



Rapid Ecological Assessment for the Sauk Prairie Recreation Area

A Rapid Ecological Assessment Focusing on Rare Plants, Selected Rare Animals, and High-quality Natural Communities

Wisconsin's Natural Heritage Inventory Program
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The Sauk Prairie Recreation Area has been the beneficiary of over a decade's worth of dedicated efforts by many citizens, scientists, and resource professionals to enhance the natural elements at the former Badger Army Ammunition Plant. These efforts have resulted in numerous publications that have been of great benefit to the authors of this report. It was our intention to use these reports as a foundation for updating the status of important species as well as habitat restoration opportunities. Often these reports provide more detail on the soils, hydrology, vegetation, and animal species than this report. These reports will be of great importance to the property master planning team.

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Cover Photo: Oleum Pond at BAAP. Photo by Tessa Whitemarsh.

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The Sauk Prairie Recreation Area At a Glance

Exceptional Characteristics of the Study Area

- **Rare Animals and Plants.** The Sauk Prairie Recreation Area (SPRA) supports numerous rare species. Thirty-three rare animal species are known from the SPRA, including four State Threatened and 29 Special Concern species. Seven rare plant species are known from the SPRA, including two State Endangered (one is also Federally Threatened) and five State Threatened species.
- **Grassland and Shrubland Birds.** Biologists and birders are concerned about population declines of many grassland bird species. Since the North American Breeding Bird Survey (BBS) began in 1966, grassland birds have declined more steeply than any other group of birds in North America and the Midwest (Sample and Mossman 1997; Askins et al. 2007). The SPRA provides extensive surrogate grassland, shrubland, and savanna habitat for 97 confirmed or probable breeding bird species (Mossman 2003). This is an impressive list for an area the size of the SPRA, especially the number and diversity of grassland and shrubland birds (21 species).
- **Bat Conservation.** The Driftless Area of Wisconsin, including the Baraboo Hills, is particularly rich in known and potential bat hibernacula sites within easy commuting distance to the SPRA for summer resident bat populations. The SPRA also provides habitat along a critical migratory corridor, the Lower Wisconsin River. Military ammunitions production and storage bunkers and similar facilities at the former Badger Army Ammunition Plant (BAAP) may provide a unique opportunity to help in the prevention and recovery of bat populations from White-Nose Syndrome (WNS; Schehr 2011), an emerging threat to Wisconsin's bats.

Site Specific Opportunities for Biodiversity Conservation

Two ecologically important sites were identified on the SPRA. These "Primary Sites" were delineated because they generally encompass the best examples of 1) rare and representative natural communities, 2) documented occurrences of rare species populations, and/or 3) opportunities for ecological restoration or connections. These sites warrant high protection and/or restoration consideration during the development of the property master plan.

- **Sauk Prairie Recreation Area Baraboo Hills Forest.** This site contains the most diverse topographic features of the SPRA and constitutes a part of the Baraboo Hills. The significance of this site is that it creates a buffer to the highly-significant Baraboo Hills and South Bluff/Devil's Nose State Natural Area. This site harbors degraded examples of Bedrock Glade and Oak Woodland and supports habitat for rare plant and animal species.
- **Sauk Prairie Recreation Area Dry Prairie and Woodland.** This site, located in the Magazine Area, features a complex of remnant prairie, Oak Woodland, and surrogate grassland. This site offers an opportunity to restore two globally rare natural communities and improve habitat for many grassland, savanna, and woodland plants and animal specialists. Rare plants have been known from this area, although recent intensive surveys have not relocated the populations. Some of these rare plant populations may be restored with appropriate management.

Introduction

Purpose and Objectives

This report is intended to be used as a source of information for developing a master plan for the 3,405-acre Sauk Prairie Recreation Area (SPRA) (Figure 1)-- site of the former Badger Army Ammunition Plant (BAAP). The authors of this report recognize the rich history of research, restoration, and collaboration that has taken place at this site. In this report we consolidate that information with results from recent biotic inventories on 1,853 acres of the SPRA, into a standard format useful for master planning documents.

The primary objectives of this project were to review literature and research for the SPRA, collect biological inventory information relevant to the development of a master plan for the SPRA and to analyze, synthesize and interpret this information for use by the master planning team. This effort focused on assessing areas of documented or potential habitat for rare species and identifying natural community management opportunities.

Survey efforts for the SPRA were limited to a “rapid ecological assessment” for 1) identifying and evaluating ecologically important areas, 2) documenting rare species occurrences, and 3) documenting occurrences of high quality natural communities. This report can serve as the “Biotic Inventory” document used for master planning, although inventory efforts were reduced compared to similar projects conducted on much larger properties such as state forests. There will undoubtedly be gaps in our knowledge of the biota of this property, especially for certain taxa groups, which present opportunities for future work.

Overview of Methods

The Wisconsin Natural Heritage Inventory (NHI) program is part of the Wisconsin DNR’s Bureau of Endangered Resources and a member of an international network of natural heritage programs representing all 50 states, as well as portions of Canada, Latin America, and the Caribbean. These programs share certain standardized methods for collecting, processing, and managing data for rare species and natural communities. NatureServe, an international non-profit organization (see www.NatureServe.org for more information), coordinates the network.

Natural heritage programs track certain elements of biological diversity: rare plants, rare animals, high-quality examples of natural communities, and other selected natural features. The NHI Working List contains the elements tracked in Wisconsin. They include endangered, threatened, and special concern plants and animals, as well as the natural community types recognized by NHI. The NHI Working List is periodically updated to reflect new information about the rarity and distribution of the state’s plants, animals, and natural communities. The most recent Working List is available from the Wisconsin DNR website (*Wisconsin Natural Heritage Working List*).

The Wisconsin NHI program uses standard methods for biotic inventory to support master planning (Appendix A). Our general approach involves collecting relevant background information, planning and conducting surveys, compiling and analyzing data, mapping rare species and high quality natural community locations into the NHI database, identifying ecologically important areas, and providing interpretation of the findings through reports and other means.

Existing information related to rare species and high quality natural communities are often the starting point for conducting a biotic inventory to support master planning. Extensive data exists for the SPRA and is described in more depth throughout the report.

The most recent taxa-specific field surveys for the study area were conducted during 2011 on 1,853 acres of the SPRA (Table 1, Fig. 3). The collective results from all of these surveys were used, along with other recent or ongoing surveys that covered the entire SPRA (Table 2), to identify ecologically important areas (Primary Sites) on the entire SPRA.

Survey locations were identified or guided by using recent aerial photos, USGS 7.5' topographic maps, various Geographic Information System (GIS) sources, information from past survey efforts, and the expertise of several biologists familiar with the property or with similar habitats in the region. Based on the location and ecological setting of the SPRA, key inventory considerations included the identification of high quality prairie, oak savanna, and oak woodland communities and the location of habitats that had the potential to support rare species. Only fee-title state lands were surveyed as part of this effort.

Within this report scientific names are used with first mention of species, thereafter the common name is used. A list of all common names used is available on pages 47-48.

Table 1. Field surveys coordinated by the Natural Heritage Inventory in 2011.

Survey	Biologist(s)	Scope of Taxa Surveyed
Aquatic Invertebrates	Kurt Schmude, William A. Smith	All species sampled were documented.
Bats	Jennifer Schehr, Heather Kaarakka	Data were collected for all species encountered.
Birds	Kim Kreitinger	Bird counts documenting all species encountered and targeted surveys for select species on the Working List.
Herptiles	Noah Anderson	Targeted surveys for Working List species. All species encountered during these surveys were documented.
Rare Plants, Natural Communities, Invasive Plants	Christina Isenring	Targeted surveys for Working List species, high-quality natural communities, and invasive plants. All species encountered during these surveys were documented.
Stream Monitoring	Jean Unmuth	Fish, quantitative habitat, macroinvertebrates, and water quality were sampled.
Terrestrial Invertebrates	Kathryn Kirk, Kyle Johnson	Targeted surveys for Working List species. All species encountered during these surveys were documented.

Table 2. Additional recent or ongoing field survey efforts accessed for the Rapid Ecological Assessment.

Survey	Biologist(s)	Scope of Taxa Surveyed
Aquatic Invertebrates	William L. Hilsenhoff	Stream and pond sampling.
Birds	Mike Mossman (ongoing), Dan Wenny, Rebecca Schroeder	Data were collected for all species encountered. Targeted taxa include grassland, shrubland and nocturnal birds.
Herptiles	Gary Casper (ongoing), Mike Mossman (ongoing), Keith Koivisto, Kathy Thompson	Targeted surveys for Working List species, auditory surveys, salamander breeding pond surveys, studies of neotenic tiger salamanders. All species encountered during these surveys were documented.
Mammals	Mike Mossman (ongoing), Keith Koivisto	All species encountered during surveys were documented.
Pond Sampling	Stanley Dodson, Eric Janssen, Rachel Murray, Emily Sack, Ericka Scarpace	Located and measured ponds and collected water samples.
Rare Plants, Natural Communities, Invasive Plants	Andy Clark, Paul Bockenstedt	Targeted surveys for Working List species, high-quality natural communities, and invasive plants. All species encountered during these surveys were documented.
Terrestrial Invertebrates	Ann Swengel	Targeted surveys for butterflies. All species encountered during surveys were documented.

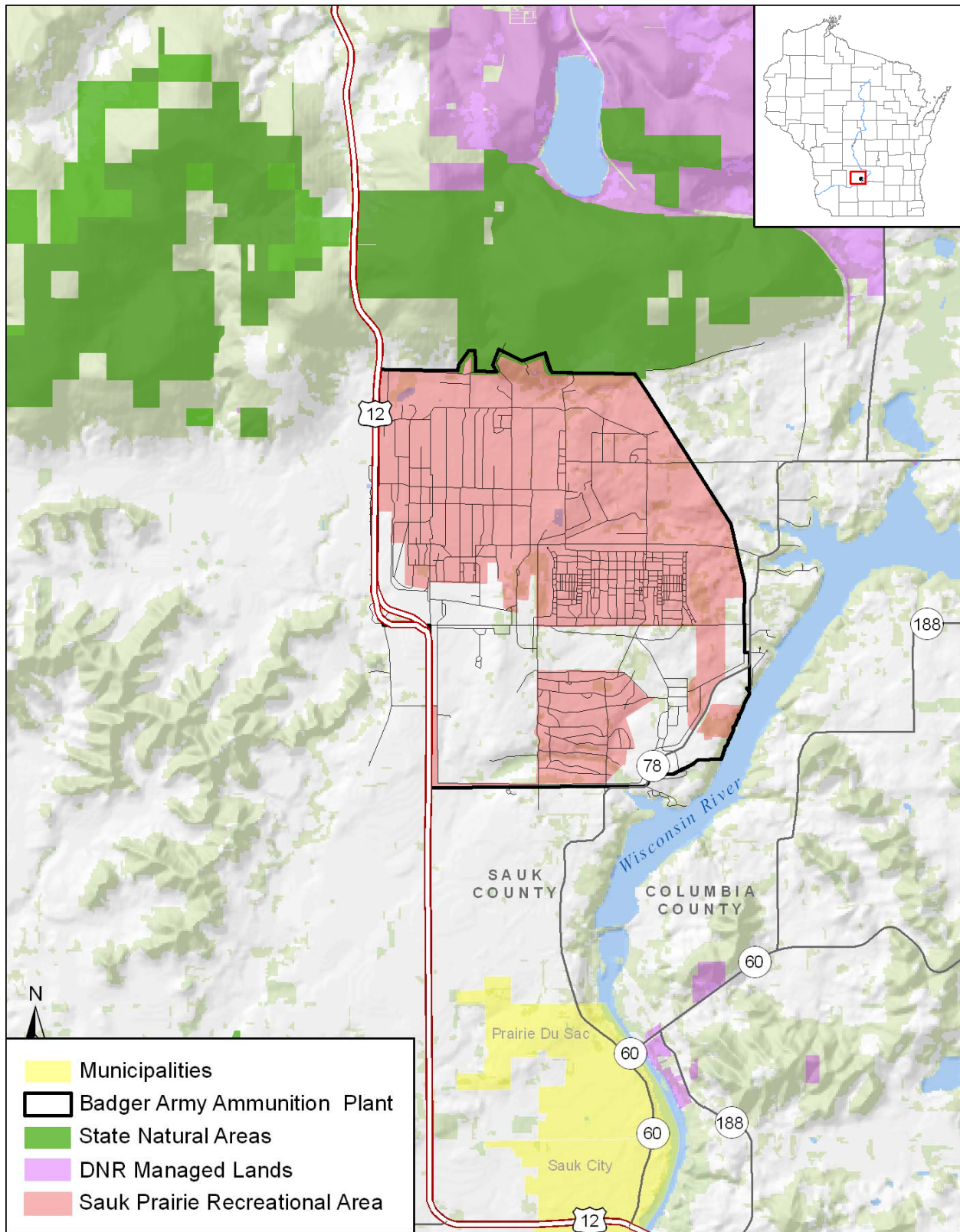


Figure 1. Overview of the Sauk Prairie Recreation Area.

Background on Past Efforts

Various large-scale research and planning efforts have identified the SPRA as being ecologically significant. The following are examples of such projects and the significant features identified.

Land Legacy Report

The Land Legacy Report (WDNR 2006a) was designed to identify Wisconsin's most important conservation and recreation needs for the next 50 years. The BAAP was recognized as having high conservation significance. The site was assigned a score of four points on their five-point scale, meaning they possess "excellent ecological qualities, are of adequate size to meet the needs of most of the critical components, and/or harbor natural communities or species of continental significance."

Grassland Bird Habitat Management

The Badger Army Ammunition Plant was recognized as a Priority Landscape for Grassland Bird Management (Sample and Mossman 1997) because of the grassland bird habitat present including: idle warm season grass/forb (short, medium, and tall), oak savanna, and dry old field.

The Baraboo Hills

The Baraboo Hills, of which the SPRA includes a very small portion, has been recognized by many previous efforts as significant. The Baraboo Hills have been designated by The Nature Conservancy as one of the Western Hemisphere's "Last Great Places," by the U.S. Department of Interior as a National Natural Landmark, by the Wisconsin DNR as a Forest Legacy Area and a Conservation Opportunity Area of continental significance, and by the Wisconsin Bird Conservation Initiative as an Important Bird Area.

