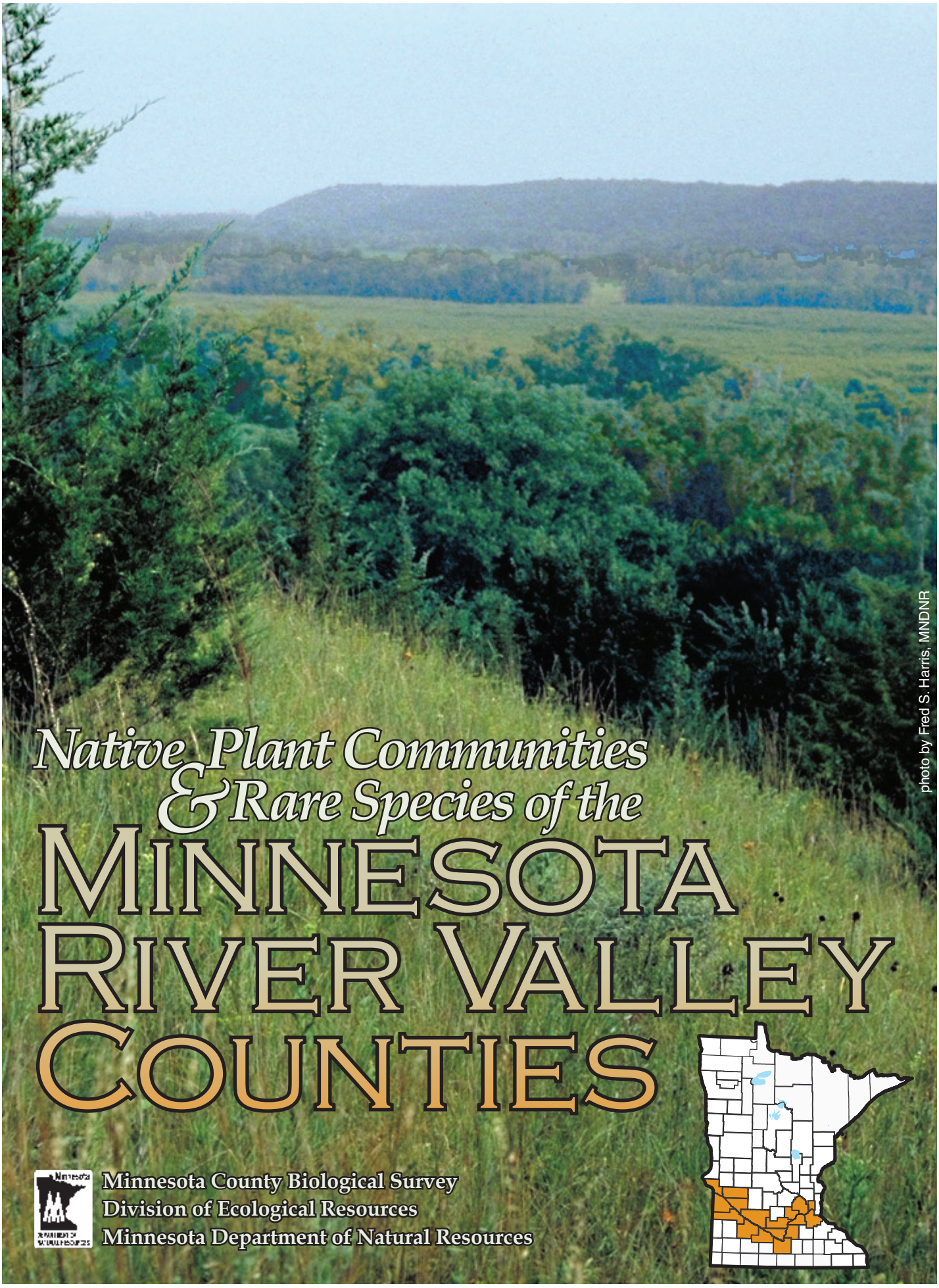


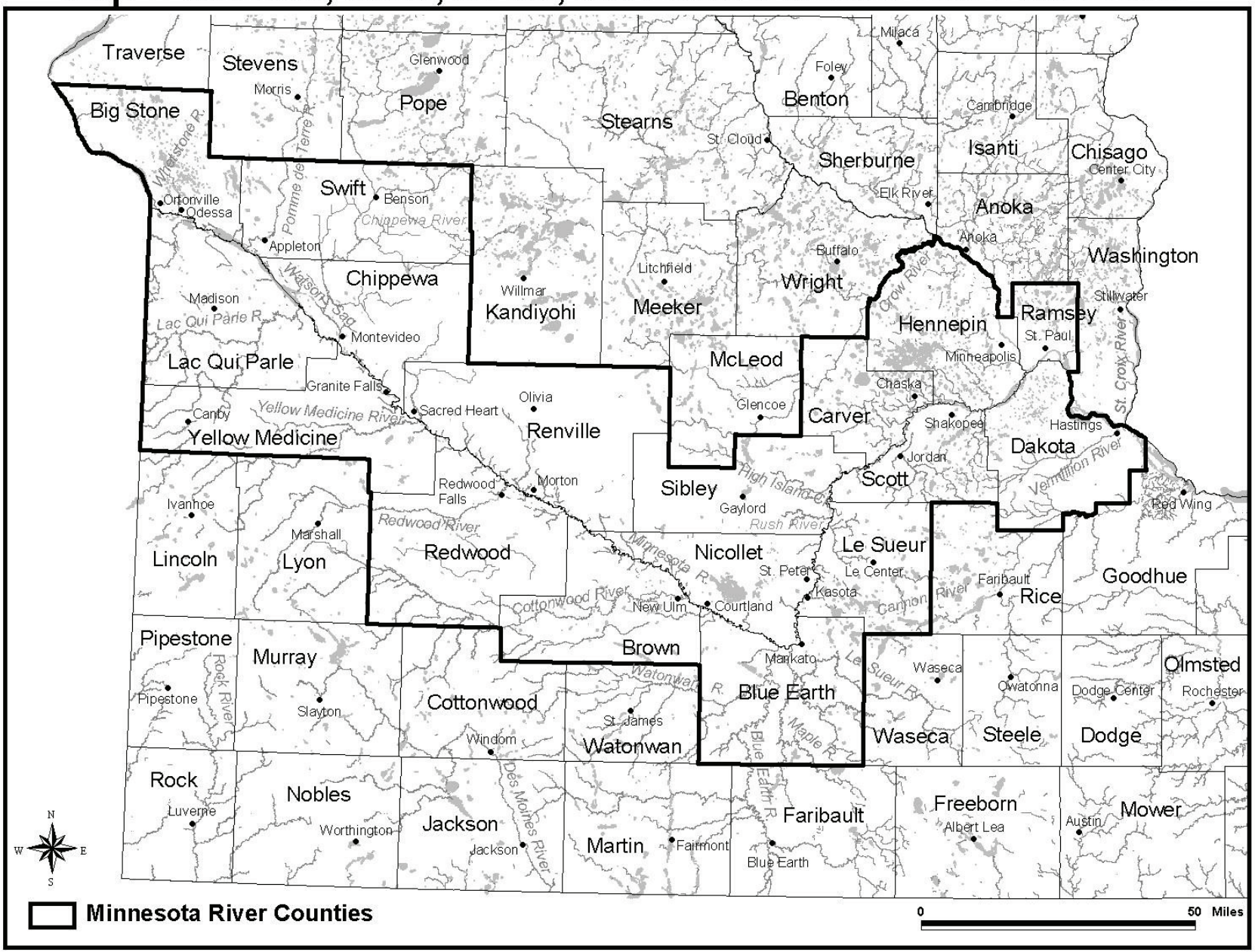
Native Plant Communities & Rare Species of the

Minnesota River Valley Counties

Minnesota County Biological Survey
Division of Ecological Resources
Minnesota Department of Natural Resources

photo by Fred S. Harris, MNDNR

Map 1: Counties, Cities, Rivers, and Lakes in Southwestern Minnesota



Native Plant Communities and Rare Species

of

The Minnesota River Valley Counties

September 2007

Minnesota County Biological Survey
Division of Ecological Resources
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Biological Report No. 89

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Summary

Clearly visible on statewide relief maps, the Minnesota River valley and its major tributaries form a deep, branching trough cutting across south-central and western Minnesota through nearly level to rolling plains and moraines. Most of this region's native habitats that existed prior to Euro-American settlement have been cultivated. Today, the valley's steep topography and associated gravelly or rocky terraces contains a large proportion of the region's remaining native plant communities, plants, and wildlife.

This report collates and summarizes the results of the Minnesota County Biological Survey (MCBS) in 17 counties bordering the Minnesota River. MCBS, a program of the Minnesota Department of Natural Resources (MNDNR), surveyed native plant communities and rare plant and animal species in the region between 1987 and 2000.

This report includes summaries of the region's vegetation at the time of Euro-American settlement, survey methodology, remaining native plant communities, and rare plants and animals. Additional contributions to the report include an overview of the region's geology, written by a geologist of the Minnesota Geological Survey, and reports on surveys of fish and freshwater mussels in the Minnesota River, written by biologists of the MNDNR's Division of Ecological Resources. Appendices to the report include checklists of plants and rare animals documented prior to and since MCBS has conducted surveys.

Two series of maps accompany this report (see CD inside back cover), each of which consists of 5 maps corresponding to groups of counties located along different segments of the Minnesota River. The first series depicts the locations of native plant communities and rare species documented by MCBS; the second series depicts all the sites surveyed by MCBS ranked according to statewide significance for biological diversity. The native plant community and biological diversity map polygons can also be obtained from the MNDNR's GIS "Data Deli" at http://deli.mndnr.gov. The CD accompanying this report also includes a full-color version of the report.

Acknowledgements

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Carmen Converse, MCBS Supervisor, organized and provided guidance for the field surveys and the writing of this report. Stacy Olszewski prepared the plant checklist. Daniel Tix and Kristen Sehr, of Great River Greening, assisted with portions of the report writing and map production. Richel Burkey-Harris, Robert Dana, John Schladweiler, Nancy Sather, Hannah Texler, Mike Davis, Tim Whitfeld, and Jan Wolff reviewed and commented on portions of early or final drafts of this report. Individuals who generously allowed us to use their photos include: Larry Allain, Patrick Beauzay, Chuck Buer, David Cahlander, John Haarstad, Anthony Hertzel, Tom Jessen, and Mark "Sparky" Stensaas.

Many individuals contributed to the surveys for rare animals, plants, and native plant communities in the Minnesota River valley counties. The field survey staff worked tirelessly in search of the target species and native plant communities. The data management staff, including many student workers, compiled the information into databases and provided expertise and guidance. The knowledge gained from their collective effort now guides conservation actions to protect significant native plant communities and our rarest animals and plants. We thank them all and list them below.

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1. Introduction and Methods

INTRODUCTION

The Minnesota County Biological Survey (MCBS) began in 1987 as a systematic survey of Minnesota's rare biological features. MCBS identifies significant natural areas and collects and interprets data on the distribution and ecology of native plant communities, rare plants, and rare animals. The information gathered by MCBS serves as a foundation for the conservation of critical components of Minnesota's biological diversity.

Biological surveys of the Minnesota River valley counties began in Lac Qui Parle and Big Stone counties at the advent of the County Biological Survey in 1987. The remaining counties were completed in 1990 through 2000, starting with Ramsey County (Table 1.1).

Table 1.1: *Years for MCBS Survey Completion in the Minnesota River Valley Counties.*

County	MCBS Survey Completion
Ramsey	1990
Hennepin	1997
Dakota	1994
Scott	1997
Carver	1997
Sibley	1998
Nicollet	1999
Le Sueur	1997
Blue Earth	1999
Brown	1999
Renville	1999
Redwood	1999
Yellow Medicine	2000
Chippewa	1999
Swift	1999
Lac Qui Parle	1988
Big Stone	1988

This report is a summary of survey findings by the MCBS of the natural features within the Minnesota River valley and adjacent counties. Guest sections on rare fish and freshwater mussel surveys conducted by other Division of Ecological Resources staff within the Minnesota Department of Natural Resources are also included because of their high significance in the Minnesota River region. The report documents the locations of rare biological features and sensitive habitats and provides baseline information useful for natural history interpretation, management, monitoring, and research related to the natural history of the Minnesota River valley.

Additional information about many of the rare features described in this report can be found in the books *Minnesota's Endangered Flora and Fauna* (Coffin and Pfannmuller 1988), and *Minnesota's St. Croix River Valley and Anoka Sandplain: A Guide to Native Habitats* (Wovcha et al. 1995), as well as in Wheeler et al. (1991). Also, a new guide to the rare species of Minnesota will be appearing on the Minnesota Department of Natural Resources website in 2007 or 2008. More information about MCBS is available on the MNDNR's website at http://www.mndnr.gov/eco/mcbs/index.html.

METHODS

Native Plant Communities

Native plant communities are groups of native plants that interact with each other and the surrounding environment in ways not greatly altered by humans or introduced plant or animal species. These groups form recognizable units, such as a mesic prairie or oak forest, that tend to repeat across the landscape and over time. They may be classified and described by considering vegetation, successional status, topography, hydrology, landforms, substrates, soils, and natural disturbance regimes (including wildfires, windstorms, normal flood cycles, and the effects of native pathogens, insects, and microorganisms).

The MCBS conducted surveys of native plant communities in the Minnesota River counties between 1987 and 2000. Prior to 1991, native plant communities within the region were initially located using 1:65,000 color infra-red photography from 1982 (National Aeronautics and Space Administration, Ames Research Center), or 1:58,000 color

infra-red photography from 1984 (National High Altitude Photography Program, U.S. Geological Survey, U.S. Department of the Interior). After 1991, native plant communities within the existing boundaries of the 17 Minnesota River counties were initially located using stereo pairs from April or May 1991 photos from the National Air Photography Program, 1:40,000 scale. Within the Twin Cities Metropolitan region, additional areas were located using October 1994 color infra-red photos from the MNDNR Division of Forestry, 1:15,840 scale. Other sources of information consulted to map and describe native plant communities included the Minnesota Soil Atlas (Harms and Rust 1973, Harms et al. 1981), The Original Vegetation of Minnesota (Marschner 1974), county soil surveys, the Natural Heritage Information System (NHIS) Rare Features Database (MNDNR Division of Ecological Resources), and Minnesota's Ecological Classification System (MNDNR 2007b). Using these sources, initial boundaries of native plant communities in the Minnesota River counties were identified and transcribed onto 7.5 minute topographic maps.

Field visits to evaluate areas located in air photos were made by the MCBS plant ecologists and botanists. Native plant communities were identified according to *Minnesota's Native Vegetation: A Key to Natural Communities, Version 1.5* (Minnesota Natural Heritage Program 1993). The quality of the communities was ranked using a scale from A to D, with A being highest quality, or essentially pristine, and D the lowest, or highly disturbed. These evaluations follow draft guidelines for ranking native plant communities (MCBS 1994). In 2005, these communities were crosswalked to a revised classification, *Minnesota's Native Plant Community Classification, Version 2.0* (MNDNR 2005a, MNDNR 2005b), which is used in this report.

Additional surveys of native prairie remnants on railroad rights-of-way were conducted throughout the Prairie Parkland Province of Minnesota by MCBS in 1997 and 1998 (MCBS 1999). Areas of prairie along active railroads identified during these surveys were included in the maps that accompany this report.

Vegetation plots, using the relevé method, were used to obtain more detailed information on the structure and composition of native plant communities in the Minnesota River counties that were in good to excellent condition. Relevé sampling is a method of describing vegetation in a semi-quantitative manner. The methodology used statewide by MCBS is described in MNDNR (2007a). Individual plot data can be compared to data from other areas and the results used to gain further understanding of the vegetation of Minnesota.

Relevé plots used in the Minnesota River counties were 400 square meters (20m x 20m) for forested communities and 100 square meters (10m x 10m) for open wetland and prairie communities. Smaller plots were used to sample plant communities on the surfaces of rock outcrops, which are much smaller than 100 square meters in the Minnesota River counties (Wheeler 2000). Within each plot, the vegetation was described by estimating the percent cover of each species in distinct height strata. Relevé data were entered into the NHIS Relevé Database. Each plot was situated in a location that well-represented the community type being sampled. Relevé data were utilized to develop version 2.0 of the MNDNR's native plant community classification (MNDNR 2005a, MNDNR 2005b).

Following site visits by the plant ecologist, native plant community boundaries were corrected on the topo maps. For counties with surveys completed before 1996, final boundaries of site polygons were digitized using the ArcInfo Geographic Information System (Environmental Systems Research Institute). For counties where surveys were completed after 1995, the final boundaries of site polygons were digitized using the ArcView version 3.1 or 3.2 Geographic Information System (Environmental Systems Research Institute). Locations and descriptions of each native plant community, known as "element occurrences," were entered into the Rare Features Database of the NHIS. Areas that were not mapped as native plant community poly-

gons primarily represent: 1) land where modern human activities such as farming, over grazing, wetland drainage, exotic species invasions, recent logging, and residential and commercial development have destroyed or greatly altered the natural vegetation; and 2) native plant community polygons that were below minimal size criteria. (Note: some areas that were not mapped are important for conservation. These areas may include habitat for native plants and animals, corridors for animal movement, buffers surrounding high-quality natural areas, open space, and target areas for restoration.) In Big Stone and Lac Qui Parle Counties, the Survey focused on prairie and savanna communities and did not include wetlands or forested vegetation.

Rare Plants

Rare plant surveys were focused on species of officially listed under the Federal Endangered Species Act of 1973, as amended, or the Minnesota Endangered Species Statute (MN Statute 84.0895). A revised state list was in effect July 1, 1996. Listed species include federal and state Endangered and Threatened species, as well as state Special Concern species (Coffin and Pfannmuller 1988). Endangered and Threatened species are provided the highest level of legal protection under federal and state laws.

State-listed species are defined as follows:

> An Endangered species is a plant or animal species that is threatened with extinction throughout all or a significant portion of its range in Minnesota.
>
> A Threatened species is a plant or animal species that is likely to become Endangered within the foreseeable future throughout all or a significant portion of its range in Minnesota.
>
> A Special Concern species is a plant or animal species that is extremely uncommon in Minnesota, or has a unique or highly specific habitat requirements, and deserves careful monitoring. Species on the periphery of their ranges may be included in this category, as well as species that were once Threatened or Endangered but now have increasing, or stable and protected, populations.

In addition, the Natural Heritage and Nongame Research Program (NHNRP) tracks selected species that are not legally listed or protected. Some of these are federal candidate species. Others are potentially rare species that require further field survey to determine their status and are denoted in this report as non-listed rare species (or Not Listed).

All rare plants encountered during field work in 1987 through 2000 were documented by the MCBS plant ecologists or botanists. All occurrences were recorded in the NHIS Rare Features Database and digitally recorded using ArcInfo or ArcView GIS software. When populations were of adequate size, plant specimens were collected, labeled, and deposited into the Herbarium of the James Ford Bell Museum of Natural History at the University of Minnesota in St. Paul.

Rare Animals

Animal surveys conducted by the Minnesota County Biological Survey targeted rare species (see the Rare Plants section, above, for descriptions of rare species). Although information on common species was obtained, the rare species potentially present in a county determined which habitats were surveyed. Therefore, these surveys were not comprehensive assessments of the animals present in the region, but were highly selective searches for rare animals. Rare mammals, breeding birds, and amphibians and reptiles (herpetofauna) were the primary focus for MCBS animal surveys. When funding and expertise were available, searches for rare fishes, butterflies, and tiger beetles were made. Rare animal surveys of Minnesota River valley counties began in 1988 and ended in 2000. Table 5.a.1 summarizes when MCBS conducted surveys in a county and which animal groups were surveyed.

The survey methods employed by MCBS are widely recognized as effective techniques for detecting

the targeted species of interest. Below are brief descriptions of the methodology used for surveys conducted by MCBS. Table 5.a.2 shows the types of surveys conducted by county for mammal, bird, and herpetofauna surveys. All specimens collected during these surveys were prepared for permanent storage at the James Ford Bell Museum of Natural History at the University of Minnesota in St. Paul.

Mammal Surveys

Most of the mammal survey effort was focused on rare small mammals, from shrew to squirrel size. A variety of small mammal traps were baited, set in arrays (or grids) of 40 stations, and checked for captures twice a day for four days. For each capture, information was collected on species, age, sex, and reproductive condition. Live animals were marked and released, dead animals were collected and further processed. Habitat information was collected about the general area and at the trapping site. Small mammals also were collected from drift fences set to capture amphibians and reptiles (see amphibian and reptile survey methods, below). These captures were documented in the same manner as trap grids.

Larger mammals, or those that remain underground, such as pocket gophers, were not effectively documented with the small mammal traps. The presence of these species was determined by observation, tracks, dens or mounds, calls, or other sign. Occasionally, specialized traps were employed to capture them.

Bats were documented by locating sites where they hibernated during winter. Spring through fall, when bats are actively foraging, they were identified through visual observation, by capture in mist nets, or by recording their calls using ultrasonic bat detectors. During early surveys of the Minnesota River valley counties, the available bat detectors did not provide reliable species identification. During the later surveys, improved technology enabled the permanent recording of calls for later identification and analysis.

Breeding Birds Surveys

Surveys of breeding birds were conducted from late May through mid-July. For early or late breeding species, surveys were begun as early as April and extended through August.

Point counts were the primary method employed by MCBS to survey breeding birds. At several points within a given habitat, all birds seen or heard singing within a 50-meter radius during a five-minute interval were identified and evidence of breeding or nesting was recorded. Birds detected outside the 50-meter radius, were also recorded to generate a species list for the site or area. Point counts were spaced a minimum of 250–300 meters apart and at least 150 meters from the edge of a habitat. Point counts were conducted from approximately 15 minutes before sunrise to about four hours after sunrise, during suitable weather conditions (i.e., wind less than 10 mph, precipitation no greater than a light rain).

Incidental record forms, with space for detailed notes on habitat and behavior, were filled out for all targeted species when encountered. Bird species lists were created when five or more bird species were recorded at a location, outside of a standardized point count.

Playback of taped calls was used to elicit responses from relatively secretive species or species known to react strongly to this technique (e.g., Red-shouldered hawks and Louisiana waterthrushes). Depending on the species, taped calls of territorial males were played using an amplifier speaker. All species reacting to the call were recorded and their behavior noted. Survey routes were established on roads or rivers in areas of suitable habitat, with stops spaced roughly 400–800 meters.

Road surveys were conducted for bird species associated with open grassland and wetland habitats. Routes were selected that bisected or ran along areas of potential habitat. Stops were made at variable intervals within tracts of habitat, and the area was scanned with binoculars or a spotting scope to search for species of interest. Road surveys

were also conducted after sunset for species that regularly vocalize at night (e.g., bitterns, rails, and owls).

Amphibian and Reptile Surveys

Surveys for amphibians and reptiles (or herpetofauna) were conducted from April through September and involved a variety of techniques depending on the species of interest.

Anuran call surveys, which document breeding frogs and toads, were conducted at night between 2130 and 0100 hours from April through July. Under suitable weather conditions and at selected wetland locations, all species heard calling during a five minute interval were recorded and their corresponding call intensity (an index of the number of calling individuals) was estimated. Due to the wide range of times over which different anuran species breed, some sites were visited several times during the field season in order to document all anurans utilizing the wetland.

Turtles were surveyed using visual searches and turtle traps in wetlands having suitable habitat. Turtles were identified with spotting scopes and binoculars as they basked on emergent structures, such as logs or rocks. Hoop nets, baited with smelt, were set in shallow wetlands and checked every other day for three to five days. Captured turtles were identified to species examined for age, sex, and reproductive condition, and then released. Searches were conducted in open, sandy areas near wetlands in early June for nesting females or predated turtle nests.

Drift fences were used to capture more secretive herpetofauna, such as salamanders, and to record seasonal movements of a variety of species. Drift fences consisted of 50 foot rolls of aluminum flashing or window screen with pit-fall traps (e.g., five gallon buckets) buried flush with the ground on either side of the flashing. Fences were installed prior to spring or late summer migrations. Buckets were checked three times per week and all herpetofauna and small mammals were removed and identified. Buckets were closed during July when herpetofauna were less active, reopened in mid August, and removed by the end of September.

Terrestrial searches were also conducted for some species. These involved actively searching a particular habitat or area and hand capturing all herpetofauna found. Logs and ground debris were turned over to check for concealed herpetofauna. Basking surfaces or rock crevices also were examined. This technique was useful for documenting snakes and lizards that might not be found using other methods. Other directed searches involved driving roads during periods of migration. On warm, rainy nights during spring and summer, large numbers of amphibians may cross roads. Snakes will use warm road surfaces to bask during morning and evening, and will cross roads during spring and fall as they travel to or from hibernacula. Turtles were also intercepted on roads during nesting periods. Incidental records of herpetofauna also were recorded when encountered.

Other Animal Surveys

Limited surveys of other animal groups were conducted in the Minnesota River valley counties as part of the Minnesota County Biological Survey (Tables 5.a3 and 5.a4).

Rare fish surveys were conducted in Swift, Chippewa, Scott, and Carver counties from 1997 through 1999. Species were captured using seine and kicknets and backpack shockers. In 1999, two locations in the Minnesota River with deep water were surveyed for Paddlefish, as part of a larger U.S. Fish and Wildlife Service project. Weighted gillnets were stretched across the river channel by boat. Fish captured were identified and released. When dead mussel shells were encountered during aquatic surveys, they were collected and given to mussel specialists in the Division of Ecological Resources for identification.

Substantial survey and monitoring of aquatic animals—such as fish and mussels—have been focused on the Minnesota River by other programs in the MNDNR's Division of Ecological Resources and Division of Fish and Wildlife, by the MN Pol-

lution Control Agency, and by researchers at the University of Minnesota. Refer to the sections on fish and mussels in Chapter 5 for more information about the methods and findings of these surveys.

Butterfly surveys were conducted in 1988 in the western Minnesota River valley counties of Big Stone and Lac Qui Parle (Dana, 1991). In 1997, surveys for butterflies and tiger beetles were conducted in Sibley, Le Sueur, Scott, Carver, Hennepin, and Dakota counties (Hansen, 1998). Refer to these publications for more information on methods and findings.

Statewide Biodiversity Significance Ranks

Following field survey, all MCBS sites that were identified for survey in the Minnesota River counties were ranked for their statewide biodiversity significance on a scale ranging from "Outstanding" to "Below Threshold." The criteria for these ranks are given in Table 1.2. The purpose of these ranks is to allow quick identification of the most significant sites for conservation of rare native plant communities and rare species. Because these ranks reflect statewide significance, they do not adequately reflect the significance of these sites at a county or more local scale. Thus, some sites ranked as "Below Threshold" may be important sites for conservation at the county level. Also, these biodiversity ranks do not adequately assess other aspects of a site that may be important for conservation, such as a site's value for conservation of wildlife species that are not listed as rare species. Maps of the Minnesota River valley counties showing sites coded by Statewide Biodiversity Significance accompany this report or are available from the MNDNR. Digital data containing sites coded by Biodiversity Significance may also be obtained from the MNDNR's GIS "Data Deli" at http://deli.mndnr.gov.

Table 1.2: *Guidelines for Minnesota County Biological Survey (MCBS) statewide biodiversity significance rank.*

MCBS Sites range from thousands of acres down to several acres in size. Initial site boundaries are determined through aerial photo interpretation, evaluation of ecological criteria (landforms, hydrology, vegetation patterns, soils data, etc.) and, if necessary, consideration of the impact of anthropogenic factors (e.g., land-use history). Boundaries are often revised following field survey. At the conclusion of survey work in a geographic region, MCBS ecologists assign a biodiversity significance rank to each site. These biodiversity significance ranks (outstanding, high, moderate, or below) represent the relative statewide biodiversity significance of a site as determined by MCBS ecologists. These ranks are used to communicate the significance of a site for native biological diversity to natural resource professionals, state and local government officials, and the public.

Important factors in ranking sites include:
1) Element Occurrence (EO) ranks for rare species[1]
2) Condition Ranks for native plant communities (NPCs)[2]
3) the size of NPC occurrences
4) the context in which these features occur.

Unlike rare species EO ranks, which incorporate consideration of population size, NPC Condition Ranks do not incorporate acreage of the NPC. However, in order for a site to be ranked "OUTSTANDING" or "HIGH" based on an NPC occurrence, the NPC must be of sufficient quality and size such that its long-term survival is likely. This means that the size of the NPC is sufficient to allow for continuation of the ecological processes that shaped the NPC or to allow for their maintenance through management. Exemplary are fire-dependent communities that occur in landscapes still influenced by wildfires or that occur in settings where it is possible to use fire as a management tool.

Specific size criteria for what constitutes large versus small for any given NPC element are not incorporated into these guidelines because NPC elements occur in different sizes depending on the NPC type and location within the state. For example, a 20-acre mesic prairie in southeastern Minnesota is considered to be highly significant, due to the near absence of that prairie type in the region. In this case, a site containing the 20-acre high quality prairie might contain the largest and best example of the NPC in the associated ECS subsection.[3] A 20-acre prairie is less significant in parts of northwestern Minnesota where larger examples remain. The viability of a given rare species population or NPC is highly dependent on the landscape context (i.e., the condition of the surrounding landscape). Sites ranked "OUTSTANDING" or "HIGH" must have a sufficient area of native habitats surrounding the rare species or NPC occurrences such that the long-term survival of these features is likely.

Although these are statewide guidelines, not all criteria are applicable to all regions. For example, NPCs are highly fragmented in portions of the state, and these areas completely lack significant components of functional landscapes such as matrix communities (communities with broad ecological amplitude that covered most of the landscape before European settlement). In order to determine the overall statewide significance of sites within an ECS subsection, MCBS plant ecologists, botanists, and zoologists working within the same subsection confer with one another about the various components of biodiversity within a site before assigning a final rank.

Footnotes are located on back

	OUTSTANDING	HIGH	MODERATE
	Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes present. These sites are characterized by one or more criteria (I, II, III) below.	**Sites containing very good quality occurrences of the rarest species, high-quality examples of rare NPCs, and/or important functional landscapes. These sites are characterized by one or more criteria (I, II, III) below.**	**Sites containing occurrences of rare species and/or moderately disturbed NPCs, and/or landscapes that have a strong potential for recovery. These sites are characterized by one or more criteria (I, II, III) below.**
Rare Species	**I.** One of the best occurrences of a G1, G2, S1, or S2 species. **or** A concentration (four or more) of excellent or good occurrences (***A*** or ***B*** rank) of S1, S2, or S3 species, at least one of which is an S1 or S2 species. These occurrences must be in an NPC assigned a Condition Rank of ***C*** or above (except for special circumstances where plant communities are not present, such as a bat cave or mussel bed).	**I.** A ***B*** or ***C*** rank occurrence of a G1, G2, S1, or S2 species. **or** A concentration (four or more) of ***A*** or ***B*** rank occurrences of S3 species. These occurrences must be in an NPC assigned a Condition Rank of ***C*** or above (except for special circumstances where plant communities are not present, such as a bat cave or mussel bed).	**I.** A ***C*** or ***D*** rank occurrence of a G1, G2, S1, or S2 species. **or** A single ***A*** or ***B*** rank occurrence of an S3 species. **or** Occurrences of ***BC*** or ***C*** rank S3 species. These occurrences must be in a NPC assigned a Condition Rank of ***C*** or above (except for special circumstances where plant communities are not present, such as a bat cave or mussel bed).
NPC	**II.** One of the highest quality examples (based on Condition Rank, size, and context) in an ECS subsection of the rarest (i.e., S1, S2, or S3) NPCs. **or** A group of important NPCs (S1, S2, or S3) that together are of sufficient size and quality as indicated by Condition Rank to constitute one of the highest quality natural areas in an ECS subsection.	**II.** A high-quality example (Condition Rank of ***B*** or higher, and also based on size and context), though not among the best in an ECS subsection, of one of the rarest (S1, S2, or S3) NPCs.	**II.** **NPCs** assigned a Condition Rank of ***C*** or above. **or** A ***CD*** Condition Rank occurrence of an S1 or S2 NPC that is among the largest for the type within the ECS subsection.
Landscape	**III.** One of the largest, least-fragmented, least-developed landscape areas in an ECS subsection that has the full spectrum of matrix to small patch NPCs (any S rank; mostly ***A*** to ***BC*** Condition Ranks) and the highest potential for intact ecological functioning (e.g., fire, natural patch dynamics, natural water-level fluctuations).	**III.** A little-fragmented, little-developed landscape area that has the full spectrum of matrix to small patch native plant communities (any S rank) and a high potential for intact ecological functioning, **but** also fits one of the following descriptions. -It is mostly composed of ***A*** to ***BC*** Condition Rank NPCs but is not one of the largest landscape areas in the ECS subsection. **or** -It is one of the largest landscape areas in the ECS subsection but has significant amounts of human-induced disturbance such that Condition Ranks of most NPCs are ***BC*** or less**.**	**III.** A little-developed landscape area that is not among the largest in an ECS subsection and is not mostly composed of ***A*** to ***BC*** Condition Rank NPCs but has high potential to recover the full spectrum from matrix to small patch NPCs and intact ecological functioning.

BELOW Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet MCBS standards for Outstanding, High, or Moderate rank. These sites may include areas of conservation value at the local level, such as habitat for native plants and animals, corridors for animal movements, buffers surrounding higher quality natural areas, or areas with high potential for restoration of native habitat.

Table 1.2: *continued*

Footnotes

[1]Rare species Element Occurrence (EO) rank: A rare species occurrence is ranked based on the estimated viability of that occurrence. Most ranks range from ***A*** (excellent estimated viability) to ***D*** (poor estimated viability). Factors used to estimate viability include size, condition, and landscape context.

[2]NPC: A native plant community (NPC) is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as oak savannas, pine forests, or marshes, that tend to repeat over space and time. Native plant communities are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes. Examples of natural disturbances include wildfires, severe droughts, windstorms, and floods. For an overview of Minnesota NPCs, see http://www.dnr.state.mn.us/npc/classification.html. Condition Ranks from ***A*** (excellent condition) to ***D*** (poor condition) are assigned to NPCs based on species composition, degree of human disturbance, presence of exotic species, and other factors.

[3]ESC Subsection: An ECS subsection is a unit of the Minnesota Department of Natural Resources' hierarchical Ecological Classification System (ECS) for ecological mapping and landscape classification in Minnesota. Subsections are defined using glacial deposition processes, surface bedrock formations, local climate, topographic relief, and the distribution of plants, especially trees. Minnesota has 26 subsections. For more information, see http://www.dnr.state.mn.us/ecs/index.html.

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2. Overview of the Quaternary Geological History of the Minnesota River Watershed

Carrie E. Jennings

"The Minnesota River valley is truly the most striking and scenic feature of all south-central Minnesota. It is a narrow sliver of wooded hill slopes in the vast plains to north and south, and it holds within it a diversity of geologic features such as rugged granite knobs on the valley floor, boulder-gravel river bars, broad sandy terraces, gentle colluvial slopes – and a stream along the axis that is almost tiny in the context of these major features" (Wright 1972).

THE WATERSHED—A GLACIAL TROUGH RUNS THROUGH IT

The Minnesota River flows down the centerline of the broad glacial trough formed by ice of the Des Moines lobe, which dominates the topography of the southern half of Minnesota (Fig. 2.1). This trough is so wide and gently-sloping that it is almost undetectable from the ground. The valley of the Minnesota River, on the other hand, is an arresting feature that was created abruptly after the Des Moines lobe retreated and is still affecting the evolution of the landscape today.

The ice lobe that formed this statewide trough was just the last of several that entered Minnesota during the last glaciation (and this last glaciation was just one of several that affected Minnesota during the last two million years). Ice lobes were dynamic tongues of ice that extended far south of the main ice sheet. Rather than being the slow inexorable movement of ice that is typically envisioned, the ice lobes advanced and stagnated quickly and repeatedly until they eventually drained the slower reservoir of ice that was feeding them. The lobes were directly controlled and fed by focused, fast-moving zones within the ice sheet called *ice streams* (Patterson 1996, 1997).

The Des Moines lobe, which extended south from the main Laurentide ice sheet that covered much of Canada and parts of the northern United States during the last ice age, had more than a dozen advances, driven by ice stream dynamics, between approximately 40,000 and 11,000 years ago (Clayton and Moran 1982, Patterson 1996). Each advance eroded a bit more from the land it covered and deposited it near the edge of the lobe, creating a suite of identifiable landforms at each ice margin. Geologists collectively refer to the sediment of all of these advances of the Des Moines lobe as the New Ulm Formation, even though each advance may have been subtly different in its composition. The sediment, or till, deposited by the ice was nearly an equal mixture of clay, silt and sand, with a predictable amount and assortment of pebbles in the fine-grained mud. Till was created as overridden sediment and rock fragments were either frozen into the glacier or dragged along by the moving ice and eventually conveyed towards the ice margin. This material was thoroughly ground up and mixed while in the shear zone at the bottom of the glacier.

