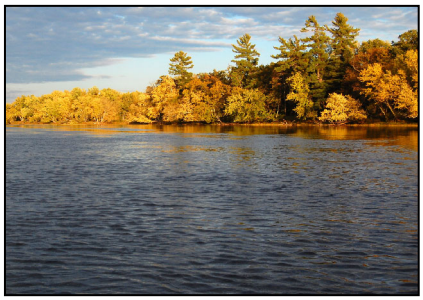

Biotic Inventory and Analysis of the Governor Knowles State Forest

A Baseline Inventory and Analysis of Natural Communities, Rare Plants, and Animals

September 2010

Natural Heritage Inventory Program
Bureau of Endangered Resources
Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

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Primary Author: Drew Feldkirchner

Contributors: Numerous contributors assisted with planning, conducted surveys, mapped and interpreted data, and delineated the Primary Sites. This project would not have been possible without the efforts and expertise of the following biologists:

- Craig Anderson – botany, rare plants, planning
- Matt Berg – passerine birds
- Julie Bleser – data management
- Barbara Delaney – community ecology, botany
- Eric Epstein – community ecology, birds, planning
- Drew Feldkirchner – report production, community ecology, planning
- Kim Grveles – planning
- Terrell Hyde – zoology, data processing
- Christina Isenring – community ecology, botany, data processing, planning
- John Krause – rare forest raptors
- Janeen Laatsch – botany data processing
- Ryan Magana – community ecology
- William Smith – zoology
- Rich Staffen – passerine birds, rare forest raptors, zoology, data processing, planning

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Executive Summary

Project Purpose and Objectives

The Governor Knowles State Forest Biotic Inventory was a survey and analysis of selected natural resources of the Governor Knowles State Forest. The Wisconsin Natural Heritage Inventory (NHI) Program, part of the Wisconsin Department of Natural Resources' Bureau of Endangered Resources, conducted the inventory in cooperation with the Division of Forestry. The overall goals were to provide baseline information on rare species, high-quality natural communities, and the overall ecology of the Governor Knowles State Forest (GKSF). Highlighting the property's best opportunities to conserve biological diversity was the major focus of this project.

A biotic inventory provides an ecological background to consider when developing a state forest master plan. This report is intended to be used in combination with other sources, including the "Regional and Property Assessment" for developing overall management recommendations for the forest. In addition to the department master planning teams, we hope this report will be useful to property managers, administrators, conservation groups, private landowners, and others who have an interest in conserving the biological diversity of this area.

The objectives of this project were:

- identification and evaluation of natural communities;
- identification and evaluation of rare or otherwise significant plant and animal populations;
- identification and evaluation of selected aquatic features and their associated biota;
- identification of sites appropriate for the restoration of lost or declining communities or important habitats;
- identification of especially important protection, management, and restoration opportunities, involving both unique and representative natural features of the GKSF and surrounding landscape;
- interpretation and synthesis of the results for department master planning teams, property managers, administrators, and others involved in the implementation of land use decisions on the Governor Knowles State Forest, as well as the surrounding landscape.

Description of the Study Area

Located in northwest Wisconsin, the GKSF comprises just over 20,000 acres in Burnett and Polk counties. Originally designated to protect the St. Croix River, the property is long and narrow, and much of the 55 miles of the property adjoin the Saint Croix National Scenic Riverway managed by the National Park Service. Other public ownerships adjacent to the GKSF include five state wildlife areas and portions of Burnett and Polk county forests. Interstate State Park is located nearby to the south. Much of the private land in the surrounding area is in non-industrial lands with numerous parcels as small as 10 acres. More extensive public lands are found on the Minnesota side of the river including two state parks, a state forest, and a state wildlife area comprising over 70,000 acres within close proximity of the river. The National Scenic Riverway helps join the GKSF with the lands in Minnesota side.

The Wisconsin portion of the area surrounding the GKSF is dominated by forests, agriculture, and some notable large wetlands to the east. Forests are particularly important in the areas immediately surrounding the GKSF, as well as much of the area just across the river in Minnesota, while agriculture becomes more dominant further to the south and east.

The property is only one-mile wide, or less, in most places and is four miles wide at its widest points, but it contains a diverse group of natural communities and habitats due to the variety of soils, landforms, and hydrological characteristics. The GKSF is bisected by two highly contrasting Ecological Landscapes, the Northwest Sands and the

Northwest Lowlands, which meet along the terrace escarpment of the St. Croix River valley found along the entire length of the GKSF. The property also varies from north to south based on the location of the Tension Zone, and the GKSF supports both northern- and southern-associated plants and animals.

Historically, the uplands of the GKSF were dominated by jack pine (*Pinus banksiana*), northern pin oak (*Quercus ellipsoidalis*) forest, and barrens. Jack pine was the most commonly reported species here during the General Land Office surveys of the mid 1800s. The GKSF was located at the western edge of the largest expanse of barrens in the state – the area corresponding to the current location of the Northwest Sands Ecological Landscape. The river valley was likely dominated by lowland hardwoods with conifer swamps interspersed. Tamarack (*Larix laricina*) was the tree species most commonly reported by the surveyors.

The broad forest type groups now present on the GKSF are likely similar those found in the mid-1800s, but the composition and structure are quite different. Jack pine is much less abundant, while aspen and red pine have both increased in relative importance. Former barrens / savanna communities have largely succeeded to forest following the lack of fire in these areas, and remaining barrens examples are small and isolated. Jack pine-dominated forests with native barrens flora are mostly limited to a few small areas. Dry forests have been replaced by plantations in many cases, and virtually all of the GKSF's red pine (*Pinus resinosa*) dominated forests (10% of the total forested acres) are plantations, with the exception of a few remnant sites including the Brant Brook Pines State Natural Area.

Upland deciduous forests are largely dominated by northern pin oak and aspen (*Populus tremuloides*), although diverse and unusual forests dominated by mesic hardwoods occur along mesic slopes or old river terraces. The largest example of this type is found near the Trade River.

The GKSF has several types of forested wetlands, almost all within the Wilderness Zone. Swamp hardwoods (Hardwood Swamp community) stands sometimes form large contiguous forests comprising extensive portions of the river terrace. Although found in much smaller stands, there are several areas of conifer swamp, including cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), and tamarack-dominated areas. All of the forested wetlands can contain seeps and other specialized microhabitats.

Non-forested areas are mostly shrub swamps, small open wetlands, areas managed for barrens (currently two SNAs), and old fields.

Exceptional Characteristics of the Study Area

The GKSF contains numerous ecologically important attributes, including several examples of High Conservation Value Forests (see "Priority Opportunities to Conserve Biodiversity" section). The characteristics described below are of major importance for master planning and understanding the area's biodiversity values. They are not listed in order of importance.

- **St. Croix River**. The GKSF was established to protect the Saint Croix River, following its national recognition as one of the eight original Wild and Scenic Rivers in the US. The stretch of the St Croix adjacent to the GKSF is entirely free-flowing and, in terms of fauna, is part of the longest and most pristine example of a large river ecosystem in the Midwest (WDNR 2002). The river supports exceptional aquatic diversity, including a high number of rare species such as the State Endangered St. Croix snaketail dragonfly (*Ophiogomphus susbehcha*), and several others. This stretch of the St. Croix is also being considered by the US Fish and Wildlife Service for re-introduction of the winged mapleleaf (*Quadrula fragosa*) mussel (L. Kitchel, pers. communication). Within the GKSF, numerous seeps and streams emanate from the terrace adjoining the river valley, ultimately feeding into the river. Ten of the GKSF streams that feed the St. Croix are designated Exceptional Resource Waters. Therefore, the GKSF has a critical role in contributing to the water quality and overall ecological integrity of the St. Croix.

- **Ecological Connections**. The location and shape of the GKSF make it extremely valuable as an ecological connector. In addition to its ecological relationship to the St Croix via 55 miles of the National Scenic Riverway, the GKSF is part of a significant forested corridor crossing portions of two states in an area otherwise dominated by agriculture, small non-industrial forests, and residential developments. These forests support numerous rare species and are likely to be of even greater importance if development pressures continue in the surrounding landscape. The property also provides potential future opportunities to connect barrens remnants and restorations; these habitats are mostly limited to tiny fragments in many places in Wisconsin where they still exist. Finally, there are opportunities within the GKSF to connect ecologically significant sites such as State Natural Areas and other Primary Sites. Several of the existing natural areas have artificial, non-ecologically based boundaries, and there are excellent opportunities on the property to modify the borders in an ecological manner, connecting these habitats and increasing their long-term viability.
- **Forested Seeps**. These specialized habitats are particularly abundant on the GKSF and found in numerous places, especially where the base of the escarpment meets the river terrace. The GKSF probably has a higher concentration of these features than any other state-managed land. These areas support high plant diversity and likely support several amphibian species and numerous invertebrates. They also contribute to high water quality of the streams to which they feed. The Primary Sites contain a portion of the seeps present on the GKSF, and there are many other undocumented occurrences on the property. These areas are very susceptible to physical and hydrological damage.
- **Large Wetlands**. The GKSF contains extensive areas of good-quality forested wetlands. Hardwood Swamps are common and can be extensive, and there are several areas of good-quality conifer swamps. These natural communities often occur within a diverse wetland mosaic within the river valley with numerous interesting microsites such as seeps, streams, and open small wetlands throughout. All of these are known to harbor rare species. In addition to several smaller areas of high-quality wetlands, the Kohler-Peet Wetlands (Site GK03) is particularly notable for its large size and the wide variety of forested and unforested wetland types that are present.
- **Dry Forest and Barrens Communities**. Pine Barrens and pine-oak dominated dry forest were once widespread across northwestern Wisconsin, providing habitat for a suite of plant and animal species. Following a long history of land use changes and fire suppression, many of these communities have become simplified and fragmented. As a result, many characteristic species of flora and fauna are no longer common within the Northwest Sands. The GKSF contains some good quality, species-rich barrens remnants, as well as a few good examples of dry forest with native herb species. Although these areas are often small, they offer opportunities for restoration and demonstration, especially given the current rarity of barrens communities statewide, regionally, and globally. Several rare species are associated with these communities on the GKSF.
- **Areas with Diverse and Unusual Species Composition.** Because of its relationship to the Tension Zone and its soils, landforms, and hydrology, the GKSF supports unusual community variants and diverse species combinations not often seen on state lands. For example, the property contains unusual mesic hardwood forest types that are difficult to classify and do not fit well into existing classification systems. These forests feature the unusual combination of bur oak (*Quercus macrocarpa*) along with sugar maple (*Acer saccharum*) and herbs typically associated with nutrient-rich mesic habitats. A diverse assemblage of animal and plant species has been found in some of these habitats, including several rare birds. In general, the property contains a mix of northern and southern species, including many that occur here at or near their range limits.
- **Old-growth Management Opportunities**. Stands of old forest are rare statewide (WDNR 2006b), and the WDNR Statewide Forest Plan (WDNR 2004) contains an objective to "conserve, protect, and manage old growth forests and, where feasible, encourage their appropriate representation on the variety of ownerships." The GKSF provides opportunities to develop forest stands with old-growth attributes of several different types and with different ecological characteristics.

Summary of Biotic Inventory Results

Rare Vascular Plants
Fourteen rare plant species have been documented on the GKSF including one State Endangered, three State Threatened, and 10 Special Concern species (Table 3). Roughly half of these species were either found or relocated during this inventory. No federally-listed plants are known from the GKSF at this time. The GKSF's rare plants are found in habitats that vary greatly in terms of moisture and nutrient status, as would be expected given the variety of community types present. In general, rare plants were found in the following habitats on the property: Pine/Oak Barrens, Forested Seep, Hardwood Swamp, open wetlands, mesic hardwood forests with moist inclusions, conifer swamps, and roadsides / rights-of-way. Rare plants with both northern and southern affinities were documented on the GKSF. Some rare plants are especially well-represented on the GKSF, including the State Threatened bog bluegrass (*Poa Paludigena*) which has one-third of its documented Wisconsin occurrences located within the GKSF.

Seven additional rare plants are known from within one-mile of the property. These include one aquatic plant in Wisconsin and six species documented from within one-mile of the St. Croix River in Minnesota. Although none of these species have been documented on the GKSF, there may be potential for them to occur on the property.

Rare Animals
Thirty-three rare animal species have been documented on or very near (i.e., the St. Croix River) the GKSF, including one beetle, 10 birds, four butterflies, three dragonflies, six fish, one mammal, two moths, four mussels, and two turtle species. Five of these species are State Endangered, nine are State Threatened, and three species are federally protected. Herptiles and invertebrates were not surveyed during this project, and the Future Needs section outlines opportunities for additional GKSF survey work.

Species associated with the St. Croix River comprise the largest group (36%) of rare species documented, with another 20% of the rare animals known from barrens habitats. The variety of habitats present on the GKSF allows for a rich bird assemblage. As with plants, the GKSF supports animals associated with both northern and southern Wisconsin, and at least three rare birds were found here at the northernmost edges of their ranges.

Twenty-seven additional rare animal species are known either from within one-mile of the GKSF in Wisconsin side or within one-mile of the St. Croix River in Minnesota. Similarly, **61** vertebrate Species of Greatest Conservation Need known to be either significantly or moderately associated with the two Ecological Landscapes comprising the GKSF have not yet been documented on the GKSF. There is potential for at least some of these rare animals to occur on the property, based on their habitat affinities.

Natural Communities
Thirty-seven high-quality examples of **17** natural communities have been documented on the GKSF, and most were identified during the biotic inventory. These areas meet the criteria to become NHI Element Occurrences and can be considered opportunities for maintaining High Conservation Value Forests. Most of these areas were new records in the NHI database, while others were historical records that were updated with new information. Locations of these natural community Element Occurrences were a major consideration in selecting the Primary Sites.

Threats to Natural Communities, Aquatic Systems, and Rare Species

Threats to GKSF biodiversity include invasive species, ecological simplification, fragmentation, habitat loss, deer impacts, altered ecological processes, and habitat degradation. In some cases, these threats may be difficult to avoid given existing resources (e.g., certain invasive species like the emerald ash borer) while in other cases, we can manage in ways that reduce or eliminate these threats (e.g., not establishing new red pine plantations). Avoiding, limiting, eliminating, or reversing these threats wherever possible will play a key role in conserving and enhancing the biological diversity of the landscape.

Priority Opportunities to Conserve Biodiversity

The GKSF presents opportunities to maintain native wetland and upland communities with connections to a regionally significant river with excellent biodiversity, as well as connections to many ecologically important areas across the river in Minnesota. Many species, both rare and common, are supported by the GKSF and its surrounding habitats.

These opportunities are provided for consideration by the GKSF Master Planning Team, as well as others interested in the biological diversity of the property. General themes are presented here with more detail on specific natural communities in the report. The section entitled "Primary Sites: Significance and Summaries," describes site-specific opportunities for conservation.

1. Continue to protect the St. Croix, a nationally recognized river with high biodiversity and important habitat for numerous rare species in both Wisconsin and Minnesota. Management of adjacent natural communities and areas surrounding tributaries is important for maintaining this high level of diversity.
2. Maintain existing connections between patches of habitat to avoid negative isolation effects.
3. Maintain High Conservation Value Forests; these include the Primary Sites (a subset of these include State Natural Areas) and high quality natural communities outside of the Primary Sites.
4. Establish connections between High Conservation Value Forests and evaluate the boundaries of these important areas, including existing State Natural Areas, to ensure that they are ecologically-based.
5. Examine opportunities to establish ecological connections with High Conservation Value Forests on adjacent or nearby properties. Identify means to increase cooperation and coordination across administrative boundaries
6. Evaluate opportunities to enhance and/or maintain additional High Conservation Value Forests through special management designations. These areas could include native communities, aquatic systems, and geological features throughout the study area. Community priorities include rare and representative types, large patches, and missing or diminished developmental stages.
7. Continue to conduct inventory and monitoring, as needed, for rare species and High Conservation Value Forests
8. Evaluate the Community-level Priorities and the Primary Sites presented in this report; these provide excellent opportunities to enhance and maintain biodiversity.
9. Manage at a landscape scale, where possible, and consider stand level opportunities within the larger context of the surrounding landscape matrix.
10. Protect and/or restore the hydrology of wetland and aquatic systems, and forested seeps.
11. Protect, manage, and restore habitat for rare and sensitive plants and animals, increasing viable habitat where feasible.
12. Include considerations for diversity in routine forest management. Critically examine the practice of establishing new monotypic pine plantations on the GKSF, and consider routine modifications to prescriptions for protecting rare species and important microhabitats in Forest Production Areas.
13. Examine the opportunities to use fire as a tool for both habitat restoration and timber management.
14. Increase management capacity to identify, monitor, and control invasive species and diseases and prevent widespread infestations
15. The WDNR has identified the need to conserve, protect, and manage old-growth forests. The GKSF offers opportunities to develop old-growth and old-growth attributes of several forest types.

Primary Sites: Significance and Summaries

Sixteen Primary Sites were identified for the GKSF. These sites were identified because they contain relatively undisturbed, high-quality, natural communities; provide important habitat for rare species; offer the property's best opportunities for restoration; could provide important ecological connections; or some combination of the above factors. These sites total approximately 11,590 acres, with over 9,000 acres of this located within the Wilderness Area. The current State Natural Areas on the property comprise 2,700 acres of the Primary Sites, mostly within the Wilderness Area. Site maps and site descriptions, including location, ecological significance, and management considerations, are provided in Appendix B.

Future Inventory, Monitoring & Research Needs

Adaptive management requires current and comprehensive biological information wherever possible. Additional inventory, research, and monitoring efforts could be very useful for informing future GKSF planning and management activities. Major needs identified during this project are related to additional surveys for rare and sensitive species, emerald ash borer information and mitigation, and various ongoing biological monitoring efforts. We also highlight the need for research and monitoring related to fire management, as well as current site preparation techniques. Additional needs will likely be identified during the master planning process.

Introduction

Project Purpose and Objectives

The Governor Knowles State Forest Biotic Inventory was a survey and analysis of selected natural resources of the Governor Knowles State Forest. The Wisconsin Natural Heritage Inventory (NHI) Program, part of the Wisconsin Department of Natural Resources' Bureau of Endangered Resources, conducted the inventory in cooperation with the Division of Forestry. The overall goals were to provide baseline information on rare species, high-quality natural communities, and the overall ecology of the Governor Knowles State Forest (GKSF). Highlighting the property's best opportunities to conserve biological diversity was a major focus of this project.

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The objectives of this project were:

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- interpretation and synthesis of the data for department master planning teams, property managers, administrators, and others involved in the implementation of land use decisions on the Governor Knowles State Forest, as well as the surrounding landscape.

Overview of Methods

The Wisconsin 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 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; these include rare plants, rare animals, high-quality examples of natural communities, and other select natural features. The NHI Working List contains 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 Elements. The most recent NHI Working List is available at the Wisconsin DNR Web site (*http://www.dnr.wi.gov/org/land/er/wlist/*).

The Wisconsin NHI program uses standard methods for biotic inventory to support master planning (Appendix A). Biotic inventory projects for department master planning typically start with a coarse-filter assessment, followed by targeted surveys for priority taxa, then data processing, analysis and report writing

(Appendix A). The project scope and intensity corresponds to the study area size and ecological complexity, along with available resources.

Field surveys for the GKSF biotic inventory were conducted primarily during 2007-2008 with limited follow-up work in subsequent years to fill information gaps for high priority sites and natural communities. Locations for surveys were identified or guided using recent aerial photos, USGS 7.5' topographic maps, various GIS sources, information from past survey efforts, discussions with GKSF staff, and the expertise of biologists familiar with the property or with similar habitats in the region. The collective results from the surveys and subsequent analyses were used to identify ecologically important areas on the GKSF.

Based on its location and ecological setting, key inventory considerations for the GKSF included the identification of large blocks of contiguous forest, patches of relatively intact older forest with diverse structure (or the potential for developing structural attributes associated with older forests), forests with diverse understory composition, intact wetland and aquatic communities, Forested Seeps, barrens/prairie remnants, and other areas with significant biodiversity. Private lands surrounding the GKSF were not surveyed, and county lands received only a very cursory treatment through a couple of site visits. Nearby state-managed lands were not surveyed as part of this project but were later surveyed and described in a report ("Rapid Ecological Assessment of the Glacial Lake Grantsburg Wildlife Areas," in preparation).

Standard methods were used for surveying each taxa group. Table 1 summarizes the surveys conducted during the project along with the principal investigator(s) and the scope of each survey.

Table 1. Field surveys conducted during 2007-2009. For "targeted" surveys, sites were chosen based on likely habitat for rare species, although associated species were also noted.

Survey	Biologist(s)	Scope of Taxa Surveyed
Birds	Matt Berg, Rich Staffen	Bird counts documenting all species encountered and targeted surveys for select species on the Working List
Botany	Craig Anderson, Barbara Delaney, and Eric Epstein	Targeted surveys for Working List species. All species encountered during these surveys were documented.
Rare Forest Raptors	John Krause and Rich Staffen	Targeted surveys for Working List species.
Natural communities	Barbara Delaney, Eric Epstein, Christina Isenring, Ryan Magana, and Drew Feldkirchner	All plant species encountered during these surveys were documented as part of the community description.

Many sources were consulted to aid in the identification and prioritization of survey sites within the GKSF. Our basic references included the Division of Forestry stand reconnaissance data, interpretations of local and regional land cover from recent aerial photographs and satellite imagery, information from the original land surveys for the area, the Ecological Landscapes of Wisconsin Handbook (WDNR In Prep.), the NHI database, the Wisconsin Wildlife Action Plan, rare species information from across the St. Croix River in Minnesota, and habitat type information.

Following surveys, we assessed the natural features of the GKSF and surrounding landscape. Information derived from field-collected data was supplemented with several other ancillary data sources including aerial photos, satellite imagery, various GIS data layers, various analyses of pre-European settlement vegetation data, and Forest Reconnaissance data. All of these data were compiled and interpreted to develop the "Primary Sites" and the "Priority Opportunities for Biodiversity Conservation" provided later in this report for consideration by department master planning teams and others.

Background on Past Efforts

Previous survey work on the GKSF had been project-specific or at different scales and levels of intensity than what was needed for this project. However, broad assessments have identified a number of locations within and around the GKSF as being ecologically significant. The following are examples of such projects and the significant features identified.

The Nature Conservancy: Ecoregional Planning

The Nature Conservancy (TNC) completed an ecoregional plan (TNC 2002) for their Superior Mixed Forest Ecoregion (an area that encompasses much of northern Wisconsin, northern Minnesota, a small portion of Michigan's Upper Peninsula, and parts of southern Manitoba and southern Ontario). The resulting set of terrestrial and aquatic "Conservation Areas" represents viable natural community types, globally rare native species, and other selected features.

The GKSF comprises a portion of two TNC Conservation Areas recognized for their biological significance. Area 39 (Fish / Lake Crex Meadows) is over 139,000 acres and corresponds roughly with the 212Ka01 (Grantsburg Dunes) Landtype Association, surrounding numerous state, county, and private ownerships in western Burnett and northwest Polk counties. Area 25 (Lower St. Croix) is over 166,000 acres and surrounds the St. Croix River down to its confluence with the Mississippi River. The TNC report also identified two Priority Aquatic sites for the portion of the St. Croix River along the GKSF: the "Lower St. Croix River" and "Middle St Croix River" sites.

Land Legacy Study

At the request of the Wisconsin Natural Resources Board, the WDNR conducted the "Land Legacy Study" (WDNR 2006a) to identify critical locations for meeting the state's conservation and recreation needs through 2050. The criteria for identifying "Legacy Places" were broader than those used in this report, as they included recreational uses, although each site was assigned a score for "Conservation Significance." The Saint Croix River was designated a Legacy Place and assigned a Conservation Significance score of five out of a possible five, meaning the area "possesses outstanding ecological qualities, is of adequate size to meet the needs of critical components, and/or harbors communities or species of global or continental significance."

Wisconsin Wildlife Action Plan Implementation

The implementation portion (WDNR 2008) of the Wisconsin Wildlife Action Plan (WDNR 2006d) identified Conservation Opportunity Areas (COAs) critical to conserving Species of Greatest Conservation Need. Portions of three terrestrial COAs cover parts of the GKSF: St. Croix Ridge (3.02), Fish Lake Barrens and Wetlands (2.07), and Crex Barrens and Wetlands (2.02). The Upper St Croix River (A.45) was also identified as an aquatic COA of upper Midwest / regional significance.

County Surveys

During the early 1980's, the Scientific Areas section of the WDNR's Bureau of Research (the predecessor to the current State Natural Areas Program) conducted county-by-county inventories to locate and assess remnant natural areas. These surveys included the GKSF but were designed primarily to identify potential State Scientific Areas and were therefore much more limited in scope than the present effort.

Surveys for Karner Blue Butterfly and Associated Invertebrates

Surveys were conducted during the mid-1990s for Karner blue butterfly. Any invertebrates that were present during the time of these surveys were recorded. These surveys were limited since only species with similar phenology to the Karner blue would have been recorded (e.g., see Kirk 1996).

Peatlands Project

The Peatlands Project (Anderson et al. 2008) was a statewide study conducted by the Bureau of Endangered Resources to obtain baseline data on species in multiple taxon groups associated with Wisconsin's peatland natural

communities. Although some data were collected for two candidate sites on the GKSF, they were not selected for more thorough inventory since they did not meet criteria to be characterized as true peatlands. Other peatland communities on the GKSF were not included in the project because of the need for non-biased selection techniques.

Description of the Study Area

Location

The Governor Knowles State Forest (GKSF), located in northwest Wisconsin, comprises portions of Burnett and Polk counties (Figure 1). Originally designated to protect the Saint Croix River, the GKSF serves as a resource protection zone for the St. Croix National Scenic Riverway, and extends along 55 miles of the Wisconsin side of the river.

Ecoregions

Ecoregions are areas of similar ecological potential and geography. Wisconsin's 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.

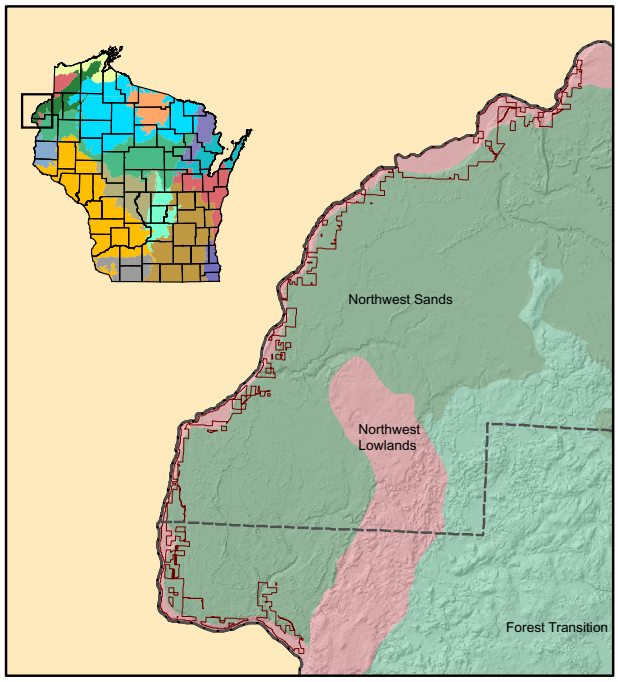


Figure 1

Location of the Governor Knowles State Forest and the Ecological Landscapes of Wisconsin (WDNR In prep).

The GKSF is bisected by two Ecological Landscapes (Figure 1): the Northwest Sands and the Northwest Lowlands. The boundaries of the two landscapes meet along the terrace escarpment of the St. Croix River valley that runs the entire length of the GKSF. The two landscapes differ significantly, highlighting the ecologically dichotomous nature of the GKSF with habitats that vary widely below and above the escarpment. See WDNR (In Prep.) for comprehensive information about Wisconsin's Ecological Landscapes.

The Northwest Sands Ecological Landscape is a large glacial outwash system consisting primarily of two major landforms: flat plains or terraces along glacial meltwater channels and pitted or "collapsed" outwash plains containing kettle lakes. Soils are predominantly deep sands and are low in organic material and nutrients. This landscape reaches its westernmost extent within the GKSF, in an area dominated by dry forest types and small barrens remnants that continue to the east.

The Northwest Lowlands Ecological Landscape is represented by a triangular shape in northwestern Wisconsin, bounded on the north by the Superior Coastal Plain and on the south and east by the Northwest Sands. In Wisconsin, the landscape continues in a narrow strip along the St. Croix River valley; then a four-mile wide swath continues north to Grantsburg. Soils of the Northwest Lowlands are predominantly loams, with significant acreages of peat deposits in the poorly drained lowlands.

The NHFEU Ecoregions at both the Subsection and LTA levels closely correspond to the Ecological Landscapes boundaries for the portions within the GKSF – all three classification levels share the same boundary that bisects the property along its entire length. The area west of the terrace escarpment is comprised of the Bayfield Sand Plains (212Ka) Subsection and the Grantsburg Dunes (212Ka01) Landtype Association. The area west of the escarpment is comprised of the Mille Lacs Uplands (212Kb) Subsection and the St. Croix Plains (212Kb18) Landtype Association.

The Northeast Lowlands and associated NHFEU ecoregions comprise only small portions of Wisconsin. The majority (89%) of the Mille Lacs Uplands Subsection is located in Minnesota where it contains extensive forested lands, wetlands, and numerous lakes but includes almost one-quarter agricultural lands (Minnesota Department of Natural Resources 2006) (Figure 2).

Figure 2

Location of Subsection 212Kb - Mille Lacs Uplands from the National Hierarchy of Ecological Units (Minnesota Department of Natural Resources 2006, Avers et al. 1994).

Size

The GKSF, at just over 20,000 acres, is the second-smallest of Wisconsin's state forests. The state forest is a long narrow property, adjoining 55 miles of the St. Croix River, and is only one-mile wide in most places. The St. Croix National Scenic Riverway adjoins or is part of the GKSF for its entire length extending full protection to the river.

Special Management Designations

Within the state forest boundary, a 412-foot "**Maximum Preservation Zone,**" extends from the river and is administered by the National Park Service as part of the Saint Croix National Scenic Riverway. The Riverway was established in 1968 as one of the eight original rivers formally designated by the Wild and Scenic Rivers Act and currently protects 252 miles of the St. Croix and Namekagon rivers through a variety of ownerships and easements.

One of three state-designated **Wilderness Areas**[1] occurs on the GKSF, running the entire length of the state forest and buffering the land administered by the National Park Service. The Wilderness Area boundary was defined in the Governor Knowles State Forest Master Plan (WDNR 1988) as follows:

> The Wilderness Area will generally have the "terrace escarpment (beginning of the steep slope down to the river basin) plus 200 feet inland as the boundary. When the escarpment is within the 412 foot Maximum Preservation Zone, the boundary will be 200 feet inland from the 412 foot line.

Within the Wilderness Area portion of the GKSF, there is no timber harvest or other vegetative manipulation, and the area is roadless with the exception of roads that were designated in the 1988 master plan.

Six **State Natural Areas** (SNAs) were designated to protect examples of Oak Barrens, Pine Barrens, Northern Dry Forest, Northern Dry Mesic Forest, Forested Seep, and other forested and open wetland community types within the GKSF (Table 2). All of the GKSF State Natural Areas were dedicated in the late 1970s, and most have sharp rectilinear boundaries that follow legal description lines, sometimes crossing intact wetland boundaries and/or High Conservation Forests. The majority of the SNA acreage is located within the Wilderness Area; the exceptions being roughly 60 acres of Brant Brook Pines and the barrens portion of Kohler-Peet Barrens and Cedar Swamp. Another SNA, St. Croix Seeps, was dedicated in 2002 and is located on the adjacent National Park Service land. All of these SNAs are incorporated with the "Primary Sites" described in Appendix B.

[1] "Wilderness" and "Wild Area" designations are from a land classification system that has since been replaced in 2001 by a different set of land management classifications used for master planning (see Wisconsin Administrative Code NR 44).

Table 2. State Natural Areas within or adjacent to the Governor Knowles State Forest

Number	SNA Name
147	Sterling Barrens
148	St Croix Ash Swamp
149	Brant Brook Pines
150	Ekdall Wetlands
151	Norway Point Bottomlands
152	Kohler-Peet Barrens and Cedar Swamp
387	St Croix Seeps*

* owned by the National Park Service

Public Lands

Although public land ownership in Polk and Burnett counties is not as extensive as many other parts of northern Wisconsin, there are some significant landholdings near the property (Table 3). These include a group of state wildlife areas managed as the Glacial Lake Grantsburg Work Unit (occupying the large sand plain resulting from the former Glacial Lake Grantsburg), portions of two county forests, and a state park.

The state wildlife areas are generally a combination of wetland and dry, sandy habitats managed for a variety of game and non-game species. Fish Lake and Crex Meadows are both particularly well-known for their diverse breeding and migratory bird habitat, and both support numerous common and rare species. An ecological assessment was recently conducted for these properties to support master planning efforts there ("Rapid Ecological Assessment of the Glacial Lake Grantsburg Wildlife Areas," in preparation).

Barrens restoration work is ongoing at Crex Meadows and Fish Lake wildlife areas, and WDNR Wildlife staff have been actively restoring portions of the GKSF, primarily within existing SNAs. There are good opportunities to manage barrens across boundaries in a way not otherwise possible on the GKSF alone, due to the small size and narrow configuration of much of the dry habitats there. The current "project boundaries" for these properties is designed to close the gap between the GKSF and the wildlife areas in several places, should opportunities become available.

Extensive public lands are found just across the river in Minnesota. Collectively, the St. Croix State Park, Chengwatana State Forest, Wild River State Park, and Rock Marsh Wildlife Area comprise over 70,000 acres. Forests dominate much of this acreage.