Special Management Designations

Forest Certification

All DNR-managed lands, including state parks, wildlife areas, and natural areas, are recognized by the Forest Stewardship Council and the Sustainable Forestry Initiative as being responsibly managed (WDNR 2009). This certification emphasizes the state's commitment to responsibly managing and conserving forestlands, supporting economic activities, protecting wildlife habitat, and providing recreational opportunities.

Public and Private Conservation Lands

Besides the Wisconsin DNR, the other owners and managers of the site of the former BAAP are the Army and Dairy Forage Research Center. The SPRA is continuous with the south end of Devil's Lake State Park. The SPRA is located near extensive properties owned by The Nature Conservancy that are managed as State Natural Areas, as well as near property managed by Riverland Conservancy.

Regional Ecological Context

Western Coulee and Ridges and Central Sand Hills Ecological Landscapes

This section is largely reproduced from the Ecological Landscapes of Wisconsin Handbook (WDNR In Prep.). The WDNR has mapped the state into areas of similar ecological potential and geography called Ecological Landscapes. The Ecological Landscapes are based on aggregations of smaller ecoregional units (Subsections) from a national system of delineated ecoregions known as the National Hierarchical Framework of Ecological Units (NHFEU) (Cleland et al. 1997). These ecoregional classification systems delineate landscapes of similar ecological pattern and potential for use by resource administrators, planners, and managers.

The SPRA is located in both the Western Coulee and Ridges and Central Sand Hills Ecological Landscapes (WDNR In Prep.) (Figure 2). The **Western Coulee and Ridges Ecological Landscape** extends over 9,642 square miles, representing 17.2% of the land area of the State of Wisconsin. It is the largest Ecological Landscape in the State.

The Western Coulee and Ridges Ecological Landscape in southwestern and west central Wisconsin is characterized by its lack of glaciation. It is part of the region called the “Driftless Area” because it lacks glacial deposits (although glacial outwash materials do occur in river valleys). The topography here is unique in Wisconsin due to the long period of erosion, with dissected ridges, steep-sided valleys, and extensive networks of streams. The Western Coulee and Ridges is still relatively heavily forested as compared with the rest of southern Wisconsin. The Baraboo Range, formed primarily of the Precambrian Baraboo Quartzite, is located in the eastern part of the Ecological Landscape. Several large rivers including the Wisconsin, Mississippi, Chippewa, Kickapoo and Black, flow through or border the Ecological Landscape.

Historical vegetation for the Western Coulee and Ridges Ecological Landscape consisted of southern hardwood forests, oak savanna, scattered prairies, and Floodplain Forests and marshes along the major rivers. As a result of widespread Euro-American settlement, most of the relatively flat land on ridgetops and valley bottoms was cleared of oak savanna, prairie, and forest for agriculture. The steep slopes between valley bottom and ridgetop, unsuitable for raising crops, grew into oak-dominated forests after the pre-settlement wildfires were suppressed.

The **Central Sand Hills Ecological Landscape** is located in central Wisconsin 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 mosaic 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.

Historical 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. 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. The major forested type is oak-hickory, with smaller amounts of white-red-jack pine, maple-basswood, lowland hardwoods, aspen-birch, and spruce-fir.

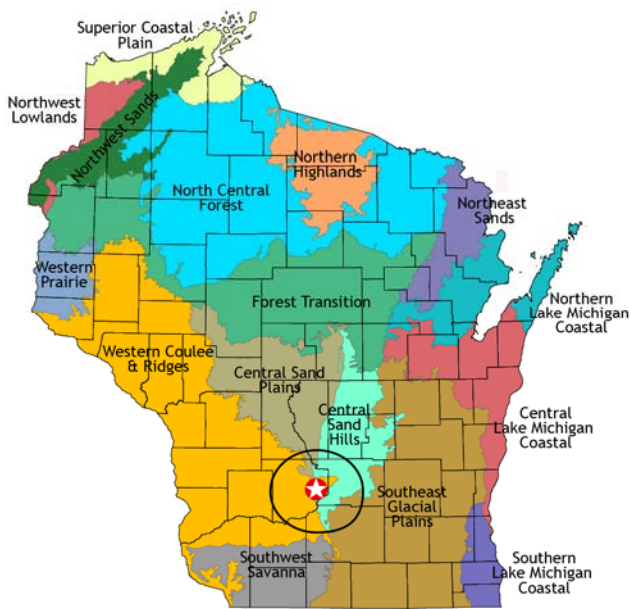


Figure 2. Ecological Landscapes of Wisconsin and the Sauk Prairie Recreation Area.

Regional Biodiversity Needs and Opportunities

Opportunities for sustaining natural communities in the Western Coulee and Ridges and Central Sand Hills Ecological Landscapes were developed in 2005 by the Ecosystem Management Planning Team (EMPT 2007) and—based on wildlife Species of Greatest Conservation Need and their habitats—by the Wisconsin Wildlife Action Plan (WDNR 2006b). The goal of sustaining natural communities is to manage for natural community types that 1) historically occurred in a given landscape and 2) have a high potential to maintain their characteristic composition, structure, and ecological function over a long period of time (e.g., 100 years). This list of opportunities can help guide land and water management activities so that they are compatible with the local ecology of the Ecological Landscape while maintaining important components of ecological diversity and function. Based on EMPT’s criteria, these are the most appropriate community types that could be considered for management activities within the Western Coulee and Ridges and Central Sand Hills Ecological Landscapes.

There are management opportunities for 45 natural communities in the **Western Coulee and Ridges Ecological Landscape**. Management opportunities vary within the Ecological Landscape and each area should be evaluated to determine if management and restoration is appropriate for that natural community. Of these, 24 are considered “major” opportunities (Table 1). A “major” opportunity indicates that the natural communities can be sustained in the Ecological Landscape, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful in maintaining the community’s composition, structure, and ecological function over a longer period of time. An additional 13 natural communities are considered “important” in this landscape. An “important” opportunity indicates that 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.

Table 3. Major Natural Community Management Opportunities in the Western Coulee and Ridges Ecological Landscape (EMPT 2007 and WDNR 2006b)

Algific Talus Slope	Dry Prairie	Oak Barrens	Southern Dry Forest
Bedrock Glade	Dry-mesic Prairie	Oak Opening	Southern Dry-mesic Forest
Cedar Glade	Emergent Marsh	Oak Woodland	Southern Mesic Forest
Coldwater streams	Floodplain Forest	Pine Relict	Submergent Marsh
Coolwater streams	Hemlock Relict	Sand Prairie	Surrogate Grasslands
Dry Cliff	Moist Cliff	Shrub Carr	Warmwater rivers

There are management opportunities for 46 natural communities in the **Central Sand Hills Ecological Landscape**. Of these, 14 are considered “major” opportunities (Table 2) and an additional 19 natural communities are considered “important” in this landscape.

Table 4. Major Natural Communities Management Opportunities in the Central Sand Hills Ecological Landscape (EMPT 2007 and WDNR 2006b)

Calcareous Fen	Impoundments/Reservoirs	Southern Sedge Meadow
Central Sands Pine - Oak Forest	Inland lakes	Submergent Marsh
Coastal Plain Marsh	Northern Wet Forest	Warmwater rivers
Coldwater streams	Shrub Carr	Wet-mesic Prairie
Emergent Marsh	Southern Dry Forest	



Surrogate Grassland habitat at the SPRA. Photo by Christina Isenring.

Rare Species of the Western Coulee and Ridges and Central Sand Hills Ecological Landscape

Numerous rare species are known from the Western Coulee and Ridges and Central Sand Hills Ecological Landscapes. “Rare” species include all of those species on the WDNR’s NHI Working List (*Wisconsin Natural Heritage Working List*) that are classified as “Endangered,” “Threatened,” or “Special Concern.” Table 3 lists the number of species known to occur in the Western Coulee and Ridges Ecological Landscape and Table 4 lists the number of species known to occur in the Central Sand Hills Ecological Landscape based on information stored in the NHI database as of October 2011.

Table 5. Listing Status for rare species in the Western Coulee and Ridges Ecological Landscape as of October 2011 (WDNR 2011).

Listing Status	Taxa Groups					Total Fauna	Vascular Plants	Total Listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
Federally Endangered	1	0	0	0	3	4	0	4
Federally Threatened	0	0	0	0	0	0	2	2
Federal Candidate	0	0	1	0	2	3	0	3
State Endangered	0	6	5	7	17	35	18	53
State Threatened	2	9	2	9	10	32	26	58
State Special Concern	4	13	11	10	74	112	62	174

Table 6. Listing Status for rare species in the Central Sand Hill Ecological Landscape as of October 2011 (WDNR 2011).

Listing Status	Taxa Groups					Total Fauna	Vascular Plants	Total Listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
Federally Endangered	1	0	0	0	1	2	0	2
Federally Threatened	0	0	0	0	0	0	2	2
Federal Candidate	0	0	1	0	1	2	0	2
State Endangered	0	6	5	1	6	18	9	27
State Threatened	1	7	2	7	7	24	14	38
State Special Concern	2	13	6	9	35	65	30	95

The Wisconsin Wildlife Action Plan denoted Species of Greatest Conservation Need (SGCN). Species of Greatest Conservation Need are animals that have low and/or declining populations that are in need of conservation action. They include various birds, fish, mammals, reptiles, amphibians, and invertebrates (e.g. dragonflies, butterflies, and freshwater mussels) that may be:

- Already listed as threatened or endangered;
- At risk because of threats to their life history needs or their habitats;
- Stable in number in Wisconsin, but declining in adjacent states or nationally.
- Of unknown status in Wisconsin and suspected to be vulnerable.

SGCN status is independent of State Listing Status and the NHI Working List. Most but not all SGCNs are on the NHI Working List (published June 2011); in addition, the NHI Working List also includes rare

species that are not designated as SGCN. There are 72 vertebrate SGCN significantly associated with the Western Coulee and Ridges Ecological Landscape and 42 vertebrate SGCN significantly associated with the Central Sand Hills Ecological Landscape (See Appendix B). This means that these species are (and/or historically were) significantly associated with the Ecological Landscape, and that restoration of natural communities with which they are associated would significantly improve conditions for their survival.

Description of the Study Area

Location and Size

The BAAP is a 7,354-acre facility that was constructed in 1942 to produce propellants for use in World War II and subsequent global conflicts. The BAAP is located in southern Sauk County west of the Wisconsin River, south of the Baraboo Hills, and 30 miles northwest of the city of Madison (Figure 1). At the time of its construction in 1942, 80 farm families were removed from the area. Originally named Badger Ordnance Works, the facility was renamed Badger Army Ammunition Works in 1963 and eventually became known as the Badger Army Ammunition Plant.

It has been in standby (idle) status since 1975. At peak use of the facility, BAAP contained 1,427 buildings, 130 miles of roads, 26 miles of rail, and countless miles of steam and power lines. The BAAP was decommissioned in 1997 and clean-up of buildings and other material continues.

The SPRA comprises ca. 3,405 acres of the former BAAP. The recent inventory effort included 1,853 acres with the remaining 1,552 acres added to the project after completion of the field season (Figure 3). The SPRA provides grassland and shrubland habitat that is unique within the surrounding landscape, and a connection between the Wisconsin River and the Baraboo Hills (Figure 3).



View of the SPRA from overlook near cement retention ponds. Photo by Christina Isenring.

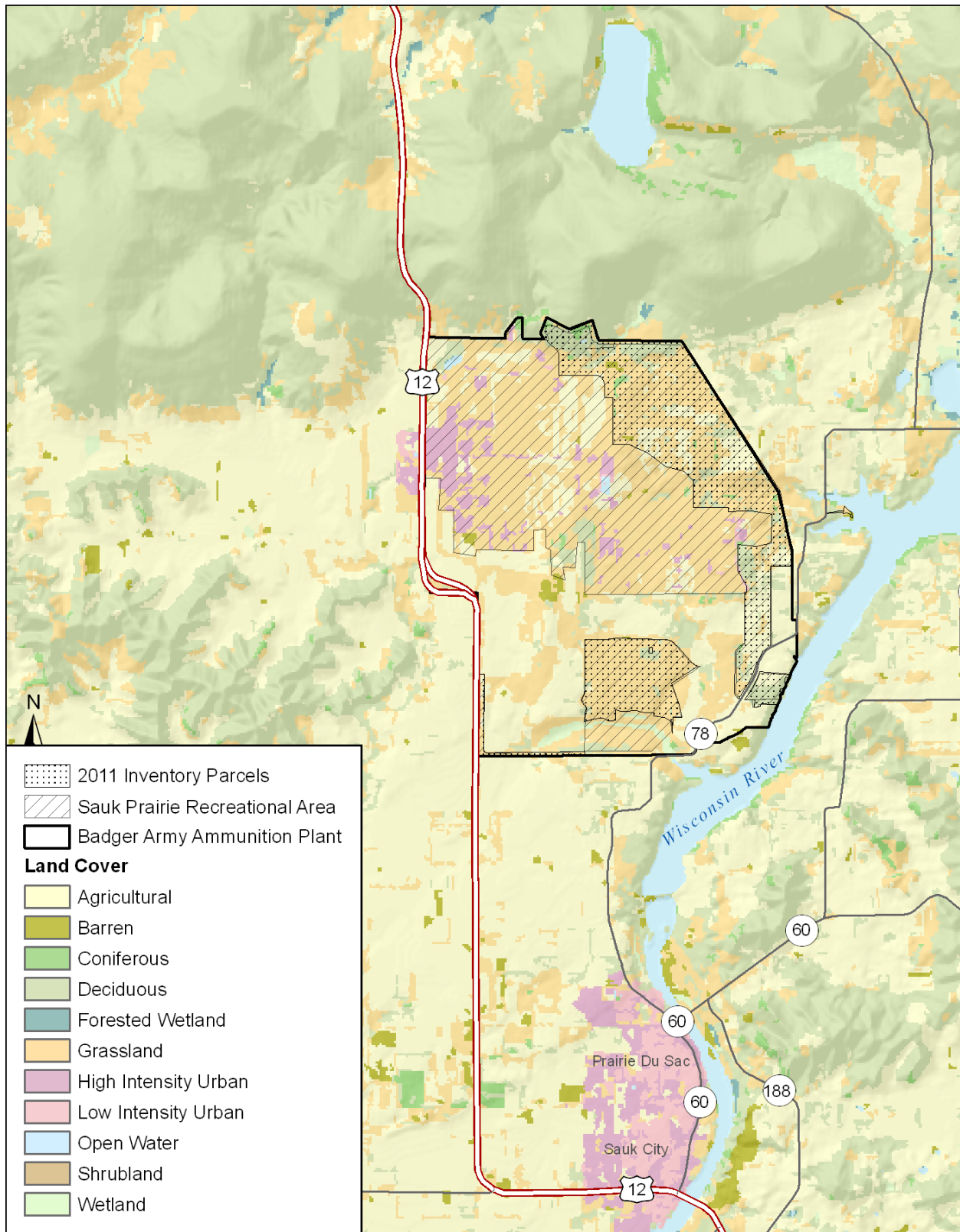


Figure 3. Landcover for the Sauk Prairie Recreation Area from the Wisconsin DNR Wiscland GIS coverage (WDNR 1993) and 2011 Biotic Inventory Survey Parcels.