The processes that occur beneath an ice sheet are difficult to study but drilling through and imaging the base of modern ice streams in West Antarctica have elucidated them. The boundaries of the subglacial shear zone change with the temperature of the bottom of the ice and these changes control whether material is eroded or deposited, frozen in or melted out. In areas of heat from friction, debris is released from the ice and left behind, forming a till sheet. Where the temperature is reduced at the glacier bed, sediment is frozen into the ice and carried away, resulting in erosion. The presence or absence of water also plays an important role in how these processes vary over time, so erosion and sedimentation vary with the temperature and melting point of the ice. Where the shearing force of the ice is reduced by lubricating water, sediment that was dragged along is left behind. Where subglacial water has drained away, the shearing force increases and a thicker pile of sediment is dragged along with the ice. Ice thickness also comes into play directly because thicker ice can drag along more sediment than thinner ice. Complicated though these processes may seem, we have evidence to show that these processes

operated in the ancient ice lobes of the Laurentide ice sheet and effectively removed debris, mixed it thoroughly, moved it for hundreds of miles, and then spread a fairly uniform blanket of the end product over the region.

Beneath the till of the Des Moines lobe lie layers of older glacial units from previous glaciations; these layers vary in thickness and completeness of preservation (Gilbertson 1990, Patterson et al. 1995). The truncated stack of older tills that remains in the Minnesota River valley is exposed in the valley walls and forms the competent (indurated) gray-brown to yellow bluffs along the lower reaches of tributary streams to the Minnesota River. More than a million years worth of glacial advances is preserved in the banks of the Yellow Medicine River in Upper Sioux Agency State Park.

Over two million years worth of sediment is layered in the better-preserved stack of old debris

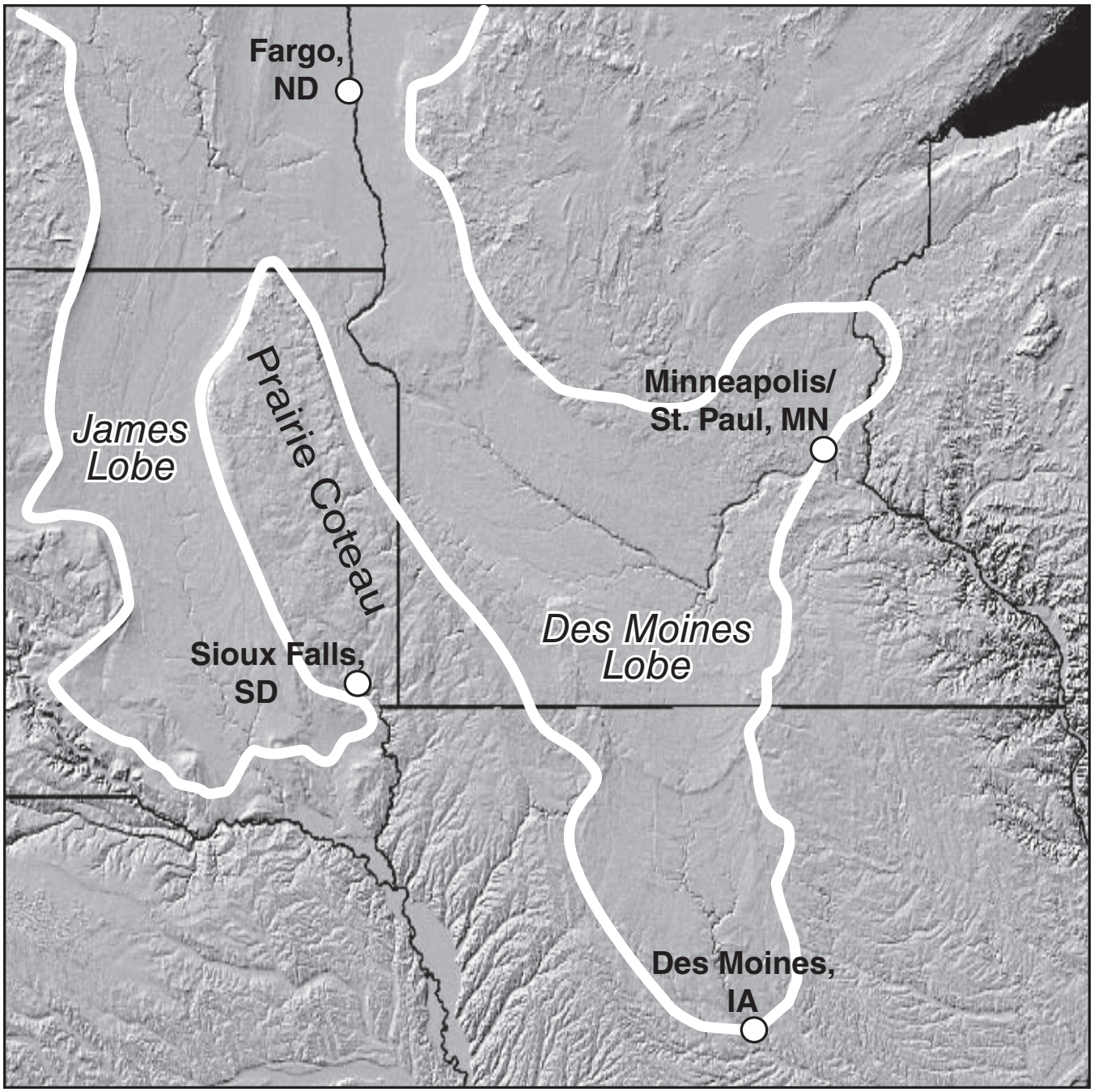

Figure 2.1: *Location of the Des Moines and James Lobes at their maximum extents.*

beneath the Coteau des Prairies (Prairie Coteau) farther west (Fig. 2.1) (Balco et al. 2005). Near the prow of the Coteau, along the North Dakota-South Dakota line, drill holes penetrate 800 feet of glacial sediment before reaching the bedrock beneath (Beissel and Gilbertson 1987). This highland, while dramatic, is not especially erosion resistant; it was simply bypassed this last time around by ice lobes on either side of it and thereby preserves a thick stack of older glacial sediment (Gilbertson 1990, Lineburg 1993, Patterson et al. 1995).

We do not know exactly what the land looked like before the advances of the Des Moines lobe and previous ice advances, but expect that it originally looked a lot like the unglaciated areas of North Dakota, west of the Missouri River (Bluemle 1991). Earlier ice lobes from older glaciations most likely initiated the path later followed by the Des Moines lobe, which was the last in a long line of ice advances from the northwest as indicated by the similar composition of the tills. Perhaps the early ice advances initially exploited a small river valley. The direct evidence for this has been removed, smeared out across Minnesota and Iowa, and deposited as far away as the Gulf of Mexico by continent-spanning meltwater streams. So we can only make an educated guess based on the nature of the unglaciated landscapes nearby.

As global climate warmed about 14,000 years ago, bringing an end to a 100,000-year-long ice age, the Des Moines lobe, rather than simply slipping back into Canada, began the long, stuttering process of advancing and stagnating in fits and starts, eventually leaving Minnesota about 11,000 years ago. The warming climate had actually created the conditions for this style of ice lobe advance by lubricating the base of the ice streams and lobes.

Today, it is this record of ice stagnation that is best preserved (Patterson 1997). Each indecisive margin is marked by an area where debris accumulated in a hilly band. In some cases, the stagnation of the lobe—which had become heavily crevassed as it wasted—was marked farther from the main margin by faint, crisscrossing pattern of debris that settled into the crevasses, forming low intersecting ridges. (Kemmis et al. 1981 and references therein, Patterson 1996). Beyond the ice, arcuate braided streams carried meltwater around the front of the melting ice but were not erosive enough to carve deep valleys (Leverett 1932, Patterson et al. 1999). Rather, they were debris-choked, shallow, and broad. After circumscribing the lobe, they flowed southeast down the regional slope, most likely near the present location of the Minnesota River, but prior to its formation. Some of the former, ice-marginal stream channels are still occupied by lazy reaches of modern rivers such as the Redwood, Cottonwood, and Watonwan (Map 1 [inside cover], Fig. 2.1). These rivers still take the long way around, looping around the margin of the phantom ice lobe. In other cases, modern streams have taken short cuts to the more recently formed Minnesota River, with courses that are more in line with the modern gradient. For example, the Yellow Medicine River begins in one former ice-marginal stream channel, then cuts across the broad, level till plain in an east-northeasterly direction until it intersects a younger ice-marginal stream, thereby taking a more direct route to the master stream, the Minnesota.

In areas away from the low-gradient braided streams, the ice lobe trough was not shaped to allow water to drain readily and pooled water, from small puddles to large lakes, formed as the lobe melted. Most of the large lakes of glacial meltwater eventually drained, but shallow depressions that held water after rains persisted. The ten to twenty feet of fine-grained, dense, gray, clayey till deposited in the trough by the Des Moines lobe did not allow rainwater and snow melt to percolate into the substrate very quickly (Patterson et al. 1999). As seasonal water perched, wetlands formed, covering about half of the area of the trough. Most of these wet areas have been intentionally and progressively drained for farmland.

After the Des Moines lobe's final retreat into North Dakota, another lobe, the Red River lobe—fed by a different ice-stream source—took advantage of the newly vacated lowland, advancing south

from the area we now know as Lake Winnipeg. It created a series of broad stagnation moraines north of Ortonville, Minnesota, collectively named for the county they lie in, Big Stone.

ICE MARGINAL LANDSCAPES—HUMMOCKS AND HILLOCKS

The thin ice of the punctuated advances of the Des Moines lobe moved a lot farther than one might have predicted—splintering into a spruce forest in Des Moines—the stumps are there to prove it (Clayton and Moran 1982, Bettis et al. 1996). The advances were most likely encouraged by pressurized water beneath the ice that allowed it to glide by reducing friction. Advances probably ended in stagnation when the water making the long glide possible was siphoned off through subglacial valleys. These tunnel valleys formed at the ice margin and worked their way up into the ice lobe, draining a large portion of it and causing it to skid to a halt (Patterson 1996). Today these valleys are marked by mile-wide depressions up to 10 miles long and frequently contain long lakes (e.g., Lake Benton) or chains of lakes (e.g., the lakes near Fairmont, see Map 1). The lobe advanced and stagnated again and again, at least thirteen times, with each advance a little less extensive than the previous one. This was because the lobe was progressively drawing down the reservoir of ice.

Each advance also eroded the ice-lobe trough a bit more, conveyed that material closer to the ice margin, and piled it near ice and debris from the previous advance. In this way, the margins of the lobe—especially those along the east and west sides, which received more total advances—accumulated thick stacks of dirt and stagnant ice. The slow decay of dirt-covered ice piles created the complex hilly areas that now mark the former limits of the ice (Clayton 1967, Patterson 1996). The western margins are marked by rolling hills that cross diagonally across Jackson, Murray, southwestern Lyon, Lincoln, and western Yellow Medicine counties (Map 1). The eastern margins are marked by the oak-dotted hillocks and hummocks, specked with lakes and wetlands, in Freeborn, Waseca, Steele, Le Sueur, Rice, Scott, Carver, and Hennepin counties (Map 1). These eastern hills fringed the former expanses of prairie (now corn and soybean fields) that occupied the flat, central trough of the lobe; they formed effective firebreaks against the windswept blazes that moved from west to east across prairie regions of the state, enabling the development of woodland and forest vegetation along the margins of the prairie.

Slightly impractical farming areas, the hummocky zones were probably the second choices of homesteaders and were more likely settled by homesick immigrants for nostalgic reasons because they looked like a left-behind "home" in Ireland, Czechoslovakia, or central Germany. The hummocks and swales formed as repeated advances of ice buckled the debris-covered, stagnant ice, which then wasted slowly and irregularly. The dirt and ice mix lasted a long time—long enough for trees to establish themselves in the wet debris. Ducks may have swum in the pools of water that developed on the ice. The dirt on top of the stagnant ice was wetted from below by melting ice, making it unstable and causing dirt, rocks, trees, and ducks to be rearranged for centuries on the ever-changing surface of the buried ice. Ultimately, all of the ice melted. The hills we see today represent the final resting place of the glacial sediment in the very last holes in the stagnant ice surface.

In some areas, water associated with melting ice, or simply gravity, sorted the till into better-organized layers of like-sized grains. Sand and gravel were carried away from the ice by flowing rivers. Silt and clay moved even farther, though it also settled out in the still waters of proglacial lakes formed by ice or moraine dams near the ice. Silt and sand became airborne with the persistent and strong glacial winds. Sand particles stay lower to the ground and saltate (bounce), continuing to dislodge particles that have settled out. The windblown silt settled out in a blanket of loess that thickens towards the Mississippi River (Mason et al. 1999). Most of this sorting occurred before vegetation became established on the landscape.

We are a state of imported dirt. Everywhere where there is sediment in Minnesota, it is likely to be the long-traveled deposits of an ice lobe or the re-sorted material described above. Pick up any rock; it was most likely imported from Manitoba or Ontario, as was the gray clay or red sand of the till matrix. Our rivers proceed to expose and erode this glacial sediment and deposit it in the nearest slackwater area, either in the streambed or floodplains or maybe a lake along the way. Some sediment might make it all the way to the Gulf of Mexico, or at least Lake Pepin.

The glacial till and the reworked byproducts of glaciation form the base for the rich soils of Minnesota. These soils were created over the past 10,000 years as the minerals in the glacial sediment were broken down. The slow movement of water through the till dissolved certain minerals and deposited them deeper in the soil profile. The mineral soil was amended with decaying organics from the succession of plants that occupied the land surface. Ten-thousand years worth of root activity, frost, fire, burrowing, and acid leaching from leaf litter have all played a role in forming the soils we depend on in the Minnesota River watershed.

THE GREATEST LAKE

In places, meltwater from the wasting ice was temporarily trapped—for at least a dozen years in the basin of glacial Lake Minnesota, which covered most of Blue Earth County in addition to parts of other contiguous counties (Patterson and Hobbs 1995), and for at least half a century in the basin of glacial Lake Benson, which covered large portions of Swift, Lac Qui Parle, and Chippewa counties (Rittenour et al. 1998) (Fig. 2.2). As the Red River lobe retreated, meltwater ponded behind the Big Stone moraine for about a millennium. The resulting glacial Lake Agassiz (Upham 1890, 1895) was one of the largest freshwater lakes in the world, eventually occupying 200,000 square miles, an area greater than all of the Great Lakes combined, covering much of what are now western Minnesota, eastern North Dakota, Manitoba, and western Ontario (Fig. 2.2) (Thorleifson 1996). The Red River lobe dammed the water to the north and the only outlet to the lake for much of this time was to the south, through the Big Stone moraine. This overflow from glacial Lake Agassiz made the initial incision into the newly vacated glacial trough, starting the process of formation of what eventually became known as the Minnesota River valley. The early river that spilled south from the vast, cold, iceberg-filled waters of glacial Lake Agassiz is referred to as glacial River Warren.

Overflowing water from glacial Lake Agassiz created glacial River Warren some time around 11,500 radiocarbon years before present (Clayton and Moran 1982, Matsch 1983) and the glacial River Warren outlet was occupied until about 10,900 radiocarbon years before present. Two other outlets were intermittently used by Lake Agassiz, one to the east, through Lake Nipigon and thence into Lake Superior, active between 10,900 to 10,300 (Thorleifson 1996), and one to the northwest in the Fort McMurray area of Canada through the Mackenzie River and thence to the Arctic Ocean between 10,000 and 9,600 radiocarbon years before present (Lowell et al. 2005). When Lake Agassiz drained through these other two outlets, the southern outlet was not used. River Warren was probably reoccupied after 9,600 but finally lost glacial lake discharge forever by 8,200 radiocarbon years before present.

The retreat of an ice sheet is not always a steady affair, however, and so the reign of Lake Agassiz was somewhat complicated. The lake did not successively take lower and lower outlets that were exposed as the ice sheet withdrew to the north. The ice lobes, driven by the independent ice streams, behaved erratically and shot out from the ice front at various times, rerouting and even blocking meltwater discharge. It appears that a late readvance of ice in the Lake Superior basin blocked the eastern outlet of Lake Agassiz through Lake Superior for a long enough interval to allow Lake Agassiz levels to rise to the elevation of the southern outlet a second time. The ever-changing part of the lake shore represented by the oscillating ice front was not the only factor complicating the drainage history of Lake Agassiz. The land had also

Fig 2.2: *Locations of glacial lakes Agassiz (after Teller et al. 1983), Benson, and Minnesota (after Hobbs and Goebel 1982) at their maximum extents. Note: these lakes were present at different times.*

been rebounding gradually as the weight of the ice sheet was lessened, more so in places where the ice was thicker. So the northern part of the basin was rising more than the southern part and that too has played a part in the occupation of the various outlets of Lake Agassiz (Thorleifson 1996).

River Warren easily cut through the stack of older tills and saprolite (weathered bedrock) that lay in the trough of the Des Moines lobe. In places it reached harder rock and could not erode deeper . It exposed old, pink quartzites near New Ulm; very old granitic rocks on terraces near Ortonville, Odessa, and Granite Falls; and the even older gneisses between Redwood Falls and Morton. These resistant rocks were local base levels that constrained the depth of erosion of River Warren (Matsch 1983) and required it to become wider to accommodate the f ow. They are still the sites of rapids or waterfalls—collectively called nick points—as can be inferred from the names of some of the towns.

As the river swept the clay and grit of the weathered rock away it exposed the strange knobby bedrock surface that lay beneath the saprolite . In a few places, pebbles swirling in River Warren eddies scoured potholes. But in most places the river just removed the loose material leaving a strange but wonderful undulating surface. This landscape is well exposed on the route through the Big Stone National Wildlife Refuge near Odessa. This chemical weathering front may have never seen the light of day were it not for River Warren, and presents a very odd landscape for us to explore. The rocky outcrop area in Granite Falls stretches for miles and is a disor ganized, lumpy moon-like landscape (Johnson et al. 1998, Patterson et al. 1999, Patterson and Boerboom 1999). The river stripped most of the saprolite from a bedrock surface that was shaped by the slow chemical weathering of hard rock in a tropical setting, with the partially dissolved rock blanketing it during this process. This is the way that rock turns to mush in places like Brazil today . The undulation of the rock surface is a result of the weathering front proceeding unevenly , going deeper along fractures and joints than over intact surfaces. In some places completely isolated rounded remnants of rock called corestones remained in the saprolite. These remnants formed as the rock around them dissolved. When the saprolite was swept away by glacial River Warren it left the lar ge rounded rocks in place (Patterson and Boerboom 1999). The saprolite still remains in a few patches near the surface and has been mined near Redwood Falls and Sacred Heart for its unique clay mineral, kaolinite. Kaolinite is the stable end-product of long-term chemical weathering and is valued for its purity. It is used in porcelain and coated color paper, among other things.

There are waterfalls or rapids (nick points) on all of the tributary streams to the modern Minnesota River. The tributaries instantly developed waterfalls when glacial River Warren was incised below the levels of its tributaries. These waterfalls gradually moved upstream or became a series of rapids or nick points. In this way the lower reaches of all of the tributaries to glacial River Warren are adjusting their gradients to meet the new level of River Warren, a journey they are still on today even though River Warren ceased to f ow millennia ago. Even now, only the lower 5–10 miles of each major stream is adjusted to the elevation of the valley f oor of the Minnesota River . Look again at the location of the waterfalls, towns or dams on these tributary rivers. Their names and locations reveal the progress of nick point migration during the last 10,000 years.

The process does not stop just because we live here now. The nick points will continue to move up the tributaries and the tributaries to the tributaries, and so on, until the entire watershed of the Minnesota River valley has adjusted. Given the progress over the last 10,000 years, one might expect another glaciation to occur before the result is achieved. However, changes we have made to the drainage system have accelerated the rate at which this process would typically take place.

Upriver from Mankato, glacial River Warren was primarily a down-cutting stream (Johnson et al.

1998 and references therein). This means that terraces there are controlled by the depth of erosion of the river, usually to a level of resistant rock, and that surfaces along the valley are not related to stable lake levels and beaches of Lake Agassiz (Johnson et al. 1998). Some are channels that were brie f y occupied before the erosive water became focused in one main channel—for example, Watson Sag (map 1) (Kehew and Lord 1986, Patterson et al. 1999). So depositional sand and gravel terraces are not a common feature of glacial River Warren in its upstream reaches. Where one does see sand or gravel f anking the upper Minnesota River valley , it is most likely remnants of braided glacial outwash streams or deltas that had formed in the wide, slower parts of the River Warren. There is a broad and complicated area of deltaic and outwash sand in the area near Appleton. It predates the formation of the glacial River Warren trench and is linked to glacial Lake Benson, which formed during ice lobe retreat (Patterson et al. 1999).

A right-angle bend exists in the Minnesota River valley at Mankato. It is likely that this bend was inherited from the course of an earlier stream that developed while the Des Moines lobe was in retreat. This stream appears to have started as an ice-marginal stream that was then used to drain glacial Lake Minnesota. There is no really good reason for a river to make a sharp left-hand turn otherwise and river courses tend to get reused. Glacial Lake Minnesota formed when the Des Moines lobe margin lay in North Mankato.The lake spread south almost to the Iowa border and deposited a fairly continuous blanket of silt and clay that buried the till in much of the Blue Earth watershed. The lake was initially deep enough to spill south through Union Slough into Iowa. Then a lower outlet to the east opened and the lake drained through what are now Waseca and Steele counties. The channel occupied by the chain of lakes that starts in Le Sueur County and trends northeast through Rice County and includes Cannon and Sakatah lakes is another presumed outlet for this lake (Patterson and Hobbs 1995). When the ice lobe receded from North Mankato, even lower ground was revealed and the lake *must have* suddenly and completely drained through a valley trending north. We see no direct evidence of that valley now; it has been completely obscured by the later drainage events of glacial River Warren. However, we do see the evidence for a proglacial lake, the outlets for which were progressively moving north towards lower ground. Some things can never be de f nitively proven, but other explanations for the bend in the river, such as a change in bedrock near the area of the bend (Wright 1972), don't seem to explain the existence of the bend as comprehensively.

Whatever the cause, the bend in the river at Mankato must have set up a mighty eddy. No civil engineer would deliberately create a channel of that shape for fear of erosion along the valley wall and the f otsam and jetsam that would accumulate in a giant, backward circling eddy. The effort of getting the water through here might have even created a hydraulic dam, backing water up in the channel as the river worked its way through the extreme bend, perhaps f ooding the newly formed mouth of the Blue Earth River as evidenced by deposits of sand and gravel that are currently being mined several miles up from the mouth of the river.

The river encountered even more engineering problems downstream of Mankato: buried valleys that had been f lled by deposits of earlier glacial episodes. The valleys were relatively easy to ream out and reoccupy but the river course was also interspersed with resistant, bedrock-reinforced areas. These sedimentary rock layers of sandstone and limestone thus created local nick points that would have migrated up a river (Johnson et al. 1998) already complicated by large f ows of water and strange hydraulics. Some of this history is recorded in the walls of a sand and gravel mine on the broad terrace near Kasota. Fifty-foot high angled beds of sand—foresets—are evidence for a very deep, pooled part of the river valley thatf lled with sand as a bar or delta migrated across tof ll it. The river lies far below this terrace now so it was eventually able to cut through the rock that is also mined here (Kasota stone is the local name given the rock) and form a narrower channel.

With the cessation of lake water discharge from glacial Lake Agassiz, the River Warren valley became grossly oversized for the regional precipitation brought to it by its tributaries. Tributaries to the Minnesota River, the successor to glacial River Warren, were in the process of adjustment to the level of the deeply incised valley and therefore were carrying as much sediment as they could handle, which they delivered to the valley. The Minnesota River was not effective at carrying this sediment away and the tributaries built fans at their mouths. Lakes formed behind these fans and long reaches of the Minnesota River were dammed (Zumberge 1952) to create river lakes that include Big Stone Lake (at the fan of the Whetstone River), Lac Qui Parle Lake (at the fan of the Lac Qui Parle River), and Marsh Lake (at the fan of the Pomme de Terre River) (Wright et al 1998). Much farther south, but in a similar fashion, Lake Pepin was created by a tributary fan from the Chippewa River of Wisconsin (Wright 1990, Wright et al. 1998). Water in Lake Pepin was initially backed up all the way to downtown St. Paul (Zumberge 1952, Wright et al. 1998).

River lakes age in the same way that an artificially dammed river does: they fill with sediment carried by the river. All of the river lakes in the state are gradually filling in as sediment is delivered to these shallow pools. The Minnesota River valley is filling in, or aggrading, everywhere; it is just more obvious in these river lakes. It is also more obvious to us now because modifications we have made to the landscape and drainage network have sped up the rate of sediment delivery (Wright et al. 1998).

Landscapes that avoided the most recent glaciation, but were glaciated previously (Fig. 2.1, southeastern and southwestern regions of Minnesota), are veined with complexly branching tributaries of river systems. Natural lakes simply do not exist in these corners of the state. Here, rivers have effectively drained any formerly flat, wetland- and lake-dotted areas in the hundreds of thousands of years they've had to get the job done. The development of this kind of dendritic drainage

Bedrock of the Minnesota River Valley

Fred S. Harris

The knobs of ancient granite-like bedrock exposed in the Minnesota River valley upstream from New Ulm include some of the oldest rocks discovered at the earth's surface. Several geologists estimate that many of these "crystalline" rocks first formed as igneous rocks from molten magma that cooled very slowly deep below the earth's surface as long as 3.6 billion years ago (Grant 1972), when the core of North America was being formed. Once formed, these early rocks underwent extreme heat and pressure over the next 1 to 1.5 billion years, which altered their crystalline structure and transformed them into metamorphic rock. These rocks include many variants of gneisses and diorites that may be found today in several parts of the valley, such as the Morton Gneiss, which is exposed in the town of Morton.

Other crystalline bedrocks exposed in the valley are far younger in age. These include igneous rocks, such as granite and gabbro, which flowed into (or "intruded") cracks in the older gneisses. Examples include the Sacred Heart Granite, which formed about 2.6 billion years ago, and the Cedar Mountain Complex near Franklin, which dates to 1.8 billion years ago (Grant 1972). Cedar Mountain is a classic example of an igneous intrusion, in which magma flowed into cracks in older rocks. This complex includes an outer ring of gray rock (the Cedar Mountain Gabbro), which encircles an inner zone of pinkish crystalline rock (Cedar Mountain Granodiorite) (Bury 1958, Grant 1972). Today, the Cedar Mountain complex forms the highest point of relief within the Minnesota River valley (Schwartz and Theil 1954).

Sioux Quartzite is a younger bedrock layer exposed in the Minnesota River valley only near New Ulm. Many more exposures of it are located farther south and west. This is a pink-to-purplish rock that formed from sandstone deposited

in a shallow sea (Ojakangas and Matsch 1982). The sandstone (composed of quartz grains) was then transformed into a metamorphic rock (quartzite) by heat and pressure, possibly due to severe compression from tectonic plate movement, which cemented the sand grains into much harder rock. Its dark, purplish color comes from iron oxide coatings on the quartz grains (Austin 1972).

In the eastern part of the Minnesota River valley, sedimentary rocks are exposed that originated as sediments in shallow seas that occupied much of the North American interior 500 million to 430 million years ago (Ojakangas and Matsch 1982). These marine environments contained a rich diversity and abundance of plants and animals, which remain embedded in some of the rocks as fossils. The Canadian Shield, which underlies northern, central, and western Minnesota, was not inundated by these shallow seas; thus these sedimentary rocks are absent from the western part of the Minnesota valley (Ojakangas and Matsch 1982). Major sedimentary rock units exposed in the lower Minnesota valley in order from youngest (400 million years old) to oldest (over 500 million years old) include the following:

- Platteville Limestone: a 35-foot thick layer of hard, fossil-rich limestone on top of the St Peter Sandstone. This is visible along the upper edges of the steep rock clifs along the Mississippi River valley in the Twin Cities.
- St. Peter Sandstone: a 155-foot thick layer of mostly white sandstone that makes up most of the exposed cliffs along the Mississippi River in the Twin Cities.
- Prairie du Chien Group (Shakopee and Oneota Dolomite): a 410-foot thick layer mostly composed of dolomitic limestone. Oneota Dolomite is the locally known Kasota Stone being mined from a glacial river terrace near Kasota, as described above.
- Jordan Sandstone: a 1 15-foot thick layer of whitish to yellowish sandstone exposed near Mankato and Jordan.

network is something that is just getting started in the recently deglaciated landscape of the Des Moines lobe. Eventually, the Des Moines lobe trough should be drained by a dendritic network every bit as complex as what we see in the southeastern and southwestern parts of the state. We can see it happening. The rate and style of drainage development, however, have been altered by the creation of new, artifcial tributaries such as farm tiles and ditches. Geologists are trying to understand the complex responses of the Minnesota River, its river lakes, and its tributaries to these changes.

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3. The Vegetation of the Minnesota River Counties at the Time of the Public Land Surveys (1853 – 1870)

Fred S. Harris

Conservationists want to know what the land was like in the Minnesota River region before most of it was plowed, logged, drained, or developed by Euro-American settlers who began settling in the region in large numbers by the latter half of the 1800s. Effective protection and management of what remains of Minnesota's native vegetation depends in part on understanding its origins.

In the early 1800s, the region was still the domain of Native Americans, though many white trappers and traders such as Joseph Renville had long since established outposts. At that time, the last European and American explorers, such as Nicollet, Geyer, and Featherstonhaugh, traversed the region and left journals, maps, and paintings documenting the terrain. They described many features we can no longer see, including huge prairie fires roaring across the landscape, abundant prairie chickens and "prairie dogs" (likely to be Richardson's ground squirrels), flocks of whooping cranes feeding in wet meadows, and beds of wild rice in many lakes and Minnesota River backwaters. Bison and elk were vanishing by then. Though the explorers encountered many difficult circumstances, they often described the landscape with awe. In 1838, Joseph N. Nicollet recorded the following lines in his journal as his expedition proceded west from what is now New Ulm under the escort of the son of Chief Sleepy Eyes (translated from French in Bray and Bray 1993):

> *"The plateau that opens here presents neither hills nor woods. It is a high, grand, and beautiful prairie. The view to the south seems limitless, the verdure losing itself far away in the azure of the sky. The spectacle is full of grandeur because of its simplicity that contrasts agreeably with the varied and picturesque countryside the valley of the Minnesota presented to us during the last five miles… Our route continues in generally a westerly direction, leaving on the right and on the left a great number of swampy ponds or more often depressions in the soil that form in springtime some many "lakes of grass" as the Indians say. The route is lovely and firm. The prairie plants, tall, plentiful, and varied, indicate that the soil is good."*

THE PUBLIC LAND SURVEYS AND MARSCHNER'S MAP

The best information for mapping Minnesota's pre-European settlement vegetation was gathered later by the Public Land Surveys. From 1853 to 1870, surveyors from the General Land Office (GLO) of the U.S. Congress measured and marked off the grid of township and section lines in the Minnesota River counties so that the land could be sold to farmers and other potential settlers. Townships usually measured six miles on a side and were divided into 36 sections of one square mile each. In order to mark the locations of section corners, surveyors recorded each corner's legal description on axe cuts in three "witness trees" (also called "bearing" trees) facing the corner. They then recorded each tree's species, diameter, compass bearing, and distance from the corner in their survey notebooks (Heinselman 1974). In the open, treeless prairie there were rarely trees for marking corners, so the surveyors often planted tree seeds, including osage orange (which does not survive at this latitude), apple, bur oak, locust, and plum. The surveyors also recorded brief notes for each section line, often noting the types of vegetation they walked through, as well as short summaries of each township.

In 1930, Francis J. Marschner, a research assistant in the Office of Agricultural Economics, U.S. Department of Agriculture, used the GLO surveys to create a hand-colored, 1:500,000 scale map entitled *The Original Vegetation of Minnesota.* Marschner spent an entire year meticulously examining 240 volumes of hand-written GLO surveyor notes, descriptions, and maps to produce his map documenting the patterns of vegetation as they existed

in the mid- to late 1800s. As of 1974, no other map of the pre-settlement vegetation of any U.S. state had ever been made with the same degree of detail as Marschner's (Heinselman 1974).

Today, Marschner's map is the principal tool for understanding Minnesota's vegetation at the time of Euro-American settlement. Other useful information includes GLO surveyor notes archived at the University of Minnesota Libraries, maps of GLO bearing trees (MNDNR), and recorded observations from explorers and surveyors.

Marschner's map shows four of North America's major ecological regions, or provinces (Cleland et al. 1997), converging in Minnesota: Prairie Parkland, Tallgrass Aspen Parklands, Eastern Broadleaf Forest, and Laurentian Mixed Forest (Figure 3.1). The Prairie Parkland Province covers most of the area occupied by tallgrass prairie before settlement. The Tallgrass Aspen Parklands Province was a low plain covered mostly by mosaics of woodlands, prairie, and wetlands, and extends between forested peatlands to the east and tallgrass prairie to the west. The Eastern Broadleaf Forest Province in Minnesota was largely a zone of transition between extensive prairie to the west and forest to the north and east, and is composed of areas of forest, woodland, and wetlands intermixed with some areas of prairie and savanna vegetation. The Laurentian Mixed Forest Province consisted of continuous conifer, conifer-hardwood, hardwood forest, and wetland vegetation.

The Minnesota River counties extend across the full width of Minnesota, covering parts of both the Prairie Parkland and Eastern Broadleaf Forest provinces (Figure 3.1). Figure 3.2 gives a closer view of the vegetation of the region at the time of the GLO surveys as interpreted by Francis Marschner. Table 3.1 gives the acreages of each of the different units of vegetation in the region as recorded on Marschner's map. These vegetation units are described in the following sections.

Prairie

At the time of Euro-American settlement, upland prairie covered by far the largest proportion of the 17 Minnesota River valley counties, covering most of the land south and west of Mankato (Table 3.1, Figures 3.1 and 3.2). In the DNR's modern plant community classification, Marschner's Prairie unit includes Southern Dry Prairie (UPs13), Southern Mesic Prairie (UPs23), and Southern Wet Prairie (WPs54) (MNDNR 2005b). Mesic, tallgrass prairie was the most prevalent community as most of the area consists of mesic, loamy soils formed on rolling till plains and moraine deposits.