Table 3. Wisconsin public lands near (within approximately 10 miles) or adjacent to the Governor Knowles State Forest

Property Name	Ownership / Management	Acreage
Amsterdam Sloughs Wildlife Area	WDNR	6,138
Burnett County Forest	Burnett County	106,554
Crex Meadows Wildlife Area	WDNR	28,019
Danbury Wildlife Area	WDNR	2,245
Fish Lake Wildlife Area	WDNR	13,438
Interstate State Park	WDNR	1,330
Kiezer Lake Wildlife Area	WDNR	1,352
Polk County Forest	Polk County	17,144

General Land Use

The GKSF and surrounding landscape are a combination of forest, agriculture, and some notable large wetlands. Forestry is a significant component, particularly in the areas surrounding the GKSF, and agriculture becomes more dominant further east, as you approach the border with the Forest Transition Ecological Landscape. The area surrounding the GKSF has many recreational uses such as canoeing, camping, horseback and snowmobile riding, cross-country skiing, fishing, hunting, and wildlife viewing. County and state-managed lands make up the largest landholdings. There are only a couple of industrial forests in the surrounding area, and much of the area is in non-industrial private properties with parcels as small as 10 acres in many places.

Physical Environment

Geology & Geography

Based on general broad-scale bedrock maps, the northern one-third of the GKSF overlies Late Precambrian volcanic or metamorphic bedrock, and the southern portion of the property is over Cambrian sandstone (Dott and Attig 2004, WDNR In Prep.). Bedrock is between 50 and 100 feet from surface throughout and is primarily covered with sand and gravel deposits. Exposed cliffs are uncommon, and the property does not have the bedrock exposures that are found further south where bedrock is closer to the surface (e.g., Interstate State Park).

The major landforms here differ corresponding to the location of the escarpment. Just west of the escarpment is the start of the Mille Lacs Uplands Subsection (Minnesota DNR 2006); this ecoregion is comprised of a large system of plains and moraines deposited by the Superior Lobe and extending well into Minnesota. The St. Croix River valley makes up the small portion of this ecoregion located within the GKSF. This broad valley was largely shaped by the draining of Glacial Lake Grantsburg followed almost 3000 years later by the draining of Glacial Lake Duluth, the largest of a series of former glacial lakes that comprised the Lake Superior basin. Later, the St. Croix River and its tributaries continued to influence the valley, deepening the channel and forming additional terraces. For more information on these landforms and how the St Croix River Valley was formed see WDNR (In Prep.), Shultz (2004), and Wovcha et al. (1995). This portion of the valley within and along the GKSF is now characterized by forested floodplains, open wetlands, and stream terraces with numerous wet depressions.

A small portion of the southwest edge of the Northwest Sands Ecological Landscape (Bayfield Sand Plains Subsection) is located within the GKSF, just east of the escarpment; this Ecological Landscape represents the most extensive xeric glacial outwash system in the state (WDNR In Prep.). This portion of the Northwest Sands is the former location of Glacial Lake Grantsburg, a large waterbody that had been formed by impounded glacial meltwater. The area later became a spillway and was buried by outwash from Glacial Lake Duluth on its way to the St. Croix River valley. In some areas just east of the GKSF (e.g., at Crex Meadows Wildlife Area), lacustrine deposits from the former lake impede drainage, resulting in extensive wetlands. Topography is nearly level in this portion of the Northwest Sands. See WDNR (In Prep.) for more information on the geology and geography of the Northwest Sands.

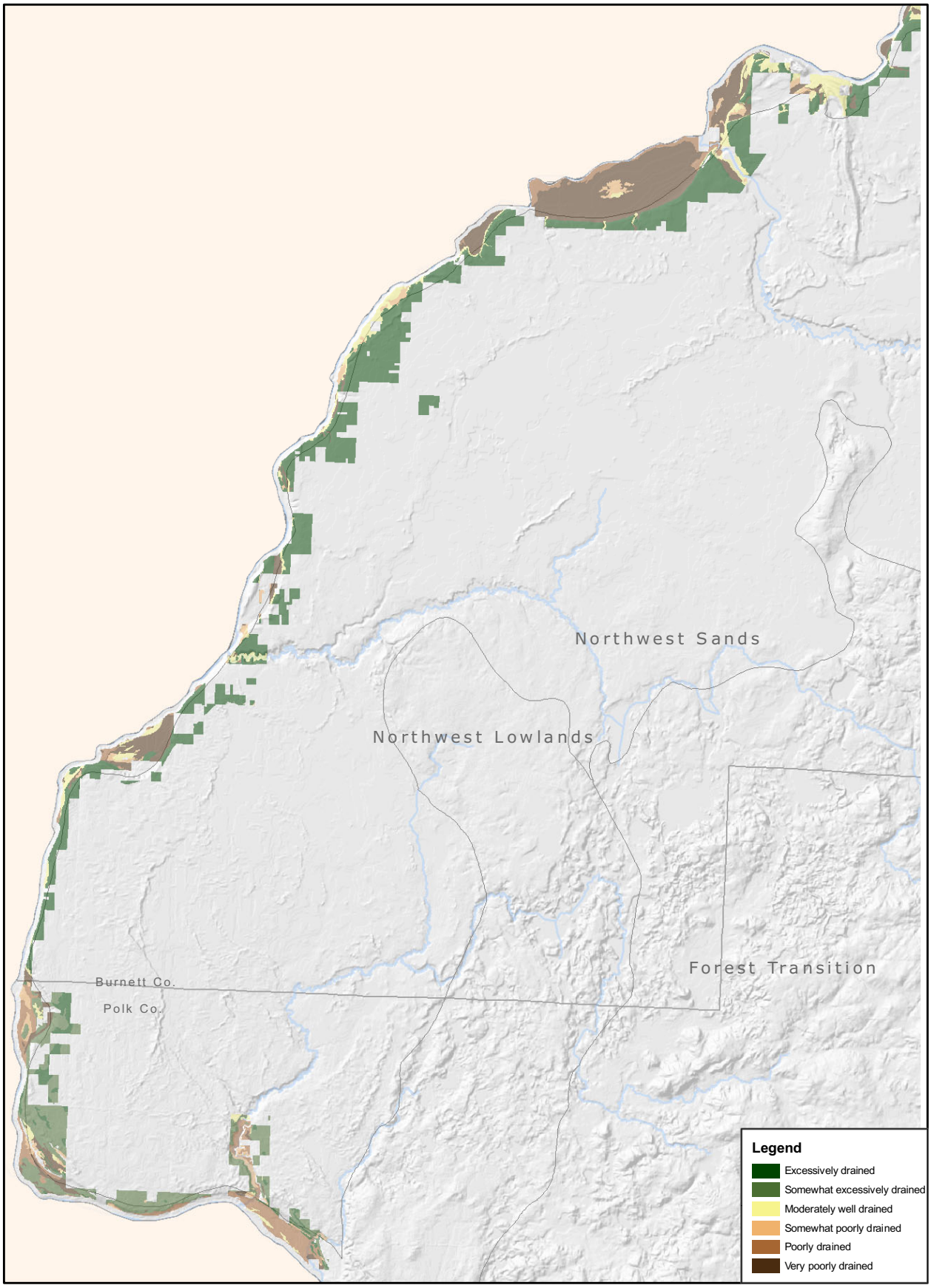
Soils

In general, the GKSF has alluvial soils near the river, sandy outwash soils on the uplands east of the escarpment and a mix of stream terraces, seeps, and some areas of moderately well-drained loamy soils in-between. Soils exhibit extreme differences as you travel from the river, over the escarpment, and into the dry sandy uplands. GKSF soil drainage classes range from excessively drained (the most extensive class at 34% of the property acreage) to very poorly drained (22% of the GKSF) (Figure 3). There are 88 different soil map units found within the GKSF boundaries.

Hydric muck soils (e.g., Bowstring Muck) dominate the large wetlands in the river valley such as those found at the Kohler Peet Wetlands, Clam River Woods North, and St. Croix Ash Swamp Primary Sites (Appendix B). In these

Figure 3

Soil drainage classes by map unit for the Governor Knowles State Forest (NRCS 2009). Ownership boundary is approximate.



cases, the muck extends up to the base of the slope, where it can be quite deep (up to 38") and susceptible to physical damage. Much of the river valley contains wet soils or soils subject to flooding. However, there are some areas where sandier soils occupy slight rises between the wet soils of the floodplain and the base of the escarpment. A large example of this type occurs at the Sunrise Ferry (GK15) Primary Site (see "Primary Sites: Significance and Summaries"), where loamy drift over sandy outwash supports a more xeric community type with numerous scattered wet depressions intermixed throughout.

Soils between the floodplain and the top of the escarpment are a diverse mix of sands and loamy sands, sometimes with abundant cobble interspersed with mucks and other organic soils. Many of the areas contain seeps and streams flowing down the slope. Sometimes there is a thick organic layer over the sands.

Grayling sand is the most prevalent soil association in the dry areas to the east of the escarpment. These are excessively drained soils found on outwash plains. The texture of these map units is sand down to at least a 60-inch depth. See the USDA Web Soil Survey for more information on these and other soils of the GKSF (*websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx*).

Hydrology: Lakes, Streams, and Wetlands

The St. Croix-Namekagon river system was one of the original eight rivers selected in 1968 to become part of the Wild and Scenic Rivers program administered by the National Park Service. The stretch of the St. Croix adjacent to the GKSF is entirely free-flowing and, in terms of its fauna, is part of the longest and most pristine example of a large river ecosystem in the Midwest (WDNR 2002). The river supports a high level of aquatic diversity and is particularly important for fish, mussels, and dragonflies. There are a high number of rare species found in the river, including the State Endangered St. Croix snaketail dragonfly, and several others. It is critically important to maintain the ecological integrity of the river through careful management of areas surrounding the river's tributaries. Mussels, in particular, can be very susceptible to issues affecting water quality.

Four warmwater streams cross the GKSF and empty into the St. Croix River: the Trade River, Clam River, Wood River, and Iron Creek. There is a hydroelectric dam at an in-holding in the forest, forming the 412-acre Clam River Flowage. The stretch from the Clam Dam to its mouth at the St. Croix has been designated an Exceptional Resource Water by the department. The impacts of the Wood River Dam, located outside of the GKSF, are currently under evaluation for impacts to habitat.

Several smaller creeks, brooks, and springs flow through the property and empty into the St. Croix River. Nine of these streams are designated Exceptional Resource Waters: Sioux Portage Creek, Ekdall Brook, Bear Brook, Kettle Brook, Brant Brook, East Brook, Pine Brook, Benson Brook, and a portion of Wolf Creek.

Wetlands are abundant west of the escarpment. Numerous seeps emanate from the escarpment and feed into these tributaries. These seeps are important for biodiversity, and rare plants are associated with them. The GKSF may have the highest number of seeps of any Wisconsin DNR-managed land. Other wetlands include sedge-dominated meadows and large forested wetlands, including Hardwood Swamps, Northern Wet-mesic Forests, and the Floodplain Forests that border the St. Croix River and some of its tributaries. Ephemeral Ponds are not commonly found in this landscape and not abundant on the property, although a few were noted during the course of the project. Wetland natural communities are further described in later sections of this report.

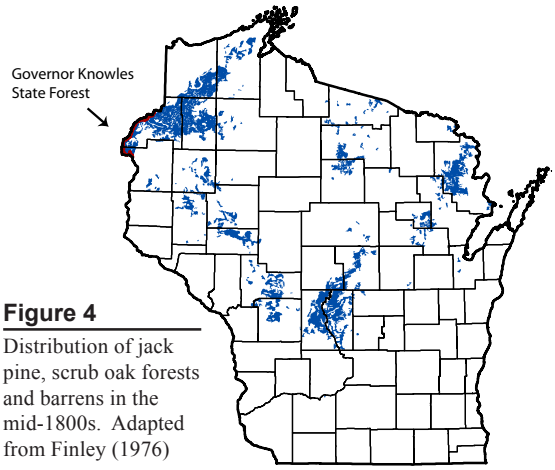


Figure 4
Distribution of jack pine, scrub oak forests and barrens in the mid-1800s. Adapted from Finley (1976)

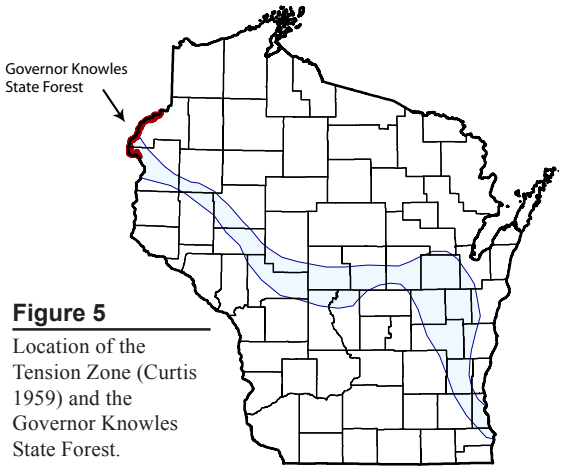


Figure 5
Location of the Tension Zone (Curtis 1959) and the Governor Knowles State Forest.

Vegetation

Historic Vegetation

Based on data from Finley (1976), the uplands of the GKSF - roughly half of the area - was historically jack pine, scrub (northern pin) oak forest, and barrens. The GKSF was located at the western edge of the largest expanse of barrens in the state (Figure 4) corresponding to the current location of the Northwest Sands Ecological Landscape.

Fire was a very important ecological driver in the Northwest Sands, and fire was the major cause of the Pine Barrens (Curtis 1959). Prior to pre-Euro-American settlement, large fires occurred at 10 to 50 year intervals, and smaller fires were also common (WDNR In Prep). In the southern portion of the Northwest Sands, fires may have been more frequent and lower-intensity; here, jack pine was likely less dense than areas further north, and the barrens had more red pine, northern pin oak, and bur oak (Radeloff et al. 2000).

A small amount (ca. 4%) of the area was typed sugar maple-basswood forest, all in the southernmost two miles of the property. Finley typed most of the river valley portion of the GKSF as lowland hardwoods, with a few sizeable blocks of swamp conifers in the areas now comprising portions of the Clam River Woods North (GK01), Kohler-Peet Wetlands (GK03), St. Croix Ash Swamp (GK10), and Sterling Barrens (GK16) Primary Sites. Because of the coarse nature of Finley's data, many smaller features such as wetland inclusions were not identified.

The narrow, linear shape of the GKSF does not lend itself well to a thorough evaluation of the Public Land Survey System[2] tree data due to the low number of witness trees located within the boundary, but general tree abundance can be examined. Based on the witness trees recorded for the area now comprising the GKSF, the top seven most often reported trees (representing 80% of the trees reported) were, in descending order, jack pine, tamarack, pine (undifferentiated), red pine, black ash (*Fraxinus nigra*), bur oak, and balsam fir (Figure 5). Several other species were reported, but each was represented by only eight or fewer trees. Interestingly, very few pin oak trees were reported, with northern pin oak comprising only 1.4% of the witness trees. Bur oak witness trees were reported in both upland and wetland areas, similar to how that species is found now on the property. All three of Wisconsin's native pines were reported with white pine (*Pinus strobus*) the least reported (ca. 4% of trees). However, undifferentiated "pine" was the third most prevalent species reported by surveyors and could potentially include be any combination of the three species. The river valley is said to have had considerable large, old-growth pine (WDNR 1988).

[2] These surveys were conducted by the US General Land Office to establish the current township-range-section system of property description. See Schulte and Mladenoff (2001) for more information on how these data are used for reconstructing pre-European settlement vegetation.

Current Vegetation

The vegetation of the GKSF has been shaped by numerous factors including flooding, grazing, and fire, as well as various management activities since the cutover. The Tension Zone (Curtis 1959) covers the southern half of the property, and tree species associated with both northern and southern Wisconsin are present (Figure 6). This section describes broad cover types with more detail available in the Natural Communities section of the report.

The GKSF is primarily forested, with 86% of the stands classified as forest according to WDNR forest reconnaissance data. The forests range from the most xeric sites to the wettest forest types, with many examples in-between. Figure 7 illustrates the extent of the major GKSF forest cover types from Forest Reconnaissance data.

The broad community types are likely similar to forests in the mid-1800s, but composition, structure, and age classes are different. Changes in GKSF vegetation since Euro-American settlement follow trends similar to many other dry forested habitats in northern Wisconsin. Jack pine is less abundant, while aspen and red pine have both increased in relative abundance. Forests are mostly found in small blocks, largely as a result of the size and configuration of the property. Former barrens / savanna communities are small and localized, having largely succeeded to forest following the lack of fire in these areas. Active barrens restorations are limited to select locations within two State Natural Areas and generally lack canopy trees.

Dry oak-dominated forests occupy much of the uplands. Scrub oak (northern pin oak) is the most common forest cover type, comprising more than one-quarter of the acreage. This type often co-occurs with jack pine and may contain several other tree species including white pine, aspen, red maple (*Acer rubrum*), and other scattered species, depending on the site. Almost three-quarters of the scrub oak are over 80 years old. The most contiguous examples of dry forest with relatively intact ground flora have been included in Primary Sites (Appendix B). This type most closely corresponds to the Northern Dry Forest community type. White (*Quercus alba*) and bur oak are also present on dry-mesic sites, usually mixed with other species, and bur oak is common in floodplain areas and is mixed with mesic species in a couple of areas such as the Trade River and Forest Primary Site (GK14).

As with much of the Northwest Sands, jack pine is much less dominant at the GKSF than it was historically. Jack-pine dominated forests now comprise approximately 2255 acres, with 469 acres of this planted in the last 10 years. However, jack pine is also a component in several mixed dry stands throughout the property. Jack pine-dominated Northern Dry Forests, still containing native barrens flora, occur in a few areas. These stands may have been Pine Barrens in the past and have been included in Primary Sites (e.g., site GK01 – Clam River Woods North).

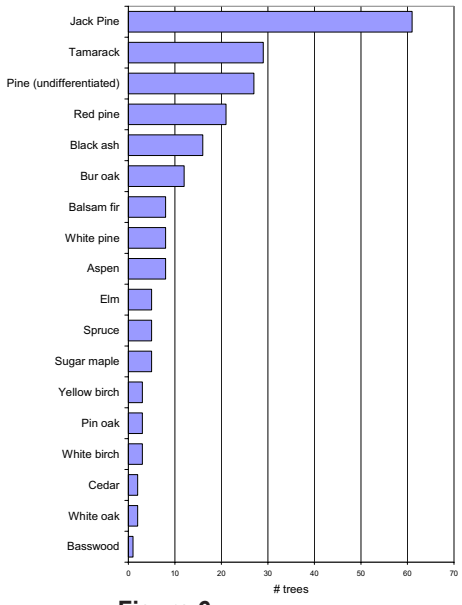


Figure 6.

Pre-European settlement tree species for the Governor Knowles State Forest based on the original General Land Office Surveys (from the WDNR GIS coverage Pre-European SettlementVegetation Database of Wisconsin: Differentiated Section and Quarter Section Corners prepared by the University of Wisconsin - Madison Forest Landscape Ecology Lab).

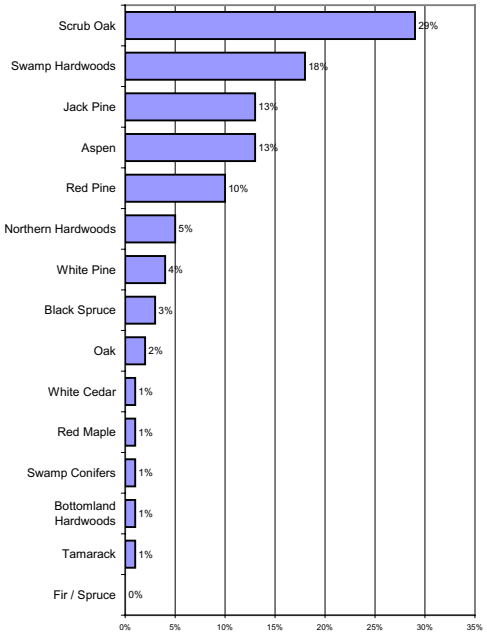


Figure 7.

Forested cover types for the Governor Knowles State Forest. Data are from the Division of Forestry WisFIRS (Wisconsin Forest Inventory and Reporting System) "Property Cover Type Acreage" report, accessed May 6, 2010. Data for each cover type are the percent of the

White and red pines are found scattered throughout the property. Natural origin white and/or red pine-dominated forest types (Northern Dry-mesic Forest) are limited to select locations, but white pine is also a component of several mixed forest types. White pine is found as a component on richer mesic site where it sometimes forms a supercanopy, in dry-mesic forests with oaks and other species, on terraces, and various places within the river valley. Red Pine is also scattered in several mixed forest types. The GKSF forests dominated by red pine (10% of the forested acres) are virtually all plantations, with the exceptions of a few sites within the Wilderness Area and/or State Natural Areas; two-thirds of the red pine plantations were planted in the last 20 years, and over 40% were planted this decade (Figure 8).

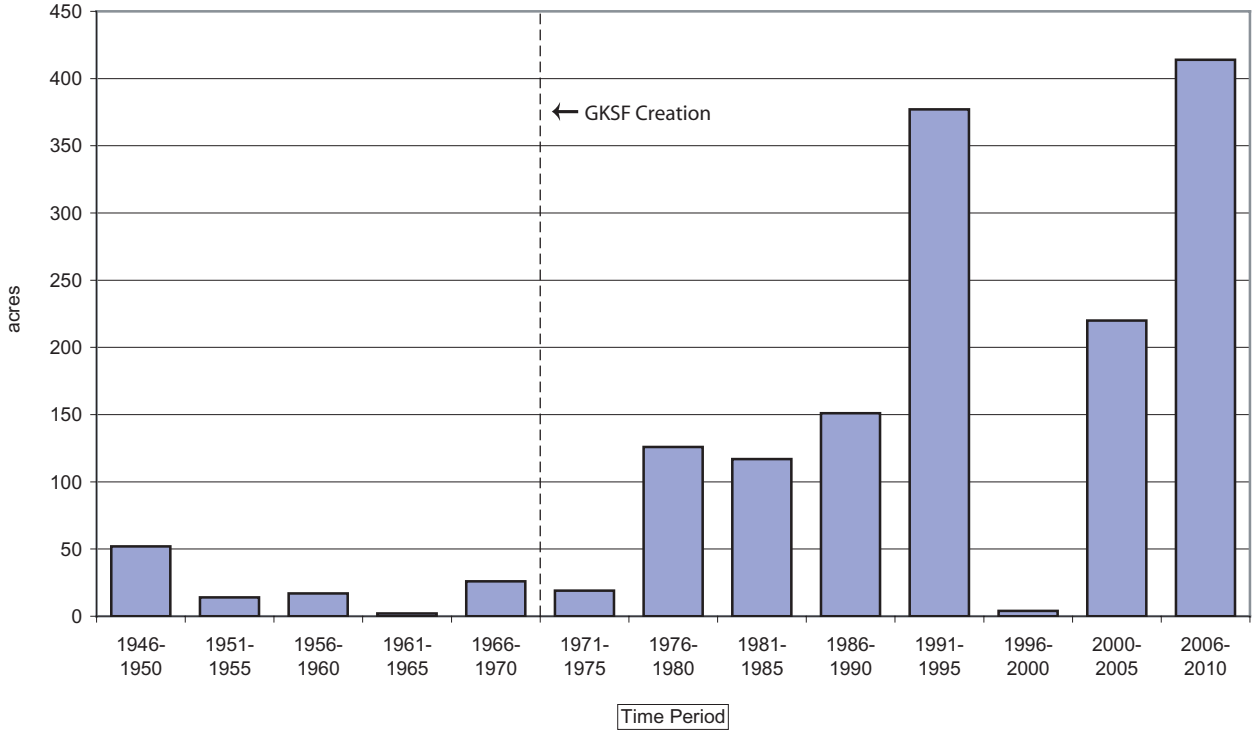
Areas typed as "northern hardwoods" on the GKSF often contain a diverse mix of species that is different from most northern hardwood forests on other state forests. Red maple, elms (*Ulmus* spp.), box elder (*Acer negundo*), ash (*Fraxinus* spp.), bur oak, white pine, and other species occur in these forests. Most of these stands are small and occupy areas along mesic slopes or old river terraces. The largest example of this type is found near the Trade River. Other areas typed as northern hardwoods on the GKSF are dominated by silver maple (*Acer saccharinum*) and bur oak and would be classified as the Floodplain Forest community type.

The GKSF has several types of forested wetlands, almost all within the Wilderness Zone. Swamp hardwoods (analogous to the Hardwood Swamp natural community) comprise the largest acreage and are usually dominated by black ash but often have a diverse group of associates such as red maple, white pine, and basswood (*Tilia americana*). Some of the areas of swamp hardwoods form large contiguous stands. Although found in much smaller stands, there are several areas of conifer swamp, including areas dominated by northern white-cedar, black spruce, and tamarack. All of the forested wetlands can contain seeps and specialized microhabitats.

Non-forested areas make up 13% of the GKSF, based on Forest Reconnaissance data. These areas are mostly shrub swamps, small open wetlands, areas managed for barrens (two SNAs), and old fields.

Figure 8

Governor Knowles State Forest pine plantation acreage by year established. Data are from the Division of Forestry WisFIRS (Wisconsin Forest Inventory and Reporting System), accessed May 6, 2010.



Summary of Findings

Natural Communities of the Study Area

Thirty-seven high-quality examples of **17** natural communities were documented on the GKSF during the biotic inventory (Table 4). These areas can be considered opportunities to develop or protect High Conservation Value Forests. Most of these areas were new records in the NHI database; the remainder were historical records that were updated with new information. These natural community Element Occurrences were a major consideration in selecting the Primary Sites.

Community types found on the GKSF but not listed in Table 4 were represented by stands that were too small, too highly disturbed, or too altered to warrant inclusion in the NHI database. Some of the material below comes from Epstein et al (2002); see this for more information about Wisconsin's natural communities. The Primary Sites mentioned below in parentheses are described in Appendix B.

Table 4. NHI natural community types documented within the Governor Knowles State Forest with at least one Element Occurrence-quality example. See Appendix regarding global and state ranks.

Community Type	Last Observed	State Rank	Global Rank
Alder Thicket	1979	S4	G4
Floodplain Forest	1984	S3	G3?
Forested Seep	2008	S2	GNR
Hardwood Swamp	2008	S3	G4
Northern Dry Forest	2008	S3	G3?
Northern Dry-mesic Forest	2007	S3	G4
Northern Sedge Meadow	2007	S3	G4
Northern Wet Forest	2008	S4	G4
Northern Wet-mesic Forest	2007	S3S4	G3?
Oak Barrens	2007	S2	G2?
Pine Barrens	2007	S2	G2
Sand Prairie	2007	S2	GNR
Shrub-carr	2008	S4	G5
Southern Mesic Forest	2008	S3	G3?
Springs and Spring Runs, Soft	2006	SU	GNR
Stream—Fast, Soft, Cold	1979	SU	GNR
Tamarack (Poor) Swamp	1979	S3	G4

Alder Thicket is a minerotrophic wetland community, typically dominated by alder, but sometimes including several other shrub species. This type occurs at many locations in the St. Croix River valley, often with muck soils and grades into other wetland types such as Northern Sedge Meadow, Hardwood Swamp or one of the conifer swamp types. The understory varies with location and degree of wetness, but often broad-leaved sedges and bluejoint grass (*Calamagrostis canadensis*) are dominant along with herbs such as marsh fern (*Thelypteris palustris*) and *Spiraea* (*Spiraea alba* and *S. tomentosa*). In addition to the large Alder Thickets found close to the St. Croix, there are smaller examples near the Trade River and bordering several other small streams and non-forested wetlands on the property.

Floodplain Forest, found along large rivers, is most commonly associated with southern Wisconsin with some notable examples in the north. The portion of St. Croix River that runs parallel to the GKSF is largely bordered by silver maple-dominated Floodplain Forest - mostly on land managed by the National Park Service. Here, silver

maple is almost always dominant; other associates include bur oak, green ash, basswood, and occasional large white pine. This type is found on the GKSF where the property line runs close to the river (e.g., near site GK16 - Sterling Barrens), and there are small areas of this type along the Trade and Clam rivers. Nettles, sedges, and ferns sometimes under winterberry (*Ilex verticillata*) are common understory dominants here, although at least one area (site GK16 - Sterling Barrens) has unusual inclusions with numerous spring ephemeral plant species normally associated with rich Northern Mesic Forests.

Forested Seeps are shaded areas with active spring discharges that may host a number of uncommon or rare species. These are abundant at the GKSF, occurring in many places along the escarpment where the base of the slope meets the river terrace. Within the GKSF, these areas are often found in association with black ask swamps (Hardwood Swamps), but they also occur in other types near the edge of the slope including northern white-cedar-dominated conifer swamps (Northern Wet-mesic Forests). These seeps form diverse microhabitats within the forest with saturated small wetlands, rivulets, and ponds filled with cold nutrient-rich groundwater. High plant diversity is associated with these areas, including some rare species such as the State Threatened bog bluegrass (*Poa paludigena*). Several other plants associated with wet habitats can be found in GKSF seeps, including swamp saxifrage (*Saxifraga pensylvanica*), cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), skunk cabbage (*Symplocarpus foetidus*), and several sedges. The high concentration of seeps on the GKSF is unusual for state-managed lands and they are a high conservation priority. Seeps are particularly susceptible to soil and hydrological disturbances.

Hardwood Swamps are forested wetlands found in poorly drained areas and dominated by deciduous species. There are many examples of this type on the GKSF, including some very large stands occupying portions of the river valley. These forests in the GKSF are usually dominated by black ash, although other species such as yellow birch (*Betula alleghaniensis*), red maple, and basswood can be important canopy associates. American elm is still found scattered in many areas, but it is much less common than it was historically, likely due to Dutch elm disease. White pine and bur oak are also occasionally found in these forests, and some of the more “northerly” examples have balsam fir or even black spruce. The wetness of these areas varies; some contain abundant standing water with shrubs and saplings limited to tall hummocks between the pools. Where a shrub layer is significant in GKSF Hardwood Swamps, it is often dominated by winterberry. The herb layer can be diverse and shares several species found in Alder Thickets and Forested Seeps. This type is often associated with seepage areas on the GKSF and grades into other wetland types, including Alder Thickets and conifer swamps.

Portion of a large Hardwood Swamp at the Kohler-Peet Wetlands (GK03) Primary Site. Here, the canopy is dominated by black ash on hummocky topography with pools of water between. Red maple and yellow birch are canopy associates with widely scattered supercanopy white pine. Saplings are red maple, yellow birch, and scattered balsam fir. Winterberry is the dominant shrub in the photo; royal fern and cinnamon fern are the dominant herbs. Photo by Drew Feldkirchner, Wisconsin DNR.

Northern Dry Forests typically occur on nutrient-poor excessively drained sites and are usually dominated by jack pine, red pine, and/or northern pin oak. On the GKSF, these forests are found on outwash sands in several areas east of the escarpment and are usually dominated by northern pin oak. Jack pine, while present in many stands, is usually not dominant; there are a few exceptions including a large (>250 acres) example north of the Clam Dam. On the GKSF canopy associates include bur oak, red pine, aspen, and red maple. This type often grades into Pine Barrens and can share some of the same herb species, especially in small openings. This community was historically fire-dependant, and many examples have been converted to other cover types through planting or succession. Northern Dry Forests are susceptible to simplification after long periods without fire and along with certain types of disturbance such as deer browse; in these cases the herb layer can become heavily dominated by Penn sedge (*Carex pensylvanica*) to the exclusion of other species.

Northern Dry-mesic Forests are dominated by white and red pine, sometimes interspersed with red maple and/or red oak. In the GKSF, examples also include bigtooth aspen (*Populus grandidentata*), northern pin oak, and white birch (*Betula papyrifera*). These types were formerly common in the landscapes that occupied the well-known "pineries" of Wisconsin at the time of Euro-American settlement. Many examples of this type in the Northwest Sands have been converted to red pine plantations with smaller trees, simplified herb layers, and reduced structural and species diversity. This type is not common on the GKSF; the best examples are in and around the Brant Brook Pines State Natural Area (site GK07 - Brant Brook Pines and Hardwoods) and another site near the north end of the property by "Pease Hill" (site GK01 – Clam River Woods North).

Northern Sedge Meadows are open wetland communities dominated by sedges and grasses that usually lack sphagnum mosses outside of scattered, discontinuous patches. The dominant species can vary, and there are several common, fairly distinctive subtypes depending on the dominant sedges present. Very large, high-quality examples of this type occur at the nearby Crex Meadows and Fish Lake wildlife areas. GKSF sedge meadows mostly occur as small wetland inclusions surrounded by other natural community types within the river valley, with a few larger exceptions (i.e., at sites GK03 - Kohler-Peet Wetlands, GK15 - Sunrise Ferry, and GK12 - Lagoo Creek and Terraces). A previously documented large sedge meadow at the southernmost end of the property near Wolf Creek has become dominated by shrubs, and the portions nearest Wolf Creek being are now heavily dominated by reed canary grass (*Phalaris arundinacea*).

Northern Wet Forests are weakly minerotrophic conifer swamps, located mostly north of the Tension Zone and dominated by black spruce and tamarack. They occur where the water table is near the surface or drainage is impeded, as well as near the margins of certain lakes. This type often grades into either acidic types such as muskeg and open bog or more minerotrophic types such as Northern Wet-mesic Forest or Hardwood Swamps, depending on the source of groundwater present. This natural community type is often split into Black Spruce Swamp and Tamarack (poor) Swamp community types based on species composition and nutrient status. The largest example of this type documented on the GKSF is part of an extensive wetland complex (GK03 – Kohler-Peet Wetlands). It is also found in small pockets elsewhere in the river valley.