Ecoregion

Landtype Associations

Nested hierarchically within each Ecological Landscape are Subsections derived from the NHFEU and each Subsection is further divided into Landtype Associations (LTAs) (Cleland et al. 1997). Landtype Associations (LTAs) are the finer scaled polygons, areas of 10,000 – 300,000 acres, that make up each subsection characterized by repeating patterns of characteristic landforms, soil groups, regional climate, and potential vegetation and are most relevant to this study. Figure 5 shows the distribution of the following LTAs on SPRA:

The following Landtype Associations are within the study area:

- **Moon Valley Plains (222Kd06) – Central Sand Hills Ecological Landscape.** The characteristic landform pattern is undulating till, outwash, and lake plain complex. Soils are predominantly well drained silt and loam over calcareous sandy loam till, gravelly sand outwash, or silty and sandy lacustrine.
- **West Baraboo Ridge (222Ld03) – Western Coulees and Ridges Ecological Landscape.** The characteristic landform pattern is steep with hills, stream terraces and floodplains common. Soils are well drained silt, typically over quartzite
- **Mississippi River Valley Train – South (222Lc17) – Western Coulees and Ridges Ecological Landscape.** The characteristic landform pattern is valley train terrace and floodplain with river islands and flood plains. Soils are excessively drained and poorly drained sandy soils with a loamy fine sand or sand surface over non-calcareous sand alluvium or outwash.

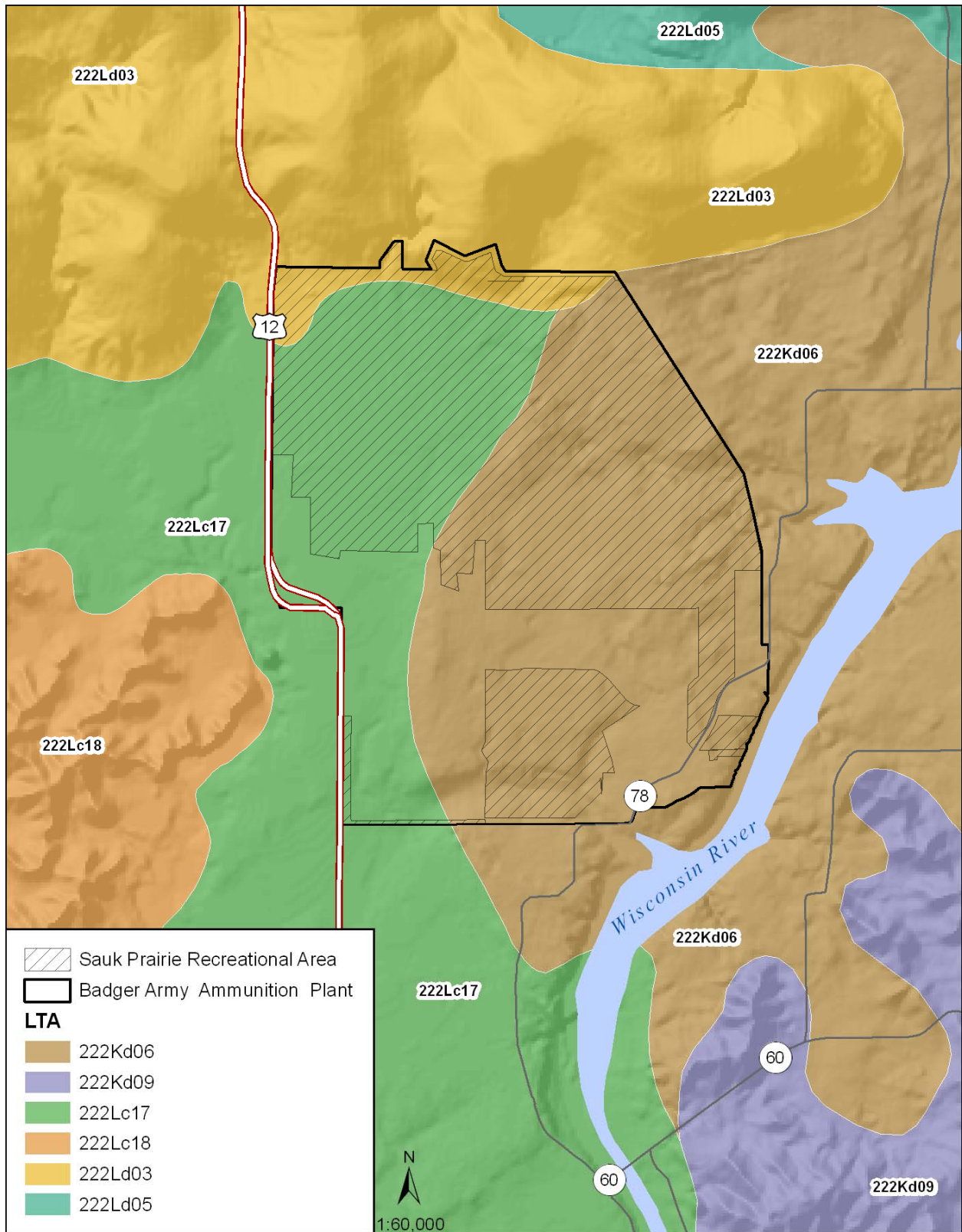


Figure 4. Landtype Associations for the Sauk Prairie Recreation Area.

Physical Environment

Geology and Geography

The SPRA lies immediately south of, and includes a very small area of, the Baraboo Hills, an ancient Precambrian mountain chain comprised primarily of erosion-resistant Baraboo quartzite, rhyolite, granite and diorite (Luthin 1999). The soils at the SPRA were deposited during the last part of the Wisconsin Glaciation between 15,000 and 10,000 years ago as the Green Bay Lobe retreated. Approximately the eastern half of the SPRA was covered by glacial ice that left a layer of till. At the edge of the glacier the Johnstown moraine developed and is currently visible as a low ridge. As the glacier remained stagnant at the Johnstown moraine an outwash plain of sand and gravel developed, in some places exceeding 300 feet thick (Dott and Attig 2004).

Soils

This section is largely based on Gundlach 1980 (with later interpretation by Thompson and Welsh 1993) and Luthin 1999.

The SPRA has three distinct topographic zones, resulting from distinct geological histories, that correspond with soil differences. Within and east of the Johnstown moraine, in the glaciated area, soils are a mosaic of silty and sandy medium-textured loams (McHenry, St. Charles, Richwood, Ringwood, and Wyocena) on gentle slopes. This undulating terrain contains several kettle ponds. These mostly well-drained soils are underlain by glacial till. West of the Johnstown moraine, on the relatively flat outwash plain, soils are comprised predominantly of deep and rich Richwood and Toddville silt loams over sandy glacial outwash. Pockets of Plainfield loamy sand occur in the southern third of the SPRA. The north edge of the SPRA lies at the base of and includes a small area within the unglaciated Baraboo Hills. The soils here are less well-drained silt loams and stony silt loams over Baraboo quartzite.

Most of the surface and subsurface soils at the SPRA have been disturbed. Virtually all of the SPRA had been cultivated and/or grazed for much of the 100 years prior to the construction of the BAAP.

Construction and industrial activities resulted in roads and rail lines being built, ditches and ponds dug, and fill material moved from source to construction sites.

Hydrology

Most of the surface water that drains off the SPRA flows west to Otter Creek or south and east to the Wisconsin River. Small kettle ponds are sparsely scattered throughout the study area. Some ponds are of natural origin, while others originated as borrow pits, reservoirs, or farm ponds. Small streams originate in the Baraboo Hills just north of the SPRA and flow south into the SPRA, then are channelled west into two shallow scraped ponds and Otter Creek. Small seeps have been located at the base of the Baraboo Hills. These seeps vary in quality due to previous land use surrounding the seeps or because their source water has been re-directed. Most of the northeast part of the SPRA drains into what was formerly an intermittent creek but is now a series of channels and ditches. These empty into a wetland area connected to the Wisconsin River.

Vegetation

Historical Vegetation

Data from the original Public Land Surveys are often used to infer vegetation composition and tree species dominance for large areas in Wisconsin prior to widespread Euro-American settlement. For the area comprising the SPRA the Public Land Surveys were conducted between 1841 and 1845. The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and

communities that are now altered in number, size, or extent, or which have been changed functionally (for example, by constructing dams or suppressing fires). Although data are limited to a specific snapshot in time, they provide valuable insights into Wisconsin's ecological capabilities. Maintaining or restoring some lands to more closely resemble historical systems and including some structural or compositional components of the historical landscape within actively managed lands can help conserve important elements of biological diversity (WDNR In Prep.).

The broad outwash plain that comprises the western half of the SPRA and areas to the south and west was prairie at the time of European settlement (Finley 1976; Figure 5). This 14,000-acre grassland was called the Sauk Prairie (Lange 1990), named after the Sauk (Sac) Indian inhabitants that had settled in what is today Sauk City during the 1700's. The northeastern and eastern portion of the SPRA, within the glaciated area, was oak savanna/oak opening (Finley 1976; Figure 5). The small portion of the Baraboo Hills within the SPRA was historically oak forest, with a small marsh where a stream exits the hills (Finley 1976; Figure 5).

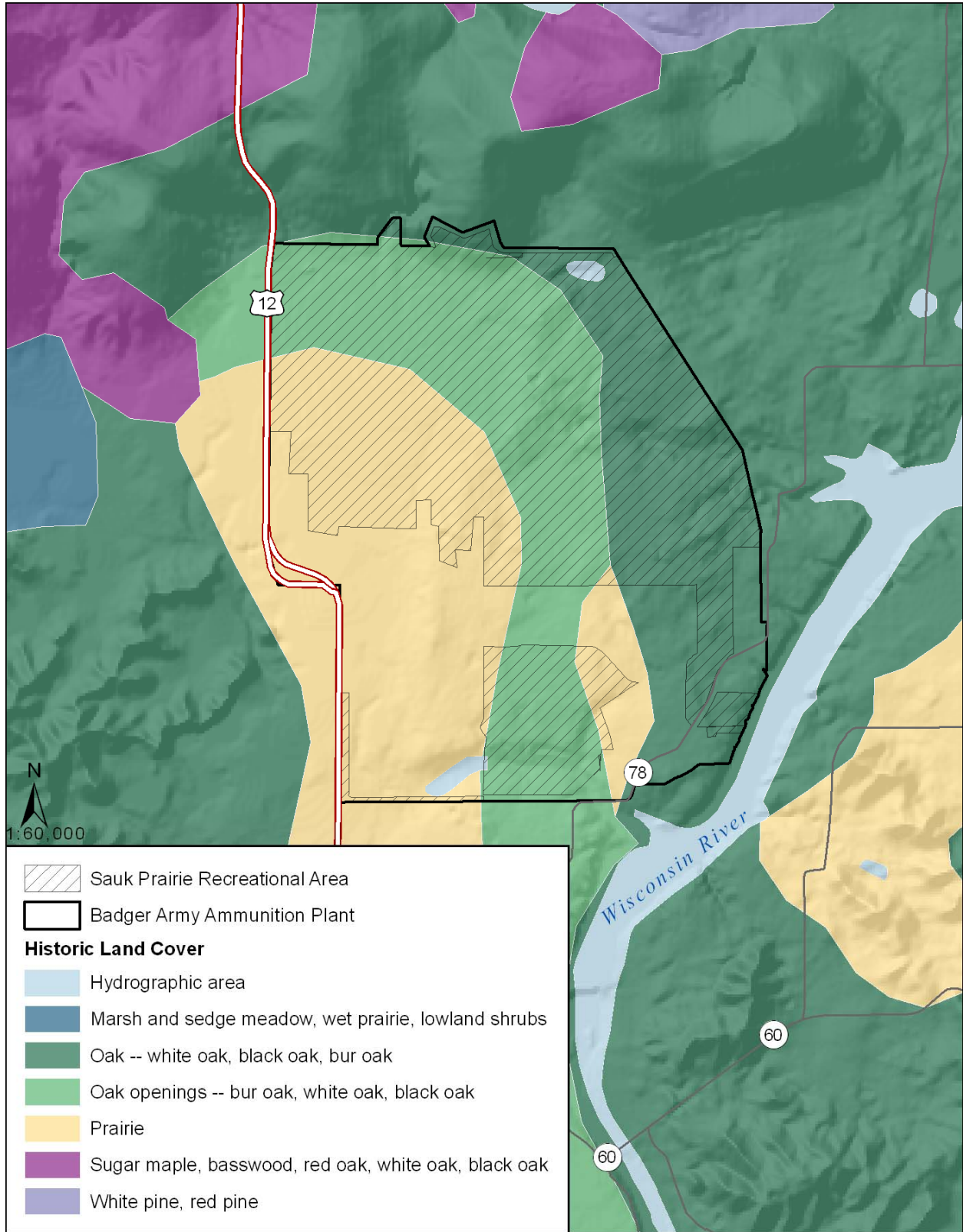


Figure 5. Vegetation for the Sauk Prairie Recreation Area prior to Euro-American settlement. Data are from Finley (1976).

Current Vegetation

By the mid-1800s much of the Sauk Prairie had been converted to agriculture. Review of 1937 aerial photos show that extensive cultivation and some pasture dominated the landscape with little to no tree cover prior to the construction of the BAAP. The large scale soil disturbance that continued with the development of BAAP and the other uses of the land such as cultivation, grazing, management for forestry and wildlife, and lack of management has greatly influenced the current vegetation.

Former agricultural fields and road edges have developed into old fields dominated primarily by smooth brome grass, reed canary grass, and quackgrass. Some row-crop agriculture continues on the property.