Two major factors accounting for the presence of prairie in the region are climate and fire. Grassland climates generally have distinct wet and dry seasons and are noted for temperature and precipitation extremes. In the central Plains of the United States, grassland vegetation is favored over deciduous forest due to a deficiency of rainfall late in the growing season (Sims 1988). With their deep roots

Table 3.1. *Numbers of polygons (mapped areas) and total acres for units in Marschner's map of the vegetation at the time of the Public Land Surveys for the Minnesota River valley counties.*

Pre-settlement Vegetation (Marschner's Units)	Number of Polygons	Total Acres
Aspen-Oak Land	57	101,544
Big Woods (hardwoods: oak, maple, basswood, hickory)	102	951,359
Brush Prairie	6	12,892
Conifer Bogs and Swamps	7	1,964
Lakes (open water)	244	122,033
Oak Openings and Barrens	82	403,666
Prairie	60	4,054,412
River Bottom Forest	44	179,725
Undefined	13	47
Wet Prairies, Marshes, and Sloughs	1,173	768,964
TOTAL	**1,788**	**6,596,606**

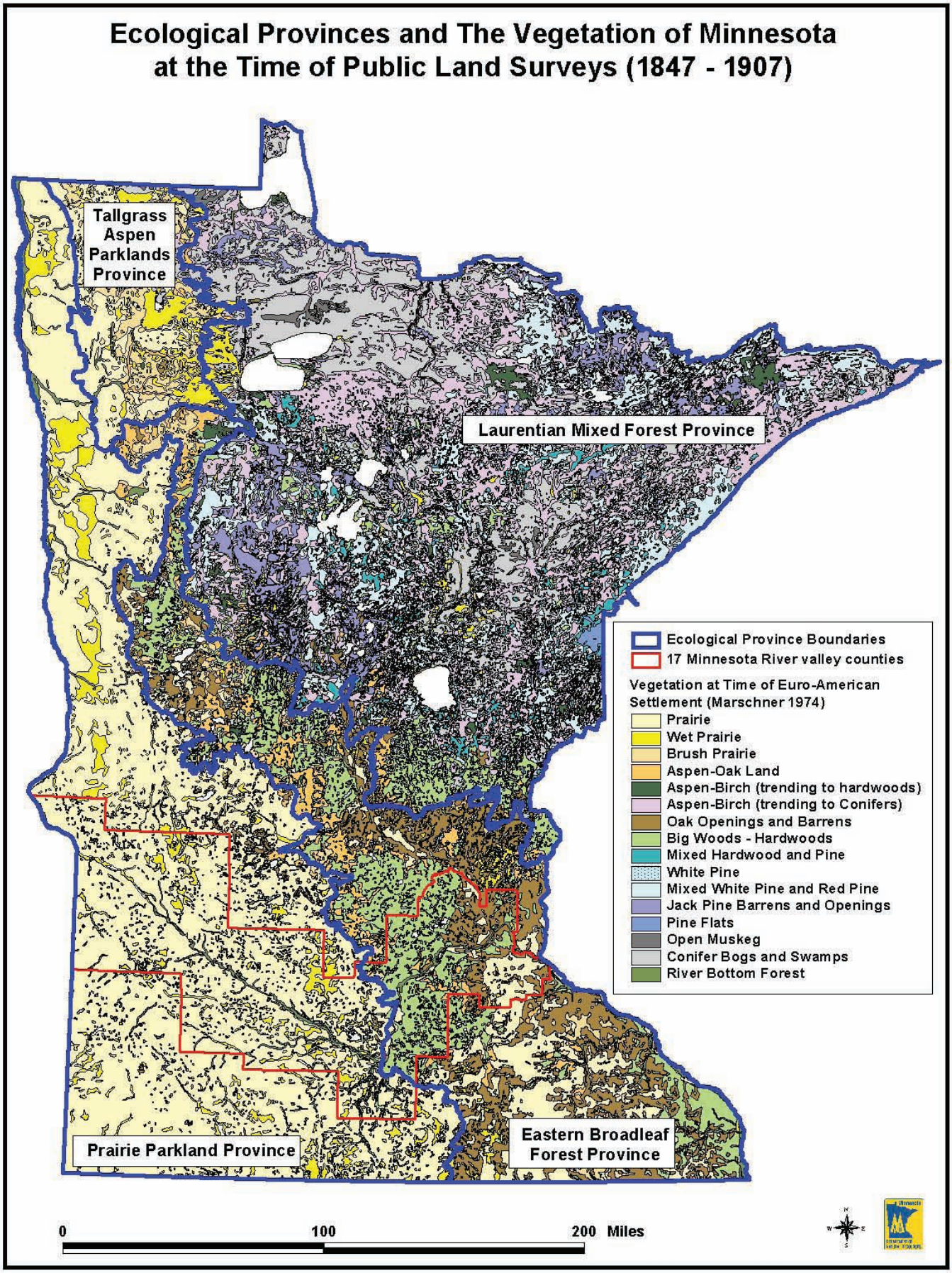

Figure 3.1. *Ecological provinces (MNDNR 2007) and the vegetation of Minnesota at the time of the Public Land Surveys (from Marschner 1974).*

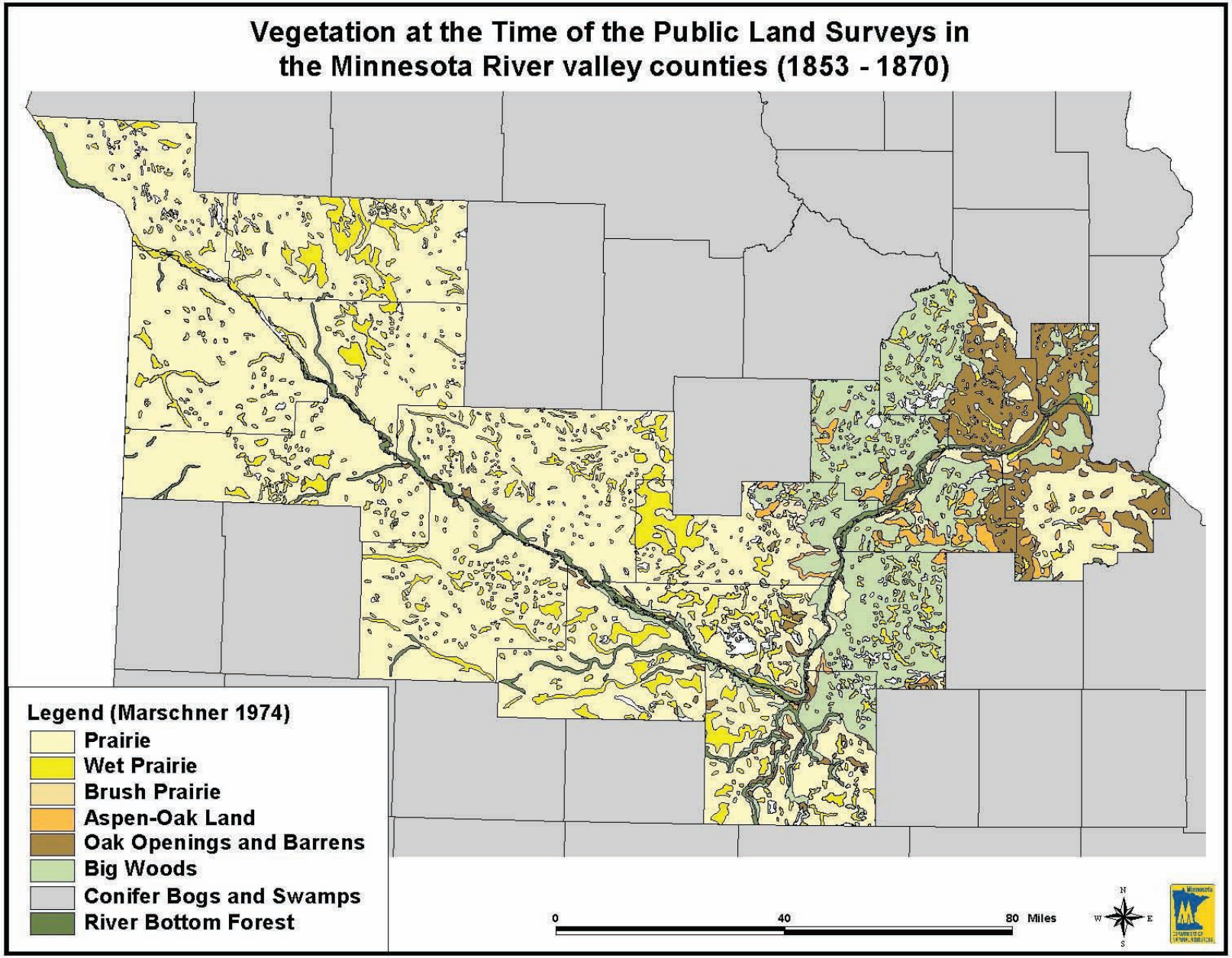

Figure 3.2:. *The vegetation of the Minnesota River valley counties at the time of the Public Land Surveys (from Marschner 1974).*

and ability to regenerate at the base, prairie plants are well adapted to survive periods of drought in mid- to late summer, as well as grazing and frequent fires (Weaver and Fitzpatrick 1980).

The climate in the western part of the Minnesota River valley region, and in western Minnesota in general, is characteristically dry and in the past contributed to widespread occurrence of prairie, especially relative to the eastern parts of the region and the state. For example, although average normal temperature is approximately 45ºF across southern Minnesota, western Minnesota receives significantly less rainfall than eastern Minnesota. From 1941 to 1970, areas along the South Dakota border averaged 20–24 inches of rain per year, whereas areas along the Wisconsin border averaged 32 inches or more per year (Baker and Kuhnast 1978). Evapotranspiration (moisture transpired by plants and evaporated from the soil) is greater in western Minnesota than eastern Minnesota (MNDNR 2000) and magnifies the east to west variation in precipitation. Thus, the moisture available for soil formation and plant growth in western Minnesota is greatly reduced relative to other parts of the state. Cummins and Grigal (1981) classified most of the soils west of New Ulm as dry prairie soils, whereas the prairie soils east of New Ulm are significantly more moist.

Before Euro-American settlement, fires burned annually over large areas of southern Minnesota, thus greatly limiting the frequency and locations of trees over much of the prairie (Grimm 1984). These fires occurred mainly in the spring and autumn, during which prevailing winds were from the southwest, spreading fires northward and eastward, in many instances to the edge of the forest (Tester 1995). In 1835, George Featherstonhaugh witnessed numerous large fires burning across the landscape in the course of his journey up the "St. Peter" [Minnesota] River. These fires moved quickly across the landscape, as recounted by Featherstonhaugh on October 1 just upstream of present day Granite Falls (Featherstonhaugh 1970):

> *"When night fell, the prairies both north and south of us showed themselves brilliantly on fire, though perhaps eight or ten miles off. Before we lay down I pointed out to Milor [his Dakota translator] the danger of our situation encamped in high, thick grass; and it was evident, that, if the wind should change, the fire might gain too rapidly upon us... We were all much too fatigued to keep up a perpetual vigilance, and having fallen into a profound sleep, were not aware that a high wind had arisen about two in the morning, which, driving the flames with wonderful velocity, had set everything on fire down to the water's edge except the low bottom where we were, and which was saved by the grass being rather green and wet. The men, who were awoke by the fire roaring within two or three hundred yards of us, rose in alarm..."*

Some of the fires were caused by lightning strikes, but historical accounts from early settlers and trappers in the region suggest that many fires were set by Native Americans (Higgins 1986). Native Americans purposely used fire as a tool to maintain open land, clear agricultural fields, and modify wildlife habitat (Dorney 1981).

The frequently burned prairie lacked trees, which was of particular concern to GLO surveyors in their assessment of the land's suitability for settling and farming. In 1867, GLO surveyor David Watson commented on Swede Prairie Township in Yellow Medicine County:

> *"The prairie is rolling or gently undulating, being hilly in the south western portion of the town[ship] and bearing most everywhere an unusually heavy growth of grasses are auspicious. To all these favorable conditions for settlers, a most severe draw back is the entire want of timber but the town[ships] east from this being abundantly supplied with timber, this very vein of life in a prairie country, there is all reason to believe that this town[ship] will settle up moderately quick [sic] as settlers are already numerous in the towns[hips] east...In some of the sloughs I found young cottonwood trees growing of one two and even three years growth even in quite isolated places and if the fire could be kept out there is no doubt but that timber would spring up most everywhere."*

In the more humid climate at the east edge of the prairie region, fire, soils, and topography were the most important determinants of the location of the prairie-forest border (Curtis 1959). Along a gradient of decreasing fire frequency, the vegetation changed from open prairie to increasing amounts of woody vegetation, such as in brushland, savanna, and woodland. Mesic hardwood forest developed in areas that did not burn. In southern Minnesota, the boundaries between the open prairie and transitional savanna, and between savanna and hardwood forest, are often sharp and correspond to firebreaks formed by waterbodies (streams, rivers, and lakes) or by breaks in physiography, such as between moraine and outwash plain (Grimm 1984) (see discussion of firebreaks in Oak Openings and Barrens below).

While extensive prairie covered the Prairie Parkland Province, smaller areas of prairie also occurred within the Eastern Broadleaf Forest Province portion of the region, primarily on well-drained, sandy outwash terraces along the Minnesota and Mississippi rivers. These terraces were flatter and drier than the adjacent moraines, as water drains out of the coarse-textured soils on outwash faster than in the loamy to clayey soils of the moraines outside the valley. The excessively-drained soils of outwash terraces caused the vegetation to dry out faster during the growing season, which promoted a greater intensity and frequency of fires (Grimm 1984). Also, these terraces bordering the great rivers were important locations for Native American encampments, and therefore experienced increased rates of human-caused fire ignition. For example, the Wahpeton Dakota people who camped at Little Rapids, along the Minnesota River near Jordan, set fires to clear the brush and open areas for their fields (Spector 1993).

Prairie also occurred in the Eastern Broadleaf Forest Province in Dakota County in the extreme eastern part of the region. Most of this prairie occurred in central and southern Dakota County on outwash plains and till plains, regions of low, level to rolling terrain where fires burned large areas of the landscape. By contrast, in the northern part of the county, the hilly St. Croix Moraine, with its abundant lakes and wetlands, supported hardwood forest.

Wet Prairies, Marshes, and Sloughs

Marschner mapped a wide range of wetland types, in both the Prairie Parkland and Eastern Broadleaf Forest provinces, as Wet Prairies, Marshes and Sloughs. These types included "seasonally inundated grasslands on mineral soil, cattail marshes, sedge and reed-covered peatlands within the forest region, and even some wild rice areas" (Heinselman 1974). In the DNR's modern plant community classification, these wetlands would include any native plant communities occurring within the region in the following systems: Open Rich Peatland, Wet Meadow/Carr, and Marsh (MNDNR 2005a, MNDNR 2005b). Some communities currently classified in the Wetland Prairie System may have been mapped by Marschner in this group, but many were likely mapped in Marschner's Prairie unit.

In the Prairie Parkland Province portion of the Minnesota River valley region, the distribution and abundance of these wetlands were determined by landforms. Numerous, scattered, small-to-large wetlands occurred throughout the till plains and the Big Stone Moraine that make up most of the Prairie Parkland portion of the region. Several large wetlands were present in broad, level river valleys, such as that of the Little Cottonwood River in Brown County and portions of the Cottonwood and Redwood rivers in Redwood County. Lake plains formed by glacial Lake Benson in central Chippewa and Swift counties had large expanses of wetland vegetation. This was not as true for most of the area occupied by glacial Lake Minnesota, south of Mankato, which was mapped mostly as upland prairie. Marschner mapped no wetlands on the edge of the Prairie Coteau in Yellow Medicine County west of Canby, a landscape of steeply sloping hills dissected by numerous streams and rivers running to the northeast.

It is not possible to determine the proportions of different plant community types in Marschner's Wet Prairies, Marshes, and Sloughs unit. The GLO surveyors did note many seasonal wetlands that

were wet in the spring but dried out by mid- to late summer, as these were useful for hay. Such wetlands were likely to have been Wet Meadow/Carr communities.

In the Eastern Broadleaf Forest Province, small-to-large lakes and wetlands were abundant on Marschner's map in the Big Woods region. This was also true in some portions of the areas located east of the Big Woods, but lakes and wetlands were very sparse in Dakota County (Marschner 1974).

Brush Prairie

According to Heinselman (1974), Marschner's Brush Prairie unit "was a fire-maintained mosaic of low shrub thickets, patches of small trees, and bits of prairie, located between the true prairies and the forest region to the east and northeast. The tree component was kept sparse, young, and short by recurrent fires. Aspen often occurred in small clumps or groves." The greater abundance of woody plants indicates a lower fire frequency than in open prairie. In the DNR's current plant community classification, areas mapped by Marschner as Brush Prairie in the 17-county region would most likely correspond to Southern Dry Savanna (UPs14) or Southern Mesic Savanna (UPs24) (MNDNR 2005b).

Few areas in the 17-county region were mapped by Marschner to Brush Prairie, and all are on the margins of open prairie. The largest area mapped to this type is in Green Isle Township of Sibley County, where in 1856 GLO surveyor Ehud Darling noted "much hazel, aspen and prickly ash among many marshes and lakes."

Oak Openings and Barrens

Oak Openings and Barrens were principally "scattered trees and groves of Oaks (mostly bur oaks) of scrubby form with some brush and thickets, in a matrix of tall-grass prairie, and occasionally with Pines. This type group, also fire-maintained, usually occurred as a buffer between the Prairies and Big Woods" (Heinselman 1974). Early observers of the barrens in eastern Hennepin County described "stunted timber" of small and scrubby trees with charred trunks and dense thickets of brush and grass caused by "annual fires that sweep over [the area]" (Grimm 1984). These Oak Openings and Barrens would be described today as Southern Dry Savanna (UPs14) or Southern Mesic Savanna (UPs24) (MNDNR 2005b).

In Big Stone, Lac Qui Parle, Swift, and Chippewa counties, the four westernmost counties in the Minnesota River valley region, very few Oak Openings and Barrens were mapped by Marschner. The only such area in Big Stone County was nestled between two substantial lakes (Bentsen and Thielke) that clearly stopped fires enough for trees and brush to persist. Land surveyor notes indicate that there were several other small groves of upland trees—particularly bur oaks on lake edges—that were too small to be mapped by Marschner. One such example is the woods located on the east side of Monson Lake (now in Monson Lake State Park) in eastern Swift County.

Elsewhere in the Prairie Parkland Province portion of the region, Oak Openings and Barrens were more numerous but were all small areas associated with lakes, wetlands, and streams that afforded protection from fire. One larger oak area bordered Sand Lake in Nicollet County, just north of the large Middle Lake.

In the Eastern Broadleaf Forest Province portion of the region, Oak Openings and Barrens were typically present in areas of transition between prairie and forest. On the western and southern edges of the large area of hardwood forest mapped by Marschner as Big Woods, the transition zone between prairie and forest was narrow and abrupt. In Sibley, Nicollet, and Blue Earth counties, the abrupt transition from Prairie to Big Woods clearly followed several firebreaks. From northwest to southeast, these firebreaks included Schilling Lake, High Island Lake, High Island Creek, Buffalo Creek, Rush River, Minnesota River, Le Sueur River, Lake Elysian, Tetonka Lake, Upper and Lower Sakatah lakes, and the Cannon River (Grimm 1984). Small portions of the transitional woods along these firebreaks were mapped as Oak Openings and Barrens (Marschner 1974). Surveyor Joel Bailey's 1854 description of Water-

ville Township in the southeast corner of Le Sueur County illustrates this abrupt border:

> *"The soil in this township is mostly first rate. South of the lakes [Tetonka and Upper Sakatah] is a pin oak, aspen, crabapple and prickly ash thicket and rolling prairie. North of them Lind [basswood], Sugar [maple], Elm and Ash timber and open uncultivable marshes."*

A large area of Oak Openings and Barrens occupied the eastern edge of the hardwood forest of the Big Woods in Hennepin, Scott, Dakota, and Ramsey counties. The bearing trees of this zone, 50% of which were bur oak, were widely spaced near the prairie and became more closely spaced as one moved toward hardwood forest, indicating a gradient from open savanna to forest (Grimm 1984). Much of this zone was occupied by a dense cover of shrubs, as described by surveyor Hiram C. Fellows in 1854 in New Market Township, Scott County:

> *"The timber is small and scattering, the soil I thought rather poor but upon reflection I have come to the conclusion that no land, save that, that is good could produce half the growth of bushes that cover the entire township."*

The savanna of this "Eastern Oak Area" (Grimm 1984) occurred on hilly end moraines between numerous marshes and small lakes. The prairie to the east of the savanna was generally on flatter and often drier lands, such as Mississippi River outwash terraces in Hennepin County, the Anoka Sand Plain in Ramsey County, and sandy outwash or loamy till plains in Dakota County—where fires were more frequent and extensive.

Marschner's Oak Openings and Barrens also included occasional stands of white pine, which occurred along the margins of the Mississippi River valley in Dakota County.

Aspen-Oak Land

Aspen-Oak Land was another fire-maintained vegetation type that occurred in the transition between open prairie and hardwood forest. Heinselman (1974) noted that this type often consisted of dense, young, closed stands of quaking aspen and big-toothed aspen, several oak species, and probably also elms, ash, and basswood along stream courses.

Potential modern equivalents of this type in the Minnesota River counties would include Southern Dry-Mesic Oak-Aspen Forest (FDs36), Southern Dry Savanna (UPs14), Southern Mesic Savanna (UPs24), and possibly Southern Wet Aspen Forest (WFs55) (MNDNR 2005b).

In the region, Aspen-Oak Land occurred in the Eastern Broadleaf Forest Province in transition zones between Prairie and Big Woods. It was less common than Oak Openings and Barrens (Table 1). As with Oak Openings and Barrens, Aspen-Oak Land had abundant bur oak and was very brushy, as described in 1854 by GLO surveyor Henry Welsh in Helena Township, Scott County:

> *"A heavy, dense undergrowth of hazel, aspen, prickly ash, lianas and briars cover the ground, rendering locomotion almost impossible."*

Big Woods

Marschner (1974) used "Big Woods" as a generic term for richer hardwood forest stands throughout Minnesota. Within the Minnesota River counties, the modern equivalents of this forest include Southern Dry-Mesic Oak Forest (MHs37), Southern Mesic Oak-Basswood Forest (MHs38), Southern Mesic Maple-Basswood Forest (MHs39), and Southern Wet-Mesic Hardwood Forest (MHs49).

This rich hardwood forest extended into the Prairie Parkland Province on slopes along river valleys, where they were protected from fire. Big Woods forest extended westward on steep slopes on both sides of the Minnesota River valley through Nicollet, Blue Earth, and Brown counties. South of Mankato, substantial zones of Big Woods also occurred along the Blue Earth, Maple, Le Sueur, and Little Cobb rivers. GLO surveyor notes indicate that these stands were dominated primarily by northern red oak, elm, and basswood, but the less fire-tolerant sugar maple was present in a few places along these rivers. Modern, ungrazed rem-

nants of these stands, particularly on north-facing slopes, have rich mesic forest herb communities.

The Eastern Broadleaf Forest Province portion of the Minnesota River counties includes the southern end of a large region of hardwood forest extending between St. Cloud and Mankato that came to be known as the Big Woods region. This region corresponds to the Big Woods Ecological Subsection in the Ecological Classification System (ECS) map of Minnesota. Surrounded to the south, east and west by prairie, this "great spur of timber extending south from the northern forests" (Winchell 1875) has been the focus of several researchers trying to understand how and why it existed. Grimm (1984) conducted a detailed analysis of GLO surveyor notes and pollen samples from lake sediments. He confirmed previous evidence that these woods invaded the prairie only 300–400 years ago, which correlates with a time of climatic cooling and presumably a reduction in fire frequency. Other features of the region also point to a decreased fire frequency. The forest formed in heavy clayey-to-loamy soils on rolling, lake-dotted moraines, whereas the lands surrounding the Big Woods are predominantly fatter and drier outwash plains, till plains, or lake plains more conducive to large wildfires. Also, the abrupt boundaries of the forest with fire-maintained prairie, brushlands, and woodlands correspond to numerous firebreaks (see discussion under Oak Openings and Barrens). These three factors in combination apparently diminished the frequency of wildfires enough for the Big Woods hardwood forest to form. Once formed, the forest was highly resistant to burning, as its dense canopy created cool, moist vegetation that did not burn well; indeed, some have called them "asbestos forest."

This forest was dominated by forest-grown and often fire-sensitive trees. Based on his study of the GLO notes, Grimm (1984) found that the percentages of bearing tree species within the Big Woods were: elm (27%), basswood (14%), sugar maple (12%), bur oak (10%), northern red oak (7 %), ironwood (7%), and aspen (7%). Portions of the Big Woods near areas of prairie contained much less sugar maple, a particularly fire-sensitive species.

The Big Woods region was highly desirable for settlers as it provided abundant timber for building and good soils for farming, as enthusiastically noted by GLO surveyor Henry Welsh in eastern Carver County in 1855:

> *"The land in this Twp is generally 1st rate. As there is a great variety in the kinds of land lying, contiguous, it is a very desirable place for farming. Many of the settlers now in it have on their farms as much opening as they want for tillage, a sufficient quantity of timber and a large amount of excellent meadow. While, lakes, springs and brooks everywhere abound. Many claims have valuable Tamarack swamps on them. The timber is principally Blk [red], Br [bur] & W [white] Oak, Sugar [maple], and soft Maple, Lind [basswood] and Elm. It is tolerably thickly settled by persons from the eastern states and Germany. From the great number of Sugar trees the settlers have named it Chanhassen Twp, the Dacotah name for the hard Maple. A Post Office is established bearing the name of the Twp. A schoolhouse and church are nearly completed. Everything indicates thrift, industry and intelligence. A territorial road from Mpls to Fort Ridgely will pass through it, also one from Shakopee to Crow River."*

Over the next century, many farms, towns, and cities were established in the Big Woods region and the forest was progressively reduced into smaller and smaller fragments, until by the late 20th Century, only 2% of it remained (Wovcha and Harris 1998).

River Bottom Forest

Marschner mapped as River Bottom Forest nearly all major floodplain and valley-bottom forests throughout Minnesota. Within the Minnesota River region, the modern equivalent would be primarily Southern Floodplain Forest (FFs68). Some areas of Southern Terrace Forest (FFs59) and Southern Wet-Mesic Hardwood Forest (MHs49) also may have been mapped as River Bottom Forest, although areas of wet-mesic hardwood forest outside of the valley bottoms and surrounded by upland hardwood forest were typically mapped as Big Woods rather than River Bottom Forest.

River Bottom Forest extended deep into the Prairie Parkland Province portion of the region along major river valleys. Floodplain forest covered a continuous corridor on the bottoms of the Minnesota River valley from the river 's confuence with the Mississippi upstream to Montevideo. River Bottom Forest also extended up some of the Minnesota River's larger tributaries, particularly the lower Chippewa, Yellow Medicine, Blue Earth, Maple, and Le Sueur rivers. Some of the smaller streams, including the Cottonwood and the Redwood rivers, lacked forests of silver maple and instead had wetmesic hardwood forest composed predominantly of American elm, rock elm, red elm, basswood and green ash.

Within the Eastern Broadleaf Forest province portion of the region, River Bottom Forest dominated bottomlands in the lower Minnesota and Mississippi rivers, among numerous backwater lakes, marshes, and sloughs.

Conifer Bogs and Swamps

Marschner used Conifer Bogs and Swamps as the map unit for most of the larger forested peatlands in northern Minnesota (Marschner 1974).The very few areas mapped with this unit in the Minnesota River region are all in Hennepin, Carver and Ramsey counties. The modern equivalent of this map unit is Southern Rich Conifer Swamp (FPs63), which is dominated by tamaracks. The GLO land surveyors and settlers prized areas with tamaracks, as they had high economic value for lumber.

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4. Native Plant Communities and Rare Plants of the Minnesota River Valley Counties

Fred S. Harris

The Minnesota County Biological Survey (MCBS) surveyed native plant communities and rare plants within the Minnesota River counties from 1987 to 2002. These results are mapped in the series of five maps that accompany this report (available as pdf files from the DNR website [www.mndnr.gov]). This chapter describes the native plant communities and rare plant species that were documented on these maps.

The classification of native plant communities used in this report is based on *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province* (MNDNR 2005a) and *Field Guide to the Native Plant Communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands Provinces* (MNDNR 2005b). The hierarchical classification in these guides uses vegetation composition, hydrology, landforms, soils, and natural disturbance regimes to categorize plant communities first into system groups, which are further divided into systems, floristic regions, classes, types, and subtypes.

A brief description is given for each native plant community system represented in the Minnesota River valley region. Within each system, the native plant community classes, types and subtypes are described as they are typically found in the region. Most native plant communities were mapped and described at the type level. Where less detailed data were available, communities were mapped and described at the class level. Whether a community description is at the level of type or class can be determined readily by the community code; class codes consist of five-characters (e.g., FDs37), while type codes are composed of the class code followed by a lowercase letter (e.g., FDs37a). The descriptions given here are the map unit descriptions used in the maps accompanying this report.

Common and scientific names of plants in this report follow the Minnesota DNR's *Vascular Plants of Minnesota* checklist from September 25, 2002, available on the Minnesota DNR website (www.mndnr.gov). A complete checklist of plant species documented in the region, organized by county, is given in Appendix A.

NATIVE PLANT COMMUNITIES OVERVIEW

A total of 100,080 acres of native plant communities were mapped by MCBS in the Minnesota valley counties (Table 4.1). This amounts to approximately 2% of the 6,597,816 acres within the 17 counties. Of that 2%, about 65,000 acres, or 65%, occur within one mile of the Minnesota River valley. The Minnesota River valley clearly contains the largest concentration of native plant communities remaining in southwestern Minnesota, a region that has been largely converted to agriculture and urban developments.

Approximately 23,200 acres, or 23%, of the native plant communities remaining in the 17-county region occur along the Minnesota River valley within the four westernmost counties: Big Stone, Lac Qui Parle, Swift, and Chippewa. Other significant concentrations of native plant communities occur on the Big Stone Moraine in Big Stone and Swift counties, on the Prairie Coteau in western Yellow Medicine County, in the Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge in Scott county, in Murphy-Hanrehan Park Reserve in Scott County, and in the Vermillion River Bottoms in Dakota County.

Table 4.1 shows the acreages of each native plant community mapped in the region by MCBS. The surveys of Big Stone and Lac Qui Parle counties, among the first surveys conducted by MCBS, did not include wetland and forest communities. Mesic Prairie (Southern) had the most acreage of all mapped communities. About 19,000 acres, or 93%, of the 20,864 acres of Mesic Prairie (Southern) mapped in the Minnesota River valley region occur in the four western counties: Big Stone, Lac Qui

Table 4.1: *Numbers of polygons (mapped areas) and acres of native plant communities mapped by MCBS in the Minnesota River counties.*

Plant Community Name(* denotes the only communities that were surveyed in Big Stone and Lac Qui Parle counties)	Plant Community Code	Number of Polygons	Total Acres
Dry Sandstone Cliff (Southern)	CTs12a	1	10
White Pine Oak Woodland (Sand)	FDs27b	1	19
Oak - (Red Maple) Woodland	FDs37a	4	186
Pin Oak - Bur Oak Woodland	FDs37b	120	3,261
Silver Maple - (Virginia Creeper) Floodplain Forest	FFs68a	236	13,718
Alder - (Maple - Loosestrife) Swamp	FPn73a	4	47
Tamarack Swamp (Southern)	FPs63a	17	370
Mud Flat (Inland Lake) Saline Subtype*	LKi54b1	1	83
Red Oak - White Oak Forest	MHs37a	31	1,182
Red Oak - White Oak (Sugar Maple) Forest	MHs37b	18	1,489
White Pine - Oak - Sugar Maple Forest	MHs38a	1	29
Basswood - Bur Oak - Green Ash Forest	MHs38b	98	3,687
Red Oak - Sugar Maple - Basswood (Bitternut Hickory) Forest	MHs38c	270	9,826
Southern Mesic Maple-Basswood Forest Class	MHs39	56	1,138
Sugar Maple - Basswood - (Bitternut Hickory) Forest	MHs39a	202	7,283
Sugar Maple Forest (Big Woods)	MHs39c	68	2,294
Elm - Basswood - Black Ash - (Hackberry) Forest	MHs49a	105	2,380
Northern Mixed Cattail Marsh Class	MRn83	12	386
Cattail - Sedge Marsh (Northern)	MRn83a	7	41
Northern Bulrush - Spikerush Marsh	MRn93	7	133
Bulrush Marsh (Northern)	MRn93a	94	4,225
Spikerush - Bur Reed Marsh (Northern)	MRn93b	10	88
Bulrush Marsh (Prairie)	MRp93a	6	2,254
Spikerush - Bur Reed Marsh (Prairie)	MRp93b	4	4
Graminoid Rich Fen (Basin)	OPn92a	6	76
Graminoid - Sphagnum Rich Fen (Basin)	OPn92b	7	35
Calcareous Fen (Southwestern)	OPp93b	31	101
Calcareous Fen (Southeastern)	OPp93c	32	389
Prairie Wetland Complex	PWL_CX	9	298
Rock Outcrop - Dry Prairie Complex	ROP_CX	66	889
Crystalline Bedrock Outcrop (Prairie) Minnesota River Subtype*	ROs12a1	141	1,283
Wet Saline Prairie Complex	SWP_CX	5	178
Dry Barrens Prairie (Southern)*	UPs13a	13	229
Dry Sand - Gravel Prairie (Southern)*	UPs13b	181	2,012
Dry Bedrock Bluff Prairie (Southern)*	UPs13c	29	137
Dry Hill Prairie (Southern)*	UPs13d	626	8,845
Dry Barrens Oak Savanna (Southern) Oak Subtype*	UPs14a2	15	319
Dry Sand - Gravel Oak Savanna (Southern)*	UPs14b	14	388
Dry Hill Oak Savanna*	UPs14c	4	24
Mesic Prairie (Southern)*	UPs23a	457	20,864
Mesic Oak Savanna (Southern)*	UPs24a	2	27
Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral)	WFn55b	1	12
Black Ash - Yellow Birch - Red Maple - Alder Swamp (Eastcentral)	WFn64b	12	215
Lowland Aspen Forest	WFs55a	6	177
Black Ash - (Red Maple) Seepage Swamp	WFs57a	12	17
Willow - Dogwood Shrub Swamp	WMn82a	35	658
Sedge Meadow	WMn82b	78	1,240
Prairie Meadow/ Carr	WMp73a	15	64
Seepage Meadow/ Carr	WMs83a	96	1,628
Wet Seepage Prairie (Southern)*	WPs54a	13	343
Wet Prairie (Southern)*	WPs54b	173	5471
Wet Saline Prairie (Southern)	WPs54c	3	31
TOTAL		**3,455**	**100,080**

Parle, Swift, and Chippewa. Upland prairie was the most common vegetation type in the region at the time of Euro-American settlement, with 4,054,412 acres of "Prairie" mapped by Marschner (1974). The total of 32,087 acres is 0.8% of the total upland prairie acreage recorded in the region at the time of Euro-American settlement.

RARE PLANT SPECIES OVERVIEW

Locations of 89 rare plant species tracked in the Minnesota Natural Heritage Information System (NHIS) of the Minnesota DNR were recorded within the Minnesota River counties since 1970. MCBS biologists, other DNR staff, and non-DNR surveyors identified these locations. The species are given in Table 4.2 and listed in this report following the native plant community classes in which they were documented. Many of the species are also described in this report.

Sixty-three of the rare plant species in this report were listed under the Minnesota Endangered Species Act (MN Statute 84.0895) as of February 2007. Codes accompanying the species names indicate the legal status of the species and are as follows: END = State Endangered; THR = State Threatened; SPC = State Special Concern. Additional species with no legal status, identified as "Not Listed," are tracked in the Natural Heritage Information System because more surveys are needed to assess their rarity.

The legal status of Minnesota's listed rare species was undergoing revision in 2007 and may change for several of the species described in this report, depending on the results of surveys since the previous list revision in 1996. Several plant species were de-listed or lowered in status in the 1996 amendment to list because statewide surveys documented many more new locations than were previously known. Species found in the Minnesota River counties that were removed from Special Concern status in the 1996 list revision include marsh arrow-grass *(Triglochin palustris*), humped bladderwort *(Utricularia gibba)*, halberd-leaved tearthumb *(Polygonum arifolium)*, and mousetail *(Myosurus minimus)*. Also, Hall's sedge *(Carex parryana)* was changed in 1996 from Threatened to Special Concern status. In the 2007 list revision, additional species may be de-listed and others may be elevated in status, depending on survey results and the extent of potential habitat surveyed. See the Minnesota DNR website (www.mndnr.gov) for the most current list.

For further information on many of the state listed rare species listed in this report, refer to Coffin and Pfannmuller (1988) and to an updated guide to the rare species of Minnesota available from the Minnesota DNR website (www.mndnr.gov) in 2007 or 2008.

One of the major groups of rare plant species documented within the Minnesota River counties are species that occur on bedrock outcrops (Table 4.2). The Minnesota River counties region is the stronghold for nearly all of these species in Minnesota, though many also occur on exposures of Sioux quartzite in the southwestern corner of the state. The ball cactus *(Coryphantha vivipara)*, located on rock exposures in Big Stone and Lac Qui Parle counties, is found nowhere else in Minnesota.

Another large proportion of the rare plant species in the Minnesota River counties occur on upland prairies, savannas, and wet prairies (Table 4.2), and are rare due to the severe reduction of their habitats over the last 150 years. Several of the rare species of dry prairies are Great Plains species with the easternmost edges of their distributions in western Minnesota. A few of the rare species of wet or mesic prairie are eastern species that reach the western limits of their U.S. distributions in southeastern Minnesota.

A third major group of rare plants in the Minnesota River counties occurs in calcareous fens (Table 4.2). These wetlands form in unusual conditions of cold groundwater seepage and elevated mineral concentrations, and are among Minnesota's rarest wetland habitats. Several plant species in these fens are found in no other plant community types in Minnesota and are rare due to the natural rarity of their habitat.