Northern Wet-mesic Forests are the classic "cedar swamps" found mostly north of the Tension Zone. These forested wetlands are dominated by northern white cedar and occupy areas with rich, neutral to alkaline peats and mucks. Balsam fir, black ash, and spruces are among the many potential canopy associates. Mosses often dominate the groundlayer, and there is potential for several rare plant species to occur. The only sizeable examples of this type found on the GKSF were parts of the large wetland complex comprising the GK03 – Kohler-Peet Wetlands, where they graded into other high-quality forested wetland types. South of this area, along both sides of the St. Croix River, Northern Wet-mesic Forests are very rare. On the Minnesota side, Wovcha et al. (1995), estimate that there are only two known locations for their study area that begins near the St Croix Ash Swamp Primary Site (GK10) and extends to the south and east to cover six counties.

Oak Barrens and Pine Barrens share many similarities and can be found intermixed in some portions of the state. The GKSF is crossed by the Tension Zone, and there are examples of both types. They both contain widely-spaced trees. Black oak is the dominant species in Oak Barrens, although the GKSF is north of the main portion of black

oak's range, so these areas are dominated by northern pin oak. Jack pine dominates the overstory in Pine Barrens. Both communities can have other oak species present, including bur oak and northern pin oak. The herbaceous layer can be diverse and contain many plant species also found in Dry Prairies and/or Sand Prairies. In general, Oak Barrens contain a higher number and abundance of prairie species and are found south of the Tension Zone. Pine Barrens are more common in the north and tend to include more ericaceous woody species (e.g., blueberries and sweetfern). Some combination of these types likely dominated much of the GKSF uplands prior to Euro-American settlement, but many of these areas have succeeded to forest types (e.g., Northern Dry Forest) or been converted to plantations. Canopy trees are mostly lacking from the managed GKSF barrens remnants. Currently, there are three areas on the GKSF with Element Occurrence –quality examples of these types: two existing SNAs (sites GK04 – Kohler-Peet Barrens and GK16 – Sterling Barrens) and one small (ca. 40 acres) area near Lagoo Creek. In addition, the area north of Clam Dam has numerous micro-barrens sites and better potential for large-scale restoration than the Lagoo Creek site. The two SNAs have been intensively managed for several years.

Sand Prairies are dominated by grasses such as little bluestem (*Schizachyrium scoparium*), junegrass (*Koeleria macrantha*), panic grass (*Panicum* spp.), and poverty-oat grass (*Danthonia spicata*). Extensive areas of this type historically are thought to have occurred along broad river terraces in Wisconsin. Within the GKSF this type probably occurred in close association with barrens communities, and some examples of this type were former barrens that now lack trees. The only examples of this type known from the GKSF occur at the Sterling Barrens SNA (site GK16), including some areas that have been managed in a treeless condition, as well as other pockets on steep south/southwest-facing slopes that support naturally-occurring sand prairie openings on droughty, wind-deposited sand.

Shrub-carrs are wetland communities dominated by tall shrubs other than alder such as red-osier dogwood (*Cornus stolonifera*), silky dogwood (*Cornus amomum* var. *schuetzeana*), meadowsweet (*Spiraea alba*), and various willows (*Salix* spp). Canada bluejoint grass is often common in this community type, as well as other species found in Alder Thickets and sedge meadows. This type often occurs in bands around lakes or ponds, on the margins of river floodplains, or, more extensively, in glacial lakebeds. This type is found in several small pockets on the GKSF, in addition to a couple of large examples within the river valley, where it is often dominated by willows along with other species such as winterberry and meadowsweet. The largest examples known from the GKSF are within extensive wetland complexes (sites GK03 – Kohler-Peet Wetlands and GK16 – Sterling Barrens).

Southern Mesic Forests are upland forests occurring on rich, well-drained loamy soils, mostly on glacial till plains or loess-capped sites. Sugar maple is typically the dominant tree species, but several other species are often present. This community type occurs mostly south of the Tension Zone, and the examples on the GKSF are the northernmost documented Element Occurrences of this type. This type can exhibit a very rich herb layer with abundant spring ephemerals. The GKSF examples of this natural community are unusual variants of the Southern Mesic Forest type that are not well-represented by the NHI natural community classification. The stands documented on the GKSF have a diverse canopy composition that includes the unusual combination of bur oak occurring with sugar maple yet with many of the typical Southern Mesic Forest herb species. They were found in two places on the St. Croix River terrace (sites GK07 – Brant Brook Pines and Hardwoods and GK15 – Sunrise Ferry), as well as a large example along both sides of the Trade River (GK14 – Trade River and Forest) and a couple of rich inclusions within the St. Croix River floodplain near the mouth of the Trade River (GK16 - Sterling Barrens).

Tamarack (poor) Swamps are weakly to moderately minerotrophic conifer swamps dominated by tamarack and a frequently containing a dense understory of speckled alder. The understory is more diverse than in Black Spruce Swamps and may include more nutrient-demanding species such as winterberry holly and black ash. Tamarack-dominated stands documented on the GKSF were mostly typed as Northern Wet Forest, and small examples were treated as inclusions within larger community types. The only Tamarack (Poor) Swamp documented for the GKSF is located in the St Croix bottomlands near the Ekdall Wetlands SNA (GK05 – Ekdall Wetlands); this site is fed by numerous seepages.

Rare Vascular Plants of the Study Area

The Wisconsin Natural Heritage Database tracks **14** rare plant species known from the GKSF including one State Endangered, three State Threatened, and 10 Special Concern species (Table 5). Roughly half of these species were either found or relocated during this inventory. The other species were not re-located during this inventory project and, in some cases, have not been seen on the property for decades. One additional plant, prickly hornwort (*Ceratophyllum echinatum*) is known from within one-mile of the GKSF; this is a special concern species found in soft-water lakes, ponds, and reservoirs. No federally-listed plants are known from the GKSF at this time. The following are general description of GKSF rare species habitats; please see also *dnr.wi.gov/org/land/er/biodiversity* for more information on these and other Working List species.

Table 5. NHI Working List plants documented within the Governor Knowles State Forest. One additional plant, prickly hornwort (*Ceratophyllum echinatum*) is known from within one-mile of the GKSF. See Appendix D for more information about ranks and status.

Scientific Name	Common Name	Last Observed	State Rank	Global Rank	State Status
Arethusa bulbosa	Swamp-pink	1975	S3	G4	SC
Asclepias ovalifolia	Dwarf Milkweed	2007	S3	G5?	THR
Carex assiniboinensis	Assiniboine Sedge	2007	S3	G4G5	SC
Carex prasina	Drooping Sedge	1993	S3	G4	THR
Cypripedium parviflorum var. *makasin*	Northern Yellow Lady's-slipper	1975	S3	G5T4Q	SC
Cypripedium reginae	Showy Lady's-slipper	2007	S3	G4	SC
Dalea villosa var. *villosa*	Silky Prairie-clover	2008	S2	G5	SC
Deschampsia cespitosa	Tufted Hairgrass	2007	S2	G5	SC
Epilobium palustre	Marsh Willow-herb	2004	S3	G5	SC
Liatris punctata var. *nebraskana*	Dotted Blazing Star	1989	S2S3	G5T3T5	END
Myriophyllum farwellii	Farwell's Water-milfoil	1971	S3	G5	SC
Ophioglossum pusillum	Adder's-tongue	1966	S2	G5	SC
Poa paludigena	Bog Bluegrass	2008	S3	G3	THR
Talinum rugospermum	Prairie Fame-flower	1994	S3	G3G4	SC

These rare plants are found in habitats with widely varying moisture and nutrient regimes, as would be expected given the disparate soils, landforms, and community types present. In general, rare plants were found in the following habitats on the property: Pine/Oak Barrens, Forested Seep, Hardwood Swamp, open wetlands, mesic hardwood forests with moist inclusions, conifer swamps, and roadsides / rights-of-way.

Dry, sandy habitats on the GKSF supporting rare plants include the two managed barrens, as well as certain roadside areas and powerline / railroad rights of way. These dry habitats support barrens-associated species such as dwarf milkweed (*Asclepias ovalifolia)*, silky prairie-clover (*Dalea villosa*), and prairie fame-flower (*Talinum rugospermum*). The GKSF records for silky prairie-clover represent significant proportions of the known occurrences in the state (Figure 9). Silky prairie-clover has a very restricted distribution in Wisconsin and is only known from dry, sandy areas near the St. Croix and Mississippi rivers. There may be additional undocumented locations for these species, as well as other barrens associates in and around the GKSF in former barrens that have

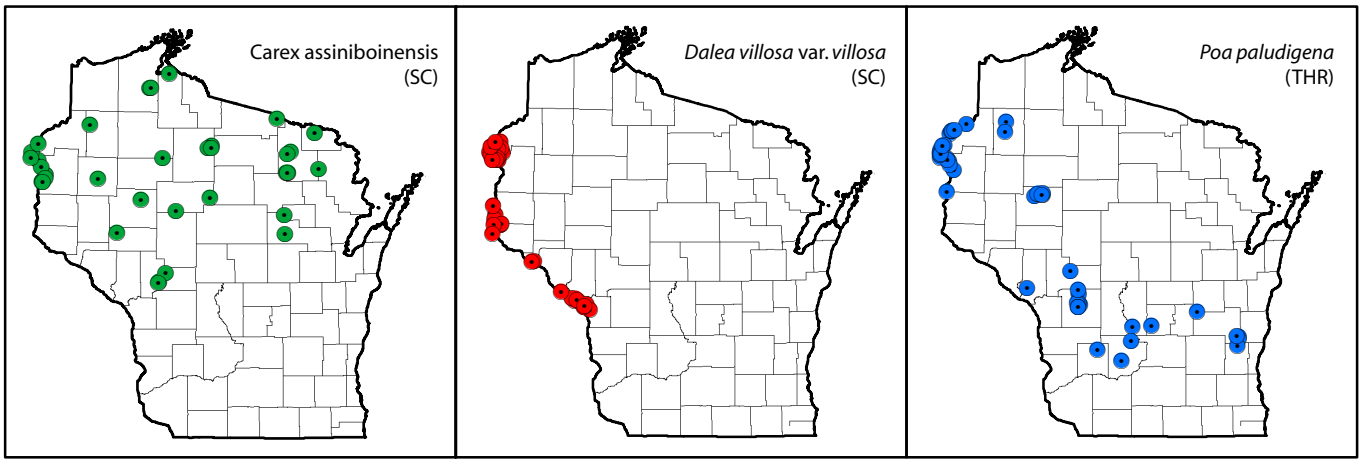


Figure 9

Distribution of documented occurrences of three rare plants that are especially well-represented at the Governor Knowles State Forest. Documented occurrences of Carex assiniboinensis, Dalea villosa var. villosa, and Poa paludigena represent 11%, 25%, and 33% of the known Wisconsin occurrences, respectively.

succeeded to dry forest but have retained open pockets. In addition to barrens management, there are opportunities to maintain and enhance habitat for these species during ongoing management activities (see the "Priority Opportunities for Biodiversity Conservation" section). Dotted Blazing Star (*Liatris punctata* var. *nebraskana*), another dry prairie / barrens species known from the GKSF, has not been relocated since the 1980s, despite several attempts. This endangered plant is known from only the extreme western counties, similar to silky prairie-clover.

Hardwood Swamps and Forested Seeps on the GKSF also provide rare plant habitat. Bog bluegrass (*Poa paludigena*) is especially well-represented on the GKSF, with one-third of its documented occurrences in Wisconsin located within the property boundary. This species is mostly found in forests with wet soils, especially near areas with groundwater seepage. It grows on a moist substrate such as sphagnum or other mosses or fallen rotting trees (NatureServe 2009). This species has been found along the length of the property within the abundant high-quality Hardwood Swamps and forested seeps, and the GKSF probably provides the most extensive habitat for this species of any property managed by the Wisconsin DNR. Showy Lady's-slipper (*Cypripedium reginae*) was also found in seeps and Hardwood Swamps on the GKSF, and there is potential for other plants to occur in these habitats. Smaller seepage inclusions within other forested natural communities types also contained rare plants on the GKSF.

Silky Prairie-clover (*Dalea villosa* var. *villosa*). Photo by Barbara Delaney.

The GKSF's conifer swamps support rare species. These forested communities include Northern Wet-mesic Forest, Northern Wet Forest, and Tamarack (poor) Swamp. Within the GKSF, these natural communities are often represented by smaller stands that grade into other community types. Northern Wet-mesic Forests on the GKSF sometimes include seeps and pools, providing important microhabitats for certain species. Rare plant species documented in GKSF conifer swamps include showy lady's slipper and marsh willow-herb (*Epilobium palustre*), a species that uses bogs and fen mats.

Rare plants were also found in small seepage areas and wetland depressions within mesic hardwood forests, as well as some dry-mesic forests, on the GKSF. These include drooping sedge (*Carex prasina*) and Assiniboine sedge (*Carex assiniboinensis*), the latter being especially well-represented on the property (Figure 9). These microhabitats within forested stands provide important habitat for several plant and animal species.

Only a couple of rare plants are known from the open wetlands of the GKSF to date. However, the largest sedge meadows, including some on NPS land were not thoroughly surveyed during this project and may harbor additional rare plant species. Tufted Hairgrass (*Deschampsia cespitosa*) was found in one location in an open meadow with seepages. Although quite uncommon, this species is known from several different habitats throughout the state, including springs, seeps, and specialized habitats near the Great Lakes. Assiniboine sedge was found on the GKSF in one small sedge-dominated wetland at the edge of a bottomland forest, although it is much more typically associated with mesic hardwoods where it was found elsewhere on the property.

Six additional Wisconsin Working List species are known from within a mile of the GKSF on the Minnesota side of the St Croix River (Table 6). Although these species have not been documented on the GKSF, there may be potential for them to occur on the property.

Table 6. NHI Working List plants documented within one mile of the Governor Knowles State Forest on the Minnesota side of the river. These non-locational species data provided courtesy of the Minnesota DNR Ecological Resources Program. See *dnr.wi.gov/org/land/er/wlist* for more information about ranks and status.

Scientific Name	Common Name	State Rank	Global Rank	State Status
Besseya bullii	Kitten Tails	S3	G3	THR
Botrychium oneidense	Blunt-lobe Grape-fern	S2	G4Q	SC
Botrychium rugulosum	Rugulose Grape-fern	S2	G3	SC
Cirsium hillii	Hill's Thistle	S3	G3	THR
Malaxis monophyllos var. *brachypoda*	White Adder's-mouth	S3	G4Q	SC
*Panax quinquefolius**	American Ginseng	S4	G3G4	SC

* species is not actively tracked by NHI, but data are collected.

Rare Animals of the Study Area

The Wisconsin NHI database tracks **33** rare animal species that have been documented on or near (e.g., river species) the GKSF, including one beetle, 10 birds, four butterflies, three dragonflies, six fish, one mammal, two moths, four mussels, and two turtle species (Table 6). Five of these species are State Endangered, nine are State Threatened, and three species are protected by the federal Endangered Species Act. Herptiles and invertebrates were not surveyed during this project, and the "Future Needs" section outlines opportunities for additional GKSF survey work for these taxa.

Barrens associates are generally restricted to dry, sandy habitats, these species comprise at least 20% of the rare animal species documented on the GKSF, including all of the butterflies, moths, and the one tiger beetle (*Cicindela patruela patruela*) known from the property. Several of these species are known from the managed barrens on the property, although rare animals were also documented in small barrens "pockets," trailsides, or roadsides. Rare

Table 7. NHI Working List animals documented within the Governor Knowles State Forest. See Appendix D for more information about ranks and status.

Scientific Name	Common Name	Last Observed	State Rank	Global Rank	State Status	Federal Status
Beetle						
Cicindela patruela patruela	A Tiger Beetle	1996	S2	G3T3	SC/N	
Bird						
Buteo lineatus	Red-shouldered Hawk	2008	S3S4B,S1N	G5	THR	
Coccyzus americanus	Yellow-billed Cuckoo	2008	S3B	G5	SC/M	
Haliaeetus leucocephalus	Bald Eagle	2007	S4B,S2N	G5	SC/P	
Picoides arcticus	Black-backed Woodpecker	2007	S2B	G5	SC/M	
Podiceps grisegena	Red-necked Grebe	1987	S1B	G5	END	
Protonotaria citrea	Prothonotary Warbler	2007	S3B	G5	SC/M	
Seiurus motacilla	Louisiana Waterthrush	2007	S3B	G5	SC/M	
Wilsonia canadensis	Canada Warbler	2008	S3B	G5	SC/M	
Wilsonia citrina	Hooded Warbler	2008	S2S3B	G5	THR	
Butterfly						
Atrytonopsis hianna	Dusted Skipper	1999	S3	G4G5	SC/N	
Callophrys henrici	Henry's Elfin	1988	S1S2	G5	SC/N	
Hesperia metea	Cobweb Skipper	1996	S2	G4G5	SC/N	
Lycaeides melissa samuelis	Karner Blue	2003	S3	G5T2	SC/FL	LE
Dragonfly						
Ophiogomphus anomalus	Extra-striped Snaketail	1994	S3	G4	END	
Ophiogomphus howei	Pygmy Snaketail	1999	S4	G3	THR	
Ophiogomphus susbehcha	Saint Croix Snaketail	2000	S2	G1G2	END	
Fish						
Acipenser fulvescens	Lake Sturgeon	1991	S3	G3G4	SC/H	
Cycleptus elongatus	Blue Sucker	1979	S2	G3G4	THR	
Fundulus diaphanus	Banded Killifish	1978	S3	G5	SC/N	
Moxostoma carinatum	River Redhorse	1979	S2	G4	THR	
Moxostoma valenciennesi	Greater Redhorse	1989	S3	G4	THR	
Percina evides	Gilt Darter	1983	S2	G4	THR	
Mammal						
Canis lupus	Gray Wolf	2008	S2	G4	SC/FL	LE
Moth						
Catocala whitneyi	Whitney's Underwing Moth	1999	S3	G3G4	SC/N	
Papaipema beeriana	Liatris Borer Moth	1997	S2	G2G3	SC/N	
Mussel						
Alasmidonta marginata	Elktoe	1997	S4	G4	SC/P	
Cumberlandia monodonta	Spectacle Case	1988	S1	G3	END	C
Cyclonaias tuberculata	Purple Wartyback	1997	S1S2	G5	END	
Pleurobema sintoxia	Round Pigtoe	1997	S3	G4G5	SC/P	
Turtle						
Emydoidea blandingii	Blanding's Turtle	1996	S3	G4	THR	
Glyptemys insculpta	Wood Turtle	1985	S2	G4	THR	

butterflies and moths often require specific host plant species for their larvae to survive, and these plants have restricted distributions on the GKSF. As you might expect given the rarity of the barrens habitat, some of these barrens associates are considered globally rare, including *Cicindela patruela patruela*, Whitney's underwing moth (*Catocala whitneyi*), and liatris borer moth (*Papaipema beeriana*). Others are not globally threatened but are quite rare in Wisconsin including Henry's elfin (*Callophrys henrici*), known from just outside of the GKSF proper. There are several additional rare barrens associates that occur within one-mile of the GKSF and for which the GKSF may offer suitable habitat or opportunities to provide connections including the State Endangered phlox moth. Table 8 lists additional rare animal species located within one mile of the GKSF, in both Wisconsin and Minnesota.

Table 8. Additional NHI Working List animals not documented within the Governor Knowles State Forest but known from within one-mile of the property. Although these species have not yet been documented on the GKSF, they may be important to consider during planning and management activities. None of these species are federally-listed. Non-locational species data for Minnesota provided courtesy of the Minnesota DNR Ecological Resources Program.

Scientific Name	Common Name	Last Observed	State Rank	Global Rank	State Status
Accipiter gentilis	Northern Goshawk	1979	S2B,S2N	G5	SC/M
*Actinonaias ligamentina**	Mucket	**	S4	G5	SC/P
Ammodramus henslowii	Henslow's Sparrow	**	S3B	G4	THR
Bartramia longicauda	Upland Sandpiper	2006	S2B	G5	SC/M
Botaurus lentiginosus	American Bittern	2007	S3B	G4	SC/M
Chlidonias niger	Black Tern	1993	S2B	G4	SC/M
Dendroica cerulea	Cerulean Warbler	**	S2S3B	G4	THR
Dolania americana	American Sand Burrowing Mayfly	1989	S1	G4	SC/N
Erynnis martialis	Mottled Dusky Wing	1991	S2	G3	SC/N
Hesperia leonardus	Leonard's Skipper	1989	S3	G4	SC/N
Heterodon platirhinos	Eastern Hog-nosed Snake	**	S3?	G5	SC/H
*Lasmigona compressa**	Creek Heelsplitter	**	S3S4	G5	SC/P
*Ligumia recta**	Black Sandshell	**	S3	G5	SC/P
Lithobates septentrionalis	Mink Frog	2006	S3S4	G5	SC/H
Macdunnoa persimplex	A Flat-headed Mayfly	1991	S1?	G4	SC/N
Notropis amnis	Pallid Shiner		S2	G4	END
Notropis anogenus	Pugnose Shiner	1928	S2	G3	THR
Pandion haliaetus	Osprey	1992	S4B	G5	SC/M
Parameletus chelifer	A Primitive Minnow Mayfly	1992	S1?	G5	SC/N
Pituophis catenifer	Gophersnake (bullsnake)	**	S2S3	G5	SC/P
Pseudiron centralis	A Flat-headed Mayfly	1992	S3	G5	SC/N
Quadrula nodulata	Wartyback	**	S1S2	G4	THR
Schinia indiana	Phlox Moth	1994	S2S3	G2G4	END
Simpsonaias ambigua	Salamander Mussel	1988	S2S3	G3	THR
Tympanuchus cupido	Greater Prairie-chicken	1979	S1B,S2N	G4	THR
Tympanuchus phasianellus	Sharp-tailed Grouse	1993	S1B,S2N	G4	SC/H

* species is not actively tracked by NHI, but data are collected.
** these species are known only from the Minnesota side of the river in this area

The St. Croix River supports the largest portion (36%) of the rare animal species known from the study area, including all of the rare dragonfly, fish, and mussel species. Two-thirds of the state-listed species, as well as one candidate for federal listing, the spectacle case (*Cumberlandia monodonta*) mussel, are found in the St. Croix. Several of these species are very susceptible to changes in water quality and rely on the high-quality river habitat for their survival. Management of the areas surrounding the tributaries to the St. Croix has important indirect impacts on these species.

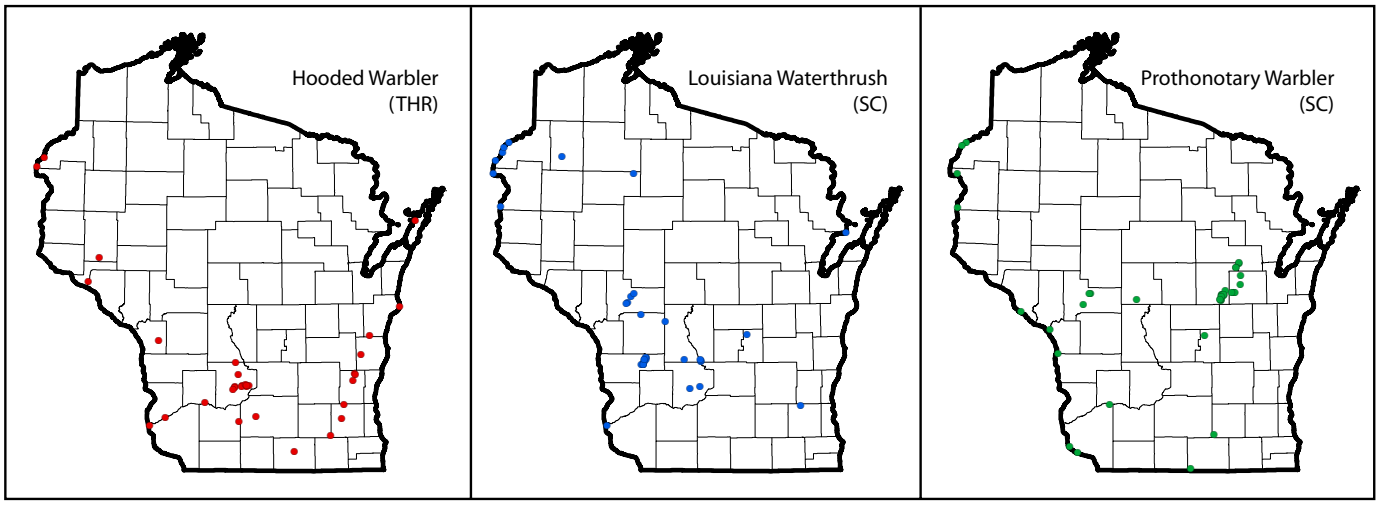


Figure 10.

Distribution of documented occurrences of three rare birds species that reach their northern range limits at the Governor Knowles State Forest.

Numerous occurrences of several rare bird species were documented on the GKSF. The varied habitats and the property's location within and around the Tension Zone likely contribute to the bird diversity, as the property contains species with both northern and southern affinities. The State Threatened Red-shouldered Hawk was found to be particularly abundant on the GKSF, and there are likely many additional territories from the adjacent NPS land, as well as across the river in Minnesota, as this species is known to be abundant in the forests of the St. Croix River valley (Wovcha et al. 1995, Mossman 1991). Louisiana Waterthrush is also an important species here and is present at high numbers that are disproportionate to the size of the property (14% of the state's Element Occurrences are from the GKSF). Louisiana Waterthrush is present here at the northernmost limits of its range, and it requires specific habitat characteristics. This species nests near flowing water including forested springs, spring runs, or streams (Mossman 1991) within extensive forest habitat, and the GKSF provides many excellent locations for nesting. Other rare birds documented at the GKSF at or near the northernmost limits of their ranges include Hooded Warbler, found here in dry mesic forest, as well as Prothonotary Warbler, a cavity-nesting species of bottomland forests that was found here in Hardwood Swamp, Floodplain Forest and Dry-mesic forests - always near a stream or river (Figure 10). The St. Croix River corridor is well-known for supporting Prothonotary Warbler, and there are likely many additional undocumented populations on National Park Service land. Finally, the GKSF supports rare birds with northern affinities such as Canada Warbler, a bird often associated with forests containing conifers, as well as forested swamps or alder thickets (Epstein 2006), and Black-backed Woodpecker, a species associated with lowland conifer forests and burned jack pine stands (Johnson 2006) that was found in dry forest stand dominated by northern pin oak.

Red-shouldered Hawk nestlings. Photo by Jim Woodford, Wisconsin DNR.

Species of Greatest Conservation Need

In addition to the aforementioned rare animals that have been documented in the NHI database, there are numerous additional species that could occur in the GKSF and surrounding landscape. The Wisconsin Wildlife Action Plan (WDNR 2006a) lists all of Wisconsin's the Species of Greatest Conservation Need (SGCN) by their degree of association with each Ecological Landscape. Table 9 contains species are either significantly or moderately associated with one or both of the two Ecological Landscapes making up the GKSF. Some of these species may use habitat not likely available on the GKSF, and some species are not tracked by NHI.

Table 9. Species of Greatest Conservation Need that are either significantly or moderately associated with the Northwest Lowlands or Northwest Sands Ecological Landscapes. See the Wisconsin Wildlife Action Plan for more information: *dnr.wi.gov/org/land/er/wwap/*. State Status for each species is shown in parentheses (endangered, threatened, or special concern), where applicable.

Common Name	Northwest Lowlands	Northwest Sands
American Bittern (SC)	X	X
American Golden Plover (SC)		X
American Marten (END)	X	
American Woodcock (SC)	X	X
Black Tern (SC)	X	X
Black-billed Cuckoo (SC)	X	X
Blue-winged Teal (SC)	X	X
Blue-winged Warbler (SC)		X
Bobolink (SC)	X	X
Boreal Chickadee (SC)	X	
Boreal Chorus Frog	X	X
Brown Thrasher (SC)	X	X
Bull Snake (SC)		X
Canvasback (SC)		X
Connecticut Warbler (SC)	X	X
Dunlin (SC)		X
Eastern Meadowlark (SC)		X
Eastern Red Bat (SC)	X	
Field Sparrow (SC)		X
Four-toed Salamander (SC)	X	X
Franklin's Ground Squirrel (SC)		X
Golden-winged Warbler (SC)	X	X
Grasshopper Sparrow (SC)		X
Hoary Bat (SC)	X	
Hudsonian Godwit (SC)		X
Le Conte's Sparrow (SC)	X	X
Least Darter (SC)		X
Least Flycatcher (SC)	X	X
Lesser Scaup (SC)		X
Longear Sunfish (THR)	X	
Marbled Godwit (SC)		X
Mink Frog (SC)	X	X
Moose (SC)	X	
Mudpuppy (SC)	X	X
Nelson's Sharp-tailed Sparrow (SC)		X

Common Name	Northwest Lowlands	Northwest Sands
Northern Flying Squirrel (SC)	X	X
Northern Goshawk (SC)	X	X
Northern Harrier (SC)	X	X
Northern Long-eared Bat (SC)	X	
Northern Prairie Skink (SC)		X
Olive-sided Flycatcher (SC)	X	X
Osprey (SC)	X	X
Pickerel Frog (SC)	X	X
Pugnose Shiner (THR)		X
Red Crossbill (SC)	X	X
Red-headed Woodpecker (SC)		X
Red-necked Grebe (END)		X
Rusty Blackbird (SC)	X	X
Sharp-tailed Grouse (SC)		X
Short-billed Dowitcher (SC)		X
Silver-haired Bat (SC)	X	
Solitary Sandpiper (SC)	X	X
Trumpeter Swan (SC)		X
Upland Sandpiper (SC)		X
Veery (SC)	X	X
Vesper Sparrow (SC)		X
Water Shrew (SC)	X	X
Whip-poor-will (SC)		X
Wilson's Phalarope (SC)		X
Wood Thrush (SC)	X	X
Woodland Jumping Mouse (SC)	X	X
Yellow Rail (THR)		X

Threats to Biodiversity

Invasive Species

Invasive species are a threat to the GKSF and the surrounding landscape, including nearby National Park Service lands. These species can out-compete and displace native species, leading to ecological simplification, habitat loss, and limiting management options. Detection and management techniques will be needed to prevent the introduction of these species and control their spread whenever possible. Controlling outbreaks while they are small and localized, especially in ecologically important areas, will likely be the most effective strategy. Early control measures will be needed, wherever possible, to avoid the major infestations that have become highly difficult to control in many other parts of the state. There are a wide variety of materials available regarding identification and control of these species in Wisconsin (e.g., Czarapata 2005, Hoffman and Kearns 1997, and Boos et al. 2010) in addition to information on the WDNR Web site (*dnr.wi.gov/invasives/*) and the Invasives Plant Association of Wisconsin Web site (*www.ipaw.org/*).

Invasive plants were documented during the biotic inventory (2007-2009), and an inventory of invasive plants had been previously conducted on the property in 2006, although much of this effort was focused along roads, trails, rights-of-way, and intensive use areas (Anderson 2006). Also, an invasive species plan was created for the property in 2008. The species below represent the biggest threats to native communities on the GKSF at this time; this is not meant to be a comprehensive list of invasive species for the property. Anderson (2006) also provides additional site-specific recommendations.

Garlic mustard (*Alliaria petiolata*), known to spread rapidly through forested habitats, has been documented on the property, but department staff have worked to control known populations soon after they were discovered. This plant threatens all but the most open/dry habitats on the GKSF, and early detection and control is important. A large patch of garlic mustard was documented along the Lagoo Creek Hiking Trail (Anderson 2006), and plants were removed by NPS staff. It will be important to follow-up on this site and any other infestations to prevent additional plants from producing seed.

Spotted knapweed (*Centaurea biebersteinii* is the most common, although there are several other non-native *Centaurea* species that can be aggressive) is found in many areas of the GKSF along roadsides and near horse and walking trails. This species is found mostly in dry, disturbed areas and is a threat to barrens, sand prairies, and dry forest communities. It has been found at Sterling Barrens (site GK16), and there is potential for it to become worse there. Elsewhere in the property, care is especially needed when conducting timber sales near an infested area, particularly those with site preparation techniques that involve soil disturbance.

Leafy (*Euphorbia esula*) and cypress (*Euphorbia cyparissias*) spurges are invasive plants that spread aggressively and are often found in dry habitats such as those occupying much of the GKSF. These species are found along roadsides, old fields, and horse trails on the GKSF and can be very difficult to control once established.

Common buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*Rhamnus frangula*) are non-native shrubs that can sometimes grow into 20' tall trees. Both species spread aggressively by seed and can be very difficult to eradicate. Both species can grow in all but the driest habitats on the GKSF, although glossy buckthorn is most often associated with wetlands. Because these species are often spread by birds that ingest the seeds along with their fruit, they can be found in numerous isolated locations. These plants are found in several areas on the property, including scattered locations with the large wetlands of the river valley. Primary Sites that are most threatened include the conifer swamps and other portions of the Kohler-Peet Wetlands (GK03), Trade River and Forest (GK14), and Sunrise Ferry (GK15). Any of the high-quality forested seeps along most of the length of the property could potentially be impacted by these species.

Non-native honeysuckles (*Lonicera* spp.) are also invasive shrubs whose seeds are spread by birds. They typically impact forests but can be found in many habitats. In northern Wisconsin, they are often found along streams in sunny locations, as well as roadside and disturbed areas. These species are present but probably not yet widespread on the GKSF, although they have been documented at a high-quality barrens site (site GK16 - Sterling Barrens), and a large area of non-native honeysuckles was documented by Anderson (2006) near the Trade River horse trail crossing.

