natural and restored wetlands throughout the state for many years. Mr. Watermolen has been working to document Wisconsin's non-insect invertebrate fauna for more than 15 years.

Crustacea: Copepoda (Copepods)

Zooplankton ecologist Dr. Stanley Dodson, University of Wisconsin, and Dreux Watermolen, WDNR, recommended four copepods for inclusion on the list of Species of Greatest Conservation Need. The Invertebrate Species Team also considered the published work of Dr. Byron Torke, Ball State University. Dr. Dodson, a zooplankton ecologist, and his colleagues have investigated zooplankton communities in the Great Lakes, small inland lakes, and natural and restored wetlands throughout the state for many years. Mr. Watermolen has been working to document Wisconsin's non-insect invertebrate fauna for more than 15 years. In the early 2000s, Dr. Torke published information collected over 30 years on the distribution of calanoid copepods in Wisconsin lakes. Dr. Torke's work included over 1,500 samples from 499 lakes in 63 of Wisconsin's 72 counties. Many of the lakes included in Dr. Torke's paper were sampled 4 times over a year-long period to obtain seasonal information. Earlier work by Torke on 190 Wisconsin lakes was published in the late 1970s and was also considered. The copepods considered Species of Greatest Conservation Need occupy two primary habitats: pristine marshes and kettles in southern Wisconsin and deep cold high-oxygen water usually in northern Wisconsin. The harpactacoid and cyclopoid copepods were not considered in the current planning effort due to a lack of adequate information.

Crustacea: Decapoda (Crayfishes and Shrimp)

Information on the distribution and abundance of crayfishes and shrimp was collected as part of the statewide fish distribution survey in the 1970s and early 1980s. Dr. Horton Hobbs, III, Wittenberg University, and invertebrate zoologist Joan P. Jass, Milwaukee Public Museum, supplemented these collections with focused field collecting efforts in 1982 and a review of numerous museum collections, before publishing *The Crayfishes and Shrimp of Wisconsin* (Hobbs and Jass 1988). Dr. Hobbs and Ms. Jass examined over 13,650 specimens during their study. The inclusion of several decapods on the Natural Heritage Inventory Working List was based in part on this extensive baseline work. Dr. Ed Stern, University of Wisconsin-Stevens Point, Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, and Dreux Watermolen, WDNR, recommended species for inclusion on the list of Species of Greatest Conservation Need. Dr. Stern has spent many years investigating the fauna of Wisconsin's aquatic communities. Dr. Schmude has worked statewide for the past 10 years conducting aquatic invertebrate surveys for various resource agencies, including WDNR, and is currently relied on extensively for expertise by the Natural Heritage Inventory Program. Mr. Watermolen has been working to document Wisconsin's non-insect invertebrate fauna for more than 15 years.

Arachnida: Araneae (Spiders)

The list of Species of Greatest Conservation Need includes 6 spiders. Comprehensive surveys of Wisconsin spiders have not been completed, but some inventory work has occurred. The Natural Heritage Inventory Working List includes only a handful of spider species. Dr. Michael Draney, University of Wisconsin-Green Bay, recommended additional spiders for inclusion on the list of Species of Greatest Conservation Need, based on an assessment of all available published spider distribution information. Those species include in the list have been collected only sporadically

in the state. Dr. Draney and colleagues have been compiling a checklist of Wisconsin (and Great Lakes region) spiders. The Invertebrate Species Team reviewed Dr. Draney's recommendations.

Insecta: Ephemeroptera (Mayflies)

The list of Species of Greatest Conservation Need includes 54 mayflies. The original submissions for the Natural Heritage Inventory Working List were from ecologist Dick Lillie, WDNR, with additional input from Dr. Bill Hilsenhoff, University of Wisconsin-Madison, and Dr. Stan Szczytko, University of Wisconsin-Stevens Point. Natural Heritage Inventory program staff conducted a status survey of mayfly species that were being considered for federal listing. Dick Lillie, the principal investigator, published these results in a WDNR *Technical Bulletin*. Recent review of collections around the United States has resulted in a number of new globally rare taxa being reported from Wisconsin. These species are now tracked by the Natural Heritage Inventory. A number of additional species were recommended by Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, as Species of Greatest Conservation Need based on recent analysis of available data. The Invertebrate Species Team reviewed Dr. Schmude's recommendations.

Insecta: Odonata (Dragonflies)

The list of Species of Greatest Conservation Need includes 42 dragonflies. The Natural Heritage Inventory list was first developed in the late 1980s with significant input from Tim Vogt and Tim Cashatt, odonatologists from the Illinois State Museum. Since then, this group has received a fair amount of attention and has been addressed by various status surveys, biotic inventories, reviews related to the federally endangered Hine's emerald dragonfly, and other sources. Many species originally thought to be quite rare in Wisconsin have turned out to not be of conservation concern and the Natural Heritage Inventory Working List has been changed several times to reflect the current population assessment resulting from surveys and compilation of available data. Recommendations for Species of Greatest Conservation Need were made primarily by William Smith, WDNR, with significant input from Robert DuBois, WDNR. Information on the distribution and habitats of state listed dragonflies is available in *The Endangered and Threatened Invertebrates of Wisconsin* (Wisconsin DNR 1999d).

Insecta: Plecoptera (Stoneflies)

The list of Species of Greatest Conservation Need includes 12 stoneflies. Natural Heritage Inventory recommendations originally came from Dr. Bill Hilsenhoff, University of Wisconsin-Madison, as a result of his extensive work on aquatic insects described under the aquatic beetle section below. Dr. Stan Szczytko, University of Wisconsin-Stevens Point, a stonefly taxonomist, has provided continual input to the Natural Heritage Inventory Working List and has recommended several additional species for consideration as Species of Greatest Conservation Need. The Invertebrate Species Team reviewed and accepted Dr. Szczytko's recommendations.

Insecta: Orthoptera (Grasshoppers, Crickets)

The list of Species of Greatest Conservation Need includes 42 grasshoppers. The Natural Heritage Inventory Working List of rare grasshoppers, crickets, and allies is based on recommendations from Kathryn Kirk, a conservation biologist with the Natural Heritage Inventory program, and Dr. Chuck Bomar, University of Wisconsin-Stout. These two individuals have been atlasing orthopteran records for the past several years and recently published a

manuscript summarizing Wisconsin records. Natural Heritage Inventory has addressed this group in some of the more recent biotic inventory projects it has undertaken. Species of Greatest Conservation Need recommendations came from Kathryn Kirk and were reviewed and accepted by the Invertebrate Species Team.

Insecta: Hemiptera (Bugs)

The list of Species of Greatest Conservation Need includes 54 true bugs. Dr. Bill Hilsenhoff, University of Wisconsin-Madison, and Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, with additional input from Richard Lillie and Richard Narf, WDNR, and Dr. Stan Szczytko, University of Wisconsin-Stevens Point, made recommendations for aquatic true bugs on the current Natural Heritage Inventory Working List. Aquatic true bug species recommendations for the invertebrate Species of Greatest Conservation Need list came primarily from Dr. Kurt Schmude based on comprehensive review of previous efforts in Wisconsin described under the Coleoptera.

True Bugs (*Insecta: Heretoptera [Homoptera]*) - A long-term WDNR project documenting invertebrate species on grassland habitats has produced a large volume of terrestrial insect occurrences. Between 1992 and 2004, this study made or documented well over 2,000 site visits on approximately 370 sites yielding about 1,900 taxa and nearly 30,000 specimens. Project biologists Rich Henderson and Scott Sauer, WDNR, have periodically provided the Natural Heritage Inventory program with recommendations of potentially rare species. The Natural Heritage Inventory so far has tracked only obligate grassland species that are probably globally rare and may be sensitive to certain management practices. These have tended to be primarily members of the Homoptera, including leafhoppers, treehoppers and spittlebugs. Dr. Andy Hamilton, Agriculture Canada, remains an important consulting expert for Wisconsin Homoptera. Many additional recommendations from this study have resulted in a number of additions to the Category 2 invertebrate list as described in Section 2.3.2.5.

Insecta: Coleoptera (Beetles)

The list of Species of Greatest Conservation Need includes 154 beetles. Aquatic beetles on the current Natural Heritage Inventory Working List were based on recommendations from a number of experts including primarily Dr. Bill Hilsenhoff, University of Wisconsin-Madison, Dr. Kurt Schmude, University of Wisconsin-Superior, Richard Lillie and Richard Narf, WDNR, Dr. Stan Szczytko, University of Wisconsin-Stevens Point, and Richard Bautz, WDNR. Dr. Hilsenhoff, an aquatic entomologist now retired from the University of Wisconsin-Madison, had systematically sampled all of Wisconsin's counties at least three times between the late 1960s and the mid-1990s for aquatic beetle and true bug species. His publications documenting Wisconsin's aquatic insects began in 1984 and continued through 1995. Dr. Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, was a student of Dr. Hilsenhoff and has continued to build on aquatic insect records assembled by Dr. Hilsenhoff. Dr. Schmude has worked statewide for the past ten years on aquatic invertebrate surveys for the WDNR, U.S. Geological Survey, counties, consulting firms, and Native American Tribes and is currently relied on extensively for expertise in aquatic entomology by the Natural Heritage Inventory Program. Recommendations for Species of Greatest Conservation Need came primarily from Dr. Kurt Schmude, integrating the work mentioned above, and were reviewed and accepted by the Invertebrate Species Team.

Terrestrial beetles on the Natural Heritage Inventory Working List include predominantly tiger beetles, one scarab beetle, and the extirpated American burying beetle. Beetle experts Matt Brust,

Dr. Harold Willis, Wayne Steffens, and William Smith made recommendations for tiger beetles for inclusion on the Natural Heritage Inventory Working List. Tiger beetles were covered in several biotic inventory projects conducted by Natural Heritage Inventory program and are relatively well known in Wisconsin. Dr. Dan Young, University of Wisconsin, and others conducted surveys for the federally endangered American burying beetle in Wisconsin. Dr. Young has also overseen projects to survey other beetle groups in Wisconsin. Kathryn Kirk, WDNR, recommended the scarab beetle. The Invertebrate Species Team drew Species of Greatest Conservation Need almost entirely from the Natural Heritage Inventory Working List and through consultation with tiger beetle expert Matt Brust.

Insecta: Trichoptera (Caddisflies)

The list of Species of Greatest Conservation Need includes 37 caddisflies. Natural Heritage Inventory recommendations originally came from Dr. Bill Hilsenhoff, University of Wisconsin, as a result of his extensive work on aquatic insects described under the aquatic beetle section above. Additional input was received from Dr. Kurt Schmude, University of Wisconsin-Superior, Dr. Stan Szczytko, University of Wisconsin-Stevens Point, and Dick Lillie and Richard Narf, WDNR. Several additional species were recommended as Species of Greatest Conservation Need by Dr. Schmude.

Insecta: Lepidopera (Butterflies and Moths)

The list of Species of Greatest Conservation Need includes 29 butterflies and 17 moths. The Natural Heritage Inventory list developed with significant input from Les Ferge, a moth taxonomist from Middleton, Wisconsin, Susan Borkin of the Milwaukee Public Museum, and other members of the Wisconsin Entomological Society. Subsequent revisions were based on recommendations primarily from Mr. Ferge. Ms. Borkin provided submissions of Species of Greatest Conservation Need. Occurrence data were drawn from a large number of collections, studies, reports, and other sources over the past several decades on this popular group. Much of the work has focused on species of grasslands and barrens or on rare species. A large set of data resulted from surveys related to the federally listed Karner blue butterfly.

Insecta: Diptera (Flies)

The list of Species of Greatest Conservation Need includes nine flies. The few species tracked by Natural Heritage Inventory are aquatic and are known only from larvae. These larvae are identifiable to genus but not species. The genera themselves, however, are rare in Wisconsin. Since a species name is not available until the larvae can be reared to the adult stage, there are no corresponding Element Codes or Natural Heritage Inventory records. These aquatic flies were recommended for the Natural Heritage Inventory list by Dr. Kurt Schmude, Lake Superior Research Institute, University of Wisconsin-Superior, and reiterated by him as Species of Greatest Conservation Need. The Invertebrate Species Team accepted his recommendations due to the rarity of the genera.

2.4 Methodology for Identifying Habitat Associations of Species of Greatest Conservation Need

Numerous habitat classification systems have already been developed for Wisconsin. Rather than developing another classification system, an existing habitat classification system was selected for use in this planning process. The selected classification system is the Ecological Landscapes/natural communities habitat classification system described in Section 2.2.

One advantage of selecting this classification system was that work had already been done to identify ecological opportunities for sustaining natural communities by Ecological Landscape through protection, restoration, and/or management. This work was previously completed by the Ecosystem Management Planning Team (Wisconsin DNR 2004a). A description of the process used by the Ecosystem Management Planning Team and their results are provided on the following web site: http://dnr.wi.gov/landscapes/opportunity/ecoloppstable.pdf. The Ecosystem Management Planning Team did not previously identify ecological opportunities for aquatic community types. However, aquatic natural communities were addressed in this plan. DNR fishery researchers developed a classification system for aquatic communities and assigned ecological opportunities for the eight aquatic natural communities of Wisconsin; coldwater streams, coolwater streams, Lake Michigan, Lake Superior, impoundments/reservoirs, inland lakes, warmwater rivers, and warmwater streams. This analysis was conducted by using personal information and references such as Wisconsin Fishes 2000: Status and Distribution (Lyons et al. 1996) and *Patterns in the species composition of fish assemblages among Wisconsin streams* (Lyons 1996). This process used the same criteria the Ecosystem Management Planning Team used for terrestrial habitats. A determination was made as to whether each of the aquatic natural communities represents a major opportunity, an important opportunity, is and/or was present, or is and/or was absent in each Ecological Landscape. A description of these terms is provided in the following table (Table 2-28). A numeric score was assigned to each ecological opportunity to facilitate data analysis.

Table 2-28. Description of Terms Used to Define Opportunities for Protection, Restoration and/or Management of Natural Communities by Ecological Landscapes. [Adapted from *Ecological Landscapes of Wisconsin* (Wisconsin DNR 2004a).]

Ecological Opportunity	Score	Description
Major	3	A major opportunity for sustaining the natural community in the Ecological Landscape exists, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful maintaining the community's composition, structure, and ecological function over a longer period of time.
Important	2	Although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and there may be a lack of opportunities elsewhere.
Present	1	The natural community occurs in the Ecological Landscape, but better management opportunities appear to exist in other parts of the state.
Absent	0	The natural community is and/or was not known to occur in the Ecological Landscape.

Vertebrate Species Teams provided the relative probability of occurrence of each of the vertebrate Species of Greatest Conservation Need in each of the 16 Ecological Landscapes of Wisconsin. Species were evaluated based on their probability of occurrence within each Ecological Landscape. It is critical to note that the probability of occurrence that was assigned to each species within an Ecological Landscape

represents the relative probability of that species to occur within the respective Ecological Landscape. It does not provide information regarding the distribution of that species within the Ecological Landscape. A description of the four probabilities used is provided in the following table (Table 2-29). A numeric score was assigned to each probability to facilitate data analysis. The probabilities and associated scores were assigned by the respective Species Team experts identified in Section 2.1 using literature sources, databases, communication with colleges, and personal knowledge. For example, species experts consulted the Natural Heritage Inventory Database (BIOTICS), Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), U.S. Shorebird Conservation Plan (Brown et al. 2001), Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan (Kushlan et al. 2002), Wisconsin Fishes 2000: Status and Distribution (Lyons et al. 2000), Geographic distributions of the amphibians and reptiles of Wisconsin (Casper 1996), Mammals of Wisconsin (Jackson 1961), and Mammals of the Great Lakes Region (Kurta 1995). Additional literature sources consulted during the planning process are provided in the Bibliography of this document. A matrix displaying the Ecological Landscape probability of occurrence scores will be made available in CD format. These data may be obtained by contacting WDNR's Bureau of Endangered Resources at (608) 266-7012.

Table 2-29. Key to Probability of Occurrence Assigned to Vertebrate Species of Greatest Conservation Need.

Probability of Occurrence	Score	Description
High	3	Species is (and/or historically was) significantly associated with the Ecological Landscape, restoration of this Ecological Landscape would significantly improve conditions for the species.
Moderate	2	Species is (and/or historically was) moderately associated with the Ecological Landscape, restoration of this Ecological Landscape would moderately improve conditions for the species.
Low	1	Species is (and/or historically was) only minimally associated with the Ecological Landscape, restoration of this Ecological Landscape would only minimally improve conditions for the species.
None	0	Species does not (and did not historically) use this Ecological Landscape.

Ecological Landscapes were chosen to represent species locations in the state because they allow the most effective application of the information in the Strategy. Coarse-level information on locations and distributions are known for all vertebrate Species of Greatest Conservation Need. However, there is considerable variation among species in the degree to which ranges and occurrence locations are known. For some, existing occurrence information, mostly contained in the Natural Heritage Inventory Database (BIOTICS), the Wisconsin Breeding Bird Atlas (Wisconsin Society for Ornithology 2005), or the Geographic distributions of the amphibians and reptiles of Wisconsin (Casper 1996), is relatively comprehensive and range maps could be drawn with considerable certainty. However, for most of the vertebrate Species of Greatest Conservation Need, recent inventory is lacking and, more importantly, the availability of critical habitat plays a major role in where species are likely to occur. Because the distribution of habitats is the primary factor separating and distinguishing one Ecological Landscape from another, and since the Ecological Landscapes split the state into 16 relatively small sections, we believe it makes more sense to evaluate species distributions based on broader ecological themes. As such, the description of the locations of the Species of Greatest Conservation Need, though based on published species ranges and known occurrences, is best represented by Ecological Landscape.

Vertebrate Species Teams also provided the level of association between each of the vertebrate Species of Greatest Conservation Need and the 66 natural communities of Wisconsin. Surrogate prairie grasslands (sometimes referred to as surrogate grasslands) were included in this analysis. This "artificial natural community" was added to capture this community-level critical habitat for some vertebrate Species of

Greatest Conservation Need (e.g., Henslow's sparrow and surrogate prairie grasslands) that would not otherwise be noted.

Species were evaluated based on their level of association with each natural community. It is critical to note that the level of association that was assigned to each species-natural community combination represents the relative level of association of that species with the respective natural community. A description of the four levels of association is provided in the following table (Table 2-30). A numeric score was assigned to each of the levels of association to facilitate data analysis. The level of association and associated scores were assigned by the respective Species Team experts identified in Section 2.1 using literature sources, databases, communication with colleges, and personal knowledge. For example, species experts consulted the Natural Heritage Inventory Database (BIOTICS), Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), U.S. Shorebird Conservation Plan (Brown et al. 2001), Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan (Kushlan et al. 2002), Wisconsin Fishes 2000: Status and Distribution (Lyons et al. 2000), Geographic distributions of the amphibians and reptiles of Wisconsin (Casper 1996), Mammals of Wisconsin (Jackson 1961), and Mammals of the Great Lakes Region (Kurta 1995). Additional literature sources consulted during the planning process are provided in the Bibliography of this document. A matrix displaying the natural community association scores will be made available in CD format. These data may be obtained by contacting WDNR's Bureau of Endangered Resources at (608) 266-7012.

Table 2-30. Key to Natural Community Associations Assigned to Vertebrate Species of Greatest Conservation Need.

Level of Association	Score	Description
Significant	3	Species is (and/or historically was) significantly associated with the natural community, restoration of this natural community would significantly improve conditions for the species.
Moderate	2	Species is (and/or historically was) moderately associated with this natural community, restoration of this natural community would moderately improve conditions for the species.
Minimal	1	Species is (and/or historically was) only minimally associated with this natural community, restoration of this the natural community would only minimally improve conditions for the species.
Absent	0	Species does not (and did not historically) use this natural community.

The majority of species included in the habitat assessment were evaluated based on all life history requirements. However, several species were evaluated based on only one life history phase. This was done because it was determined that certain species may have a greater dependency on (a) specific natural community type(s)/Ecological Landscape(s) during distinct phases of their life cycle. Species that use different habitats to complete their life cycle to differing degrees were evaluated based on the most limiting life history requirement. These species were evaluated on either breeding, wintering, or migration habitat. For example, Le Conte's sparrow was evaluated based on its relationship with Ecological Landscapes and natural communities during its breeding phase only. Life history requirements on which species were ranked are provided in the natural community association and Ecological Landscape probability of occurrence assessment matrices that can be obtained by contacting WDNR's Bureau of Endangered Resources at (608) 266-7012.