Many areas that received heavy disturbance during construction of the BAAP, but which were later abandoned, have grown up into brush and woody thickets of eastern cottonwood (*Populus deltoides*), quaking aspen (*P. tremuloides*), boxelder (*Acer negundo*), black cherry (*Prunus serotina*), black locust (*Robinia pseudoacacia*), and other tree species. Autumn olive (*Elaeagnus umbellata*) and multiflora rose (*Rosa multiflora*), both planted on the property, are abundant in many of these areas. Other planted species include red (*Pinus resinosa*) and white pine (*P. strobus*), white spruce (*Picea glauca*), northern white cedar (*Thuja occidentalis*), and black walnut (*Juglans nigra*).

In the northwest part of the property, the area around the Ballistics Pond was scraped of soil at the time the pond was developed. The altered hydrology allowed wet-adapted species to invade and this area currently resembles a low quality Southern Hardwood Swamp.

Prairie plantings are present and vary in plant species diversity and shrub cover. Many of the prairie plantings are dominated by Canada goldenrod (*Solidago canadensis*), smooth brome (*Bromus inermis*), big bluestem (*Andropogon gerardii*), Kentucky bluegrass (*Poa pratensis*), and Canada thistle (*Cirsium arvense*). Shrubs include honeysuckle (*Lonicera* spp.), common buckthorn (*Rhamnus cathartica*), and autumn olive.

Although much of the vegetation at the SPRA has developed since the original soil disturbance events, some areas retain remnants of original vegetation.

Remnant prairie vegetation at SPRA is very rare, with only three prairies having been located totaling less than six acres. The largest remnant (four acres) is located on a west-facing hill on the western side of the Magazine Area. This low-diversity Dry to Dry-mesic Prairie is dominated by grasses, especially big bluestem (*Andropogon gerardii*), yellow Indian grass (*Sorghastrum nutans*), side-oats grama (*Bouteloua curtipendula*), hairy grama (*B. hirsuta*), and Kentucky bluegrass (*Poa pratensis*). Tree and shrub encroachment (mostly black cherry, autumn olive, honeysuckle, and prickly ash [*Zanthoxylum americanum*]) is common along the edge of the prairie, while problem species such as wild parsnip (*Pastinaca sativa*), Queen Anne's lace (*Daucus carota*), and smooth brome occur within.

Oak Opening (oak savanna), a globally rare natural community, is represented by only one remnant example at the SPRA. This area has semi-open grown bur oaks (*Quercus macrocarpa*; 15-30 inch diameter at breast height [dbh]) in the canopy and black cherry (10 dbh) in the subcanopy over a very dense layer of brambles (*Rubus* spp.), common burdock (*Arctium minus*), honeysuckle, and smooth brome.

Much of the forest on the SPRA has either developed on open old field or from existing Oak Woodland communities. Grazing had maintained the open canopy of the Oak Woodlands, which have developed a closed canopy since grazing has discontinued. These forests, which today resemble Southern Dry and Dry-mesic Forest communities, occur on the south-facing slope of the Baraboo Bluffs (northern edge of the SPRA). They are characterized by various oak species (white [*Quercus alba*], black [*Q. velutina*], and red [*Q. rubra*]) as well as shagbark hickory (*Carya ovata*), black cherry, red maple (*Acer rubrum*), and

ironwood (*Ostrya virginiana*). Thickets of brush, including many non-native invasive species, now dominate the understory in many areas. Forests on open field typically developed from farmstead plantings and hedegrows (especially green ash, American elm, cottonwood and box elder), and forestry plantings of white and red pines, white spruce, and black walnut. A dense shrub cover of multiflora rose, honeysuckle, buckthorn, autumn olive, and crabapples that invaded from wildlife plantings and off-site sources is also present.

Two areas have been identified on the SPRA that are degraded Bedrock Glades. Bedrock Glades are found in scattered locations on unglaciated quartzite throughout the Baraboo Hills. Glacial erratics and 30-foot-tall outcrops are present. The glades intergrade with the surrounding forested communities and have thick canopy cover. Canopy trees are slightly stunted white oak over a subcanopy of shagbark hickory and bur oak. The sapling layer is sparse with prickly-ash. Ground flora is similar to the surrounding forest and dominated by Pennsylvania sedge (*Carex pensylvanica*) with shooting star (*Dodecatheon* sp.) and wild-coffee (*Triosteum perfoliatum*). Rock outcrops have brambles, common ragweed (*Ambrosia artemisiifolia*), and garlic mustard (*Alliaria petiolata*) and other non-native invasive species.

Pine Relicts are unique to the Driftless Area of southwestern Wisconsin and one example is present at SPRA. White pine and black oak dominate the overstory. Early low blueberry (*Vaccinium angustifolium*) and partridgeberry (*Mitchella repens*) occur in the understory.

Detailed vegetation summaries are available in the *Preliminary Ecological Restoration Plan for 1300 Acres of the Badger Army Ammunition Plant, Baraboo, Wisconsin* (Luthin 1999). These summaries will aid the development of the master plan and management goals of the property.



Planted prairie at the SPRA. Photo by Christina Isenring.

Rare Species and High-Quality Natural Communities of the Sauk Prairie Recreation Area

Numerous rare species have been documented within the SPRA. No high quality natural communities were located, although numerous areas have potential to increase in quality with ecological restoration. Table 7 shows the rare species currently known from the SPRA. See Appendix C for summary descriptions of the rare species that occur on the SPRA.

Table 7. Documented rare species and high-quality natural communities for the Sauk Prairie Recreation Area. For an explanation of state and global ranks, as well as state status, see Appendix D. Species with a “W” in the “Tracked by NHI” column are on the Watch List (see Appendix D) and are not mapped in the NHI database. Various sources were used to determine the Watch List species and SGCN present and this may not be a complete list. State status is based on the NHI Working List published June 2011.

Common Name	Scientific Name	Last Observed Date	State Rank	Global Rank	State Status	Federal Status	SGCN	Tracked by NHI
Amphibian								
Pickerel Frog	<i>Lithobates palustris</i>	1993	S3?	G5	SC/H		Y	Y
Aquatic Invertebrate								
A Fingernet Caddisfly	<i>Wormaldia moesta</i>	1993	S2S3	G5	SC/N		Y	Y
A Lepidostomatid Caddisfly	<i>Lepidostoma libum</i>	2011	S2S3	G3G4	SC/N		Y	Y
A Predaceous Diving Beetle	<i>Agabus inscriptus</i>	2011	S2S3	GNR	SC/N		Y	Y
A Predaceous Diving Beetle	<i>Agabus leptapsis</i>	1993	S2S3	GNR	SC/N		Y	Y
A Predaceous Diving Beetle	<i>Hydroporus pseudovilis</i>	2011	S2S3	GNR	SC/N		Y	Y
A Predaceous Diving Beetle	<i>Laccophilus undatus</i>	1993	S2S3	GNR	SC/N		Y	Y
Swamp Darner	<i>Epiaeschna heros</i>	2011	S2S3	G5	SC/N		Y	Y
Bird								
American Woodcock	<i>Scolopax minor</i>	1998	S3S4B	G5	SC/M		Y	W
Bald Eagle	<i>Haliaeetus leucocephalus</i>	2011	S4B,S4N	G5	SC/P		Y	Y
Bell's Vireo	<i>Vireo bellii</i>	2011	S2B	G5	THR		Y	Y
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	2011	S3S4B	G5	SC/M		Y	W
Blue-winged Warbler	<i>Vermivora pinus</i>	2011	S4B	G5	SC/M		Y	W
Bobolink	<i>Dolichonyx oryzivorus</i>	2011	S3S4B	G5	SC/M		Y	W
Brown Thrasher	<i>Toxostoma rufum</i>	2011	S3S4B	G5	SC/M		Y	W
Cerulean Warbler	<i>Dendroica cerulea</i>	2011	S2S3B	G4	THR		Y	Y
Common Nighthawk	<i>Chordeiles minor</i>	2011 ¹	S2S3B	G5	SC/M		N	Y
Dickcissel	<i>Spiza americana</i>	2011	S3B	G5	SC/M		Y	W
Eastern Meadowlark	<i>Sturnella magna</i>	2011	S3S4B	G5	SC/M		Y	W
Field Sparrow	<i>Spizella pusilla</i>	2011	S3S4B	G5	SC/M		Y	W
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	2011	S3B	G5	SC/M		Y	W
Henslow's Sparrow	<i>Ammodramus henslowii</i>	2011	S2S3B	G4	THR		Y	Y
Hooded Warbler	<i>Wilsonia citrina</i>	2011	S2S3B	G5	THR		Y	Y
Least Flycatcher	<i>Empidonax minimus</i>	1998	S4B	G5	SC/M		Y	W
Northern Bobwhite	<i>Colinus virginianus</i>	1998	S2S3B	G5	SC/M		Y	Y

¹ More information is needed on this occurrence before it is processed into the NHI Database.

Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	1998	S3B	G5	SC/M		Y	W
Upland Sandpiper	<i>Bartramia longicauda</i>	2002	S2B	G5	SC/M		Y	Y
Vesper Sparrow	<i>Pooecetes gramineus</i>	2011	S3S4B	G5	SC/M		Y	W
Western Meadowlark	<i>Sturnella neglecta</i>	2002	S2B	G5	SC/M		Y	Y
Whip-poor-will	<i>Caprimulgus vociferus</i>	1998	S3B	G5	SC/M		Y	W
Willow Flycatcher	<i>Empidonax traillii</i>	2011	S4B	G5	SC/M		Y	W
Wood Thrush	<i>Hylocichla mustelina</i>	2011	S4B	G5	SC/M		Y	W
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	2011	S3B	G5	SC/M		Y	W
Yellow-breasted Chat	<i>Icteria virens</i>	2002	S2B	G5	SC/M		N	Y
Mammal								
Big Brown Bat	<i>Eptesicus fuscus</i>	2011	S2S4	G5	THR		N	Y
Eastern Red Bat	<i>Lasiurus borealis</i>	2010	S3	G5	SC/N		Y	W
Hoary Bat	<i>Lasiurus cinereus</i>	2010	S3	G5	SC/N		Y	W
Little Brown Bat	<i>Myotis lucifugus</i>	2010	S2S4	G5	THR		N	Y
Prairie Vole	<i>Microtus ochrogaster</i>	2008	S2	G5	SC/N		Y	Y
Reptile								
Timber Rattlesnake	<i>Crotalus horridus</i>	2004	S2S3	G4	SC/P		Y	Y
Animal Assemblage								
Bat Hibernaculum		2011 ²	S3	GNR	SC		N	Y
Plant								
Drooping Sedge	<i>Carex prasina</i>	1993	S3	G4	THR		NA	Y
Pale Green Orchid	<i>Platanthera flava var. herbiola</i>	1993	S2	G4T4Q	THR		NA	Y
Prairie Bush-clover	<i>Lespedeza leptostachya</i>	1993	S2	G3	END	LT	NA	Y
Purple Milkweed	<i>Asclepias purpurascens</i>	1999	S3	G5?	END		NA	Y
Roundstem Foxglove	<i>Agalinis gattingeri</i>	1993	S2	G4	THR		NA	Y
Slender Bush-clover	<i>Lespedeza virginica</i>	1993	S2	G5	THR		NA	Y
Woolly Milkweed	<i>Asclepias lanuginosa</i>	1993	S1	G4?	THR		NA	Y

² More information is needed on this occurrence before it is processed into the NHI Database.

Rare species that are located within one mile of the SPRA and not currently known from the SPRA or mapped at a low precision in the NHI Database (Table 6) are important to consider during planning efforts. These species may be located on the SPRA with additional survey efforts.

Table 8. Rare species that are either 1) found within one mile of the Sauk Prairie Recreation Area (SPRA) and not found on the SPRA or 2) mapped at a low precision. Listing status is based on the NHI Working List published June 2011.

Common Name	Scientific Name	Last Observed Date	State Rank	Global Rank	State Status	Federal Status	SGCN	Tracked by NHI
Animal								
A Predaceous Diving Beetle	<i>Lioporeus triangularis</i>	1985	S2S3	GNR	SC/N		Y	Y
Buckhorn	<i>Tritogonia verrucosa</i>	1993	S2	G4G5	THR		Y	Y
Acadian Flycatcher	<i>Empidonax virescens</i>	2011	S3B	G5	THR		Y	Y
Black Buffalo	<i>Ictiobus niger</i>	1980	S2	G5	THR		Y	Y
Blanding's Turtle	<i>Emydoidea blandingii</i>	1982	S3S4	G4	THR		Y	Y
Blue Sucker	<i>Cycleptus elongatus</i>	2010	S2	G3G4	THR		Y	Y
Canada Warbler	<i>Wilsonia canadensis</i>	2010	S3S4B	G5	SC/M		Y	W
Eastern Massasauga	<i>Sistrurus catenatus catenatus</i>	1932	S1	G3G4T3 Q	END	C	Y	Y
Gray Ratsnake	<i>Pantherophis spiloides</i>	1920	S3	G5T5	SC/P		Y	Y
Kentucky Warbler	<i>Oporornis formosus</i>	1987	S1S2?B	G5	THR		Y	Y
Lake Sturgeon	<i>Acipenser fulvescens</i>	2005	S3	G3G4	SC/H		Y	Y
Louisiana Waterthrush ³	<i>Seiurus motacilla</i>	2011	S3B	G5	SC/M		Y	Y
Osprey	<i>Pandion haliaetus</i>	2010	S4B	G5	SC/M		Y	W
Pirate Perch	<i>Aphredoderus sayanus</i>	2007	S3	G5	SC/N		N	Y
Pugnose Minnow	<i>Opsopoeodus emiliae</i>	1984	S3	G5	SC/N		N	Y
Shoal Chub	<i>Macrhybopsis aestivalis</i>	2009	S2	G5	THR		Y	Y
Silver Chub	<i>Macrhybopsis storeriana</i>	2010	S3	G5	SC/N		N	Y
Veery	<i>Catharus fuscescens</i>	2010	S3S4B	G5	SC/M		Y	W
Western Ribbonsnake	<i>Thamnophis proximus</i>	1975	S1	G5	END		Y	Y
Western Sand Darter	<i>Ammocrypta clara</i>	2010	S3	G3	SC/N		Y	Y
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	1998	S1B	G5	END		Y	Y
Plant								
Christmas Fern	<i>Polystichum acrostichoides</i>	1991	S2	G5	SC		NA	Y
Hooker's Orchid	<i>Platanthera hookeri</i>	1946	S2	G4	SC		NA	Y
Prairie False-dandelion	<i>Nothocalais cuspidata</i>	1928	S2	G5	SC		NA	Y
Purple-stem Cliff-brake	<i>Pellaea atropurpurea</i>	1947	S2	G5	SC		NA	Y
Small Forget-me-not	<i>Myosotis laxa</i>	1993	S2	G5	SC		NA	Y
Small White Lady's-slipper	<i>Cypripedium candidum</i>	1885	S3	G4	THR		NA	Y
Vasey's Pondweed	<i>Potamogeton vaseyi</i>	1974	S3	G4	SC		NA	Y

³ More information is needed on this occurrence before it is processed into the NHI Database.