Reed canary grass (*Phalaris arundinacea*) is found in many wetlands throughout the state. It thrives in open wetlands but often spread into Floodplain Forests and other forested wetlands and will respond whenever light conditions are favorable such as following a timber harvest. Once well-established, it forms dense stands that out-compete native vegetation. This species is found in spotty patches throughout the GKSF outside of forested areas mostly near streams, in wet depressions, and along the river on National Park Service land. An extensive infestation occurs near Wolf Creek at the southern end of the property.

Phragmites, or common reed (*Phragmites australis*), is a large wetland grass that is very difficult to control. In some portions of the state, entire wetlands have become completely dominated by this species. Phragmites was only found in small patches during the biotic inventory, although many of the large wetlands were not checked thoroughly. Phragmites plants seen during this project were likely the native subspecies based on plant location, morphology, and habit. However, several large patches of non-native Phragmites are known to occur nearby at the Crex Meadows Wildlife Area.

Several invasive animal species may also impact the GKSF in the future. The Division of Forestry' Forest Health Program assists with monitoring for these species and providing management guidance. Two of the non-native species that are likely to impact the GKSF in the future are gypsy moth (*Lymantria dispar*) and emerald ash borer (*Agrilus planipennis*). Gypsy moth continues to move west across the state and is not yet in high numbers near the GKSF. Gypsy moth can defoliate several tree species, with oak often the most heavily impacted. Emerald ash borer was known from six counties in Wisconsin as of this writing, with 11 counties under quarantine, and it likely occurs undetected in others. This beetle attacks all species of ash in Wisconsin and, with enough time, can lead to almost complete ash mortality in a given stand. This will be a particular concern for much of the GKSF occupying the St. Croix River valley where large stands of ash dominate numerous ecologically important areas and rare species habitats. Large-scale loss of ash in this area, whether through emerald ash borer-caused mortality or harvesting, is a concern and may potentially lead to non-forest cover, elevated water tables, or an increase in exotic plants such as reed canary grass and glossy buckthorn (WDNR 2010a).

Oak wilt is caused by a fungus, *Ceratocystis fagacearum*, that effects water movement within oak trees, often killing the trees. Species in the red oak group are most susceptible; this group includes northern pin oak, one of the major dominants in the dry forests of the GKSF. The fungus was thought to be native, but the most recent science suggests that it is not (J. Cummings Carlson, pers. commun). It has been in the state for at least 100 years and is widespread throughout the southern part of the state. In recent years, however, it has been identified more commonly in the north, and it is known from both of the counties comprising the GKSF. Oak wilt is often not a major concern for woodland or barrens restoration areas where open canopy conditions are favored, and dead oak trees can make long-lasting wildlife cavity trees. It can, however, have significant impacts to forested stands with a heavy oak component. Management and planning efforts for the GKSF will need to consider oak wilt along with other ecological and cultural factors. See dnr.wi.gov/forestry/fh/oakwilt/ for more information on oak wilt.

Ecological Simplification and Habitat Loss

Ecological simplification, or homogenization, of both overstory (Schulte et al. 2007) and understory (Rooney et al. 2004) species has been identified as a major threat to northern and southern forests in the Lake States. Forests throughout this region have exhibited reduced species diversity, structural diversity, and functional complexity and have altered spatial patterns due to factors such as land uses, invasive species, lack of fire regime, and heavy browse pressure.

Many examples of native dry forest and barrens communities have been replaced by plantation monocultures in the coarse-soiled areas of the state since these stands often provide a consistent level of timber production on dry and dry-mesic sites. Red pine is planted in many cases with jack pine planted less frequently. Several hundred acres of red pine have been planted in the last decade at the GKSF (Figure 8). In some portions of the GKSF, plantations have failed and been re-planted multiple times.

The negative impacts of red pine plantations on native species diversity is now well-understood, and there are many areas where this type of management is ecologically inappropriate because of the likely impacts to local biodiversity. Converting more complex natural communities to plantations eliminates or drastically reduces habitat for many native species, both rare and common, and greatly simplifies community structure and composition. Herbicides are typically used now when GKSF plantations are established to control competing vegetation, and this can negatively impact the site's flora and further reduce diversity on a site. For this reason, establishing new plantations on state managed lands warrants critical review. Important considerations for establishing plantations include: 1) the locations of rare species occurrences, 2) landscape vegetation patterns, and 3) the overall distribution of plants and animals that contribute to the area's biodiversity. Consideration should be given to biological hotspots, rare community types such as prairie/barrens and including small inclusions, and other ecologically important areas when locating and designing plantations. From a biodiversity perspective, the acreage and distribution of the existing GKSF plantations should be evaluated during master planning, along with an evaluation of whether any new plantations should be established. Some of the older GKSF plantations have lower tree density and higher species diversity than modern plantations. Where red pine plantations already exist, there are some techniques that can increase community diversity and improve habitat for certain species (WDNR 2010b).

Deer Herbivory

Herbivory by white-tailed deer has been identified as having major impacts on tree and herb species in northern forests of the Lake States (e.g., Schulte et al. 2007, WDNR 2006c, WDNR 2004, Rooney et al. 2004, Rooney and Waller 2003, Alverson et al. 1988), and the Michigan Society of American Foresters (2006) recently released a position statement addressing the need to control the impacts caused by white-tailed deer. In addition to direct impacts on plants, deer density has been shown to negatively impact species richness and abundance levels of songbirds that nest in the intermediate canopy layer (DeCalesta 1994, McShea and Rappole 2000). Excessive deer herbivory is known to inhibit reproduction of certain trees, especially those species that are preferred forage, as well as species growing in areas where deer "yard" during portions of winter months. Northern white-cedar and hemlock (*Tsuga canadensis*) are, perhaps, most notably impacted by heavy deer browse, and regeneration of both species is now severely limited throughout the state. Many other tree species are impacted in varying degrees as well. Heavy herbivory can also subject several forest herbs and shrubs to pressures they cannot withstand, resulting in loss of vigor, population size and reducing the number of species present through extirpation of species from the site. Because of the long linear nature of the GKSF, it would be challenging to manage deer via habitat on a landscape scale, and control of deer densities may be the only option.

Altered Ecological Processes and Habitat Degradation

Fires have been suppressed statewide for many decades. In addition to active suppression policies, land use factors continue to have strong influences on the fire regime (Cardille et al. 2001). Land uses affect the ability for fires to spread and often necessitate quick containment to protect human life and property. With the exception of infrequent and usually quickly contained wildfires, fires that would significantly impact natural communities are now limited to those used by managers as a tool for restoration or maintenance of early successional habitat on a relatively small acreage statewide.

In northwestern Wisconsin, fires were likely very frequent prior to Euro-American settlement. Frequent, low-intensity fires likely occurred in the southern part of the Northwest Sands (Radeloff et al. 2000), and several of the GKSF natural communities originated from fire and are difficult to maintain without it. There may be opportunities to use fire as a management tool where it is not already being used, especially for communities dominated by shade-

intolerant species such as jack pine, red pine, and some of the oaks.

Site preparation techniques can impact rare plant species, and care is needed when they are used in either planted or naturally-regenerated stands. Chemical treatments, such as broadcast spraying with herbicides, may negatively impact or eradicate conservative native plants, including rare plants, or the host plants needed by rare animals, so they should be used with care. Physical site preparation, such as blade scarification, is commonly used to prepare the seedbed and control competing vegetation, but it can have dramatic impacts on understory plants. Like all mechanized activities that disturb the soil, there can be a risk of introducing non-native invasive species. Past mechanical site preparation methods used on the GKSF include: Bracke scarification, roller chopping, furrowing, blade scarification and disc trenching. Scalping and roller chopping have not been used in the last decade or more on the GKSF. Typically blade scarification and disc trenching disturb 40-60% of the soil on a site. Furrowing disturbs 50% or less of the soil depending on site characteristics. Since any amount of disturbance or equipment operation can impact rare plant or animal species, care is needed when they are used in either planted or naturally-regenerated. The long-term effects of scarification on the ground flora have not been well documented or monitored in Wisconsin. Long term monitoring is needed on these sites, and care is warranted in areas with high plant diversity, and/or rare species.

The GKSF supports excellent examples of Forested Seeps, streams, and many other high-quality natural communities in the Wilderness Area. The streams often feed into tributaries of the St. Croix River. In many places, the slope drops off sharply from the escarpment to the river valley, and there is potential for both natural (sloughing) and human-caused (e.g., rutting and channelization) erosion and sedimentation to these high-quality areas. It is important to use caution when intensively managing areas near the edge of the escarpment. A conservative approach might include providing a buffer from the edge of the escarpment where disturbance is avoided or kept to a minimum. There are some areas where the bluff line recognized for management purposes is slightly different from the geological bluff line or where the bluff line is indistinct; in these cases forestry activities may now be occurring on Forested Seeps or other bottomland areas. Determining the location of the true bluff line is an important master planning consideration. Erosion from recreational trails, including horse trails, can negatively impact natural communities. An example of this was noted near the Trade River (see Appendix B for more information).

Priority Opportunities to Conserve Biodiversity

The GKSF presents opportunities to maintain 55 miles of native wetland and upland communities with connections to a regionally significant river with excellent biodiversity, as well as connections to many ecologically important areas across the river in Minnesota. Many species, both rare and common, are supported by the GKSF and its surrounding habitats. These opportunities are provided for consideration by the GKSF Master Planning Team, as well as others interested in the biological diversity of the property. General themes are presented in this section, and Appendix B describes site-specific opportunities for conservation.

Landscape Level Priorities

Ecological Connections

The ecological context of any given site has a strong influence on the site's ecological integrity, so how an area connects to the surrounding landscape is important. The location and shape of the GKSF make it extremely valuable as an ecological connector in different ecosystem types. There are many opportunities to either maintain or restore ecological connections within the GKSF and its surrounding areas. The GKSF was originally established because of its connection to the St. Croix River, and this is still a critical need. The St. Croix River has long been recognized for its biological importance, and the GKSF fills a valuable role by buffering many miles of habitat either adjacent to or within close proximity of the river. The GKSF also contains many seeps, wetlands, and streams that are hydrologically connected to the river, so its management is important to the river's health.

Second, the GKSF is part of a significant forested corridor, in combination with over 70,000 acres of mostly forested state –managed lands on the Minnesota side of the river and portions of two county forests on the Wisconsin side (Figure 11). This broad corridor occurs in an area otherwise dominated by agriculture, small non-industrial forests, and residential developments. These forests support numerous species with both southern and northern affinities and are likely to be of even greater importance as development pressures continue in the surrounding landscape.

There are also opportunities to connect to other ecosystems in the opposite direction from the river. The two areas managed for barrens on the GKSF (sites GK04 - Kohler-Peet Barrens and GK16 - Sterling Barrens) could offer opportunities to connect with nearby areas in the future. Kohler-Peet Barrens is within one mile of Crex Meadows where large-scale active barrens management occurs and Sterling Barrens (site GK16) is part of a township with many small barrens remnants in both county and private ownerships.

Finally, there are opportunities within the GKSF to connect ecologically significant sites such as State Natural Areas and other Primary Sites. Several of the existing State Natural Areas have artificial boundaries that cut across intact wetlands and other natural communities. During the

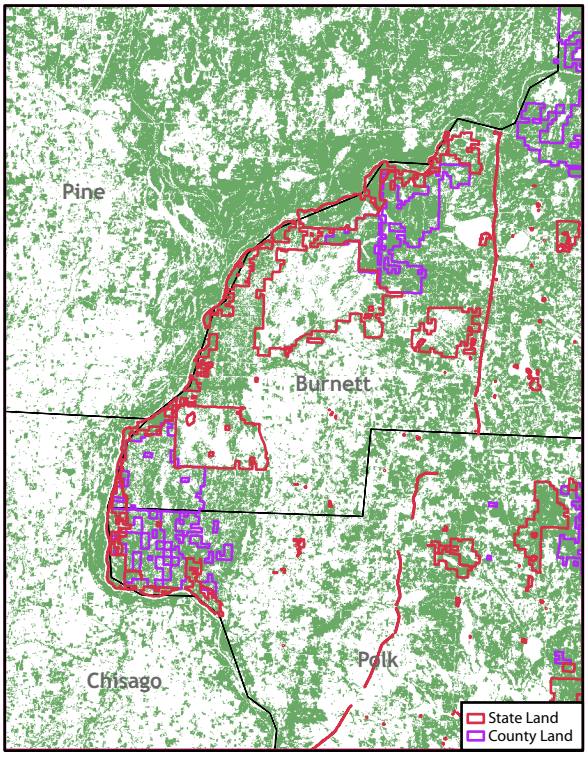


Figure 11

Forested cover from the National Land Cover Database (Homer et al. 2004) for the portions of Wisconsin and Minnesota surrounding the Governor Knowles State Forest.

planning process, consideration could be given to natural community patterns and processes, as well as the landscape context of ecologically important areas and how they connect to other portions of the property. Fragmentation (of the mesic to wet forested areas or areas comprising the barrens to dry forest continuum) should also be avoided wherever possible to preserve the GKSF's ecological integrity.

Old forests and Old-growth

Old-growth stands are often characterized by large trees; a multi-layered, uneven age and size class structure; a high degree of compositional and structural patchiness and heterogeneity; and significant amounts of woody debris and tip-up mounds (WDNR 2006b). The structural diversity found in these forests can support unique assemblages of plants, birds, and other animals and are important for providing the diverse range of habitats needed for sustainable forest management.

Older forests (greater than 100-120 years old) across Wisconsin are rare because of the Cutover and continue to decline, largely due to timber harvesting (WDNR 2010c). The WDNR has identified a need to conserve, protect, and manage old-growth forests (WDNR 2004, WDNR 1995), and state and federal lands provide some of the best opportunities to do this.

As in most forested areas throughout the state, there is a lack of old forest (e.g. >120 years) on the GKSF, particularly in large habitat patches. Further, old-growth opportunities here are somewhat limited here compared to other state forests in northern Wisconsin because of the size and shape of the property. However, old-growth of any size is rare in the state, and there are places on the property where old-growth forests could be developed over time. For example, the current Wilderness Zone provides many areas for older stands to continue to develop in types not well-represented on other properties, including various types of forested wetlands with numerous seeps found in the river and in different old-growth management categories. In addition to "reserved" old-growth, there may also be good opportunities for "managed old-growth" (WDNR 2006b).

The concept of old-growth in Wisconsin forest types that originated from fire is not well-understood at this time. Some of these species are not long-lived (i.e., "early successional"), the fire regime is completely altered, and it is unclear how abundant older stands of these types were historically. However, future chapters planned for the department's Old-growth Handbook will cover pine and oak ecosystems and could provide guidance for some of the areas on the GKSF. It could be useful to have some of these areas available as benchmarks for reference or for evaluating alternative techniques in the future.

High Conservation Value Forests

The Wisconsin DNR manages 1.5 million acres that is certified by both 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); these are defined as possessing one or more of the following High Conservation Values:

1. Contain globally, regionally, or nationally significant concentrations of biodiversity values, including rare, threatened, or endangered species and their habitats
2. 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
3. Are in or contain rare, threatened, or endangered ecosystems
4. Provide basic services of nature in critical situations (e.g., watershed protection, erosion control)
5. Are fundamental to meeting basic needs of local communities (e.g., subsistence, health)

6. Are critical to local communities' traditional cultural identity (areas of cultural, ecological, economic, or religious significance identified in cooperation with such local communities)

Based on the current draft criteria for defining HCVFs (Forest Stewardship Council 2009) the best opportunities for maintaining HCVF on the GKSF are the Primary Sites and high quality natural communities outside of the Primary Sites.

Community Level Priorities

This section highlights the natural community types for which GKSF has good-quality examples that are relatively large, embedded within a mosaic of other intact communities, and show relatively little evidence of disturbances such as hydrologic alteration, presence of invasive species, or intensive management (with the exception of barrens sites that are intensively managed specifically to maintain communities using restoration techniques). Age, structure, patch size, and ecological context are also especially important considerations for the forested natural communities. High-quality examples of natural communities are often excellent candidates for High Conservation Value Forests required by Forest Certification.

Communities that are especially representative of the two Ecological Landscapes making up the GKSF are also included here. Some of these community types are already protected through SNA designation, although the majority of this acreage is in the Wilderness Area and does not include some of the communities such as the dry forests or mesic hardwoods communities. There are other significant natural community types on nearby landholdings that are not discussed, including Floodplain Forests on National Park Service land.

Aquatic Communities

The St. Croix River is uniquely biologically important, and numerous streams feed into the river from the GKSF. Many of these streams exhibit good water quality and have the potential to support rare species. These streams were not sampled for rare animals during the course of this inventory, and opportunities to conduct surveys have been identified in the Future Needs section. It will be important to maintain these streams in a high-quality condition.

Barrens / Savanna / Woodland Communities

Collectively, these communities likely dominated the majority of the GKSF uplands prior to European settlement. Most examples have either succeeded to other types or have been converted. These communities are globally rare, and they are associated with numerous rare species. The two existing barrens SNAs are currently maintained without mature trees, and tree species are primarily limited to shrubby or sapling growth forms. There are opportunities to manage nearby areas in compatible ways, perhaps including some areas with more tree cover to benefit slightly different species assemblages. Many of the historical barrens would have had scattered trees present and would have occurred in a continuum from the most open (Sand Prairie) stands to areas with the highest tree cover (Northern Dry Forest) with other combinations in-between, including barrens and woodland communities. There may also be opportunities to partner with landowners in the nearby surrounding landscape to manage in complementary ways, as there are scattered barrens remnants on some of the nearby public and private lands, as well as large areas of managed barrens on nearby Crex Meadows Wildlife Area[3].

Conifer Swamps

Good-quality examples of several types of conifer swamps were found on the GKSF: Northern Wet Forest, Northern Wet-mesic Forest, and Tamarack (poor) Swamp. Although none of these communities are abundant on the GKSF or are present in very large acreages, they were all found to be of good quality and located in a favorable context. On the GKSF, these communities contribute to a larger matrix of wetland communities in the river valley. They can support rare and unusual species and are sensitive to disturbances, including changes in hydrology. Because there are few examples and they contribute to the ecological integrity of the river valley, they all warrant continued protection.

[3] Note: a biotic inventory is currently being conducted at the Crex Meadows and Fish Lake wildlife areas, and a report entitled "Rapid Ecological Assessment of the Glacial Lake Grantsburg Wildlife Areas" will be available in late 2010.

Forested Seep
Forested Seeps are particularly abundant on the GKSF and are found in many places, especially where the base of the slope meets the river terrace. The GKSF probably has a higher concentration of these features than any other state-managed land. They support high plant diversity and likely support several amphibian species and numerous invertebrates. They also contribute to the high water quality of the streams to which they feed. These features are highly susceptible to damage, and land use practices that lead to soil or hydrological disturbance should be avoided. The Primary Sites contain only a portion of the many seeps present on the GKSF, and there is a need to provide for their continued long-term ecological integrity.

Hardwood Swamp
These forested wetlands make up much of the forested matrix within the St. Croix River valley where there are some large stands that often intergrade with other wetland types. There are few opportunities to maintain Hardwood Swamps in most of the Northwest Lowlands Ecological Landscape. These forests are susceptible to physical damage and changes in hydrology. Emerald ash borer appears to be a significant threat to their continued existence, and it is unclear how other species such as red maple and balsam fir will be able to fill the void left by the anticipated large-scale decline of Wisconsin's ash species. The GKSF offers opportunities to monitor these areas and provide large benchmarks or control stands not possible in the surrounding landscapes.

Mesic Hardwoods
Because of its soils and landforms, the GKSF has only a very few small areas that would be typical of the classic northern hardwood forests found throughout much of northern Wisconsin. However, there are some areas, often associated with former river terraces or on mid-elevation slopes where mesic hardwood species occur. These forests are difficult to classify and do not fit well into either the NHI Community Classification or Forest Habitat Classification (Kotar et al. 2002) systems. These interesting variants are likely the result of a combination of factors, including soil characteristics and their location within the Tension Zone. These forests feature the unusual combination of bur oak alongside sugar maple and herbs typically associated with nutrient-rich mesic habitats. We have classified these stands as Southern Mesic Forests for the purposes of this report. They typically occur within a diverse mosaic of other types on the GKSF.

Notable mesic hardwood examples are found near the Trade River in a matrix of drier forest mixed with areas of seeps and streams upslope from the river floodplain. The diversity of habitats in this area translates into species diversity for both plants and animals, and this area was found to have the most diverse assemblage of rare birds found on the property. Some other examples of this community type are highlighted in Appendix B. Because of the unusual nature of these areas, they warrant special management consideration.

Northern Dry Forest
Occurring on the driest, most nutrient-poor sites, these forests are characteristic of the Northwest Sands Ecological Landscape comprising much of the sandy uplands of the GKSF. Many examples of this type in the Northwest Sands have been converted to monotypic red pine plantations and lack diversity. Most of the GKSF's remaining examples of this type are dominated by northern pin oak, as jack pine was harvested from many of these stands 30 years ago when jack pine timber markets were favorable and the jack pine was starting to decline (Mike Wallis, pers. commun). Currently, there is one relatively large Northern Dry Forest example dominated by jack pine north of the Clam Dam. Fire suppression and succession have limited the floristic diversity of many dry forests in the state. In many cases, the herb layer becomes dominated by Penn sedge to the exclusion of other species, making restoration difficult and necessitating intensive practices such as blade scarification to re-establish trees following harvest in areas managed for timber. Restorable savanna/woodland openings are few on the GKSF, and none are currently in a protected status.

There are opportunities on the GKSF to explore alternative management on some examples of this type. Consideration could be given for increased use of fire to manage these forests, whether stands are to be managed for timber production or for conservation purposes. There are still some good examples to manage for a barrens/savanna/woodland continuum, including the area north of Clam Dam (site GK01 – Clam River Woods North), as well as the

area just east of Sterling Barrens (site GK16 – Sterling Barrens). In stands that are to be managed with timber as a primary objective, additional consideration could be given to the understory flora, especially where rare species or otherwise sensitive flora are present, by adjusting site preparation techniques and providing small gaps, where applicable, for increased light.

Northern Dry-mesic Forest
High-quality examples of Northern Dry-mesic Forests are limited to a few locations on the GKSF; the best examples are in and around the Brant Brook Pines State Natural Area (site GK07) and another near the north end of the property by Pease Hill (site GK01 – Clam River Woods North) (see Appendix B). These stands contain older trees, abundant conifers, and areas of high crown closure. These sites offer opportunities to develop older forests of an uncommon type on the property. They may also provide a seed source to potentially re-establish the missing pine component in some of the adjoining forests. Active management may be needed as a tool if the goal is to maintain some examples of these communities over time in the absence of fire, and this could be a good area for using non-traditional management techniques including managed old-growth.

Non-forested Wetlands
Non-forested wetlands occur at several locations within the river valley. There are fairly extensive areas of shrub swamp (Alder Thicket, as well as other wetlands dominated by willows or other shrubs) and other areas dominated by graminoids. The GKSF sedge meadows, with a few exceptions, are often small wetland inclusions surrounded by other natural community types within the river valley.

Non-forested wetlands are important components of the vegetation mosaic in the river valley and contribute to plant and animal species diversity. The biggest threats to these areas are invasive species such as reed canary grass, changes to hydrology, and sedimentation. The wetlands embedded within the extensive habitats of the Wilderness Area may have the best long-term viability. Some of the best quality wetlands could be considered for special management and protection designation, particularly where sensitive (including rare) species have been documented.

Unique Microhabitats within Managed Areas
Forests often contain important microhabitats for rare or uncommon plants and animals, and there are often opportunities to provide for these species within managed stands (WDNR 2009). The features present will vary based on the soils, landform, natural community present, and numerous other factors. Seeps and springs are discussed many times in this report and warrant special consideration, as would other permanent or ephemeral waterbodies or wetlands, including isolated wetlands. The current Wisconsin's Forestry Best Management Practices for water quality (WDNR 1995) provide guidance for protecting these features to some extent, and new guidelines are under development. Moist and dry cliffs (i.e., with exposed bedrock) are rare on the GKSF, but these and other features such as ravines could also be important for certain species if present. For the GKSF, in particular, small areas with diverse and/or rare and unusual native flora in dry and dry-mesic managed forests are worthy of protection and could be accommodated during routine management activities. Maintaining certain structures within all managed forests such as cavity trees, coarse and fine woody debris, and large, old trees can be important "biological legacies." Most recently, some of these features are being recognized for their importance to bat species (e.g., Taylor 2006).

Wisconsin's Statewide Forest Strategy

Wisconsin's Statewide Forest Assessment (WDNR 2010c) was based on Wisconsin's Forest Sustainability Framework (Wisconsin Council on Forestry 2007) 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 2010c) 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 GKSF planning efforts in regard to opportunities to maintain or enhance biological diversity (WDNR 2010c).

Table 10. Select stratgies from the Wisconsin's Statewide Forest Strategy (WDNR 2010c)

Strategy Number	Strategy
5	Pursue the conservation and protection of large, unfragmented blocks of forest lands
6	Strengthen collaborative and large scale planning at the town, county, state and federal levels
7	Increase the functional size of forest blocks by encouraging coordination of management of clusters of forest ownerships
11	Encourage the management of under-represented forest communities
12	Improve all forested communities with a landscape management approach that considers the representation of all successional stages
13	Increase forest structure and diversity
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
16	Encourage multi-state landscape scale planning
22	Strive to prevent infestations of invasive species before they arrive
23	Work to detect new infestations early and respond rapidly to minimize impacts to forests
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: Significance and Summaries

Sixteen ecologically important sites were identified as a result of the biotic inventory. These "Primary Sites" contain relatively undisturbed, high-quality, natural communities; provide important habitat for rare species; offer opportunities for restoration; could provide important ecological connections; or some combination of the above factors. The sites are meant to highlight the best areas for conserving biological diversity for consideration by master planning teams. These sites total approximately 11,590 acres, with over 9,000 acres of this located within the Wilderness Area. The current State Natural Areas on the property comprise 2,700 acres of the Primary Sites, mostly within the Wilderness Area. Boundaries should be considered approximate. Figure 9 illustrates the locations of the Primary Sites.

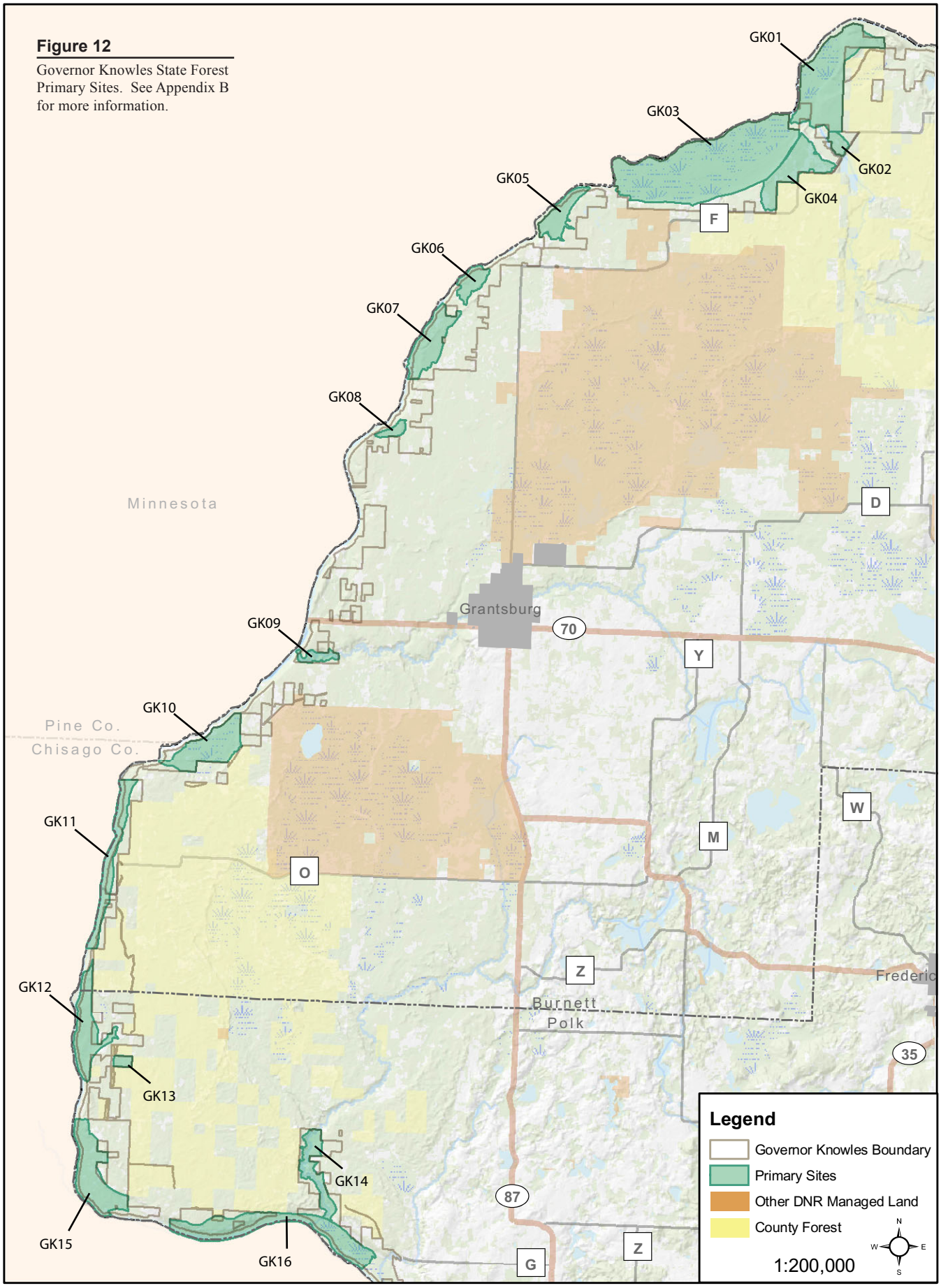
Appendix B provides a description for each of these sites. Each site description includes locational information, a site map, a brief summary of the natural features present, the site's ecological significance, and management considerations.

Governor Knowles State Forest Primary Sites

GK01. Clam River Woods North
GK02. Clam Dam Woods
GK03. Kohler-Peet Wetlands
GK04. Kohler-Peet Barrens
GK05. Ekdall Wetlands
GK06. Fox to Nelson Landing
GK07. Brant Brook Pines and Hardwoods
GK08. East Brook Springs
GK09. Wood River Woods
GK10. St Croix Ash Swamp
GK11. St. Croix Seeps
GK12. Lagoo Creek and Terraces
GK13. Lagoo Creek Barrens
GK14. Trade River and Forest
GK15. Sunrise Ferry
GK16. Sterling Barrens

Figure 12

Governor Knowles State Forest Primary Sites. See Appendix B for more information.



Future Inventory, Monitoring and Research Needs

The following would provide useful ecological information to guide future planning and adaptive management efforts on the GKSF.

- **Bat Surveys and Monitoring** - Due to the emerging threats that face the bat population in Wisconsin (i.e., white nose syndrome) and the limited availability of data from most of the state, more data in the form of surveys (acoustic and roost) are needed to accurately describe the bats that use the GKSF. Priorities include establishing volunteer-based acoustical bat monitoring routes on tributary streams and the St. Croix River to identify areas of high bat concentrations. Locating bat roosting areas is also a future need.
- **Emerald Ash Borer** – this species is a threat to some of the major GKSF natural community types. More information is needed regarding the best strategies to mitigate emerald ash borer effects. The wetland natural communities here are very susceptible to hydrological modifications, and attempting to control or reduce the impacts through logging could do more harm than good. At this point, there is no evidence that thinning or other forms of timber harvest will reduce the spread of this insect. A well-researched, well-monitored, conservative approach is warranted for the St. Croix River valley. As of this writing, emerald ash borer was known from only the southern half of the state, although it has been detected in St. Paul, Minnesota and likely occurs at other locations in the state. Since the adults can only move about one-half mile per year, spread will most likely occur through accidental introductions (WDNR 2010a). The remote location of some of the largest stands on the GKSF might help to buy time in the event that an effective biological control agent can be identified and produced.
- **Aquatic and Terrestrial Invertebrate Surveys** – the St. Croix River is well-known for its importance to aquatic invertebrate species. However, its tributaries have not been adequately sampled. The many small high-quality streams, rivulets, and seeps may harbor rare species, especially aquatic macroinvertebrates. Similarly, the GKSF has the potential to support numerous rare terrestrial invertebrates, especially in barrens habitats. Although surveys were not possible for these species during the course of this project, future surveys could provide useful information for these taxa groups.
- **Invasive Plants** – expanded detection, monitoring, and control of invasive species will be critical on the GKSF.
- **Rare Herptiles** – rare amphibians and reptiles were not surveyed during this inventory project, but there is potential for rare species in the barrens, wetlands and aquatic features, as well as the forested habitats. Communal turtle nesting sites should be a priority for inventory and protection, as predation and destruction of these nesting areas has led to poor population numbers for several rare turtle species. Rare Sand Prairie and Barrens reptiles are known in abundance from nearby Crex Meadows and are likely to occur in GKSF and should be documented. Frog and toad calling surveys could be performed at lakes, wetlands, and ephemeral ponds in GKSF.
- **Selected SGCN/Habitat surveys** – additional targeted surveys and monitoring for certain groups (e.g., a recurring breeding bird survey, Franklin's ground squirrel surveys) would be useful for informing management decisions, as well as monitoring the effectiveness of special management areas.
- **Site Preparation** – the effects of these techniques on tree regeneration are fairly well-understood. However, more information is needed to understand the effects on the rest of the GKSF flora. Some of the dry forests still contain native barrens flora that could be impacted by these techniques, so it would be helpful to establish plant monitoring in these areas, including surveys conducted before and after site preparation is conducted.

- **Using Fire as a Management Tool** – prescribed fires are used routinely at the barrens sites, as well as a few other locations. There are opportunities to explore the use of fire in other areas, including monitoring of plants and other species. This could be included in the site preparation monitoring efforts described above.