Specific habitat requirements of individual vertebrate species were also collected and recorded. This was done in order to capture those microclimates and niche requirements of species that would not be adequately captured in tables or matrices, but would need to be considered during development of conservation actions. As much as possible, use of standard terminology was encouraged during the development of specific habitat requirement descriptions.

The Ecological Landscape and natural community relationship data for vertebrate Species of Greatest Conservation Need were examined to determine the relationships between Species of Greatest Conservation Need and their habitats. The results are presented within the Assessment and Conservation Strategies Chapter (Chapter 3).

A number of different analyses of the Species of Greatest Conservation Need-Ecological Landscape-natural community association data were conducted. For example, each species' probability of occurrence within each of the 16 Ecological Landscapes (high, moderate, low, or none) was evaluated. These results were used to generate a map that was included in each respective vertebrate Species of Greatest Conservation Need species summary (Section 3.1.2.3, 3.1.3.3, 3.1.4.3, and 3.1.5.3). These maps display species' probability of occurrence by varying color intensity. It must be noted that these maps do not show the boundaries of the known or historic ranges of vertebrate Species of Greatest Conservation Need. As previously discussed, sufficient data do not exist in a format that would allow for the timely production of scientifically defensible Wisconsin range maps for all of the vertebrate Species of Greatest Conservation Need. These maps do provide a visual representation of the probability of occurrence for the species in question for any location within that Ecological Landscape. For example, the corresponding map for the western worm snake highlights the entire Western Coulee and Ridges Ecological Landscape. However, this species has only been observed in the western half of Grant County.

To determine which natural communities are most important to a vertebrate Species of Greatest Conservation Need, a more complex analysis was conducted. This analysis summed natural community association and Ecological Landscape probability of occurrence scores for each species with the Ecological Landscape opportunity score for each community-landscape combination in which that species occurs. This summary statistic was termed ecological priority. For example, red-headed woodpecker is significantly associated with oak openings (natural community association = 3) and has a high probability of occurring in the Southeast Glacial Plains (Ecological Landscape probability of occurrence score = 3). Though oak openings are no longer extensive in the Southeast Glacial Plains, they remain important ecological opportunities for protection and/or management (Ecological Landscape opportunity score = 2). The ecological priority score for red-headed woodpecker in oak openings of the Southeast Glacial Plains is therefore 8. Red-headed woodpecker also has a high probability of occurring in the Western Prairie Ecological Landscape, but in this landscape there remain greater ecological opportunities for protection and/or management of oak openings (Ecological Landscape opportunity score = 3). The ecological priority score for red-headed woodpecker in oak openings of the Western Prairie is therefore 9, higher than in the Southeast Glacial Plains.

The highest scoring ecological priorities for each species are displayed in the table "Landscape-community Combinations of Highest Ecological Priority" in each species summary. At least 10 of the highest scoring landscape-community combinations are listed for each species. More than 10 landscape-community combinations are listed when there were "ties" between numerous landscape-community combinations. For example, if a species had 10 ecological priority scores of 9, those would be the ecological priorities listed. However, if a species had 5 ecological priority scores of 9 and 15 ecological priority scores of 8, 20 ecological priorities were listed.

Species that are habitat generalists occur in many natural communities in most Ecological Landscapes. As a result, these species may exhibit more than one hundred community-landscape combinations. The ecological priority score allows for the rapid determination of which natural communities in which Ecological Landscapes of Wisconsin represent our greatest opportunities to conserve the most important habitat for a Species of Greatest Conservation Need. This is a relative measure that is not meant for comparison between species. This score does not consider socio-economical factors that may dictate protection and/or management priorities differently than those determined solely by ecological analysis.

Further, a low ecological priority score does not imply that management or preservation should not occur on a site if there are important reasons for doing so locally.

2.5 Methodology for Identifying Habitat and Species Threats, Issues, and Conservation Actions

Threats, issues, and conservation actions were identified for habitats (natural communities within Ecological Landscapes) as well as on a species-by-species basis. The Ecosystem Management Planning Team members identified in Section 2.1 developed habitat level threats, issues, and conservation actions primarily using personal knowledge as well as literature sources such as *Ecological Landscapes of Wisconsin* (Wisconsin DNR 2004a) and Wisconsin's Biodiversity as a Management Issue (Addis et al. 1995). Habitat threats, issues, and conservation actions have been incorporated into each of the respective natural community sections of the plan (Section 3.3).

A separate process was established to identify threats, issues, and conservation actions for individual vertebrate species of Greatest Conservation Need. Species threats, issues, and conservation actions were provided by the Species Teams and other knowledgeable individuals, including Conservation Partners. The threats, issues, and conservation actions were identified using personal knowledge, literature sources, and databases. For example, individuals consulted the Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), U.S. Shorebird Conservation Plan (Brown et al. 2001), Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan (Kushlan et al. 2002), Wisconsin Fishes 2000: Status and Distribution (Lyons et al. 2000), Geographic distributions of the amphibians and reptiles of Wisconsin (Casper 1996), Mammals of Wisconsin (Jackson 1961), Mammals of the Great Lakes Region (Kurta 1995) and Natural Heritage Inventory Database (BIOTICS). Additional literature sources consulted during the planning process are provided in the Bibliography of this document.

Comments received involved both habitat related and non-habitat related threats, issues, and conservation actions. Threats, issues, and conservation actions that are relevant to a number of Species of Greatest Conservation Need within a given vertebrate taxa (birds, fish, herptiles, or mammals) appear in the introduction section for each respective taxa group in Section 3.1.1. Specific threats, issues, and conservation actions that apply to individual Species of Greatest Conservation Need are addressed within the species summaries that follow the corresponding taxa introduction.

Threats, issues, and conservation actions provided in this plan are intended to be illustrative rather than definitive and were not ranked in any way. All of the species-specific and habitat related conservation actions identified in this plan are considered to be a priority. Any species-specific or habitat related conservation action that was not determined to be a priority was not included. Important first steps in the implementation of *Wisconsin's Strategy for Wildlife Species of Greatest Conservation Need* will include working with Conservation Partners to collectively recommend priority conservation actions at a regional level and developing specific conservation action performance measures and monitoring strategies for those conservation actions.

It is important to recognize that there are some conflicting conservation actions that have been identified in this plan. At times, managing for one or several Species of Greatest Conservation Need may conflict with other Species of Greatest Conservation Need or other more common species. This is expected and ecologists and land managers have long wrestled with how best to balance the management of multiple species. When implemented, conservation actions should seek to minimize incompatibility issues to the greatest extent practicable.

Chapter 3. Vertebrate Species of Greatest Conservation Need: Assessments and Conservation Strategies

Note: This chapter has been replaced by a dynamic online version that pulls information directly from the Wildlife Action Plan database. Please see the species profiles pages.

Chapter 4. Invertebrate Species of Greatest Conservation Need: Assessments and Conservation Strategies

This chapter provides information on Wisconsin's Invertebrate Species of Greatest Conservation Need including general threats and issues (Section 4.1) and priority conservation actions (Section 4.2) that must be considered in conserving Wisconsin invertebrates, the list of Species of Greatest Conservation Need (Section 4.3), and threats, issues, and priority conservation actions by taxonomic group for the invertebrate Species of Greatest Conservation Need (Section 4.4).

4.1 General Invertebrate Threats and Issues

When considering threats and Priority Conservation Actions that need to be addressed in order to protect and conserve invertebrate species in Wisconsin, the most formidable obstacle to conservation is a lack of knowledge about the basic biology of these species. As is evident from the state of our knowledge tables (Section 2.3.2.2), there are many groups for which we cannot even compile a Wisconsin species list much less describe which species are of conservation need. In addition, the lack of information has fostered extensive public misunderstanding regarding many invertebrate species. Wisconsin is not alone, most invertebrate groups have not been studied or catalogued and basic lists of species are lacking for most taxa for most states (McCollough 1997).

Even for those invertebrates that are relatively well known, a major difficulty researchers and managers face is the lack of readily available, easy-to-use references for the accurate identification of species. This is confounded by the unstable taxonomy in many groups and the lack of investigators working on others. Most taxonomists spend years, even decades, learning the organisms, the literature, and the ecosystems in which the organisms are found. In most cases, this, unfortunately, is not a science that can be performed by amateurs. Incorrect identification leads to confusion, poor interpretation of inventory data, and ultimately, poor decisions regarding resource protection and management.

4.2 General Invertebrate Priority Conservation Actions

- Systematic and focused inventories of invertebrates should be undertaken. Often invertebrates can be collected incidental to other studies/efforts at little additional expense. Data collected should comply with DNR data collection standards and updated protocols.
    - Efforts should be made to link professional observers with non-specialists and leverage opportunities to involve citizen scientists.
- New keys for identifying Wisconsin organisms must be written by experienced taxonomists. These individuals have the background knowledge, literature collections, contacts with other taxonomists, and source materials that are vital to producing high quality reference works.
    - Efforts should be made to compile and make available catalogs of existing taxonomic and related references for Wisconsin invertebrate groups.
    - Experts throughout North America should be contacted prior to initiating work on new keys or taxonomic references to ensure that similar efforts are not underway or that major taxonomic revisions of the taxa under consideration are not forthcoming.
    - Conservation organizations should help foster the training of future taxonomists so understudied invertebrate groups can be investigated more thoroughly (e.g., land managers

could open their properties to inventory efforts, field workers could collect specimens incidental to their work, organizations could fund and publish taxonomic works).

- Consideration should be given to producing interactive computer-based "expert" systems, simultaneously with printed keys/references so that the accuracy of identification by non-specialists can be improved.

- Further define what we need to know to conserve invertebrates (e.g., additional aspects of life history, genetics, etc.) and better determine what we already do know (e.g., consolidate available information on individual or groups of Species of Greatest Conservation Need).

    - Refine methodologies for assessing status and conservation priorities for invertebrate species.

- Additional attention should be focused on groups for which adequate taxonomic references do not exist and for which little zoogeographical or life history information is available.

- Develop management guidelines and best management practices that can be applied to the conservation and management of invertebrate Species of Greatest Conservation Need. Such practices could be applied on both public and private lands.

- Efforts should be made to integrate fully invertebrate Priority Conservation Actions into site planning and land management activities, especially where state or federally listed species are involved. This will require concerted efforts to share data and information with a broader audience.

- Undertake information, education, and media efforts to foster awareness and knowledge regarding the important roles invertebrates play in natural systems and create opportunities for natural resources professionals, citizens, local governments, and other public entities to be involved in invertebrate protection and conservation efforts.

- Develop and implement recovery plans for those invertebrate Species of Greatest Conservation Need that have limited opportunities to remain viable in Wisconsin without meaningful intervention.

4.3 Invertebrate Species of Greatest Conservation Need

Five hundred and thirty invertebrate species have been identified as Species of Greatest Conservation Need in Wisconsin. Species of Greatest Conservation Need are divided into three broad taxonomic groups: Nonarthropod invertebrates (Table 4-1), Noninsect arthropods (Table 4-2), and Insects (Table 4-3).

Table 4-1. Invertebrate Species of Greatest Conservation Need: Nonarthropod Invertebrates

Scientific Name	Common Name	Number of Species in Group
Mollusca: Gastropoda		**Count: 31**
Catinella exile	Pleistocene Catinella	
Catinella gelida	A Land Snail	
Cochlicopa morseana	Appalachian Pillar	
Euchemotrema hubrichti	Carinate Pillsnail	
Gastrocopta procera	Wing Snaggletooth	
Glyphyalinia rhoadsi	Sculpted Glyph	
Glyphyalinia wheatleyi	Bright Glyph	
Guppya sterkii	Brilliant Granule	

Table 4-1 *continued*

Scientific Name	Common Name	Number of Species in Group
Mollusca: Gastropoda, continued		
Hendersonia occulta	Cherrystone Drop	
Hoyia sheldoni	Storm Hydrobe	
Paravitrea multidentata	Dentate Supercoil	
Physella magnalacustris	Great Lakes Physa	
Physella parkeri	A snail	
Planogyra asteriscus	Eastern Flat-whorl	
Striatura ferrea	Black Striate	
Strobilops aeneus	Bronze Pinecone	
Strobilops affinis	Eightfold Pinecone	
Valvata winnebagoensis	Flanged Valvata	
Vertigo bollesiana	Delicate Vertigo	
Vertigo brierensis	Briarton Pleistocene Snail	
Vertigo hubrichti	Midwest Pleistocene Vertigo	
Vertigo hubrichti hubrichti	A Land Snail	
Vertigo hubrichti variabilis	A Land Snail	
Vertigo iowaensis	Iowa Pleistocene Vertigo	
Vertigo morsei	Six-whorl Vertigo	
Vertigo nylanderi	Deep-throated Vertigo	
Vertigo occulta	Occult Vertigo	
Vertigo paradoxa	Mystery Vertigo	
Vitrina angelicae	Transparent Vitrine Snail	
Zonitoides limatulus	Dull Gloss	
Zoogenetes harpa	Boreal Top	
Mollusca: Pelecypoda		**Count: 26**
Alasmidonta viridis	Slippershell Mussel	
Anodonta suborbiculata	Flat Floater	
Arcidens confragosus	Rock Pocketbook	
Cumberlandia monodonta	Spectacle Case	
Cyclonaias tuberculata	Purple Wartyback	
Ellipsaria lineolata	Butterfly	
Elliptio crassidens	Elephant Ear	
Epioblasma triquetra	Snuffbox	
Fusconaia ebena	Ebony Shell	
Lampsilis higginsii	Higgins' Eye	
Lampsilis teres	Yellow & Slough Sandshells	
Lampsilis teres teres	Slough Sandshell	
Leptodea leptodon	Scaleshell	
Plethobasus cyphyus	Bullhead	
Pleurobema rubrum	Pyramid Pigtoe	
Potamilus capax	Fat Pocketbook	
Potamilus ohiensis	Pink Papershell	
Quadrula fragosa	Winged Mapleleaf	
Quadrula metanevra	Monkeyface	
Quadrula nodulata	Wartyback	
Quadrula quadrula	Mapleleaf	
Simpsonaias ambigua	Salamander Mussel	
Tritogonia verrucosa	Buckhorn	
Truncilla donaciformis	Fawnsfoot	
Venustaconcha ellipsiformis	Ellipse	
Villosa iris	Rainbow Shell	
Annelida: Polychaeta		**Count: 1**
Manayunkia speciosa		

Table 4-2. Invertebrate Species of Greatest Conservation Need: Noninsect Arthropods

Scientific Name	Common Name	Number of Species in Group
Crustacea: Anostraca		**Count: 3**
Eubranchipus bundyi	A fairy shrimp	
Eubranchipus ornatus	A fairy shrimp	
Eubranchipus serratus	A fairy shrimp	
Crustacea: Conchostraca		**Count: 1**
Lynceus brachyurus	Holartic Clam Shrimp	
Crustacea: Copepoda		**Count: 4**
Aglaodiaptomus leptomus	A copepod	
Aglaodiaptomus stagnalis	A copepod	
Onychodiaptomus birgei	A copepod	
Limnocalanus macrunus	A copepod	
Crustacea: Isopoda		**Count: 1**
Lirceus lineatus	An aquatic sow bug	
Crustacea: Amphipoda		**Count: 3**
Crangonyx minor	A Side-swimmer	
Crangonyx richmondensis	A Side-swimmer	
Stygobromus putealis	Wisconsin Well Amphipod	
Crustacea: Decapoda		**Count: 4**
Orconectes immunis	Calico Crayfish	
Palaemonetes kadiakensis	Mississippi Grass Shrimp	
Procambarus acutus	White River Crayfish	
Procambarus gracilis	Prairie Crayfish	
Arachnida: Araneae		**Count: 6**
Araneus groenlandicolus	An orb-web spider	
Marpissa grata	A spider	
Paradamoetas fontana	A Jumping Spider	
Phidippus apacheanus	A jumping spider	
Sassacus papenhoei	A spider	
Sphodros niger	A purse-web spider	