Management Considerations and Opportunities for Biodiversity Conservation

Landscape-scale Management

The location of the SPRA, situated between the Baraboo Hills and the formerly extensive Sauk Prairie, presents the opportunity to consider management options within the greater landscape context. For example, grassland, shrubland, and oak savanna restoration and management at the SPRA could be coordinated with similar initiatives at Roznos Meadow within Devil's Lake State Park, at Riverland Conservancy's Merrimac Preserve, and on private lands nearby (Mossman 2003). The SPRA offers a significant opportunity to manage a landscape scale surrogate grassland habitat. Within this surrogate grassland, a mosaic of grassland, shrubland, and savanna habitats could be established to meet the needs of many animal species that require a variety of grassland structure for shelter, foraging, and rearing their young. Managing from a landscape perspective can better accommodate complex habitat needs, including wetland, upland, and savanna components, needed for grassland birds, small mammals, herptiles, terrestrial invertebrates, and other grassland obligate species.

Additionally, the bluffs at the north end of the SPRA are part of the extensive Baraboo Hills, and offer opportunities for coordinated management of oak woodland and glade restoration. By providing this continuum, the habitat needs for wildlife are maximized, and their safe movement from one location to the next is ensured. Birds are extremely mobile, but other animals like small mammals and herptiles need to have suitable habitat connections to enable them to repopulate suitable areas or to fulfill their life history requirements. The SPRA was historically prairie and savanna with connections to the open glades and oak woodlands to the north on the Baraboo bluffs. These connections to open forest types represents a significant opportunity to attract numerous rare snakes by providing critical areas for basking, overwintering den sites, staging areas for gravid females, and habitats for an abundant prey base.

Grassland and Shrubland Birds

Biologists and birders are concerned about population declines of many grassland bird species. Since the North American Breeding Bird Survey (BBS) began in 1966, grassland birds have declined more steeply than any other group of birds in North America as well as the Midwest (Sample and Mossman 1997; Askins et al. 2007). Badger Army Ammunition Plant was recognized as a Priority Landscape for Grassland Bird Management (Sample and Mossman 1997) because of the grassland bird habitat present including idle warm season grass/forb (short, medium, and tall), oak savanna, and dry old field. Grassland and shrubland bird habitat management is a major component of the Natural Resources Management Plan for the former BAAP (Luthin 1999), the ecological restoration plan for 1300 acres of the former BAAP (Luthin 1999), and is addressed in the need to restore prairie and savanna habitat at the former BAAP in Value 7, Criterion 7.2 in the BAAP Reuse Plan (2001).

The SPRA provides habitat for 97 confirmed or probable breeding bird species, of which 21 are grassland and shrubland dependent (Mossman 2003). This is an impressive list for an area the size of the SPRA, especially the number and diversity of grassland and shrubland birds (Table 7). Surrogate grassland/shrubland habitat at the SPRA is made up of a mix of planted prairies, pasture, oak savanna, and old fields ranging from open to densely shrubby.

Grassland and shrubland birds, a group of species of critical conservation need in Wisconsin, would benefit from a diversity of grassland habitat in large unfragmented tracts. Grassland bird habitat is most

effectively maintained as large landscapes of continuous grassland, uninterrupted by hedgerows, with the cover of woody plants less than 5% (Sample and Mossman 1997). Hedgerows fragment grasslands and provide habitat/movement corridors for predators of grassland birds. Structural diversity within the grassland, including scattered patches of shrubs, short and tall grass, amount of residual herbaceous duff, a mix of grasses and forbs, and a management rotation of type, intensity, and frequency, is also important. Currently the high level of shrub and tree encroachment in the grasslands of the SPRA threatens the diverse grassland bird community.

Breeding bird surveys in 1998 and 2011 indicate that invasive shrub growth has greatly increased and has changed the breeding bird composition. Species that have benefited from the increase of shrubs in old fields and the shrub invasion in forests include Bell's vireo (*Vireo bellii*), field sparrow (*Spizella pusilla*), hooded warbler (*Wilsonia citrina*), American redstart (*Setophaga ruticilla*), rose-breasted grosbeak (*Pheucticus ludovicianus*), and gray catbird (*Dumetella carolinensis*). The shrub increase has been too much for some species and caused a shift of clay-colored sparrow (*Spizella pallida*) from areas that have become too shrubby to support them, to areas that were once too open and grassy but are now invaded with their preferred scattering or moderately dense shrubs. In the more open grassland areas that were formerly characterized by scattered buildings and pasture, there has been a decrease in species that formerly used the buildings and utility poles for nesting, e.g., European starling (*Sturnus vulgaris*) and red-headed woodpecker (*Melanerpes erythrocephalus*). The removal of cattle has probably led to decreases in European starling and brown-headed cowbird (*Molothrus ater*). The replacement of pasture with thick tall grass is probably responsible for a big increase in Henslow's sparrow (*Ammodramus henslowii*), a decrease in upland sandpiper (*Bartramia longicauda*) and disappearance of Western meadowlark (*Sturnella neglecta*).

Table 9. Grassland and shrubland birds known from the Sauk Prairie Recreation Area. Listing status is based on the NHI Working List published June 2011.

Common Name	Scientific Name	State Status
Bell's vireo	<i>Vireo bellii</i>	THR
blue-winged warbler	<i>Vermivora pinus</i>	SC/M
bobolink	<i>Dolichonyx oryzivorus</i>	SC/M
brown thrasher	<i>Toxostoma rufum</i>	SC/M
clay-colored sparrow	<i>Spizella pallida</i>	NA
common nighthawk	<i>Chordeiles minor</i>	SC/M
dickcissel	<i>Spiza americana</i>	SC/M
eastern bluebird	<i>Sialia sialis</i>	NA
eastern meadowlark	<i>Sturnella magna</i>	SC/M
field sparrow	<i>Spizella pusilla</i>	SC/M
grasshopper sparrow	<i>Ammodramus savannarum</i>	SC/M
Henslow's Sparrow	<i>Ammodramus henslowii</i>	THR
northern bobwhite	<i>Colinus virginianus</i>	SC/M
orchard oriole	<i>Icterus spurius</i>	NA
savannah sparrow	<i>Passerculus sandwichensis</i>	NA
sedge wren	<i>Cistothorus platensis</i>	NA
upland sandpiper	<i>Bartramia longicauda</i>	SC/M
vesper sparrow	<i>Poocetes gramineus</i>	SC/M
western meadowlark	<i>Sturnella neglecta</i>	SC/M
whip-poor-will	<i>Caprimulgus vociferous</i>	SC/M
yellow-breasted chat	<i>Icteria virens</i>	SC/M

Activities that create an urbanized environment (clean pavement, mowed grass, maintained buildings, and ornamental landscaping) are predicted to produce a bird community dominated by a few non-native and common native bird species (Mossman 2003). Knowledge of the current distribution of critical bird communities at the SPRA suggests that if urbanized environments are to occur, they should be concentrated at the west-central boundary to limit their impact (Mossman 2003). The highest quality habitats for grassland birds (Figure 6) are found in the extensive non-native grasslands (Surrogate Grasslands) in the southcentral tract and northcentral section of the SPRA. High-quality grassland bird habitat with a moderate shrub component is located in the northeast section of the SPRA (Figure 6). These areas should be contiguous and when combined with the restoration potential of the surrounding property and landscape would offer significant management opportunities for viable populations of grassland and shrubland birds.

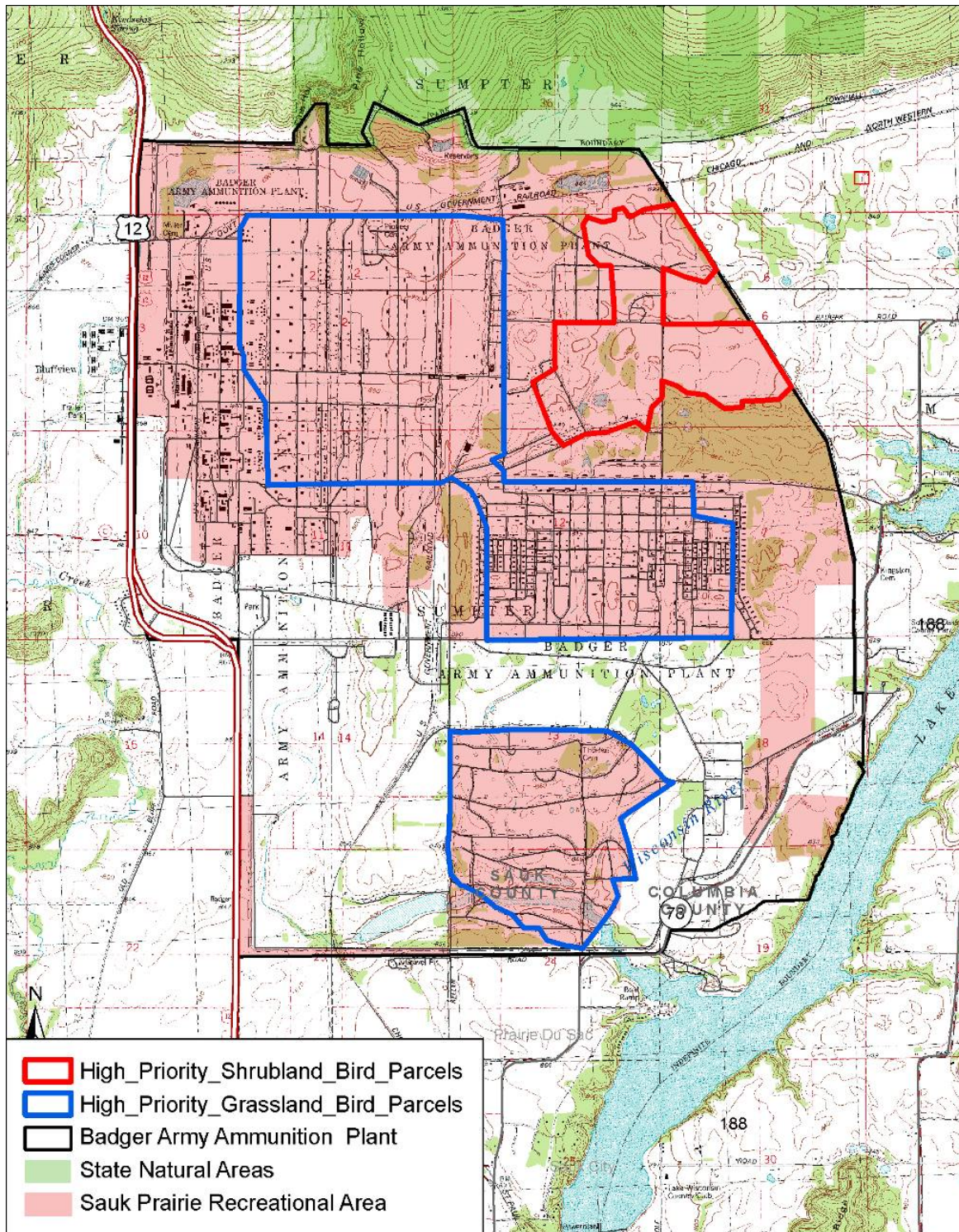


Figure 6. Distribution of Critical Species of open grassland and shrubland habitats at Sauk Prairie Recreation Area, Sauk County, Wisconsin.

Bat Conservation

The Driftless Area of Wisconsin, including the Baraboo Hills, is particularly rich in known and potential bat hibernacula within easy commuting distance of the SPRA for summer resident bat populations. The SPRA also provides habitat along a critical migratory corridor, the Lower Wisconsin River. The older forests of the Baraboo Hills provide favorable characteristics for bats by offering roosting, foraging, and commuting habitat. One limited mobile survey at the SPRA was conducted in June 2010 along roadways primarily encircling the 2011 NHI survey parcels. Surveys detected the presence of four of the seven species currently known from Wisconsin, and included two state Threatened and two Special Concern species.

By feeding on insects, bats are an important component of healthy ecosystems. Opportunities to promote bat habitat include providing resources for roosting, foraging, and drinking. Bats of the SPRA may be roosting under loose, peeling bark and in crevices and cavities in trees. Often these attributes are found in older forests with snags of varying decay level, size, and height.

Foraging is done in and along small to medium forest openings or gaps, such as ponds, natural and artificial openings, roads, or water courses (Taylor 2006). Though uncommon on the highly modified landscape of the SPRA, these habitat features are still important, especially along the south edge of the Baraboo Hills and natural and artificial wetlands on the property. Maintaining diverse forest flora and reducing non-native plant abundance is important for promoting invertebrate prey diversity and thus promoting foraging opportunities for bats (WDNR 2006b).

Water resources are used for drinking, travel, and foraging. Maintaining high-water quality and access to water is important for protecting bat populations. Wide buffers (generally wider than those recommended in Best Management Practices for Water Quality [WDNR 2010c]) around water, including rivers, streams, and wet meadows, are important for bats and other wildlife species using these areas (Taylor 2006).

Hibernaculum disturbance, habitat degradation, and wind-turbine mortality are threats that affect all bat species found in Wisconsin. An emerging threat to Wisconsin's bats, White-Nose Syndrome (WNS) has been called the "most precipitous wildlife decline in the past century in North America" by Bat Conservation International and has devastated bat populations in the eastern United States since 2006 (*White-nose Syndrome*). It has recently been discovered that the fungus *Geomyces destructans* is the causal agent of White-Nose Syndrome (Lorch et al. 2011). Due to the emerging threats that bat populations face in Wisconsin, more surveys (acoustic and roost) are needed to more accurately describe the bats that use the SPRA.