Glossary

adaptive management – a formal, structured approach to dealing with uncertainty in natural resource management, using the experience of management as an ongoing and continually improving process (WDNR 1995).

aquatic macrophyte – vascular plants such as cattails, bulrushes, pond lilies, and pondweeds that have special adaptations that enable them to live in aquatic habitat

biodiversity - A general definition (Matthiae et al., 1993) is "the spectrum of life forms and the ecological processes that support and sustain them. Biological diversity is a complex of four interacting levels: genetic, species, community, and ecosystem."

Cambrian – the earliest geologic period of the Paleozoic Era, from 500 to 600 million years before the present. Most of the exposed or otherwise prominent bedrock in the study area is sandstone of Cambrian age.
"closed canopy" (or "relatively intact") – crown closure that approximates that achieved in the absence of major artificial or natural disturbance. This will vary somewhat by forest type.

complex – used here to reference an integrated mosaic of natural communities and/or aquatic features.

context- used in this report to aid in the assessment of the ecological effects that surrounding biological and physical features, land uses, ownership or other significant attributes of the environment may have on the potential to maintain an occurrence of a natural community or rare species population at a given location.

cover type – a method of broadly classifying vegetation based on the single species or species group comprising a majority of the living plants. As used by professional WDNR Foresters, a cover type is a tract of forest land characterized by the predominance of one or more key species which make up 50% or more of the basal area of sawtimber and poletimber stands, or of the number of trees in seedling and sapling stands. Forest lands less than 10% stocked with commercial tree species are classified as upland brush, grass, or lowland brush. See WDNR (2006c) for cover type descriptions. A broader usage of "cover type" is sometimes used to describe areas with remotely-sensed data; these types may describe anthropogenic features such as cornfields, pastures, or urban areas.

diversity – used in this report as a shortened form for biological diversity, or biodiversity.

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. The GKSF is located in the "North Central Forest" Ecological Landscape.

ecoregion – geographic units that are differentiated by climate, geology, geomorphology, physiography, hydrology, soils, and vegetation. These units have been defined and organized in different ways by various institutions but in this document we use the National Hierarchical Framework of Ecological Units (NHFEU). As described by Avers et al (1994), the NHFEU can provide a basis for assessing resource conditions at multiple scales. In this report we have most frequently referred to ecoregions of the "subsection" level, which are intermediate in scale within the NHFEU and typically cover areas of hundreds to thousands of square miles. In recent years the NHI has found the ecoregions of the NHFEU to be useful tools for work planning, interpreting the collected data, and communicating across political and administrative boundaries.

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 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 individual example of an element (a natural community, a rare plant population, a rare animal population, or other feature tracked by the Natural Heritage Inventory program) at a specific geographic location.

flowage – a body of standing water (an impoundment) created by constructing a dam or other water control structure across a stream or flowing ditch.

forb – a general term that usually refers to those native herbaceous plants of prairies and savannas that are not grasses, or grasslike. In broad terms, "wildflowers."

fragmentation – the breaking up of large and continuous ecosystems, communities, and habitats into smaller discontinuous areas that are surrounded by altered or disturbed lands or aquatic features.

Global Rank - NatureServe global conservation status rank (G-Ranks). These ranks reflect an assessment of the condition of the species or ecological community across its entire range. Appendix C describes each of the G-Ranks currently used.

habitat – references those environmental attributes necessary to provide a niche that supports the needs of a species or group of species.

habitat classification system – a site classification system based on the floristic composition of plant communities. See Kotar et al. (2002) for more information.

habitat type – as used in the Forest Habitat Classification System (e.g., Kotar et al. 2002), all sites capable of producing similar climax plant communities. This system of vegetation classification uses the floristic composition of a plant community as an integrated indicator of those environmental factors that affect reproduction, growth, competition, and community development. These include soils, moisture, nutrient levels, and topography. Professional foresters in the upper Great Lakes region often use this system as a forest management tool..

inventory site – also "site" in text. The geographic location at which a biological survey has been conducted. These may be large or small, depending on the nature of the species or community surveyed. Boundaries may be finite and discrete (a property boundary, a single stand of a forest community) or rather arbitrary. When sites become very large (exceeding several thousand acres) and encompass complex landscapes, they are sometimes referred to as "macrosites" (see below). A subset of these become "Primary Sites" (see Appendix B).

Landtype Association (LTA) – a level in the National Hierarchical Framework of Ecological Units representing an area of thousands to hundreds of thousands of acres. Similarities of landform, soil, and vegetation are the key factors in delineating LTAs.

macroinvertebrate – a term used in this report to refer to aquatic insects and mollusks.

matrix – used in this document to refer to the dominant land cover within which other features of the landscape are embedded.

mesic – used by ecologists to describe site conditions that are well-drained but almost never excessively dry or inundated.

minerotrophic – wetlands that receive water enriched in mineral cations from surface runoff or water that has percolated through nearby mineral soils.

National Hierarchical Framework of Ecological Units (NHFEU) – a land unit classification system developed by the U.S. Forest Service and many collaborators. As described by Avers et al (1994): "The NHFEU can provide a basis for assessing resource conditions at multiple scales. Broadly defined ecological units can be used for general planning assessments of resource capability. Intermediate scale units can be used to identify areas with similar disturbance regimes. Narrowly defined land units can be used to assess specific site conditions including: distributions of terrestrial and aquatic biota; forest growth, succession, and health; and various physical conditions."

natural community – an assemblage of (mostly native) plants and animals in a particular place at a particular time, interacting with one another and the abiotic environment around them, and subject to primarily natural disturbance regimes.

natural community occurrence – a place on the landscape that supports an example of a natural community that has been surveyed, evaluated, and documented by ecologists using standard NHI methodology that meets the minimum criteria for condition, context, and size. These places become "Element Occurrences" in the NHI database.

natural community type – a classified plant association used to describe assemblages that are repeated across a landscape in an observable pattern. These types are generalizations since no two assemblages are exactly alike.

Natural Heritage Inventory – A system developed by the Science Division of The Nature Conservancy and currently coordinated by NatureServe for the collection, management, and use of biological, ecological, and related information. In Wisconsin, the Natural Heritage Inventory was established by an act of the state legislature in 1985, after which the program was installed within the WDNR's Bureau of Endangered Resources.

old forest - forests which are older than the typical managed forest (beyond traditional rotation age), but are not biologically old. They are beyond economic maturity, but are not senescent (WDNR 2006b).

old-growth forest - forests which are relatively old and relatively undisturbed by humans. The forest is biologically old, containing some trees which are nearing or beyond their average expected lifespan. The original even-aged overstory is becoming senescent, is senescing, or has senesced (WDNR 2006b). These forests are often associated with attributes such as large living trees, standing snags, coarse woody debris, pit and mound microtopography, and complex multi-layered canopies. Old-growth stages of many forest types were formerly common and/or widespread in Wisconsin but are now very rare (Frelich, 1995).

outwash – composed of materials sorted and deposited by glacial meltwaters. The resulting topography can range from a level plain ("uncollapsed") to very hilly ("collapsed" or "pitted"). Pitted outwash may contain numerous lakes, which originated when blocks of ice stranded by a receding glacier were buried within outwash deposits, but pitted outwash is absent from the Central Sands.

peat – organic deposits consisting of the partially decomposed remains of plants, which accumulate over time more rapidly than decomposition processes can break them down. Peat may be derived from the remains of mosses, sedges, or woody plants.

Pleistocene – in the geologists parlance, "the first epoch of the Quaternary Period." In more common usage, the Ice Age.

Precambrian – the oldest major division in the geologic time scale, equivalent to ca. 90% of geologic time, covering the period up to approximately 600 million years ago.

rare– used in this report to refer to native species known or suspected to be uncommon and/or declining in the state. Specifically, these are the plants and animals on the NHI Working List. Included are species legally designated as "Endangered" or "Threatened" by either the WDNR or the US Fish and Wildlife Service, as well as species in the Department's advisory "Special Concern" category and on the US Fish & Wildlife Service's "Candidate" and "Species of Concern" lists. For animals, these species would also be considered "Species of Greatest Conservation Need" (WDNR 2006d).

"rare" natural community – in this context the modifier can refer to the relative scarcity of the community type itself on a state or global scale (see a discussion of Global and State Ranks), on a landscape scale, or rarity of a community within a given property or other boundary. In addition to rarity of a type of community, other considerations include the scarcity of a particular developmental stage or other specific attribute(s) of a particular community.

"relatively intact" (or "closed canopy") – crown closure that approximates that achieved in the absence of major artificial or natural disturbance. This will vary somewhat by forest type.

restoration – used in this report to refer to the re-establishment of a natural community, habitat, species population, or other ecological attribute, that has been eliminated or greatly reduced on a given property or landscape. Many factors, sociological as well as ecological, must be weighed when making a decision to engage in a restoration project.

significant – has either documented or high potential for biodiversity conservation based on present condition, stand size, presence of rare species, or other factors

site – see "inventory site."

State Natural Area – sites that are formally designated by the state of Wisconsin to protect outstanding examples of both representative and rare native plant communities, aquatic and geologic features, or archaeological sites. State Natural Areas are often among the last refuges in the state for rare and endangered species of plants and animals. State Natural Areas are devoted to scientific research, the teaching of conservation biology and, especially, to the preservation of natural values and genetic diversity for future generations. Management may be active or passive, depending on the natural features present. (For more information regarding Wisconsin's State Natural Areas, see the State Natural Areas Web pages, *dnr.wi.gov/org/land/er/sna/*).

State Rank - NatureServe state or subnational conservation status rank (S-Ranks). These ranks reflect an assessment of the condition of the species or ecological community within a given state or province. Subnational ranks are assigned and maintained by state or provincial natural heritage programs and conservation data centers. Appendix C describes each of the S-Ranks currently used.

Subsection – This is a level in the NHFEU that is intermediate in scale. Subsections are characterized by distinctive glacial landforms (e.g., outwash or moraine), soils, and broadly, by vegetation. The 16 Ecological Landscapes developed by the WDNR are largely based on NHFEU Subsections (see ***Ecological Landscape***).

survey site – see "inventory site."

Tension Zone – a climatic transition area first described by Curtis (1959) crossing Wisconsin from northwest to southeast and separating the conifer-hardwood forests of northern Wisconsin from the mosaic of prairie, savanna, and mainly deciduous forests of the south.

Species List

List of species referred to by common name in this report

Plants

Adder's-tongue	*Ophioglossum pusillum*
alder	*Alnus incana*
American Ginseng	*Panax quinquefolius*
ash	*Fraxinus pennsylvanica*
Assiniboine Sedge	*Carex assiniboinensis*
balsam fir	*Abies balsamea*
basswood	*Tilia americana*
big-tooth aspen	*Populus grandidentata*
black ash	*Fraxinus nigra*
black spruce	*Picea mariana*
Blunt-lobe Grape-fern	*Botrychium oneidense*
Bog Bluegrass	*Poa paludigena*
box elder	*Acer negundo*
cedar	*Thuja occidentalis*
cinnamon fern	*Osmunda cinnamomea*
common buckthorn	*Rhamnus cathartica*
Cypress spurge	*Euphorbia cyparissias*
Dotted Blazing Star	*Liatris punctata* var. *nebraskana*
Drooping Sedge	*Carex prasina*
Dwarf Milkweed	*Asclepias ovalifolia*
elm	*Ulmus* spp.
Farwell's Water-milfoil	*Myriophyllum farwellii*
Garlic mustard	*Alliaria petiolata,*
glossy buckthorn	*Rhamnus frangula*
hemlock	*Tsuga canadensis*
Hill's Thistle	*Cirsium hillii*
honeysuckles	*honeysuckles*
jack pine	*Pinus banksiana*
junegrass	*Koeleria macrantha*
Kitten Tails	*Besseya bullii*
leafy spurge	*Euphorbia esula*
little blue-stem	*Schizachyrium scoparium*
Marsh Willow-herb	*Epilobium palustre*
meadowsweet	*Spiraea alba*
northern pin oak	*Quercus ellipsoidalis*
northern white-cedar	*Thuja occidentalis*
Northern Yellow Lady's-slipper	*Cypripedium parviflorum* var. *makasin*
Panic grasses	*Panicum* spp.
paper birch	*Betula papyrifera*
Phragmites, or common reed	*Phragmites australis*
poverty oat grass	*Danthonia spicata*
Prairie Fame-flower	*Talinum rugospermum*
red maple	*Acer rubrum*
red osier dogwood	*Cornus stolonifera*
red pine	*Pinus resinosa*
reed canary grass	*Phalaris arundinacea*
Rugulose Grape-fern	*Botrychium rugulosum*
sensitive fern	*Onoclea sensibilis*
Showy Lady's-slipper	*Cypripedium reginae*
silky dogwood	*Cornus amomum*
Silky Prairie-clover	*Dalea villosa* var. *villosa*
silver maple	*Acer saccharinum*
skunk cabbage	*Symplocarpus foetidus*
Spotted knapweed	*Centaurea biebersteinii*
sugar maple	*Acer saccharum*

swamp saxifrage	*Saxifraga pensylvanica*
Swamp-pink	*Arethusa bulbosa*
tamarack	*Larix laricina*
trembling aspen	*Populus tremuloides*
Tufted Hairgrass	*Deschampsia cespitosa*
White Adder's-mouth	*Malaxis monophyllos* var. *brachypoda*
white oak	*Quercus alba*
white pine	*Pinus strobus*
willow	*Salix* spp.
willows	*Salix* spp.
winterberry	*Ilex verticillata*
yellow birch	*Betula alleghaniensis*

Animals

American Bittern	*Botaurus lentiginosus*
American Golden Plover	*Pluvialis dominica*
American Marten	*Martes americana*
American Sand Burrowing Mayfly	*Dolania americana*
American Woodcock	*Scolopax minor*
Bald Eagle	*Haliaeetus leucocephalus*
Banded Killifish	*Fundulus diaphanus*
Black Sandshell	*Ligumia recta*
Black Tern	*Chlidonias niger*
Black-backed Woodpecker	*Picoides arcticus*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Blanding's Turtle	*Emydoidea blandingii*
Blue Sucker	*Cycleptus elongatus*
Blue-winged Teal	*Anas discors*
Blue-winged Warbler	*Vermivora pinus*
Bobolink	*Dolichonyx oryzivorus*
Boreal Chickadee	*Poecile hudsonica*
Boreal Chorus Frog	*Pseudacris maculata*
Brown Thrasher	*Toxostoma rufum*
Bull Snake	*Pituophis catenifer*
Canada Warbler	*Wilsonia canadensis*
Canvasback	*Aythya valisineria*
Cerulean Warbler	*Dendroica cerulea*
Cobweb Skipper	*Hesperia metea*
Connecticut Warbler	*Oporornis agilis*
Creek Heelsplitter	*Lasmigona compressa*
Deer (white-tailed deer)	*Odocoileus virginianus*
Dunlin	*Calidris alpina*
Dusted Skipper	*Atrytonopsis hianna*
Eastern Hog-nosed Snake	*Heterodon platirhinos*
Eastern Meadowlark	*Sturnella magna*
Eastern Red Bat	*Lasiurus borealis*
Elktoe	*Alasmidonta marginata*
Emerald Ash Borer	*Agrilus planipennis*
Extra-striped Snaketail	*Ophiogomphus anomalus*
Field Sparrow	*Spizella pusilla*
Four-toed Salamander	*Hemidactylium scutatum*
Franklin's Ground Squirrel	*Spermophilus franklinii*
Gilt Darter	*Percina evides*
Golden-winged Warbler	*Vermivora chrysoptera*
Gophersnake (bullsnake)	*Pituophis catenifer*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Wolf	*Canis lupus*
Greater Prairie-chicken	*Tympanuchus cupido*
Greater Redhorse	*Moxostoma valenciennesi*
gypsy moth	*Lymantria dispar*
Henry's Elfin	*Callophrys henrici*
Henslow's Sparrow	*Ammodramus henslowii*
Hoary Bat	*Lasiurus cinereus*

Hooded Warbler	*Wilsonia citrina*
Hudsonian Godwit	*Limosa haemastica*
Karner Blue	*Lycaeides melissa samuelis*
Lake Sturgeon	*Acipenser fulvescens*
Le Conte's Sparrow	*Ammodramus leconteii*
Least Darter	*Etheostoma microperca*
Least Flycatcher	*Empidonax minimus*
Leonard's Skipper	*Hesperia leonardus*
Lesser Scaup	*Aythya affinis*
Liatris Borer Moth	*Papaipema beeriana*
Longear Sunfish	*Lepomis megalotis*
Louisiana Waterthrush	*Seiurus motacilla*
Marbled Godwit	*Limosa fedoa*
Mink Frog	*Lithobates septentrionalis*
Moose	*Alces alces*
Mottled Dusky Wing	*Erynnis martialis*
Mucket	*Actinonaias ligamentina*
Mudpuppy	*Necturus maculosus*
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*
Northern Flying Squirrel	*Glaucomys sabrinus*
Northern Goshawk	*Accipiter gentilis*
Northern Harrier	*Circus cyaneus*
Northern Long-eared Bat	*Myotis septentrionalis*
Northern Prairie Skink	*Eumeces septentrionalis*
Olive-sided Flycatcher	*Contopus cooperi*
Osprey	*Pandion haliaetus*
Pallid Shiner	*Notropis amnis*
Phlox Moth	*Schinia indiana*
Pickerel Frog	*Rana palustris*
Prothonotary Warbler	*Protonotaria citrea*
Pugnose Shiner	*Notropis anogenus*
Pugnose Shiner	*Notropis anogenus*
Purple Wartyback	*Cyclonaias tuberculata*
Pygmy Snaketail	*Ophiogomphus howei*
Red Crossbill	*Loxia curvirostra*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-necked Grebe	*Podiceps grisegena*
Red-shouldered Hawk	*Buteo lineatus*
River Redhorse	*Moxostoma carinatum*
Round Pigtoe	*Pleurobema sintoxia*
Rusty Blackbird	*Euphagus carolinus*
Saint Croix Snaketail	*Ophiogomphus susbehcha*
Salamander Mussel	*Simpsonaias ambigua*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Short-billed Dowitcher	*Limnodromus griseus*
Silver-haired Bat	*Lasionycteris noctivagans*
Solitary Sandpiper	*Tringa solitaria*
Spectacle Case	*Cumberlandia monodonta*
Trumpeter Swan	*Cygnus buccinator*
Upland Sandpiper	*Bartramia longicauda*
Veery	*Catharus fuscescens*
Vesper Sparrow	*Pooecetes gramineus*
Wartyback	*Quadrula nodulata*
Water Shrew	*Sorex palustris*
Whip-poor-will	*Caprimulgus vociferus*
Whitney's Underwing Moth	*Catocala whitneyi*
Wilson's Phalarope	*Phalaropus tricolor*
Wood Thrush	*Hylocichla mustelina*
Wood Turtle	*Glyptemys insculpta*
Woodland Jumping Mouse	*Napaeozapus insignis*
Yellow Rail	*Coturnicops noveboracensis*
Yellow-billed Cuckoo	*Coccyzus americanus*

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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 develop 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***

APPENDIX A

Natural Heritage Inventory Overview and General Methodology

This biotic inventory and analysis was conducted by the Wisconsin Natural Heritage Inventory (NHI) program. The Wisconsin 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 standardized methods for collecting, processing, and managing data for rare species, natural communities, and certain other natural features (e.g., bird rookeries). NatureServe, an international non-profit organization, coordinates the network. This appendix provides a general overview of the methodology we use for these projects. Please see the NatureServe Web site for more detailed information about standard methods used by the Heritage Network (*www.NatureServe.org*) for locating, documenting, and ranking rare species and natural community occurrences.

General Process Used when Conducting Biotic Inventories for Master Planning

The Wisconsin NHI Program typically uses a "coarse filter-fine filter" approach to conducting biotic inventory projects for master planning. This approach begins with a broad assessment of the natural communities and aquatic features present, along with their relative quality and condition. The area's landforms, soils, topography, hydrology, current land uses, and the surrounding matrix are also evaluated using Geographic Information Systems (GIS) and other electronic and hardcopy data sources. Data that describe conditions for the area prior to Euro-American settlement are often used during this step and at other times to further understand the ecological capabilities of the area. Often, we consult with local managers, biologists, or others familiar with the ecology of the area when preparing for an inventory project. The goals for this step are to identify the important ecological attributes and biological processes present, as well as to focus our inventory efforts.

The level of survey intensity varies based on the size and ecological complexity of the property or group of properties, as well as the resources available. For larger properties such as state forests, biotic inventory efforts typically take more than one year. Ideally, taxa surveys are conducted following a coarse-filter analysis that sometimes include extensive natural community surveys. There is often time for "mop-up work" during the year following the completion of the main survey effort, whereby additional surveys are conducted for areas that could not be reached the first year or for which new information has become available. For smaller properties, a "Rapid Ecological Assessment" often takes the place of a full-scale biotic inventory. The level of effort for these projects varies based on the needs of the study area, although surveys are almost always completed during one field season. Coarse filter work for rapid assessments is often done based on GIS data, aerial photos, data acquired from previous efforts, and information from property managers and others knowledgeable about the area.

Taxa-specific surveys can be costly and intensive and sometimes must be completed during a very narrow period of time. For example, bird surveys must be completed within an approximately one-month time window. For this and several other reasons, ***our surveys cannot locate every rare species occurrence within a given area.*** Therefore, it is important to use resources as efficiently as possible, making every effort to identify the major habitats present in the study area from the start. This approach concentrates inventory efforts on those sites most likely to contain target species to maximize efficient use of resources. Communication among biologists during the field season can help identify new areas of interest or additional priorities for surveys. The goal is to locate species populations with the highest conservation value whenever possible.

After all of the data are collected, occurrences of rare species, high-quality natural communities, and certain other features are documented, synthesized, and incorporated into the NHI Database. The NHI program refers to this process as "mapping" the data and uses a tabular and spatial database application designed specifically for the

Heritage Network. Other secondary databases are also used by the Wisconsin NHI Program for storing additional species and community information such as species lists, GPS waypoints, photos, and other site documentation.

Once the data mapping and syntheses are completed, the NHI Program evaluates data from the various department biologists, contractors, and other surveyors. This information is examined along with many other sources of spatial and tabular information including topographic maps, various types of aerial photography, digital soil and wetland maps, hydrological data, forest reconnaissance data, and land cover data. Typically, GPS waypoints and other spatial information from the various surveys are superimposed onto these maps for evaluation by NHI biologists.

In addition to locating important rare species populations and high-quality natural community occurrences, the major products culminating from all of this work are the "Primary Sites." These areas contain relatively undisturbed, high-quality, natural communities; provide important habitat for rare species; offer opportunities for restoration; could provide important ecological connections; or some combination of the above factors. The sites are meant to highlight, based on our evaluation, the best areas for conserving biological diversity for the study area. They often include important rare species populations, High Conservation Value Forests, or other ecologically important areas.

The final report describes the Primary Sites, as well as rare or otherwise notable species, and other ecological opportunities for conserving or enhancing the biological diversity of the study area. The report is intended for use by department master planning teams and others and strives to describe these opportunities at different scales, including a broad, landscape context that can be used to facilitate ecosystem management.

Select Tools Used for Conducting Inventory

The following are descriptions of standard tools used by the NHI Program for conducting biotic inventories. Some of these may be modified, dropped, or repeated as appropriate to the project.

File Compilation: Involves obtaining existing records of natural communities, rare plants and animals, and aquatic features for the study area and surrounding lands and waters from the NHI Database. Other databases with potentially useful information may also be queried, such as: forest reconnaissance data; the DNR Surface Water Resources series for summaries of the physical, chemical, and biological characteristics of lakes and streams (statewide, by county); the Milwaukee Public Museum's statewide Herp Atlas; the Wisconsin Breeding Bird Atlas; other NHI "atlas" and site databases; museum/herbarium collections for various target taxa; soil surveys; geological surveys; and the department's fish distribution database.

Additional data sources are sought out as warranted by the location and character of the site, and the purpose of the project. Manual files maintained within the Bureau of Endangered Resources, including the State Natural Area files, often contain information on a variety of subjects relevant to the inventory of natural features for an area.

Literature Review: Field biologists involved with a given project consult basic references on the natural history and ecology of the area, as well as any documented rare species. This sometimes broadens and/or sharpens the focus of the inventory efforts.

Target Elements: Lists of target elements including natural communities, rare plants and animals, and aquatic features are developed for the study area. Field inventory is then scheduled for the times when these elements are most identifiable or active. Inventory methods follow accepted scientific standards for each taxon.

Compilation of Maps and Other Spatial Data: USGS 7.5 minute topographic quadrangles, most often in digital form, serve along with aerial photos as the base maps for field survey and often yield useful clues regarding access, extent of area to be surveyed, developments, and the presence and location of special features. These are used in conjunction with numerous GIS layers, which are now a basic resource tool for the efficient and comprehensive planning of surveys and the analysis of their results.

WDNR wetland maps consist of aerial photographs upon which all wetlands down to a scale of 2 or 5 acres have been delineated. Each wetland polygon is classified based on characteristics of vegetation, soils, and water depth. These polygons have been digitized for most counties, and the resulting GIS layers can be superimposed onto other maps.

Ecoregion GIS layers are useful for comprehensive projects covering large geographic areas such as counties, national and state forests, and major watersheds. These maps integrate basic ecological information on climate, landforms, geology, soils, and vegetation. Ecological Landscapes provide the broad framework most often used in Wisconsin; however smaller units, including Landtype Associations, can be very helpful for evaluating ecoregions at finer scales.

Aerial photographs: These provide information on a study area not available from maps, paper files, or computer printouts. Examination of both current and historical photos, taken over a period of decades, can be especially useful in revealing changes in the environment over time. The Wisconsin NHI Program uses several different types of both color and black and white air photos. Typically, these are in digital format, although paired photos in print format can be valuable for stereoscopic viewing. High-resolution satellite imagery is often cost-prohibitive but is available for some portions of the state and is desirable for certain applications.

Original Land Survey Records: The surveyors who laid out the rectilinear Town-Range-Section grid across the state in the mid-nineteenth century recorded trees by species and size at all section corners and along section lines. Their notes also included general impressions of vegetation, soil fertility, and topography, and note aquatic features, wetlands, and recent disturbances such as windthrow and fire. As these surveys typically occurred prior to extensive settlement of the state by Europeans, they constitute a valuable record of conditions prior to extensive modification of the landscape by European technologies and settlement patterns. The tree data are available in GIS format as raw points or interpreted polygons, and the notes themselves can provide helpful clues regarding the study area's potential ecological capabilities.

Interviews: Interviews with scientists, naturalists, land managers or others knowledgeable about the area to be surveyed often yield invaluable information.

Global Positioning Systems (GPS): Small, portable GPS units are now a routine piece of field equipment used for virtually all NHI survey work. Collecting coordinates (waypoints) facilitates mapping and makes it easy to quickly communicate specific locations among biologists. Often waypoints are paired with photos and/or other information and stored in a waypoint tracking database.

Aerial Reconnaissance: Fly-overs are desirable for large sites, and for small sites where contextual issues are especially important. When possible, this should be done both before and after ground level work. Flights are scheduled for those times when significant features of the study area are most easily identified and differentiated. They are also useful for observing the general lay of the land, vegetation patterns and patch sizes, aquatic features, infrastructure, and disturbances within and around the site.

APPENDIX B

Governor Knowles State Forest Primary Sites

The ecologically significant sites identified through the biotic inventory are depicted on Figure 12 and described in the following narratives. Each site contains documented, significant occurrences of rare and/or representative high quality natural features. Department master planning teams, land managers, and the general public can use these sites for identifying protection and management opportunities. Restoration potential for some native communities is discussed, as well as the presence of ecologically important resources on nearby lands outside of the GKSF boundary. Site boundaries are rough first approximations.

In some places in this Appendix, we suggest that particular sites have the potential for additional rare species that have not yet been documented. Arguably, the same could be said for any location on the property. However, these statements are meant as general considerations for the site, based on our evaluation of the habitats present. Since it is impossible for every location of every rare species to be documented within the course of an inventory, the lack of a documented occurrence for a species should never be taken to mean that a species does not exist at a site. All of the boundaries on the maps are approximate and are subject to change in the future.

Table of Primary Sites

GK01. CLAM RIVER WOODS NORTH

Location

County:	Burnett
USGS 7.5' Quadrangle:	Monson Lake
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	1530

Description of Site

Stretching from the Clam River north for more than two miles, this large site encompasses a variety of contrasting community types ranging from wetland to dry forest. Beginning in the north, just west of "Pease Hill" and located above the St. Croix River valley bluff, is the largest contiguous block of mature oak-dominated Northern Dry-mesic Forest known from the GKSF. The forest here is dominated by red oak and northern pin oak with occasional mature red and white pines.

The center of the site is made up of a large wetland complex, lying in the river valley and extending south nearly to the Clam River. An extensive black ash dominated Hardwood Swamp comprises the majority of the wetland with smaller areas of Northern Sedge Meadow and shrub swamp closer to the river. Tree size and understory composition vary throughout the swamp. A small, unnamed stream flows through the center of the wetland to the St Croix River. Floodplain Forest dominated by silver maple, bur oak, and ash occurs along the river.

A good-quality example of Northern Dry Forest comprises the southeast end of the site. This extensive (>250 acres) area occurs on outwash plain above the escarpment and is dominated by 60-year-old jack pine with northern pin oak. Closed canopy forest grades into an open woodland structure in places, with characteristic barrens flora dominating the understory.

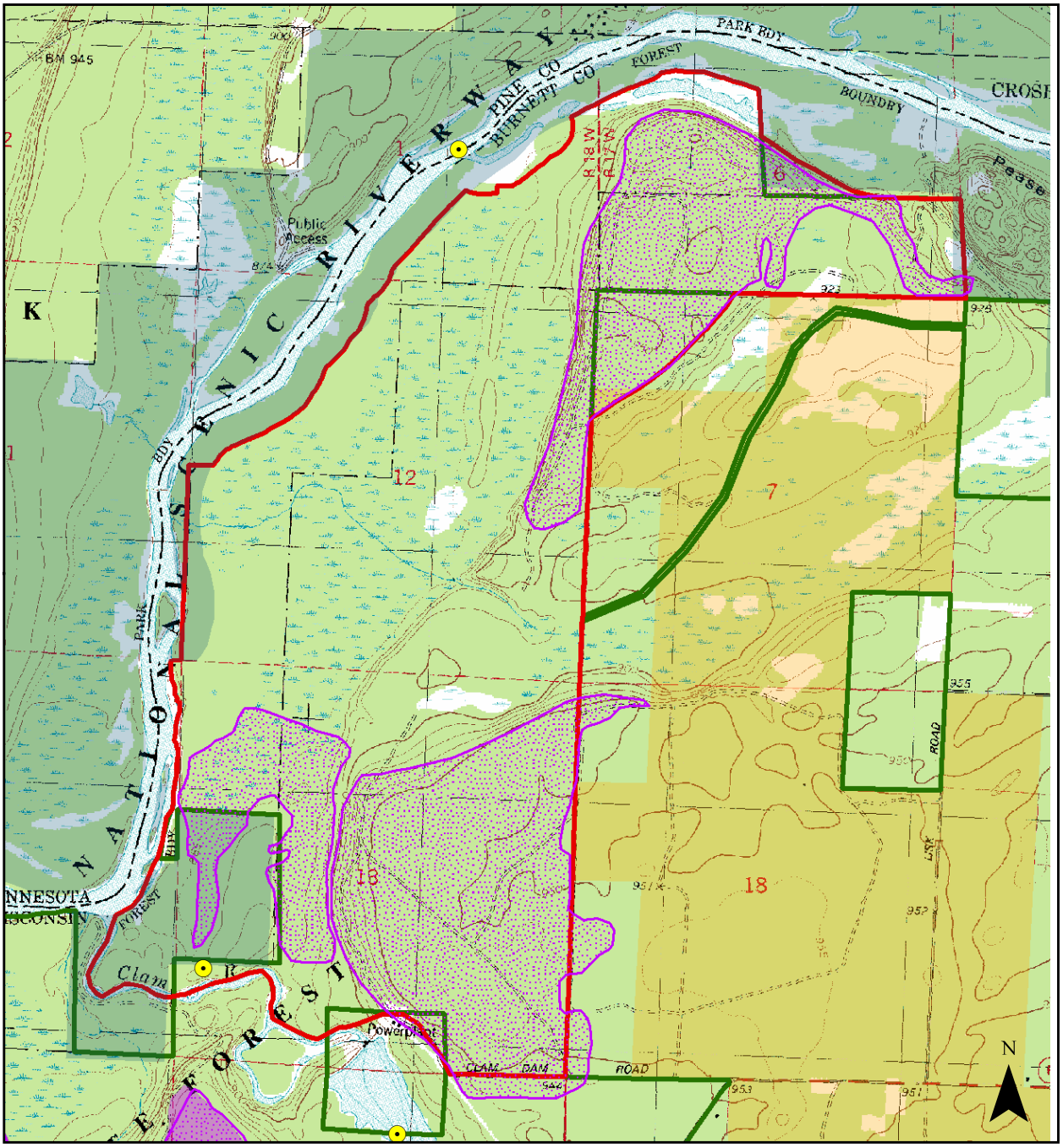
Significance of Site

Large, representative examples of several natural commmunity types occur here, including extensive tracts of both Northern Dry-mesic Forest and Northern Dry Forest. Rare birds have been documented at the site, and there is potential for several other rare species, including rare plants in both the dry areas and the Hardwood Swamp.

Management Considerations

This area is of high conservation value, as it contains some of the property's best opportunities to maintain and restore high-quality natural communities within a favorable ecological context. There are several distinct community types represented within a single contiguous block, providing opportunities to manage at a landscape-level and increasing the ecological significance of the site.