Table 4.2: *Legal status, habitat, and numbers of occurrences since 1970 of rare plant species in the Minnesota River counties recorded in the Minnesota Natural Heritage Information System (NHIS) as of February 2007.*

Scientific Name	Common Name	Status*	Primary Habitat in MN River Counties	Number of Occurrences Observed Since 1970#
Agalinis auriculata	Eared False Foxglove	END	Wet prairie	4
Alopecurus carolinianus	Carolina Foxtail		Rock outcrop	36
Arabis laevigata	Smooth Rock-cress		Wet mesic hardwood forest	1
Aristida purpurea var. *longiseta*	Red Three-awn	SPC	Dry prairie	5
Aristida tuberculosa	Sea-beach Needlegrass	SPC	Dry prairie	2
Asclepias amplexicaulis	Clasping Milkweed	SPC	Dry prairie	1
Asclepias sullivantii	Sullivant's Milkweed	THR	Wet prairie	11
Astragalus flexuosus	Slender Milk-vetch	SPC	Dry prairie	41
Astragalus lotiflorus	Low Milk-vetch		Dry prairie	68
Astragalus missouriensis	Missouri Milk-vetch	SPC	Dry prairie	36
Bacopa rotundifolia	Water-hyssop	SPC	Rock outcrop	12
Baptisia alba	White Wild Indigo	SPC	Dry prairie	2
Baptisia bracteata var. *leucophaea*	Plains Wild Indigo	SPC	Dry prairie	1
Besseya bullii	Kitten-tails	THR	Dry prairie, Dry oak savanna	43
Botrychium campestre	Prairie Moonwort	SPC	Dry prairie	10
Buchloe dactyloides	Buffalo Grass	SPC	Rock outcrop	4
Buellia nigra	A Species of Lichen	END	Rock outcrop	14
Cacalia plantaginea	Tuberous Indian-plantain	THR	Wet prairie, Mesic prairie	7
Carex parryana	Hall's Sedge	SPC	Wet prairie	5
Carex sterilis	Sterile Sedge	THR	Calcareous fen	9
Carex vulpenoidea var. *ambigua*	Yellow-fruited Sedge	SPC	Wet prairie	5
Cerastium brachypodum	Mouse-ear Chickweed		Rock outcrop	3
Cirsium hillii	Hill's Thistle	SPC	Dry prairie	5
Cladium mariscoides	Twig-rush	SPC	Calcareous fen	6
Coryphantha vivipara	Ball Cactus	END	Rock outcrop	1
Polanisia jamesii	James' Polanisia	END	Dry prairie	3
Cyperus acuminatus	Short-pointed Umbrella-sedge	THR	Rock outcrop	4
Cypripedium candidum	Small White Lady's-slipper	SPC	Wet prairie, Mesic prairie	95
Dalea candida var. *oligophylla*	White Prairie-clover	SPC	Dry prairie	12
Decodon verticillatus	Waterwillow	SPC	Conifer swamp	4
Desmanthus illinoensis	Prairie Mimosa	SPC	Lake shore	12
Desmodium cuspidatum var. *longifolium*	Big Tick-trefoil	SPC	Mesic hardwood forest	2
Echinochloa walteri	Walter's Barnyard Grass		Emergent marsh, River beach	2
Elatine triandra	Three Stamened Waterwort		Rock outcrop	3
Eleocharis quinqueflora	Few-flowered Spike-rush	SPC	Calcareous fen	2
Eleocharis rostellata	Beaked Spike-rush	THR	Calcareous fen	5
Eleocharis wolfii	Wolf's Spike-rush	END	Rock outcrop	2
Eryngium yuccifolium	Rattlesnake-master	SPC	Wet prairie, Mesic prairie	14
Fimbristylis autumnalis	Autumn Fimbristylis	SPC	Wet meadow, Wet prairie, Lake shore	1
Fimbristylis puberula var. *interior*	Hairy Fimbristylis	END	Calcareous fen	1
Gaura biennis	Biennial Gaura		Dry prairie	1
Gymnocladus dioica	Kentucky Coffee-tree		Wet mesic hardwood forest	17
Helianthemum canadense	Canada Frostweed		Dry prairie, Dry oak savanna	1
Hieracium longipilum	Long-bearded Hawkweed		Dry prairie	14
Hordeum pusillum	Little Barley		Rock outcrop	11
Hudsonia tomentosa	Beach-heather	SPC	Dry prairie	1
Juncus marginatus	Marginated Rush	SPC	Wet meadow, Wet prairie, Lake shore	1
Juniperus horizontalis	Creeping Juniper	SPC	Dry prairie	1
Lechea tenuifolia	Narrow-leaved Pinweed	END	Dry prairie	1
Lespedeza leptostachya	Prairie Bush Clover	THR	Dry prairie	12

Table 4.2: *continued*

Scientific Name	Common Name	Status*	Primary Habitat in MN River Counties	Number of Occurrences Observed Since 1970#
Limosella aquatica	Mudwort	SPC	Rock outcrop	4
Linaria canadensis	Old Field Toadflax		Dry prairie	1
Liparis liliifolia	Lilia-leaved Twayblade		Dry mesic oak woodland	20
Lycopus virginicus	Virginia Water Horehound		Poor fen	1
Machaeranthera pinnatifida	Cutleaf Ironplant	SPC	Dry prairie	12
Minuartia dawsonensis	Rock Sandwort	SPC	Dry prairie	1
Myosotis verna	Forget-me-not		Rock outcrop	10
Myosurus minimus	Mousetail		Rock outcrop	26
Najas marina	Sea Naiad	SPC	Lake	2
Oenothera laciniata	Slashed Evening Primrose		Dry prairie	1
Oenothera rhombipetala	Rhombic-petaled Evening Primrose	SPC	Dry prairie	4
Opuntia humifusa	Plains Prickly Pear	SPC	Rock outcrop	22
Orobanche fasciculata	Clustered Broomrape	SPC	Dry prairie	4
Orobanche ludoviciana	Louisiana Broomrape	SPC	Dry prairie	2
Oxypolis rigidior	Cowbane		Calcareous fen	15
Panax quinquefolius	American Ginseng	SPC	Mesic hardwood forest	40
Platanthera flava var. *herbiola*	Tubercled Rein-orchid	END	Wet prairie	3
Poa arida	Bunch Speargrass		Wet prairie	6
Polygonum arifolium	Halberd-leaved Tearthumb		Conifer swamp	2
Psathyrella rhodospora	A Species of Fungus	END	Mesic hardwood forest	1
Puccinellia nuttalliana	Alkali Grass		Wet prairie	2
Rhynchospora capillacea	Hair-like Beak-rush	THR	Calcareous fen	16
Sagittaria graminea	Grass-like Arrowhead		Emergent marsh	1
Salicornia rubra	Red Saltwort	THR	Lake shore	1
Schedonnardus paniculatus	Tumblegrass	SPC	Rock outcrop	4
Scirpus clintonii	Clinton's Bulrush	SPC	Wet meadow, Wet prairie, Lake shore	3
Scleria triglomerata	Tall Nut-rush	END	Wet meadow, Wet prairie, Lake shore	1
Scleria verticillata	Whorled Nut-rush	THR	Calcareous fen	7
Scutellaria ovata	Ovate-leaved Skullcap	THR	Dry mesic oak woodland	1
Solidago mollis	Soft Goldenrod	SPC	Dry prairie	13
Taenidia integerrima	Yellow Pimpernel		Dry oak savanna	1
Talinum rugospermum	Rough-seeded Fameflower	END	Rock outcrop	1
Triglochin palustris	Marsh Arrow-grass		Calcareous fen	18
Trillium nivale	Snow Trillium	SPC	Mesic hardwood forest	16
Utricularia gibba	Humped Bladderwort		Lake	1
Valeriana edulis ssp. *ciliata*	Valerian	THR	Calcareous fen	12
Viola lanceolata	Lance-leaved Violet	THR	Wet meadow, Wet prairie, Lake shore	1
Viola nuttallii	Yellow Prairie Violet	THR	Dry prairie	6
Woodsia oregana var. *cathcartiana*	Oregon Woodsia		Rock outcrop	1

* Legal status under the Minnesota Endangered Species Act as of February 2007: END = Endangered; THR = Threatened; SPC = Special Concern. Species with no status are non-listed species tracked in the NHIS Rare Features Database. The legal status of rare species is undergoing review and may change in 2007.

Each "occurrence" of a rare species is an area where a population or group of local populations of the species ("metapopulation") was observed.

Rare plant species that have not been recorded in the region since 1970 are listed in Table 4.3. Many of these were outliers of northern or eastern deciduous forest or wetland species on the far edges of their distributions, and were never common in the region; some are species for which very few records have ever been recorded in Minnesota; and at least one species, *Platanthera praeclara*, is rare because its once widespread habitat in the region (wet prairie) was severely reduced to small fragments following European settlement.

Table 4.3: *Rare plant species in the Minnesota Natural Heritage Information System (NHIS) not recorded in the Minnesota River counties since 1970.*

Scientific Name	Common Name	Status as of February 2007*	Last Observed Date#
Actaea pachypoda	White baneberry		1890-05-
Agalinis purpurea	Purple gerardia		1891-08-
Arethusa bulbosa	Dragon's-mouth		1885
Arisaema dracontium	Green dragon		1904-06-10
Atriplex glabriuscula	Smoothish orach		1960-09-29
Aureolaria pedicularia	Fernleaf false foxglove	THR	1896
Callitriche heterophylla	Larger water starwort	SPC	1946-06-06
Carex formosa	Handsome sedge	END	1878-05-
Carex plantaginea	Plantain-leaved sedge	END	1903-05-06
Cephalanthus occidentalis	Buttonbush		1967-07-10
Cuscuta polygonorum	Smartweed dodder		1918-09-20
Cypripedium arietinum	Ram's-head lady's-slipper	THR	1911-05-20
Dermatocarpon moulinsii	A species of lichen	END	1896-07-31
Drosera linearis	Linear-leaved sundew	SPC	1878-07-18
Dryopteris goldiana	Goldie's fern	SPC	1891-06-
Eleocharis parvula	Dwarf spike-rush	SPC	1939-08-22
Huperzia porophila	Rock clubmoss	THR	1902-09-24
Juncus articulatus	Jointed rush		1926-09-15
Juncus brachycarpus	Short-fruited rush		1948-08-03
Leptogium apalachense	A species of lichen	END	1899-06-26
Monolepis nuttalliana	Povertyweed		1944-06-14
Najas gracillima	Thread-like naiad	SPC	1936-10-05
Platanthera clavellata	Club-spur orchid	SPC	1890-07-
Platanthera praeclara	Western prairie fringed orchid	END	1892-07
Polygala cruciata	Cross-leaved milkwort	END	1896-07-01
Potamogeton diversifolius	Diverse-leaved pondweed	END	1945-10-09
Potentilla nicolletii	Nicollet's cinquefoil		1958-09-18
Psathyrella cystidiosa	A species of fungus	END	1912-08-17
Psoralidium tenuiflora	Slender-leaved scurf pea	END	1890-07
Rorippa sessiliflora	Sessile-flowered cress	SPC	1891-07-
Rotala ramosior	Toothcup	THR	1890-08
Rubus semisetosus	Half bristly bramble		1952-07-03
Rudbeckia triloba	Three-leaved coneflower	SPC	1960-08-16
Ruppia maritima	Widgeon-grass	SPC	1937-08-29
Sagittaria montevidensis	Long-lobed arrowhead		1889-08-
Triodanis leptocarpa	Venus' looking-glass		1939-06-25
Verbena simplex	Narrow-leaved vervain	SPC	1891-06-
Xyris torta	Twisted yellow-eyed grass	END	1889-08

* Legal Status under the Minnesota Endangered Species Act (MN Statute 84.0895) as of February 2007: END = Endangered THR = Threatened SPC = Special Concern. Other species with no status in this table are species that are tracked in the NHIS Rare Features Database. These species are referenced in the report as "Not Listed."

Date of the most recent observation recorded in the Minnesota River counties in the NHIS Rare Features Database.

FIRE-DEPENDENT FOREST/WOODLAND SYSTEM

Fire-Dependent Forest/Woodland communities are strongly influenced by wild fires. The dominant tree species are species with "seeds or vegetative structures designed to survive fire, or are opportunists that can take advantage of short periods when nutrient levels are low and light levels are high" (MNDNR 2005a). These communities typically lack much development of a tree subcanopy layer but the shrub cover is often dense. In the prairie region, many contemporary woodland communities developed from areas of savanna or brushland following settlement and suppression of the frequent fires that had maintained the latter communities. These stands occur on coarse, sandy, or gravelly soils or shallow soils over bedrock (MNDNR 2005a). These communities are likely mapped as Aspen - Oak Land, Brush Prairie, or Oak Openings and Barrens on the map of the vegetation of Minnesota at the time of the Public Land surveys (Marschner 1974).

FDs27 Southern Dry-Mesic Pine-Oak Woodland Class

Map Unit Description:

FDs27b White Pine - Oak Woodland (Sand)

Dry-mesic woodlands on steep slopes on sandy outwash deposits. Fires were common historically. Patchy to interrupted canopy (25-75% cover) dominated by white pine, with lesser amounts of northern red oak, white oak, bur oak, and paper birch. Common subcanopy species are white pine, northern red oak and paper birch; basswood, black cherry, and quaking aspen may also be present. Low to high shrub cover includes red raspberry, chokecherry, American hazelnut, prickly ash, and gray dogwood. Common herbs include lopseed, wild sarsaparilla, heart-leaved aster, northern bedstraw, zig-zag goldenrod, common enchanter's nightshade, and hog peanut.

Native Plant Community Survey Results:

At the time of Euro-American settlement, White Pine - Oak Woodland (Sand) had a very limited range in the Minnesota River counties, as it was

Figure 4.1: *Dry-mesic pine-oak woodland in the Mississippi River valley at Pine Bend Bluffs SNA, Dakota County. MNDNR photo by H. Texler.*

conf ned to areas of excessively-drained sandy outwash deposits bordering the Mississippi River in Dakota County. Marschner did not map a distinct pine-dominated vegetation type within the Minnesota River valley region; instead he mapped communities containing mixtures of pine and oak within the Oak Openings and Barrens unit (Marschner 1974). The one location mapped by MCBS occurs on a deep sandy outwash deposit along the Mississippi River's "Pine Bend" on the eastern edge of Dakota County. Scattered white pines occur elsewhere on the bluffs in the vicinity of this stand as minor components of stands mapped as Red Oak - White Oak Forest (MHs37a).

Rare Plant Records:
Kittentails *(Besseya bullii)* THR (Fig. 4.41)

FDs37 Southern Dry-Mesic Oak (Maple) Woodland Class

Map Unit Descriptions:

FDs37a Oak - (Red Maple) Woodland
Dry-mesic woodlands on undulating, sandy outwash and rolling to hummocky, sandy or gravelly glacial till. Historically fires were common and many stands were brushlands 100 years ago. Interrupted to continuous canopy (50-100% cover) dominated by northern red oak, northern pin oak, and white oak, with lesser amounts of bur oak and red maple. Subcanopy either absent or composed of red maple. Chokecherry, American hazelnut, gray dogwood and bush honeysuckle are common shrubs. Common herbs include pointed-leaved tick trefoil, Clayton's sweet cicely, wild geranium, lady fern, bracken, wild sarsaparilla, and Pennsylvania sedge.

FDs37b Pin Oak - Bur Oak Woodland
Dry-mesic woodlands on well-drained soils formed in sandy outwash deposits or occasionally on sandy or gravelly glacial till, often on south- to west-facing slopes. Historically, fires were common and many stands were brushlands 100 years ago. Interrupted to continuous canopy (50-100% cover) dominated by open-grown bur oak and/or northern pin oak, and often including paper birch, eastern red cedar, and quaking aspen. Understory is generally patchy to barely present and typically contains ironwood, green ash, and bur oak. Shrub layer typically is dense and commonly includes chokecherry, gray dogwood, prickly ash, prickly gooseberry, and downy arrow-wood. Ground layer consists of moderately shade-tolerant species, including hog peanut, pointed-leaved tick trefoil, white snakeroot, Clayton's sweet cicely, woodland sunflower, northern bedstraw, golden alexanders, and Pennsylvania sedge.

Native Plant Community Survey Results:
Three locations for Oak - (Red Maple) Woodlands were mapped by MCBS in Ramsey and Dakota counties. These occurred on well-drained soils on stagnation moraine or outwash deposits in the Anoka Sandplain and the St Paul Baldwin Plains and Moraines ecological subsections. Several of the characteristic species of this community type are northern species with limited distribution in the Minnesota River valley region, including red maple (a common subcanopy and canopy tree), large-leaved aster, starflower, and pale bellwort. Pin Oak - Bur Oak Woodlands were mapped by MCBS in several locations along the north side of

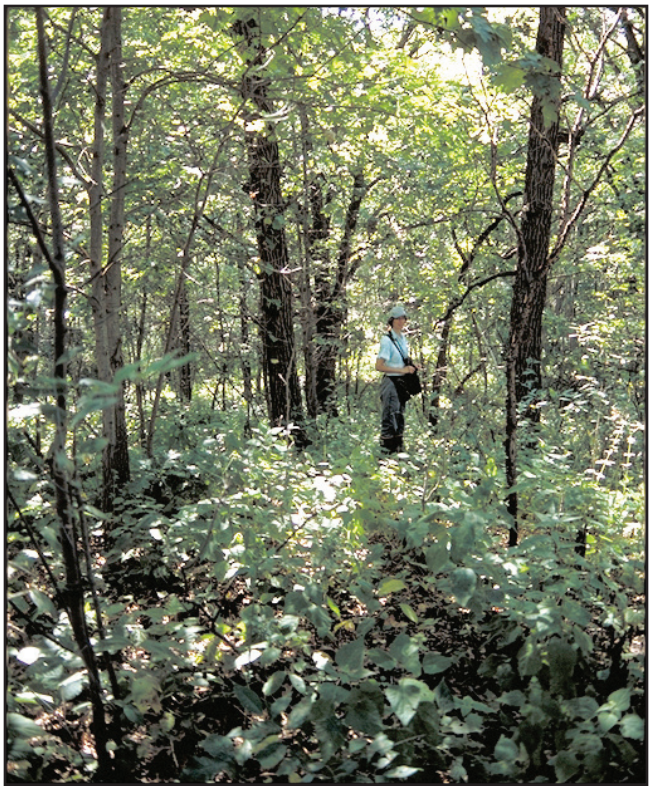

Figure 4.2: *Oak - (red maple) woodland on gravelly till in the Mississippi River valley, Katherine Ordway Natural History Study Area (Macalester College), Dakota County. MNDNR photo by H. Texler.*

the Minnesota River valley on steep south-facing slopes, mostly on soils formed in excessively-drained outwash deposits, with some on soils formed in gravelly till. Many of these sites alternate with open areas of Dry Sand-Gravel Prairie or Dry Hill Prairie. Most of these woodlands are in fair to poor condition due to past grazing.

Surveys for Pin Oak - Bur Oak Woodland were not conducted in Lac Qui Parle and Big Stone counties.

Rare Plant Records:
Ginseng *(Panax quinquefolium)* SPC (Fig. 4.9)
Kittentails *(Besseya bullii)* THR (Fig. 4.41)
Lilia-leaved twayblade *(Liparis liliifolia)* Not Listed (Fig. 4.3)

Figure 4.3: *Lilia-leaved twayblade (Liparis liliifolia), a rare species of dry-mesic oak woodland and prairie openings, Battle Creek Regional Park, Ramsey County. MNDNR photo by W. Smith.*

MESIC HARDWOOD FOREST SYSTEM

Mesic Hardwood Forests are upland communities on moist soils, usually in settings protected from fire. They are dominated by continuous canopies of deciduous trees including sugar maple, basswood, bur oak, northern red oak, and green ash (MNDNR 2005a). The stands in the region are located primarily in the Eastern Broadleaf Forest Province, including the counties north and east of Mankato, which contained extensive hardwood forests at the time of Euro-American settlement (Marschner 1974). In the prairie region, scattered stands are associated with features, such as lakes and rivers, that historically protected them from fire. Sugar maple, a fire sensitive species, is absent from much of the prairie region.

Much of the region's deciduous forest has been fragmented. Marschner's map indicates approximately 951,359 acres of "Big Woods - Hardwoods" were present in the Minnesota River valley counties at the time of Euro-American settlement (Table 3.1). Recent surveys by MCBS documented a total of just 26,637 acres of mesic and wet-mesic hardwood forest (MHs38, MHs39, MHs49) and an additional 2,671 acres of dry-mesic hardwood forest (MHs37), the modern analogues of Marschner's Big Woods forests (Table 4.1). This remaining acreage represents approximately 2.7% of the area mapped as Big Woods - Hardwoods by Marschner. Some of the oak-dominated forests in classes MHs37 and MHs38 were mapped by Marschner as Oak Openings and Barrens, so the actual percent of Marschner's Big Woods unit that remains is 2% or less. The hardwood forests of the Big Woods ecological subsection, located on the west edge of the Twin Cities Metropolitan Area, have been greatly fragmented by agriculture and urban development, with only 2% of these forests remaining (Wovcha and Harris 1998).

Many of the region's larger forest remnants are on steep slopes of river valleys or stagnation moraines, areas unsuitable for cultivation or houses. A few large, continuous blocks (1,000 acres or more) of deciduous hardwood forest remain today in the lower reaches of the Rush River Valley (Sibley County), the lower reaches of the High Island Creek Valley (Sibley County), in Blakeley Township (Scott County), and at Murphy-Hanrehan Park Reserve (Scott County).

Most forests in the region are in degraded condition due to poor logging practices, the presence of invasive, non-native shrubs and herbaceous

species, and, in some cases, past grazing. Logging activities that have tar geted certain species, such as oaks, have greatly reduced the abundance of these species (or even eliminated them) in some stands. Several lar ge forest areas within or on the edge of the prairie region were divided into numerous small woodlots that have been managed for f rewood and lumber by several generations of farm families. Examples of these forests occur along the Cottonwood River in Brown County and the Rush River in Sibley County.

MHs37 Southern Dry-Mesic Oak Forest Class

Map Unit Descriptions:

MHs37a Red Oak - White Oak Forest

Dry-mesic forests on sandy or gravelly moraine or outwash deposits; on slopes with shallow soil over bedrock along the Mississippi River bluf fs; or on steep slopes on outwash terraces in the Minnesota River valley. Interrupted to continuous canopy (50-100% cover) dominated by northern red oak and white oak, with occasional quaking aspen, big-toothed aspen, basswood, green ash, and black cherry. Subcanopy composed of the same species present in the canopy plus American elm. Shrub layer commonly contains American hazelnut, gray dogwood, round-leaved dogwood, and black cherry. Common forbs are hog peanut, lar ge-f owered bellwort, white snakeroot, woodland sunf ower, and Canada mayf ower.

MHs37b Red Oak - White Oak - (Sugar Maple) Forest

Dry-mesic forests on sandy or gravelly moraine or outwash deposits; on slopes with shallow soil over bedrock along the Mississippi River bluf fs; or on steep slopes on outwash terraces in the Minnesota River valley. Generally on more mesic sites than MHs37a. Interrupted to continuous canopy (50-100% cover) dominated by northern red oak and white oak, with sugar maple, red elm, bitternut hickory, and basswood also common in the canopy. Sugar maple and ironwood are common in the understory. Shrub layer typically contains American hazelnut, Missouri gooseberry, prickly ash, and black raspberry. Common herbs include wood nettle, wild geranium, lopseed, shining bedstraw, rugulose violet, pale touch-me-not, starry sedge, and wood anemone.

Figure 4.4: *Red oak - white oak forest at Murphy-Hanrehan Park Reserve, Scott County. MNDNR photo by D. Wovcha.*

Native Plant Community Survey Results:
Scattered stands of Southern Dry-Mesic Oak Forest occur in the eastern end of the Minnesota River valley region within the Eastern Broadleaf Forest Province, predominantly in areas mapped as Oak Openings and Barrens in the map of the vegetation at the time of Euro-American settlement (Marschner 1974). Several of the stands mapped by MCBS occur in association with open areas of dry prairie. The largest remnant of these forests is within Murphy-Hanrehan Park Reserve in eastern Scott County and adjacent parts of Dakota County.

Rare Plant Records:
Kittentails *(Besseya bullii)* THR (Fig. 4.41)
Ovate-leaved skullcap *(Scutellaria ovata)* THR

MHs38 Southern Mesic Oak-Basswood Forest Class

Map Unit Descriptions:

MHs38a White Pine - Oak - Sugar Maple Forest
Mesic forests on wind-deposited silt or residuum over bedrock, typically on steep north- to east-facing slopes in southeastern Minnesota. Supercanopy of scattered white pines is present above canopy dominated by northern red oak, sugar maple, and basswood. Understory has abundant ironwood and sugar maple, occasionally with scattered white pine. Common shrubs include chokecherry, nannyberry, and pagoda dogwood. Ground layer composed of common herbs of mesic hardwood forests, including wild geranium, bloodroot, Clayton's sweet cicely, wood anemone, Pennsylvania sedge, and long-stalked sedge.

MHs38b Basswood - Bur Oak - (Green Ash) Forest
Mesic forests on hummocky topography of rolling till plains or stagnation moraines. Interrupted to continuous canopy (50-100% cover) dominated mostly by bur oak, basswood, and green ash. Understory usually contains ironwood, and occasionally basswood, green ash, and red elm. Shrub layer is sparse and typically contains prickly gooseberry and prickly ash. Ground layer commonly contains Virginia waterleaf, zig-zag goldenrod, Clayton's sweet cicely, wild geranium, lopseed, Jack-in-the-pulpit, blue cohosh, nodding trillium, and bloodroot.

Figure 4.5*: Red oak - sugar maple - basswood - (bitternut hickory) forest at Blakeley Wayside, Scott County. MNDNR photo by F. Harris.*

MHs38c Red Oak - Sugar Maple - Basswood - (Bitternut Hickory) Forest
Mesic forests on hummocky till plains or moraines, often on steep north-facing slopes in stream valleys. Interrupted to continuous canopy (50-100% cover) dominated primarily by straight-trunked northern red oak, with abundant sugar maple and basswood; other canopy trees include bitternut hickory, green ash, and bur oak. Sugar maple and ironwood are the most abundant trees in the subcanopy , with bitternut hickory usually present. Shrub layer is sparse and commonly contains prickly gooseberry, sugar maple, prickly ash, chokecherry, and pagoda dogwood. Common herbaceous species include Clayton's sweet cicely , common enchanter 's nightshade, Virginia waterleaf, bloodroot, lar ge-f owered bellwort, zig-zag goldenrod, and wild sarsaparilla.

Native Plant Community Survey Results:
A distinct white pine-dominated vegetation type was not mapped in the Minnesota River counties in the pre-European settlement vegetation map (Marschner 1974), though narrow zones of white pines did occur along Mississippi River bluf fs in Dakota County . The one location of White Pine - Oak - Sugar Maple Forest (MHs38a) mapped in the region by MCBS occurs within the northernmost extent of the Bluf f ands ecological subsection along a tributary of the Cannon River in the southeast corner of Dakota County in the Miesville Ravine Park Reserve. This community type occurs frequently farther southeast in the Bluff ands of southeastern Minnesota (MCBS 2005a). Other white pine-dominated stands in Dakota county occurring on excessively-drained sand were classi f ed and mapped as White Pine - Oak Woodland (Sand) (FDs27b) due to their distinctly dry-mesic f oras.

Basswood - Bur Oak - (Green Ash) Forest (MHs38b) stands occur throughout the Prairie Parkland Province portion of the 17-county region but were not surveyed or mapped in Lac Qui Parle and Big Stone counties. These stands originated predominantly as small islands of forest protected by f rebreaks and surrounded by prairie. They contain many common mesic forest plant species but lack sugar maple, a highlyf re sensitive species that is absent from most of the Prairie Parkland Province. These stands were mostly classi f ed as Oak Openings and Barrens on the pre-European settlement vegetation map (Marschner 1974) and are dominated mostly by open-grown bur oaks, indicating they were once open savannas or woodlands. Because they occur in mesic soils, these stands have under gone succession to mesic forest fairly rapidly following f re suppression since Euro-American settlement.

Figure 4. 6: *Basswood - bur oak - (green ash) forest on level terrain adjacent to the north side of the Minnesota River valley near Morton, Renville County. MNDNR photo by F. Harris.*

Several Basswood - Bur Oak - (Green Ash) For-est stands occur west of Nicollet County along the north side of the Minnesota River valley. This fol-lows an overall pattern of lar ger woodland rem-nants on the north or east sides of f rebreaks in the prairie region of southern Minnesota due to f res typically sweeping from southwest to northeast (Grimm 1984). Some of the lar gest stands occur along tributaries at their junctions with the Min-

nesota River valley, such as in Renville County along Hawk Creek, Middle Creek, and Beaver Creek. Other stands are associated with lakes, such as at Monson Lake State Park in eastern Swift County and at Sand Lake in Nicollet County. Several stands occurring south of the Minnesota River valley are associated with smaller rivers or creek valleys, such as at Ramsey Park at the junction of Ramsey Creek and the Redwood River , and in central Blue Earth County north of the Little Cobb River. Portions of these stands were never grazed and contain a high diversity of native hardwood forest wildf owers.

Red Oak - Sugar Maple - Basswood - (Bitternut Hickory) Forest (MHs38c) occurs throughout the region within the Eastern Broadleaf Forest Province and adjacent portions of the Prairie Parkland Province. These stands appear to have been more protected from f re than MHs38b as they are dominated by forest-grown northern red oaks and commonly contain sugar maple. On the pre-settlement vegetation map, these stands predominantly occur within the Big Woods unit, but also in areas mapped as Oak Openings and Barrens (Marschner 1974). Narrow bands of these forests extended into the Prairie Parkland Province along river valleys, particularly along the Minnesota River valley in Nicollet and Brown counties, and along the Blue Earth, Maple, and Le Sueur River valleys south of Mankato in Blue Earth County. Many of these stands have high sugar maple reproduction and are succeeding into forests dominated more by maples and less by oaks. Few remnants remain in outstanding condition as many stands were subjected to grazing and selective logging. An excellent example can be seen at Sakatah Lake State Park in Le Sueur County; it is located on the south side of a major f rebreak (Sakatah Lake) on the edge of the prairie-forest border (Grimm 1984).

Rare Plant Records:

Big tick-trefoil *(Desmodium cuspidatum var. longifolium)* SPC
Ginseng *(Panax quinquefolium)* SPC (Fig. 4.9)
Lilia-leaved twayblade *(Liparis liliifolia)* Not Listed (Fig. 4.3)
Snow trillium *(Trillium nivale)* SPC (Fig. 4.10)
Smooth rock-cress *(Arabis laevigata)* Not Listed

Big tick-trefoil was located only twice in the Minnesota River counties since 1970, both times in southern Dakota county, and appears to be fairly rare in Minnesota.

MHs39 Southern Mesic Maple-Basswood Forest Class

Map Unit Descriptions:

MHs39a Sugar Maple - Basswood - (Bitternut Hickory) Forest

Mesic forests mostly on north-facing slopes on loamy soils derived from calcareous till of stagnation moraines and till plains. Interrupted to continuous canopy (50-100% cover) dominated primarily by forest-grown basswood, sugar maple and northern red oak; green ash, red elm, bitternut hickory, black ash, and white oak may also be present in the canopy. Ironwood and sugar maple are the most abundant subcanopy species. Shrub layer is generally sparse and typically includes prickly gooseberry, chokecherry, pagoda dogwood, and bitternut hickory . Common herbs include bloodroot, Virginia waterleaf, wild leek, lar ge-f owered bellwort, rugulose violet, yellow violet, and blue cohosh.

MHs39c Sugar Maple Forest (Big Woods)

Mesic forests on gently sloping sites with loamy soils derived from calcareous till of stagnation moraines and till plains. Interrupted to continuous canopy (50-100% cover) dominated primarily by forest-grown sugar maple and basswood; other frequent canopy species include northern red oak, bur oak, hackberry, and red elm. Subcanopy often dominated by sugar maple and usually contains basswood and hackberry. Shrub layer is usually sparse and commonly contains prickly gooseberry, red-berried elder, and chokecherry. Ground layer dominated through much of the growing season by wood nettle; other common herbs include cleavers, Virginia waterleaf, bloodroot, lar ge-f owered bellwort, rugulose violet, yellow violet, puttyroot, wild leek, and nodding trillium. Spring ephemeral wildf owers such as Dutchman' s breeches, cut-leaved toothwort, and white trout lily are present.

Figure 4.7: *Sugar maple forest (Big Woods) with a dense carpet of emerging wildflowers in early spring, Hennepin County. MNDNR photo by D. Wovcha.*

Native Plant Community Survey Results:
Southern Mesic Maple - Basswood Forest stands were a major component of the hardwood forests that covered most of the Big Woods region at the time of Euro-American settlement (Grimm 1984). Today, most of these forests remain as small fragments, following extensive clearing for agriculture and suburban development in the region. Many remnants have been used for maple-sugaring. Most stands have had varying degrees of selective logging, which in many cases altered the canopy tree composition by selecting out specific species, particularly oaks. Due to Dutch elm disease, the remaining stands have also been altered by the loss of American elms, which co-dominated these forests at the time of Euro-American settlement. Several stands have ground layers denuded by consumption of soil organic matter by exotic earthworms, herbivory by deer, past grazing by livestock, and/or heavy shade created by dense sugar maple saplings (Wovcha and Harris 1998). The combination of high deer densities and expanding populations of earthworms poses a serious threat to the diverse wildflower communities in the region's remaining high quality forest remnants (Augustine and Frelich 1998, Frelich et al. 2006).

High-quality forest stands containing a rich diversity of herbaceous plants in the groundlayer remain at the following locations: Seven Mile Creek County Park, North Star Unit of Swan Lake Wildlife Management Area (WMA), and along Barney Fry Creek in Nicollet County; Richter Woods County Park in Le Sueur County; along High Island Creek in Sibley County; and Elm Creek Park Reserve and Henry Woods in Hennepin County. Wolsfeld Woods Scientific and Natural Area (SNA) in Hennepin County is an outstanding old-growth forest. Minneopa State Park in Blue Earth County has a beautiful example on steep north-facing slopes below Minneopa Falls that contains outliers of northern plants including yellow birch and bush honeysuckle.

Rare Plant Records:
Ginseng *(Panax quinquefolium)* SPC (Fig. 4.9)
Kentucky coffee tree *(Gymnocladus dioica)*
Not Listed (Fig. 4.13)
Snow trillium *(Trillium nivale)* SPC (Fig. 4.10)

Very few locations of rare plants were documented in mesic hardwood forests in the region. Searches for several rare plant species that had been documented in Big Woods hardwood forest in the early 1900s were unsuccessful, including handsome sedge,

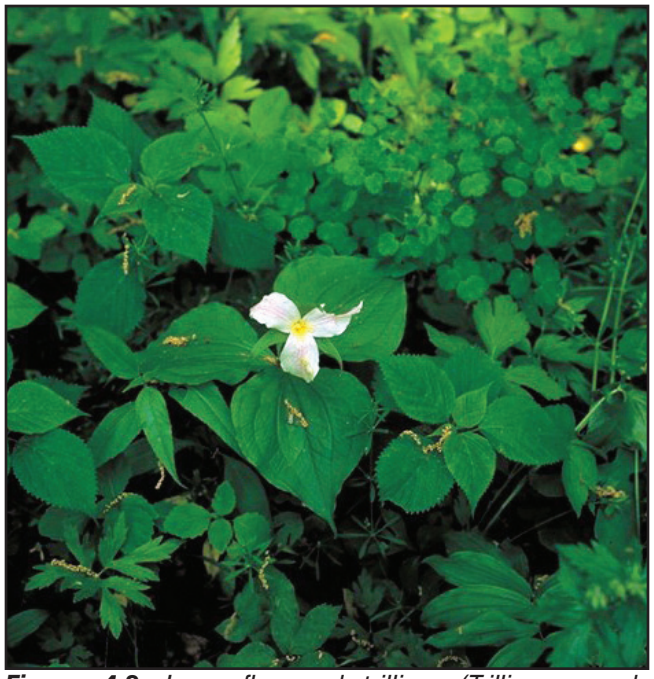

Figure 4.8: *Large-flowered trillium (Trillium grandiflorum) in sugar maple–basswood (bitternut hickory) forest along Barney Fry Creek, Nicollet County. MNDNR photo by F. Harris.*

Goldie's fern, and plantain-leaved sedge (Table 4.3). These species were probably never common in the Big Woods region but still persist in a few hardwood forests in the Bluffands subsection of southeastern Minnesota.