Table 4-3. Invertebrate Species of Greatest Conservation Need: Insects

Scientific Name	Common Name	Number of Species in Group
Insecta: Ephemeroptera		**Count: 54**
Acanthametropus pecatonica	Pecatonica River Mayfly	
Ameletus lineatus		
Anepeorus simplex	Wallace's Deepwater Mayfly	
Arthroplea bipunctata		
Baetisca obesa	An Armored Mayfly	
Brachycercus nasutus	A Small Square-gilled Mayfly	
Caenis anceps	A Small Square-gilled Mayfly	
Caenis diminuta	A Small Square-gilled Mayfly	
Caenis hilaris	A Small Square-gilled Mayfly	
Caenis punctata	A Small Square-gilled Mayfly	
Caenis tardata	A Small Square-gilled Mayfly	
Caenis youngi	A Small Square-gilled Mayfly	
Callibaetis pallidus	A Mayfly	
Callibaetis skokianus	A Mayfly	
Centroptilum conturbatum	A Small Minnow Mayfly	
Centroptilum triangulifer	A Small Minnow Mayfly	
Centroptilum victoriae	A Small Minnow Mayfly	
Centroptilum walshi	A Small Minnow Mayfly	
Danella lita	A Spiny Crawler	
Diphetor hageni	A Small Minnow Mayfly	
Dolania americana	American Sand Burrowing	
Drunella cornuta	A Spiny Crawler	
Drunella cornutella	A Spiny Crawler	
Ephemerella catawba	A Spiny Crawler	
Eurylophella aestiva	A Spiny Crawler	
Heptagenia pulla	A Flat-headed Mayfly	
Hexagenia atrocaudata	A Common Burrower Mayfly	
Hexagenia rigida	A Common Burrower Mayfly	
Homoeoneuria ammophila	A Brush-legged Mayfly	
Leucrocuta maculipennis	A Flat-headed Mayfly	
Macdunnoa persimplex	A Flat-headed Mayfly	
Metretopus borealis	A Cleft-footed Minnow Mayfly	
Neoephemera bicolor	A Large Squaregill	
Nixe inconspicua	A Flat-headed Mayfly	
Paracloeodes minutus	A Small Minnow Mayfly	
Parameletus chelifer	A Primitive Minnow Mayfly	
Pentagenia vittigera	A Common Burrower Mayfly	
Plauditus cestus	A Small Minnow Mayfly	
Plauditus cingulatus	A Small Minnow Mayfly	
Procloeon bel lum	A Small Minnow Mayfly	
Procloeon convexum	A Small Minnow Mayfly	
Procloeon irrubrum	A Small Minnow Mayfly	
Procloeon pennulatum	A Small Minnow Mayfly	
Procloeon rubropictum	A Small Minnow Mayfly	
Procloeon rufostrigatum	A Small Minnow Mayfly	
Procloeon simplex	A Small Minnow Mayfly	
Pseudiron centralis	A Flat-headed Mayfly	
Pseudocentroptiloides usa	A Small Minnow Mayfly	
Pseudocloeon dardanum		
Pseudocloeon longipalpus		
Rhithrogena impersonata	A Flat-headed Mayfly	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Ephemeroptera, Continued		
Rhithrogena jejuna	A Flat-headed Mayfly	
Rhithrogena undulata	A Flat-headed Mayfly	
Serratella serrata	A Spiny Crawler	
Insecta: Odonata		**Count: 42**
Aeshna clepsydra	Mottled Darner	
Aeshna mutata	Spatterdock Darner	
Aeshna sitchensis	Zigzag Darner	
Aeshna sitchensis	Zigzag Darner	
Aeshna subarctica	Subarctic Darner	
Amphiagrion saucium	Eastern Red Damsel	
Anax longipes	Comet Darner	
Argia plana	Highland Dancer	
Arigomphus submedianus	Jade Clubtail	
Arigomphus villosipes	Unicorn Clubtail	
Coenagrion interrogatum	Subarctic Bluet	
Cordulegaster diastatops	Delta-spotted Spiketail	
Enallagma anna	River Bluet	
Enallagma clausum	Alkali Bluet	
Enallagma traviatum	Slender Bluet	
Enallagma vernale	Gloyd's Bluet	
Epiaeschna heros	Swamp Darner	
Gomphaeschna furcillata	Harlequin Darner	
Gomphus exilis	Lancet Clubtail	
Hetaerina titia	Dark Rubyspot	
Ischnura hastata	Citrine Forktail	
Ischnura kellicotti	Lilypad Forktail	
Ischnura posita	Fragile Forktail	
Libellula cyanea	White-spangled Skimmer	
Libellula incesta	Slaty Skimmer	
Libellula semifasciata	Painted Skimmer	
Libellula vibrans	Great Blue Skimmer	
Macromia pacifica	Gilded River Cruiser	
Macromia taeniolata	Royal River Cruiser	
Nannothemis bella	Elfin Skimmer	
Nehalennia gracilis	Sphagnum Sprite	
Ophiogomphus howei	Pygmy Snaketail	
Ophiogomphus smithi	Sand Snaketail	
Ophiogomphus susbehcha	Saint Croix Snaketail	
Somatochlora cingulata	Lake Emerald	
Somatochlora ensigera	Lemon-faced Emerald	
Somatochlora forcipata	Forcipate Emerald	
Somatochlora hineana	Hine's Emerald	
Somatochlora incurvata	Warpaint Emerald	
Somatochlora tenebrosa	Clamp-tipped Emerald	
Tramea carolina	Violet-masked Glider	
Williamsonia lintneri	Ringed Boghaunter	
Insecta: Plecoptera		**Count: 12**
Allocapnia frisoni	Evansville Snowfly	
Amphinemura linda	Lovely Forestfly	
Attaneuria ruralis	Giant Stone	
Clioperla clio	Clio Stripetail	
Haploperla orpha	Quadrate Sallfly	
Isogenoides olivaceus	Olive Springfly	
Leuctra ferruginea	Eastern Needlefly	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Plecoptera, Continued		
Paracapnia opis	Northeastern Snowfly	
Perlinella ephyre	Vernal Stone	
Shipsa rotunda	Intrepid Forestfly	
Soyedina vallicularia	Valley Forestfly	
Zealeuctra narfi	Northern Needlefly	
Insecta: Orthoptera		**Count: 42**
Aeropedellus clavatus	Club-horned Grasshopper	
Arphia conspersa	Speckled Rangeland Grasshopper	
Arphia simplex	A Grasshopper	
Arphia xanthoptera	Yellow-winged Grasshopper	
Booneacris glacialis	Wingless Mountain Grasshopper	
Camnula pellucida	Clear-winged Grasshopper	
Chloealtis abdominalis	Rocky Mountain Sprinkled	
Dendrotettix quercus	Post-oak Grasshopper	
Dichromorpha viridis	Short-winged Grasshopper	
Encoptolophus costalis	Dusky Grasshopper	
Eritettix simplex	Velvet-striped Grasshopper	
Hesperotettix speciosus	A Grasshopper	
Hesperotettix viridis	Green-streak Grasshopper	
Melanoplus benni		
Melanoplus bruneri	Bruner's Spur-throat Grasshopper	
Melanoplus fasciatus	Huckleberry Spur-throat Grasshopper	
Melanoplus foedus	A Spur-throat Grasshopper	
Melanoplus gladstoni	Gladston's Spur-throat	
Melanoplus punctulatus griseus		
Melanoplus rusticus	A Spur-throat Grasshopper	
Melanoplus scudderi	Scudder's Short-winged Grasshopper	
Melanoplus stonei	Stone's Locust	
Mermiria bivittata	Mermiria Grasshopper	
Neoconocephalus lyristes	Bog Conehead	
Neoconocephalus robustus	Crepitating Conehead	
Opeia obscura	Obscure Grasshopper	
Orchelimum delicatum	Delicate Meadow Katydid	
Orphulella pelidna	Spotted-winged Grasshopper	
Paratylotropidia brunneri	An Acridid Grasshopper	
Pardalophora haldemani	Haldmen's Grasshopper	
Phoetaliotes nebrascensis	Large-headed Grasshopper	
Psinidia fenestralis	Sand Locust	
Schistocerca damnifica		
Scudderia fasciata	Black-striped Katydid	
Spharagemon marmorata	Northern Marbled Locust	
Stethophyma gracile	Northern Sedge Locust	
Stethophyma lineatum	Striped Sedge Grasshopper	
Syrbula admirabilis	Handsome Grasshopper	
Trachyrhachys kiowa	Ash-brown Grasshopper	
Trimerotropis huroniana	Lake Huron Locust	
Trimerotropis maritima	Seaside Grasshopper	
Trimerotropis verruculata	Crackling Forest Grasshopper	
Insecta: Heteroptera (Hemiptera, Homoptera)		**Count: 54**
Aflexia rubranura	Red-tailed Prairie Leafhopper	
Amplicephalus kansiensis	A Leafhopper	
Aphelonema simplex		
Attenuipyga vanduzeei	A Leafhopper	
Buenoa limnocastoris	A Backswimmer	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Heteroptera, Continued		
Buenoa macrotibialis	A Backswimmer	
Cenocorixa dakotensis	A Water Boatman	
Cenocorixa utahensis	A Water Boatman	
Corisella edulis	A Water Boatman	
Cuerna sayi		
Cymatia americana	A Water Boatman	
Dasycorixa hybrida	A Water Boatman	
Destria crocea	A Leafhopper	
Driotura robusta		
Fitchiella robertsoni		
Flexamia prairiana	A Leafhopper	
Gerris marginatus	A Water Strider	
Hebrus buenoi	A Velvet Waterbug	
Hebrus burmeisteri	A Velvet Water Bug	
Hesperocorixa interrupta	A Water Boatman	
Hesperocorixa laevigata	A Water Boatman	
Hesperocorixa lobata	A Water Boatman	
Hesperocorixa lucida	A Water Boatman	
Hesperocorixa obliqua	A Water Boatman	
Hesperocorixa semilucida	A Water Boatman	
Hydrometra martini	A Water Measurer	
Laevicephalus vannus	A Leafhopper	
Lethocerus griseus	A Giant Water Bug	
Limotettix elegans	A Leafhopper	
Limotettix pseudosphagneticus	A Leafhopper	
Memnonia panzeri		
Microvelia albonotata	A Broad-shouldered Water Strider	
Microvelia fontinalis	A Broad-shouldered Water Strider	
Neogerris hesione	A Water Strider	
Nepa apiculata	A Water Scorpion	
Notonecta borealis	A Backswimmer	
Paraphilaenus parallelus	A Spittle Bug	
Paraphlepsius maculosus	A Leafhopper	
Pelocoris femorata	A Creeping Water Bug	
Polyamia dilata	Net-veined Leafhopper	
Prairiana angustens	A Leafhopper	
Prairiana cinerea	A Leafhopper	
Prairiana kansana	A Leafhopper	
Ramphocorixa acuminata	A Water Boatman	
Ranatra kirkaldyi	A Water Scorpion	
Ranatra nigra	A Water Scorpion	
Sigara dolabra	A Water Boatman	
Sigara macropala	A Water Boatman	
Sigara transfigurata	A Water Boatman	
Sigara variabilis	A Water Boatman	
Trepobates knighti	A Water Strider	
Trepobates pictus	A Water Strider	
Trichocorixa kanza	A Water Boatman	
Insecta: Coleoptera		**Count: 154**
Acilius mediatus	A Predaceous Diving Beetle	
Agabetes acuductus	A Water Scavenger Beetle	
Agabus aeruginosus	A Predaceous Diving Beetle	
Agabus bicolor	A Predaceous Diving Beetle	
Agabus canadensis	A Predaceous Diving Beetle	
Agabus confinis	A Predaceous Diving Beetle	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Coleoptera, Continued		
Agabus discolor	A Predaceous Diving Beetle	
Agabus disintegratus	A Predaceous Diving Beetle	
Agabus immaturus	A Predaceous Diving Beetle	
Agabus inscriptus	A Predaceous Diving Beetle	
Agabus leptapsis	A Predaceous Diving Beetle	
Berosus aculeatus	A Water Scavenger Beetle	
Berosus infuscatus	A Water Scavenger Beetle	
Berosus pantherinus	A Water Scavenger Beetle	
Berosus stylifer	A Water Scavenger Beetle	
Celina hubbelli	A Predaceous Diving Beetle	
Cicindela hirticollis hirticollis	A Tiger Beetle	
Cicindela hirticollis rhodensis	Beach-dune Tiger Beetle	
Cicindela lepida	Little White Tiger Beetle	
Cicindela limbalis transversa	A Tiger Beetle	
Cicindela longilabris	A Tiger Beetle	
Cicindela macra	A Tiger Beetle	
Cicindela patruela huberi	A Tiger Beetle	
Cicindela patruela patruela	A Tiger Beetle	
Colaspis suggona		
Collops vicarius	A Melyrid Beetle	
Copelatus chevrolati	A Predaceous Diving Beetle	
Copelatus glyphicus	A Predaceous Diving Beetle	
Crenitis digestus	A Water Scavenger Beetle	
Cymbiodyta acuminata	A Water Scavenger Beetle	
Cymbiodyta blanchardi	A Water Scavenger Beetle	
Cymbiodyta chamberlaini	A Water Scavenger Beetle	
Cymbiodyta semistriata	A Water Scavenger Beetle	
Cymbiodyta toddi	A Water Scavenger Beetle	
Dubiraphia bivittata	A Dubiraphian Riffle Beetle	
Dubiraphia robusta	Robust Dubiraphian Riffle Beetle	
Dytiscus alaskanus	A Predaceous Diving Beetle	
Dytiscus carolinus	A Predaceous Diving Beetle	
Dytiscus dauricus	A Predaceous Diving Beetle	
Ectopria sp. 2	A False Water Penny Beetle	
Enochrus collinus	A Water Scavenger Beetle	
Enochrus consortus	A Water Scavenger Beetle	
Enochrus diffusus	A Water Scavenger Beetle	
Enochrus perplexus	A Water Scavenger Beetle	
Enochrus sayi	A Water Scavenger Beetle	
Graphoderus manitobensis	A Predaceous Diving Beetle	
Gymnocthebius nitidus	A Minute Moss Beetle	
Gyrinus confinis	A Whirlygig Beetle	
Gyrinus gehringi	A Whirlygig Beetle	
Gyrinus impressicollis	A Whirlygig Beetle	
Gyrinus parcus	A Whirlygig Beetle	
Gyrinus pectoralis	A Whirlygig Beetle	
Gyrinus sayi	A Whirlygig Beetle	
Haliplus apostolicus	A Crawling Water Beetle	
Haliplus canadensis	A Crawling Water Beetle	
Haliplus fasciatus	A Crawling Water Beetle	
Haliplus fulvus (=subguttatus)	A Crawling Water Beetle	
Haliplus leopardus	A Crawling Water Beetle	
Haliplus nitens	A Crawling Water Beetle	
Haliplus pantherinus	A Crawling Water Beetle	
Haliplus tortilipenis	A Crawling Water Beetle	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Coleoptera, Continued		
Helocombus bifidus	A Water Scavenger Beetle	
Helophorus latipenis	A Water Scavenger Beetle	
Helophorus oblongus	A Water Scavenger Beetle	
Helophorus orchymonti	A Water Scavenger Beetle	
Hydraena angulicollis	A Minute Moss Beetle	
Hydraena pennsylvanica	A Minute Moss Beetle	
Hydrobius melaenum	A Water Scavenger Beetle	
Hydrocanthus iricolor	A Burrowing Water Beetle	
Hydrochara leechi	A Water Scavenger Beetle	
Hydrochara spangleri	A Water Scavenger Beetle	
*Hydrochus brevitars*is	A Water Scavenger Beetle	
Hydrochus currani	A Water Scavenger Beetle	
Hydrochus granulatus	A Water Scavenger Beetle	
Hydrochus rufipes	A Water Scavenger Beetle	
Hydrochus scabratus	A Water Scavenger Beetle	
Hydrochus setosus	A Water Scavenger Beetle	
Hydrochus subcupreus	A Water Scavenger Beetle	
Hydrocolus persimilis	A Predaceous Diving Beetle	
Hydrocolus rubyae	A Predaceous Diving Beetle	
Hydroporus columbianus	A Predaceous Diving Beetle	
Hydroporus dichrous	A Predaceous Diving Beetle	
Hydroporus hybridus	A Predaceous Diving Beetle	
Hydroporus morio	A Predaceous Diving Beetle	
Hydroporus nigellus	A Predaceous Diving Beetle	
Hydroporus obscurus	A Predaceous Diving Beetle	
Hydroporus pseudovilis	A Predaceous Diving Beetle	
Hydroporus pseudovilis	A Predaceous Diving Beetle	
Hydroporus pulcher	A Predaceous Diving Beetle	
Hydroporus stagnalis	A Predaceous Diving Beetle	
Hydroporus tartaricus	A Predaceous Diving Beetle	
Hydroporus vittatus	A Predaceous Diving Beetle	
Hydroporus wickhami	A Predaceous Diving Beetle	
Hygrotus acaroides	A Predaceous Diving Beetle	
Hygrotus compar	A Predaceous Diving Beetle	
Hygrotus falli	A Predaceous Diving Beetle	
Hygrotus farctus	A Predaceous Diving Beetle	
Hygrotus marklini	A Predaceous Diving Beetle	
Hygrotus patruelis	A Predaceous Diving Beetle	
Hygrotus sylvanus	A Predaceous Diving Beetle	
Ilybius angustior	A Predaceous Diving Beetle	
Ilybius gagates	A Predaceous Diving Beetle	
Ilybius ignarus	A Predaceous Diving Beetle	
Ilybius incarinatus	A Predaceous Diving Beetle	
Ilybius picipes	A Predaceous Diving Beetle	
Ilybius pleuriticus	A Predaceous Diving Beetle	
Ilybius subaeneus	A Predaceous Diving Beetle	
Ilybius wasastjernae	A Predaceous Diving Beetle	
Laccobius agilis	A Water Scavenger Beetle	
Laccobius minutoides	A Water Scavenger Beetle	
Laccobius reflexipenis	A Water Scavenger Beetle	
Laccobius truncatipennis	A Water Scavenger Beetle	
Laccophilus undatus	A Predaceous Diving Beetle	
Laccornis deltoides	A Predaceous Diving Beetle	
Laccornis latens	A Predaceous Diving Beetle	
Liodessus cantralli	Cantrall's Bog Beetle	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Coleoptera, Continued		
Liodessus flavicollis	A Predaceous Diving Beetle	
Lioporeus triangularis	A Predaceous Diving Beetle	
Lutrochus laticeps		
Matus bicarinatus	A Predaceous Diving Beetle	
Matus ovatus	A Predaceous Diving Beetle	
Megacephala virginica	Virginia Big-headed Tiger Beetle	
Microcylloepus pusillus	An Elmid Beetle	
Nebrioporus rotundatus	A Predaceous Diving Beetle	
Neoporus superioris	A Predaceous Diving Beetle	
Neoporus tennetum	A Predaceous Diving Beetle	
Neoscutopterus angustus	A Predaceous Diving Beetle	
Neoscutopterus hornii	A Predaceous Diving Beetle	
Nicrophorus americanus	American Burying Beetle	
Ochthebius lineatus	A Minute Moss Beetle	
Oreodytes scitulus	A Predaceous Diving Beetle	
Platambus confusus	A Predaceous Diving Beetle	
Postelichus lithophilus	A Long-toed Riffle Beetle	
Rhantus gutticollis	A Predaceous Diving Beetle	
Rhantus sericans	A Predaceous Diving Beetle	
Rhantus sinuatus	A Predaceous Diving Beetle	
Saxinis omogera		
Sperchopsis tessellatus	A Water Scavenger Beetle	
Stenelmis antennalis	A Riffle Beetle	
Stenelmis bicarinata	A Riffle Beetle	
Stenelmis cheryl	A Riffle Beetle	
Stenelmis douglasensis	Douglas Stenelmis Riffle Beetle	
Stenelmis fuscata	A Riffle Beetle	
Stenelmis knobeli	Knobel's Riffle Beetle	
Stenelmis mera	A Riffle Beetle	
Stenelmis musgravei	A Riffle Beetle	
Stenelmis quadrimaculata	A Riffle Beetle	
Stenelmis sandersoni	A Riffle Beetle	
Stenelmis sexlineata	A Riffle Beetle	
Suphisellus puncticollis		
Thermonectes basilaris	A Predaceous Diving Beetle	
Thermonectes ornaticollis	A Predaceous Diving Beetle	
Tropisternus ellipticus	A Water Scavenger Beetle	
Insecta: Trichoptera		**Count: 37**
Agapetus hessi	A Saddle Casemaker Caddisfly	
Agarodes distinctus		
Banksiola dossuaria	A Giant Casemaker Caddisfly	
Beothukus complicatus	A Giant Casemaker Caddisfly	
Brachycentrus incanus	A Humpless Casemaker Caddisfly	
Brachycentrus lateralis	A Humpless Casemaker Caddisfly	
Fabria inornata	A Giant Casemaker Caddisfly	
Hagenella canadensis	A Giant Casemaker Caddisfly	
Hydropsyche arinale	A Netspinning Caddisfly	
Hydropsyche bidens	A Netspinning Caddisfly	
Hydropsyche cuanis	A Netspinning Caddisfly	
Hydropsyche leonardi	A Netspinning Caddisfly	
Hydropsyc he phalerata	A Netspinning Caddisfly	
Hydroptila valhalla	A Micro Caddisfly	
Hydroptila virgata	A Micro Caddisfly	
Lepidostoma costale	A Lepidostomatid Caddisfly	
Lepidostoma griseum	A Lepidostomatid Caddisfly	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Trichoptera, Continued		
Lepidostoma libum	A Lepidostomatid Caddisfly	
Lepidostoma prominens	A Lepidostomatid Caddisfly	
Lepidostoma vernale	A Lepidostomatid Caddisfly	
Limnephilus janus	A Northern Casemaker Caddisfly	
Limnephilus parvulus	A Northern Casemaker Caddisfly	
Limnephilus perpusillus	A Northern Casemaker Caddisfly	
Limnephilus rossi	A Northern Casemaker Caddisfly	
Limnephilus sericeus	A Northern Casemaker Caddisfly	
Ochrotrichia riesi	A Purse Casemaker Caddisfly	
Oecetis nocturna	A Long-horned Casemaker Caddisfly	
Oxyethira anabola	A Micro Caddisfly	
Oxyethira serrata	A Milk-bottle micro caddisfly	
Polycentropus glacialis	A Trumpet-net Caddisfly	
Polycentropus weedi	A Trumpet-net Caddisfly	
Psilotreta indecisa	A Strong Casemaker Caddisfly	
Rhyacophila lobifera	A Free-linving Caddisfly	
Rhyacophila vibox	A Free-linving Caddisfly	
Triaenodes nox	A Long-horned Casemaker Caddisfly	
Wormaldia moesta	A Fingernet Caddisfly	
Wormaldia shawnee	A Fingernet Caddisfly	
Insecta: Lepidoptera		**Count: 46**
Boloria chariclea	Arctic Fritillary	
Boloria freija	Freija Fritillary	
Boloria frigga	Frigga Fritillary	
Boloria frigga saga	Frigga Fritillary	
Calephelis muticum	Swamp Metalmark	
Callophrys irus	Frosted Elfin	
Catocala coelebs	Old Maid Underwing Moth	
Catocala semirelicta	Semirelict Underwing Moth	
Catocala whitneyi	Whitney's Underwing Moth	
Copablepharon longipenne	A Noctuid Moth	
Erebia discoidalis	Red-disked Alpine	
Erynnis baptisiae	Wild Indigo Dusky Wing	
Erynnis lucilius	Columbine Dusky Wing	
Erynnis martialis	Mottled Dusky Wing	
Erynnis persius	Persius Dusky Wing	
Erynnis persius persius	Persius Dusky Wing	
Euchlaena milnei	A Looper Moth	
Exyra fax	Pitcher Plant Moth	
Faronta rubripennis	Pink-streak	
Grammia oithona	Pithona Tiger Moth	
Hemaris gracilis	Graceful Clearwing	
Hemileuca sp. 3	Midwestern Fen Buckmoth	
Hesperia metea	Cobweb Skipper	
Hesperia ottoe	Ottoe Skipper	
Lacinipolia implicata		
Lycaeides idas	Northern Blue	
Lycaeides melissa samuelis	Karner Blue	
Lycaena dione	Gray Copper	
Macrochilo bivittata	An Owlet Moth	
Oarisma powesheik	Powesheik Skipperling	
Oeneis chryxus	Chryxus Arctic	
Papaipema beeriana	Liatris Borer Moth	
Papaipema silphii	Silphium Borer Moth	
Pieris virginiensis	West Virginia White	

Table 4-3 *continued*

Scientific Name	Common Name	Number of Species in Group
Insecta: Lepidoptera, Continued		
Plebeius saepiolus	Greenish Blue	
Pompeius verna	Little Glassy Wing	
Problema byssus	Byssus Skipper	
Psectraglaea carnosa	Pink Sallow	
Ptichodis bistrigata	A Noctuid Moth	
Pygarctia spraguei	Sprague's Pygarctica	
Richia sp. 1	A Noctuid Moth	
Satyrium caryaevorum	Hickory Hairstreak	
Satyrodes eurydice fumosa	Smokey Eyed Brown	
Schinia bina	Bina Flower Moth	
Schinia indiana	Phlox Moth	
Speyeria idalia	Regal Fritillary	
Insecta: Diptera		**Count: 9**
Blepharicera sp. A	Net-winged Midge	
Blepharicera tenuipes	Net-winged Midge	
Lasiodiamesa sp. or spp.	A Midge	
Parochlus kiefferi	A Midge	
Phalacrocera replicata	A Crane Fly	
Phalacrocera tipulina	A Crane Fly	
Protanypus sp. or spp.	A Midge	
Pseudodiamesa pertinax ?	A Midge	
Ulomorpha sp.	A Crane Fly	

4.4 Threats, Issues, and Priority Conservation Actions by Taxonomic Group

In this section, threats, issues, and priority conservation actions specific to species or species groups are highlighted. These listings of threats and priority conservation actions, however, should be considered illustrative rather than definitive and should be recognized as being specific to the species considered of greatest conservation need, not the entire group to which they belong. Conservation planning for vertebrates can be done at the habitat, landscape, and ecoregional scales. Planning at these scales, however, lacks relevance to most invertebrates, which often have specific microhabitat requirements that can not be addressed adequately at these broader scales. Consequently, readers will not find invertebrates discussed in the habitat sections of this *Strategy.* In addition, the threats and priority conservation actions included in this section focus more on the species and less on their habitats.