GK01. Clam River Woods North



Legend Disclaimer:

Element Occurrence (EO) locations were generated using November 2009 NHI data records. Each symbol often represents more than one EO, and symbols may overlap each other. The absence of evidence does not indicate evidence of absence, and there are some natural community occurrences not shown, as they are based on recent data and have not yet been incoporated into the NHI database.

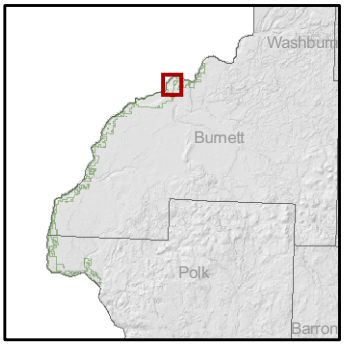
The Primary Site boundary is approximate, and it should be used only generally, not literally, for management purposes.

Surveys were conducted between 2007-2009 for natural communities and priority taxa. The surveys were not comprehensive for all taxa potentially present.

Ownership shown is approximate and only meant to illustrate the site locations.

1:26,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK02. CLAM DAM WOODS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Monson Lake
Landtype Association:	212Ka01. Grantsburg Dunes
Approximate Size (acres):	115

Description of Site

The primary feature of this site is a block of Northern Dry Forest dominated by jack pine, trembling aspen, and northern pin oak, transitioning to more mesic forest in some areas. The site borders the Clam River Flowage and is bisected by a powerline ROW. There is a small tamarack swamp inclusion south of the powerline ROW that appears to be the headwaters of a very small tributary to the Clam River. Further downstream, is a small area of Alder Thicket. A Northern Dry-mesic Forest dominated by red, bur, and white oak, with red maple, white pine, paper birch, black ash, and green ash borders the flowage. Just south of the flowage is a wetland with black ash dominated Hardwood Swamp and Alder Thicket; it was not included in the site due to its relatively small size and because it is separated from the rest of the site by the flowage. To the east of the site, an area with relatively open structure and high-quality barrens flora is continuous with a much larger example of this type just to the north at the Clam River Woods North site (GK01).

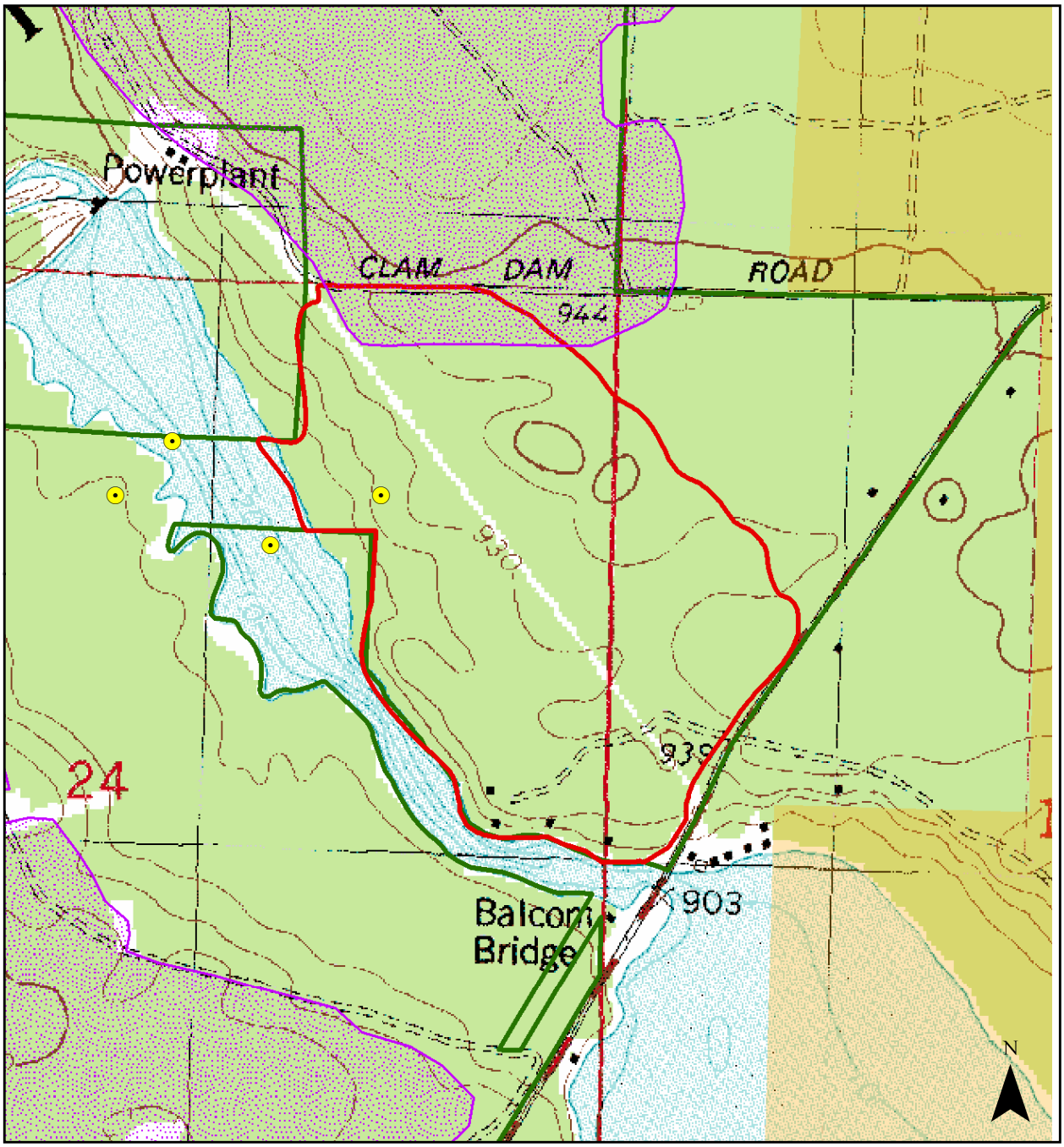
Significance of Site

This site is relatively small and bisected by a wide powerline corridor. Red-shouldered Hawk habitat is the most ecologically important feature here, although birds were not relocated during the most recent site visits.

Management Considerations

Although small when considered on its own, this site contains representative barrens ground flora, and is similar to areas north of the site, at Clam River Woods North (GK 01). This provides the potential for large-scale restoration of a Northern Dry Forest/Pine Barrens complex. This site is not likely to be one of the most ecologically important areas for consideration during master planning. However, it does have some important features, as well as a State Threatened species, so it is included for consideration during planning of management activities.

GK02. Clam Dam Woods



Legend Disclaimer:

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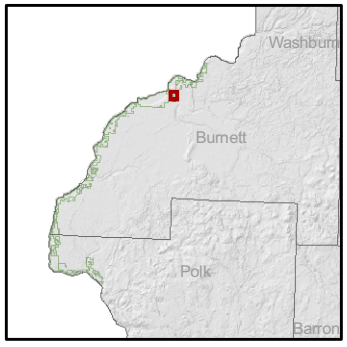
Surveys were conducted between 2007-2009 for natural communities and priority taxa. The surveys were not comprehensive for all taxa potentially present.

Ownership shown is approximate and only meant to illustrate the site locations.

1:10,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK03. KOHLER-PEET WETLANDS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Lake Clayton, Monson Lake
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	3331

Description of Site

At over 3,000 acres, this is easily the largest wetland complex within the GKSF and surrounding landscape. This large bottomland is mostly intact and encompasses a diverse mix of good quality wetland communities including Hardwood Swamp, Alder Thicket, Shrub Carr, Black Spruce Swamp, Tamarack (poor) Swamp, and Northern Wet-mesic Forest, as well as numerous Forested Seeps flowing from the escarpment to the south. Portions of two existing State Natural Areas, Kohler-Peet Barrens and Cedar Swamp (No. 152) and Norway Point Bottomlands (No.151), are located at the eastern and western ends of the site, respectively.

An upland “island” of approximately 180 acres occurs near the center of the site and is dominated by mature aspen, red maple, and northern pin oak. Just to the northeast of these uplands and comprising much of the north end of the site, is a stand typed as aspen in the forest reconnaissance data. This area is actually an extensive black ash-dominated Hardwood Swamp that grades into a large shrub swamp. These natural communities are not shown on the map accompanying this site, as fieldwork here was completed late in the project, and data have not yet been incoporated into the NHI database. Barrett Creek, bordered by open wetlands and draining into the St. Croix, bisects the western one-third of the site.

Significance of Site

This is a very large wetland complex with mostly intact native communities, including several examples of unusual types or variants not well-represented elsewhere. Forested Seeps, found in many locations in the GKSF at the base of the escarpment, are particularly well-represented at this site. One of these areas occurs within a high-quality Northern Wet-mesic Forest (white cedar swamp) with iron-rich seepage pools and streamlets; this is the only example of this type of stand found along the valley slope within the GKSF. Although there is evidence of past disturbance in some areas (e.g., ditch and ditch spoils adjacent to the east side of the Kohler-Peet SNA) most of the wetlands are of good to very good overall quality. Several rare species have been documented here, and there is good potential for several others such as bog bluegrass, Assiniboine Sedge, Golden-winged Warbler, and Canada Warbler .

Management Considerations

This site is of high ecological importance and merits consideration for special designation in the new master plan, including review of the existing SNA boundaries. The current SNA boundaries date back to the late 1970s and follow political, rather than ecological boundaries. The ecological features for which these SNAs were identified extend well beyond the existing boundaries. Several high-quality natural communities and rare species habitats are located between the two SNAs, and sometimes they share hydrological connections. As part of the master planning process, all of these boundaries should be evaluated.

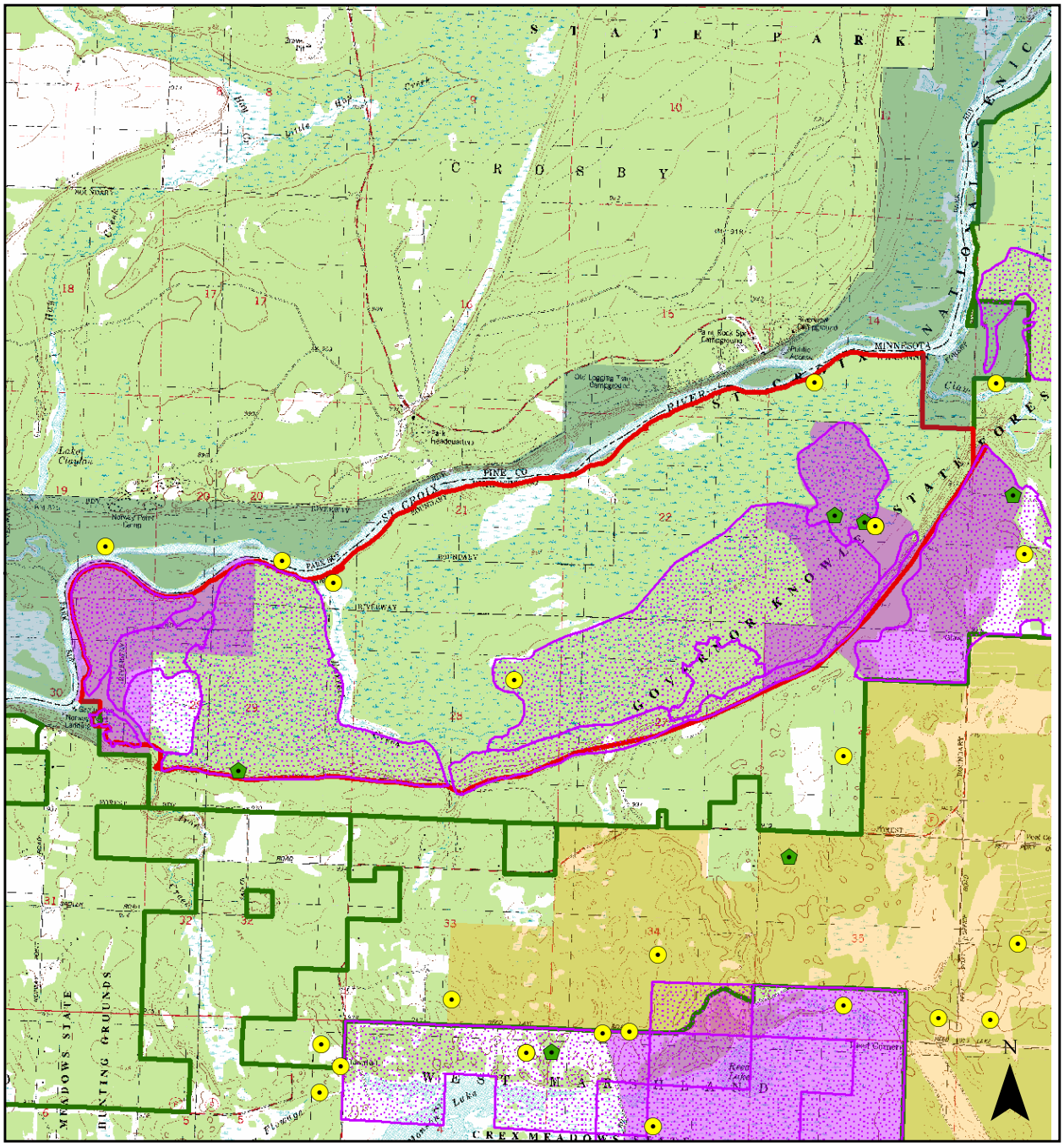
The seeps, a defining ecological theme for the GKSF, are well-represented at this site. These unique habitats warrant continued protection and are particularly susceptible to soil / hydrological disturbance. Several rare plants have the potential to occur in these areas, in addition to those already documented. Special care may also be needed when conducting management activities in the nearby uplands.

Although this area is mostly undisturbed, non-native invasive plants have been observed in a few locations, including common and glossy buckthorn, a significant threat to wetlands in many other parts of the state. Common reed (*Phragmites australis*) is found here in several small patches within the moderately acidic, open canopied tamarack swamp; however, it appears to be the much less aggressive native strain of the species based on growth habit, morphological characteristics, and its location within this expansive, mostly undisturbed area.

Much of this site was not thoroughly surveyed, as this area is very large and difficult to access. Future surveys could reveal numerous undocumented rare species populations as well as a more thorough assessemnt of the hardwood swamp between the two SNAs.

Governor Knowles State Forest

GK03. Kohler-Peet Wetlands



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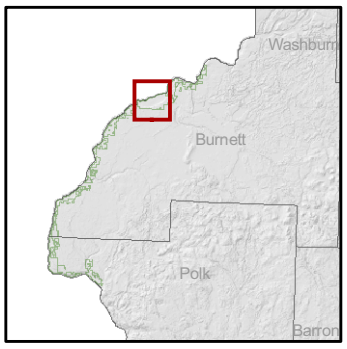
Ownership shown is approximate and only meant to illustrate the site locations.

1:50,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK04. KOHLER-PEET BARRENS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Monson Lake
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	659

Description of Site

One of two GKSF primary sites (along with GK16) being actively managed to maintain and restore barrens communities, this site is a complex that includes the dry upland portion of the existing Kohler-Peet Barrens & Cedar Swamp SNA. Adjacent areas outside of the SNA were included in the site because of their barrens restoration potential; some of these are areas already being managed for barrens. There are also adjacent old fields, some with good native species re-colonization, and a small (ca. 16 acres) forested area dominated by northern pin oak and red maple between the open barrens and a small access road.

Significance of Site

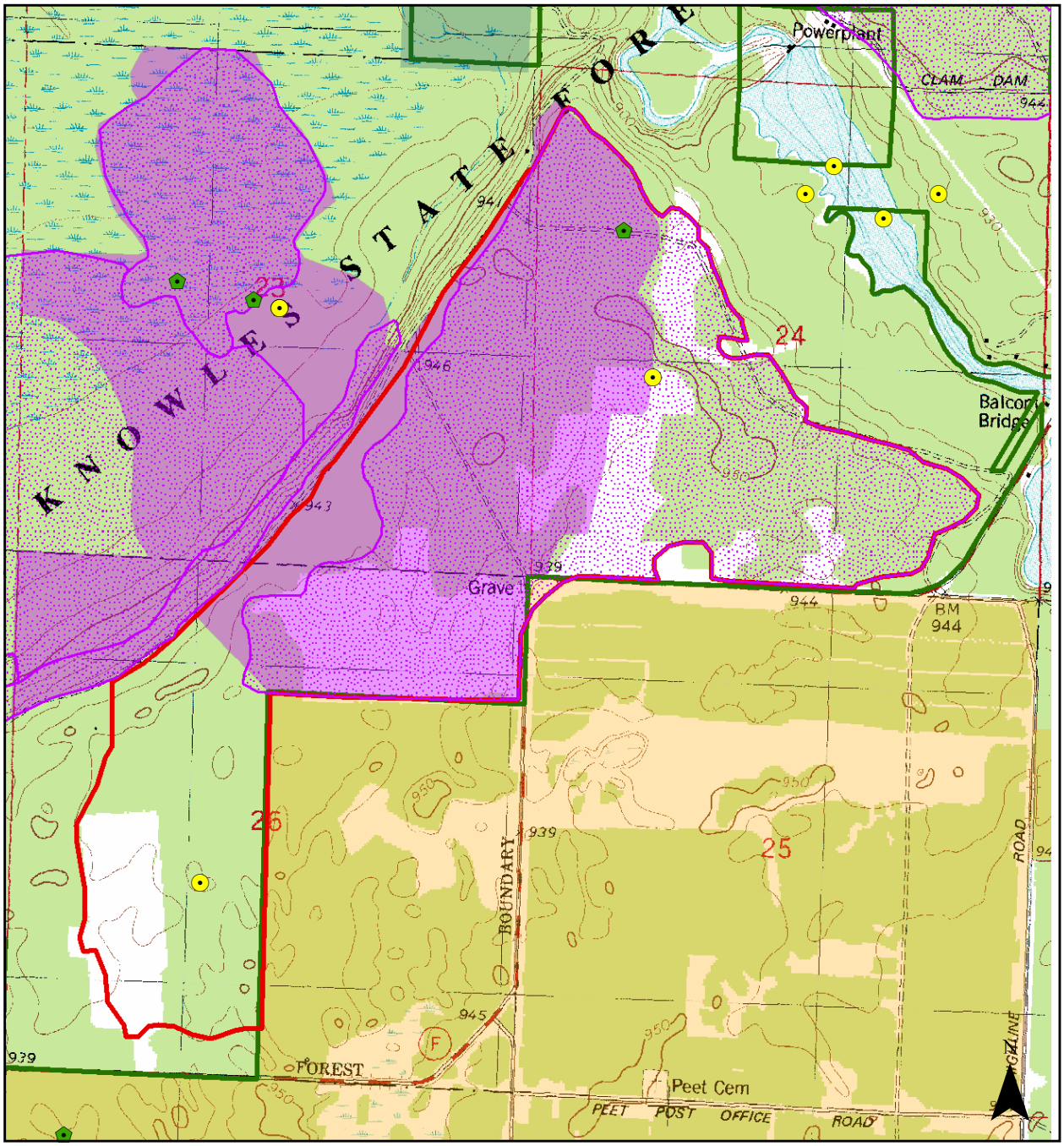
The site has an open barrens structure and composition that is unique on the GKSF. The Sterling Barrens SNA (GK16) is the most similar area on the property, although it contains a different species assemblage. Much of this site has a fairly continuous native barrens groundlayer and the best prairie species diversity among barrens on the GKSF. Several rare plants and animals have been documented here. In addition, barrens communities are globally rare, and there could be opportunities to link this area with the larger barrens at Crex Meadows in the future.

Management Considerations

As barrens are a globally rare community type, the existing SNA boundary should be evaluated for possible expansion to adjacent areas with barrens restoration potential. The species located in the young jack pine and oak-dominated forests within the site offer opportunities for additional barrens / dry forest management. However, consideration should be given to maintaining partial shade here to accommodate some of the species that may differ from those found in the more open barrens. This site is also in close proximity to Crex Meadows, where an active barrens restoration program is in place, allowing for broad-scale barrens management.

Governor Knowles State Forest

GK04. Kohler-Peet Barrens



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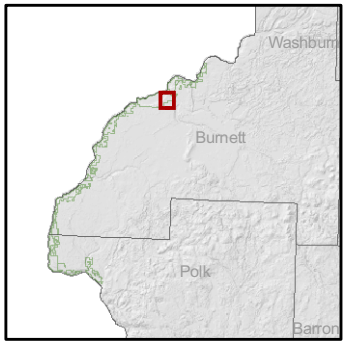
1:20,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK05. EKDALL WETLANDS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Lake Clayton
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	355

Description of Site

A wetland complex occupying the slope and bottomlands of the St. Croix River valley, this site includes the Ekdall Wetlands State Natural Area (No.150), as well as an adjacent area to the northeast where the wetlands extend outside of the SNA. The southern 2/3 of the site is composed mostly of conifer swamp (much of it tamarack-dominated but some portions with black spruce or cedar), Alder Thicket, and Hardwood Swamp, with open wetland grading into Floodplain Forest closer to the river.

The boundary follows the existing SNA boundary and includes several ravines along the escarpment. The valley walls are rimmed with seeps, often with pools of iron-bacteria, and there are clear water seepage runs and clear water springs within the peatland that feature small, sand bottom streamlets. The northeast portion of the site extends beyond the existing SNA to include a diverse black ash-dominated Hardwood Swamp, along with high-quality cedar swamp.

Significance of Site

This ecologically important wetland complex contains several good-quality natural communities, as well as excellent microsites with rare species habitats. Two rare plants were documented in the wetlands, and there is potential for others. Dotted blazing star, a Great Plains species, has been found on the uplands. Two rare birds have also been documented at this site, both near the northernmost limits of their Wisconsin ranges.

Management Considerations

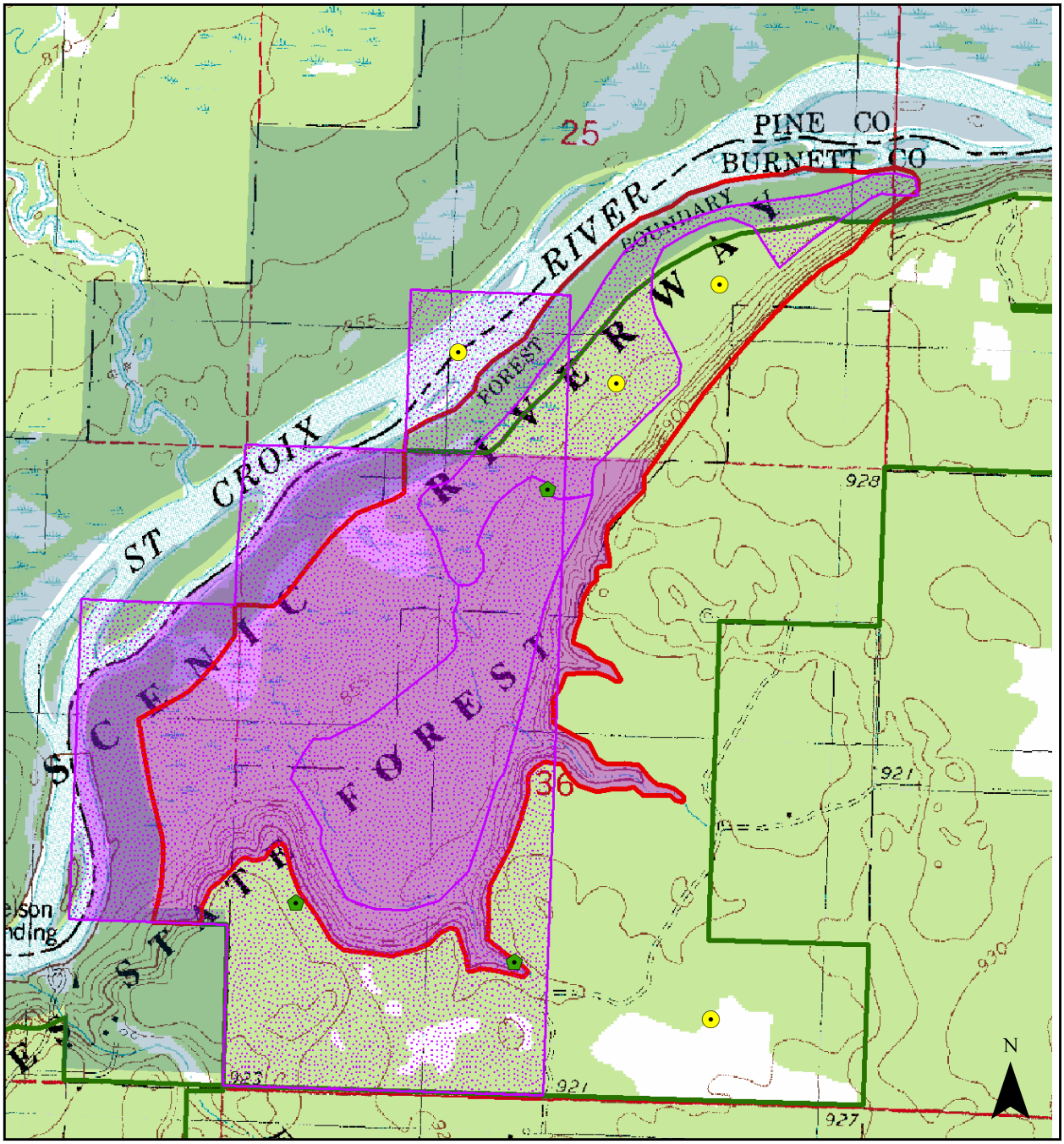
The existing SNA boundary should be evaluated, as the current boundary cuts across good quality wetland communities. Rare plants and animals have been documented in the northern portion of the site near the edge and outside of the existing SNA.

The seeps, a defining ecological theme for the GKSF, are well-represented at this site. These warrant protection and are particularly susceptible to soil / hydrological disturbance. Several rare plants have the potential to occur in these areas, in addition to those already documented. Special care may be needed when conducting management activities in the nearby uplands.

Phragmites australis, a significant threat to wetlands in many other parts of the state, has been found here; however, it may be the less aggressive native strain of the species.

Governor Knowles State Forest

GK05. Ekdall Wetlands



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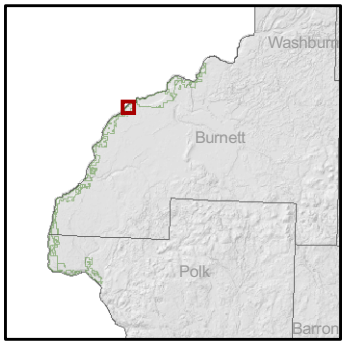
Ownership shown is approximate and only meant to illustrate the site locations.

1:16,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK06. FOX TO NELSON LANDING

Location

County:	Burnett
USGS 7.5' Quadrangle:	Lake Clayton
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	234

Description of Site

Similar to much of Brant Brook Pines and Hardwoods (GK07), the main feature here is a fairly large block of Northern Dry-mesic Forest with some wetland inclusions and other notable features. Much of the forest is dominated by mature / older oak (red, bur, and Hill's) situated on a broad, mostly level mid-elevation terrace covered with loamy sands north of Fox Landing Road. Large (14-18") red pine of natural origin is found in several places, and red maple is scattered throughout. In addition to mature trees, some areas contain advanced structural features including tip-up mounds, snags, and abundant coarse woody debris, and small wetlands. Another smaller area of older dry-mesic forest comprises the southernmost portion of the site south of Fox Landing Road.

At the base of the slope, and continuing to the west, much of the site is comprised of Hardwood Swamp dominated by mature (up to 15" dbh) black ash and yellow birch with smaller amounts of red maple and occasional white pine. Bear Brook and associated seep habitats cross the site near Fox Landing Road.

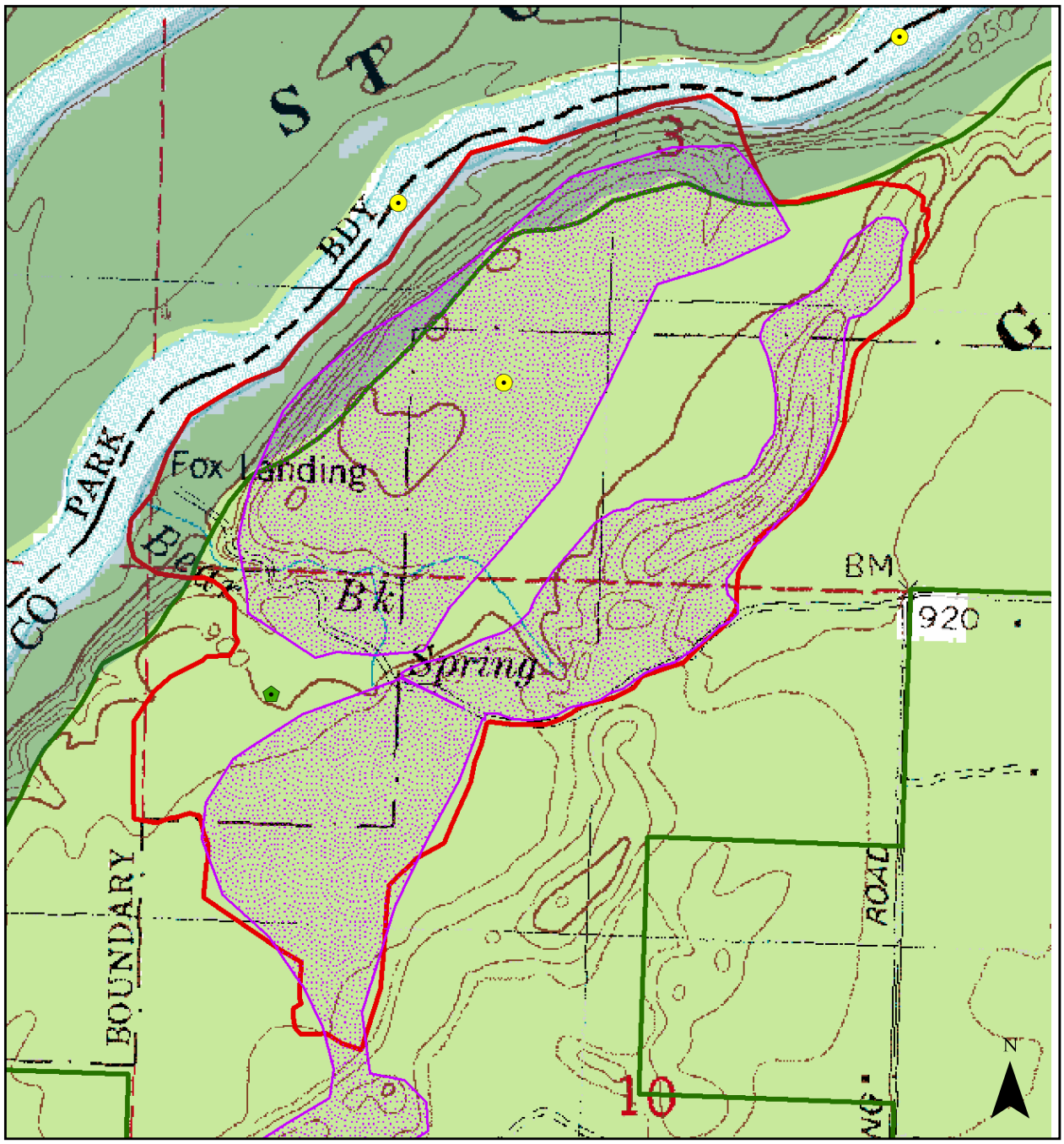
Significance of Site

The site contains one of the larger areas of mature dry-mesic forest within the GKSF, and this is one of two Primary Sites (the other is Brant Brook Pines and Hardwoods) with a substantial component of natural-origin red pine. A State Threatened bird has been documented here. A State Threatened plant has been found in the Hardwood Swamp, and there is potential for other rare plants in those areas as well.

Management Considerations

This site offers opportunities to maintain older dry-mesic forest, a formerly widespread type that is now relatively uncommon. The Wisconsin DNR Old-growth Handbook, currently in preparation, is expected to contain chapters on both pine and oak-dominated forests. This site offers one of the better opportunities on the GKSF to apply these principles due to its size and the presence of natural origin pine. Although not as large or diverse as the Brant Brook site, this site could provide a secondary area with similar characteristics in the event of serious wind-damage or other catastrophe.

GK06. Fox to Nelson Landing



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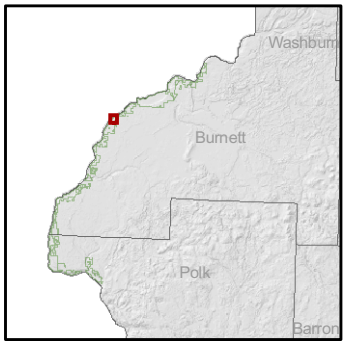
1:10,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK07. BRANT BROOK PINES AND HARDWOODS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Grantsburg, Lake Clayton
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	581

Description of Site

Encompassing the Brant Brook Pines SNA and adjacent lands, this Primary Site contains a number of ecologically important attributes. The existing SNA makes up the core of the site, but the boundary extends further to both the north and the east to include adajcent wetlands, seeps, and forested uplands.

The Brant Brook Pines SNA, making up the core of the site, was established in 1979 to conserve an old-growth stand of red pines originating in the mid-1880s along with the surrounding dry-mesic forest and Brant Brook itself. Adjacent National Park Service lands were added to the SNA in 2002, including portions of the river terrace and its associated forests and seeps. The Northern Dry-mesic Forest is dominated by red pine with white and jack pine, Hill's oak, basswood, large-toothed aspen, and white birch. On the elevated river terrace above the pines is a dense forest of young oak, while a more mature lowland forest of oak, black ash, and red maple occurs on the low terrace below the pines. Brant Brook is a steep gradient, sandy-bottomed coldwater stream deeply incised into the river terrace that supports native brook trout.