Ginseng (Fig. 4.9) is rare throughout its range in mesic oak and maple-basswood forests in southern Minnesota, as it has been harvested since the 1850s. Several small populations of plants persist in small valleys of Minnesota River tributaries.

Snow trillium (Fig. 4.10), the smallest of Minnesota's four trillium species, grows in moist, silty soils in mesic hardwood forests. It is one of the first wildflowers to emerge in the spring, sometimes flowering in mid-April before the last snows have melted. The state's highest concentration of this species occurs in Blue Earth County in hardwood forests on steep north-facing slopes within river valleys south of Mankato. These stands are on moist, silt loam soils that originated from deposits of glacial Lake Minnesota. Snow trillium may also be seen on north-facing slopes in Seven Mile Creek County Park in Nicollet County.

Figure 4.9: *Ginseng (Panax quinquefolium), a rare plant due to more than a century of harvesting, survives in mesic hardwood forests in a few tributary valleys of Minnesota River. MNDNR photo by W. Smith.*

Figure 4.10: *Minnesota's greatest concentration of populations of the rare snow trillium (Trillium nivale), which flowers in April, is in mesic hardwood forests in river valleys south of Mankato. MNDNR photo by S. Zager.*

MHs49 Southern Wet-Mesic Hardwood Forest Class

Map Unit Descriptions:

MHs49a Elm - Basswood - Black Ash - (Hackberry) Forest

Wet-mesic forests on silty alluvial soils on level ground within small to mid-sized stream or river valleys and occasionally on lake margins. These sites are not subject to prolonged seasonal flooding but have a high water table or other conditions that cause moisture retention in the rooting zone during most of the growing season. Interrupted to continuous canopy (50-100% cover) dominated by a combination of green ash, basswood, black ash, American elm, and hackberry; rock elm or sugar maple are also sometimes present. Hackberry and

American elm typically dominate the understory . Shrub layer is usually sparse and contains Missouri gooseberry and chokecherry . Ground layer commonly dominated by Virginia waterleaf, cleavers, and false rue anemone in the spring, and later dominated by wood nettle through the summer. Cow parsnip, tall conef ower, wild ginger, and Sprengel's sedge are also common. Vines are present in nearly all sites, most commonly Canada moonseed, wild grape, and Virginia creeper.

Native Plant Community Survey Results:
Elm - Basswood - Black Ash - (Hackberry) Forest occurs in both the Eastern Broadleaf Forest and Prairie Parkland provinces in southern Minnesota. These forests were not surveyed or mapped in Big Stone and Lac Qui Parle counties. Areas mapped to this type occur mostly as narrow zones on the bottoms of small to medium-sized river or creek valleys. In a few locations, this forest type also occurs within poorly-drained basins.

On the pre-European settlement vegetation map, these stands occur predominantly within areas mapped as Big Woods (Marschner 1974), with a major exception being the Cottonwood River valley in Brown County , which Marschner mapped as River Bottom Forest. The several remaining stands

Figure 4.12: *Elm - basswood - black ash - (hackberry) forest on the bottomlands of the Swan Lake outlet in the North Star Unit of Swan Lake WMA, Nicollet County. MNDNR photo by F. Harris.*

Figure 4.11: *Elm-basswood-black ash (hackberry) forest along the Cottonwood River, Brown County. MNDNR photo by F. Harris.*

on Cottonwood River bottomlands are all Elm - Basswood - Black Ash - (Hackberry) Forest instead of Silver Maple - (V irginia Creeper) Floodplain Forest (FFs68a), which is the typical modern-day analogue of Marschner 's River Bottom Forest. Other small river valleys in the prairie region that were mapped by Marschner as River Bottom Forest, including the Blue Earth River Valley and the lower reaches of the Chippewa River Valley, have f oodplain forest (FFs68a) remnants.

Few remnants of Elm - Basswood - Black Ash - (Hackberry) Forest retain dense tree canopies today due to the loss of American elm to Dutch elm disease and selective logging. One of the largest remaining contiguous areas of these forests in the region is in the Rush River Valley in Sibley County, where stands have been maintained as woodlots by several generations of farm families. A particularly high quality remnant is in the North Star Unit of Swan Lake Wildlife Management Area in Nicollet County.

Rare Plant Records:
Ginseng *(Panax quinquefolium)* SPC (Fig. 4.9)
Kentucky coffee tree *(Gymnocladus dioica)* (Fig.4.13)
Not Listed
Snow trillium *(Trillium nivale)* SPC (Fig. 4.10)

Figure 4.13: *Colonies of Kentucky coffee trees (Gymnocladus dioica), occasionally seen on river terraces in southern Minnesota, may mark the locations of past camps of American Indians, who ate and played with the dime-sized seeds. MNDNR photos from Sibley County by F. Harris.*

Isolated clusters of Kentucky cof fee trees (Fig. 4.13) were located in mesic and wet-mesic hardwood forest on terraces in the valleys of the Minnesota River and several of its tributaries. These trees produce pods with lar ge, round seeds that were eaten and used in games by American Indians and may mark locations of their camps (Day 1953).

FLOODPLAIN FOREST SYSTEM

Floodplain forests are deciduous forests on seasonally f ooded, alluvial soils of major river valleys. They occur in the region within both the Eastern Broadleaf Forest and Prairie Parkland provinces. At the time of Euro-American settlement, a continuous band of f oodplain forest extended up the length of the Minnesota River valley as far as present-day Montevideo (Marschner 1974). Floodplain forest also extended into the prairie region along larger tributary rivers of the Minnesota, including lower reaches of the Chippewa, Blue Earth, and Le Sueur rivers. Large areas of f oodplain forest also occurred along the Mississippi River at the northeast end of the Minnesota River valley region.

FFs68 Southern Floodplain Forest Class

Map Unit Description:

FFs68a Silver Maple - (Virginia Creeper) Floodplain Forest

Wet forests on annually f ooded, alluvial deposits in f oodplains of major rivers. Interrupted to continuous canopy (50-100% cover) consists primarily of silver maple, often under a supercanopy of scattered, taller cottonwoods. Other frequent canopy and subcanopy trees include willows, green ash, hackberry, American elm, box elder, and basswood. Shrubs are sparse or absent. Vines are abundant, including Virginia creeper, wild grape, bur cucumber, and Canada moonseed. On higher ground between recent f ood channels the ground layer is typically dominated by wood nettles, and also contains tall cone f ower, cow parsnip, white grass, Ontario aster, false nettle, ambiguous sedge, and Virginia wild rye. Within recent f ood channels, ground-layer herbs are generally absent.

Native Plant Community Survey Results:
Floodplain forests, once present in continuous bands along the region's largest rivers, remain mostly as small patches separated by heavily logged areas, cultivated fields, or formerly cultivated fields. Most remaining stands lack a dense, continuous canopy due to the die-off of American elms from Dutch elm disease and recent logging. The invasive species garlic mustard and common buckthorn have invaded most remnants in the region.

The largest continuous area of floodplain forest within the region borders the Mississippi and Vermillion rivers in Dakota County, mostly within the Gores Pool Wildlife Management Area. These 3,000 acres of forest constitute the northern end of one of Minnesota's largest floodplain forest remnants, which extends south into Goodhue County. This large, continuous forest is highly important for forest birds.

Several floodplain forest stands remain in the valleys of the Minnesota, Chippewa, and Blue Earth rivers. Outstanding remnants with dense, multi-layered forest canopies can be seen at the Minnesota Valley National Wildlife Refuge,

Figure 4.15: *Silver maple - (Virginia creeper) floodplain forest along the Minnesota River at Chamberlain Woods SNA, Le Sueur County. MNDNR photo by F. Harris.*

Figure 4.14: *View from Mendota Bridge of floodplain forest at floodstage on June 25, 1993, at Fort Snelling State Park, Dakota County. MNDNR photo by M. Lee.*

near Kelly Lake in the Lawrence Wayside of the Minnesota Valley State Recreation Area in Carver County, and at the Chamberlain Woods SNA in Le Sueur County. This community type was not surveyed or mapped in Lac Qui Parle and Big Stone counties. Stands lacking at least 50% cover of mature trees were not mapped.

In the Blue Earth River Valley, silver maple floodplain forest dominates the low, annually flooded ground. Smaller areas of more diverse forest lacking silver maples but dominated by basswood, American elm, slippery elm, green ash, hackberry, and box elders occur on higher terraces. These terraces also frequently contain Kentucky coffee trees (Fig. 4.13), an uncommon species in Minnesota.

Some abandoned agricultural fields on the Minnesota River bottomlands are naturally succeeding to floodplain forest, proceeding through successive invasions of sand bar willows, cottonwoods, and silver maples, as described by Noble (1979). Other abandoned fields have been planted to, or taken over by, the exotic reed canary grass and are not succeeding to forest.

Rare Plant Records:
Kentucky coffee tree *(Gymnocladus dioica)*
Not Listed (Fig. 4.13)

WET FOREST SYSTEM

Wet Forest communities commonly occur in mineral or mucky soils on the margins of lakes, rivers, and peatlands. Soils remain wet through the season, but standing water is generally present only in the spring. The soils are not saturated continuously enough to build up deep layers of peat (MNDNR 2005a).

It is difficult to determine the extent of wet forest in the landscape of the region at the time of Euro-American settlement. In the southern half of the Eastern Broadleaf Forest Province, Marschner included wet forests within the River Bottom Forest, Big Woods, Oak Openings and Barrens, and Aspen-Oak units, as they were too small to have been mapped separately (Marschner 1974). By contrast, in central and northern Minnesota where Wet Forest communities were much more extensive, Marschner often mapped them separately from surrounding communities as part of his Conifer Bogs and Swamps unit.

WFn55 Northern Wet Ash Swamp Class

Map Unit Description:
WFn55b Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral)
Wet forests on mucky mineral soils in shallow basins or on low, level terrain near rivers, lakes or wetlands. Typically with standing water in the spring but draining by late summer. Canopy dominated by black ash, usually with abundant red maple, yellow birch, and basswood. Subcanopy may contain American elm, paper birch, and quaking aspen, in addition to species present in canopy. Shrubs are variable in cover and may include chokecherry and swamp red currant. Ground layer contains upland forest herbs on hummocks, decaying logs and around tree bases, including lady fern and dwarf raspberry.

Native Plant Community Survey Results:
Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral) is a northern plant community that reaches its southernmost extent in northern Ramsey County (MNDNR 2005a). The one example mapped in the region is a small, atypical example in the Mississippi River floodplain in association with a stand of Silver Maple - (Virginia Creeper) Floodplain Forest (FFs68a).

Rare Plant Records:
No rare species were documented within mapped areas of this class in the Minnesota River valley region.

WFn64 Northern Very Wet Ash Swamp Class

Map Unit Description:
WFn64b Black Ash - Yellow Birch - Red Maple - Alder Swamp (Eastcentral)
Very wet forests on peaty soils in small, closed depressions or around the edges of large peatlands. Typically with standing water throughout the spring and summer. Patchy to interrupted canopy

(50-75% cover) dominated by black ash, often mixed with yellow birch, red maple, or paper birch. Subcanopy typically contains black ash, red maple, and yellow birch. Shrub layer commonly contains speckled alder and winterberry. Common ground-layer herbs include clearweeds, dwarf raspberry, common marsh marigold, touch-me-nots, northern bugleweed, fowl manna grass, bluejoint, and lake sedge.

Native Plant Community Survey Results:
Black Ash - Yellow Birch - Red Maple - Alder Swamp (Eastcentral) is a northern plant community that reaches its southernmost extent in Ramsey County (MNDNR 2003). Ten locations of this type occur in large wetland basins in northern Ramsey and northeastern Hennepin counties. Most are in poor condition due to alterations in hydrology, logging, elm deaths, and invasions of the exotic species reed canary grass. Mapped locations for this community are near the upland margins of shallow wetland basins, often in association with other wetland communities including Northern Mixed Cattail Marsh (MRn83), Willow - Dogwood Shrub Swamp (WMn82a), Graminoid Rich Fen (Basin) (OPn92a), and Alder - (Maple - Loosestrife) Swamp (FPn73a) (Wovcha et al. 1995).

Rare Plant Records:
No rare species were documented within mapped areas of this class in the Minnesota River valley region. Water-willow *(Decodon verticillatus)* (Fig. 4.18) is a rare plant species that may potentially occur in this community type.

WFs55 Southern Wet Aspen Forest Class

Map Unit Description:
WFs55a Lowland Aspen Forest
Wet to wet-mesic woodlands in poorly drained, shallow depressions on mineral or organic soil, often on former wet prairies or wet meadows where fire has been excluded. Interrupted canopy (50-70% cover) dominated by quaking aspen. Shrub layer is often dense and composed of pussy willow, Bebb's willow, and red-osier dogwood. Ground layer is similar to wet prairie or wet meadow but may also contain some species common to mesic forests.

Native Plant Community Survey Results:
Six small locations of Lowland Aspen Forest were mapped within the region—all are in Scott, Dakota, and Carver counties. These occur in areas of groundwater seepage and areas in which better-drained soils and fire suppression have allowed the dominance of aspen and shrubs. Two locations contain patches of Wet Seepage Prairie (WPs54a) and were probably predominantly wet prairie at the time of Euro-American settlement. Other locations are associated with areas of Seepage Meadow/Carr (WMs83a). The invasion of the exotic reed canary grass is a problem in unshaded areas in this community.

Rare Plant Records:
Cowbane *(Oxypolis rigidior)* Not Listed
Edible valerian *(Valeriana edulis)* THR

WFs57 Southern Wet Ash Swamp Class

Map Unit Description:
WFs57a Black Ash - (Red Maple) Seepage Swamp
Wet hardwood forests on mucky or peaty soils in areas of groundwater seepage. Usually present on level river terraces at the bases of steep slopes. Patchy to interrupted canopy (25-75% cover) dominated primarily by black ash, often with basswood, American elm, red maple, and green ash. Red maple saplings and seedlings commonly present. Shrubs are sparse and usually include wild black currant, chokecherry, and nannyberry. Seepage areas typically contain patches of skunk cabbage. Other wet areas contain wetland species such as common marsh marigold, lake sedge, and fowl manna grass. Hummocks are covered with mesic or wet-mesic forest species such as touch-me-nots, Virginia creepers, lady fern, wild sarsaparilla, naked miterwort, long-leaved chickweed, sensitive fern, side-flowering aster, Maryland black snakeroot, and tall coneflower.

Native Plant Community Survey Results:
Historically, few locations of Black Ash - (Red Maple) Seepage Swamp occurred in the region. Present-day occurrences are confined to small, localized groundwater seeps. Twelve small locations of Black Ash - (Red Maple) Seepage

Figure 4.16: *Black ash - (red maple) seepage swamp with skunk cabbage in the Minnesota Valley National Wildlife Refuge, Hennepin County. MNDNR photo by H. Texler.*

Swamp were mapped in the region by MCBS–two in Dakota County and ten in Hennepin County. All sites are on toe slopes at the bases of steep slopes formed in glacial river outwash deposits in either the Mississippi or Minnesota River valleys. These small seeps occur on the mar gins of Red Oak - White Oak Forest (MHs37a) on steep slopes, and on the edges of Silver Maple - (V irginia Creeper) Floodplain Forest (FFs68a) on valley bottomlands. Most of the remnants in Hennepin County occur within the Minnesota Valley National Wildlife Refuge or Minnehaha Creek Regional Park.

Rare Plant Records:

No rare species were documented within mapped areas of this class in the Minnesota valley counties. American water-pennywort *(Hydrocotyle americana)*, bog bluegrass *(Poa paludigena)*, and false mermaid *(Floerkea proserpinacoides)* are rare plant species that may potentially occur in these habitats.

FORESTED RICH PEATLAND SYSTEM

Forested Rich Peatlands are conifer - or tall shrub-dominated communities on deep, actively developing peat. They typically have a dense cover of mosses adapted to high mineral content, low nutrients, and sustained moisture on the ground surface, including brown mosses, feather mosses, and minerotrophic species of *Sphagnum* (MNDNR 2005a).

Forested Rich Peatlands are predominantly northern plant communities with very limited distribution in southern Minnesota. At the southern edges of their ranges in the state, these communities occur mostly in small basins and were not mapped separately from the surrounding vegetation in Marschner's map of the pre-settlement vegetation map (Marschner 1974).

FPn73 Northern Rich Alder Swamp Class

Map Unit Description:

FPn73a Alder - (Maple - Loosestrife) Swamp
Tall shrub wetlands on mineral, muck or peat soils in wetland basins on glacial moraines and till plains, or along streams and drainageways. Dominated by dense cover of speckled alder, with red-osier dogwood, swamp gooseberry , and bog birch. Trees, if present, are sparse and may include red maple, black ash, or paper birch. Herbs occur mostly between shrub clumps in patches dominated by bluejoint. Other common herbs include fowl bluegrass, fowl manna grass, bristle-stalked sedge, dwarf raspberry, northern bugleweed, touch-me-nots, common marsh marigold, red-stemmed aster, and crested fern.

Native Plant Community Survey Results:
Alder - (Maple - Loosestrife) Swamp is a northern plant community that reaches its southernmost extent in Ramsey and Hennepin counties (MNDNR 2003). The only location where this community was mapped in the Minnesota River valley counties was a 47-acre area in a basin in Vadnais – Snail Lakes Regional Park on the Anoka Sandplain ecological subsection in northern Ramsey County. This site contains scattered lar ge tamaracks that are not reproducing. It occurs in association with areas of Graminoid Rich Fen (Basin) (OPn92a) and Northern Mixed Cattail Marsh (MRn83).

Rare Plant Records:
No rare species were documented within mapped areas of this class in the Minnesota River valley region. Halberd-leaved tearthumb *(Polygonum arifolium)*, and water -willow *(Decodon verticillatus)* (Fig. 4.18) are rare plant species that may potentially occur in this community type.

FPs63 Southern Rich Conifer Swamp Class

Map Unit Description:
FPs63a Tamarack Swamp (Southern)
Forested swamps on shallow to deep peat in basins on moraines and outwash plains. Occasionally present on f oating mats on the edges of ponds. Surface water circumneutral to mildly acidic. Patchy to interrupted (25-75% cover) canopy dominated by moderately to fairly dense stands of tamarack; red maple or paper birch are occasionally present. Shrub cover is variable but usually includes bog birch, willows, and red-osier dogwood. Diverse ground layer commonly includes northern marsh fern, dwarf raspberry, tall northern bog orchid, tufted loosestrife, bluejoint, bristle-stalked sedge, great water dock, and soft-leaved sedge. Some occurrences have a continuous mat of *Sphagnum* mosses, but often *Sphagnum* is only present in small acidic microhabitats, such as on decayed stumps.

Native Plant Community Survey Results:
The Conifer Bogs and Swamps mapped in the Minnesota River counties in Marschner 's map of the pre-European settlement vegetation no longer existed at the time of MCBS surveys, as they were destroyed or degraded by urban activities. MCBS did map a few remnants in scattered, isolated basins in Hennepin, Ramsey, Carver, and Dakota counties that were probably too small for Marschner to map separately from the surrounding vegetation, which was mostly Big Woods and Wet Prairie, Marshes, and Sloughs. These locations are among the southernmost extent of this community type in Minnesota, with the exception of a couple of

Figure 4.17: *Tamarack swamp (southern) on a floating* ***Sphagnum*** *mat on the south side of Hidden Lake, Hennepin County. MNDNR photo by F. Harris.*

scattered outliers located farther south. One outlier within the Cannon River watershed in Le Sueur County remains in poor condition due to a peat f re in the 1980s. The extent of *Sphagnum* cover in these sites varies greatly from continuous cover to small patches. Two remnants in excellent condition occur in Morris T. Baker Park Reserve and YMCA Camp Iduhapi, both in Hennepin County.

Rare Plant Records:
Halberd-leaved tearthumb *(Polygonum arifolium)* Not Listed
Water-willow *(Decodon verticillatus)* SPC (Fig. 4.18)

Few rare plant records were located in the few coniferous swamps remaining in the Minnesota River counties. Some rare species recorded in coniferous swamps in Hennepin and Ramsey counties in the early 1900s were never seen in recent surveys: these were outliers of northern species, including club-spur orchid *(Platanthera clavellata)*, dragon's mouth *(Arethusa bulbosa)*, ram's head lady's slipper *(Cypripedium aretinum)*, and linear-leaved sundew *(Drosera linearis)*.

Water-willow (Fig. 4.18) grows on the mar gins of small lakes or swamps, often onf oating mats. This

Figure 4.18: *Water-willow (Decodon verticillatus) on a floating mat bordering a tamarack swamp. Photo by J. Haarstad, Cedar Creek Natural History Area.*

species occurs in east-central Minnesota, including four known locations in Hennepin, Ramsey , and Dakota counties, which is at the northwestern edge of its U.S. distribution

CLIFF/ TALUS SYSTEM

Dry Cliff plant communities occur on the unshaded parts of steep south- to west-facing clif fs along small-to-large river valleys. These communities most commonly occur on the extensive exposures of sedimentary bedrock in the Bluff ands ecological subsection of southeastern Minnesota. The only potential locations for these communities in the Minnesota valley counties are on steep exposures of St. Peter Sandstone and Platteville Limestone that occur along the Mississippi River Valley in Dakota, Ramsey, and Hennepin counties. Because of extensive development, erosion, and quarrying in this region, most of the natural cliff plants have been lost and replaced by weedy plants (W ovcha et al. 1995).

CTs12 Southern Dry Cliff Class

Map Unit Description:
CTs12a Dry Sandstone Cliff (Southern)
Sparsely vegetated communities composed of lichens, mosses, and small herbaceous plants growing on dry south- to west-facing, sandstone bedrock cliffs. Located on the sides of small to large river valleys that cut through sedimentary bedrock layers. Vascular plants are lar gely restricted to crevices and ledges, and may include smooth cliff brake, harebell, columbine, rusty woodsia, and species of adjacent dry prairie such as plains muhly.

Native Plant Community Survey Results:
The one location mapped in the region is a degraded remnant on a south-facing St Peter Sandstone cliff along the north side of the Mississippi River Valley at Hidden Falls Regional Park in Ramsey County.

Rare Plant Records:
No rare species were documented within mapped areas of this class in the Minnesota River valley region. Cliff goldenrod *(Solidago sciaphila)* is a rare plant species of dry clif f communities that may potentially occur within the Minnesota River counties.

ROCK OUTCROP SYSTEM

Rock Outcrop plant communities are sparsely-vegetated, lichen- or shrub-dominated plant communities on level or sloping bedrock exposures. Vascular plants are present on shallow soil deposits that accumulate in rock depressions and cracks. The shallow soils do not retain much moisture, and open, unshaded sites have frequent and severe droughts during the growing season. These plant communities occur on shallow soils over bedrock in several regions of the state. The f oras of northern outcrop communities have little overlap with those of southern Minnesota (MNDNR 2005a, 2005b). In Southern Minnesota, distinct community types include crystalline outcrops of the prairie region, crystalline bedrock outcrops of the prairie-forest transition zone (central Minnesota), and sedimentary outcrops in the bluff ands of southeastern Minnesota (MNDNR 2005b).

Crystalline rock outcrop communities in the Prairie Parkland Province are limited mostly to small bedrock exposures in the Minnesota River valley between New Ulm and Big Stone Lake, and exposures of Sioux Quartzite in four counties in the southwestern corner of Minnesota. Outcrop communities contain very unusual f oras and have always been rare in southwestern Minnesota, even before extensive settlement and clearing of native vegetation. It is only because humans did not easily "exploit" these outcrops in the past that they persist today.

ROs12 Southern Bedrock Outcrop Class

Map Unit Descriptions:

ROs12a Crystalline Bedrock Outcrop (Prairie)

ROs12a1 Crystalline Bedrock Outcrop (Prairie) Minnesota River Subtype

Dry, open, lichen-dominated plant communities on exposures of igneous or metamorphic bedrock in the Minnesota River valley between Ortonville and New Ulm. A small area of this community also occurs on Jordan sandstone in the lower Minnesota River valley . Woody vegetation is sparse and vascular plants are restricted to crevices and shallow soil deposits. Bare rock surfaces have numerous species of lichens and mosses. Shallow soil accumulations less than three centimeters deep in bedrock hollows typically contain species able to withstand frequent, extreme drought, including rock spikemoss, small-f owered famef ower, brittle cactus, Carolina cranesbill, false pennyroyal, wild parsley, Pursh's plantain, Virginia forget-me-not, and rusty woodsia. Deeper soils over rock typically contain many species of dry prairie, such as blue grama, little bluestem, junegrass, and bracted spiderwort. Temporary rainwater pools in small rock depressions may contain Carolina foxtail, ovoid spikerush, water hyssop, or disk hyssop. Deeper, more persistent rainwater pools may contain submergent plants, such as species of water starwort, mudwort, and pondweeds, as well as emergent plants including pointed broom sedge, water plantains, and smartweeds.

ROP_CX Rock Outcrop - Dry Prairie Complex

A complex of Crystalline Bedrock Outcrop (ROs12a1) with one or more of the following community types: Dry Sand – Gravel Prairie (UPs13b), Mesic Prairie (UPs23a), and Prairie Bulrush – Arrowhead Marsh (MRp93). Areas mapped as this complex occur on bedrock knobs where native plant community types occur in a mosaic of patches that are too small to map individually.

Native Plant Community Survey Results:

Crystalline Bedrock Outcrop (Prairie) plant communities occur on massive exposures of ancient metamorphic and igneous bedrock unearthed when glacial River Warren removed overlying deposits of glacial till and saprolite (weathered bedrock), forming the valley now occupied by the Minnesota River. These outcrops consist mostly of gneisses and granites, many of which date to approximately 3.6 billion years of age and are among the oldest known rocks at the earth's surface (Grant 1972). Some of the Minnesota valley's most scenic features are the smooth domes of pink, grey , and black bedrock that overlook the river and numerous backwater lakes. The smoothly undulating surface

Figure 4.19: *Crystalline bedrock outcrops (prairie) on a Minnesota River terrace, Big Stone County. MNDNR photo by R. Dana.*

Figure 4.20: *Small-flowered fameflower and rock spikemoss in 1 cm of soil over granitic bedrock, Nicollet County. MNDNR photo by F. Harris.*

Figure 4.21: *Ovoid spikerush growing in an ephemeral rainwater pool on a bedrock outcrop in Renville County. MNDNR photo by F. Harris.*

of many of the outcrops appears to be primarily a consequence of chemical weathering of the rock surface while it was buried by saprolite and till, whereas sculpting of the rock surface by the glacial river was relatively minor (Patterson et al. 1999). Also present are lar ge, smooth-surfaced boulders that rolled along the bed of the glacial river and came to rest on the bottomlands.

Within the Minnesota River counties, rock outcrop plant communities occur on exposures of igneous or metamorphic crystalline bedrock located between Big Stone Lake and the city of Courtland. They also occur in a small area on Jordan Sandstone in Scott County.

Figure 4.22: *Rock outcrop-dry prairie complex, with plains prickly pear at Cedar Mountain, Redwood County. MNDNR photo by F. Harris.*

Those outcrops with an intact rock outcrop flora were mapped in this project. Some outcrops that are significant geological and scenic features had highly disturbed vegetation, typically due to overgrazing or mining, and were not mapped. Eastern red cedar has greatly increased its population in the region, due mostly to fire suppression since Euro-American settlement, and has colonized many rock outcrops. Cattle grazing may also have suppressed the establishment of red cedars on many rock outcrops in the past. Where it is particularly dense, red cedar shades out and displaces characteristic outcrop species. The least disturbed outcrop communities have unshaded areas with a diverse flora of characteristic species on thin soils over bedrock, bordered by native prairie growing on deeper soils and cracks.

The rock outcrops of the Minnesota River valley have an unusual flora that includes many species rarely seen elsewhere in Minnesota. Many of these plants are adapted to withstand frequent extreme drought. Species such as mousetail, water hyssop (fig. 4.23), and Virginia forget-me-not, avoid the heavy desiccation of mid-summer by rapidly completing their life cycles within one or two wet spring months. Other typical species, including cacti and famefowers, are succulents that can withstand heavy drought stresses and persist throughout the growing season. Another common plant is rock spikemoss, a moss-like vascular plant that becomes dormant under severe drought stress and revives in wet periods.

Many rock outcrops also have permanent and ephemeral wetland pools located in shallow to deep depressions on the rock surface (fig. 4.21). Varying from forty centimeters to over twenty meters in diameter, these wetlands contain a distinctive flora that includes several rare plant species. Rare aquatic plants growing in rock outcrop wetlands include larger water-starwort, mudwort, three-stamened waterwort, and water hyssop (fig. 4.23). Other rare species specialize in wet mud on the margins of wetlands, including Carolina foxtail, mousetail, short-pointed umbrella sedge, Virginia forget-me-not, and Wolf's spikerush (fig. 4.24).

There is some regional variation in the flora of Minnesota valley rock outcrop communities that follows differences in the types of rock present along different river segments. The outcrops near Granite Falls are highly fractured and form tall, steep-sided pyramids that lack temporary or permanent pools and the corresponding wetland floras. By contrast, many outcrops in Redwood and Renville counties are massive, horizontal slabs with frequent depressions that form permanent and ephemeral rainwater pools.

Good examples of bedrock outcrop communities, though most are very small, are at the following sites: Big Stone National Wildlife Refuge (Big Stone County); Gneiss Outcrops SNA (Chippewa County); Blue Devil Valley SNA (Yellow Medicine County); Vicksburg County Park and Cold Springs WMA (Renville County); Swede's Forest Skink SNA, Cedar Rock WMA, and Cedar Mountain SNA (Redwood County); and Carver Rapids Wayside of the Minnesota River Valley State Recreation Area (Scott County). Each of these areas preserves different combinations of the plants and plant communities associated with rock outcrops.

Rare Plant Records:

A species of lichen *(Buellia nigra)* END (Fig. 4.26)
Ball cactus *(Coryphantha vivipara)* END (Fig. 4.27)
Carolina foxtail *(Alopecurus carolinianus)* SPC
Larger water-starwort *(Callitriche heterophylla)* SPC
Little barley *(Hordeum pusillum)* Not Listed
Mouse-ear chickweed *(Cerastium brachypodum)* Not Listed
Mousetail *(Myosurus minimus)* Not Listed
Mudwort *(Limosella aquatica)* SPC
Oregon woodsia *(Woodsia oregana* var. *cathcartiana)* Not Listed
Plains prickly pear *(Opuntia humifusa)* SPC (Fig. 4.28)
Rough-seeded fameflower *(Talinum rugospermum)* END (Fig. 4.29)
Short-pointed umbrella sedge *(Cyperus acuminatus)* THR
Three-stamened waterwort *(Elatine triandra)* Not Listed
Tumble grass *(Schedonnardus paniculatus)* SPC
Virginia forget-me-not *(Myosotis verna)* Not Listed
Water hyssop *(Bacopa rotundifolia)* SPC (Fig. 4.23)
Wolf's spikerush *(Eleocharis wolfii)* END (Fig. 4.24)

The larger water-starwort *(*last recorded in the region in 1946) and three-stamened waterwort, two rare plant species of aquatic habitats on rock outcrops, were not seen in the MCBS surveys of the region and appear to be quite rare. Other rare aquatic plants of rock outcrops are mostly confined to small rainwater pools – though some occurrences consist of several hundred plants, they are often confined to an areal extent of a few square meters or less.

Water hyssop (Fig. 4.23) grows in small, ephemeral, rainwater pools on top of rock outcrops. This species completes its life cycle in a short period while water is present. It persists as seeds within the dried mud deposits in rock depressions until spring rains recreate the pools. Most known locations in Minnesota are on rock outcrops in the Minnesota River valley.

Figure 4.23: *Water hyssop rapidly completes its life cycle in short-lived rainwater pools on bedrock – photo from Cedar Mountain SNA, Redwood County. MNDNR photos by C. Converse.*

Wolf's spikerush (Fig. 4.24) is a diminutive species of sedge that grows in seasonally wet depressions on rock outcrops or on the margins of prairie wetlands. It has been recorded in only seven locations in Minnesota, three of which are very old records of populations that probably no longer exist (Coffman and Pfannmuller 1988). Two of the four recent records are from shallow, ephemeral pools on rock outcrops in the Minnesota River valley: one small population on a gneiss outcrop in Renville County and a very large population on a Jordan Sandstone outcrop in Scott County.

Figure 4.24*: The 7 inch tall Wolf's spikerush, known from only 4 locations in Minnesota, grows in a shallow swale over sandstone bedrock on a Minnesota River terrace at Carver Rapids Wayside, Scott County MNDNR photo by F. Harris.*

Buellia nigra (Fig.s 4.25, 4.26) is a black, shiny lichen that had been collected from only three locations in the world before the mid-1990s. In 1997-1999, eighteen new locations were discovered in Minnesota and South Dakota, twelve of which are on rock outcrops within the Minnesota River valley (Wheeler 1999).

Ball cactus (Fig. 4.27) is a Great Plains species that reaches the easternmost edge of its U.S. distribution in the western end of the Minnesota River valley. One of Minnesota's rarest plant species, one population of plants persists in the state: on a cluster of rock outcrops in western Big Stone and Lac Qui Parle counties. Some plants occur within the Big Stone National Wildlife Refuge, whereas most of the plants are on private land, portions of which are under going bedrock mining (Coffn and Pfannmuller 1988). Plains prickly pear cactus (Fig. 4.28) occurs in the eastern U.S. and northern Great Plains. In Minnesota, it grows on thin soil over bedrock located primarily along the Minnesota River between New Ulm and Montevideo. A few populations also occur on Sioux quartzite rock exposures in the southwestern corner of the state. For unknown reasons, it does not occur on the

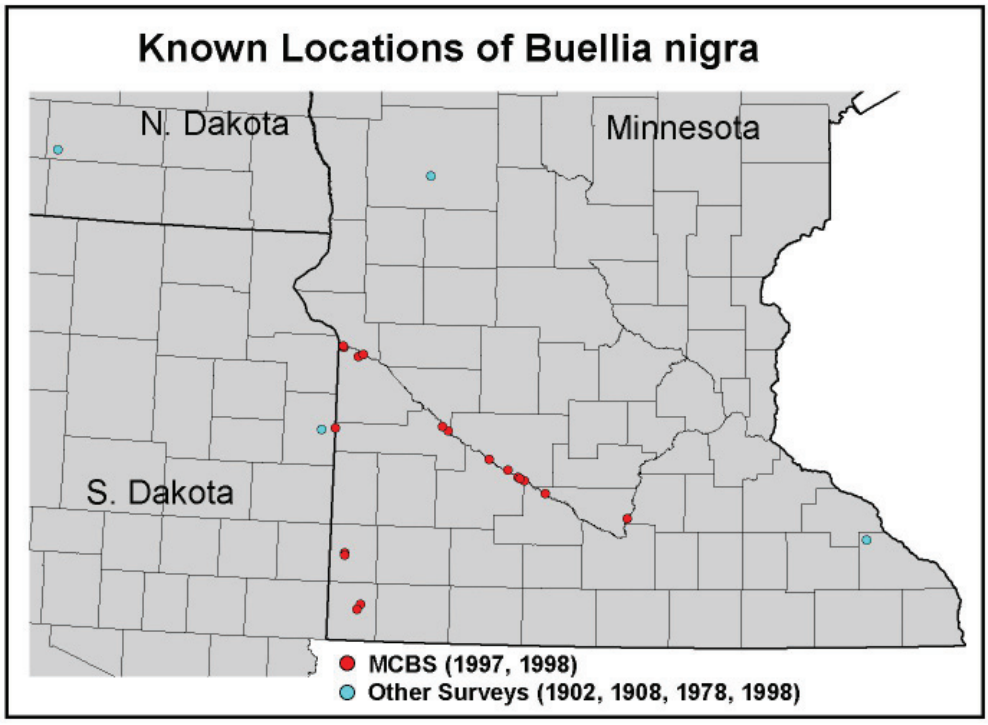

Figure 4. 25: *All of the world's 22 known locations for the lichen, Buellia nigra, are on crystalline bedrock or glacial erratic boulders in Minnesota and the Dakotas.*

Minnesota River valley rock outcrops west of Montevideo.