Mollusca: Gastropoda (Snails)

The following threats, issues, and conservation actions apply only to terrestrial snails as only land snails are included on the list of Species of Greatest Conservation Need. Aquatic gastropod species are considered as either category 2 or category 4 (see chapter 6 for additional information on these categories).

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Land snails occupy a variety of habitats, but usually prefer sites with shelter, moisture, food, and an available source of lime. Forested river valleys and sites with limestone outcrops

support the most diverse snail assemblages. Several land snail species are closely associated with algific (cold-producing) slopes in the Driftless Area of western Wisconsin. Others occupy similar sites along the Niagara Escarpment in eastern Wisconsin. These habitats are threatened by a variety of factors, including:

- overgrazing and erosion of fragile slopes caused by pasturing animals,
- building of access roads to hilltop agricultural fields or forest management sites,
- quarrying,
- contamination of karst features from surface water runoff,
- recreation trails when placed adjacent cliff bases (trampling can cause compaction of the litter layer where snails live, as well as crushing the animals themselves), and
- development along the bluff tops or in the valleys and removal of vegetation on the slopes.

Invasive Animal Species

- Introduced nonnative gastropods may compete with native gastropods for habitat or may prey upon native species.

Priority Conservation Actions

- Conduct population monitoring and basic life history research.
- Preserve habitat and protect from human disturbance those unique sites currently occupied by snails.
- Maintain natural forest cover to protect surface areas that drain into fissures and minimize opportunities for pesticide infiltration and physical blockage of sinkholes.
- Maintain corridors connecting occupied sites to prevent isolating populations.

Mollusca: Pelecypoda (Mussels)

Threats and Issues

Lack of Information

- Larval hosts and host relationships is incomplete.
- Water quality impacts have not been adequately studied on adult and larval stages.
- Species specific habitat requirements are poorly known.
- Specific causes of large scale (continental) declines are only partially understood.

Alteration of Ecological Processes

Changes in land use patterns have altered the natural hydrologic regimes of some river systems. These changes cause:

- unstable physical habitat alterations (e.g., fluctuating river current velocities, shear stress, altered temperature and water chemistry regimes) that long-lived mussels are unable to adapt to, and
- changes in fish host communities and fish host abundance,

Dams create unnatural conditions that few riverine mussel species are able to tolerate by:

- slowing or stopping the flow of water that mussels need to bring food to them and carry their wastes away,
- restricting fish movements and migrations, thus limiting access to hosts during a critical stage in the mussels' life cycles,
- causing changes in water temperatures and dissolved oxygen concentrations in impoundments and tail waters,

- causing fluctuating water levels that can leave mussels stranded above the water surface,
- creating hydrologic instability (e.g., currents that move or cover mussel beds and sweep mussels onto shifting sandbars where they are smothered), and
- causing increased sediment containment behind the dam which buries mussel beds.

Siltation, primarily from nonpoint source pollution, poses one of the most significant threats to the continued health of Wisconsin mussel populations.

- Heavy sedimentation can bury once suitable habitats along with glochidia (larvae) and resident adult mussels.
- Increased turbidity can result in reduced food supplies and lower oxygen supplies.
- Sediments transport other pollutants of concern (e.g., chemicals and toxins, excess nutrients) that can affect mussel health and longevity.

Water Pollution

Many mussels are highly sensitive to changes in water quality.

- Changes in water hardness, alkalinity, pH, temperature, and dissolved oxygen concentrations can impact mussel populations negatively.
- Many mussels are sensitive to chemical pollutants (e.g. heavy metals, agricultural pesticides, etc.).

Invasive Animal Species

The nonnative zebra mussel and Asiatic clam pose a significant threat to native mussel populations.

- Nonnative zebra mussels colonize the shells of native mussels.
- Zebra mussels compete with native mussels for food resources and may limit reproduction. Asiatic clam may also pose similar threats to native species.

Over-harvesting

Impacts of mussel harvesting include:

- reduction of breeding stock to levels exceeding their maximum sustainable harvest rate (e.g., where reproduction does not offset mortality),
- wasteful death of individuals—especially juveniles—below useful or legal size limits,
- abortion of glochidia by gravid females when disturbed,
- death of adults that are unable to rebury themselves after being uprooted, and
- disruption and destruction of stream and river beds.

Loss of Vertebrate (primarily fish) Hosts

- Loss of larval host species appears to have eliminated some mussel species from some river systems.
- Use of alternative host species may only be marginally successful.

<u>Priority Conservation Actions</u>

- Continue or expand legal protection and monitor harvest.
- Conduct population monitoring and basic life history research.
- Evaluate impacts of changes in water quality and hydrologic dynamics to mussel populations.

- Restore natural hydrologic regimes by removing dams, modifying dam operations, preventing and mitigating nonpoint source pollution, and addressing watershed land use practices.
- Control and manage invasive species; prevent future introductions of nonnative species.
- Consider larval host fish species in fish community management efforts.
- Develop and implement species recovery plans for listed mussel species.
- Apply site specific management for highly localized populations.
- Augment populations or establish species at additional sites (e.g., historic sites).
- Develop and apply general habitat management guidelines.

Many threatened mussel species continue to produce large numbers of viable glochidia (larvae). Therefore, it is logical to suspect that the availability of host species and the survival of the early juvenile stages may be critical issues for the continued survival of some species. Several freshwater mussels considered Species of Greatest Conservation Need have known or suspected vertebrate hosts that are also considered Species of Greatest Conservation Need (Table 4-4). Addressing the conservation needs of these larval host species will be an important part of any conservation strategies for the mussels of conservation need. Actions taken to preserve larval hosts may aid conservation of some mussel populations.

Table 4-4. Mussel Species of Greatest Conservation Need known or suspected to use vertebrate Species of Greatest Conservation Need as hosts

Mussel Species of Greatest Conservation Need	**Larval Hosts (Species of Greatest Conservation Need in *Italics*)**
Arcidens confragosus (Rock Pocketbook)	*American eel*, drum, shad, rockbass, crappie
Cumberlandia monodonta (Spectacle Case)	*mudpuppy* (potentially)
Elliptio crassidens (Elephant-Ear)	*skipjack herring*
Fusconaia ebena (Ebonyshell)	crappie, bass, *skipjack herring*
Lampsilis teres (Yellow Sandshell)	gars, centrarchids, basses, *sturgeon*
Simpsonaias ambigua (Salamander Mussel)	*mudpuppy*

Annelida: Polychaeta (Aquatic Annelid Worms)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Water Pollution

Annelids may be sensitive to changes in water quality.

- Changes in water hardness, alkalinity, pH, temperature, and dissolved oxygen concentrations can impact worm populations negatively.
- Many annelids are sensitive to chemical pollutants (e.g. heavy metals, agricultural pesticides, etc.).
- Siltation - primarily from nonpoint source pollution - can bury once suitable habitats and organisms, increase turbidity and lower oxygen supplies, and transport other pollutants of concern that can affect worm populations.

Priority Conservation Actions

- Prepare a synthesis of basic biological information on the single freshwater species included in this group.
- Conduct status surveys, population monitoring, and basic life history research.
- Develop and implement general habitat management guidelines.
- Prevent and mitigate nonpoint source pollution.

Crustacea: Anostraca (Fairy Shrimp)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

- Complete loss of natural habitat due to disturbance, draining, and filling of ephemeral ponds. Factors affecting water quality in ephemeral habitats have not been investigated well enough to know their impacts on fairy shrimp populations.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Develop and implement general habitat management guidelines (i.e. for ephemeral ponds).
- Apply site specific management for highly localized populations.
- Protect ephemeral pond habitats.

Crustacea: Laevicaudata (Clam Shrimp)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

- Complete loss of natural habitat due to disturbance, draining, and filling of ephemeral ponds and wetlands.

Water Pollution

Clam shrimp may be sensitive to changes in water quality.

- Changes in water hardness, alkalinity, pH, temperature, and dissolved oxygen concentrations can impact crustacean populations negatively.
- Many crustaceans are sensitive to chemical pollutants (e.g. heavy metals, agricultural pesticides, etc.).
- Siltation - primarily from nonpoint source pollution - can bury once suitable habitats and organisms, increase turbidity and lower oxygen supplies, and transport other pollutants of concern that can affect clam shrimp populations.

Invasive Animal Species

- Nonnative cladoceran predators may impact clam shrimp populations.
- Nonnative zebra mussels may alter trophic dynamics in clam shrimp habitats.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Develop and implement general habitat management guidelines (e.g., for ephemeral ponds).
- Apply site specific management for highly localized populations.
- Protect ephemeral ponds and other occupied habitats.
- Control and manage invasive species.
- Prevent and mitigate nonpoint source pollution.

Crustacea: Copepoda (Copepods)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Water Pollution

The copepods considered Species of Greatest Conservation Need occupy two primary habitats: pristine marshes and kettles in southern Wisconsin and deep cold high-oxygen water usually in northern Wisconsin. Copepods may be sensitive to changes in water quality.

- Changes in water hardness, alkalinity, pH, temperature, and dissolved oxygen concentrations can impact crustacean populations negatively.
- Many crustaceans are sensitive to chemical pollutants (e.g. heavy metals, agricultural pesticides, etc.).
- Siltation - primarily from nonpoint source pollution - can bury once suitable habitats and organisms, increase turbidity and lower oxygen supplies, and transport other pollutants of concern (i.e. nutrients) that can affect copepod populations.

Invasive Animal Species

- Nonnative cladoceran predators may impact copepod populations.
- Nonnative zebra mussels may alter trophic dynamics in copepod habitats.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Control and manage invasive species.
- Prevent and mitigate nonpoint source pollution.

Crustacea: Isopoda (Isopods, Sow Bugs)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Water Pollution

Isopods occupy a variety of aquatic habitats, which are influenced or threatened by a variety of factors. Isopods may be sensitive to changes in water quality:

- Changes in water hardness, alkalinity, pH, temperature, and dissolved oxygen concentrations can impact crustacean populations negatively.
- Many crustaceans are sensitive to chemical pollutants (e.g. heavy metals, agricultural pesticides, etc.).
- Siltation - primarily from nonpoint source pollution - can bury once suitable habitats and organisms, increase turbidity and lower oxygen supplies, and transport other pollutants of concern that can affect isopod populations.

Invasive Animal Species

- Nonnative zebra mussels and crayfishes may alter trophic dynamics in isopod habitats.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Control and manage invasive species.
- Prevent and mitigate nonpoint source pollution.

Crustacea: Amphipoda (Amphipods)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Loss or Alteration

Amphipods occupy a variety of aquatic habitats. These habitats are influenced or threatened by a variety of factors (see also Water Pollution section below).

- The lone locality record in the world presently known to harbor one subterranean species has been covered by a highway, with a manhole located over the site.
- Withdrawing water (surface water, groundwater) can alter the natural groundwater regime that provides the only known habitat for one subterranean species.

Water Pollution

Amphipods may be sensitive to changes in water quality.

- Changes in surface or groundwater hardness, alkalinity, pH, temperature, and dissolved oxygen concentrations can impact crustacean populations negatively.
- Many crustaceans are sensitive to chemical pollutants (e.g. heavy metals, agricultural pesticides, etc.).
- Siltation - primarily from nonpoint source pollution - can bury once suitable habitats and organisms, increase turbidity and lower oxygen supplies, and transport other pollutants of concern that can affect surface water amphipod populations.

Invasive Animal Species

- Nonnative zebra mussels and crayfishes may alter trophic dynamics in amphipod surface water habitats.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Control and manage invasive species.
- Prevent and mitigate nonpoint source pollution.
- Protect and maintain natural groundwater regimes and quality.

Crustacea: Decapoda (Crayfishes and Shrimp)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.
- The effects of bait harvest on crayfish populations remains unknown.

Habitat Alteration or Loss

Crayfishes and shrimp occupy a variety of aquatic habitats. These habitats are influenced or threatened by a variety of factors, including:

- inorganic and organic sedimentation imbedded in stream substrate,
- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants,
- shoreline modification,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Invasive Animal Species

- Nonnative rusty crayfish may compete for resources with native crayfishes.
- Nonnative rusty crayfish may hybridize with native crayfish altering genetic structure of populations.
- Nonnative zebra mussels may alter trophic dynamics in some crayfish habitats.
- Nonnative zebra mussels may colonize the exoskeleton of crayfish and limit the ability to feed and their ability to molt.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Develop and implement general habitat management guidelines (e.g., for ephemeral ponds).
- Apply site specific management for highly localized populations of species of conservation need.
- Control and manage invasive species.
- Prevent and mitigate nonpoint source pollution.

Arachnida: Araneae (Spiders)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.
- Public perceptions of many arachnids remain negative.

Habitat Alteration or Loss

- Complete loss of natural habitat due to conversion of habitat to urban, housing, commercial, industrial, and agricultural development.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Undertake public information and education efforts to foster awareness and knowledge regarding the important roles spiders play in natural systems.
- Develop and apply general habitat management guidelines.

Insecta: Ephemeroptera (Mayflies)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Mayflies occupy a variety of aquatic habitats in their larval stages. These habitats are influenced or threatened by a variety of factors, including:

- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants,
- shoreline and littoral zone modifications,
- potential global climate change impacts,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.

Insecta: Odonata (Dragonflies)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Dragonflies and damselflies occupy a variety of aquatic habitats, but the Species of Greatest Conservation Need tend to be either associated with flowing water, specialized wetlands such as peatlands, and specialized lake types. Species of Greatest Conservation Need often have a life cycle of two to three years which means the predominant life stage (larvae) have to have their requirements met for long periods of time. These habitats are influenced or threatened by a variety of factors, including:

- portion of the watershed in forest cover (stream species),
- inorganic and organic sedimentation imbedded in stream substrate,
- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants,
- shoreline and littoral zone modifications,
- potential global climate change impacts,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.
- Protect and manage specific waterbodies and watersheds containing significant populations of Species of Greatest Conservation Need.

Insecta: Orthoptera (Grasshoppers*)*

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.
- Public perceptions of grasshoppers as agricultural pests may create management obstacles.

Habitat Alteration or Loss

Few grasshoppers are specific in their choices of food plants. The taxa, however, fall into preference groups by vegetation type; grasses, herbs, shrubs and trees. Most open habitat grasshoppers require a loose substrate for oviposition and those that rely on visual signals for mate selection need areas with reduced vegetation. Arboreal species need persistent stands of woody vegetation and some species in this category are found only in proximity to particular families or genera of shrubs or trees. Given these requirements, habitat loss is always a threat to the ability of these animals to persist on the landscape. Threats include:

- complete loss or fragmentation of habitat due to development,
- disturbance due to human activities (recreation, transportation, land management, etc.),
- alteration of plant community structure through succession, prairie management, and incursion of invasive plant species,
- shoreline and wetland modification, and
- non-specific broadcast of insecticides.

Priority Conservation Actions

- Conduct status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.
- Protect dune and similar habitats known to be occupied by Species of Greatest Conservation Need.
- Maintain corridors connecting occupied sites to prevent isolating populations.

Insecta: Hemiptera: Heteroptera (True Bugs)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

True bugs occupy a variety of aquatic habitats. These habitats are influenced or threatened by a variety of factors, including:

- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants,
- shoreline and littoral zone modifications,
- potential global climate change impacts,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Protect and manage specific waterbodies and watersheds containing significant populations of Species of Greatest Conservation Need.

Insecta: Hemiptera: Auchenorrhyncha (Plant Bugs, Leafhoppers)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.
- Lack of basic understanding of limiting factors for most species

Habitat Alteration or Loss

- Succession of grassland to woody vegetation
- Plantings or conversions from open vegetation types to plantations, agriculture, etc.
- Narrow host specificity of several species

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.

Insecta: Coleoptera (Terrestrial Beetles – Tiger, Leaf, Burying, and Scarab Beetles)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.
- Threats to the other terrestrial beetles are unknown, but may include light pollution (American burying beetle) and narrow host specificity (*Xyloryctes jamaicensis* and *Longitarsus subrufus*).

Habitat Alteration or Loss

Beetles occupy a variety of terrestrial habitats. These habitats are influenced or threatened by a variety of factors, including:

- succession of sand blows and barrens,
- foot or vehicular traffic on beaches and sand blows, and
- plantings or conversions from open vegetation types to plantations, agriculture, etc.

Tiger beetles require bare soil ranging from loose sand to packed clay. Partial to full exposure to sunlight also is required, although some species require openings in forested landscapes. Larvae cannot withstand excessive disturbance of the soil in which they burrow.

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.

Insecta: Coleoptera (Aquatic Beetles - Water Scavenger, Predaceous Diving, Riffle, Whirlygig, Minute Moss, Burrowing Water, Crawling Water, Long-toed Water, Travertine, Water Penny, and Beaver Beetles and Weevils)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Aquatic beetles considered Species of Greatest Conservation Need are taxonomically and ecologically diverse and occupy almost every conceivable aquatic or wetland habitat. Certain beetle habitats (e.g., spring seeps, spring runs, and spring ponds, forested ephemeral ponds, peatlands, warm headwater streams, medium to large fast flowing warmwater streams, as well as a variety of very specific microhabitats in aquatic settings) merit targeted conservation efforts. These habitats are influenced or threatened by a variety of factors, including:

- alterations to groundwater hydrology,
- impoundments and their associated impacts,
- nonpoint source pollution, particularly inorganic sedimentation,
- direct physical disturbance, and
- opening or alteration of forest canopies.

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.
- Protect and manage specific waterbodies and watersheds containing significant populations of Species of Greatest Conservation Need.

Insecta: Plecoptera (Stoneflies)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Stoneflies occupy a variety of aquatic habitats in their larval stages. These habitats are influenced or threatened by a variety of factors, including:

- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants,
- shoreline and littoral zone modifications,
- potential global climate change impacts,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.
- Protection and management of specific waterbodies and watersheds containing significant populations of Species of Greatest Conservation Need.

Insecta: Trichoptera (Caddisflies)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Caddisflies occupy a variety of aquatic habitats in their larval stages. These habitats are influenced or threatened by a variety of factors, including:

- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants,
- shoreline and littoral zone modifications,
- potential global climate change impacts,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.
- Protection and management of specific waterbodies and watersheds containing significant populations of Species of Greatest Conservation Need.

Insecta: Lepidoptera (Butterflies and Moths)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of some species remain poorly known.
- We lack sufficient information on specific species or populations.

Biological Factors

- Small populations may be affected by inbreeding and genetic swamping.
- Small numbers of populations or extremely small or very localized extant populations limit genetic exchange and long-term population viability.
- The poor dispersal ability of some species or lack of dispersal from core populations may limit population viability and conservation opportunities.
- Potential mortality to some species due to over collecting.

Habitat Alteration or Loss

Many lepidopterans have specific food plant preferences. Given these requirements, habitat loss poses a threat to the ability of these animals to persist on the landscape. Threats include:

- complete loss or fragmentation of habitat due to development,
- disturbance due to human activities (recreation, transportation, land management, etc.),
- alteration of plant community structure through succession, prairie and forest management practices, and incursion of invasive plant species, and
- wetland modification.