A bat hibernaculum with 50 big brown bats (*Eptesicus fuscus*) was found recently on the property within a man-made structure. Bats hibernate in both the above-ground portion of this building as well as several subsurface reservoir areas and are able to access these areas through several entrances. Military ammunitions production and storage bunkers and similar facilities at the former BAAP may provide additional unique opportunities to help in the prevention of and recovery of bat populations from WNS (Schehr 2011). The subterranean nature of these structures makes them likely candidates for artificial hibernacula due to the buffered temperatures and humid conditions they provide. Without excessive cost or effort, the environmental conditions of these man-made structures are being modified and could possibly be a site of future treatments of the fungus that causes WNS. Structures that could be suitable for use in these efforts include storage magazines, nitroglycerin production bunkers, cannon range tunnels, and subterranean infrastructure such as large-diameter water and sewer piping and water containment areas.

High Conservation Value Forests

The Wisconsin DNR manages 1.5 million acres that are certified by the Forest Stewardship Council (FSC) and the Sustainable Forest Initiative (SFI). Forest certification requires forests to be managed using specified criteria for ecological, social, and economic sustainability. Principle 9 of the *Draft 7 FSC-US Forest Management Standard* concerns the maintenance of High Conservation Value Forests (HCVF). High Conservation Value Forests are defined as possessing one or more of the following:

- Contain globally, regionally, or nationally significant concentrations of biodiversity values, including rare, threatened, or endangered species and their habitats.
- Globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.
- Are in or contain rare, threatened, or endangered ecosystems.
- Provide basic services of nature in critical situations (e.g., watershed protection, erosion control).
- Are fundamental to meeting basic needs of local communities (e.g., subsistence, health).
- Are critical to local communities' traditional cultural identity (areas of cultural, ecological, economic, or religious significance identified in cooperation with such local communities).

Primary Sites, high quality natural communities, and rare species habitat are typically the best HCVF opportunities. Based on the current draft criteria for defining HCVFs (Forest Stewardship Council 2009) opportunities for HCVF on the SPRA are limited, although ecological restoration may elevate these areas to meet HCVF criteria.

Ecological Priorities for SGCN

The Wisconsin Wildlife Action Plan identifies ecological priorities in each Ecological Landscape. Ecological priorities are the natural communities in each Ecological Landscape that are most important to the Species of Greatest Conservation Need. Appendix B highlights the Ecological Priorities for vertebrate SGCN on the SPRA. Note that these Ecological Priorities include all of the natural communities that we have determined to provide the best opportunities for management on the SPRA from an ecological/biodiversity perspective.

Invasive Plants

The unique land use history of the SPRA has contributed to the diversity and abundance of non-native invasive plants present. Some of these non-native invasive plant species have come in on their own (e.g., garlic mustard [*Alliaria petiolata*], Japanese hedge parsley (*Torilis japonica*), (common buckthorn [*Rhamnus cathartica*], black locust) while 52 others have been deliberately planted into the area or are a result of historic farming activities (e.g., reed canary grass [*Phalaris arundinacea*], smooth brome grass, autumn olive, multiflora rose, honeysuckle). Some of the old farmsteads contain various exotic species probably planted for ornamentation (e.g., Japanese barberry [*Berberis thunbergii*], Norway spruce [*Picea abies*]) (Luthin 1999).

Non-native invasive plants out-compete and even kill native plants by monopolizing light, water, and nutrients, and by altering soil chemistry and, in the case of garlic mustard, mycorrhizal relationships. In situations where invasive plants become dominant, they may even alter ecological processes by limiting

one’s ability to use prescribed fire (e.g. common buckthorn), by modifying hydrology (e.g., reed canary grass can alter surface flow and clog culverts), and by limiting tree regeneration and ultimately forest composition [e.g. honeysuckle (Gorchov and Trisel 2003)]. In addition to the threats on native communities and native species diversity, terrestrial invasive species negatively impact forestry (by reducing tree regeneration, growth and longevity), recreation (by degrading wildlife habitat and limiting access), agriculture, and human health (plants that cause skin rashes or blisters).

While eliminating non-native invasive species at the SPRA may not be a realistic goal, land managers may want to consider how to limit spread of these invasives to other sites and to limit their negative impacts on achieving wildlife habitat goals.

Natural Community Management Opportunities

The Wisconsin Wildlife Action Plan (WAP) (WDNR 2006b) identifies 24 natural communities for which there are “major” opportunities for protection, restoration, or management in the Western Coulee and Ridges Ecological Landscape. Ten natural communities offer restoration opportunities.

Table 10. Major Natural Community Management Opportunities in the Western Coulee and Ridges Ecological Landscape (EMPT 2007 and WDNR 2006b) that are also restoration opportunities at the Sauk Prairie Recreation Area

Bedrock Glade	Dry-mesic Prairie	Pine Relict	Surrogate Grasslands
Coldwater streams	Oak Opening	Southern Dry Forest	
Dry Prairie	Oak Woodland	Southern Dry-mesic Forest	

The Wisconsin Wildlife Action Plan (WDNR 2006b) identifies 14 natural communities for which there are “major” opportunities for protection, restoration, or management in the Central Sand Hills Ecological Landscape. None of these natural communities are found in high quality condition on the SPRA, although 2 natural communities present restoration opportunities.

Table 11. Major Natural Communities Management Opportunities in the Central Sand Hills Ecological Landscape (EMPT 2007 and WDNR 2006b) that are also restoration opportunities at the Sauk Prairie Recreation Area

Impoundments/Reservoirs
Southern Dry Forest

Aquatic Habitat Restoration

Coldwater streams are a major natural community management opportunity in the Western Coulee and Ridges Ecological Landscape and a Conservation Opportunity Area north of the SPRA was designated because the bedrock influenced headwater streams in the Baraboo Hills harbor many SGCN invertebrates. Surveys of aquatic fauna and evaluation of water quality were conducted in 1993 (Thompson and Walsh 1993), 1998 (Dodson et al. 1998), and 2011 (Unmuth 2011 and Schmude 2011) on a subset of sites. Results from these surveys indicate that cool to coldwater streams are present, including Pine Glen Creek, and represent a management opportunity.

Pine Glen Creek begins within the Baraboo Hills, in Devil’s Lake State Park, and flows mainly in a southerly and slightly easterly direction into the SPRA. Historically the stream ended at the southern border of section 35. During the development of the BAAP, the stream was ditched at the base of the

bluffs and flowed across BAAP lands, and under STH. 12, where it emptied into an unnamed tributary of Otter Creek to the west of BAAP land. More recently, the stream was rerouted to flow into the Ballistics Pond. Both coldwater and intermittent stream indexes of biotic integrity (IBI) were calculated (Unmuth 2011), and scores of zero, and 60 respectively indicate that the stream is in poor to fair condition, and stream restoration is the recommended approach to management. Poor fish diversity is also likely due to an abundance of panfishes running out of the Ballistics Pond and up into the stream for both better water quality and to prey on small stream fishes. Disconnecting the stream from the pond, restoring stream meanders and general direction, and retrofitting perched culverts to properly pass baseflow would improve water quality and fish habitat. Further baseline monitoring of the stream is necessary to determine if the waterway should be listed as impaired.

Surveys of the Ballistics Pond highlight the need for restoration to improve water quality. During 2011 surveys (Unmuth 2011), blue-green algae was abundant. Blue-green algae are capable of making a range of toxins which can have minor to serious effects on wildlife, livestock, pets, and humans. The pH level was extremely high (10.2), which is as alkaline as ammonia and does not meet the criteria the DNR has established for fish and aquatic life waters (State Statute NR 102). Fish surveys detected small panfish with the majority having bulging eyes and some had loss of eyesight. This disease is likely due to a combination of gas bubble disease resulting from oxygen super saturation of the water with the nitrogen gas and ammonia toxicity.

There are several ephemeral and permanent kettle ponds on the SPRA varying in quality and biological diversity. There are two western ponds that are relatively amphibian poor, with two species of amphibians and 2 species of fish (sticklebacks and *Pimophales* sp.) These two ponds are heavily silted in. In contrast, there are two ponds in better condition on the far northeast portion of the site, likely because they are ephemeral, seemingly lacking fish and have relatively little silt. They are serving as important amphibian breeding areas. Additionally, the East Reservoir is the site of a population of neotenic tiger salamanders. These salamanders can not escape the pond and have adapted to a fully aquatic life, complete with feathery gills, wide jaws, and tail fins.

Restoration of aquatic habitats at the SPRA would improve fish and wildlife habitat and is necessary in some locations before any recreational or human uses of the property are considered.



Pond within the Magazine Area that supports tiger salamanders.
Photo by Christina Isenring.

Wisconsin’s Statewide Forest Strategy

Wisconsin’s Statewide Forest Assessment (WDNR 2010a) was based on Wisconsin’s Forest Sustainability Framework (“Wisconsin Forest Sustainability Framework”) and was designed to assess the current state of Wisconsin’s public and private forests and analyze the sustainability of our forested ecosystems. Wisconsin’s Statewide Forest Strategy (WDNR 2010b) contains a collection of strategies and actions designed to address the management and landscape priorities identified in the Statewide Forest Assessment. The strategies are broad guides intended to focus the actions of the forestry community.

All three of these documents include topics related to biological diversity in Wisconsin’s forests, and provide information useful for department master planning and management activities. The following strategies, organized using their number in the Statewide Forest Strategy document, are particularly pertinent to the SPRA planning efforts in regard to opportunities to maintain or enhance biological diversity (WDNR 2010b). These strategies may not be applicable to all areas of the SPRA.

Strategy Number	Strategy
1	Encourage planting to enhance, protect, and connect larger tracts of forested land in appropriate locations consistent with ecological landscapes.
6	Strengthen collaborative and large scale planning at the town, county, state and federal levels
14	Encourage the use of disturbance mechanisms to maintain diverse forest communities
15	Maintain the appropriate forest types for the ecological landscape while protecting forest health and function
24	Control and management of existing (non-native invasive species) infestations.
25	Rehabilitate, restore, or adapt native forest habitats and ecosystems
29	Attempt to improve the defenses of the forest and increase the resilience of natural systems to future climate change impacts

Primary Sites: Site-specific Opportunities for Biodiversity Conservation

Two ecologically important sites were identified on the SPRA (Figure 6). These Primary Sites were delineated because they generally encompass the best examples of 1) rare or representative natural communities, 2) documented occurrences of rare species populations, and/or 3) opportunities for ecological restoration or connections. These sites warrant high protection and/or restoration consideration during the development of the property master plan. This report is meant to be considered along with other information when identifying opportunities for various management designations during the master planning process.

Information provided in the summary paragraphs includes location information, a site map, a brief summary of the natural features present, the site's ecological significance, and management considerations. Appendix E lists the rare species and high-quality natural communities currently known from the SPRA by Primary Site.

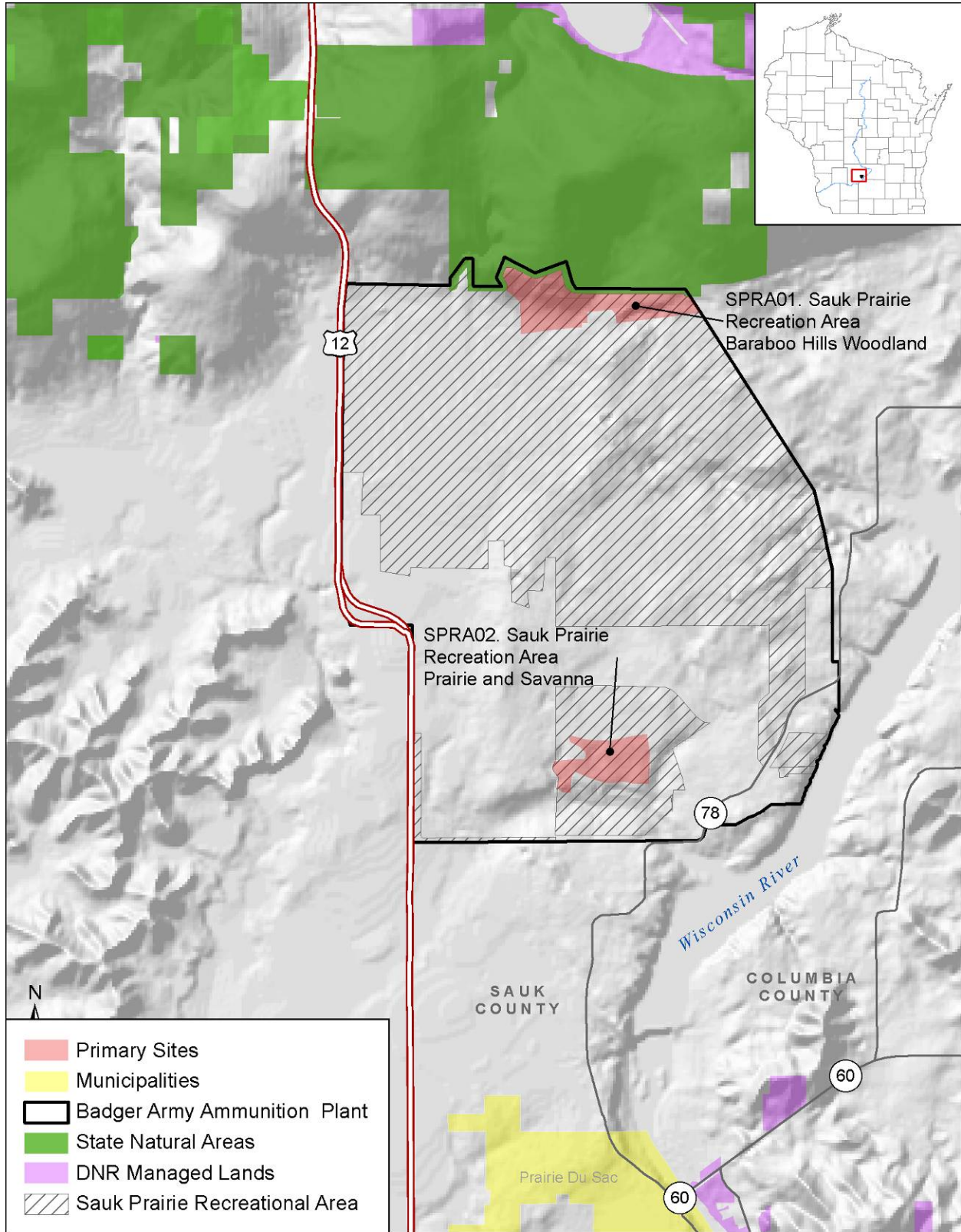


Figure 7. Primary Sites of the Sauk Prairie Recreation Area

SPRA01. SAUK PRAIRIE RECREATION AREA BARABOO HILLS WOODLAND

Location

County: Sauk
Landtype Association: 222Kd06. Moon Valley Plains; 222Ld03. West Baraboo Ridge; 222Lc17. Mississippi River Valley Train – South
Approximate Size (acres): 188

Description of Site

This site contains the most diverse topographic features of the SPRA and constitutes a part of the Baraboo Hills (Figure 9). The bluff in the northwest part of the site rises 240 feet above the rest of the site. Below the bluffs, the site is characterized by a ridge of rock and other material that was deposited during the retreat of the Wisconsin glacier. The slope is considerable on the south-facing bluff surrounding the reservoirs, but becomes more gradual at the base of the hills. In the eastern half of the site, the topography is less steep with a moderately sloped area at the base of the Baraboo Hills. In the center of this area is a steep ridge with an east – west orientation that was part of the Johnstown moraine and is comprised of thick glacial till. To the south of this ridge is a natural kettle pond that formed behind the moraine during the glacial period (Clayton and Attig 1990).