The areas outside of the SNA contain natural communities are contiguous with those inside of the SNA boundary. These include high quality dry-mesic forest, perched wetlands dominated by Hardwood Swamp with large diameter black ash and yellow birch in places, Forested Seeps, and diverse mesic forest inclusions with sugar maple, basswood, and yellow bud hickory. There are also sedge-dominated open wetlands found within depressions in the dry-mesic oak forest near the center of the site.

Significance of Site

This site includes the largest stands of natural-origin red pine on the GKSF and one of the best examples for managing a larger block of oak-dominated dry-mesic forest. Rare species have been documented here, and the pines could provide habitat for some uncommon bird species associated with mature conifers.

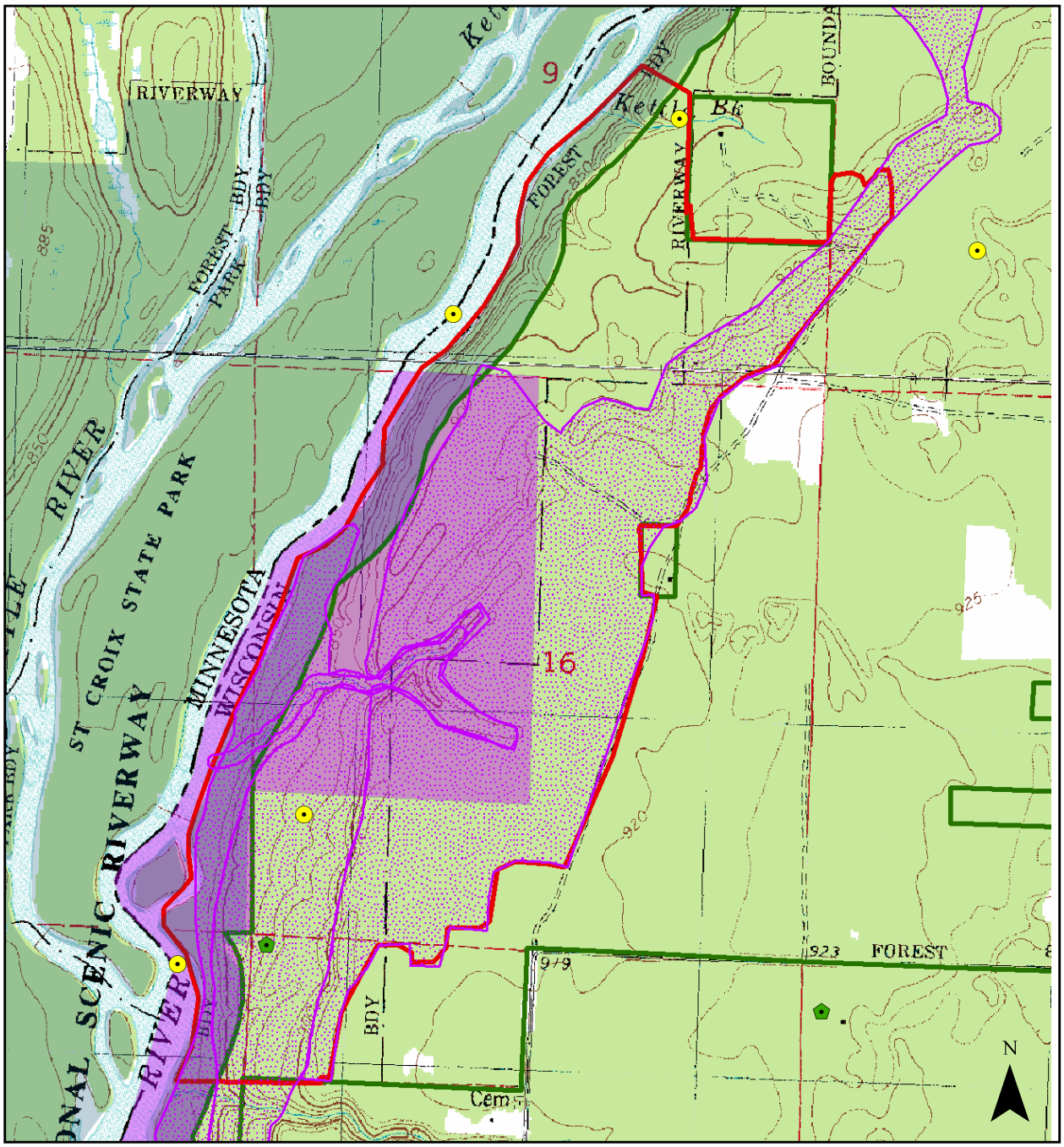
Management Considerations

The current SNA boundaries follow political, rather than ecological, boundaries. The ecological features for which these SNAs were identified extend beyond the existing boundaries. As part of the master planning process, all of these boundaries should be evaluated for possible expansion.

The Wisconsin DNR Old-growth Handbook, currently in preparation, is expected to contain chapters on both pine and oak-dominated forests; this site offers one of the best opportunities on the GKSF to apply these principles.

Governor Knowles State Forest

GK07. Brant Brook Pines and Hardwoods



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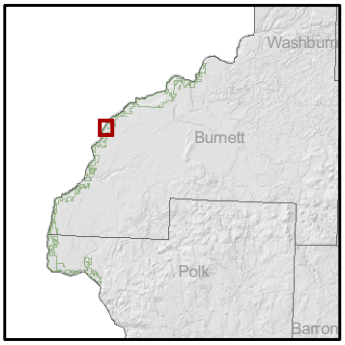
1:18,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK08. EAST BROOK SPRINGS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Bass Creek, Grantsburg
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	91

Description of Site

Located along Paint Mine Road, this site is composed of mature Northern Dry Forest dominated by northern pin oak, with lesser amounts of red maple and scattered bur oak, basswood, and bigtooth aspen. Much of the site is open and park-like with abundant standing and downed coarse woody debris. A Spring Run in the narrow ravine of East Brook Spring, at the north end of the site, is diverse with a moderate canopy cover of red maple with sugar maple, basswood, black ash, and white oak. A mature Northern Dry-mesic Forest occupies the bluff slopes and contains white pine, red pine, and mixed hardwoods.

Significance of Site

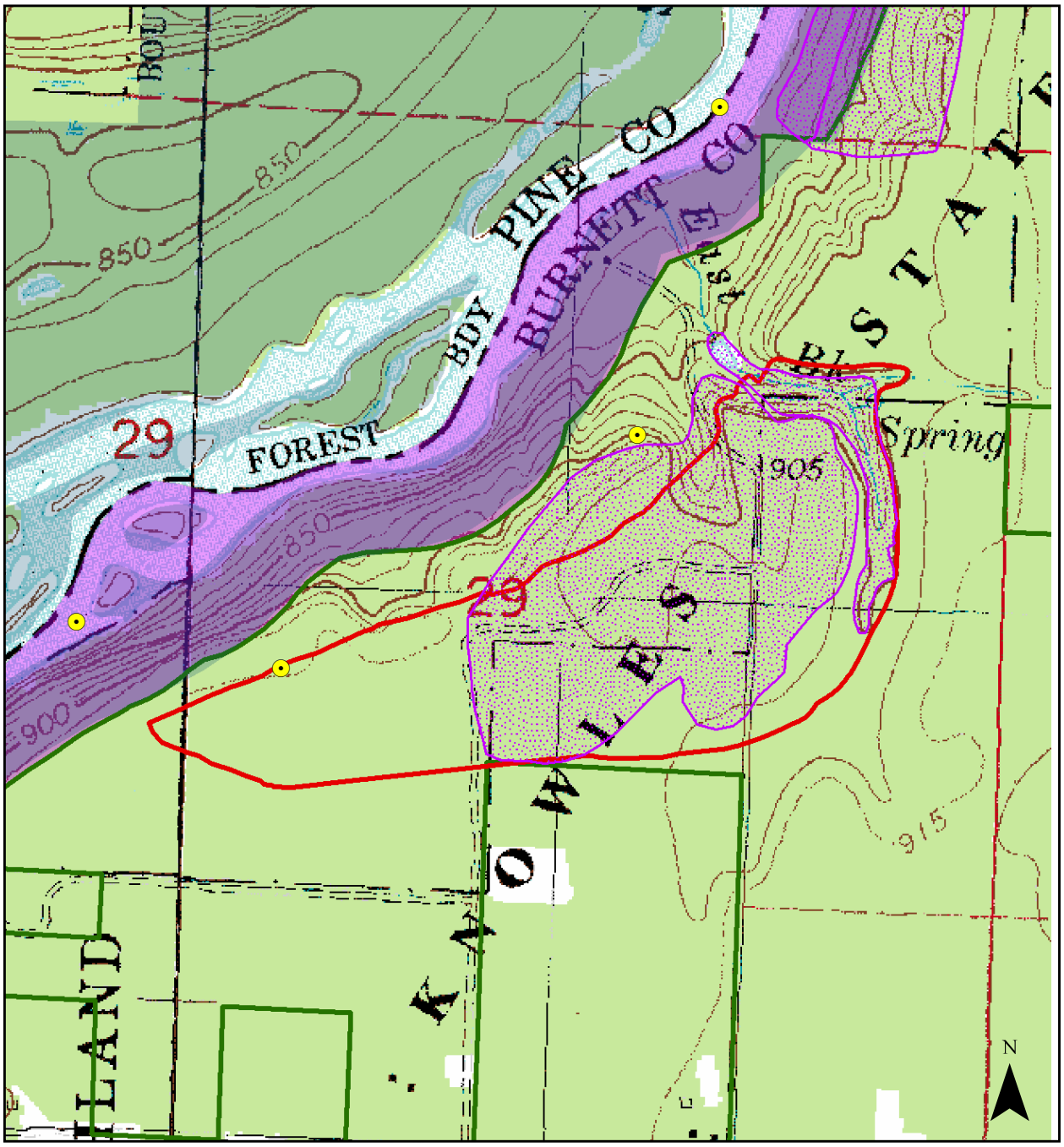
Portions of this site were logged recently. The remaining core area of dry forest is only 30 acres and separated from the spring area by a road and a logged area and has young previously clearcut forest on the other side. However, the site does offer an opportunity to buffer and connect nearby NPS land.

Management Considerations

The NPS land to the west has a couple of good quality stands of mature pine. This site could act as a transition area between the pine, and the nearby young forests on state land.

Governor Knowles State Forest

GK08. East Brook Spring



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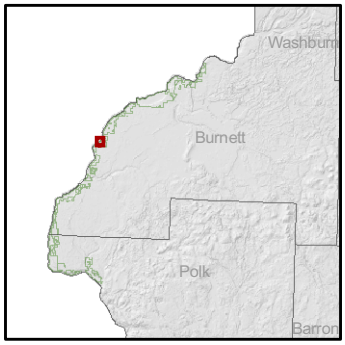
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK09. WOOD RIVER WOODS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Bass Creek
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	124

Description of Site

Forming a narrow, but mostly contiguous, forested buffer surrounding the Wood River, this site includes a small portion in the wilderness area and extends east to the property boundary near River Road. Mixed hardwood forest, including areas with mature red and white pine groves, surround the river. The steep slopes leading to the river contain several seepages, and in some areas, these flow through level terraces dominated by black ash with yellow birch.

Significance of Site

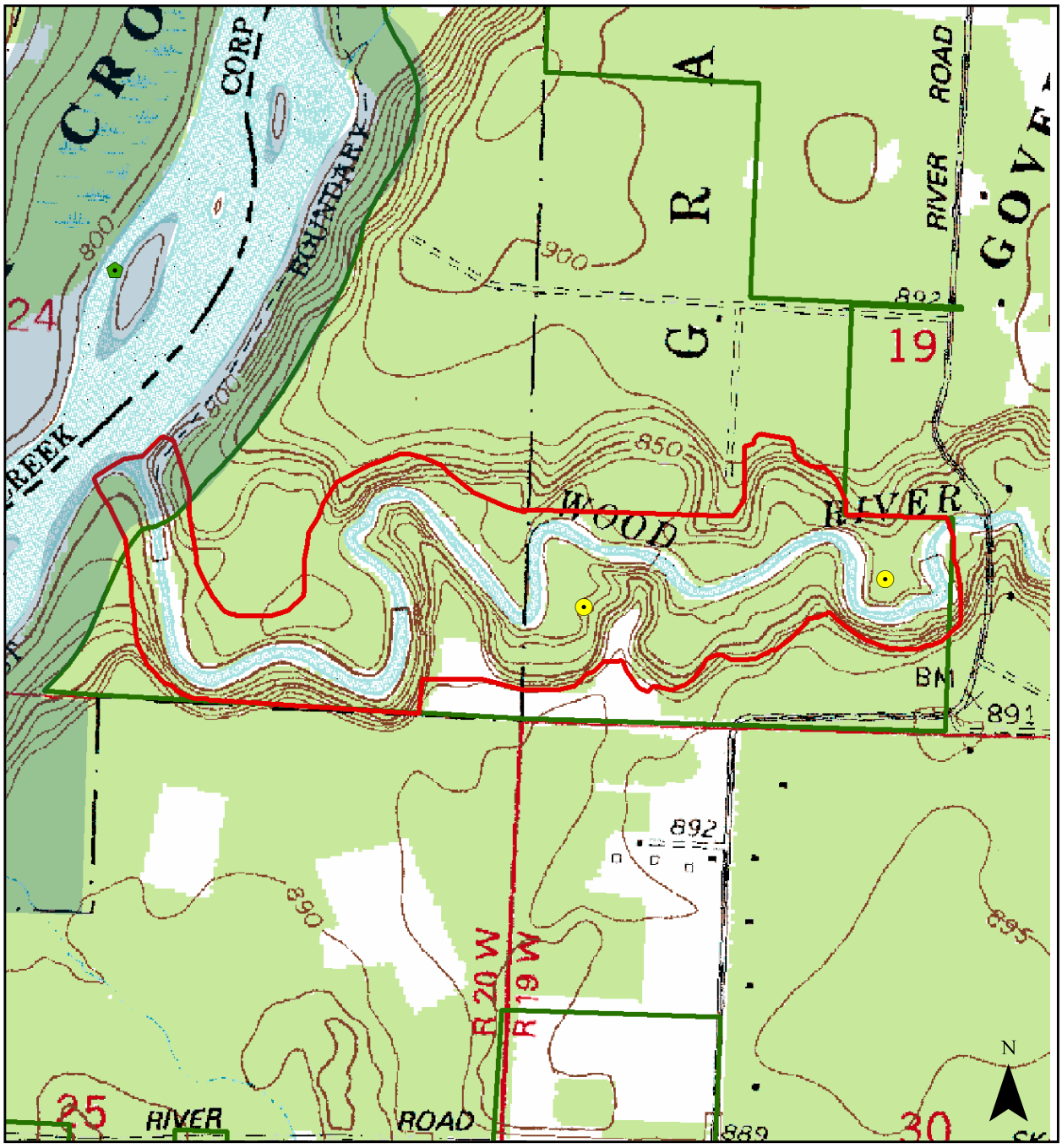
A State-Threatened bird was documented at this site, near the northernmost edge of its range. The site protects mature pine groves, can help to maintain water quality, and there is potential for rare plants in the seeps, along with other rare species such as Lousiana Waterthrush.

Management Considerations

This site provides a forested corridor along the entire length of the portion of the Wood River currently in state ownership. A pine plantation exists just outside of the south end of the site. Care will be needed to avoid erosion when the plantation is thinned, as the seepage slope is unstable.

Governor Knowles State Forest

GK09. Wood River Woods



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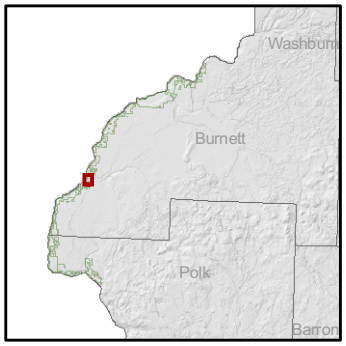
1:12,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK10. ST CROIX ASH SWAMP

Location

County:	Burnett
USGS 7.5' Quadrangle:	Randall
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	756

Description of Site

Located in a bottomland of the St Croix Valley, this site is comprised of extensive, high-quality wetlands. The St. Croix Ash Swamp SNA makes up approximately one-third of the site, along with the portions of the wetlands lying outside of the SNA boundary.

Mature Hardwood Swamp with high canopy cover and dominated by black ash with yellow birch, red maple, and scattered white pine comprises the majority of the site. Other natural communities include Northern Mesic Forest (in small patches), Tamarack Swamp, Alder Thicket, and Northern Sedge Meadow, along with at least one area with cedar-dominated Northern Wet-mesic Forest. An upland rise in the southernmost portion of the wetland is comprised of oak (bur and Hill's) with red maple and white pine, including some super-canopy trees up to 20" dbh. The river valley contains very steep sides, rising nearly 100 feet above the swamp with small spring-fed streams and seepages.

Pleasant Prairie Road runs north-to-south crossing the western portion of the site. Benson Brook, a coldwater creek, crosses the southernmost portion of the site and is surrounded by Northern Sedge Meadow and Hardwood Swamp with a small area of Northern Dry-mesic Forest on the adjacent southern slope. The Northern Dry-mesic Forest is located south of Benson Brook on the slope, crest, and top of a bluff with stumps indicating recent thinning. The bluff extends west to high-quality, mature, rich mesic forest on a north-facing slope with Forested Seeps. Although a very small example, rich north-facing slopes such as this are rare in the St. Croix Valley. A large (ca. 75 acres) upland area currently managed for aspen separates the Benson Brook area from the large wetlands that comprise the majority of the site further north and east.

Significance of Site

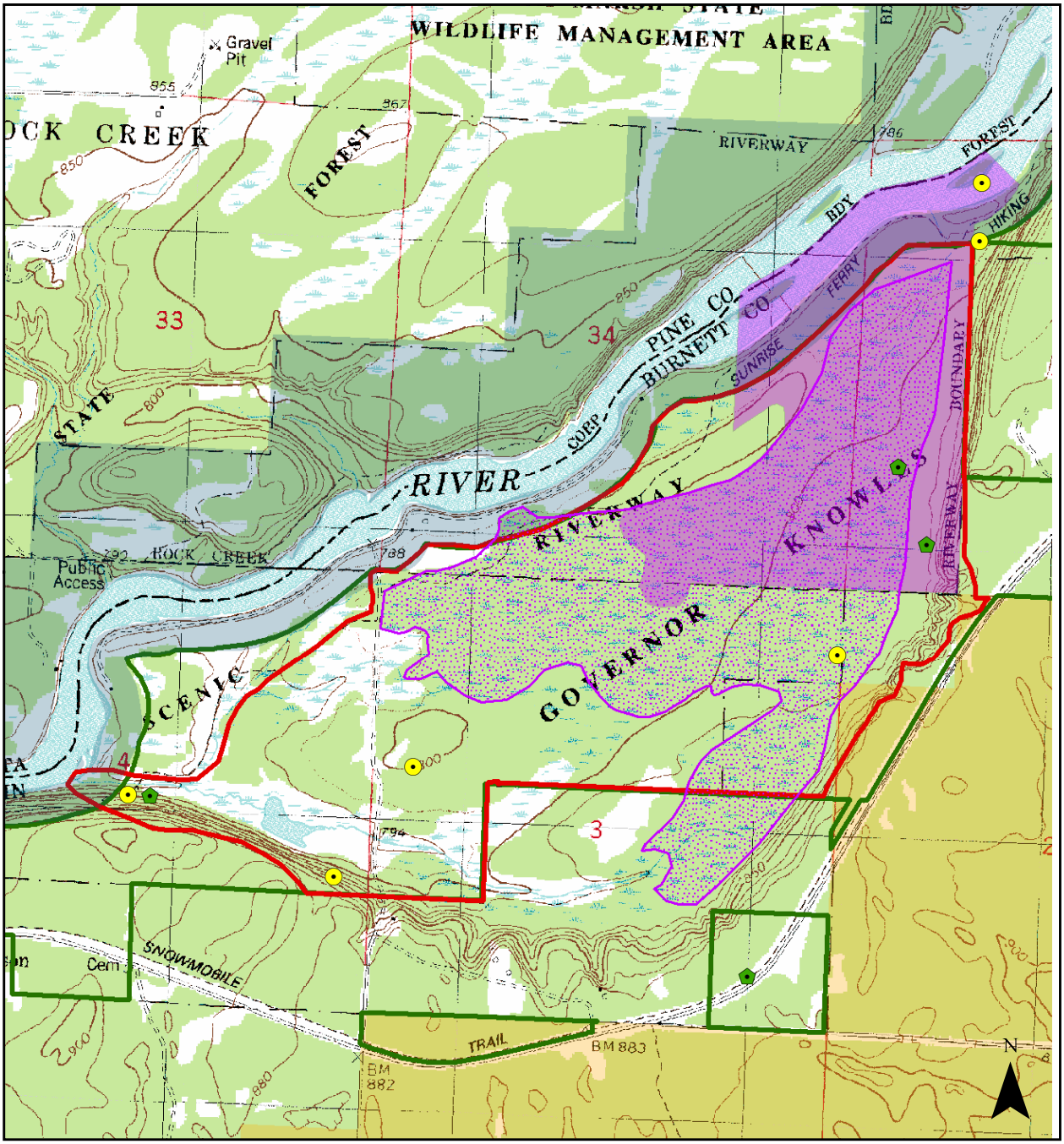
This site features a large, good-quality, contiguous example of a Hardwood Swamp community, as well as several other natural community types. It harbors several rare species, including a State Threatened plant and a State Threatened bird, along with several other Special Concern species. There are numerous high-quality microsites providing diverse habitats near the escarpment.

Management Considerations

The current SNA boundaries follow political, rather than ecological, boundaries. The ecological features for which these SNAs were identified extend beyond the existing boundaries. As part of the master planning process, all of these boundaries should be evaluated. The SNA boundary for this site cuts across an intact high-quality wetland, and there are several natural community types outside of the existing SNA including small areas of Northern Mesic Forest, Tamarack Swamp, Alder Thicket, and Northern Sedge Meadow.

Governor Knowles State Forest

GK10. St Croix Ash Swamp



Legend Disclaimer:

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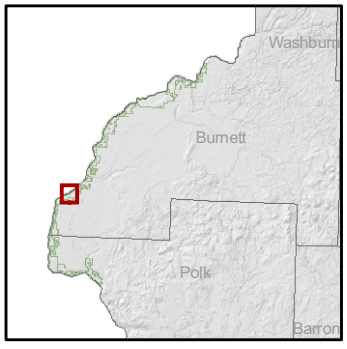
The Primary Site boundary is approximate, and it should be used only generally, not literally, for management purposes.

Surveys were conducted between 2007-2009 for natural communities and priority taxa. The surveys were not comprehensive for all taxa potentially present.

Ownership shown is approximate and only meant to illustrate the site locations.

1:22,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK11. ST. CROIX SEEPS

Location

County:	Burnett
USGS 7.5' Quadrangle:	Randall, Rush City
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	576

Description of Site

Narrow (in most places 0.25-miles or less wide) and linear in shape, this site includes the St. Croix Seeps State Natural Area and the adjacent escarpment and some uplands. The SNA is managed by the National Park Service and was designated in 2002 to protect high-quality natural communities and rare species habitats located along a four-mile stretch of the St. Croix River. The river terrace here is very narrow, and numerous seeps and spring runs emanate from the lower slopes of the steep, west-facing bluff. This area supports a high quality black ash seepage swamp with yellow birch and red maple. The steep slope is forested with a diverse mix of mature to old-growth trees, and white and red pine are frequent on the upper slope and crest.

The primary site boundary extends the existing SNA east to the current Wilderness Area boundary. This part of the site is comprised of dry and dry-mesic forest remnants above the St. Croix Valley bluff line and provides an ecologically important buffer to St. Croix Seeps State Natural Area. The quality of the forest varies here due to various natural and anthropogenic disturbances.

Significance of Site

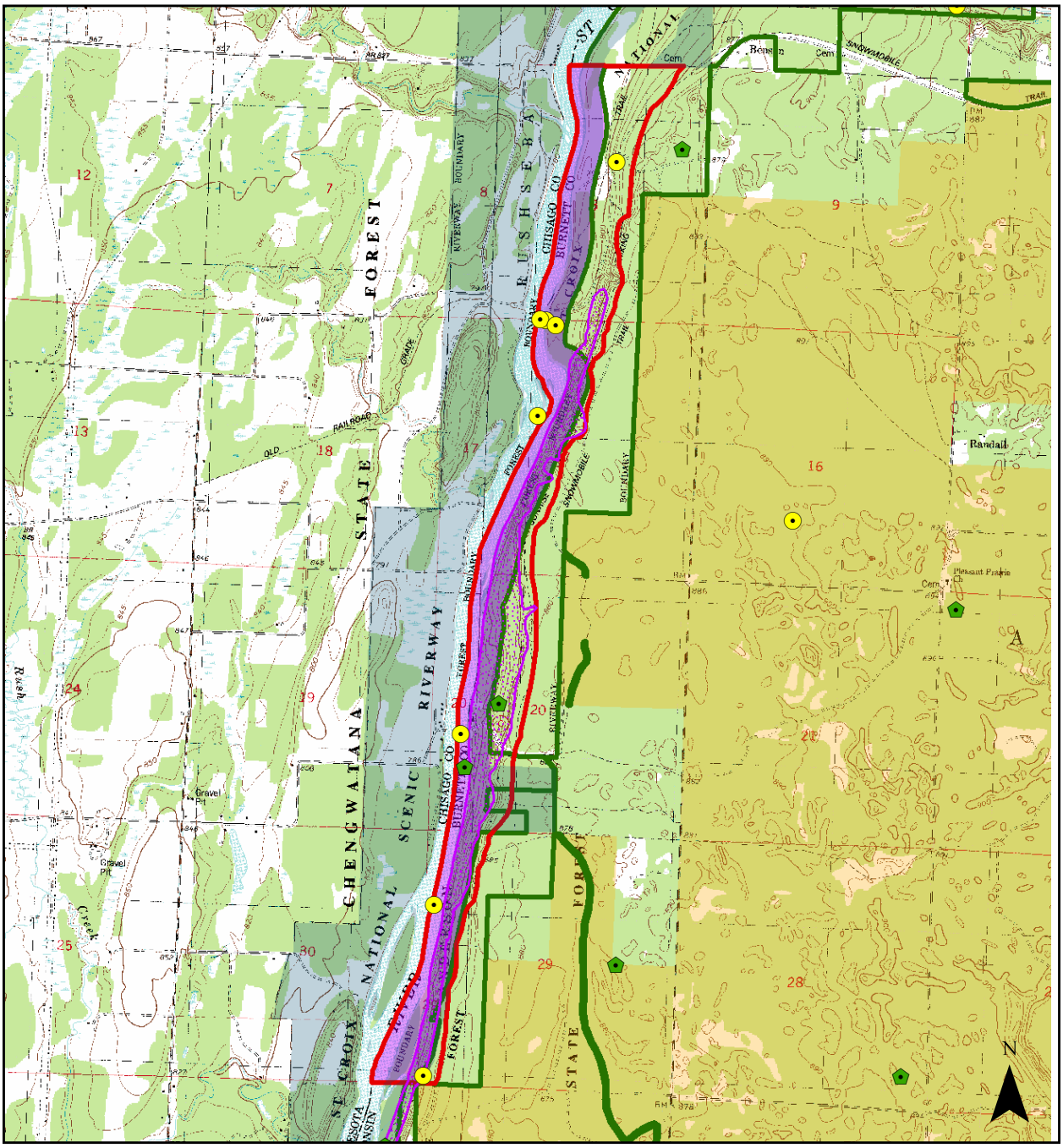
This is one of the most diverse areas known along the St. Croix National Scenic Riverway for rare species, with adundant specialized habitats including the numerous seepage runs incised in the slope that occur approximately every 100 meters. Rare animals include two birds near the northern edges of their ranges. At least three rare plants are known from the site. This stretch of the St. Croix River is known to provide important habitat for several rare aquatic animals.

Management Considerations

The current SNA boundaries follow political, rather than ecological, boundaries. The ecological features for which this SNA was identified extend beyond the existing boundaries. In addition, the SNA is very narrow, and areas outside of the SNA can provide important buffers to the high quality natural communities and rare species habitats within the SNA. As part of the master planning process, all of these boundaries should be evaluated. As with many other parts of the GKSF, care may be needed when conducting management activities near the edge of the slope; considerations include maintaining hydrology, as well as avoiding erosion, siltation, and increased light levels for sensitive species.

Governor Knowles State Forest

GK11. St. Croix Seeps



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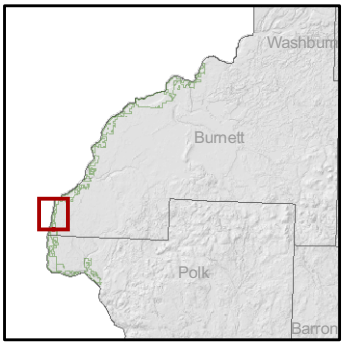
Ownership shown is approximate and only meant to illustrate the site locations.

1:40,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK12. LAGOO CREEK AND TERRACES

Location

County:	Polk, Burnett
USGS 7.5' Quadrangle:	Rush City
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	660

Description of Site

Located along both sides of the Burnett / Polk county line, this site is located within a wide terrrace on a former bend of the St. Croix River. The vegetation is a complex, interesting, and diverse mix making the forested communities difficult to characterize. The soils range from poorly drained wet alluvial soils to somewhat excessively drained sands in this large "bottomland." Several mucky inclusions are present, including some sizeable sedge meadows near Lagoo Creek. As with several GKSF sites, there are species typically associated with both northern and southern community types present. The escarpment extends beyond the property boundary in a few places.

Much of site's core is comprised of an unusual dry-mesic "bottomland" forest similar to the Sunrise Ferry (GK15) Primary Site. These areas are dominated by mature oak (typically bur oak, but red oak is sometimes present and Hill's oak can be found in the driest portions). Red maple, green and/or black ash, and mature aspen are common associates. The shrub and sapling layers are often very dense, with musclewood and ironwood the most common shrub species. Herb species are quite variable, depending on the location. There are a few small areas, mostly near the center of the site, dominated by mature (10-24") white and red pines.

Wetlands here include a fairly long but narrow Tamarack Swamp; sedge and bluejoint dominated sedge meadows near Lagoo Creek, as well as smaller areas near the north end of the site; numerous small wet inclusions; and seeps near the escarpment at the north end of the site.

Lagoo Creek, a fast coldwater stream, flows through the center of the site, mostly near the base of the escarpment and empties into the St. Croix River. Several ravines occur along the creek, and there are areas of maple and oak-dominated mesic forest interspersed with Forested Seeps along the steep northwest-facing bluff.

Significance of Site

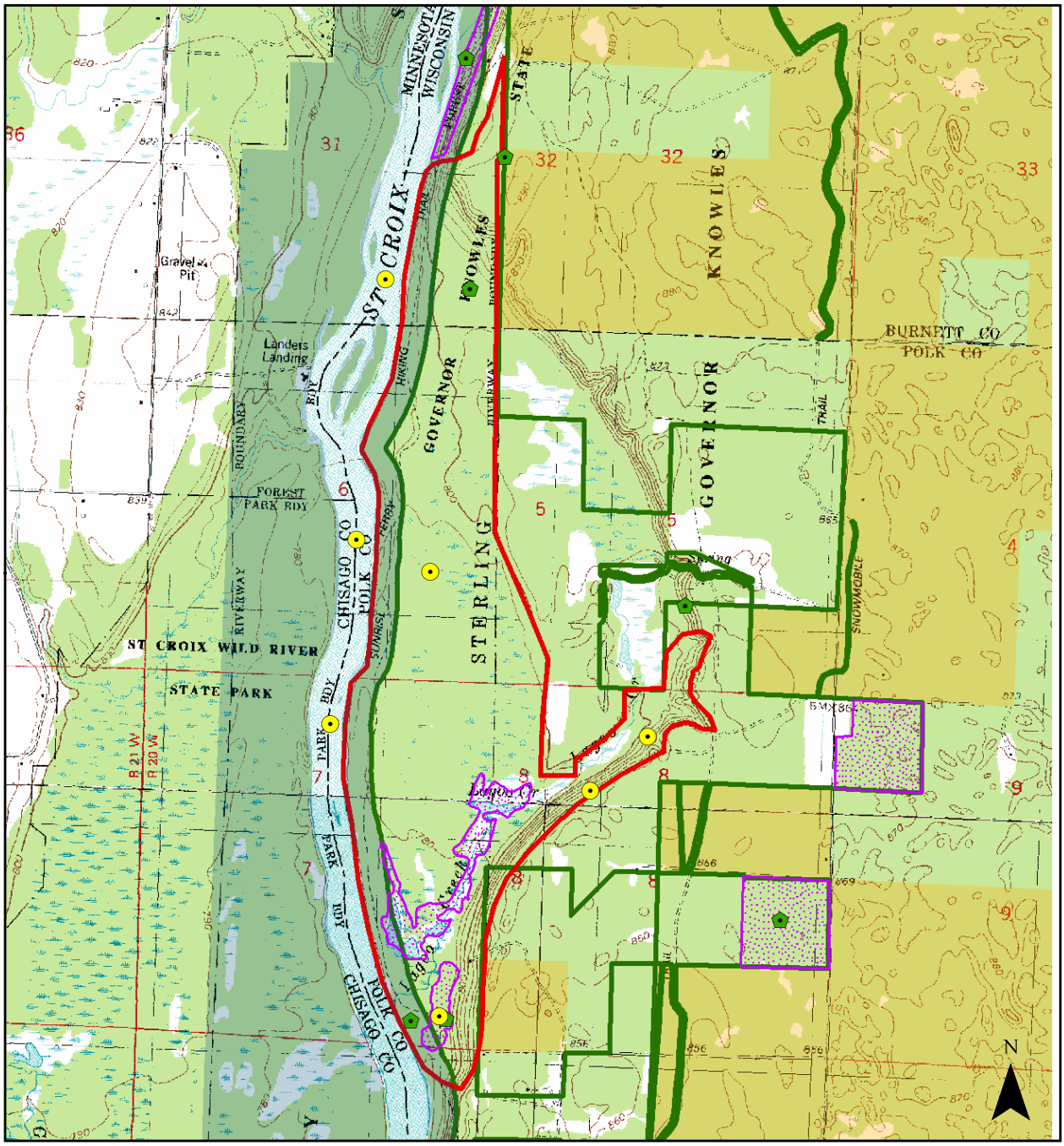
This relatively large forested area supports multiple pairs of the State Threatened Red-shouldered Hawk, and there are several other rare bird species present, especially near Lagoo Creek. Rare plants are known from the seeps, and there is potential for additional species. The site includes a fairly large example of an unusual forest type and might also be important for research, as these types are not well-understood.