Management Challenges

- Lack of communication with and/or involvement of site managers in lepidopteran conservation efforts.
- Lack of appropriate site management plans (including how to address any conflicting management guidelines recommended for different species).

- Unintended consequences of habitat management practices (e.g. lack of management, over management, intensity of management, timing of management, scale of management, etc.).
- Broadcast application of insecticides (e.g., Btk)

Priority Conservation Actions

- Continue systematic species atlasing and inventory efforts.
- Conduct population monitoring and life history research for those species that require additional information for successful conservation.
- Prepare and implement species recovery plans needed for all state-listed lepidopterans.
- Develop and implement site-specific management for highly localized populations.
- Augment populations or establish species at additional sites (e.g., at historic sites).
- Prepare and implement general habitat management guidelines (e.g., for grassland Species of Greatest Conservation Need).
- Maintain corridors connecting occupied sites to prevent isolating populations.
- Control and manage invasive species.
- Identify those species or populations where specific management actions are not required or appropriate.

Insecta: Diptera (Aquatic Flies)

Threats and Issues

Lack of Information

- Many aspects of the basic biology of the species remain poorly known.
- We have limited information on species distributions and populations.

Habitat Alteration or Loss

Flies occupy a variety of aquatic habitats in their larval stages. These habitats are influenced or threatened by a variety of factors, including:

- alteration of flow regimes caused by impoundments and large scale conversion of natural cover types in the watershed,
- point and nonpoint sources of pollutants.
- shoreline and littoral zone modifications,
- potential global climate change impacts,
- drainage or impoundment of natural wetlands, and
- introduction of fish or management for fish in naturally fishless (shallow) waterbodies.

Priority Conservation Actions

- Conduct systematic species atlasing, status surveys, population monitoring, and basic life history research.
- Develop and apply general habitat management guidelines.
- Protect and manage specific waterbodies and watersheds containing significant populations of Species of Greatest Conservation Need.

Chapter 5. Monitoring

This chapter provides an overview of current species and habitat monitoring efforts in Wisconsin that are relevant to the Species of Greatest Conservation Need and identifies gaps in those efforts. The conceptual basis for monitoring Species of Greatest Conservation Need and their habitats is also presented, along with the basic approach for monitoring the effectiveness of the species and natural community priority conservation actions presented in Chapter 3. Strategies for adapting conservation actions through application of an adaptive management model are also described along with strategies for incorporating citizen-based monitoring into the monitoring efforts related to Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need: A Comprehensive Wildlife Conservation Plan*.

5.1 Overview and Purpose of Monitoring Species of Greatest Conservation Need, Natural Communities, and Priority Conservation Actions

The overall purpose of natural resource monitoring is to determine the status of and trend in the condition of selected resources. Information obtained from scientifically sound monitoring programs can be used to evaluate the effectiveness of management and restoration efforts, identify problems while cost-effective options are still available, provide early warning of threats, and provide a basis for understanding and identifying change in complex and variable natural systems. Monitoring data may help identify the normal limits of variation and can therefore also help determine when something may be wrong in a system (National Park Service's *Guidance for Designing an Integrated Monitoring Program at* http://science.nature.nps.gov/im/monitor). Knowing the condition of Wisconsin's natural resources is fundamental to the ability to manage those resources for the future.

This chapter seeks to provide a clear and holistic picture of monitoring in Wisconsin, through the identification of gaps at the taxa and ecosystem level, and through recommended actions that will result in greater coordination and higher quality data. The central goal is to use monitoring within an adaptive management context to test the effectiveness of conservation actions and to develop a long-term monitoring program for ecosystems, natural communities, and population trends of Species of Greatest Conservation Need.

Sections 5.2, 5.3, and 5.4 discuss monitoring as an element of the adaptive management cycle, data collection, and data sharing. Section 5.3 specifically focuses on assessing the effectiveness of conservation actions. Sections 5.5 and 5.6 consider all monitoring programs that involve Species of Greatest Conservation Need or their habitats in some way, even if they are only one component of larger monitoring activities. Sections 5.6 and 5.7 discuss multi-organizational monitoring initiatives and strategies.

While the following sections address Element 5 (see Chapter 1) as described by congressional legislation and further guidance from the National Advisory Acceptance Team, they do not suggest specific habitat and species monitoring priorities, protocols, or programs. There was insufficient time to develop specific monitoring programs for Species of Greatest Conservation Need, their associated natural communities, and priority conservation actions prior to the October 1, 2005 deadline for submitting Wisconsin's Comprehensive Wildlife Conservation Plan (CWCP). As a result, important first steps in the implementation of Wisconsin's CWCP will be working with partners to collectively recommend priority threats and conservation actions at a regional level and developing specific conservation action performance measures and monitoring strategies for those threats and actions.

5.2 Adaptive Management

Monitoring conservation actions and habitat trends is a critical step in wildlife conservation because it measures progress toward meeting an objective and provides evidence for continuation or change in the proposed management regime. As a component of the adaptive management cycle (Figure 5-1), monitoring ensures that each conservation action is linked to a specific hypothesis that evaluates the success or failure of the action, and, in turn, influences the adaptation of existing activities or the design of future actions.

Priority conservation actions and strategies proposed under the CWCP must be implemented by utilizing an experimental design that tests project assumptions and is part of an adaptive management cycle. Monitoring programs that use a formal experimental design not only determine if the expected results took place, but also suggest new conservation actions to implement or modifications needed to meet the originally intended outcome.

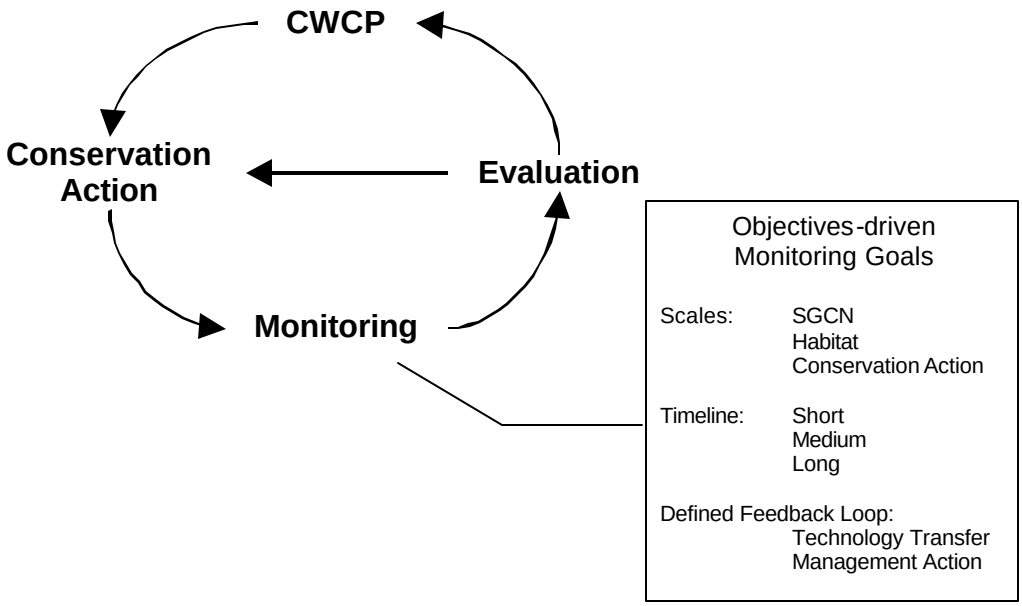


Figure 5-1. Monitoring within the adaptive management cycle.

Because monitoring may generate data that do not support the continuation of a proposed conservation action, the plan and conservation agency must establish guidelines governing the implementation of needed changes *before* an activity is undertaken in the field. Such guidelines will provide the ability to switch to another conservation action that may be more effective before the completion of the project, thereby conserving both ecological and fiscal resources. Consequently, all conservation action proposals should include an adaptive management component.

In order for monitoring to play a constructive role in the adaptive management cycle it must be tied to specific objectives. The project objectives describe the desired environmental outcome and in turn define what will be measured, how it will be measured, and how often it will be measured. Management activities are designed to meet the objective using an experimental design that tests its effectiveness, and monitoring is designed to determine if the objective is met or can be met under the proposed conservation

action. Regardless of the specific project objectives, the following actions ensure the completion of the adaptive management process:

1. Assess
- Define scope of management problem.
- Define measurable management objectives.
- Identify key indicators for each objective.
- Explore effects of alternative actions on indicators.
- Make explicit forecasts about responses of indicators to management actions.
- Identify and assess key gaps in understanding.

2. Design
- Design a management plan that will provide reliable feedback and fill gaps in understanding.
- Evaluate management options/alternative designs, and choose one to implement.
- Design monitoring protocol.
- Plan data management and analysis.
- State how management actions or objectives will be adjusted.
- Set up a system to communicate results and information.

3. Implement
- Follow the plan.
- Monitor implementation and document any deviations from the plan.

4. Monitor
- Monitor for implementation, effectiveness, validation, and surprises.
- Follow the monitoring protocol designed in Step 2.

5. Evaluate
- Compare actual outcomes to forecasts made in Step 1.
- Document results and communicate them to others facing similar management issues.

6. Adjust
- Identify uncertainties and where they remain unresolved.
- Adjust the model used to forecast outcomes, so that it reflects the hypothesis supported by results.
- Adjust management actions and reevaluate objectives as necessary.
- Make new predictions, design new management experiments, and test new options...repeat cycle.

The adaptive management cycle will be used to ensure that Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* allows for evaluation of conservation actions and implementation of new actions accordingly. As mentioned in Section 5.1, there was insufficient time to develop specific monitoring programs for the CWCP, but as those monitoring programs are developed over the upcoming years and months, those programs will use the adaptive management philosophy outlined above.

5.3 Conservation Action Performance Measures

Because significant changes in populations and habitats often take many years to detect, progress toward the long term conservation strategy or goal must be monitored throughout the project period utilizing performance indicators. Ideally, monitoring plans track objectives for each performance indicator annually. Interim conclusions can then be drawn regarding the effects or outcomes at the site level that could influence implementation of similar conservation actions across the landscape or indicate the need for research on cause and effect.

Performance indicators are management tools that measure work performed and results achieved by stating inputs, outputs, and outcomes in specific and measurable terms. Table 5-1 below demonstrates the relationship between performance indicators, monitoring and adaptive management.

Table 5-1. The relationships among performance indicators, monitoring, and adaptive management.

	Input	Activity	Output	Outcome
Definition	Investments of staff/funding	Actions in the field	Products	Resulting environmental benefit
Example objective	Provide funding and staff time to develop a portable bat monitoring system to be used by volunteer monitors.	Contract for development of five bat monitoring sets built to staff specifications. Train volunteer monitors to calibrate and maintain systems, and collect data.	Five bat monitoring systems deployed and maintained in priority habitats, and data collected by volunteer monitors used to estimate bat population size and trends over time.	Appropriate conservation strategies applied for five high priority bat populations.
Example monitoring question	Were funds allotted to the development of portable bat monitoring systems and volunteer monitor training?	Were five functional systems built to staff specifications? Were volunteers trained to run the systems and collect data in a manner that will yield useable data?	Did the systems and volunteer monitors produce population and distribution data necessary to suggest appropriate protection measures for the targeted bat populations?	Were appropriate bat conservation measures proposed for five high priority bat populations?
Reporting mechanism	Conservation action proposal	Annual report	Annual and final report	Final report
Feedback loop examples	Conservation registry, similar conservation plans	Original proposal, similar conservation plans	Future conservation plans, proposed new research, NHI, ATRI	CWCP update, proposed new research, proposed new conservation actions

Successful implementation depends on clearly defined objectives, consistent monitoring, appropriate experimental design and good documentation over the life of the project. Consistently addressing the following questions through the appropriate reporting mechanisms ensures the completion of the adaptive management feedback loop:

- Are the assumptions of the original ecological model still valid? Should the model be modified based on collected data? Do the new data suggest another attribute would be more sensitive or easier to measure?
- Was the objective met? Although data from most monitoring may not conclusively identify causes of failure, what reasonable adjustment can be suggested? What additional research is needed? What was the agreed upon response outlined in the project proposal?

- Could the monitoring design be implemented as planned? What were the necessary modifications to methods, indicators, or timeline?
- Analysis after each data collection episode allows for the periodic assessment of the conservation action and the effectiveness of the monitoring approach. Are there quality assurance/quality control issues that need to be addressed?

Development of specific monitoring programs for Species of Greatest Conservation Need, their associated natural communities, and priority conservation actions will be important next steps in developing an implementation plan for Wisconsin's CWCP. The WDNR will work with partners to collectively recommend priority threats and conservation actions at a regional level. As part of that process, performance indicators, or metrics, will be developed for the priority threats and conservation actions to facilitate performance measurement.

5.4 Designing and Implementing a CWCP Monitoring Program

Information on the condition of Wisconsin's natural resources is fundamental to management of those resources. As described in Sections 5.5 and 5.6, many existing monitoring programs provide valuable information on our state's natural resources, and in many cases, this information is applied to land-use planning and management activities. This same information can be used, through the adaptive management process, to evaluate the effectiveness of new management or restoration efforts targeting Species of Greatest Conservation Need and their habitats. The following information should be considered before and during the design of new monitoring programs as well as during reviews of existing programs, recognizing that modifying existing programs may not be advisable if changes will negatively affect data continuity or comparability.

General principles and elements of a monitoring program (International Association of Fish and Wildlife Agencies 2005) include the following:

Principles

- Utilize existing monitoring efforts
- Integrate monitoring with local, regional, and national programs
- Produce quantitative, comprehensive assessments of the resource
- Strategically develop a short list of indicator species to monitor
- Relate habitat monitoring to species monitoring
- Maintain detailed, accurate documentation of data and results
- Strive for consistency of protocols among monitoring projects, so results are comparable
- Require internal and external peer-review of plans and products
- Encourage partnerships, leveraging of resources, and cost-sharing

Elements

- Identify monitoring goals and objectives
- Identify targets or indicators to monitor
- Determine sampling design and methodology
- Quality Assurance/Quality Control
- Data management and archiving
- Data analysis and assessment
- Protocol documentation
- Reporting
- Periodic review and evaluation

The development of a CWCP monitoring program in Wisconsin should include an analysis of the following initiatives and recommendations:

1. WISCLAND. Probably the most important first is to obtain a new land-cover GIS layer. The current "WISCLAND" is based on images from 1992-93 and significant changes in land-cover have occurred since that time. Current information is essential for the quantification of changes in land cover and for the spatial design of new monitoring programs.

2. An Inter-Agency Fish, Wildlife, and Habitat Surveys Team. Include continuing participation by relevant WDNR bureaus, state and federal agencies, conservation organizations, and the Citizen-Based Monitoring Advisory Board. Top priorities should be general awareness and coordination, and the development of a statewide monitoring plan (#3 below) to supplement the Wisconsin Comprehensive Wildlife Conservation Plan and any subsequent implementation plan. The Wisconsin Bird Conservation Initiative and the Wisconsin Old Growth Project may provide models of cross-jurisdictional organization. Team function should be established and staffing appointments made immediately following approval of the Wisconsin Comprehensive Wildlife Conservation Plan by the U.S. Fish and Wildlife Service.

3. A Statewide Environmental Resource Monitoring Plan. Based on the outcome and participation in the upcoming "Wisconsin Resource Monitoring and Data Sharing Network" workshop, an implementation plan (or series of plans) may be needed to address the monitoring needs of the Wisconsin Comprehensive Wildlife Conservation Plan. This plan should include, but may not be limited to, the following components.

    - Review the Wisconsin Comprehensive Wildlife Conservation Plan, any subsequent implementation plan, and past State Wildlife Grant projects. Consider the principles and elements from above (International Association of Fish and Wildlife Agencies 2005) and establish 6-month, 1, 2, 3, and 5-year benchmarks for the development and implementation of a statewide resource monitoring plan.

    - Identify focal management issues (e.g., the USGS Coordinated Bird Monitoring Plan http://amap.wr.usgs.gov) at the state, Ecological Landscape, and local scales.

    - Quantitatively evaluate relevant surveys. The Inventory and Monitoring Review (Wisconsin DNR 2004c) and this chapter cover *taxa* and *topical* limitations of existing surveys and monitoring programs. The ability of individual surveys and monitoring programs to meet *quantitative* objectives should be statistically tested and their limitations understood before these surveys can be adjusted or expanded to accommodate new interests. The Wisconsin Bird Conservation Initiative Research Inventory and Monitoring Committee will complete a bird survey evaluation in 2005.

    - Develop wildlife and habitat monitoring criteria and indicators (see the Montréal Process at http://www.mpci.org and the cautionary review of Sieg et al. 2003). Criteria and indicators should focus on the needs of the Comprehensive Wildlife Conservation Plan; however the information needs of WDNR programs and partner organizations should be considered, to the extent possible, to prevent the development of a segregated program.

    - Investigate the use of the "2010 Resource Monitoring Grid" (WDNR, Ecological Inventory and Monitoring Section, unpublished report), USDA Natural Resources Conservation Service "National Resources Inventory" sites (http://www.nrcs.usda.gov/technical/land/nri02), USDA Forest Service/WDNR "Forest Inventory and Analysis" sites (on public lands), and the proposed new WDNR "Continuous Forest Inventory" sites as the basis for a statewide biotic sampling framework. Incorporate State Natural Areas as potential control sites for habitat and taxa monitoring programs (Appendix C).

    - Utilize WDNR and relevant partner data standards (http://atriweb.info/AboutATRI); incorporate metadata into the Aquatic and Terrestrial Resources Inventory (http://atriweb.info) to increase project awareness and data sharing. Maintain Natural Heritage Inventory documentation and data management standards.

- Consider the following technical resources when developing the environmental resource monitoring plan:
  - USGS Coordinated Bird Monitoring Plan (http://amap.wr.usgs.gov) and the WBCI Coordinated Bird Monitoring Plan (in prep.).
  - U.S. Geological Survey "Managers' Monitoring Manual: How to Design a Wildlife Monitoring Program" http://www.pwrc.usgs.gov/monmanual
  - U.S. Geological Survey "Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans" http://www.dfg.ca.gov/nccp/pubs/monframewk10-04.pdf.
  - National Park Service "Guidance for Designing an Integrated Monitoring Program" http://science.nature.nps.gov/im/monitor/vsmTG.htm#Design.

- Consider the following data management and archiving systems in the environmental resource monitoring plan:
  - Conservation Registry: Schoonmaker, P. and W. Luscombe's (2005) *Habitat Monitoring: An Approach for Reporting Status and Trends for State Comprehensive Wildlife Conservation Strategies*, recommends the establishment of a state-level registry of conservation actions. The proposed registry is a spatially explicit database of conservation actions that would include conservation goals, location, habitat type, type of action, etc. This would allow agencies and partners to display the relationship between conservation action and stated priorities as well as identify geographic or habitat gaps in implementation of the plan. Data for a Wisconsin conservation registry can be compiled based on metadata submitted to the Aquatic and Terrestrial Resources Inventory (ATRI). Submittal of metadata is required by WDNR for all SWG funded projects in the state.
  - Citizen-based Monitoring GIS Layer: The Citizen-based Monitoring Network of Wisconsin will produce a GIS layer relating the kinds and geographic range of volunteer monitoring activities across the state. The tool will enable citizen-based monitoring groups to target monitoring gaps and access current monitoring data, protocols and monitoring guidance.
  - SWIMS: There are a variety of databases used by the WDNR to store water monitoring data, many of which are accessible to the public via the internet. However, these systems are not linked to one another and some are not easily accessible. To unify the various database systems and more easily access data from each of them, a project is underway to combine many of these databases as part of the new Surface Water Integrated Monitoring System (SWIMS), projected to be available by the end of 2006.
  - NHI: The Wisconsin Natural Heritage Inventory (NHI) program was established by the Wisconsin Legislature in 1985 and is part of an international network of NHI programs coordinated by NatureServe, a non-profit organization. These programs locate and document occurrences of rare species and natural communities (including state and federally endangered and threatened plants and animals) using a standard methodology for collecting, characterizing, and managing data. The programs maintain standardized databases with spatial and tabular components; the Wisconsin database contains over 21,000 records. In addition to its own inventory efforts, the Wisconsin program relies on data from contributors throughout the state. The Wisconsin NHI Working List contains the species and natural communities tracked by the program. Wisconsin NHI data are distributed at different levels of precision, depending on the user and the intended use of the data. Data with generalized locations can be obtained from the WDNR Web site by using either the "NHI Online

Database" or "NHI County Maps." A secure online application is used by WDNR staff and others that have a license agreement with NHI for obtaining more precise data.