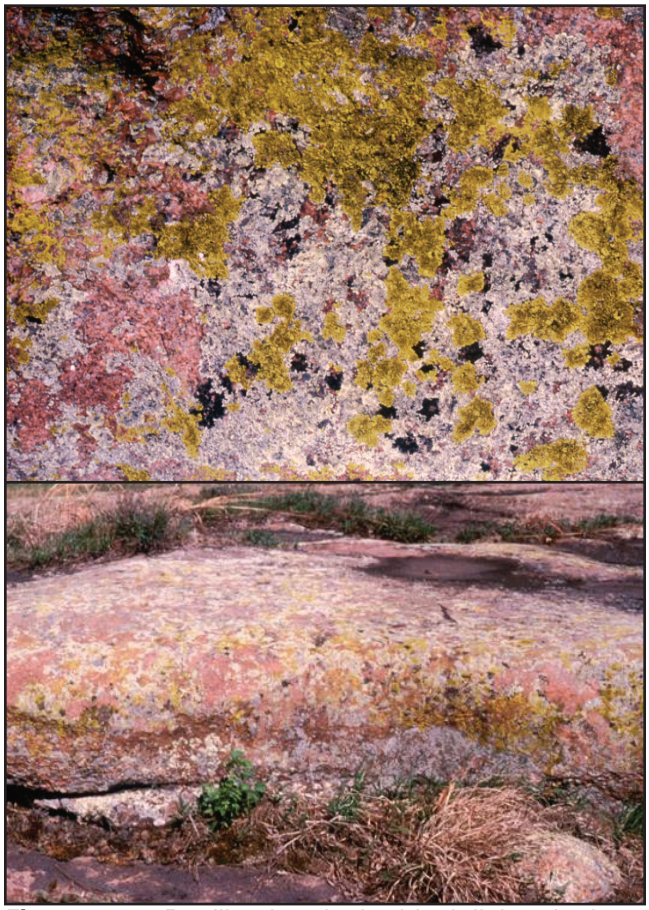

Figure 4.26: *Buellia nigra is the black lichen in these photos – it was growing on a crystalline bedrock outcrop in Big Stone County. MNDNR photos by G. Wheeler.*

Figure 4.27: *Ball cactus, one of Minnesota's rarest plants, on a bedrock outcrop at Big Stone National Wildlife Refuge, Big Stone County. Photo by C. Buer.*

Rough-seeded famef ower (Fig. 4.29) is a succulent plant species that is rare throughout its range in North America. MCBS located a new , but small, population of this species growing on a sandstone outcrop along the Minnesota River in the Minnesota

Figure 4.28: *Prickly pear cacti of Minnesota bedrock outcrops. Top: the rare plains prickly pear has palm-sized, flat pads. Bottom: the more common brittle prickly pear has small, rounded pads. MNDNR photos by F. Harris.*

Valley National Wildlife Refuge. Elsewhere in Minnesota, it was previously known only from a few dry barrens and sand-gravel savannas in southeastern Minnesota and a basalt outcrop along the St. Croix River . This species is distinguished from the similar , small-f owered famef ower *(T. parviflorum*, Fig. 4.20, commonly found on the rock outcrops of the western Minnesota River valley) by its larger f owers with 10-25 stamens, as compared to the smaller f owers and 4-8 stamens in the common species. Famef owers are so named because each f ower is f eeting like fame: it opens once for a brief period in late afternoon.

Figure 4.29: *Rough-seeded fameflower, an exceedingly rare succulent plant, is distinguished from the common small-flowered fameflower (fig. 4.20) by its larger flowers with 10 or more stamens. One population persists on a sandstone outcrop in the Minnesota River valley in Scott County. MNDNR photos by F. Harris.*

LAKESHORE SYSTEM

Lakeshore communities occur along the shorelines of lakes and ponds in the zone between the annual low water level and the upper limit of storm waves and spring ice-scouring (MNDNR 2005a). The vegetation of these zones is usually sparse due to spring flooding and draw-down later in the season, and frequent disturbance by waves, ice, and wind. These areas are prone to invasion by the exotic species reed canary grass. Lakeshore communities were not surveyed systematically in the Minnesota River valley region.

LKi54 Inland Lake Clay/Mud Shore Class

Map Unit Description:

LKi54b Mud Flat (Inland Lake)

LKi54b1 Mud Flat (Inland Lake) Saline Subtype

Herb-dominated communities in shallow saline basins that flood and draw down seasonally. Exposed sediments provide habitat for a distinctive community of plants that tolerate high salinity. Characteristic plants are red saltwort, Nuttall's alkali grass, prairie bulrush, salt grass, and seablite.

Native Plant Community Survey Results:

The only known location for Mud Flat (Inland Lake) Saline Subtype in Minnesota is on the margins of 312-acre Salt Lake in Salt Lake Wildlife Management Area in Lac Qui Parle County. The high salinity of the lake results from a combination of alkaline soils in the surrounding watershed and absence of an outlet from the lake; salts leach into the lake from the alkaline soils and are then concentrated in the basin as lake water evaporates, rather than being flushed out by outflow. The distinctive flora of this saline basin includes halophytic species very rarely seen elsewhere in Minnesota.

Figure 4.30: *Mud flat (inland lake) saline subtype with clumps of red saltwort at Salt Lake WMA, Lac Qui Parle County. MNDNR photo by W. Smith.*

Rare Plant Records:
Nuttall's alkali grass *(Puccinellia nuttalliana)*
Not Listed
Red saltwort *(Salicornia rubra)* THR
(Figs. 4.30, 4.31)

Red saltwort (Fig. 4.31) is a succulent plant of alkaline lakes and salt flats in the western U.S. This species thrives in the exposed, salt-encrusted silt on the margins of Salt Lake in Lac Qui Parle County. The only other populations of this species documented in Minnesota are in Kittson County and are likely to have been destroyed.

Figure 4.31: *Red saltwort is a rare species on the salt-encrusted shore of Salt Lake in Lac Qui Parle County--its leaves turn red in the fall. MNDNR photo by W. Smith.*

LKi32 Inland Lake Sand/Gravel/Cobble Shore Class

Map Unit Description:
No areas of this plant community class were mapped in the Minnesota River counties.

Rare Plant Records:
Prairie mimosa *(Desmanthus illinoensis)* is a rare plant that was recorded on sandy lake and pond margins in Big Stone and Swift counties (Wheeler et al. 1991). An 1892 collection of this species is from the shores of Swan Lake in Nicollet County.

UPLAND PRAIRIE SYSTEM

Native grasslands extended from the Great Plains across the western and southern regions of Minnesota. Minnesota's prairies fall within the tallgrass prairie zone that forms the eastern edge of the Great Plains (Barbour and Billings 1988). Upland prairie, including dry and mesic prairie types, was once the most extensive vegetation type in the Minnesota valley counties, covering 4,054,412 acres (Marschner 1974). MCBS mapped a total of 32,087 acres of dry and mesic prairies in the Minnesota River valley region, which represents 0.8% of the area Marschner mapped as Prairie.

Mesic prairie dominated mostly by big bluestem, Indian grass, prairie dropseed, switchgrass, and little bluestem occurred predominantly on moist, loamy soils. Extensive areas of these soils spanned the uplands of the nearly level to shallowly rolling till plains of the Minnesota River basin, and were present on lower slopes of hills of stagnation moraines and on better-drained soils of glacial lake plains.

Dry prairie dominated by shorter grasses, primarily little bluestem and side-oats grama, formed on more excessively-drained, droughty soils, such as on sandy or gravelly outwash deposits, dry hilltops, steep south-facing slopes, and wind-formed sand dunes. Large proportions of the open prairie of the region burned annually (Grimm 1984), which prevented the establishment of significant tree cover.

Savannas, communities with scattered or clumped trees and shrubs interspersed with patches of prairie vegetation, formed in areas of reduced fire frequency, such as behind firebreaks formed by rivers and lakes. Along the prairie-forest ecotone, savannas and woodlands formed transition zones between frequently burned prairies and mesic hardwood forests that did not burn (Grimm 1984).

UPs13 Southern Dry Prairie Class

Map Unit Descriptions:
UPs13a Dry Barrens Prairie (Southern)
Dry prairies on excessively drained, wind-reworked sands with little to no organically enriched soil formation. Dune forms are typically evident, with small local blowouts present. Common grasses include little bluestem, porcupine grass, hairy

Figure 4.32: *Dry barrens prairie (southern) on dunes along the Minnesota River near Jordan, Scott County. MNDNR photo by F. Harris.*

grama, and junegrass. Other distinctive graminoids include sand reed grass, Schweinitz' s nut sedge, sand dropseed, sandbur , hairy beadgrass, and Wilcox's panic grass. Shrubs are generally sparse and commonly include leadplant, tall wormwood, and prairie rose. Distinctive forb species not commonly seen in other prairie types include snake cotton, silky prairie clover , western spiderwort, hairy puccoon, and rock spikemoss.

UPs13b Dry Sand - Gravel Prairie (Southern)
Dry prairies on coarse-textured, usually gravelly soils formed in outwash. On nearly level to steeply sloping sites on glacial river terraces or glacial ice-contact deposits such as kames or eskers. Dominant grasses are little bluestem, porcupine grass, prairie dropseed, and side-oats grama; junegrass and plains muhly are also abundant. Sand reed grass, hairy grama, and sometimes needle-and-thread grass are prevalent in xeric areas of loose sand. Common shrubs include leadplant, sage wormwood, and smooth sumac; prairie rose and sand cherry are occasionally present. Some of the forbs occurring more frequently in sand-gravel prairie than other dry prairie types include Missouri goldenrod, aromatic aster, bastard toad f ax, silky aster, pasquef ower, slender beard tongue, white beard tongue, Missouri milk vetch, narrow-leaved puccoon, and bluets.

UPs13c Dry Bedrock Bluff Prairie (Southern)
Dry prairies on shallow loess or residuum over sedimentary bedrock on steep south- to west-facing bluffs in southeastern Minnesota. Dominant grasses are little bluestem, Indian grass, side-oats grama, and prairie dropseed. Other common grasses include big bluestem, plains muhly , and Leiberg's panic grass. Leadplant, smooth sumac, and prairie rose are common shrubs.These prairies share many of the same species with other dry prairie types but lack western species not present in eastern Minnesota. Some of the more distinctive forbs include bird's foot coreopsis, skyblue aster , cylindric blazing star , gray-headed cone f ower, false boneset, and f owering spurge.

UPs13d Dry Hill Prairie (Southern)
Dry to dry-mesic prairies on well-drained soils formed in glacial till on slopes and hilltops on stagnation moraines and steep slopes in large river valleys. Dominant grasses are little bluestem, side-oats grama, porcupine grass, and prairie dropseed, with much Indian grass, big bluestem, and Leiberg's panic grass in dry-mesic areas such as mid-slopes. Other common graminoids include plains muhly, junegrass, sun-loving sedge, and Scribner's panic grass. Leadplant, wolfberry , and prairie rose are common shrubs. Common forbs

include rough blazing star, alumroot, silverleaf scurfpea, heart-leaved alexanders, prairie milk vetch, purple prairie clover, hoary puccoon, heath aster, prairie smoke, Flodman's thistle, and hairy golden aster.

Native Plant Community Survey Results: Marschner mapped dry prairie together with mesic prairie in his Prairie map unit. Dry prairie was a small proportion of this map unit relative to mesic prairie as it occurred only on specific, localized areas of dry soil conditions. Today, however, dry prairie constitutes approximately one-third of the upland prairie acreage remaining in the region, as it occurs in locations less suitable for cultivation than mesic prairie.

More than half of the acreage of dry prairie in the region is on steep south-facing slopes on the north side of the Minnesota River valley (Table 4.4). Most of these remnants are on glacial till and are mapped as Dry Hill Prairie (Southern). A small portion of the dry prairies of the Minnesota valley are on sandy-gravelly outwash deposited by glacial River Warren (in the lower valley) or by outwash streams that pre-date River Warren (upper valley), such as on the steeply sloping sides of outwash terraces in Bloomington, just upstream of Carver, and in the southeast corner of Renville County. Several Dry Sand - Gravel Prairies remain on steep slopes of tributary stream valleys where the streams cut through glacial river outwash deposits near their confluence with the Minnesota River.

Table 4.4: *Distribution of dry prairie (UPs13) remnants in the Minnesota River valley counties.*

Location	Total Acres
Minnesota River valley slopes	6,083
Prairie Coteau in Yellow Medicine County	1,766
All other locations	3,374
Entire 17-County Region	11,223

The Prairie Coteau in the western end of Yellow Medicine County, west of the town of Canby, also contains a large concentration of dry prairie remnants, nearly all of which occur in large pastures undergoing heavy grazing by cattle. Most of the prairie on the Coteau is Dry Hill Prairie (Southern) on stagnation moraine deposits of the Altamont Moraine, but the area also includes small areas of Dry Sand - Gravel Prairie (Southern) on sandy outwash deposits on hilltops. Most of the dry prairie in these pastures remains on mid- to upper slopes and hilltops, as the prairie of lower slopes and low mesic ground between hills has essentially been destroyed by heavy grazing. The common practice of applying broadleaf herbicide by airplanes or boom sprayers for thistle control in pastures is also degrading the prairie by indiscriminately killing large numbers of prairie forbs.

Dry Barrens Prairie (Southern) is very rare in the region, as it is for the state as a whole, because very few areas exist of the wind-formed sand dunes on which the community develops. A very small remnant of this type occurs on dunes located along the Minnesota River near Jordan in Scott County. Small remnants of a once extensive area of Dry Barrens Prairie are also found on the terrace between Shakopee and Savage in Scott County, an area that underwent extensive development in the 1990s.

Dry Bedrock Bluff Prairie (Southern) occurs primarily on steep, south-facing bluffs with sedimentary bedrock exposures in the Bluff lands ecological subsection of southeastern Minnesota, which includes only a very small portion of the Minnesota River counties. A few remnants of dry bedrock bluff prairie occur along Miesville Ravine, a tributary of the Cannon River, a few small tributary valleys that drain into the Vermillion River in eastern Dakota County, and on bluffs above the Mississippi River in Spring Lake Park Reserve.

Most dry prairie remnants in the region are in fair to poor condition due to grazing or invasion of eastern red cedars. High-quality dry prairie remnants are located in Bonanza Prairie Scientific and Natural Area (SNA), Big Stone Lake State Park, and Big Stone WMA (Big Stone County); Yellow Bank Hills SNA and Florida Creek WPA (Lac Qui Parle County); Lac Qui Parle WMA (Chippewa County); Mound Springs Prairie SNA and Upper Sioux Agency State Park (Yellow Medicine County); Fort

Ridgely State Park (Nicollet County); Cottonwood River Prairie SNA (Brown County); Ottawa Bluffs Preserve (Le Sueur County); Hidden Valley City Park (Scott County); the Richard T. Anderson Conservation Area in Eden Prairie (Hennepin County); and Pine Bend Bluffs SNA and Miesville Ravine Park Reserve (Dakota County).

Rare Plant Records:

Beach heather *(Hudsonia tomentosa)* SPC
Biennial gaura *(Gaura biennis)* Not Listed
Buffalo grass *(Buchloe dactyloides)* SPC
Canada frostweed *(Helianthemum canadense)* Not Listed
Clasping milkweed *(Asclepias amplexicaulis)* SPC
Clustered broomrape *(Orobanche fasciculata)* SPC
Creeping juniper *(Juniperus horizontalis)* SPC
Cutleaf ironplant *(Machaeranthera pinnatifida)* SPC
Great plains prickly pear *(Opuntia humifusa)* SPC (Fig. 4.28)
Hill's thistle *(Cirsium hillii)* SPC
James' polanisia *(Polanisia jamesii)* END (Fig. 4.39)
Western white prairie clover *(Dalea candida* var. *oligophylla)* SPC
Kittentails *(Besseya bullii)* - THR (Fig. 4.41)
Long-bearded hawkweed *(Hieracium longipilum)* Not Listed
Louisiana broomrape *(Orobanche ludoviciana)* SPC
Low milk-vetch *(Astragalus lotiflorus)* Not Listed
Missouri milk-vetch *(Astragalus missouriensis)* SPC
Narrow-leaved pinweed *(Lechea tenuifolia)* END
Old f eld toadf ax *(Linaria canadensis)* Not Listed
Plains wild indigo *(Baptisia bracteata* var. *leucophaea)* SPC
Prairie bush clover *(Lespedeza leptostachya)* THR (Fig. 4.38)
Prairie moonwort *(Botrychium campestre)* SPC
Red three-awn *(Aristida purpurea* var. *longiseta)* SPC
Rhombic-petaled evening-primrose *(Oenothera rhombipetala)* SPC
Slashed evening primrose *(Oenothera laciniata)* Not Listed
Rock sandwort *(Arenaria stricta* var. *litorea (Minuartia dawsonensis))* SPC
Seaside three-awn *(Aristida tuberculosa)* SPC
Slender milk-vetch *(Astragalus flexuosus)* SPC
Soft goldenrod *(Solidago mollis)* SPC
White wild indigo *(Baptisia alba)* SPC
Yellow pimpernel *(Taenidia integerrima)* Not Listed
Yellow prairie violet *(Viola nuttallii)* THR (Fig. 4.35)

Several rare plant species documented in dry prairie remnants near the western border of the state are Great Plains species at the eastern edges of their distribution. These include yellow prairie violet *(Viola nuttallii)*, western white prairie clover *(Dalea candida* var. *oligophylla)*, soft goldenrod *(Solidago mollis)*, and cutleaf ironplant *(Machaeranthera pinnatifida)*. Other western species that extend further east into western Minnesota (to Granite Falls) include several species of milk-vetch: slender milk-vetch *(Astragalus flexuosus)*, Missouri milk-vetch *(Astragalus missouriensis)*, and low milk-vetch *(Astragalus lotiflorus)*.

Seaside three-awn *(Aristida tuberculosa)*, beach heather *(Hudsonia tomentosa)*, rhombic-petaled

Figure 4.33: *Silky prairie clover, a distinctive species of dry prairies on excessively-drained sand, at the Hastings Sand Coulee, Dakota County. MNDNR photo by M. Lee.*

Figure 4.34: *Dry sand-gravel prairie (southern) on kames at the Yellow Bank Hills SNA, Lac Qui Parle County. MNDNR photo by T. Whitfeld.*

Figure 4.35: *Dry sand - gravel prairie (southern), with yellow prairie violet and Missouri milk vetch in flower in early May at Yellow Bank Hills SNA, Lac Qui Parle County. MNDNR photos by C. Converse.*

evening-primrose *(Oenothera rhombipetala)*, and Canada frostweed *(Helianthemum canadense)* occur predominantly on wind-blown sand deposits (dunes) and have a very limited presence in the Minnesota River counties due to the extreme rarity of dry barrens prairie.

The yellow prairie violet (Fig. 4.35) is a Great Plains species that reaches the easternmost edge of its U.S. distribution in far western Minnesota. This tiny, stemless, yellow violet grows on a few , excessively-drained, gravelly prairies in western Yellow Medicine, Lac Qui Parle and Traverse counties, where it f owers in early May. They can be seen at Yellow Bank Hills SNA in Lac Qui Parle County.

Prairie bush clover (Fig. 4.38) is endemic to prairie in the upper Midwest, occurring only in Minnesota, Iowa, Wisconsin and Illinois. Because of the extensive loss of its prairie habitat, prairie bush clover is one of the rarest plants in the region and is federally-listed (Threatened) as well as state-listed. This species grows on dry to dry-mesic hill prairie, particularly on north-facing slopes. The Cottonwood River Prairie SNA, in western Brown County, harbors one of the world's largest remaining populations of this species.

James' polanisia (Fig. 4.39) is a central Great Plains species that is very rare in the Mississippi River drainage. A few populations of this distinctive annual plant occur on open patches of bare sand in dry sand-gravel prairies along the Mississippi River and in the sand coulee south of Hastings in Dakota County.

UPs14 Southern Dry Savanna Class

Map Unit Descriptions:

UPs14a Dry Barrens Oak Savanna (Southern)

UPs14a2 Dry Barrens Oak Savanna (Southern) Oak Subtype

Dry savannas on excessively drained, wind-reworked sands with little to no or ganically

Figure 4.36: *Grazed dry hill prairie (southern) on the Prairie Coteau west of Canby, Yellow Medicine County. MNDNR photo by F. Harris.*

Figure 4.37: *Pale purple coneflowers and sideoats grama in dry hill prairie (southern) in Fort Ridgely State Park, Nicollet County. MNDNR photo by F. Harris.*

enriched soil formation. Dune forms are typically evident, with small, local blowouts present. Open tree canopy (10-50% cover) dominated mostly by bur oak, with occasional eastern red cedar, quaking aspen, and northern pin oak. Shrubs are generally sparse in cover and commonly include leadplant, prairie rose, tall wormwood, prairie willow , and black cherry. The herbaceous species of dry barrens prairie are present in open areas between trees. Patches of closely spaced trees may be present that

Figure 4.38: *Prairie bush clover is endemic to prairies in the midwestern U.S., where it grows in dry hill prairie on north-facing slopes. MNDNR photo by W. Smith.*

Figure 4.39: *James' polanisia on a dry sand-gravel prairie on outwash deposits at Sand Coulee, Dakota County. MNDNR photo by C. Converse.*

contain plant species that tolerate moderate shade, including northern bedstraw, Canada may f ower, bastard toadf ax, and starry false Solomon's seal.

UPs14b Dry Sand - Gravel Oak Savanna (Southern)

Dry savannas on coarse-textured, usually gravelly soils formed in outwash. On nearly level to steeply sloping sites on glacial river terraces or glacial ice-contact features such as kames or eskers. Open canopy (10-50% cover) dominated by open-grown bur oak or northern pin oak; eastern red cedar may also be present. Shrubs are commonly moderate to dense in cover and include smooth sumac, leadplant, prairie rose, juneberries, American hazelnut, and American plum. The herbaceous species of dry sand-gravel prairie are present in open areas. Patches of clustered trees are commonly present and contain plant species adapted to partial shade, such as white snakeroot, Pennsylvania sedge, woodland sunf ower, and starry false Solomon' s seal.

UPs14c Dry Hill Oak Savanna (Southern)

Dry to dry-mesic savannas on well-drained soils formed in glacial till on slopes and hilltops on stagnation moraines and steep valley slopes. Open canopy (10-50% cover) dominated by open-grown bur oak; quaking aspen may also be present. Shrubs are commonly dense in cover and include smooth sumac, leadplant, chokecherry , wolfberry, prickly ash, black raspberry, and prairie rose. The herbaceous species of dry hill prairie are present in open areas. Patches of clustered trees are commonly present and contain plant species adapted to partial shade, such as white snakeroot, Pennsylvania sedge, woodland sun f ower, hog peanut, and northern bedstraw.

Native Plant Community Survey Results:

In his map of the pre-settlement vegetation of Minnesota, Marschner mapped three groups of f re-maintained communities that occurred between the "true prairie" and the forested regions: Oak Openings and Barrens, Brush Prairie, and Aspen - Oak Land (Marschner 1974). Much of these areas, which totaled 518,102 acres on Marschner's map (Table 4.5), would be classi f ed today as oak savannas or woodlands. Just 4,224 acres of oak savannas and f re-dependent forests and woodlands were mapped by MCBS in the region, of which only 758 acres are savanna. Many oak woodlands that were highly disturbed by past grazing and exotic species were not mapped by MCBS, and the total acreage of remaining woodlands would be somewhat higher than 4,224 if these disturbed

Table 4.5: *Acreage of savanna and related community types in Minnesota River valley counties at the time of Euro-American settlement vs. acreage documented by MCBS.*

Vegetation at the time of Public Land Surveys (Marschner 1974)	Acres
Oak Openings and Barrens	403,666
Aspen - Oak Land	12,892
Brush Prairie	101,666
TOTAL	518,102
MCBS Maps	
All Oak Savanna communities (Dry and Mesic)	758
All Fire-Dependent Forest and Woodland communities	3,466
TOTAL	4,224

Figure 4.40: *Dry sand-gravel oak savanna (southern) on sandy outwash over bedrock on a terrace at Carver Wayside, Minnesota River Valley State Recreation Area, Scott County. MNDNR photo by F. Harris.*

areas were included. Nevertheless, the percentage of acres covered by savannas and related communities remaining in the region is very low at approximately 1%. The actual extent of true, intact savannas is extremely low; these are among the rarest native plant communities in the state, representing 0.2% of Marschner's Oak Openings and Barrens unit. Many savannas were destroyed for cultivation or urban development—nearly all others underwent succession to woodland or forest as a result of fire suppression.

As with the classification of dry prairie, four different variants of dry oak savanna are recognized, according to the soils and landforms on which they occur. Restoration of natural savannas is underway in several areas within the region, including Fort Ridgely State Park (Nicollet County), the Carver Rapids Unit of the Minnesota Valley State Recreation Area (Scott County), and the Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge (Scott County). Much of the oak savanna mapped by MCBS in 1995 near Shakopee (Scott County) has since been destroyed by housing developments.

Rare Plant Records:

The rare species associated with Dry Prairie may also be associated with Dry Oak Savannas. Species more strongly associated with savanna than dry prairie include:

Canada frostweed *(Helianthemum canadense)* Not Listed

Kittentails *(Besseya bullii)* THR (Fig. 4.41)

Yellow pimpernel *(Taenidia integerrima)* Not Listed

Kittentails (Fig. 4.41) occur in open dry prairie or in semi-shade on the fringes of woody vegetation, most commonly in dry oak savanna. This species is endemic to a few states in the upper Midwestern U.S. and is rare due the extreme rarity of its savanna habitat. Minnesota locations are concentrated in the Twin Cities metropolitan area in dry prairie and savanna remnants on gravelly soil formed in outwash deposits (Coffin and Pfannmuller 1988), such as at Carver Rapids State Wayside, the Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge, and Hidden Valley City Park (all in Scott County). One significant outlier containing thousands of plants was found on gravelly soils over crystalline bedrock in Renville County.

UPs23 Southern Mesic Prairie Class

Map Unit Description:

UPs23a Mesic Prairie (Southern)

Dry-mesic to wet-mesic prairie on level to

Figure 4.41: *Kittentails: the world's largest concentration of populations of this exceedingly rare species is in semi-shaded areas in dry oak savannas and small sand-gravel prairies in the Twin Cities metropolitan area. MNDNR photo from Scott County by F. Harris.*

undulating terrain on glacial till or outwash. Soils are moderately well-drained to moist loams with deep, dark, or ganic-enriched upper horizons. Dominated mostly by big bluestem, prairie dropseed, and Indian grass, in combination with porcupine grass and little bluestem on drier sites, and with prairie cordgrass and switchgrass on wetter sites. Other typical graminoids include Leiberg's panic grass, slender wheatgrass, Kalm's brome, and Mead's sedge. Shrubs are sparse but leadplant and prairie rose are usually present on dry-mesic sites; willows may be present on wet-mesic sites. Typical forbs on dry-mesic to mesic sites include smooth aster , purple prairie clover , white sage, black-eyed Susan, white camass, heath aster, heart-leaved alexanders, and stiff goldenrod; on wetter sites, giant sunf ower, great blazing star, Maximilian's sunf ower, northern plains blazing star, smooth rattlesnakeroot, andVirginia mountain mint are common.

Native Plant Community Survey Results:
Mesic prairie was the most widespread native plant community in the region at the time of Euro-American settlement, covering most of the four million acres mapped as Prairie in the Minnesota valley counties on pre-European settlement vegetation map (Marschner 1974). During recent surveys, MCBS documented 20,864 acres of mesic prairie in the region, which amounts to 0.5% of the Prairie mapped on the pre-European settlement vegetation map. Over 19,000 acres, or 93%, of the remaining mesic prairie occurs in four counties at the west end of the Minnesota River valley (Table 4.6). Two of these counties, Big Stone and Lac Qui Parle, were mapped in 1987 and, because some prairie remnants have since been destroyed by housing developments, cultivation, or overgrazing, the actual acreage of prairie remaining in 2007 is somewhat lower than the amount recorded during MCBS surveys.

Most mesic prairie remnants in the region are concentrated on glacial River Warren terraces in the west end of the Minnesota River valley in the Prairie Parkland Province. These terraces contain the largest concentration of mesic prairie remnants in southern Minnesota and one of the lar gest concentrations of prairie remaining in the stateThe area is a major refuge for a wide variety of prairie-associated plant and animal species that are rare or uncommon as a result of the loss of prairie habitats. Most of these prairies have been grazed in the past and vary in quality , depending on the intensity of past grazing. A large proportion of the prairie in this region is conserved within the Big Stone National Wildlife Refuge, Lac Qui Parle Wildlife Management Area, and the Nature Conservancy's Chippewa and Plover Prairie preserves.

A second major concentration of mesic prairie remnants is on the Big Stone Moraine, a series of hummocky stagnation moraines in Big Stone and western Swift counties. These prairies exist on steeply-sloping, boulder-strewn areas not suitable for cultivation. Many of these areas are grazed, and a few of them are on public preserves.

A total of 1,345 acres of mesic prairie was mapped in the seven other counties that make up the rest of the Prairie Parkland Province within the Minnesota River valley region (T able 4.6). These scattered, small fragments represent an extremely small proportion of the mesic prairie vegetation that was present in these counties at the time of Euro-American settlement. The predominant landforms

Figure 4.42: *Annually hayed wet-mesic example of mesic prairie (southern) with much prairie phlox in early June on a Minnesota River terrace, Redwood County. MNDNR photo by F. Harris.*

of these counties are low, rolling till plain or lake plain deposits that have been almost completely cultivated. Most of the mesic prairie remnants are adjacent to poorly-drained soils that are too wet in the spring to cultivate. Many have been mowed for hay late in the season.

Some prairie preserves containing high-quality mesic prairie include Big Stone National Wildlife Refuge (Big Stone County, Lac Qui Parle County), Prairie Wildlife Production Area (WPA), Big Stone Lake State Park, and Clinton Prairie Scientif c and Natural Area (SNA) (Big Stone County); Lac Qui Parle Wildlife Management Area (WMA), Maki WPA, and Svor WPA (Swift County); Hastad WPA and Plover Prairie Preserve (Lac Qui Parle County); Chippewa Prairie Preserve (Chippewa and Swift Counties); Joseph A. Tauer Prairie SNA (Brown County); and Kasota Prairie SNA (Le Sueur County).

Rare Plant Records:

Eared false foxglove *(Agalinis auriculata*) END (Fig. 4.67)
Prairie bush clover *(Lespedeza leptostachya)* THR (Fig. 4.38)
Rattlesnake-master *(Eryngium yuccifolium)* SPC
Slender milk-vetch *(Astragalus flexuosus)* SPC
Small white lady's slipper *(Cypripedium candidum)* SPC (Fig. 4.68)
Sullivant's milkweed *(Asclepias sullivantii)* THR (Fig. 4.45)
Tubercled rein-orchid *(Platanthera flava* var. *herbiola)* END
Tuberous Indian plantain *(Cacalia plantaginea)* THR (Fig. 4.46)
Yellow-fruited sedge *(Carex vulpenoidea* var. *ambigua)* SPC

Table 4.6: *Distribution of mesic prairie (UPs23) mapped by MCBS in the Minnesota River valley counties.*

Location	Total Acres	Average Polygon Acres
Big Stone, Chippewa, Lac Qui Parle, Swift Counties	19,312	59
Blue Earth, Brown, Nicollet, Redwood, Renville, Sibley, Yellow Medicine Counties (Remainder of Prairie Parkland Province)	1,345	13
Carver, Dakota, Hennepin, Le Sueur, Ramsey, Scott Counties (Eastern Broadleaf Forest Province)	207	8
Entire 17-County Region	20,864	

Figure 4.43: *Mesic prairie (southern) with abundant leadplant in mid-summer following a spring burn on a Minnesota River terrace at Chippewa Prairie Preserve, Swift County. MNDNR photo.*

Sullivant's milkweed *(*Fig 4.45) occurs in wet and wet-mesic prairie in southern Minnesota. Due to the extreme loss of this habitat, this species is also exceedingly rare. It is easily identif ed by its long-tapered, thick, leathery leaves, lack of hairs on the stem or leaves, and purplish f owers. It is abundant in narrow strips of prairie along State Highway 22 between Mapleton and Minnesota Lake in Blue Earth County. An outlier population persists in the Prairie Smoke Nature Area in Granite Falls. Other populations in the state are in narrow prairie strips in railroad rights-of-way (MCBS 1999).

Tuberous Indian plantain (Fig. 4.46) is a tall, distinctive forb of mesic prairie in southeastern Minnesota that is intolerant of grazing and is rare due to the loss of its prairie habitat. A few small and isolated populations of this species occur in small mesic prairie remnants in Blue Earth and Brown counties.

UPs24 Southern Mesic Savanna Class

Map Unit Description:

UPs24a Mesic Oak Savanna (Southern)

Dry-mesic savannas on moist soils on outwash or till. Open canopy (10-50% cover) dominated by open-grown bur oak or northern pin oak; quaking aspen, black cherry , and green ash may also be present. Shrubs are abundant and include American hazelnut, smooth sumac, gray dogwood, chokecherry, and red raspberry . Many graminoid and forb species typical of dry and mesic prairie are present, including big bluestem, little bluestem, Indian grass, stiff goldenrod, butter f y weed, and white prairie clover . Patches of clustered trees are commonly present and contain woodland plant species adapted to partial shade, such as white snakeroot, Pennsylvania sedge, woodland sunf ower, hog peanut, starry false Solomon's seal, northern bedstraw, pointed-leaved tick trefoil, Clayton's sweet cicely, and golden alexanders.

Native Plant Community Survey Results:

Only two small remnants of mesic oak savanna were recorded by MCBS in the Minnesota River valley region, one in Big Stone County and one in Hennepin County; together they total 27 acres. Most mesic savannas existing at the time of Euro-American settlement were either destroyed or rapidly underwent succession to woodland or

Figure 4.44: *Mesic prairie (southern) in the fall, dominated by big bluestem, on the Blue Earth till plain near the town of Butternut, Blue Earth County. MNDNR photo by E. Fuge.*

Figure 4.45: *Sullivant's milkweed (Asclepias sullivantii) is very rare species of wet and wet-mesic prairies in southern Minnesota. MNDNR photo by W. Smith.*

Figure 4.46: *Tuberous Indian plantain (Cacalia plantaginea), a rare species of mesic prairies in southeastern Minnesota. MNDNR photo by M. Lee.*

forest due to fire suppression. The example in Big Stone County is on a steep west-facing slope along Big Stone Lake. The example in Hennepin County is on sandy, well-drained soils formed in glacial outwash in Fort Snelling State Park.

Rare Plant Records:
No rare plants were recorded in Mesic Oak Savanna (Southern) in the Minnesota River counties. Areas of Mesic Oak Savanna (Southern) could include any of the rare plant species associated with Mesic Prairie (Southern).

OPEN RICH PEATLAND SYSTEM

Open Rich Peatlands are graminoid- or low shrub-dominated wetlands on actively forming, deep peat. Peat accumulates due to slow decomposition rates resulting from cold water temperatures caused by cold climates (in northern Minnesota) or cold upwelling groundwater (MNDNR 2005a). Narrow-leaved sedges *(Carex* spp.) dominate and are the primary source of material for peat formation in three of the four rich peatland community types in the region. In the other community type, dense cover of *Sphagnum* mosses is a primary source of material for peat accumulation.

It is difficult to determine how much Open Rich Peatland vegetation existed in the region at the time of Euro-American settlement. Many of the existing peatland sites are very small and were not mapped separately from the surrounding vegetation in Marschner's map of the original vegetation, but rather were included in his Prairie or Big Woods units (Marschner 1974). Larger peatlands, such as zones of calcareous fens in the lower Minnesota River valley, were included by Marschner within his Wet Prairies, Marshes, and Sloughs unit (Marschner 1974).

OPn92 Northern Rich Fen (Basin) Class

Map Unit Descriptions:

OPn92a Graminoid Rich Fen (Basin)
Open peatlands on deep, well-decomposed peat or floating peat mats in basins, often adjacent to lakes and ponds. These sites receive enough groundwater flow to maintain circumneutral pH (>5.5). Dominated most commonly by wiregrass sedge; other frequent graminoids include tussock sedge, clustered muhly grass, and tall cottongrass. Shrubs may be scattered or co-dominant, including slender willow, pussy willow, Bebb's willow, red-osier dogwood, bog willow, and bog birch. Typical forbs include spotted Joe Pye weed, common boneset, cut-leaved bugleweed, Labrador bedstraw, northern marsh fern, marsh cinquefoil, and great water dock. When present, *Sphagnum* mosses cover less than 25% of the community.