One drainage originates in a wet meadow north of the boundary fence in Devil’s Lake State Park, and flows through the center of the site and drains into a depression (Oleum West) west of the road that runs roughly north – south through the center of the site. There are several drainages to the south of the steeper portion of the bluff that carry seasonal flow. A seep trickles out at the base of the bluffs in the center of the unit. Two cement-lined reservoirs exist on the site and when they held water supported a population of neotenic tiger salamanders. The reservoirs were excavated from the quartzite bluff in 1942, with the rubble deposited into fan-shaped piles west and east of the reservoirs. A small farm pond is found west and slightly south of the reservoirs. Below this, adjacent to a north - south road, are the two shallow ponds excavated in 1997 and 1998 during the clay removal process. The Oleum East pond is a natural kettle pond that was manipulated during the construction of BAAP and received cooling water discharge from the former Oleum Plant.

To the south of the site are an old rail line and the Oleum Plant with associated buildings and roads.

Review of 1937 aerial photos for this site indicate that at that time it was characterized by open pasture. In the northwestern part of the site the area has transitioned from generally a more open canopy to closed-canopy forest. Only on the steepest slopes in the northwest section was there a closed-canopy forest in the 1937 aerial photo. Today that area resembles a Bedrock Glade natural community in part because of the huge quartzite boulders and rock outcroppings. This very small area (<5 acres) has a canopy of large (30"+ dbh), stunted white oak. The canopy is over a dense subcanopy of shagbark hickory and black cherry, a sapling layer of white ash (*Fraxinus americana*) and buckthorn. Although ground layer species of Bedrock Glades are typically similar to those of prairie and savanna, the species at this site resemble those of the surrounding forest instead.

Much of the forest in this site has developed from savanna-like conditions, crop fields, or pasture (as interpreted from 1937 aerial photos and historical accounts). Current forest condition varies based on these differences. The highest quality forests are those that developed from savanna-like conditions, including the area north of the reservoirs and on the moraine ridge north of Oleum Pond. These areas resemble Oak Woodland natural communities with a canopy dominated by white oak, shagbark hickory, and black cherry. Common woodland species are whorled loosestrife (*Lysimachia quadrifolia*), pointed

tick trefoil (*Desmodium glutinosum*), dogbane (*Apocynum androsaemifolium*), field pussy-toes (*Antennaria neglecta*), and Pennsylvania sedge.

Significance of Site

The significance of this site is that it creates a buffer to the highly-significant Baraboo Hills and South Bluff/Devil's Nose State Natural Area. This site harbors degraded examples of Bedrock Glade and Oak Woodland and supports habitat for rare plant and animal species. The Western Coulee and Ridge Ecological Landscape offers major opportunities to sustain Oak Woodland and Bedrock Glade (WDNR In prep. a.), two globally imperiled communities. Oak woodland once occupied approximately 1.4 million acres (Curtis 1959) in pre-Euro-American settlement Wisconsin; today, it is extraordinarily rare – only about 140,000 acres remain in the state (Hoffman 2009).

Based on 2011 herptile surveys, the bedrock outcrops within this site provide the best opportunity for enhancing habitat for herptiles on the SPRA. Existing records of rare snakes are found adjacent to this site and would likely benefit from restoration efforts to restore the Bedrock Glade to a more open state.

This site was not specifically targeted in the most recent breeding bird survey effort but previous surveys and incidental observations in 2011 located several uncommon species utilizing this area. These results indicate that restoration of this site to an Oak Woodland would enhance bird habitat with the adjoining Baraboo Hills forest.

Management Considerations

Restoration of the remnant natural communities (Bedrock Glade and Oak Woodland) and enhancement of habitat for rare species should be considered a high-priority. Restoring these historically fire dependant communities to a more natural state would allow for a gentle transition zone between the vast closed canopy forests of the Baraboo Hills and the expansive grasslands of BAAP. Invasive species are prevalent and cause serious harm to the integrity of the site as well as have the potential to spread into the neighboring Devil's Lake State Park. Restoring site hydrology is also important since this site supports multiple springs and ponds.

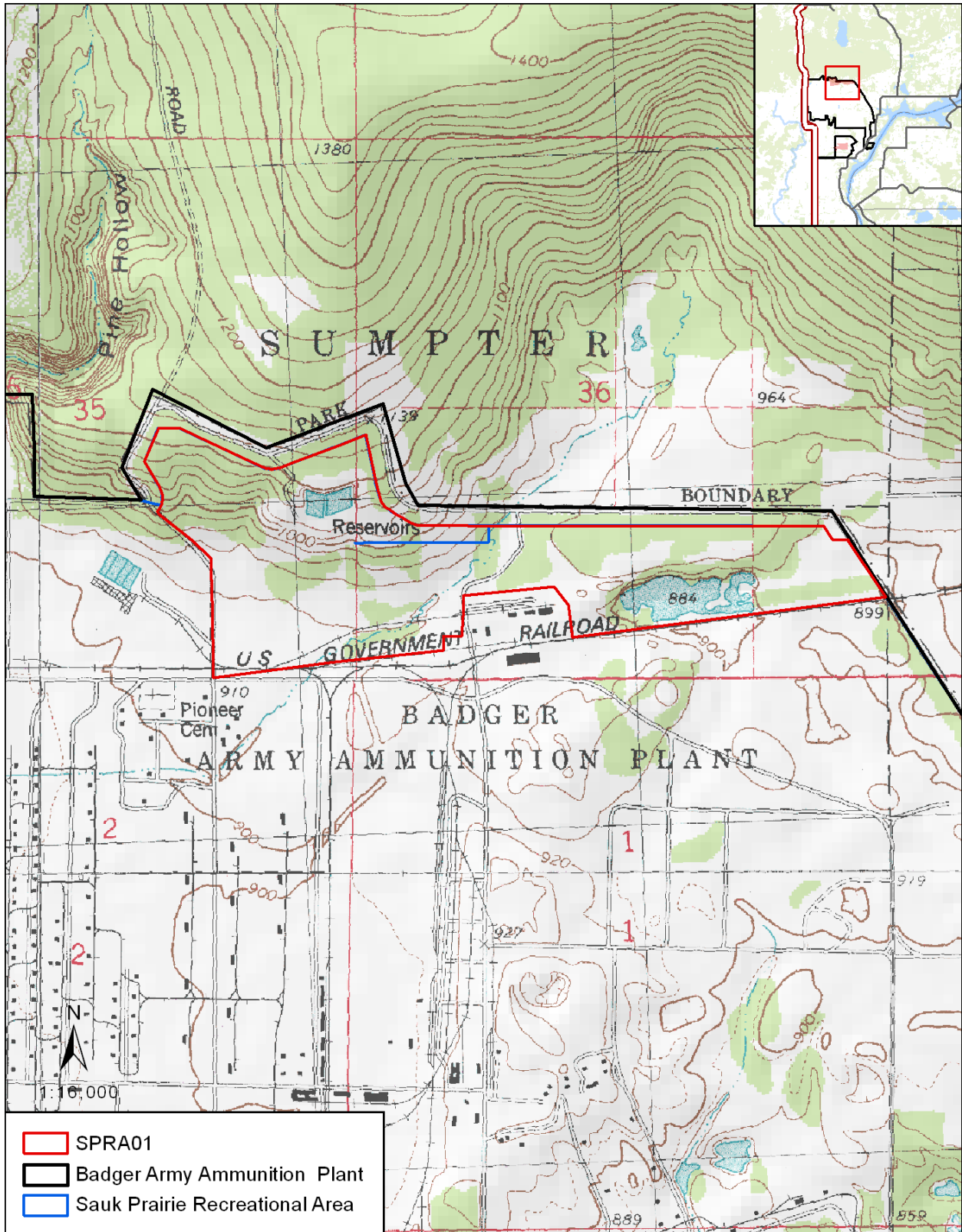


Figure 8. Sauk Prairie Recreation Area Baraboo Hills Woodland

SPRA02. SAUK PRAIRIE RECREATION AREA PRAIRIE AND SAVANNA

Location

County:	Sauk
Landtype Association:	222Kd06. Moon Valley Plains
Approximate Size (acres):	110

Description of Site

This site, located in the Magazine Area (Figure 8), features a complex of remnant prairie, Oak Woodland, and surrogate grassland. The remnant prairie is small and grass dominated with big bluestem, yellow Indian grass, side-oats grama, hairy grama, and Kentucky bluegrass common. Tree and shrub encroachment is common along the edge of the prairie and typically has scattered black cherry, autumn olive, honeysuckle, and prickly ash, over a low diversity prairie with such problem species as wild parsnip, Queen Anne's lace, and smooth brome. At the south end of the prairie is an area resembling an Oak Woodland natural community with semi-open grown bur oaks (15-30 inch dbh) in the canopy and black cherry (10 inch dbh) in the subcanopy over a very dense layer of brambles, burdock, honeysuckle, and smooth brome. The majority of the site is characterized by a smooth brome dominated old field with scattered cottonwood groves and shrubs, including autumn olive. Cement building foundations are common.

Significance of Site

This site, in conjunction with the large expanse of surrogate grassland making up the entire SPRA, offers an opportunity to restore two globally rare natural communities and improve habitat for many grassland, savanna, and woodland plant and animal specialists, especially grassland birds. Prairies and Oak Woodlands were historically common in Wisconsin but are now rare throughout the state. Restoration of these globally rare natural communities is critical to the survival of many rare plants and animals that depend on them. Oak Woodland once occupied approximately 1.4 million acres (Curtis 1959) in pre-widespread Euro-American settlement Wisconsin; today, it is exceedingly rare – only about 140,000 acres remain in the state (Hoffman 2009). With most of these remnants being highly degraded and having converted to closed-canopy oak forest.

Prairie once occupied approximately 2.1 million acres in Wisconsin. Now, approximately 2,000 acres remain – less than 0.1% (Leach and Givnish 1999). Of these, only those prairies that occurred at the wet and dry ends of the soil spectrum survived. Virtually all deep-soil Mesic Prairies were converted to agricultural or residential uses. The surviving remnants are highly degraded due to fire suppression, over-grazing, invasion of woody species, non-native invasive species and, in the case of Wet Prairies, ditching and tiling. Wisconsin has more Dry Prairies than any other state because of the many steep-sided bluffs in the extensive Driftless Area, the rough terrain of the kettle interlobate moraine, and the north-south orientation of several major river valleys such as the Mississippi, the Chippewa, and the St. Croix (WDNR 2006b). These topographic attributes provide suitable sites for the development and persistence of this prairie type in conjunction with management to control brush and non-native invasive species encroachment.

Rare plants have been known from this area, although recent intensive surveys have not relocated the populations. One of the best populations in the entire state of the prairie vole is found at the SPRA with documented records from nearby the primary site. Its habitat is limited to Dry Prairies and sandy oldfields in the southern half of Wisconsin. The primary site falls within one of the high priority grassland bird parcels (Figure 6), as several conservative grassland obligate bird species breed within this area.

Management Considerations

The Dry Prairie within this site has received close attention from volunteer groups conducting prairie restoration at the former BAAP. Current management practices include brush removal and prescribed burning. Both of these activities are compatible with the remnant prairie flora that is present.

This small site is unique because remnant plant communities are very rare at the SPRA, and therefore warrants special management consideration in future master planning efforts. In order to provide the habitat size and structure necessary for grassland and shrubland bird communities that may be using this small site, compatible management outside of the site that restores prairie and savanna or connects surrogate grasslands such as pasture, idle exotic grasses or late-cut grass hay is crucial. The value of this site for animals depends entirely on opening a large expanse of open grassland habitat. The site itself is too small to meet the needs of area sensitive grassland species alone but creating connections to open landscapes to the north and clearing brush on adjoining properties to the east and west would be critically important to the long-term viability of the grassland animal community present here.

The most aggressive non-native invasive plant species at this site are generally limited to the tree and shrub dominated areas.



Surrogate Grassland within the Sauk Prairie Recreation Area Prairie and Savanna Primary Site. Photo by Christina Isenring.