- ATRI: The ATRI concept was formed in 1994 by DNR staff and external partners who recognized the need for decision makers to access and integrate environmental information. After considerable analysis concerning the role and structure of ATRI, the program was established by Wisconsin Statute 23.09(2)(km) which directed the Department of Natural Resources to "develop an information system to acquire, integrate and disseminate information concerning inventories and data on aquatic and terrestrial natural resources." The Metadata Explorer is a computerized "card catalog" designed to help locate ecological data affecting Wisconsin's landscape. It is primarily composed of data collected by the WDNR, but also contains pertinent data from other sources.

4. Assist in the development of the Continuous Forest Inventory (CFI) on state lands. The Interagency Team and Comprehensive Wildlife Conservation Plan experts should provide direct assistance to the Division of Forestry in the development of the Wisconsin CFI which is proposed in the FY06-07 State Budget.

5.5 Species of Greatest Conservation Need Monitoring

Numerous agencies and organizations are involved in natural resource-related monitoring programs in Wisconsin. In 2004, the WDNR conducted a review of most bird, herptile, mammal, invertebrate, and plant inventory and monitoring programs to assess the adequacy of current efforts in meeting our collective information and data needs (Wisconsin DNR 2004c). The review covered key topics including population trend, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. A listing and description of those existing or historic inventory and monitoring programs that include Species of Greatest Conservation Need can be found in Appendix D. Because of the large number of species under consideration in the CWCP, we were forced to group species by status (endangered, threatened, and special concern), life history traits (e.g., colonial nesters), or coarse taxonomic groups for summary and discussion purposes.

The Wisconsin CWCP lists 152 mammal, bird, herptile, and fish species that need conservation actions in order to sustain or reestablish their populations (i.e., Species of Greatest Conservation Need, Table 3-1). Another 208 species have specific information needs because of unknown population trends or other life history traits (Appendix B); this number is in the tens of thousands when invertebrates are considered. Comprehensive inventory and monitoring strategies will be needed to measure the success of conservation actions for Species of Greatest Conservation Need, to reassess the status of Species of Greatest Conservation Need in the future, and to ascertain the status of the 208 species with information needs. This will require a major commitment from resource agencies and organizations in Wisconsin.

Most vertebrate species are monitored using cost-effective techniques that gather data on a variety of animals at once, such as track surveys for furbearers, point counts for passerine birds, trapping for small mammals, and fyke netting or shocking for large fishes. This leaves substantial gaps in species representation and information; usually only the more common species are encountered in sufficient numbers to provide accurate and precise estimates of population characteristics. Using these common or well-surveyed species as indicators for demographic trends in poorly known species has little scientific support (Sieg et al. 2003) and any such proposal should be carefully considered prior to acceptance as a "criteria or indicator" for monitoring.

5.5.1 Birds

Table 3-1 in Chapter 3 provides a complete list of bird Species of Greatest Conservation Need; this list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats. Numerous agencies and organizations collect bird monitoring data in Wisconsin (Appendix D, Table 1). Most surveys gather some information on Species of Greatest Conservation Need. Despite this, we are lacking data on many topics needed to fully assess status and to derive workable management strategies. Existing programs will need to be adjusted or expanded and new surveys will need to be implemented in order to address the significant weaknesses noted in the Inventory and Monitoring Review (Wisconsin DNR 2004c).

<u>Gaps in Bird Monitoring</u>

There are 284 native bird species for which Wisconsin provides important breeding, wintering, or migratory habitat. Of these 284 species, 84 (30%) have been identified as Species of Greatest Conservation Need in Wisconsin. Twenty-four of these are currently listed as Threatened or Endangered in Wisconsin and two are listed as federally Threatened or Endangered. Because of these large numbers, it was not feasible during the Inventory and Monitoring Review (Wisconsin DNR 2004c) to discuss the adequacy of existing monitoring programs and information for each species. Consequently we grouped species by status (endangered, threatened, and special concern), life history traits (colonial nesters), and

coarse taxonomic groups (waterfowl, passerines, etc.) in order to provide an overview of the perceived adequacy of monitoring information for these groups.

Endangered, Threatened, and Special Concern Species
In general, inventory and monitoring efforts are inadequate to address population trends, specific habitat requirements, habitat conditions and availability, population status, and wildlife health for most Special Concern species in Wisconsin. For certain listed species, good information is available. For example, there is good population trend data for nesting bald eagles, peregrine falcons, trumpeter swans, and whooping cranes. For many other listed species trend data is not readily available. Information on species distribution/range is better due to the recent breeding bird atlas (Wisconsin Society for Ornithology 2005). Current efforts will need to increase significantly in order to improve information and management opportunities. Specific needs include constant monitoring of grassland, forest, and wetland species.

Waterfowl
In general, monitoring efforts are adequate to address population trends and distribution/range for waterfowl and existing programs should continue at the current level. Specific needs include better population status information for ducks listed as Species of Greatest Conservation Need.

Colonial Nesters
Population trend and wildlife health monitoring efforts are largely inadequate for this group, while distribution/range and habitat requirement information was considered adequate. Our knowledge of habitat condition/availability and population status is variable by species within this group. Current efforts will need to increase in order to address population trends and habitat condition/availability, but information and data quality vary widely for the other topic areas due to the heterogeneity within this group. Specific needs include long-term monitoring and use of the Wisconsin Waterbird Registry or eBird (http://www.ebird.org/content/) to aid in data collection and synthesis.

Bitterns and Rails
Inventory and monitoring efforts are inadequate in all topic areas except habitat requirements where slightly more information exists. Efforts will need to greatly increase in all topic areas for bitterns and rails.

Shorebirds
Population trend, distribution/range, habitat condition/availability, population status, and wildlife health information and survey efforts are lacking. In general, habitat requirements for shorebirds are fairly well known. Specific needs include participation in regional long-term monitoring efforts and monitoring the effectiveness of management activities (e.g., draw-downs at managed impoundments).

Gallinaceous Birds
Because of long-standing efforts by the WDNR and other organizations, current inventory and monitoring efforts and information are largely adequate in all topic areas except wildlife health. Monitoring of habitat condition/availability and wildlife health should increase. Specific needs include more work in all topic areas for spruce grouse and sharp-tailed grouse.

Birds of Prey
In general, efforts to address population status are inadequate. The level or quality of information in all other topic areas is highly variable depending on the species in question. Specific needs, relative to Species of Greatest Conservation Need, include better information on all owl species, northern goshawk, red-shouldered hawk, and northern harrier.

Non-passerine Landbirds
Monitoring of population trends, habitat requirements, habitat conditions/availability, population status, and wildlife health are largely inadequate for this group. Efforts on all topics, except distribution/range, should increase. Specific needs for this group were wide ranging due to the diverse species composition.

Passerine Landbirds
In general, efforts to address population trends, habitat requirements, habitat condition/availability, population status, and wildlife health are inadequate and efforts must increase in order to gain needed management information. Information on species distributions/range are largely adequate. This is a large group, thus specific needs are wide ranging, but one significant deficit is a lack of programs to monitor and evaluate management projects.

Addressing Gaps in Bird Monitoring
Because of the large number of relevant bird surveys and the extensive species list involved, we do not attempt to provide specific recommendations for improving or expanding avian monitoring programs in this report. The Wisconsin Bird Conservation Initiative, a consortium of resource agencies, organizations, and supporting businesses, has a Research, Inventory and Monitoring Committee which is actively working on an evaluation of avian surveys and a coordinated bird monitoring plan for Wisconsin. This evaluation will scrutinize applicable surveys (Appendix D, Table 1) for species coverage, objectives, relevant spatial scales, types of data collected, and statistical adequacy. The "Evaluation of Avian Surveys" report will be released late in 2005 and a "Coordinated Bird Monitoring Plan" will follow in 2006.

5.5.2 Fish

Fish monitoring programs have been in place since the 1940s, with most monitoring activities focusing on recreationally or commercially important species. Current surveys range from tracking stocking and recreational fishing efforts to investigating habitat-species interactions, the impacts of development, and the effectiveness of management actions (Appendix D, Table 2). Fish Species of Greatest Conservation Need are rarely the focus of individual projects; however, in the majority of current monitoring programs, information on these taxa is often recorded when captured. Table 3-1 in Chapter 3 provides a complete list of fish Species of Greatest Conservation Need. This list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats. New or expanded monitoring efforts will be needed to obtain these data.

Addressing Gaps in Fish Monitoring
A comprehensive monitoring program is in place for Wisconsin's fisheries resources. Additional funding for fish tissue contaminant analysis would allow for expanded coverage and more detailed sampling (Wisconsin DNR 2005). Fish are currently collected from 50-100 sites per year. This includes analysis of approximately 600 samples for mercury, 350 for total polychlorinated biphenyls, 30 for banned pesticides, 20 for dioxin/furan analysis, and 10 for polybrominated diphenyl ethers. Monitoring temporal changes in contaminants at fixed sites is a priority not currently addressed in the fish contaminant program.

5.5.3 Herptiles

Compared to most other taxa groups, there are relatively few ongoing inventory and monitoring programs for herptiles in Wisconsin. Much of our knowledge of this group comes from a few ongoing efforts including the Wisconsin Frog and Toad Survey (WFTS) and the Natural Heritage Inventory, both programs of the WDNR, and the Wisconsin Herpetological Atlas Project, a program of the Milwaukee

Public Museum. Each of these programs provides information about the distribution of herptile species in the state, and the WFTS also adds data about breeding phenology and population trends. In addition to these state initiatives, several federal agency programs address amphibians and reptiles in Wisconsin, including the North American Amphibian Monitoring Program (NAAMP) and the Amphibian Research and Monitoring Initiative (ARMI), both of which are sponsored by the U.S. Geological Survey. Some of the federal programs complement state efforts, while others serve more to assist states with data and information management, analysis or interpretation. Other information regarding herptiles in the state is obtained through short-term research projects, which are usually focused on individual species or a small group of species, and through incidental observations by both citizens and scientists.

While past and current efforts provide information on some herptiles identified as Species of Greatest Conservation Need, many gaps remain. Table 3-1 in Chapter 3 provides a complete list of herptile Species of Greatest Conservation Need. This list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats. Existing programs should be expanded and new programs must be designed carefully to most effectively address remaining information needs.

Gaps in Herptile Monitoring

The information summarized below has been compiled from the following three sources, which should be referenced for more detailed information:

1. *WDNR's Inventory and Monitoring Review* (Wisconsin DNR 2004c)
2. *A review of the amphibians and reptiles of the Lake Superior Watershed* (Casper 2002)
3. *Monitoring long-term trends in Wisconsin frog and toad populations* (Mossman et al. 1998)

Reptiles
In general, current inventory and monitoring efforts for reptiles are not adequate to provide good information on status and trends or for directing management and conservation actions. Information is generally lacking for most species in the areas of distribution and range, habitat requirements, habitat conditions and availability, wildlife health and toxicology, and other stressors like climate change. However, fairly good information is available on habitat requirements for most turtles and on distribution and range of most snake species.

Amphibians
The Wisconsin Frog and Toad Survey (WFTS), initiated in 1981, is the longest running calling-frog survey in the United States and has been a model for other amphibian calling survey programs throughout the country. The primary purpose of the WFTS is to determine the status, distribution, and long-term population trends of Wisconsin's twelve frog and toad species (Mossman et al. 1998). The survey also provides information regarding the effects of climate and site factors on breeding-call phenology and breeding activity, which is useful in interpreting trend estimates (Mossman et al. 1998). While the WFTS provides an indication of general population trends for most Wisconsin anuran species, it does not adequately sample for some Species of Greatest Conservation Need such as pickerel frogs, mink frogs, and Blanchard's cricket frogs. In addition, the survey's geographic coverage currently falls short of the goal of two survey routes per county.

Individual monitoring programs are warranted for Blanchard's cricket frog and pickerel frog. Mossman et al. (1998) provides some suggestions for obtaining adequate monitoring information for these species. Additional information for most anurans is also needed in the areas of habitat requirements and condition, and health, including disease and contaminant exposure and effects.

For salamanders, current inventory and monitoring efforts are generally not adequate to provide good information on status and trends or for directing management and conservation actions. Efforts are lacking for most salamander species in the areas of distribution and range, habitat requirements, habitat conditions and availability, wildlife health and toxicology, and other stressors like climate change.

Addressing Gaps in Herptile Monitoring

A comprehensive plan for achieving monitoring goals is not currently in place for herptiles. Existing survey, inventory, and monitoring programs that include Species of Greatest Conservation Need are identified in Appendix D, Table 3. Funding to support herptile monitoring is generally low, although following WDNR's Inventory and Monitoring Review in 2004 (Wisconsin DNR 2004c), the Department has started at least two new efforts to address existing gaps (Blanchard's cricket frog and Butler's gartersnake surveys). More efforts are needed and should be coordinated across state and federal agencies and organizations. Coordination is also needed among survey and inventory work, monitoring efforts, and research. Survey, inventory, and monitoring efforts should be used to inform and direct more targeted research. Research information should then be incorporated into conservation actions and on-the-ground management activities. All of these areas in combination will help to create a more complete effort to address gaps in our knowledge of the herptiles of Wisconsin.

Efforts at addressing gaps in herptile needs throughout the state provide an excellent opportunity for collaborative participation by a wide range of groups. The WDNR is not the only agency with the ability to conduct inventory and monitoring efforts for reptiles and amphibians. There are opportunities to involve a variety of other groups in inventory and monitoring activities, including federal agencies, conservation organizations, citizen scientists, K-12 schools, and universities. Different groups are likely to be better suited to certain activities and topics than others. Citizen scientists could help provide data on the distributions and habitats of some species that are relatively common and easily identified if provided with appropriate resources (e.g., photos, user-friendly taxonomic keys). Other species are more difficult to inventory and monitor or may require more resources than are generally available to the public. Efforts in these areas will need to be undertaken by an appropriate agency or organization. Regardless of the specific type of work or who accomplishes it, a thoughtful, coordinated planning effort and a strong commitment by WDNR are important precursors to undertaking these efforts. A monitoring program for herptiles should be considered in conjunction with other monitoring needs for the state and should be an integrated part of a comprehensive, resource-monitoring program in Wisconsin.

The following specific suggestions for addressing information gaps for herptiles were compiled from the three sources listed in the previous section. Additional recommendations and conservation actions for individual herptile Species of Greatest Conservation Need can be found in Section 3.1.4.

- Implement more routes and surveys for all amphibian and reptile monitoring programs in the state.
- Use the existing network of WFTS sites for more intensive studies on population dynamics, microhabitat requirements, contaminants, and other areas of need.
- Initiate or increase participation in some of the existing nation-wide herptile monitoring programs (e.g., Terrestrial Salamander Monitoring Program, Frogwatch USA).
- Identify reasons for population changes.
- Where malformations are documented at a specific site in multiple years, conduct thorough water quality testing.
- Identify appropriate conservation and management practices for amphibians and reptiles in the region.

- Develop new volunteer programs for monitoring certain herptile groups including salamanders and turtles.
- Encourage the development and use of standard or comparable protocols, analytical tools, training and planning, and common databases and reporting mechanisms across ecological regions, scientific disciplines, and governmental and institutional boundaries.
- Compile existing information on all of Wisconsin's amphibian and reptile species and develop a database of population status, trends, habitat conditions, and relative level of stressors. If regularly updated and maintained, managers would be able to set quantitative management objectives for each species and evaluate how well they were meeting their objectives over time. This information could be summarized in a public website, thus communicating the status of these species to the general public.
- Conduct more training in field identification and survey methods. Training is often the limiting factor in many natural history surveys.
- Increase efforts to involve the public, K-12 schools, and colleges in collecting inventory and monitoring data on a wide range of species. A large organizational and planning effort on the part of the WDNR would need to precede such involvement. The federal government and universities could provide needed biological and statistical expertise to increase the overall quality of any new programs that are planned.

5.5.4 Mammals

WDNR and public volunteers currently collect the vast majority of mammal monitoring data in Wisconsin, most of which are focused on game animals and a few Threatened or Endangered species (Appendix D, Table 4). Even within the game category, however, inventory and monitoring efforts are considered adequate only for quota harvested species, a relatively small group where harvests are restricted through permit systems (Wisconsin DNR 2004c). Existing surveys gather a small amount of information on some Species of Greatest Conservation Need (Appendix D, Table 4), but they do not cover all topics or types of data needed to implement a comprehensive conservation plan. Existing programs must be expanded and new programs must be carefully designed to address the significant weaknesses noted in the Inventory and Monitoring Review (Wisconsin DNR 2004c). Table 3-1 in Chapter 3 provides a complete list of mammal Species of Greatest Conservation Need. This list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats.

Gaps in Mammalian Monitoring

Insectivores and Small Rodents
Based on the 2004 review, inventory and monitoring efforts are not adequate to address *any* topic area for this group, including population trends, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. Inventory and monitoring efforts should be increased to address these deficits.

Large Rodents, Rabbits, and Hares
Inventory and monitoring efforts are, in general, adequate to address distribution, habitat condition, and habitat availability for this group; however, we have little or no information on these topics for Species of Greatest Conservation Need. Current efforts are deemed inadequate to address population trends, population status, and wildlife health for the species in this group. Inventory and monitoring efforts should be increased, especially with respect to Species of Greatest Conservation Need.

Bats
Inventory and monitoring efforts for bats are not adequate to address *any* topic area, including population trends, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. Inventory and monitoring efforts should be increased to address these deficits.

Weasel Family, Raccoon, and Virginia Opossum
Inventory and monitoring efforts are adequate to address distribution, habitat condition, and habitat availability, and inventory and monitoring efforts should be maintained or increased. Efforts related to population trend, wildlife health, and population status should increase.

Larger Mammals
The Inventory and Monitoring Review (Wisconsin DNR 2004c) did not include moose. Inventory and monitoring efforts are adequate to address population trend, population status, distribution, habitat requirements, and habitat condition. Inventory and monitoring efforts related to those topics should be maintained or increased. Efforts are inadequate for wildlife health and current efforts should increase.

Addressing Gaps in Mammal Monitoring
Where possible, existing systems should be expanded and improved to take advantage of established infrastructure and precedence. For mammals, that might include the following:

1. *Winter Track Survey* – This survey is central to the furbearer population monitoring program and it has the ability to provide data on additional species. Routes are being expanded into central and southern Wisconsin to keep pace with expanding furbearer distributions; the pace of this expansion should be increased to accomplish statewide coverage. Required data collection on white-tailed jackrabbit should also be added.

2. *Bowhunter Wildlife Survey* – Species coverage is currently limited; consider adding several mammalian and avian Species of Greatest Conservation Need. Consider elevating the awareness of the survey through the Citizen-Based Monitoring Network and using NatureMapping as the reporting tool to improve spatial data collection and timeliness.

3. *Summer Wildlife Survey* – Add recognizable Species of Greatest Conservation Need (e.g., Franklin's ground squirrel and white-tailed jackrabbit).

4. *Rare Mammal Observations* – Add white-tailed jackrabbit and Franklin's ground squirrel. Increase awareness of what constitutes a rare mammal sighting and reporting rates. Consider using NatureMapping as a reporting tool.

5. *Small Mammal Inventory* – Increase the overall effort. Publish existing protocols, standards, and methods. Expand partnership development and increase support, especially through graduate programs and the Citizen-Based Monitoring Network of Wisconsin.

6. *NatureMapping* – Significantly expand the public and professional awareness and use of this program. Add "Special Projects" to assist with standard DNR wildlife surveys such as the Bowhunter Wildlife Survey, Summer Wildlife Survey, Rare Mammal Observations, and Small Mammal Inventory.

Where there is no precedent and infrastructure do not exist, we recommend careful consideration of the following points:

1. *Bats* - The North American Bat Conservation Partnership (NABCP) outlines a strategic plan (http://www.batcon.org/nabcp/newsite/index.html) for identifying and addressing priorities related to research, monitoring, and management actions. The plan provides the framework and direction for local, state, and federal bat conservation and management plans. The DNR and partners should develop a state plan following the NABCP guidelines, goals, and priority actions.

2. *Quantitative Review of Existing Surveys* - Conduct a detailed evaluation of mammalian surveys, determine long-term monitoring priorities, and develop a Coordinated Wildlife and Habitat Monitoring Plan in conjunction with other taxa groups.