Figure 4.47: *Graminoid rich fen (basin) dominated by wiregrass sedge (Carex lasiocarpa) on the margin of Fish Lake, Le Sueur County. MNDNR photo by F. Harris.*

OPn92b Graminoid - Sphagnum Rich Fen (Basin)
Open peatlands on floating peat mats in small, nutrient-poor basins that have little surface water runoff. *Sphagnum* mosses have nearly continuous cover throughout. A narrow moat of open water often separates the floating *Sphagnum* mat from dry land on the edge of the basin. Stunted shrubs, such as bog birch, slender willow, speckled alder, and bog willow are often scattered across the

community. Ericaceous shrubs are also present, including small cranberry and leatherleaf. Fine-leaved sedges are abundant, particularly wiregrass sedge, creeping sedge, three-way sedge, slender cottongrass, Chamisso's cottongrass, and tall cottongrass. Typical forbs include round-leaved sundew, marsh cinquefoil, marsh St. John's wort, tufted loosestrife, northern marsh fern, and Labrador bedstraw.

Native Plant Community Survey Results:
Communities of the Northern Rich Fen (Basin) class are northern communities with the southern edge of their range in the Twin Cities metropolitan area. Though they were never abundant in the metro area, several of these sites have been lost over the last century due to urban activities.

Graminoid Rich Fen (Basin) occurs in six small basins dominated by wiregrass sedge in Ramsey and Scott counties. Two small areas of this community also occur on floating mats on the margins of Fish Lake in southern Le Sueur County and are unusual, southern outliers.

Graminoid - Sphagnum Rich Fen (Basin) occurred in seven small, isolated basins in Ramsey, Hennepin, and Scott counties in 1995. At least five of the basins were surrounded by suburban development in the 1990s and are not likely to persist. The extensive *Sphagnum* mats in these basins degrade and disappear when exposed to stormwater runoff carrying road salt and fertilizer residues from surrounding developments. Large fluctuations in water tables due to increased flooding and later drawdown can cause these wetlands to convert to Northern Wet Meadow/Carr communities, which lack *Sphagnum* and are dominated by broad-leaved sedges (MNDNR 2005a).

Rare Plant Records:
Virginia water horehound *(Lycopus virginicus)* Not Listed: one record in Hennepin county.

Other rare plant species recorded in northern rich fen communities in Hennepin or Ramsey counties in the late 1800s/early 1900s, but not since then, include Dragon's mouth *(Arethusa bulbosa)*, club-spur orchid *(Platanthera clavellata)*, cross-leaved milkwort *(Polygala cruciata)*, and twisted yellow-eyed grass *(Xyris torta)* (Table 4.3). Water-willow *(Decodon verticillatus)* (Fig. 4.18) may also be present in these communities.

Figure 4.48: *Graminoid - sphagnum rich fen (basin) with large cranberry near Savage, Scott County. MNDNR photo by F. Harris.*

OPp93 Prairie Extremely Rich Fen Class

Map Unit Descriptions:

OPp93b Calcareous Fen (Southwestern)

Open peatlands continuously saturated by upwelling, calcium-rich groundwater; typically at bases of steep slopes formed in calcareous till on stagnation moraines or the sides of the glacial River Warren Valley. Deep deposits of peat, accumulated over thousands of years, often form large, elevated mounds (Fig. 4.50) or shelves.Wet, saturated muck on the tops of peat mounds is typically dominated by aquatic sedge, bog birch, and willows. Areas of greatest groundwater seepage have scattered groundwater pools and sparsely vegetated soils encrusted with marl deposits. These seepage zones contain a distinctive flora that includes hair-like beak rush, whorled nutrush, three-square bulrush, American grass-of-Parnassus, seaside arrowgrass, clustered muhly grass, marsh arrowgrass, Kalm's lobelia, bog aster, purple false foxglove, and lesser fringed gentian. Margins of seepage zones are dominated by other wetland species, including prairie sedge, hardstem bulrush, narrow reedgrass, and tussock sedge.

OPp93c Calcareous Fen (Southeastern)

Open peatlands continuously saturated by upwelling, calcium-rich groundwater; typically at bases of steep slopes formed in calcareous till on rolling moraines or the sides of the glacial River Warren Valley. Deep deposits of peat, accumulated over thousands of years, often form elevated mounds (Fig. 4.50) or broad shelves. Low shrubs are often common and typically include sage-leaved willow, bog birch, and red-osier dogwood; shrubby cinquefoil is present in a few placesAreas of greatest groundwater flow have soils containing marl deposits and are dominated by low sedges and grasses including prairie sedge, sterile sedge, clustered muhly grass, and mat muhly grass. Other typical forb and graminoid species include American grass-of-Parnassus, lesser fringed gentian, Kalm's lobelia, marsh arrowgrass, seaside arrowgrass, porcupine sedge, prairie loosestrife, swamp thistle, flat-topped aster, swamp saxifrage, and Riddell's goldenrod; a few sites also have edible valerian, beaked spikerush, whorled nutrush, and twig rush. Margins of seepage zones are dominated by other wetland species, most commonly hardstem bulrush and tussock sedge.

Figure 4.49: *Calcareous fen (southwestern) on low peat mound in pasture in late September on the edge of the Prairie Coteau, Yellow Medicine County. Note the low sedge zone forming an arc around the right and far sides of the mound (indicated by arrow). MNDNR photo by F. Harris.*

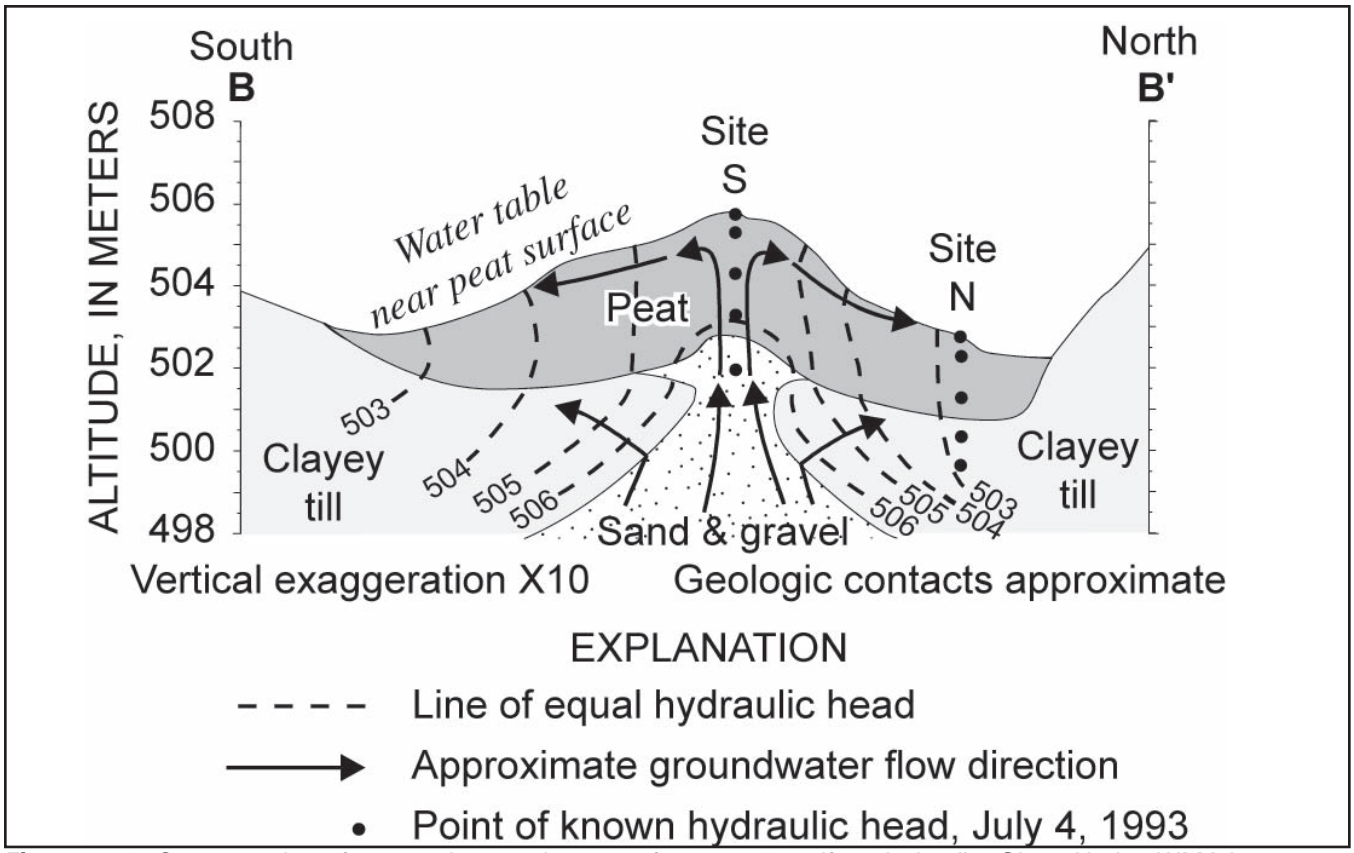

Figure 4.50. *Cross section of a peat-dome calcareous fen on an "aquifer window" at Sioux Nation WMA in western Yellow Medicine County. Reprinted from Almendinger and Leete 1998a.*

Native Plant Community Survey Results:
Calcareous fens are extremely rare native plant communities because they occur under very specif c conditions. They require permeable, calcar - eous parent materials (such as calcareous glacial outwash deposits), higher elevations where water replenishes underground aquifers, and low-lying areas in which pressurized, calcium carbonate-saturated groundwater discharges at ground level (Almendinger and Leete 1998a). At the fen's surface, the release of pressure causes outgassing of carbon dioxide from the groundwater and precipitation of calcium carbonate minerals as whitish deposits called marl. The cold, anoxic environment within these seeps results in very slow decomposition rates of organic matter and promotes the accumulation of deep layers of peat. In three fens in the Minnesota River Basin, peat began to accumulate 4,700 to 11,000 years ago (Almendinger and Leete 1998b).

Calcareous fens contain many plant species adapted to cold, mineral-enriched environments that are not seen in any other habitats in southern Minnesota (see discussion below under "Rare Plant Records"). Because these fens are so small and isolated, populations of obligate fen plant species are likely to be isolated disjuncts that have been in place for thousands of years (W. Smith, MNDNR, pers. comm.). Several plants in these sites are among the rarest plants in Minnesota. Recognizing the extreme rarity of these wetlands, the Minnesota Legislature established special protective status for calcareous fens under the Wetland Conservation Act in 1991 (MN Statute 103G).

One of Minnesota's largest concentrations of calcareous fens occurred within extensive seepage wetlands in the lower Minnesota River valley from present day Savage to the Minnesota River 's con- f uence with the Mississippi River. These wetlands formed deep "peat aprons" on the toe slopes of the valley (Almendinger and Leete 1998b). Many of the fens of this region have been reduced in size or altered by agricultural and development activities, such as ditching and cultivation, or by groundwa-

Figure 4.51: *Calcareous fen (southwestern) in the spring with American grass-of-Parnassus (inset) in flower on a broad peat shelf on a Minnesota River terrace, Redwood County. MNDNR photos by F. Harris.*

ter pumping within the groundwater recharge zone (MCBS 1995). Some remnants remain in Fort Snelling State Park, Black Dog Nature Preserve SNA, and Savage Fen SNA. Another remnant on the north side of the valley in Chanhassen is Seminary Fen, portions of which are in outstanding condition.

Another notable concentration of calcareous fens is on a broad glacial river terrace south of the town of Ottawa in Le Sueur County. Several calcareous fens in excellent condition occur here as patches of low sedge-dominated vegetation within a matrix of marshes and wet seepage meadows dominated by taller, broad-leaved sedges and hardstem bulrush.

In southwestern Minnesota, a cluster of calcareous fens occurs on the edge of the Prairie Coteau in Yellow Medicine County, west of the town of Canby These fens form small, elevated domes of peat on the toe slopes of steep hills and appear to correlate with "aquifer windows" where groundwater from a shallow aquifer emerges from gaps in clayey till deposits (Figure 4.50; Almendinger and Leete 1998a). Typically, the flanks on the downslope sides of the mounds accumulate high concentrations of minerals and are covered with low sedges and wildflowers that tolerate the high mineral content. A couple of fens in this region are also covered with a hard, grayish-white crust of precipitated calcium carbonate deposits (tufa) one to two inches thick. These tufa crusts are being deposited around the rhizoids (root-like structures) and stems of a calciphilic variant of a common moss, *Drepanocladus aduncus (*Figure 4.56), which is facilitating the tufa deposition (J. A. Janssens, Lamda-Max Ecological Research, pers. comm.). Most peat-dome fens in western Yellow Medicine County are in outstanding condition and support a diverse assemblage of rare plant species. Four high quality remnants may be seen in Sioux Nation WMA.

Calcareous fens are highly sensitive to perturbations in groundwater flow. Disturbances that result in decreased groundwater flows into fens, such as

groundwater pumping, will alter these habitats and eliminate them. Many fens in the region occur within heavily grazed pastures, but the cattle tend to avoid them so disturbance from grazing is typically limited to the edges.

Rare Plant Records:

Beaked spikerush *(Eleocharis rostellata)* THR (Fig. 4.54)
Cowbane *(Oxypolis rigidior)* Not Listed
Edible valerian *(Valeriana edulis var. ciliata)* THR
Few-f owered spikerush *(Eleocharis quinqueflora)* SPC
Hair-like beak-rush *(Rhynchospora capillacea)* THR (Fig. 4.52)
Hairy f mbry *(Fimbristylis puberula var. interior)*END (Fig. 4.53)
Marsh arrowgrass *(Triglochin palustris)* Not Listed
Small white lady's slipper *(Cypripedium candidum)* SPC (Fig. 4.68)
Sterile sedge *(Carex sterilis)* THR
Twig rush *(Cladium mariscoides)* SPC
Whorled nutrush *(Scleria verticillata)* THR

Cowbane and edible valerian reach the western ends of their U.S. distributions in southeastern Minnesota and are seen in the Minnesota River counties only in the fens along the lowermost reaches of the Minnesota valley. Sterile sedge also occurs only in the eastern fens in the Minnesota River counties, but also occurs in northwestern Minnesota fens.

Hair-like beak rush (Fig. 4.52) is a diminutive species of sedge that occurs in Minnesota only in calcareous fens, where it colonizes bare, mineral-encrusted peat on the mar gins of groundwater pools. It may be seen in August and September in several small fens located across the Minnesota River valley counties region.

Twig rush, whorled nutrush, beaked spikerush, and hairy f mbry are all species in the sedge family that are more abundant in Atlantic coastal salt marshes of the southeastern U.S., and have inland distributions limited to small, infrequent calcareous wetland habitats (Coff n and Pfannmuller 1988).

Hairy f mbry (Fig. 4.53) is one of the rarest plants in Minnesota. It is highly abundant in one calcareous fen in Redwood County. The species has been seen

Figure 4.52: *Open pools lined with hair-like beak-rush (inset) on peat in calcareous fen (southwestern) on Minnesota River terrace, Redwood County. MNDNR photo by F. Harris. (Inset photo by M. Lee, MNDNR.)*

Figure 4.53: *Hairy fimbry (Fimbristylis puberula) occurs in only two locations in Minnesota, both calcareous fens. Photo ©Larry Allain, USDA-NRCS PLANTS Database (reproduced with permission).*

in one other location in the state, in a calcareous fen in Wilkin County. Elsewhere, the nearest known population of this species is 250 miles to the south in Holt County, Nebraska (Wheeler et al. 1991). This species is listed as Endangered, Threatened, or Probably Extirpated in nine states (NatureServe 2006).

Beaked spikerush (Fig. 4.54) is a species in the sedge family with a long, f rm culm that typically arches and roots at the tip, resulting in a large loop rooted at both ends that catches the legs of humans crossing the fen. Primarily a species of coastal salt marshes in the eastern and southern U.S. and alkaline wetlands in the West, inland occurrences are very rare. Only about a dozen locations of this species are known in Minnesota, all of which are in Extremely Rich Fens, including three calcareous fens in the lower Minnesota River valley.

Figure 4. 54: *Beaked spikerush roots at the tip, forming loops at Seminary fen, Carver County. MNDNR photo by F. Harris. (Close-up photo by W. Smith, MNDNR.)*

Figure 4.55: *Distinctive wildflowers in calcareous fens: lesser fringed gentian (left); purple false foxglove (middle); Kalm's lobelia (right). MNDNR photos by F. Harris.*

Figure 4.56: *A calciphilic variant of the moss Drepanocladus aduncus enhances the formation of tufa (a grayish crust of precipitated calcium carbonate) on the surface of a couple of calcareous fens in Yellow Medicine County. MNDNR photo by F. Harris.*

WET MEADOW/CARR SYSTEM

Wet Meadow/Carr communities are dominated mostly by broad-leaved sedges, wetland grasses, and shrubs. They occur in shallow basins thatf ood in the spring or during periods of heavy rains and then have periodic drawdowns during the summer (MNDNR 2005a).

Within the region, Wet Meadow/Carr communities are present mostly in isolated, shallow basins within mesic hardwood forests on f at to hummocky terrain or groundwater seepage areas on toe slopes within the Minnesota River valley . It is dif f cult to determine from Marschner 's map the extent of these communities at the time of Euro-American settlement, as they were lumped into the broad wetland category of "W et Prairies, Marshes, and Sloughs." Wet meadows are a common component of prairie potholes, most of which were drained and cultivated in the region, particularly on the till plain and lake plain landscapes. Most of the Wet Meadow/Carr communities mapped by MCBS in the Prairie Parkland Province portion of the Minnesota River valley region are not in shallow basins but in groundwater seepage zones within river valleys that are not well suited for agriculture.

WMn82 Northern Wet Meadow/Carr Class

Map Unit Descriptions:

WMn82a Willow - Dogwood Shrub Swamp

Open wetlands on mineral to sapric peat soils in basins or along streams. Trees are sometimes present, mostly as scattered saplings of American elm, black ash, or red maple. Tall shrub layer has greater than 25% cover and includes a mix of pussy willow, Bebb's willow, slender willow, red-osier dogwood, and speckled alder; occasionally bog birch, meadowsweet, swamp gooseberry, and red raspberry are also present. Dominant graminoids are bluejoint, tussock sedge, beaked sedge, or lake sedge. Common forbs include marsh bell flower, tufted loosestrife, marsh skullcap, great water dock, northern marsh fern, common boneset, spotted Joe Pye weed, willow herbs, bulb-bearing water hemlock, water smartweed, and marsh cinquefoil.

WMn82b Sedge Meadow

Open wetlands on mineral to sapric peat soils in basins or along streams. Shrubs typically have less than 25% cover, and include red-osier dogwood, willows, and speckled alder. Dominated by broad-leaved graminoids, including lake sedge, bluejoint, tussock sedge, or beaked sedge. Common forbs include marsh bell flower, tufted loosestrife, marsh skullcap, great water dock, northern marsh fern, common boneset, spotted Joe Pye weed, willow herbs, bulb-bearing water hemlock, water smartweed, and marsh cinquefoil.

Native Plant Community Survey Results:

The two community types in this class have a large overlap in species composition, and Sedge Meadows will convert to Willow - Dogwood Shrub Swamps where the water table has been reduced, such as by drainage ditches. Northern Wet Meadow/Carr communities occur throughout the Eastern Broadleaf Forest portion of the 17-county area, mostly in large wetland basins in complexes with Northern Mixed Cattail Marsh (MRn83), Graminoid Rich Fen (OPn92a), Alder - (Maple - Loosestrife) Swamp (FPn73a), and Black Ash - Yellow Birch - Red Maple - Alder Swamp (East-central) (WFn64b) communities.

Most remnants have been degraded by grazing or wetland drainage. Many are also under going invasion of the exotic species reed canary grass.

Figure 4.57: *Sedge meadow dominated by lake sedge and beaked sedge with abundant marsh fern in small basin surrounded by mesic hardwood forest, Hennepin County. MNDNR photo by F. Harris.*

Rare Plant Records:
Autumn f mbristylis *(Fimbristylis autumnalis)* SPC
Marginated rush *(Juncus marginatus)* SPC
Lance-leaved violet *(Viola lanceolata)* THR
Tall nut-rush *(Scleria triglomerata)* END
Water-willow *(Decodon verticillata)* SPC (Fig. 4.18)

Lance-leaved violet, mar ginated rush, tall nut-rush, and autumn f mbristylis are part of a suite of species, with Clinton's bulrush, that occurs on wet sandy or peaty soils in wet meadows, lakeshores, and wetland margins. In Minnesota, these species are known primarily from the Anoka Sandplain, which barely enters the Minnesota River counties in the north end of Ramsey County. The habitat for these species is threatened by urban development like road building, houses, golf courses, and exotic species invasions. A notable population of waterwillow occurs in Sedge Meadow around Chub Lake in Dakota County, about 40 miles south of the nearest population.

WMs83 Southern Seepage Meadow/Carr Class

Map Unit Description:

WMs83a Seepage Meadow/Carr

Open wetlands on peat or mucky peat soils continuously saturated by upwelling, calcium-rich groundwater; typically at bases of steep slopes formed in calcareous till on rolling moraines or the sides of the glacial River Warren Valley. Sometimes occurring adjacent to areas of Calcareous Fen (OPp93c). Shrub cover varies and includes bog birch, pussy willow, slender willow, and red-osier dogwood. Dominated by sedges and grasses, including tussock sedge, prairie sedge, hardstem bulrush, woolly sedge, bluejoint, and mat muhly grass. Common forbs include many species of wet meadows and some of calcareous fens, such as spotted Joe pye weed, willow herbs, f at-topped aster, bog aster, marsh bell f ower, swamp thistle, giant sunf ower, and prairie loosestrife.

Figure 4.58: *Seepage meadow/carr dominated by hardstem bulrush (dark green stems) on a Minnesota River valley terrace, Ottawa WMA, Le Sueur County. MNDNR photo by F. Harris.*

Figure 4.59: *Seepage meadow/carr on a toe slope of the Minnesota River valley, Nicollet County. MNDNR photo by F. Harris.*

Native Plant Community Survey Results:
Southern Seepage Meadow/Carr communities occur throughout the Minnesota River valley in areas of groundwater seepage on toe slopes, although they were not surveyed or mapped in Lac Qui Parle or Big Stone counties. Extensive areas of this community type occur in association with Calcareous Fens on glacial river terraces, such as at Savage Fen WMA (Scott County), Seminary Fen (Carver County), and Ottawa WMA (Le Sueur County). Seepage Meadow/Carr is often present on the mar gins of calcareous fens in portions of wetlands that do not have as much mineral accumulation as calcareous fens. Seepage Meadow/Carr is more common in the Minnesota valley counties than other sedge-dominated wetland types, because seepage wetlands occur in locations and soil types that do not lend themselves to wetland drainage and cultivation (Table 4.1).

Figure 4.60: *Showy lady's slipper in a seepage meadow/carr on the edge of a Minnesota River terrace in Minneopa State Park, Blue Earth County. MNDNR photo by F. Harris.*

Some Seepage Meadow/Carrs have expanding colonies of common reed grass. The distribution and abundance of common reed grass in marshes and related wetlands has greatly increased in North America over the last 150 years, which appears to be due to the invasion of aggressive, non-native strains (Saltonstall 2002). These strains may be particularly well-adapted to disturbances such as siltation. They form dense, expanding colonies that crowd out other native species and should be considered an invasive species.

Rare Plant Records:
Small white lady's slipper *(Cypripedium candidum)* SPC (Fig. 4.68)
Sterile sedge *(Carex sterilis)* THR

WMp73 Prairie Wet Meadow/Carr Class

Map Unit Descriptions:

WMp73a Prairie Meadow/Carr

Open wetlands on muck or shallow mucky peat soils in shallow basins or swales on rolling moraines and till plains. Commonly dominated by woolly sedge, Sartwell's sedge, narrow reedgrass, prairie cordgrass, and Baltic rush. Shrub cover is generally sparse to patchy and includes red-osier dogwood, pussy willow, and slender willow. Common forbs include eastern panicled aster , swamp milkweed, rough bugleweed, spotted Joe pye weed, common mint, and cut-leaved bugleweed.

Figure 4.61: *Prairie meadow/carr in a broad drainageway on the Prairie Coteau west of Canby, Yellow Medicine County. MNDNR photo by F. Harris.*

PWL_CX Prairie Wetland Complex

A complex of Prairie Meadow/Carr (WMp73a), Wet Prairie (WPs54b), Mesic Prairie (UPs23a), and Prairie Mixed Cattail Marsh (MRp83) where the individual plant community types occur in a mosaic of patches that are too small to map individually. Occurs in broad stream valleys within till plains and outwash plains in areas with poorly-drained soils in low areas and better -drained soils on rises.

Native Plant Community Survey Results:

Sixteen locations of Prairie Meadow/ Carr totaling 64 acres, were mapped in the Minnesota River valley region. This community was not surveyed or mapped in Lac Qui Parle and Big Stone counties. Many small inclusions of this wetland type occur in areas mapped as Southern Wet Prairie (WPs54) or Prairie Wetland Complex (PWL_CX) and are not large enough to map separately.

This was once an abundant community in numerous prairie potholes throughout the Minnesota River Basin. Over 65% of the prairie potholes in the region have been drained and cultivated, which was promoted by federal government subsidies dating from the Swamp Land Act of 1860 to the Swampbuster provision of the Food Security Act of 1985 (Delta Land Trust 1998). Many others have been highly disturbed and colonized by reed canary grass.

Rare Plant Records:

No rare species were documented within mapped areas of this class in the Minnesota River valley region.

MARSH SYSTEM

Marshes consist of tall emer gent forb- and graminoid-dominated communities where standing water exists throughout most of the growing season. Separate classes are identi f ed for a northern region of the state, which includes the Eastern Broadleaf Forest Province, and for the Prairie Parkland Province. Within each of those regions, marshes are divided into classes dominated by cattails versus communities dominated primarily by bulrushes. The difference between these classes appears to be related to the degree of exposure to wave action. Cattail-dominated marshes typically occur in shallow basins, bays of lakes, or sluggish streams where vegetation is at least partially protected from wave action or strong currents. Bulrush-dominated marshes occur along wave-washed lake shores, on sandbars, or in stream channels (MNDNR 2005a).

It is difficult to determine the extent of marsh acreage within the Minnesota River valley region at the time of Euro-American settlement. Marschner (1974) mapped 768,964 acres of "Wet Prairie, Marshes and Sloughs," which would include four different systems of wetlands in the recent DNR classification: Marsh, Wet Meadow/Carr, Open Peatland, and Wet Prairie.

Many marshes in the landscape today were not mapped by MCBS, as they are not remnants of Minnesota's native vegetation. Many marshes present today in the agricultural regions of the state were cultivated during the severe droughts of the 1930s and later re-flooded. Most present-day cattail marshes in the region have been overtaken by narrow-leaved cattail, a species of north Atlantic coastal salt marshes that migrated westward along canals, railroad swales, and roadside ditches following the development of transportation networks in the late 19th century (Stuckey and Salamon 1987, Gleason and Cronquist 1991). Narrow-leaved cattails readily colonize disturbed wetlands. Many of the region's soils are formed from Des Moines lobe till, calcareous glacial deposits containing fragments of limestone and dolomite, that provide ideal conditions for narrow-leaved cattail establishment (Miklovic 2005).

MRn83 Northern Mixed Cattail Marsh Class

Map Unit Descriptions:

MRn83 Northern Mixed Cattail Marsh

Open emergent marshes dominated by cattails in shallow wetland basins or along lake shores and river valleys where standing water is present most of the year. Found on floating mats or mineral or shallow organic soils on glacial till, outwash, or alluvium. Historically, broad-leaved cattail dominated these communities but has been largely displaced by narrow-leaved and hybrid cattails, which are invasive species not native to Minnesota. Communities dominated by broad-leaved cattail were not documented in the region and may no longer exist in southern Minnesota. Some wetlands dominated by cattails have a significant component of other emergent species, including sedges, giant bur reed, and bluejoint.

MRn83a Cattail - Sedge Marsh (Northern)

Open emergent marshes in shallow wetland basins or along lake shores and river valleys where standing water is present most of the year. Found on floating mats or mineral or shallow organic soils on glacial till, outwash, or alluvium. Dominated primarily by species of cattails but with a significant component of other emergents, including lake sedge, bluejoint, common reed grass, giant bur reed, hardstem bulrush, and red-stalked spikerush. Other common graminoids include bristly sedge, soft stem bulrush, tall manna grass, fowl manna grass, fowl bluegrass, and rice cut grass. Common forbs include sweet flag, spotted touch-me-not, spotted Joe pye weed, broad-leaved arrowhead, common mint, and bulb-bearing water hemlock. Floating or submergent aquatic plants are present in open pools, including pondweeds, duckweeds, and common bladderwort. Shrubs are absent or sparse, with willows and red-osier dogwood most common.

Native Plant Community Survey Results:

Northern Mixed Cattail Marshes occur throughout the Eastern Broadleaf Forest portion of the 17-county area, mostly where standing water persists throughout the growing season in large wetland basins in association with Northern Wet Meadow/Carr (WMn82), Graminoid Rich Fen (OPn92a), Alder - (Maple - Loosestrife) Swamp (FPn73a), and Black Ash - Yellow Birch - Red Maple - Alder Swamp (Eastcentral) (WFn64b) communities.

Many cattail marshes throughout the region are highly disturbed by runoff and siltation from surrounding lands, wetland drainage, and invasion of exotic species. Most basins are nearly completely dominated by narrow-leaved or hybrid cattail and were not mapped by MCBS.

Rare Plant Records:
Grass-like arrowhead *(Sagittaria graminifolia)*
Not Listed
Water-willow *(Decodon verticillatus)* SPC (Fig. 4.18)

MRp83 Prairie Mixed Cattail Marsh Class

Map Unit Description:

MRp83 Prairie Mixed Cattail Marsh

Open emergent marshes dominated by cattails in shallow wetland basins or along lake shores and river valleys where standing water is present most of the year. Found on floating mats or mineral or shallow organic soils on glacial till, outwash, or alluvium. Two types are recognized in the region, Cattail Marsh (Prairie) and Cattail - Sedge Marsh (Prairie). Historically, broad-leaved cattail dominated these communities but has been largely displaced by narrow-leaved and hybrid cattails, which are invasive species not native to Minnesota. Pure stands of broad-leaved cattail may not still exist in southern Minnesota and wetlands dominated entirely by narrow-leaved or hybrid cattails were not mapped. Some wetlands dominated by cattails have a significant component of other emergent species, including sedges, giant bur reed, sweetflag, and bluejoint.

Native Plant Community Survey Results:

Large areas of Prairie Mixed Cattail Marsh occurred in the pre-European settlement landscape and were included within several wetland types mapped as Wet Prairie, Marshes and Sloughs in Marschner's map of original vegetation (Marschner 1974). Prairie Mixed Cattail Marsh communities would have occurred in prairie potholes and along lake margins where standing water persists through the growing season.

Prairie Mixed Cattail Marsh was not mapped within the Minnesota River valley region, due to extensive colonization by narrow-leaved cattail, an invasive species not native to the region.

Rare Plant Records:

No rare plant species were recorded in this plant community class.

MRn93 Northern Bulrush-Spikerush Marsh Class

Map Unit Descriptions:

MRn93 Northern Bulrush-Spikerush Marsh

Open emergent marshes in shallow wetland basins or along lake shores and river valleys where standing water is present most of the year. Found on floating mats, or mineral or shallow organic soils on glacial till, outwash, or alluvium. Dominated by persistent emergent vegetation, often in a mosaic of single species patches, including river bulrush, soft stem bulrush, hardstem bulrush, wild rice, rice cut grass, broad-leaved arrowhead, giant bur reed, common reed grass, and red-stalked spikerush. Two types occur in the region, Bulrush Marsh (Northern) and Spikerush-Bur Reed Marsh (Northern).

MRn93a Bulrush Marsh (Northern)

Open emergent marshes along lake shores and river valleys that have standing water present during most of the year. Found on mineral or shallow

Figure 4.62: *Bulrush marsh (northern) dominated by river bulrush on the Minnesota River floodplain at the Minnesota Valley National Wildlife Refuge, Hennepin County. MNDNR photo by F. Harris.*

organic soils on glacial till, outwash, or alluvium. Dominated primarily by river bulrush, soft stem bulrush, or hardstem bulrush. May include patches dominated by other species, including wild rice, rice cut grass, and broad-leaved arrowhead. Floating-leaved and submergent aquatic plants are usually present, including pondweeds, duckweeds, and northern water milfoil.

MRn93b Spikerush - Bur Reed Marsh (Northern)
Open emergent marshes in shallow wetland basins and occasionally along lake shores and river valleys that have standing water present during most of the year . Found on mineral or shallow organic soils on glacial till, outwash, or alluvium. Dominated primarily by red-stalked spikerush and giant bur reed. Plant species diversity is variable: some sites have a diverse assemblage of wetland plant species, including broad-leaved arrowhead, hardstem bulrush, soft stem bulrush, sweet flag, lake sedge, rice cut grass, common water plantain,

Figure 4.63: *Spikerush-bur reed marsh (northern) dominated by giant bur reed in a backwater zone of the Minnesota River valley at the Minnesota Valley National Wildlife Refuge, Hennepin County. MNDNR photo by F.Harris.*

bristly sedge, common mint, water parsnip, swamp milkweed, and cut-leaved bugleweed.

Native Plant Community Survey Results:
Large areas of Bulrush Marsh (Northern) were mapped within the floodplains of the Minnesota and Mississippi rivers in the Eastern Broadleaf Forest Province, in low, poorly drained backwater areas where standing water is present most of the year. River bulrush is a major dominant species in a large proportion of these marshes, but these areas also include zones dominated by wild rice, common reed grass, and rice cut grass.

Much less Spikerush - Bur Reed Marsh (Northern) was mapped in the region. Areas mapped to this type include several sloughs and lake margins on terraces within the Mississippi and Minnesota River valleys as well as some shallow basins outside of the major river valleys. These wetlands have a much greater diversity of wetland plants than deep-water marshes dominated by river bulrush.

Some areas of outstanding wildlife habitat are mapped to this type, including the series of marshes and lakes within the Minnesota Valley National Wildlife Refuge, Fort Snelling State Park, and the Minnesota Valley State Recreation Area in the lower Minnesota River valley. These marshes and lakes are highly significant sites for waterbirds, and the area in which they occur merited designation as one of Minnesota's Important Bird Areas (Audubon Minnesota 2005).

Rare Plant Records:
Walter's barnyard grass *(Echinochloa walteri)*
Not Listed

MRp93 Prairie Bulrush-Arrowhead Marsh Class

Map Unit Descriptions:
MRp93a Bulrush Marsh (Prairie)
Open emergent marshes along lakeshores and river valleys that have standing water present during most of the year. Found on mineral or shallow organic soils on glacial till, outwash, or alluvium. Dominated primarily by hardstem bulrush, slen-

der bulrush, or river bulrush. May include patches dominated by other species, including broad-leaved arrowhead and beaked sedge. Floating-leaved and submergent aquatic plants are usually common, including pondweeds, duckweeds, common coontail, and whorled water milfoil.

MRp93b Spikerush - Bur Reed Marsh (Prairie)
Open emergent marshes in shallow wetland basins and occasionally along lakeshores and river valleys that have standing water present during most of the year. Found on mineral or shallow organic soils on glacial till, outwash, alluvium, or bedrock outcrops. Dominated primarily by red-stalked spikerush and giant bur reed. Other graminoids may be abundant, including tall manna grass, woolly sedge, pointed broom sedge, Sartwell's sedge, and prairie cordgrass. Plant species diversity is variable: some sites have a diverse assemblage of wetland plant species, including water smartweed, giant water dock, dotted smartweed, bulb-bearing water hemlock, marsh skullcap, common mint, and cut-leaved bugleweed.

Native Plant Community Survey Results:
Few Prairie Bulrush - Arrowhead marshes remain within the Prairie Parkland Province portion of the Minnesota River valley region, as most were drained for cultivation or have been overtaken by the invasive narrow-leaved cattail. These communities were not surveyed or mapped in Lac Qui Parle and Big Stone counties.

A large Bulrush Marsh (Prairie) was mapped at Swan Lake WMA in Nicollet County in portions of the marsh that have not been overtaken by narrow-leaved cattail. The vegetation of this area is only in fair condition due to invasive species, nutrient runoff, and siltation. A portion of this area was never cultivated in the past. Swan Lake is a highly significant stopover place for migrating waterfowl and supports breeding populations of Forster's terns, Franklin's gull, western grebe, red-necked grebe, and eared grebe.

A few basins with Spikerush - Bur Reed Marsh (Prairie) dominated primarily by giant bur reed were mapped in the region. Two of these are shallow basins that occur between rock outcrop knobs within the Minnesota River valley. Others occur in shallow basins between hills on the Altamont moraine on the Prairie Coteau in Yellow Medicine County west of the town of Canby.