Management Considerations

In addition to providing rare species habitat, this site provides an opportunity for developing a significant block of forest with old-growth attributes, a component lacking in most of the surrounding landscape, and important to uncommon forest interior birds such as Red Shouldered Hawks. Invasive plants have been documented in this area, including reed canary grass near Lagoo Creek, and scattered occurrences of common buckthorn near the river. The seeps warrant continued protection and are particularly susceptible to soil / hydrological disturbance. Several rare plants have the potential to occur in these areas, in addition to those already documented. Special care may also be needed when conducting management activities in the nearby uplands.

Governor Knowles State Forest

GK12. Lagoo Creek and Terraces



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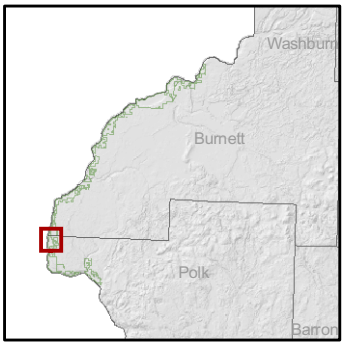
Ownership shown is approximate and only meant to illustrate the site locations.

1:28,986

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK13. LAGOO CREEK BARRENS

Location

County:	Polk
USGS 7.5' Quadrangle:	Sunrise
Landtype Association:	212Ka01. Grantsburg Dunes
Approximate Size (acres):	69

Description of Site

Located on flat outwash terrain, this site contains a small and isolated, but otherwise good quality, Pine Barrens remnant with a diverse, intact ground layer flora. The species assemblage differs from Sterling Barrens SNA (GK16) because, in addition to the diverse set of species found in the more open barrens examples on the property, there are species associated with the partial shade formed by the scattered trees present. Jack pine is the dominant tree species, along with scattered red pine and Hill's oak. The site is surrounded on three sides by Polk County Forest. Much of the nearby areas have been bulldozed and/or converted to pine plantations on.

Significance of Site

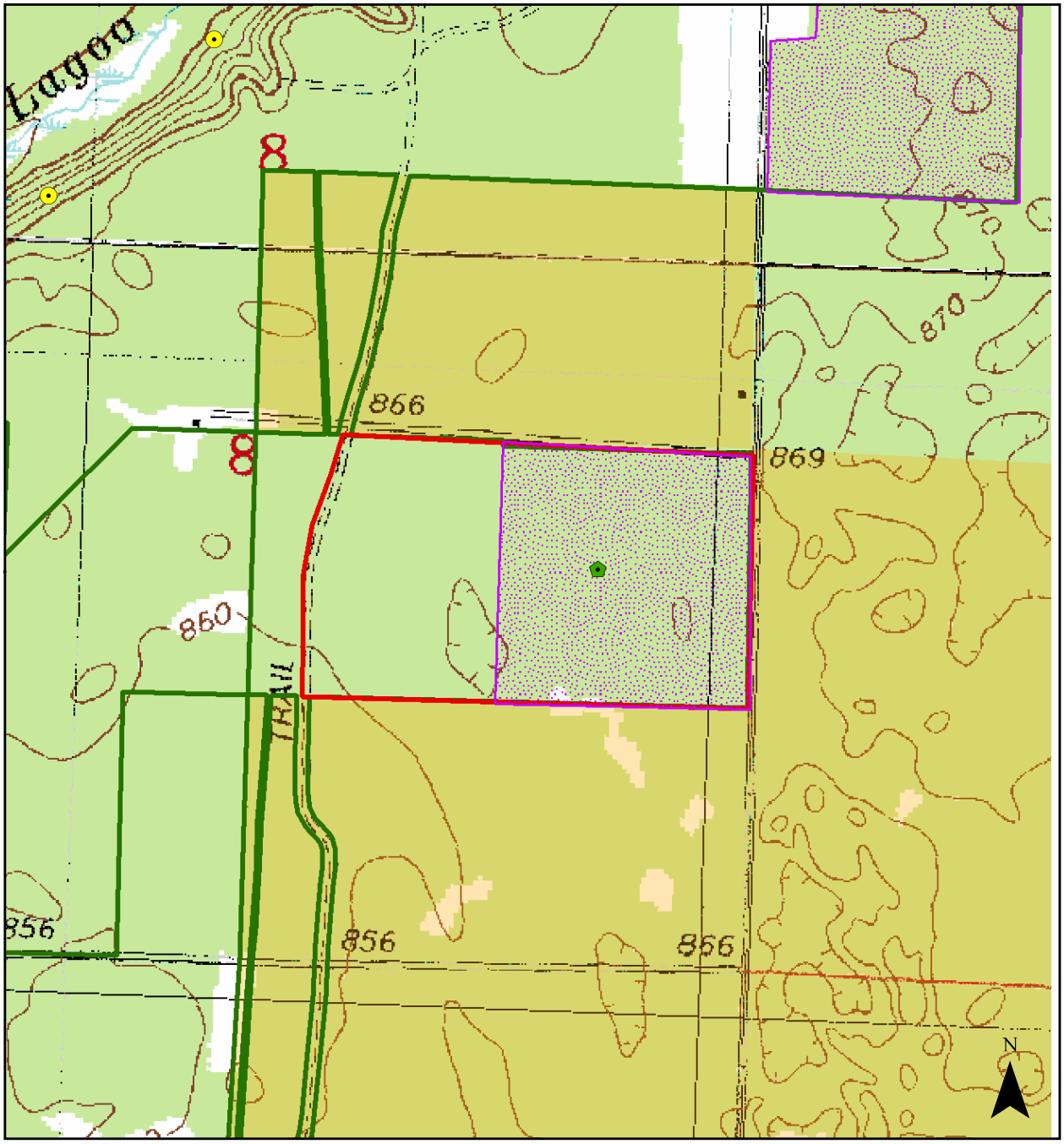
Although small and isolated, this barrens remnant is floristically the best of its kind documented on the GKSF. Plant species diversity here is high, and there is at least one rare plant present.

Management Considerations

This site offers an opportunity to restore a small but relatively undisturbed Pine Barrens , while providing a reference area for this globally rare type and educational opportunities for GKSF visitors. Expansion of the site would likely be difficult due to the surrounding vegetation, but the opportunities could be evaluated. A fairly large patch of cypress spurge is present at this site. Control of this species should be a priority in order to prevent its spread to adjacent habitat.

Governor Knowles State Forest

GK13. Lagoo Creek Barrens



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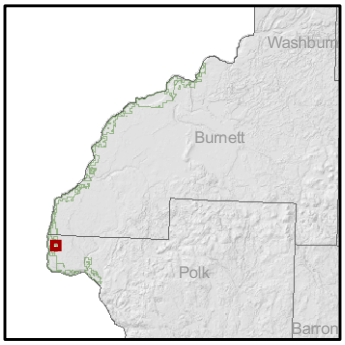
1:10,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK14. TRADE RIVER AND FOREST

Location

County:	Polk
USGS 7.5' Quadrangle:	Sunrise
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	421

Description of Site

Surrounding the Trade River near the southern end of the forest, this site has an excellent diversity of landforms and habitats. The Trade River is the largest tributary of the St. Croix River in the GKSF. Numerous high-quality Forested Seeps feed cold water into the stream in its lower reaches. Embedded within the complex of Forested Seeps are inclusions of saturated Hardwood Swamps and pockets of mesic forest on bends in the river.

Most of the site is forest with diverse community types including unusual examples of Southern Mesic Forest, in some cases dominated by bur oak and basswood over fairly rich mesic herbs. There is also good-quality Northern Dry-mesic Forest, as well as oak-dominated Northern Dry Forest with scattered jack pine on sandy soils near the bluffline. The southern boundary of the site adjoins the Sterling Barrens SNA; this portion of the SNA is mostly wetland and comprised of silver maple dominated Floodplain Forest with a very diverse herb layer in places, as well as Alder Thicket and sedge meadow inclusions. Horse trails running the length of the site from north-to-south are located just outside of the site boundary. There is a recently upgraded horse campground, picnic area, and stretch of trail within the site boundary at the north end of the site.

Significance of Site

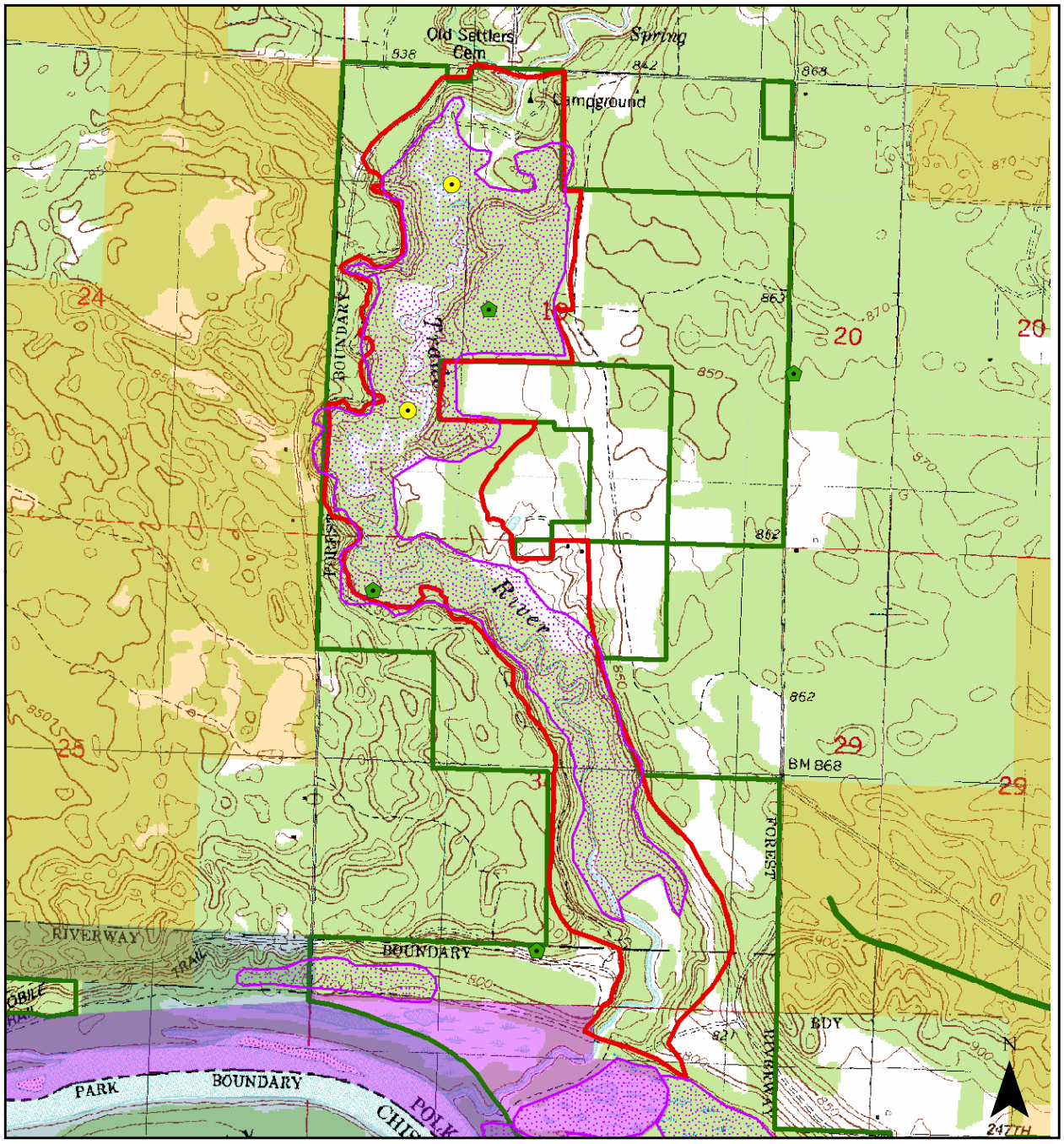
This site contains numerous good to high quality example of natural communities, including some unusual variants, and diverse habitats for numerous rare species. Rare plants include bog bluegrass and Assiniboine sedge. This area exhibits the highest bird species richness of any site surveyed on the GKSF and includes two state Threatened birds and numerous bird SGCN.

Management Considerations

This area warrants consideration for special management designation in the upcoming master plan because it contains several ecologically important attributes, including a unique mix of northern and southern forest types and habitat for uncommon species of plants and animals . The site adjoins the Sterling Barrens SNA where the boundary seems artificial and should be evaluated on an ecological basis during planning. The horse trails are badly eroded in places due to sandy soils and their location near the erodable bluffline. In some areas, trails are washing down into the seepage areas. Trail locations and condition should be evaluated to protect the ecological integrity of the site. The boundary of this site will require evaluation due to the presence of the horse campground and related use areas.

Governor Knowles State Forest

GK14. Trade River and Forest



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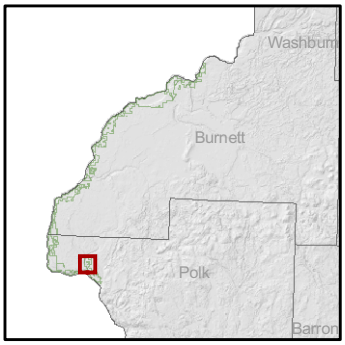
1:22,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK15. SUNRISE FERRY

Location

County:	Polk
USGS 7.5' Quadrangle:	North Branch, Sunrise
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	860

Description of Site

Located between Evergreen Avenue and Sunrise Landing, this site surrounds a large acreage of mature forest along the terraces and in the fairly level "bottomlands" of the St Croix River. The forest includes various natural community types with a wide variety of species and several interesting microsites.

The northern portion of this site includes a long, narrow, mid-elevation terrace with mature mesic and dry-mesic forest. Here the forest ranges from white pine dominated areas near the north end to drier Hill's oak dominated areas. Bur oak occurs sporadically and is co-dominant with ash and basswood in places. Some areas contain sugar maple in the overstory. Trees are typically 10-15" in diameter and much larger (i.e. 20-24") in many areas. The understory often contains typical dry-mesic herbs, although species associated with richer/moister habitats (e.g., maidenhair fern) are found in pockets. Numerous seeps and some slightly larger streams flow downslope toward the river, providing many important microsites and rare species habitats.

The southern portion, comprising the bulk of the site, contains an extensive mostly oak-dominated forest on sandy loam soils derived from outwash. Interspersed in this area are numerous mucky wetland openings, and there are many small forested wetlands dotted throughout the area, including Hardwood Swamp. Much of the area is comprised of an unusual dry-mesic forest variant with bur oak, basswood, and green ash dominant, along with many canopy and sub-canopy associates such as red, white, and northern pin oak, bitternut hickory, black ash, white pine, black cherry, hackberry, red maple, bigtooth aspen, and paper birch. Tree diameters are often 12" and greater. Although often dry, the soils appear to be periodically saturated in many areas. A one-mile long open wetland is dominated by broad and narrow-leaved sedges along with bluejoint grass and areas of Alder Thicket

Significance of Site

In addition to containing diverse habitats and excellent microsites, this is one of few Primary Sites with large blocks of older forest. Several bird SGCN were documented here during the biotic inventory, including one State Threatened bird and a Special Concern warbler at the northernmost end of its range. One rare plant associated with the seepy areas of the site was documented here, and there is potential for others.

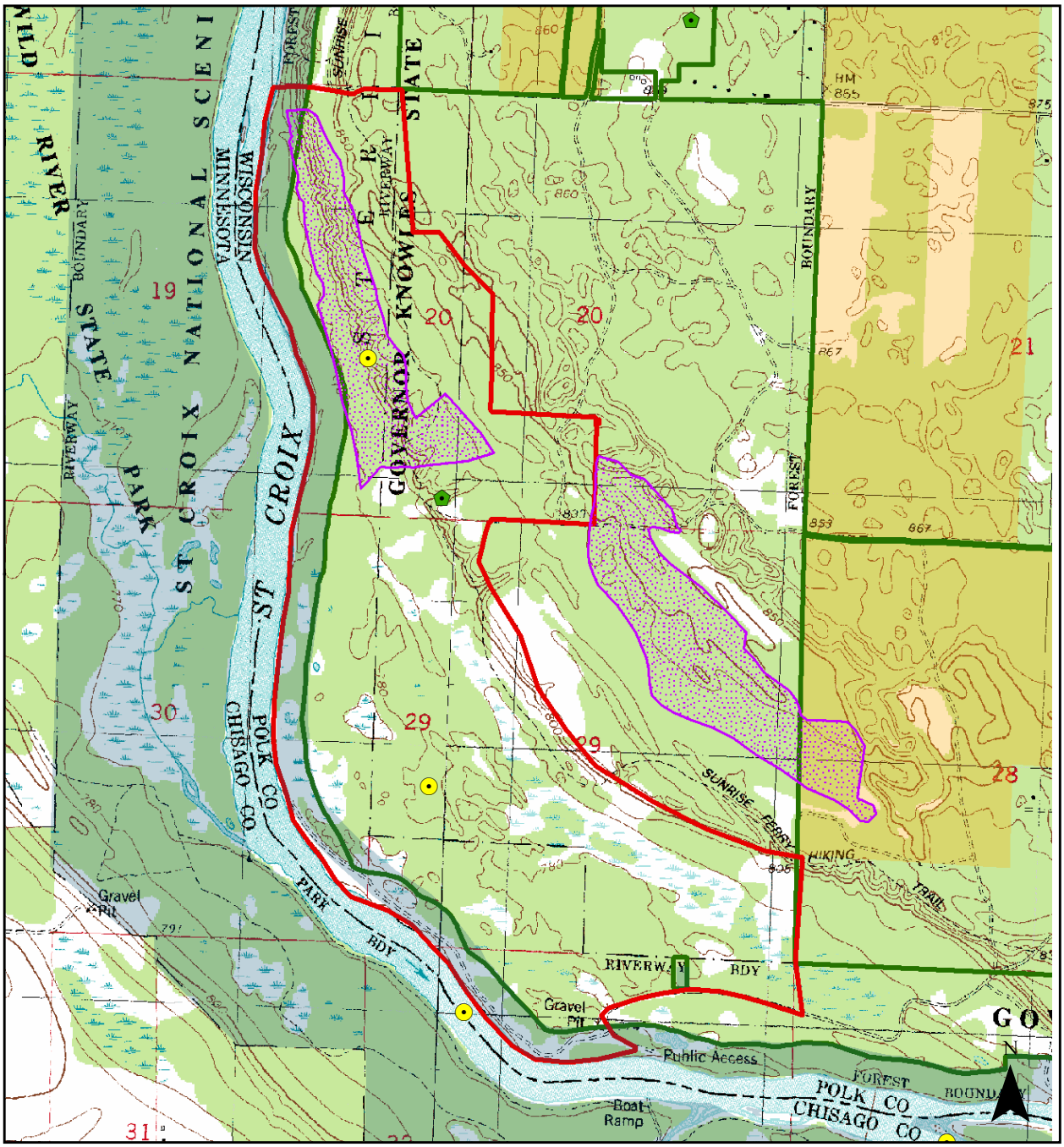
Management Considerations

This site should be considered for special designation. In addition to providing rare species habitat, it provides an opportunity for developing a significant block of old-growth forest, a component lacking in most of the surriounding landscape.

Invasive plants have been documented in this area, including reed canary grass. The most pressing invasive plant threats are common buckthorn present near Sunrise Ferry Road, and several populations of garlic mustard on adjacent National Park Service land. Both of these species present a significant threat to the timber resources and biodiversity of the State Forest. Priority should be given to controlling their spread.

Governor Knowles State Forest

GK15. Sunrise Ferry



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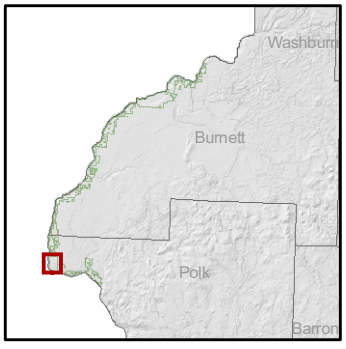
1:24,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



GK16. STERLING BARRENS

Location

County:	Polk
USGS 7.5' Quadrangle:	Cushing, Sunrise
Landtype Association:	212Ka01. Grantsburg Dunes, 212Kb18. St. Croix Plains
Approximate Size (acres):	1224

Description of Site

Located at the southern end of the forest, this site includes a wide variety of high-quality natural communities along a five-mile stretch of the St. Croix River. The Sterling Barrens SNA makes up much of the site. The SNA includes 124 acres of state managed land orginally designated in 1974 to protect a matrix of dry forest and barrens, as well as numerous rare plants and animals. The adjacent National Park Service land, a narrow (700-900 feet) strip located along the river, was added to the SNA in 2002. This primary site includes both of these areas, as well as adjacent barrens and wetland habitats.

Sterling Township contains numerous oak and pine barrens remnants. The structure and composition of these remnants varies greatly based on past and current management. The largest, most contiguous barrens area within this site is located within sections 34 and 35 and includes a portion of the existing SNA and adjacent areas to the east. The SNA portion of the barrens have been managed for a very open structure with only a few tall standing trees remaining; some areas have tall brush with prairie openings. The adjacent area outside of the SNA contains more bur oak, Hill's oak, and jack pine trees in and around the prairie openings. This area maintains a high quality Oak Barrens structure.

Silver maple-dominated Floodplain Forest comprises much of the area near the river, sometimes with bur oak, green ash, and basswood, similar to many portions of the park service land adjoining the GKSF. The Floodplain Forest contains inclusions with a diverse groundflora and herbs associated with-nutrient rich habitats (e.g., bloodroot, wild leeks, wild ginger, Virginia waterleaf).

A large wetland complex occupies a broad bottomland area comprising the portion of the site east of the Trade River outlet. Here, a mature, closed-canopy Hardwood Swamp dominated by 12-18" dbh black ash, yellow birch, silver maple grades into an extensive sedge-meadow / shrub swamp complex. The wetland continues to the east beyond the site boundary where it becomes dominated by reed canary grass. East of Wolf Creek (outside of the site proper) there is also a spring with sand bottom flowage channels and at least one rare plant.

Note: the boundary for this site should be evaluated. The area comprising T36N R20W, N1/2 S34 likely contains similar and/or compatible characteristics.

Significance of Site

There are numerous ecologically important attributes here including the best barrens / sand prairie examples on the GKSF, mature Hardwood Swamp, the largest non-forested wetland communities on the Forest, Floodplain Forest with unusual species-rich inclusions, and numerous rare species. Rare plants were documented in several locations throughout the barrens portion of the site, as well as areas just north on both GKSF and Polk County lands, some of them near the north and/or eastern edges of their ranges.

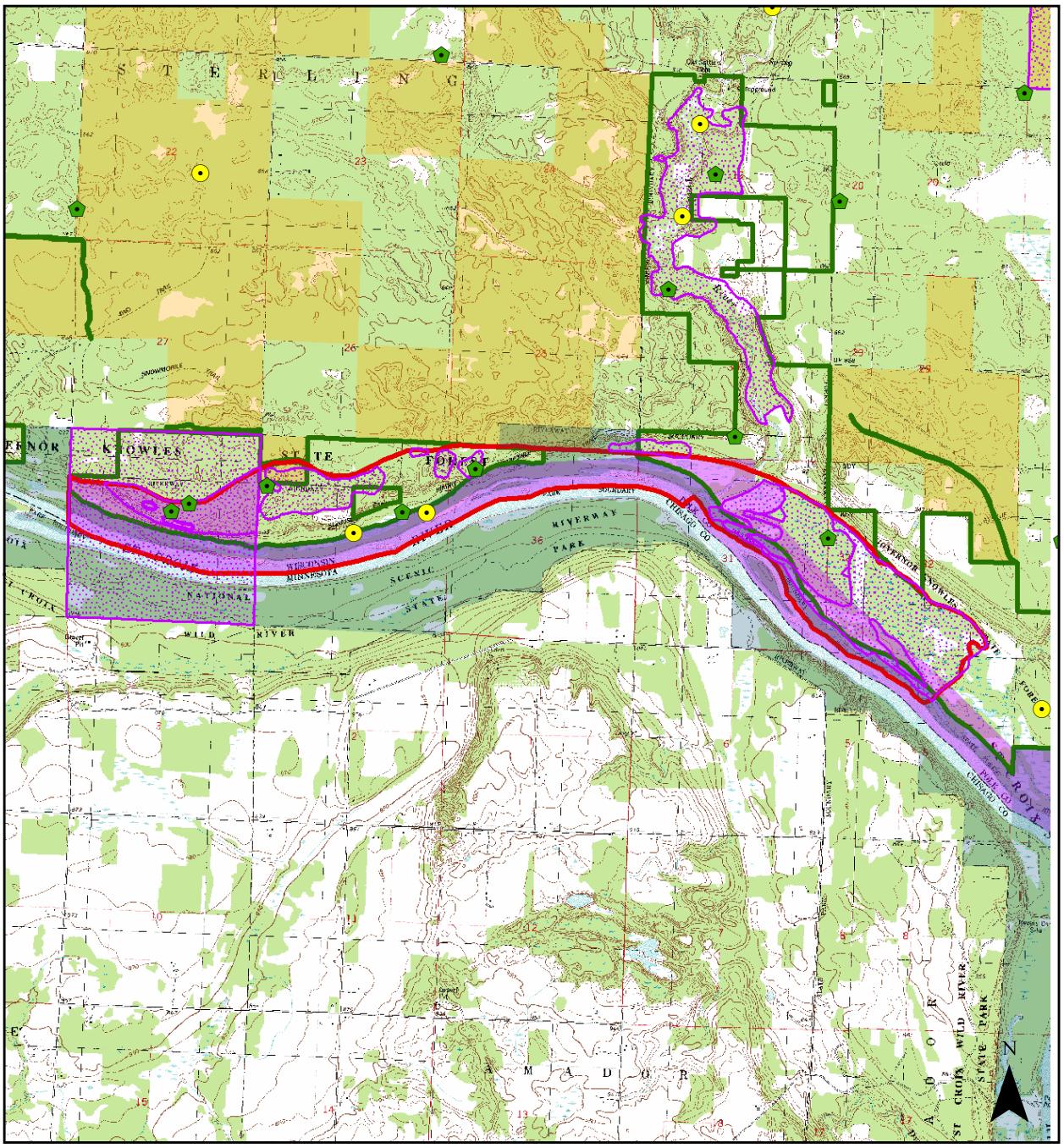
Management Considerations

The current SNA boundaries on the GKSF portion of the site date back to the late 1970s and follow political, rather than ecological, boundaries. These boundaries should be evaluated, including consideration for both the barrens remnants currently outside of the SNA, as well as the large wetlands. The species composition and stucture of the barrens within the current SNA should be evaluated. The area outside of the SNA contains oak savanna structure with excellent restoration potential and opportunities to keep many of the large oaks.

Sterling Township barrens outside of the GKSF have excellent potential for management. There are opportunities to partner with nearby land managers to consider the rare flora and fauna during planning and management activities. In particular, opportunities exist to tailor site preparation and retain partial open canopy, where feasible and appropriate, to preserve rare species habitats and high-quality natural community remnants. Fire, as a management tool, is needed to maintain these communities.

Invasives are a significant threat here. Spotted knapweed has been observed in the dry barrens / prairie areas. Reed canary grass is abundant in some of the wetland areas near the streams, and a large portion of the wetland near Wolf Creek (including the spring east of the creek) was excluded from the site boundary because of a heavy and extensive reed canary grass infestation. Several populations of garlic mustard are known from the floodplain forest adjacent to the river.

GK16. Sterling Barrens



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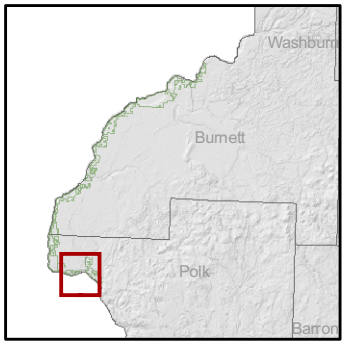
1:54,000

- Animal EO
- Plant EO
- Community EO
- Primary Sites
- GKSF Boundary
- State Natural Areas
- County Land
- Scenic Riverway: other ownerships



APPENDIX C

Wisconsin Natural Heritage Working List Description

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. Most of the species and natural communities on the list are actively tracked and we encourage data submissions on these species. This list is meant to be dynamic - it is updated as often as new information regarding the biological status of species becomes available. See the Endangered Resources Program web site for the most recent Natural Heritage Inventory Working List (http://dnr.wi.gov/org/land/er/wlist/).

Working List Key

Scientific Name: Scientific name used by the Wisconsin Natural Heritage Inventory Program.

Common Name: Standard, contrived, or agreed upon common names.

Global Rank: Global element rank. See the rank definitions below.

State Rank: State element rank. See the rank definitions below.

US Status: Federal protection status in Wisconsin, designated by the Office of Endangered Species, U.S. Fish and Wildlife Service through the U.S. Endangered Species Act. LE = listed endangered; LT = listed threatened; XN = non-essential experimental population(s); LT,PD = listed threatened, proposed for de-listing; C = candidate for future listing.

WI Status: Protection category designated by the Wisconsin DNR. END = endangered; THR = threatened; SC = Special Concern.

WDNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are SC/P = fully protected; SC/N = no laws regulating use, possession, or harvesting; SC/H = take regulated by establishment of open closed seasons; SC/FL = federally protected as endangered or threatened, but not so designated by WDNR; SC/M = fully protected by federal and state laws under the Migratory Bird Act.

Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Global & State Element Rank Definitions

Global Element Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factors making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = Apparently globally secure, though it may be quite rare in parts of its range, especially at the periphery.

G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GH = Of historical occurrence throughout its range, i.e., formerly part of the established biota, with the expectation that it may be rediscovered.

GU = Possibly in peril range-wide, but their status is uncertain. More information is needed.

GX = Believed to be extinct throughout its range (e.g. Passenger pigeon) with virtually no likelihood that it will be rediscovered.

G? = Not ranked.

Species with a questionable taxonomic assignment are given a "Q" after the global rank.

Subspecies and varieties are given subranks composed of the letter "T" plus a number or letter. The definition of the second character of the subrank parallels that of the full global rank. (Examples: a rare subspecies of a rare species is ranked G1T1; a rare subspecies of a common species is ranked G5T1.)

State Element Ranks

S1 = Critically imperiled in Wisconsin because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in Wisconsin because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3 = Rare or uncommon in Wisconsin (21 to 100 occurrences).

S4 = Apparently secure in Wisconsin, with many occurrences.

S5 = Demonstrably secure in Wisconsin and essentially ineradicable under present conditions.

SA = Accidental (occurring only once or a few times) or casual (occurring more regularly although not every year); a few of these species (typically long-distance migrants such as some birds and butterflies) may have even bred on one or more of the occasions when they were recorded.

SE = An exotic established in the state; may be native elsewhere in North America.

SH = Of historical occurrence in Wisconsin, perhaps having not been verified in the past 20 years, and suspected to be still extant. Naturally, an element would become SH without such a 20-year delay if the only known occurrence were destroyed or if it had been extensively and unsuccessfully looked for.

SN = Regularly occurring, usually migratory and typically non-breeding species for which no significant or effective habitat conservation measures can be taken in Wisconsin. This category includes migratory birds and bats that pass through twice a year or, may remain in the winter (or, in a few cases, the summer) along with certain lepidoptera which regularly migrate to Wisconsin where they reproduce, but then completely die out every year with no return migration. Species in this category are so widely and unreliably distributed during migration or in winter that no small set of sites could be set aside with the hope of significantly furthering their conservation.

SZ = Not of significant conservation concern in Wisconsin, invariably because there are no definable occurrences in the state, although the taxon is native and appears regularly in the state. An SZ rank will generally be used for long-distance migrants whose occurrence during their migrations are too irregular (in terms of repeated visitation to the same locations), transitory, and dispersed to be reliably identified, mapped, and protected. Typically, the SZ rank applies to a non-breeding population.

SR = Reported from Wisconsin, but without persuasive documentation which would provide a basis for either accepting or rejecting the report. Some of these are very recent discoveries for which the program hasn't yet received first-hand information; others are old, obscure reports that are hard to dismiss because the habitat is now destroyed.

SRF = Reported falsely (in error) from Wisconsin but this error is persisting in the literature.

SU = Possibly in peril in the state, but their status is uncertain. More information is needed.

SX = Apparently extirpated from the state.

State Ranking of Long-Distance Migrant Animals:

Ranking long distance aerial migrant animals presents special problems relating to the fact that their non-breeding status (rank) may be quite different from their breeding status, if any, in Wisconsin. In other words, the conservation needs of these taxa may vary between seasons. In order to present a less ambiguous picture of a migrant's status, it is necessary to specify whether the rank refers to the breeding (B) or non-breeding (N) status of the taxon in question. (e.g. S2B,S5N).