5.5.5 Terrestrial Invertebrates

Current monitoring efforts are taxa-specific due to the particular expertise of individual scientists. Several subgroups remain unevaluated because of the high species diversity of terrestrial invertebrates and limited taxonomic expertise among biologists in the state of Wisconsin. See Appendix D, Table 5 for details on monitoring surveys for terrestrial invertebrate Species of Greatest Conservation Need. Monitoring is adequate only for the following subgroups and topic areas:

- Hemipteroid Orders - habitat requirements
- Orthopteroid Orders - population status and trends and habitat requirements
- Panorpoid Orders - population status and trends; habitat requirements, conditions, and availability

Several hundred terrestrial invertebrate species are listed as Species of Greatest Conservation Need in Wisconsin (Tables 4-1, 4-2, and 4-3). See Chapter 4.0 for more details on invertebrate Species of Greatest Conservation Need threats and priority conservation actions.

Gaps in Terrestrial Invertebrate Monitoring

Monitoring is insufficient for all topic areas (population status and trends; distribution and range; wildlife health; habitat requirements, conditions, and availability) for most terrestrial invertebrate Species of Greatest Conservation Need. Work should increase or be undertaken soon to address these gaps (Wisconsin DNR 2004c). Additional inventory and monitoring work is needed on endemic and threatened habitats, using a wider variety of sampling methods. An assessment is also needed of potential interactions among native Lepidoptera and introduced European moths in habitats where they coexist (Wisconsin DNR 2004c).

Addressing Gaps in Terrestrial Invertebrate Monitoring

A comprehensive plan for achieving monitoring goals is not in place for terrestrial invertebrates. The taxa group needs to be included in coordinated fish and wildlife monitoring plans. The DNR has the knowledgeable staff, infrastructure, and statewide perspective to work with certain terrestrial invertebrate groups, but expertise for other taxa is lacking (Wisconsin DNR 2004c). Funding to support terrestrial invertebrate monitoring is low overall, although select taxa are being addressed (e.g., Karner blue butterfly). Citizen scientists could help provide data on the distributions and habitats of select taxa that are relatively common and easily identified, if provided with photos, reference specimens, and user-friendly taxonomic keys. Additional recommendations and conservation actions can be found in the invertebrate section of this report (Chapter 4).

5.5.6 Aquatic Invertebrates

Current monitoring efforts are taxa-specific due to the particular expertise of individual scientists. Several subgroups remain unevaluated because of the high species diversity of aquatic invertebrates and limited numbers of experts in the state of Wisconsin. See Appendix D, Table 6 for details on monitoring

surveys for aquatic invertebrate Species of Greatest Conservation Need. Monitoring is adequate for the following groups and topic areas:

- Introduced and Accidental - population status
- Crustacea - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Mayflies - population status
- Dragonflies and Damselflies - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Alderflies and Fishflies - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Aquatic Bugs (Heteroptera) - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Aquatic Moths and Spongillaflies - habitat requirements, conditions, and availability
- Aquatic Beetles - population status and trends; distribution and range; habitat conditions, and availability
- Snails, Limpets, Clams, and Mussels - habitat requirements, conditions, and availability

Several hundred aquatic invertebrate species are listed as Species of Greatest Conservation Need in Wisconsin (Tables 4-1, 4-2, and 4-3). See Chapter 4.0 for more details on invertebrate Species of Greatest Conservation Need threats and priority conservation actions.

Gaps in Aquatic Invertebrate Monitoring

Current monitoring efforts are inadequate for several aquatic invertebrate subgroups and topic areas. Work should increase or be undertaken soon to address these gaps (Wisconsin DNR 2004c). Monitoring is insufficient for all topic areas (population status and trends; distribution and range; wildlife health; habitat requirements, conditions, and availability) for the following aquatic invertebrate groups:

- Endangered, Threatened, and Special Concern species
- Aquatic worms and leeches
- Stoneflies
- Caddisflies
- Aquatic flies and midges

Addressing Gaps in Aquatic Invertebrate Monitoring

A comprehensive plan for achieving monitoring priorities is not in place for aquatic invertebrates. The taxa group needs to be included in coordinated fish and wildlife monitoring plans. The DNR has the knowledgeable staff, infrastructure, and statewide perspective to work with certain aquatic invertebrate groups, but expertise for other taxa is lacking (Wisconsin DNR 2004c). Funding to support aquatic invertebrate monitoring is low overall, although select taxa are being addressed (e.g., odonates). With proper training, citizen scientists could help provide fundamental data on the distributions and habitats of select taxa that are larger in size and easily identified (e.g., lepidopterans; odonates; crayfish; and some mussels, snails, and heteropterans).

Recommendations for additional aquatic invertebrate inventory and monitoring work include the following:

- Developing rearing programs to establish larval/adult associations, especially for Natural Heritage Inventory Working List species.

- Provide funding to publish surveys of discrete groups for which data already exist.
- Update and expand the Hilsenhoff Biotic Index.
- Expand survey work to include State Parks and State Natural Areas.
- Conduct invertebrate surveys of the Pine-Popple River System and the upper Wisconsin River System to compare the fauna of impacted and pristine river systems (Wisconsin DNR 2004c).

Additional recommendations and conservation actions can be found in the invertebrate section of this report (Chapter 4).

5.6 Species of Greatest Conservation Need Habitat (Natural Community) Monitoring

Many resource management organizations, including WDNR, have attempted to shift from species to ecosystem-based management strategies (Pikitch 2004) which focus on habitats and multi-species, trophic interactions (National Research Council 1999). The *Wisconsin's Biodiversity as a Management Issue* report (Addis et al. 1995) recommended the development and use of statewide resource inventories within the ecoregions of Wisconsin (including assessments of the status and distribution of aquatic and terrestrial species, biological communities, and other attributes). This increased the need for broad scale vegetation, natural community, and landscape data collection and the creation of the Aquatic and Terrestrial Resources Inventory to function as a statewide information center that could facilitate the maximum use of those data.

In 2004, WDNR reviewed bird, mammal, herptile, invertebrate, and plant inventory and monitoring programs to assess the adequacy of our resource programs and information (Wisconsin DNR 2004c). The review was conducted by asking taxa experts, most of whom were consumers of natural resource inventory and monitoring data, to provide feedback on data gaps, priorities, and niche related questions. The review, and subsequent assessments conducted for this Comprehensive Wildlife Conservation Plan, identified numerous species or taxa-specific surveys, but few natural community or ecoregional monitoring programs. A listing and description of the existing or historic aquatic and terrestrial community monitoring programs can be found in Appendix D, Tables 7 and 8.

Monitoring activities are generally designed to measure the composition, structure, or function of an ecosystem. Composition, or the plants, animals, and habitat types that occupy an area, can be defined at different scales, from ecosystems within a landscape to the genetic composition of species. Structure refers to the physical organization and distribution patterns of plants and animals. Monitoring for structure usually indicates floristic and faunal guild diversity. Function refers to the interactions of biotic and abiotic components in ecological processes. Most monitoring efforts in Wisconsin focus on species and habitat composition, leaving gaps in our knowledge of ecosystem structure and function. At a coarse landscape-level, there are monitoring efforts that focus on the placement and condition of natural communities, and trends that affect them such as housing development and global climate change. Most of these efforts are conducted by the federal agencies at the regional or national level.

A number of long-term capital improvement-type projects are required to facilitate habitat and ecosystem monitoring in Wisconsin. First, we need to create an updated landcover GIS layer; the current version, called "WISCLAND," is based on images from 1992-93. Significant changes in land-use have occurred across many ecosystems since that time, the consequences of which are not readily known. A second need is the creation of a statewide registry of conservation practices. Currently, these data are only available in a spatial (i.e., GIS) format for specific project areas. The entire discipline of landscape ecology is based on understanding the spatial relationships (i.e., patch size, shape, position) of habitats at appropriate scales. Knowing where and, to some extent, when conservation practices were implemented on private lands will assist resource managers in assessing everything from the viability of nesting habitat for the greater prairie chicken to non-point pollution loading in streams, rivers, and lakes.

5.6.1 Overview of Habitat Monitoring Gaps

The Inventory and Monitoring Review (Wisconsin DNR 2004c) covered the adequacy of current inventory and monitoring efforts for natural communities, but did not directly address ecoregional issues. Most reviewers indicated that current efforts were not adequate to address data and information needs for natural communities and that work should increase. Particular deficiencies included a lack of standardization, coordination, monitoring of forest management for effectiveness and impacts, and staff to track field information and manage databases. They recommended the development of a statewide

inventory and monitoring network to monitor natural communities, with a special emphasis on invasive plants. The WDNR and Wisconsin Herbarium have an early detection program for new invasive species and other agencies collect data about invasive species occurrence and control efforts; however, a broadly accessible database is needed to coordinate and track habitat monitoring and management programs.

Sections 5.6.2 through 5.6.8 provide a description of the specific monitoring gaps that have been identified for each of the natural community groups evaluated during the development of Wisconsin's CWCP.

5.6.2 Gaps in Aquatic Monitoring

Aquatic monitoring programs have been in place since the late 1930s, covering many streams and rivers, Lakes Michigan and Superior, several hundred inland lakes, and the watersheds contributing to these aquatic systems. Many programs evaluate heavily-used waterbodies (e.g., Lake Winnebago) but detailed surveys of small, isolated streams have also been conducted. Current surveys range from detecting changes in water quality using satellite data to investigating the impacts of commercial development and non-indigenous species (Appendix D, Table 7). Aquatic monitoring may also contribute to the designation of State Natural Areas or Outstanding and Exceptional Resource Waters (OERWs).

High-priority needs, or gaps, listed in the recent *Water Resources Monitoring Strategy for Wisconsin* (Wisconsin DNR 2005) included the following:

- Developing a Lake Index of Biotic Integrity (IBI) incorporating baseline monitoring data
- Funding and staffing to cover all high-priority river reaches statewide
- Additional funding for ongoing Mississippi River water quality monitoring
- Gathering land use data and combining land use data with baseline monitoring to enhance the predictive capabilities of the WDNR non-point source program
- Restoring recently closed stream flow stations to evaluate effectiveness of the infiltration performance standard
- Spatiotemporal expansion of water toxicity testing for biological effects; make toxicity data more accessible to WDNR staff and external customers
- Developing a coordinated, online database for all water-related data; implementation of the Surface Water Integrated Monitoring System (SWIMS) is underway

If more funding becomes available, additional monitoring priorities include the following:

- Increasing efforts toward a formal stream classification monitoring system
- Expanding surface water quality monitoring to include 1st and 2nd order streams
- Chemical analyses of waters receiving effluents from permitted entities
- Total Maximum Daily Load (TMDL) source monitoring
- Increasing TMDL 303(d) listing efforts
- Contaminated sediments monitoring
- Inland beach pathogen monitoring
- Volunteer beach pathogen monitoring of Great Lakes hotspots
- Groundwater data mining, database development and management; production of groundwater maps and other educational materials
- Establishing a statewide volunteer coordinator

5.6.3 Gaps in Barrens Monitoring

Though both large and small-scale efforts at inventory and monitoring of barrens exist, the data aren't always widely available. For example, students from Northland College in Ashland, Wisconsin, conduct biannual monitoring on Moquah Barrens in northern Wisconsin. The results are shared with Chequamegon-Nicolet National Forest staff, but are not readily available to other barrens managers. The lack of a statewide clearinghouse for these types of data limits their use by other researchers and land managers.

Access to a statewide invasive species database for barrens mangers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8). Other gaps in monitoring and inventory of barrens habitats include the need to describe the full range of variability of these communities (Addis et al. 1995).

Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

5.6.4 Gaps in Grassland Monitoring

Access to a statewide invasive species database for grassland mangers will help with effective invasive plant management. There is also a lack of comprehensive monitoring of the effects of management on the native diversity of grasslands. Some of the less common types of grasslands require more extensive floristic studies to capture the full range of community variability.

Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

5.6.5 Gaps in Northern Forest Monitoring

Access to a statewide invasive species database for northern forest mangers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8).

Deer herbivory is a common threat to components of many northern forest communities, but there is no consistent monitoring of herbivory to determine how widespread or long-lasting the effects might be. There is also a need for a consistent monitoring program of the effects of forest management and recreation on forest structure, composition, and function (Wisconsin DNR 2004c).

Human-created transportation corridors contribute to changes at large and small scales, including fragmentation, movement of invasive species, and changes in hydrologic regimes. An inventory of roads, trails and other transportation corridors, both official and user developed, would allow land managers to determine the effects of those corridors. Data on habitat losses due to fragmentation and rural development are being collected but are not widely disseminated for use by land managers (Appendix D, Table 8). Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

Monitoring as part of an adaptive management program is needed to support an increase in the range of age classes and community components of some of the northern forest communities. Other northern forest communities need both more inventorying (to identify intact, high-quality sites and to determine the status of associated rare species) and more monitoring (to determine composition, function, and processes).

5.6.6 Gaps in Oak Savanna Monitoring

According to the Midwest Oak Ecosystems Recovery Plan (U.S. EPA 1994) there are presently numerous public and private agencies, organizations, and institutions that are conducting research and prescribing and implementing management to restore savanna and woodland natural communities in the Midwest. Often managers and researchers are not aware that databases of ongoing or recently completed research exist. One important challenge is to bring the vast amount of information contained in these databases together in a format that is accessible. Some of the gaps in information include 1) classification and characterization of savannas and woodlands, 2) threats to the ecosystem, and 3) inventories of what is protected (U.S. EPA 1994).

One threat to oak savannas is invasion by non-native plant species, and access to a statewide invasive plant species database for savanna mangers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8).

Some savanna communities need more inventorying to identify potentially restorable sites. Monitoring of oak regeneration would facilitate management to enhance regeneration success. Data on habitat losses due to fragmentation and rural development are being collected but are not widely disseminated for use by land managers (Appendix D, Table 8). Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

5.6.7 Gaps in Southern Forest Monitoring

To use adaptive management techniques to manage southern forests as a matrix of community types, we need to bring together the large amount of existing technical information on silviculture, forest ecology, and wildlife ecology by establishing a natural community information system (Addis et al. 1995). Monitoring as part of that program is needed to support the restoration of structure, function and composition in some southern forest communities. In addition, a platform needs to be created to share that information with other southern forest managers. Some southern forest communities still need more inventorying to identify intact, high-quality sites and degraded but restorable sites, and to determine the status of rare species. More inventory work is also needed to document the variability of southern mesic forest communities. Monitoring of oak regeneration would facilitate management to enhance regeneration success.

Access to a statewide invasive species database for southern forest mangers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8). New monitoring efforts for the emerald ash borer will likewise be used.

Deer herbivory is a common threat to components of many southern forest communities, but there is no consistent monitoring of herbivory to determine how wide-spread or long-lasting the effects might be.

Human-created transportation corridors contribute to changes at large and small scales, including fragmentation, movement of invasive species, and changes in hydrologic regimes. An inventory of roads, trails and other transportation corridors, both official and user developed, would allow land managers to determine the effects of those corridors. There is also a need for a consistent monitoring program of the effects of forest management and recreation on forest structure, composition, and function (Wisconsin DNR 2004c). Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities. Data on habitat losses due to fragmentation and rural development are being collected but are not widely disseminated for use by land managers (Appendix D, Table 8).

Select taxa in hemlock relict communities need to be inventoried to determine presence and status of rare species. Also in hemlock relicts, recreational trails need to be monitored for negative effects such as invasive species and soil erosion.

5.6.8 Gaps in Wetland Monitoring

A statewide inventory and monitoring system for invasive plants is needed (Wisconsin DNR 2004c). The current reed canary-grass mapping project is a start towards a statewide inventory, with an expected completion date of 2006 (Appendix D, Table 7). The purple loosestrife survey and mapping projects are conducted on a volunteer basis so there may be gaps and inconsistencies in the quality and quantity of the data.

The methods for the Wisconsin Floristic Quality Assessment for Wetlands (Appendix D, Table 7) have been developed, and software for sharing the methods is to be released in the near future. However, development of a database for the results and making that database widely available are dependent on future funding (Tom Bernthal, personal communication, 2005).

Other recommendations for inventory and monitoring wetlands listed in *Wisconsin's Biodiversity as a Management Issue* (Addis et al. 1995) and the *Water Resources Monitoring Strategy for Wisconsin* (Wisconsin DNR 2005) include the following:

- Utilize the Natural Heritage Inventory to identify high-quality, undisturbed wetlands that should be protected.
- The WDNR wetland inventory maps should be updated every ten years for effective monitoring for state wetland protection and regulatory needs. In addition, the information needs to be collected and disseminated in an easily accessible manner. This will require additional staff and funding.
- The inventory mapping program should continue to be integrated with the Department's overall Geographic Information System program and the Department's Aquatic and Terrestrial Resources Inventory.
- Reliable funding is needed to implement a wetland assessment and monitoring program.

5.7 Importance of Citizen-collected Data to CWCP Monitoring

Citizen-based monitoring can and will greatly augment our ability to fill the gaps identified for monitoring Species of Greatest Conservation Need and their habitats. Recognizing that, it is important to understand the potential roles of citizen-based monitoring and the components of a successful citizen-based monitoring program.

In 1998, private citizens acting as volunteers through nonprofit organizations in the United States provided work equivalent to 9.3 million fulltime jobs (Independent Sector, 2001). As the baby boom generation enters retirement, the number of volunteers interested in the assessment and protection of natural resources will only increase.

Wisconsin in particular has a history of long-term, successful citizen-based monitoring programs. A wide array of organizations and agencies have developed longstanding or expanding efforts such as volunteer lake and stream monitoring programs, the Wisconsin Frog and Toad survey, Naturemapping, the Breeding Bird Survey, Christmas Bird Counts, and the Statewide Small Mammal Inventory. Indeed, these sources were relied on heavily in the assessment of Species of Greatest Conservation Need and critical habitats for this plan.

As part of the WDNR Inventory and Monitoring Review (Wisconsin DNR 2004c), citizen-based programs were seen as critical in addressing problems of shrinking state resources, both in terms of staffing and project funding, while meeting the ever present and growing demands for natural resource monitoring. Consequently, natural resource experts and conservation organizations alike called for the increased use of citizen-collected data. However, there was also universal recognition that utilization of these data requires WDNR leadership in the provision of training, prioritization of effort, quality assurance/quality control, and methods development.

Properly trained citizens not only reduce the cost of data collection and ground-truthing, but they also become engaged supporters of fish and wildlife conservation. Citizen scientists can have a much more detailed and intimate knowledge of a particular landscape than agency biologists due to the amount of time that they are able to spend in that area. While citizen monitoring can provide important information at less of a cost than professionals, this is not to say that there is no cost, nor that support is not necessary.

The following citizen monitoring discussion is designed to forecast citizen monitoring opportunities and to document current activities. This section seeks to address a number of relevant questions and concerns related to citizen monitoring. The WDNR Water Monitoring Strategy specifically addresses citizen-based monitoring and relevant portions of that strategy are included in this general discussion. In the coming months, the development of a mirrored terrestrial strategy will be completed.

5.7.1 Uses of Citizen-collected Data

With the development of training, protocols, and quality assurance/quality control, citizen-collected data have the potential to contribute to the following areas as identified by the WDNR Water Monitoring Strategy and WDNR Inventory and Monitoring Review:

- Gather data concerning population trends
- Assess distribution, range, and habitat requirements
- Assess habitat conditions and availability
- Assess population status
- Establish, review, and revise water quality standards

- Identify impaired waters
- Evaluate management (protection/restoration) effectiveness
- Assess ecosystem health
- Provide broader spatial and temporal coverage in river, stream, wetland, lake, groundwater, and beach water quality
- Monitor water quality conditions to support TMDL/303(d) listing, 305(b) reports, and general information on the water quality of Wisconsin waterbodies
- Assess water quality conditions in relation to nonpoint source management projects

However, citizen monitoring opportunities may be limited for the following reasons:

- Monitoring certain resources may pose a safety hazard/unacceptable risk to citizen monitors.
- The required training level is more rigorous than is economically feasible or the cost of sample analysis prohibits widespread monitoring of the parameter.
- Equipment availability is limited or financial constraints are prohibitive.
- The size of the monitoring area prevents assessment by citizen monitors (e.g., size of area and thus time required to monitor the location would require citizen input beyond what can be expected of a volunteer).
- A high level of scientific knowledge is required to make an assessment.
- There is a lack of required support or recognition of value of collected data.
- Some rare species can be difficult to identify and proper identification must be confirmed for data to be used for conservation and regulatory purposes. Also, some habitats and species are particularly vulnerable to collection or disturbance and may not be suitable for all citizen-based monitoring efforts. Important considerations include:
  - Species identification and documentation including factors necessary to validate the observation and associated information to collect.
  - Guidelines for how and when to collect plant or animal voucher specimens including regulations and necessary permits, as well as when collection should be avoided due to laws or to protect the viability of the species' population.
  - Special considerations for minimizing impacts to high quality natural communities that are fragile or otherwise susceptible to disturbance.