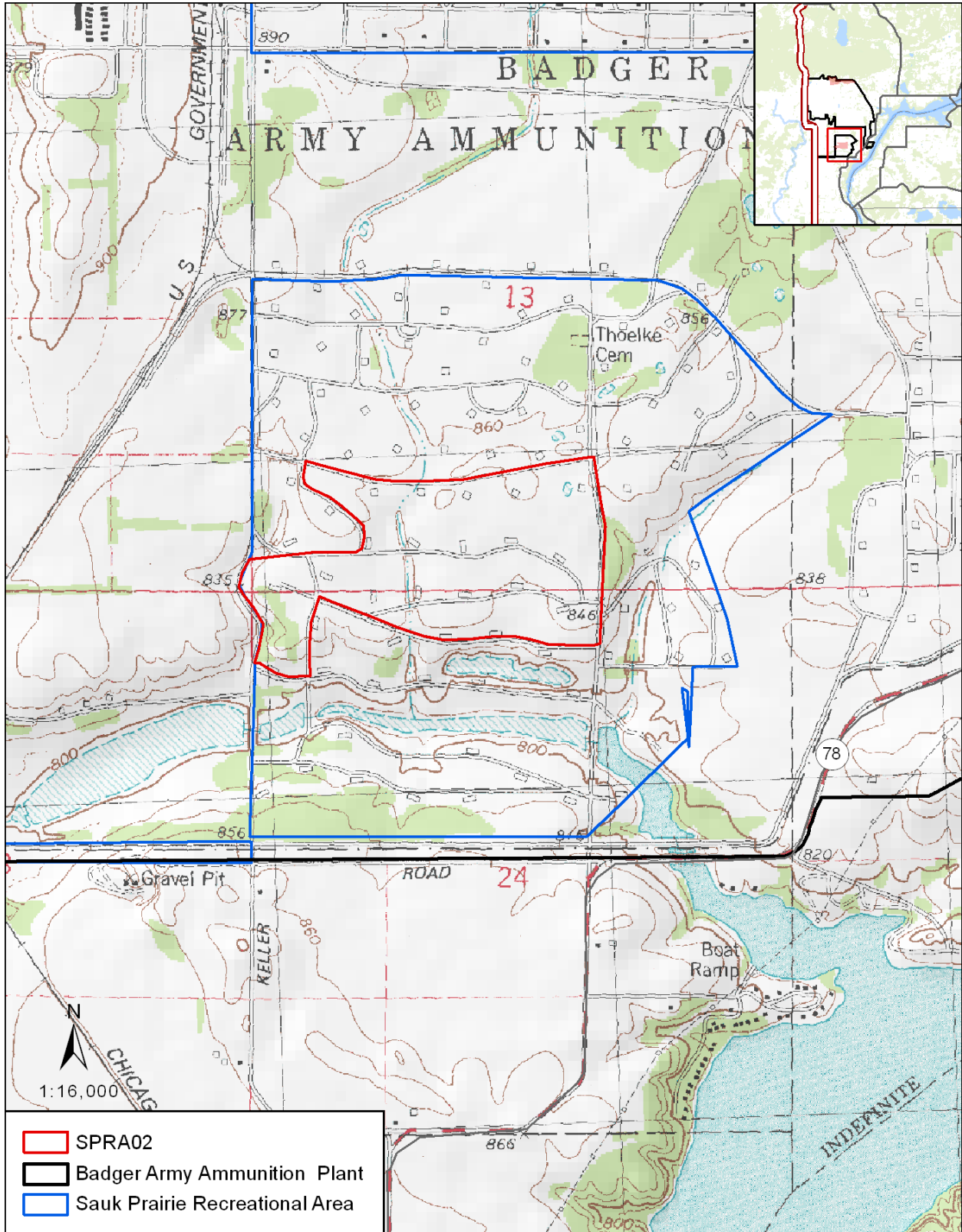


Figure 9. Sauk Prairie Recreation Area Prairie and Savanna

Future Needs

This project was designed to provide a rapid assessment of the biodiversity values for the SPRA. Although the report should be considered adequate for master planning purposes, additional efforts could help to inform future adaptive management efforts, along with providing useful information regarding the natural communities and rare species contained on the SPRA.

Breeding Birds – Breeding bird populations respond quickly to changes in vegetation structure and can be indicators of change in habitat types. Continued monitoring of breeding bird populations will be critical as this property undergoes management.

Small Mammals – Several records of the prairie vole are located within the SPRA. More survey work is needed to detail the rarity of this species statewide, but the SPRA appears to be an important landscape for maintaining this uncommon small mammal.

Invasive Species – Monitoring and control of terrestrial and aquatic non-native invasive species will be critical on the SPRA.

Bats – Due to the emerging threats that bat populations face in Wisconsin, more information in the form of surveys (acoustic and roost) are needed to more accurately describe the bats that use the SPRA.

Herptiles - Additional inventory and monitoring is needed for reptiles and amphibians on the SPRA. Efforts to identify additional amphibian breeding ponds, monitoring of existing pond sites, and continuation of existing frog and toad survey routes would be beneficial. Additional surveys for reptiles (snakes and lizards) with low detection probabilities would be warranted as the property holds good potential to harbor uncommon species.

Aquatic Resources –

- Intensively monitor the Ballistics Pond and Pine Glen Creek for oxygen, conductivity, temperature and pH using continuous monitoring equipment.
- Further baseline monitoring of Pine Glen Creek is necessary to determine if the waterway should be listed as impaired.
- Collect water chemistry samples on a monthly basis from the Ballistics Pond and Pine Glen Creek from May through November.
- Collect fish and instantaneous water quality at all other ponds that were not recently (past 10 years) created on the SPRA property.
- Collect fish from the Ballistics Pond for disease evaluation.

Other Rare Species and Habitats – Locations of surrogate grassland and remnant prairie and savanna habitats should be identified and mapped. These areas should be prioritized for conducting additional rare animal surveys or representative species during appropriate seasons. This should include additional vertebrate and invertebrate animal taxon groups.

Glossary

Ecological Landscape - landscape units developed by the WDNR to provide an ecological framework to support natural resource management decisions. The boundaries of Wisconsin's sixteen Ecological Landscapes correspond to ecoregional boundaries from the National Hierarchical Framework of Ecological Units, but sometimes combine subsections to produce a more manageable number of units.

element - the basic building blocks of the Natural Heritage Inventory. They include natural communities, rare plants, rare animals, and other selected features such as colonial bird rookeries, bat hibernacula, and mussel beds. In short, an element is any biological or ecological entity upon which we wish to gather information for conservation purposes.

element occurrence - an Element Occurrence (EO) is an area of land and/or water in which a rare species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For species, the EO often corresponds with the local population, but when appropriate may be a portion of a population (e.g., a single nest territory or long distance dispersers) or a group of nearby populations (e.g., metapopulation). For communities, the EO may represent a stand or patch of a natural community or a cluster of stands or patches of a natural community. Because they are defined on the basis of biological information, EOs may cross jurisdictional boundaries.

Landtype Association (LTA) - a level in the National Hierarchical Framework of Ecological Units (see next entry) representing an area of 10,000 – 300,000 acres. Similarities of landform, soil, and vegetation are the key factors in delineating LTAs.

natural community – an assemblage of plants and animals, in a particular place at a particular time, interacting with one another, the abiotic environment around them, and subject to primarily natural disturbance regimes. Those assemblages that are repeated across a landscape in an observable pattern constitute a community type. No two assemblages, however, are exactly alike.

representative - native plant species that would be expected to occur in native plant communities influenced primarily by natural disturbance regimes in a given landscape - e.g., see Curtis (1959).

SGCN (or “Species of Greatest Conservation Need”) – native wildlife species with low or declining populations that are most at risk of no longer being a viable part of Wisconsin's fauna (from the “Wisconsin Wildlife Action Plan,” WDNR 2006b).

Species List

The following is a list of species referred to by common name in the report text.

Common Name	Scientific Name
Plants	
autumn olive	<i>Elaeagnus umbellata</i>
big bluestem	<i>Andropogon gerardii</i>
black cherry	<i>Prunus serotina</i>
black locust	<i>Robinia pseudoacacia</i>
black oak	<i>Quercus velutina</i>
black walnut	<i>Juglans nigra</i>
blueberry	<i>Vaccinium</i> sp.
brambles	<i>Rubus</i> sp.
bur oak	<i>Quercus macrocarpa</i>
burdock	<i>Arctium</i> sp.
Canada goldenrod	<i>Solidago canadensis</i>
Canada thistle	<i>Cirsium arvense</i>
common buckthorn	<i>Rhamnus cathartica</i>
dogbane	<i>Apocynum androsaemifolium</i>
eastern cottonwood	<i>Populus deltoides</i>
garlic mustard	<i>Alliaria petiolata</i>
hairy grama	<i>Bouteloua hirsuta</i>
honeysuckle	<i>Lonicera</i> sp.
ironwood	<i>Ostrya virginiana</i>
Japanese barberry	<i>Berberis thunbergii</i>
Kentucky bluegrass	<i>Poa pratensis</i>
multiflora Rose	<i>Rosa multiflora</i>
northern white cedar	<i>Thuja occidentalis</i>
Norway spruce	<i>Picea abies</i>
partridgeberry	<i>Mitchella repens</i>
Pennsylvania sedge	<i>Carex pennsylvanica</i>
prickly ash	<i>Zanthoxylum americanum</i>
pussytoes	<i>Antennaria</i> sp.
quaking aspen	<i>Populus tremuloides</i>
Queen Anne's lace	<i>Daucus carota</i>
ragweed	<i>Ambrosia</i> sp.
red maple	<i>Acer rubrum</i>
red oak	<i>Quercus rubra</i>
red pine	<i>Pinus resinosa</i>
reed canary grass	<i>Phalaris arundinacea</i>
shagbark hickory	<i>Carya ovata</i>
shooting star	<i>Dodecatheon</i> sp.
side-oats grama	<i>Bouteloua curtipendula</i>
smooth brome	<i>Bromus inermis</i>
tick trefoil	<i>Desmodium</i> sp.
white oak	<i>Quercus alba</i>
white pine	<i>Pinus strobus</i>

white spruce	<i>Picea glauca</i>
whorled loosestrife	<i>Lysimachia quadrifolia</i>
wild coffee	<i>Triosteum perfoliatum</i>
wild parsnip	<i>Pastinaca sativa</i>
yellow Indian grass	<i>Sorghastrum nutans</i>

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Additional Resources

Numerous online resources are available for learning more about the rare species, natural communities, and ecological concepts contained within this report. These are just a few of the resources that we recommend.

- 1. Bureau of Endangered Resources' Animals, Plants, and Communities Web Pages.**
Information for plants, animals, and natural communities on the Wisconsin Working List, as well as Species of Greatest Conservation Need from the Wisconsin Wildlife Action Plan. For reptiles and amphibians, information for more common species is also provided here. At this time, the level of detail available varies among species; some have detailed factsheets while others have only a short paragraph or a map. These pages will continue to evolve as more information becomes available and are the Bureau of Endangered Resources' main source of information for species and communities. dnr.wi.gov/org/land/er/biodiversity/
- 2. Wisconsin Natural Heritage Inventory Working List.** The Wisconsin Natural Heritage Working List contains species known or suspected to be rare in the state and natural communities native to Wisconsin. It includes species legally designated as "Endangered" or "Threatened" as well as species in the advisory "Special Concern" category. This Web page offers a printable pdf file and a key to the Working List for use in conjunction with the information provided in #1 above. dnr.wi.gov/org/land/er/wlist/
- 3. Ecological Landscapes of Wisconsin Handbook.** Wisconsin's 16 Ecological Landscapes have unique combinations of physical and biological characteristics such as climate, geology, soils, water, or vegetation. This handbook will contain a chapter for each of these landscapes with detailed information about their ecology, socioeconomics, and ecological management opportunities. An additional introductory chapter will compare the 16 landscapes in numerous ways, discuss Wisconsin's ecology on the statewide scale, and introduce important concepts related to ecosystem management in the state. The full handbook is in development as of this writing, and chapters will be made available online as they are published. Currently, a set of Web pages provide brief Ecological Landscape descriptions, numerous maps, and other useful information, including management opportunities for natural communities and Species of Greatest Conservation Need. dnr.wi.gov/landscapes/
- 4. The Wisconsin Wildlife Action Plan.** This plan is the result of a statewide effort to identify native Wisconsin animal species of greatest conservation need. The plan also presents priority conservation actions to protect the species and their habitats. The plan itself is available online, and there are several online tools to explore the data within the plan. The Web pages are closely integrated with the pages provided in items #1 and #3 above. The Wildlife Action Plan Web pages are quite numerous, so we recommend the following links as good starting points for accessing the information.
 - the plan itself: dnr.wi.gov/org/land/er/wwap/
 - explore Wildlife Action Plan data: dnr.wi.gov/org/land/er/wwap/explore/
 - Wildlife Action Plan Implementation: dnr.wi.gov/org/land/er/wwap/implementation/
- 5. Wisconsin's Biodiversity as a Management Issue - A Report to Department of Natural Resources Managers.** This now out-of-print report presents a department strategy for conserving biological diversity. It provides department employees with an overview of the issues associated with biodiversity and provides a common point of reference for incorporating the conservation of

biodiversity into our management framework. The concepts presented in the report are closely related to the material provided in this report, as well as the other resources listed in this section. dnr.wi.gov/org/es/science/publications/rs915_95.htm

6. **Wisconsin's Statewide Forest Strategy.** Wisconsin's Statewide Forest Strategy is a collection of many strategies and actions designed to address major issues and priority topics over the next five to ten years. It provides a long-term, comprehensive, coordinated approach for investing resources to address the management and landscape priorities identified in the Statewide Forest Assessment. Several of the strategies contain issues related to biodiversity and ecosystem management. dnr.wi.gov/forestry/assessment/strategy/overview.htm
7. **2010 Wisconsin's Statewide Forest Assessment.** The goal of this project was to assess the "state of affairs" of Wisconsin's public and private forests and analyze the sustainability of our forested ecosystems. The Statewide Forest Assessment helps to explain trends, identify issues, and present an updated view of the status of forests in Wisconsin. The first chapter deals with biological diversity in Wisconsin's forests, and the major conclusions from this assessment were used to develop the strategies in # 6 above. dnr.wi.gov/forestry/assessment/strategy/assess.htm
8. **Preliminary Ecological Restoration Plan for 1300 acres of the Badger Army Ammunition Plant.** This document represents a preliminary attempt to develop a restoration vision, establish restoration and reconstruction goals and provide recommendations for the restoration process on approximately 1,309 acres in the north of the Badger Army Ammunition Plant. It has been developed under contract to the U.S. Army/Olin Corporation, with financial assistance from U.S. Fish and Wildlife Service, The Prairie Enthusiasts, Community Conservation Coalition for the Sauk Prairie and The Nature Conservancy. This plan was produced with considerable oversight and input from a large number of restoration ecologists and practitioners in the region. <http://www.saukprairievision.org/PDFs/BAAP%20Hist%20Cult%20Ecol%20Values/BAAP%20Ecol%20restoration%20plan.pdf>
9. **Badger Army Ammunition Plan Reuse Plan – Final Report.** In early 2000, the Sauk County Board of Supervisors acted to establish a locally driven reuse planning process. The 21-member BRC included representatives from neighboring communities, local, state, and federal governments, and the Ho-Chunk Nation. In its mission statement, the BRC charged itself with the task of developing "a common vision for the reuse of the Badger property that can be meaningfully considered and realistically implemented by the appropriate local, state, and federal agencies." <https://www.co.sauk.wi.us/sites/default/files/fileattachments/Badger%20Army%20Ammunition%20Plant.pdf>