Although there has been renewed interest in the expansion of citizen-based monitoring programs, a wide array of citizen activities is already underway in Wisconsin (Appendix D, Table 9). There are many options along the citizen-based monitoring data use continuum and organizations or programs may use the data differently. Some data will be used as red flags, some to replace or supplement current WDNR staff activities, and some as part of education and outreach efforts. In the coming months, the WDNR, in conjunction with external partners, will explore how to best match citizen-based monitoring activities to current priorities. Citizen monitoring will likely be an important component of monitoring programs for many Species of Greatest Conservation Need and their habitats.

5.7.2 Elements in the Development of Citizen-based Monitoring Programs

Training

Citizen groups should be provided the same level of training provided to WDNR staff for any given activity. Additional information will need to be provided to citizens in order to meet their level of experience and to orient them to agency monitoring priorities. Regardless of the specific monitoring program, all training programs should consider inclusion of the following information:

- Trespassing laws
- Liability
- Water and equipment use safety
- How to minimize the spread of exotic invasive species when monitoring
- Impacts to threatened or endangered species and their habitat
- Quality assurance and quality control measures
- General understanding of what the data mean
- Data recording, entry, reporting, and presentation
- How to geolocate monitoring locations
- Expected response from the Department to citizen-generated data results

Quality Assurance/Quality Control

Existing WDNR quality management programs, data collection standards, and metadata standards should be utilized in order for data to be accepted into agency databases. A listing of accepted non-WDNR protocols should be maintained by the WDNR and consideration should be given to the development and support of widely recognized citizen certification programs.

Methods

Citizens should be trained in standardized WDNR methodologies. Many of these methods are available in the field procedures manuals and through program websites. Challenges that need to be met for citizens to be able to follow Department methods include the following:

- Allocating staff to provide training and methods development
- Obtaining funding to purchase equipment for the citizens to use that is equivalent to equipment that the Department uses and to pay for laboratory analysis
- Training citizens to use and maintain the equipment, monitor safely, and enter and report data results
- Updating the Field Procedures Manuals
- Supporting development and enhancement of a citizen monitoring network with well-developed communication and recognition strategies defined

Evaluation

Inclusion of citizen-collected data in the implementation of Comprehensive Wildlife Conservation Plan monitoring strategies provides a unique opportunity to explore how well citizens can be trained to carry out professional-level monitoring, to address issues that are found through evaluation, and to adapt the program so that it is most efficient and useful. Areas of investigation may include the following:

- Potential new roles of citizen-based monitoring in the implementation of the Comprehensive Wildlife Conservation Plan and other initiatives
- Use of citizen-collected data in resource management decisions and the level at which programs accept such data
- Citizen-collected data as a supplement or replacement for selected WDNR-collected data
- Level of staff support needed for coordination, training and methods development
- Cost comparisons of agency and volunteer data collection

Data Management
Although citizen-collected data will reside in designated project specific databases, the greater utilization of the data for broader management and trends analysis is equally important. Adherence to accepted methods and data collection standards makes this possible. An analysis of how citizen-collected data could be utilized by the datasets discussed in the habitat monitoring section (Section 5.6) should be explored.

Support and Recognition
Citizen monitors need to be supported and recognized for their efforts through:

- Award programs
- Outreach regarding the use of citizen-collected data
- Responsiveness by the agency to needs or questions
- Training opportunities

5.7.3 WDNR Support for the Expansion of Citizen-based Monitoring Activities

Wisconsin citizen groups have demonstrated that with training and direction they are quite capable of collecting valid and accurate information and can provide cost-effective support. In recognition of these accomplishments and the need to better support natural resource monitoring efforts, the WDNR has taken the following steps:

- Creation of a statewide citizen-based monitoring network
- Creation of an advisory board to work with the WDNR on monitoring priorities, funding opportunities, legislative support, and agency responsiveness
- Establishment of a citizen-based monitoring grant program
- Creation of the Citizen-based Monitoring Network website to serve as a clearinghouse for monitoring data, training, and protocols
- Identification of data gaps and strategies for how citizens can help fill those gaps
- Review of administrative rules and department policies with regard to citizen monitoring

Citizen participation in these efforts directly benefits the community through the collection of relevant and timely community-specific data beyond the capacity of state government, and through the development of a stewardship ethic within the population. Government benefits from the expansion of citizen-based monitoring through the opportunity to initiate, augment, or replace a variety of monitoring activities now conducted by the WDNR. With appropriate guidance and follow-up, the resulting citizen-collected data may be used in the description of trends and as early indication of ecosystem or population changes.

Chapter 6. Public Participation

Public participation and input was sought from the very beginning of the planning process to provide opportunities for participation using a variety of methods selected to meet the needs of different audiences.

A set of eleven interactive teams, with sponsorship by the Bureau of Endangered Resources and a multi-program Coordination Team at the "hub," were assigned specific roles in the planning process. Section 2.1 provides a description of each these teams, including their roles, responsibilities, and members.

For the broader range of interested conservation partners and publics, the Coordination Team sought to provide balanced and objective information to assist them in understanding the *Strategy's* purpose, approach, outcomes, and benefits and in knowing when and how to provide feedback or input. A series of initial mailings were followed by an opportunity for all those interested to attend a nearby Regional Briefing (six of these briefings were located around the state) to learn about the Species of Greatest Conservation Need and their habitats and then to suggest specific threats, issues, and conservation actions relevant to those species and their habitats. The briefings were followed by additional mailings to update participants on the process and inform them as to how the information they provided had been used.

The statewide review of the draft *Strategy* was well publicized and provided an opportunity for all interested parties to review the technical document; specific invitations to review relevant sections of the document were extended to known experts, conservation biologists, and others across the state to ensure adequate technical review of the draft *Strategy* contents. An update with the Executive Summary, including *Strategy* highlights, announcements, and information on the statewide technical review, was posted on the website, announced in press releases, and mailed to the 600-person *Strategy* mailing list for those people and groups who preferred to be informed rather than take part in the technical review.

Participation by the broader range of interested conservation partners and the general public is expected to further increase after the *Strategy* is approved and we move into the implementation phase. At that time we will use results and excerpts from this technical document to develop additional outreach materials that will inform and involve broader conservation audiences.

6.1 Communication and Coordination for *Strategy* Development

Beginning in February 2004, the Coordination Team prepared outreach materials on the Comprehensive Wildlife Conservation planning process, the purpose of the planning effort, the required elements from Congress, and State Wildlife Grant program materials, in addition to various pieces of technical and guidance information for participating teams and interested individuals or groups to use. A webpage provided updates and kept the most current information available to participants and the public. The webpage, http://dnr.wi.gov/org/land/er/cwcp/, also serves as a permanent archive for planning information and will continue to be updated throughout the acceptance and implementation phases of the *Strategy.*

Outlined below are significant events in the development of Wisconsin's *Strategy for Species of Greatest Conservation Need*. These events also highlight the opportunities provided for public participation.

February, 2004 – First external Comprehensive Wildlife Conservation Plan Advisory Team meeting. Included discussion of the criteria to be used to identify Wisconsin's Wildlife Species of Greatest Conservation Need.

April 2004 – Natural Resources Board informational briefing.

May, 2004 – Initial opportunities for various parties to become informed about and involved in the planning process:

- Initial mailing to a broad range of conservation partners that described the *Strategy* development and how to get on a mailing list to receive updates and participate in planning (Appendix E. Public Involvement Materials).
- Invitation to tribal chairpersons to participate in and be kept informed of the planning process.
- Invitation to Bird, Fish, Herptile, Mammal, and Invertebrate experts to serve on one of the five Taxa Teams.

May & June 2004 – Hired five Regional Ecologists to play a major role in assembling the *Strategy* and serve as regional advocates for the *Strategy*.

June & July 2004 – Advisory Team meetings. Reviewed the preliminary results of the application of criteria to identify Species of Greatest Conservation Need.

June 2004 to April 2005– Taxa Team members. Ongoing correspondence to identify and review the list of Species of Greatest Conservation Need; identify and review species associations with natural communities and Ecological Landscapes; and identify and review threats, issues, and priority conservation actions.

September & October 2004 – Advisory Team correspondence. Updates on applying scientific criteria to identify Species of Greatest Conservation Need.

November & December, 2004 – Preparation for Regional Briefings

- Advisory Team meetings. Reviewed the classification systems used to assign Species of Greatest Conservation Need to natural communities and Ecological Landscapes; reviewed process for identifying threats, issues, and priority conservation actions; and provided input on the format and content of the upcoming Regional Briefing meetings.
- Mailing and statewide press release (http://dnr.wi.gov/org/caer/ce/news/on/2004/on041223.htm#art2) inviting people to participate in January Regional Briefings and encouraging them to be involved in the planning process (Appendix E).

January 2005 – Regional Briefings. Over 340 people attended six Regional Briefings held throughout the state (Green Bay, LaCrosse, Madison, Milwaukee, Rhinelander, and Spooner).

February 2005 – Updates with tribal contacts. Department Regional Ecologists sent Regional Briefing materials to local tribal contacts and/or biologists and followed up with phone calls and/or emails.

February 2005 - Progress Report. Posted on the web site and sent to over 600 people on mailing list as well as all who attended the Regional Briefings. Provided an update on planning progress and feedback received at the January Regional Briefings (Appendix E).

April, 2005 – Working Draft review in preparation for the Statewide Review.

- Taxa Teams, Advisory Team, and other collaborators peer reviewed selected sections of the draft *Strategy*.
- Briefing held in Madison with U.S. Fish & Wildlife Service Region 3 staff members; they provided initial, positive feedback on selected sections of draft *Strategy* and offered helpful suggestions.

June & July 2005 – Preparation of the *Strategy* for Natural Resources Board approval and submission to the US Fish & Wildlife Service.

- Statewide review of the draft *Strategy* by experts, conservation partners and others interested in participating in the technical review.
- Continued information and updates posted on the web and sent to all on the mailing list.
- Press releases to the general public announcing availability of draft *Strategy* for statewide review (http://dnr.wi.gov/org/caer/ce/news/on/2005/on050607.htm#art1).

August, 2005 – Progress Report. Provided a summary of types of recommendations, questions, and concerns received during the statewide review as well as an explanation of how these issues were addressed within the subsequent revisions made to the *Strategy* (Appendix E).

August 17, 2005 – Natural Resources Board accepted Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need*. Letters of support from several Advisory Team members accompanied the *Strategy* (Appendix F. Letters of Support). Press release announcing Natural Resources Board approval can be reviewed at (http://dnr.wi.gov/org/caer/ce/news/rbnews/2005/081705co2.htm).

6.2 Communication and Coordination for *Strategy* Implementation

After the *Strategy* is accepted by the U.S. Fish & Wildlife Service, outreach materials for the general public will be developed. As part of the review and revision process (see Chapter 7), interested conservation partners and publics will be kept informed of updates, evaluations, and opportunities to participate.

Communication and coordination with partners and interested citizens will be important in *Strategy* implementation. The Department of Natural Resources will lead, develop, and manage *Strategy*-related communications in the future. In order to ensure successful *Strategy* implementation, ongoing communications will be pursued in these areas:

- Informational updates to partners and other stakeholders on the *Strategy* implementation progress, *Strategy* reviews and revisions, and responses to the adaptive management approach.
- Web site updates and improvements.
- Coordination of State Wildlife Grant application, allocation, and evaluation.
- Annual summary of the *Strategy* accomplishments, achievements, advances, and modifications that occur from on-the-ground projects funded by State Wildlife Grants.
- Continued development of the *Strategy* database into a communication and data dissemination tool for partners to access via the web.
- Continued encouragement for use of the *Strategy* and database as guidance for statewide conservation programs.

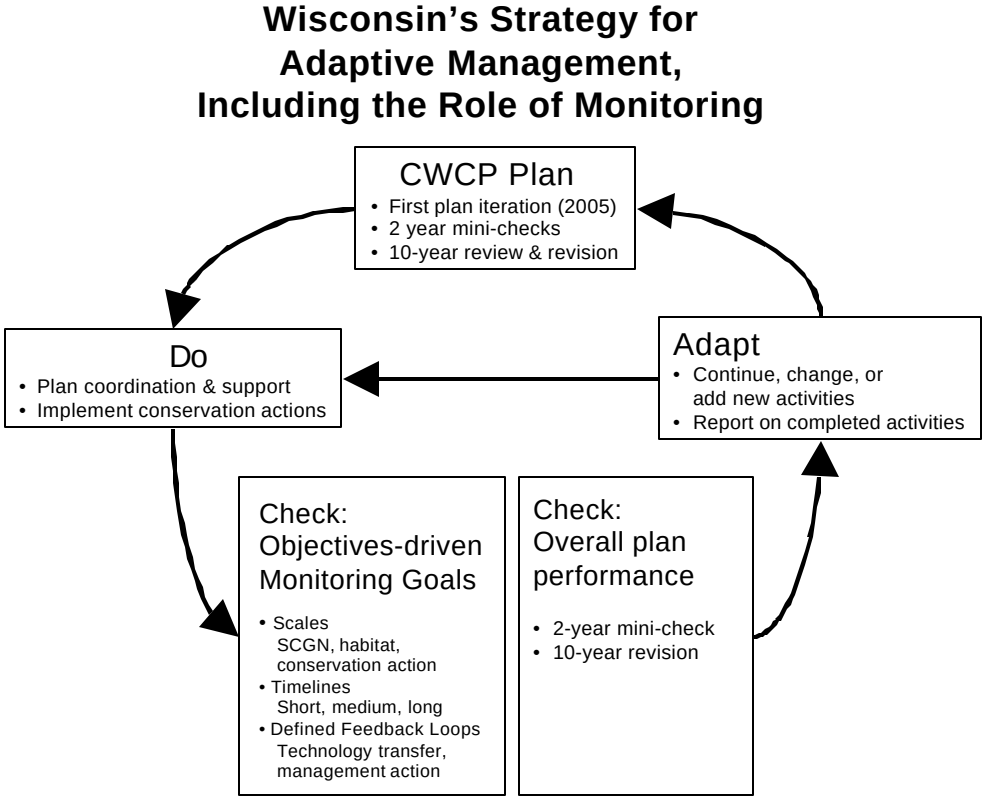
Chapter 7. Review and Revision

7.1 Introduction

This section of Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* sets out the steps of the review and revision process, defining its scope, breadth, and timing. Review and revision will include assessment of the overall administration and coordination of the *Strategy*, and perhaps even more importantly, it will evaluate and report the success of the conservation actions implemented to protect the Species of Greatest Conservation Need and their habitats.

Strategy review and revision will follow the principles of Adaptive Management, an approach to continuous improvement that incorporates the results of monitoring and evaluation into management actions in order to adapt and learn over time (Figure 7-1). In order to keep the *Strategy* light on its feet and responsive to changing information and conditions, we are planning several interim steps in review throughout the life of the *Strategy*, at approximately 2-year intervals, leading into a full review and revision of the *Strategy* within the ten year period required by the U.S Fish &Wildlife Service.

Figure 7-1. Wisconsin's strategy for adaptive management including the role of monitoring.



7.2 Organization

Lead responsibility for the review and revision of the *Strategy* and its components will lie with the Department of Natural Resources' Endangered Resources program. Endangered Resources staff will coordinate the full 10-year review and revision, to include experts from throughout the Department of Natural Resources and its conservation partners, such as the Advisory Team members who participated in the development of the *Strategy* itself. Other key DNR programs will include Integrated Science

Services, Wildlife Management, Fisheries, and Forestry. Input by staff and partners in each of the five DNR Regions will likely be coordinated through the Regional Ecologists. Species teams, similar to those formed during the initial development of the *Strategy*, will be reconvened and augmented with additional scientists as appropriate. Endangered Resources' staff will also lead an effective, efficient, and inclusive short-term review process approximately every two years to check in with key Department staff and conservation partners and identify key updates needed in the *Strategy* to address important changes in species' status, environmental circumstances and other newly available, critical information, without diverting significant attention or resources from the implementation of on-the-ground conservation actions.

7.3 Scope and Recommendations for *Strategy* Review and Revision

Ten-Year Full Review and Revision

- Use the original eight required *Strategy* elements and/or any new guidance and criteria issued at the Federal level.

- Review basic approach and methodology:
  - The processes used to develop the first iteration of the list of Species of Greatest Conservation Need and their habitat associations will be reviewed and modified as needed.

- Report on the *Strategy*'s influence on the status of Wisconsin's Species of Conservation Need:
  - Are there species that can now be removed from Wisconsin's list of Species of Greatest Conservation Need? What role did the *Strategy* play in this status change?
  - Are there species that should be added to Wisconsin's list of Species of Greatest Conservation Need?
  - Are there species that were initially identified as 'needing more information' that are now ready to be added to or removed from the list of Species of Greatest Conservation Need?
  - How has the quality and quantity of habitat for the Species of Greatest Conservation Need changed?
  - How has the assessment of issues, threats and conservation actions for the species, Ecological Landscapes, or natural communities changed over the past 10 years?
  - Are conservation actions being implemented and are they having a positive effect on Species of Greatest Conservation Need and their habitats? Are State Wildlife Grant dollars being applied in areas where they have the most impact? (Approaches to evaluate these are clearly laid out in the Monitoring Chapter (Chapter 5) and are not repeated here).
  - Are there important conservation actions that were not or could not be implemented? What can be done to remedy this situation?

- Report on the database and information management:
  - Is there an accessible and dynamic database system for the Species of Greatest Conservation Need and their habitats?
  - What progress has been made to inform and involve the public in becoming aware of and taking action to protect or restore the Species of Greatest Conservation Need and their habitats?

- Report on coordination and communication among conservation partners?
  - Have outreach and coordination efforts been effective and included all partners?
  - What feedback do conservation partners have to offer based on their perspective and experience in implementation?
  - Do we have evidence that Wisconsin's Strategy is embraced as a statewide base for information and planning?

- Include the performance measures and analysis through Monitoring (see Chapter 5) as an integral part of *Strategy* revision.

- Identify the issues and topics that were beyond reach during the development of the first Strategy and select those that are of priority to cover during revision. For example:
  - Consider approaches for partners to collectively recommend priority threats and conservation actions at a regional level.
  - Consider approaches to more fully explore threats and conservation action in social and economic contexts.
  - Take steps to better integrate the invertebrate species into the summary and analysis of vertebrate Species of Greatest Conservation Need and their habitats.

The ten-year review and revision will also encompass and build upon each of the checks listed below for the more rapid, efficient short-term reviews.

Short Term Checks (at approximately 2-year intervals)

- Scan for new Issues & Threats: Are there any major new threats to species or their habitats that must be addressed through immediate conservation actions?
  - For example, large-scale energy development, outbreaks of disease such as the West Nile virus, a documented population crash or damage to major portion of a species' habitat, or predictions of the impacts of global warming.

- Check the list of Species of Greatest Conservation Need: Revisions to the list of Species of Greatest Conservation Need will be considered if substantial new information indicates that revisions are warranted. Global and state ranks will be updated based on changes to Natural Heritage Inventory rankings. Species experts will check to see if there are significant enough adjustments to the ranking criteria, given any new information now available and with special attention to those species previously identified as having information needs, to warrant a full review of the list. Assuming that there are substantive changes to the species rankings, scores will be recalculated and the list of Species of Greatest Conservation Need revised.

- Check the effectiveness of database management:
  - Are data gathered through State Wildlife Grants being captured in the Natural Heritage Inventory and other relevant databases?
  - Is new and significant information about the Species of Greatest Conservation Need and their habitats being added to the database as appropriate to help identify critical conservation issues and needs?

- Check the outcomes of the State Wildlife Grants:
  - Is implementation helping conservation partners move from strategy to on-the-ground operation?
  - Are projects being completed on time and with expected results?
  - Are grantees submitting results in the format needed to keep consistent records and contribute to the science-based management and effective monitoring of the Species of Greatest Conservation Need and their habitats?

- Check the overall effectiveness of the *Strategy* administration, coordination, and communication:
  - Are coordination and communication going smoothly, and have partners been effectively involved?

- Is the infrastructure to support database and website management, monitoring, and overall administration, coordination, communication, and outreach sufficient?
- Are the Regional Ecologists adequately supported, with consistent guidance and resources, to lead *Strategy* implementation in the regions?
- Are the most recent updates to the *Strategy* routinely available through newsletters, status reports, and the web?
- Is current information on the Species of Greatest Conservation Need, their habitats, and priority conservation actions currently being implemented for both readily available to all Wisconsin partners and citizens?

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