Rare Plant Records:
No rare plant species were recorded in this community type.

WETLAND PRAIRIE SYSTEM

Wetland Prairie occurs on mineral or shallow organic soils in wet depressions where the water table is below the rooting zone for most of the growing season. Wet prairie was once abundant throughout the Prairie Parkland Province. It cannot be determined how much wet prairie covered the region from the pre-European settlement vegetation map because a wide range of wetland types were combined into the broad category of "Wet Prairies, Marshes and Sloughs," of which 768,964 acres were mapped in the Minnesota River valley region (Marschner 1974). This unit includes communities within the Wetland Prairie, Wet Meadow/Carr, Open Rich Peatland, and Marsh systems in the current MNDNR classification (MNDNR 2005a, 2005b).

A large proportion of the region's wet prairie and other wetlands have been drained and cultivated, particularly in the areas most suitable for cultivation, such as broad rolling till plains and lake plains.

Approximately 83% of the wet prairie acres mapped by MCBS were in four counties at the western end of the Minnesota River valley, located mostly in large areas of uncultivated land on the valley's toe slopes and terraces (Table 4.7). Outside of the Minnesota River valley, where large portions of the region consist of till plains or glacial lake plains generally suited for agriculture, all but a very, very small amount of the wet prairie has been cultivated. Many of the narrow strips of prairie remaining in railroad right-of-ways are wet prairie (MCBS 1999).

Table 4.7: *Distribution of wet prairie (WPs54) mapped by MCBS in the Minnesota River valley counties.*

Location	Total Acres	Average Polygon Acres
Big Stone, Chippewa, Lac Qui Parle, Swift Counties	4,860	39
Blue Earth, Brown, Nicollet, Redwood, Renville, Sibley, Yellow Medicine Counties (Remainder of Prairie Parkland Province)	853	15
Carver, Dakota, Hennepin, Le Sueur, Ramsey, Scott Counties (Eastern Broadleaf Forest Province)	132	14
Entire 17 County Region	5,845	

WPs54 Southern Wet Prairie Class

Map Unit Descriptions:

WPs54a Wet Seepage Prairie (Southern)

Wet prairies on wet, calcareous silt or silty clay loam soils with high organic matter, groundwater seepage, and poor drainage. Located on level or shallowly sloping terrain at the bases of hills in rolling moraines or on valley toe slopes in large river channels. Dominated mostly by narrow reedgrass, prairie cordgrass, bluejoint, and tussock sedge. Other common graminoids include Baltic rush, knotty rush, Dudley's rush, interior sedge, and mat muhly grass. Common forbs include great blazing star, golden alexanders, giant goldenrod, eastern panicled aster, spotted Joe pye weed, great lobelia, Riddell's goldenrod, prairie loosestrife, clasping dogbane, rough bugleweed, New England aster, western heart-leaved groundsel, tall meadow rue, giant sunflower, and Virginia mountain mint. Shrubs cover 30% or less of the area and commonly include red-osier dogwood, pussy willow, heart-leaved willow, and slender willow.

Figure 4.64: *Wet prairie (southern) with great blazing stars in a broad drainageway in southern Redwood County. MNDNR photo by F. Harris.*

WPs54b Wet Prairie (Southern)

Wet prairies on mineral soil formed in glacial till or glacial outwash deposits. Occurs in shallow depressions where drainage is impeded but flooding is temporary and water tables are below the rooting zone for most of growing season. Dominated mostly by prairie cordgrass, big bluestem, switchgrass, bluejoint, and woolly sedge. Other common graminoids include Baltic rush, Sartwell's sedge, Buxbaum's sedge, rigid sedge, marsh muhly grass, and dark green bulrush. Typical forbs include great blazing star, grass-leaved goldenrod, closed gentian, swamp milkweed, spotted water hemlock, autumn sneezeweed, giant sunflower, prairie loosestrife, New England aster, and great lobelia. Shrubs cover 30% or less of the area and commonly include pussy willow, Bebb's willow, slender willow, and red-osier dogwood.

WPs54c Wet Saline Prairie (Southern)

Wet prairies on fine-textured loams formed in glacial lake sediments or broad stream valleys within till plains. Subject to temporary flooding, but water tables are generally below the rooting zone for most of the growing season. Elevated concentrations of salts (sulfates and carbonates of calcium and magnesium) result in bare, salt-

Figure 4.65: *Wet prairie (southern) with northern plains blazing stars on a Minnesota River terrace near Judson, Blue Earth County. MNDNR photo by F. Harris.*

encrusted soil patches and a distinctive vegetation. Major grasses are mat muhly grass, little bluestem, rough dropseed, switchgrass, scratchgrass, and salt grass. Common or distinctive associates are big bluestem, prairie cordgrass, foxtail barley , very slender sedge, Dudley's rush, f attened spikerush, and plains bluegrass. Typically, forb diversity is low and commonly includes heath aster , western ragweed, alkali plantain, and seaside crowfoot.

SWP_CX Wet Saline Prairie Complex
A complex of Wet Saline Prairie (WPs54c), Wet Prairie (WPs54b), and Mesic Prairie (UPs23a) where the plant community types occur in a mosaic of patches that are too small to map individually . Occurs within broad stream valleys on till plains in areas of shallowly undulating topography with poorly drained soils in low areas and better-drained soils on rises.

Native Plant Community Survey Results:
A few Wet Seepage Prairies were mapped in the region—all in areas of groundwater seepage that have predominantly mineral soil. Most are on toe slopes at the foot of steep slopes within the Minnesota River valley or the Watson Sag, a glacial river meander (side channel) in Chippewa County. Many of these sites occur on landforms similar to those of Calcareous Fens or Seepage Meadow/Carr communities, but lack the more sustained groundwater f ow, the deep organic soils, and the strongly calciphytic wetland f ora of those communities. Wet Seepage Prairies were also mapped in northeastern Swift County, in wetlands located on the toe slopes of hills that also have groundwater discharge.

Wet Prairie (Southern) was mapped throughout the Prairie Parkland Province and in portions of the Eastern Broadleaf Forest Province. Many small remnants of this prairie occur in shallow basins on rolling till plains or stagnation moraines. These are sites that were too wet for cultivation and were never drained. Some of the remnants are in pastures and have been degraded by the physical pounding of grazing animals and invasions of exotic species. Several have never been grazed but are utilized as hay meadows that are cut at the end of the growing season when conditions are dry enough for harvest. Some of these ungrazed hay meadows have prairie in excellent condition with a rich diversity of native plant species.

Other wet prairies occur within the valleys of the Minnesota River and major tributaries, including the Cottonwood River, predominantly on glacial river terraces that are not subject to river f oods.

Figure 4.66: *Wet saline prairie (southern) covers low areas where mineral salts accumulate at the soil surface in the Lower Antelope Creek valley, Yellow Medicine County. MNDNR photo by F. Harris.*

Several locations in the Minnesota valley occur on soils that are poorly-drained because of subsurface clay deposits. A few of these sites are also ungrazed hay meadows in excellent condition.

Wet Saline Prairie (Southern) occurs only in western Minnesota where evapotranspiration (water lost from transpiration from plants and evaporation from the soil) exceeds precipitation. This promotes the concentration at the soil surface of carbonate and sulfate minerals originating from the calcareous Des Moines lobe till of the region. These saline wetlands do not occur farther east in the same till deposits because the heavier rainfall to the east has leached out much of these minerals in the upper soil layers over time (Cummins and Grigal 1981).

Remnants of wet saline prairies are extremely rare in the Minnesota River valley region—they were documented by MCBS only within broad, shallow drainages in the nearly level, rolling till plain of western Yellow Medicine County , east of the Prairie Coteau. All but one of the mapped locations are in the Lower Antelope creek valley . These areas are mapped as Wet Saline Prairie Complex because they contain a mosaic of patches of saline wet prairie, wet prairie, and mesic prairie. Two rare saline prairie plant species, very rarely seen in southern Minnesota, have been documented in these prairies: Hall's sedge and Plains bluegrass. These are Great Plains species that reach the eastern end of their distribution in western Minnesota (Wheeler et al. 1991). Wet saline prairie is more frequently seen in northwestern Minnesota in association with beach deposits of glacial Lake Agassiz.

Wet Saline Prairie (Southern) also occurs in some areas mapped by MCBS as Wet Prairie (Southern). For example, wet saline prairie is an important component of a series of prairie remnants in Lac Qui Parle County located within broad, shallow creek valleys in landforms similar to those of the wet saline prairies in Yellow Medicine County . These prairies could also have been mapped as Wet Saline Prairie Complex, a map unit that was created after the MCBS survey of Lac Qui Parle County was completed.

High quality wet prairie can be seen in Big Stone National Wildlife Refuge (Lac Qui Parle and Big Stone counties), Lac Qui Parle WMA (Swift County), Bergo WMA (Chippewa County), Sena

WMA (Chippewa County), Kemen WMA (Lac Qui Parle County), and Jim' s Prairie (Ramsey County).

Rare Plant Records:
Clinton's bulrush *(Scirpus clintonii)* SPC
Cowbane *(Oxypolis rigidior)* Not Listed
Eared false foxglove *(Agalinis auriculata)* END (Fig. 4.67)
Hall's sedge *(Carex parryana (= C. hallii))* SPC
Plains bluegrass *(Poa arida)* Not Listed
Small white lady's slipper *(Cypripedium candidum)* SPC (Fig. 4.68)
Sullivant's milkweed *(Asclepias sullivantii)* THR (Fig. 4.45)
Tall nut-rush *(Scleria triglomerata)* END
Tubercled rein-orchid *(Platanthera flava* var.*herbiola)* END
Yellow-fruited sedge *(Carex vulpenoidea* var. *ambigua)* SPC

Clinton's bulrush, tubercled rein-orchid, and tall nut-rush are rare plant species seen in Minnesota primarily in wet prairie, wet meadows, and lake margins on sandy or peaty, non-calcareous soils of the Anoka Sandplain. These species are represented in the Minnesota River counties by only one or two records in Ramsey and Dakota counties.

Hall's sedge and plains bluegrass are Great Plains species of wet saline prairie at the eastern edges of their U.S. distributions on the western edge of Minnesota. Few records of these species are known within the Minnesota River counties, due to the small amount of known habitat, and more are known in the more abundant wet saline prairies associated with glacial Lake Agassiz beach ridges in northwestern Minnesota.

Eared false foxglove (Fig. 4.67) is a little-under - stood annual plant of wet-mesic and wet prairie that f owers for a brief period in late August. It is a root parasite that gets most of its nutrition from tapping into the roots of other plant species. Prior to MCBS surveys, only three records were known of this species in Minnesota, all dating before 1960 (Coff n and Pfannmuller 1988). MCBS located six new locations in the Minnesota River Basin, four of which are in wet prairie strips bordering U.S. Highway 212 in Renville and McLeod counties.

Figure 4.67: *Eared false foxglove (Agalinis auriculata) is a parasitic species that appears for a brief period in late August/early September. Photo is from a small strip of wet prairie along a railroad track in Renville County. MNDNR photo by G. Wheeler.*

Figure 4.68: *Small white lady's slipper (Cypripedium candidum) in wet prairie on the edge of a calcareous fen in early June, Redwood County. MNDNR photo by F. Harris.*

This species is listed as Endangered, Threatened, or Extirpated in states throughout its range in the U.S. (NatureServe 2006).

Small white lady' s slipper (Fig. 4.68) is a small orchid that f owers in the spring throughout Minnesota's prairie region, primarily in wet to wet-mesic prairie, but also in wet meadow and calcareous fen habitats. Due to habitat loss, this species has become quite rare throughout its U.S. range. Minnesota occupies the center of its current range and therefore has more populations than any other state (Smith 1993).

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5. Animal Surveys in the Minnesota River Valley Counties

5.a. OVERVIEW

Gerda E. Nordquist

Surveys for rare animals along the Minnesota River valley have spanned over a decade. The Minnesota County Biological Survey (MCBS) first began rare animal surveys in Big Stone and Lac Qui Parle counties in 1988, while surveys in Scott and Carver counties were not completed until 1999 (Table 5.a1). Follow-up surveys continue even today in areas of particular importance to rare animals. Rare small mammals, rare breeding birds, and rare amphibians and reptiles (or herps) were the focus of surveys in all the river valley counties. Table 5.a2 summarizes the survey efforts for these areas. When funding and expertise were available, surveys for rare fish, butterflies, and tiger beetles also were conducted. Summaries of findings for rare mammals, birds, and herps in the Minnesota River valley counties appear in the following sections of this chapter. Additionally, staff from other programs in MNDNR's Division of Ecological Resources were invited to present information about fish and mussels of the Minnesota River valley.

Animal species identified for MCBS surveys were those considered rare and expected to occur in the survey counties. Rare species included those federally listed as endangered or threatened; species that were state-listed as endangered, threatened, or of special concern; rare but unlisted species that were tracked as elements by the Natural Heritage Information System (NHIS); and sensitive aggregations of animals, such as colonial waterbird nesting sites or bat hibernacula. Over the duration of MCBS surveys along the Minnesota River, both the federal and state lists of endangered and threatened species were modified, thereby changing the species targeted for surveys (see Coffin and Pfannmuller 1988, MNDNR 1986, 1996).

Lists of rare animals potentially occurring in an area were prepared prior to MCBS field surveys. Tables 5.a3 and 5.a4 are examples of such lists prepared for the 1997–1999 field seasons. They provide a fairly complete list of rare animals in the eastern and western portions of the Minnesota

Table 5.a1: *Summary of MCBS animal survey activities in the Minnesota River valley counties.*

County (Arranged W to E)	Survey Years (major effort in bold)	Animal Groups Surveyed				
		Mammals	Birds	Amphibians and Reptiles	Fishes	Insects
Big Stone	**1988**, 1999	X	X	X		X
Lac Qui Parle	**1988**, 1999	X	X	X		X
Yellow Medicine	**1998, 1999, 2000**	X	X	X		
Swift	**1999**	X	X	X	X	
Chippewa	1998, **1999**	X	X	X	X	
Renville	**1998**, 1999	X	X	X		
Redwood	**1998**, 1999	X	X	X		
Brown	1997, **1998**, 1999	X	X	X		
Nicollet	1997, **1998**, 1999	X	X	X		
Blue Earth	1997, **1998**, 1999	X	X	X		
Le Sueur	**1997**, 1998	X	X	X		X
Sibley	1996, **1997**, 1998	X	X	X		X
Scott	1996, **1997**, 1998, 1999	X	X	X	X	X
Carver	1996, **1997,** 1998, 1999	X	X	X	X	X
Hennepin	1993, 1994, **1997**, 1998	X	X	X		X
Dakota	1992, **1993**, 1997	X	X	X		X
Ramsey	**1990**	X	X	X		

River valley, respectively. All new records of rare animals found during MCBS surveys in the region were entered into the NHIS Rare Features database. Appendix B provides a county-by-county checklist of records for all rare animals presently tracked by NHIS.

Since the completion of surveys in the Minnesota River valley, Minnesota developed a Comprehensive Wildlife Conservation Strategy that identified 292 animal species in greatest conservation need. These are species "whose populations are rare, declining, or vulnerable to decline and are below levels desirable to ensure their long-term health and stability" (MNDNR 2006). Findings from MCBS animal surveys along the Minnesota River and elsewhere in the state provided crucial information for the development of this plan.

In the process of documenting the presence or absence of rare species, data were collected on more common species. Information obtained about common animals is available through ***AniMap*** on the MNDNR's website (MNDNR 2005a; http://www.mndnr.gov/maps/animap/index.html). This interactive mapping tool allows the user to obtain lists of mammals, breeding birds, or amphibians and reptiles that have been documented by the MCBS for a particular county, township, or state-managed area. It also allows the user to view a map of all locations where a particular species has been recorded.

Other reports have been produced by MCBS that contain additional information about animals, both common and rare, in the Minnesota River valley counties. These include Big Stone and Lac Qui Parle counties (Birney and Nordquist 1991, Dana 1991, Eliason 1991, Moriarty 1991), Dakota County (MCBS 1992), Ramsey County (Wovcha et al. 1995), Fort Snelling State Park (MCBS 1995), Hennepin, Carver, Scott, Sibley, and Le Sueur counties (Hansen 1998), and the Minnesota Valley State Recreation Area (MCBS 2002). Additional distribution and natural history information about Minnesota's animals are Hazard (1982) for mammals, Janssen (1987) for birds, and Oldfield and Moriarty (1994) for amphibians and reptiles.

Table 5.a2: *Animal surveys conducted by MCBS for mammals, birds, and herps in the Minnesota River valley counties.*

Survey Technique	COUNTIES ALONG THE MINNESOTA RIVER (arranged from west to east)																
	Big Stone	Lac Qui Parle	Yellow Medicine	Swift	Chippewa	Renville	Redwood	Brown	Nicollet	Blue Earth	Le Sueur	Sibley	Scott	Carver	Hennepin	Dakota	Ramsey
MAMMALS																	
Small mammal trap grids	10	11	11	9	3	6	8	7	9	6	7	2	22	5	6	16	6
Bat surveys				√	√	√	√	√	√	√	√	√	√	√	√	√	√
Other surveys or observations	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
BIRDS (breeding-season records, only)																	
Point count surveys or species lists	38	34	27	58	29	20	30	45	34	10	36	23	95	25	46	88	33
Playback surveys					√							√	√				
Other surveys or observations	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
AMPHIBIANS and REPTILES*																	
Anuran call surveys			√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Terrestrial and aquatic searches	5	18	12	7+	7	7	7	7	8+	8+	3+	4	21+	7	7	25+	9
Drift fences				3	1			2								7	
Turtle traps				√	√	√		√	√	√		√	√	√	√	√	√
Other surveys or observations	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

"+" = additional surveys conducted by contractors are not included in total

***Table 5.a3**: Rare animals potentially occurring in the eastern portion of the Minnesota River valley.*

RARE ANIMALS IN COUNTIES TARGETED FOR MCBS ANIMAL SURVEYS
1997-1998

Nicollet, Blue Earth, Le Sueur, Sibley, Scott, Carver, and Hennepin counties

To report observations of these species, call the toll-free **MCBS Report Line: 1-888-345-1730**

Species	Status (F: federal, S: state)
Mammals	
Eastern Spotted Skunk *(Spilogale putorius)*	S: Threatened
Northern Myotis *(Myotis septentrionalis)*	S: Special Concern
Eastern Pipistrelle *(Pipistrellus subflavus)*	S: Special Concern
Plains Pocket Mouse *(Perognathus flavescens)*	S: Special Concern
Prairie Vole *(Microtus ochrogaster)*	S: Special Concern
Least Weasel *(Mustela nivalis)*	S: Special Concern
Western Harvest Mouse *(Reithrodontomys megalotis)*	S: Element tracked by NHIS
Northern Grasshopper Mouse *(Onychomys leucogaster)*	S: Element tracked by NHIS
Mule Deer *(Odocoileus hemionus)*	S: Delisted, element tracked by NHIS
Breeding Birds	
Peregrine Falcon *(Falco peregrinus)*	F: Endangered, S: Threatened
Bald Eagle *(Haliaeetus leucocephalus)*	F: Threatened, S: Special Concern
Henslow's Sparrow *(Ammodramus henslowii)*	S: Endangered
Wilson's Phalarope *(Phalaropus tricolor)*	S: Threatened
Loggerhead Shrike *(Lanius ludovicianus)*	S: Threatened
Red-shouldered Hawk *(Buteo lineatus)*	S: Special Concern
Yellow Rail *(Coturnicops noveboracensis)*	S: Special Concern
Common Moorhen *(Gallinula chloropus)*	S: Special Concern
Marbled Godwit *(Limosa fedoa)*	S: Special Concern
Forster's Tern *(Sterna forsteri)*	S: Special Concern
Short-eared Owl *(Asio flammeus)*	S: Special Concern
Acadian Flycatcher *(Empidonax virescens)*	S: Special Concern
Cerulean Warbler *(Dendroica cerulea)*	S: Special Concern
Louisiana Waterthrush *(Seiurus motacilla)*	S: Special Concern
Hooded Warbler *(Wilsonia citrina)*	S: Special Concern
Nelson's Sharp-tailed Sparrow *(Ammodramus nelsoni)*	S: Special Concern
Bell's Vireo *(Vireo bellii)*	S: Element tracked by NHIS
American Bittern *(Botaurus lentiginosus)*	S: Delisted, element tracked by NHIS
Sandhill Crane *(Grus canadensis)*	S: Delisted, element tracked by NHIS
Upland Sandpiper *(Bartramia longicauda)*	S: Delisted, element tracked by NHIS
Osprey *(Pandion haliaetus)*	S: Delisted, no longer tracked by NHIS
Amphibians and Reptiles	
Blanding's Turtle *(Emydoidea blandingii)*	S: Threatened
Snapping Turtle *(Chelydra serpentina)*	S: Special Concern
Smooth Softshell *(Apalone mutica)*	S: Special Concern
Five-lined Skink *(Eumeces fasciatus)*	S: Special Concern
Eastern Racer *(Coluber constrictor)*	S: Special Concern
Western Hog-nosed Snake *(Heterodon nasicus)*	S: Special Concern
Gophersnake *(Pituophis catenifer)*	S: Special Concern
Bullfrog *(Rana catesbeiana)*	S: Delisted, element tracked by NHIS

Table 5.a3: *continued*

Species	Status (F: federal, S: state)
Amphibians and Reptiles continued	
Western Foxsnake *(Elaphe vulpina)*	S: Delisted, element tracked by NHIS
Eastern Hog-nosed Snake *(Heterodon platirhinos)*	S: Delisted, element tracked by NHIS
Milksnake *(Lampropeltis triangulum)*	S: Delisted, element tracked by NHIS
Fish	
Paddlefish *(Polyodon spathula)*	S: Threatened
Lake Sturgeon *(Acipenser fulvescens)*	S: Special Concern
Skipjack Herring *(Alosa chrysochloris)*	S: Special Concern
Pugnose Shiner *(Notropis anogenus)*	S: Special Concern
Blue Sucker *(Cycleptus elongatus)*	S: Special Concern
Black Buffalo *(Ictiobus niger)*	S: Special Concern
Least Darter *(Etheostoma microperca)*	S: Special Concern
Gilt Darter *(Percina evides)*	S: Special Concern
American Brook Lamprey *(Lampetra appendix)*	S: Delisted, element tracked by NHIS
Shovelnose Sturgeon *(Scaphirhynchus platorynchus)*	S: Delisted, element tracked by NHIS
Mollusks	
Higgins Eye *(Lampsilis higginsi)*	F: Endangered, S: Endangered
Wartyback *(Quadrula nodulata)*	S: Endangered
Ebonyshell *(Fusconaia ebena)*	S: Endangered
Sheepnose *(Plethobasus cyphyus)*	S: Endangered
Elephant-ear *(Elliptio crassidens)*	S: Endangered
Rock Pocketbook *(Arcidens confragosus)*	S: Endangered
Yellow Sandshell *(Lamsilis teres)*	S: Endangered
Spectaclecase *(Cumberlandia monodonta)*	S: Threatened
Washboard *(Megalonaias nervosa)*	S: Threatened
Pistolgrip *(Tritogonia verrucosa)*	S: Threatened
Monkeyface *(Quadrula metanevra)*	S: Threatened
Purple Wartyback *(Cyclonaias tuberculata)*	S: Threatened
Round Pigtoe *(Pleurobema sintoxia)*	S: Threatened
Elktoe *(Alasmidonta marginata)*	S: Threatened
Salamander Mussel *(Simpsonaias ambigua)*	S: Threatened
Mucket *(Actinonaias ligamentina)*	S: Threatened
Butterfly *(Ellipsaria lineolata)*	S: Threatened
Ellipse *(Venustaconcha ellipsiformis)*	S: Threatened
Snuffbox *(Epioblasma triquetra)*	S: Threatened
Spike *(Elliptio dilatata)*	S: Special Concern
Creek Heelsplitter *(Lasmigona compressa)*	S: Special Concern
Fluted-shell *(Lasmigona costata)*	S: Special Concern
Hickorynut *(Obovaria olivaria)*	S: Special Concern
Black Sandshell *(Ligumia recta)*	S: Special Concern
Fat Pocketbook *(Proptera capax)*	S: Element tracked by NHIS
Butterflies	
Dakota Skipper *(Hesperia dacotae)*	S: Threatened
Ottoe Skipper *(Hesperia ottoe)*	S: Threatened
Powesheik Skipper *(Oarisma powesheik)*	S: Special Concern

Table 5.a3: *continued*

Species	Status (F: federal, S: state)
Butterflies continued	
Leonardus Skipper *(Hesperia leonardus)*	S: Special Concern
Arogos Skipper *(Atrytone arogos)*	S: Special Concern
Regal Fritillary *(Speyeria idalia)*	S: Special Concern
Two-spotted Skipper *(Euphyes bimacula)*	S: Element tracked by NHIS
Bog Copper *(Epidemia epixanthe michiganensis)*	S: Delisted, element tracked by NHIS

Table 5.a4: *Rare animals potentially occurring in the western portion of the Minnesota River valley.*

RARE ANIMALS IN COUNTIES TARGETED FOR MCBS ANIMAL SURVEYS
1998 - 1999

Yellow Medicine, Swift, Chippewa, Renville, Redwood, Brown, Nicollet, Blue Earth, and Sibley counties
To report observations of these species, call the toll-free **MCBS Report Line: 1-888-345-1730**

Species	Status (F: federal, S: state)
Mammals	
Eastern Spotted Skunk *(Spilogale putorius)*	S: Threatened
Northern Myotis *(Myotis septentrionalis)*	S: Special Concern
Eastern Pipistrelle *(Pipistrellus subflavus)*	S: Special Concern
Plains Pocket Mouse *(Perognathus flavescens)*	S: Special Concern
Prairie Vole *(Microtus ochrogaster)*	S: Special Concern
Least Weasel *(Mustela nivalis)*	S: Special Concern
Western Harvest Mouse *(Reithrodontomys megalotis)*	S: Element tracked by NHIS
Northern Grasshopper Mouse *(Onychomys leucogaster)*	S: Element tracked by NHIS
Mule Deer *(Odocoileus hemionus)*	S: Delisted, element tracked by NHIS
Breeding Birds	
Peregrine Falcon *(Falco peregrinus)*	F: Endangered, S: Threatened
King Rail *(Rallus elegans)*	S: Endangered
Burrowing Owl *(Speotyto cunicularia)*	S: Endangered
Sprague's Pipit *(Anthus spragueii)*	S: Endangered
Baird's Sparrow *(Ammodramus bairdii)*	S: Endangered
Henslow's Sparrow *(Ammodramus henslowii)*	S: Endangered
Chestnut-collared Longspur *(Calcarius ornatus)*	S: Endangered
Bald Eagle *(Haliaeetus leucocephalus)*	F: Threatened, S: Special Concern
Wilson's Phalarope *(Phalaropus tricolor)*	S: Threatened
Loggerhead Shrike *(Lanius ludovicianus)*	S: Threatened
Red-shouldered Hawk *(Buteo lineatus)*	S: Special Concern
Common Moorhen *(Gallinula chloropus)*	S: Special Concern
Marbled Godwit *(Limosa fedoa)*	S: Special Concern
Forster's Tern *(Sterna forsteri)*	S: Special Concern
Short-eared Owl *(Asio flammeus)*	S: Special Concern
Greater Prairie-chicken *(Tympanuchus cupido)*	S: Special Concern
Acadian Flycatcher *(Empidonax virescens)*	S: Special Concern
Cerulean Warbler *(Dendroica cerulea)*	S: Special Concern
Louisiana Waterthrush *(Seiurus motacilla)*	S: Special Concern
Hooded Warbler *(Wilsonia citrina)*	S: Special Concern
Nelson's Sharp-tailed Sparrow *(Ammodramus nelsoni)*	S: Special Concern
Bell's Vireo *(Vireo bellii)*	S: Element tracked by NHIS
American Bittern *(Botaurus lentiginosus)*	S: Delisted, element tracked by NHIS
Sandhill Crane *(Grus canadensis)*	S: Delisted, element tracked by NHIS
Upland Sandpiper *(Bartramia longicauda)*	S: Delisted, element tracked by NHIS
Amphibians and Reptiles	
Blanding's Turtle *(Emydoidea blandingii)*	S: Threatened
Snapping Turtle *(Chelydra serpentina)*	S: Special Concern
Smooth Softshell *(Apalone mutica)*	S: Special Concern

Table 5.a4: *continued*

Species	Status (F: federal, S: state)
Amphibians and Reptiles continued	
Five-lined Skink *(Eumeces fasciatus)*	S: Special Concern
Eastern Racer *(Coluber constrictor)*	S: Special Concern
Western Hog-nosed Snake *(Heterodon nasicus)*	S: Special Concern
Gophersnake *(Pituophis catenifer)*	S: Special Concern
Bullfrog *(Rana catesbeiana)*	S: Delisted, element tracked by NHIS
Western Foxsnake *(Elaphe vulpina)*	S: Delisted, element tracked by NHIS
Milksnake *(Lampropeltis triangulum)*	S: Delisted, element tracked by NHIS
Fish	
Paddlefish *(Polyodon spathula)*	S: Threatened
Lake Sturgeon *(Acipenser fulvescens)*	S: Special Concern
Skipjack Herring *(Alosa chrysochloris)*	S: Special Concern
Pugnose Shiner *(Notropis anogenus)*	S: Special Concern
Blue Sucker *(Cycleptus elongatus)*	S: Special Concern
Black Buffalo *(Ictiobus niger)*	S: Special Concern
Blue Catfish *(Ictalurus furcatus)*	S: Special Concern
Least Darter *(Etheostoma microperca)*	S: Special Concern
American Brook Lamprey *(Lampetra appendix)*	S: Delisted, element tracked by NHIS
Shovelnose Sturgeon *(Scaphirhynchus platorynchus)*	S: Delisted, element tracked by NHIS
Mollusks	
Wartyback *(Quadrula nodulata)*	S: Endangered
Rock Pocketbook *(Arcidens confragosus)*	S: Endangered
Yellow Sandshell *(Lamsilis teres)*	S: Endangered
Pistolgrip *(Tritogonia verrucosa)*	S: Threatened
Monkeyface *(Quadrula metanevra)*	S: Threatened
Round Pigtoe *(Pleurobema sintoxia)*	S: Threatened
Elktoe *(Alasmidonta marginata)*	S: Threatened
Salamander Mussel *(Simpsonaias ambigua)*	S: Threatened
Mucket *(Actinonaias ligamentina)*	S: Threatened
Spike *(Elliptio dilatata)*	S: Special Concern
Creek Heelsplitter *(Lasmigona compressa)*	S Special Concern
Fluted-shell *(Lasmigona costata)*	S: Special Concern
Hickorynut *(Obovaria olivaria)*	S: Special Concern
Black Sandshell *(Ligumia recta)*	S: Special Concern
Butterflies	
Dakota Skipper *(Hesperia dacotae)*	S: Threatened
Ottoe Skipper *(Hesperia ottoe)*	S: Threatened
Powesheik Skipper *(Oarisma powesheik)*	S: Special Concern
Pawnee Skipper *(Hesperia leonardus pawnee)*	S: Special Concern
Arogos Skipper *(Atrytone arogos)*	S: Special Concern
Regal Fritillary *(Speyeria idalia)*	S: Special Concern
Two-spotted Skipper *(Euphyes bimacula)*	S: Element tracked by NHIS
Bog Copper *(Epidemia epixanthe michiganensis)*	S: Delisted, element tracked by NHIS

5.b. RARE MAMMALS OF THE MINNESOTA RIVER VALLEY COUNTIES

Gerda E. Nordquist

Of the 16 rare mammal species tracked by the Natural Heritage Information System, half (eight species) are known to occur in one or more of the counties along the Minnesota River. They are comprised of five rodents, two bats, and a skunk (Appendix B). Gone from the landscape are the large mammals, such as bison and elk, that were once observed along the Minnesota River and adjacent prairies at the time that Euro-American settlers moved into the area. An elk antler sticking out of the eroded riverbank or the waterlogged bones of bison resting on the bottom of Big Stone Lake are the only evidence remaining of mammals that once were a dominant part of the landscape in the western Minnesota River valley. Many of the remaining 40-odd species of mammals occurring in the Minnesota River valley counties are widespread across the state and adaptable to human-induced changes to native habitats. Species including deer, raccoons, deer mice, and big brown bats have become so successful at living with humans as to be considered pests. Conversely, the rare mammals of the Minnesota River valley are only becoming rarer.

Rodents of the Prairies

All five rare rodents are strongly associated with dry native prairie. Records for the Prairie Vole, Northern Grasshopper Mouse, and Richardson's Ground Squirrel are concentrated in the western portions of Yellow Medicine and Lac Qui Parle counties, or found in the expanse of prairie and grassland in the Lac Qui Parle WMA/Big Stone NWR area of Swift and Chippewa counties (Figure 5.b1). These species require short, open grasslands and are not found in fields of dense planted grasses and other plantings typically grown for wildlife cover. The Plains Pocket Mouse and the Western Harvest Mouse also occur in eastern counties along the Minnesota River where appropriate habitat is present.

Figure 5.b1: *MCBS survey staff preparing small mammal specimens, Chippewa County. MNDNR photo by Carol Hall.*

Prairie Vole *(Microtus ochrogaster)* State Special Concern

Since the Minnesota County Biological Survey (MCBS) began animal surveys in 1988, only two locations from the Minnesota River Valley counties—western Yellow Medicine and western Lac Qui Parle—have been found for the Prairie Vole, despite expending substantial effort to find this species and other prairie-associated rare mammals. A 1917 record for a PrairieVole from Fort Snelling State Park cannot be verified and since that time the small prairie remnant has become over grown with woody vegetation.

Plains Pocket Mouse *(Perognathus flavescens)* State Special Concern

The Plains Pocket Mouse (Figure 5.b2) is strongly associated with dry open habitats and light sandy soils, typical of river outwash. Old records exist from Lac Qui Parle County, but the continued presence of this species in the county was not confirmed by MCBS. The most recent records for this seed-specialist come from the Twin Cities metropolitan area, in Scott and Ramsey counties. Regrettably, the presence of the Plains Pocket Mouse at Savage, Scott County, was not sufficient reason to modify plans for development of a business park and this population was lost in 1997. Currently,

the only known population for the Plains Pocket Mouse in the Minnesota River valley counties occurs at the Twin Cities Army Ammunition Plant, in Ramsey County.

Figure 5.b2: *Plains Pocket Mouse. Photo by B.L. Clauson, from the Mammal Slide Library, American Society of Mammalogists.*

Northern Grasshopper Mouse *(Onychomys leucogaster)* (not listed but tracked as a rare species)

Six recent records have been obtained for the Northern Grasshopper Mouse (Figure 5.b3), in western Yellow Medicine and Lac Qui Parle counties, as well as in the large grasslands in Swift and Chippewa counties. Unlike other rodents, which are herbivorous, this species is a predator on insects and other terrestrial invertebrates. The presence or absence of prey is likely a more important factor in the distribution of this species than for herbivorous rodents.

Figure 5.b3: *Northern Grasshopper Mouse. MNDNR photo by Gerda Nordquist.*

Richardson's Ground Squirrel *(Spermophilus richardsonii)* (not listed but tracked as a rare species)

Only two records from Minnesota River Valley counties exist in the database, but this is due more to a lack of survey effort than actual rarity. Colonies of Richardson's Ground Squirrel are found in heavily-grazed pastures of the western counties, but do not appear in similar habitats east of Redwood County. This species appears to be in decline due to the removal of grazers and conversion of pasturelands to crops or other plantings.

Western Harvest Mouse *(Reithrodontomys megalotis)* (not listed but tracked as a rare species)

Of all the rare rodents, the Western Harvest Mouse is most closely associated with the hillside prairies and grasslands of the Minnesota River valley. It was once considered a common species and university classes routinely collected harvest mice from the hillsides adjacent to Flying Cloud Airport, Hennepin County, in the 1970s (D. W. Warner, University of Minnesota, personal communication). Between 1996 and 1998, the MCBS repeatedly searched this area, but found no Western Harvest Mice (Figure 5.b4). The negative impact of urbanization on this species is indicated by the lack of documentation for extant populations in the metropolitan counties of Carver (last record 1954), Hennepin (last record 1979), and Ramsey (no record). Other counties where no new records were obtained by MCBS included Lac Qui Parle (last record 1952), Le Sueur (unconfirmed report), and Renville (last record 1974). A population was found in Scott County, on lands protected by the U.S. Fish and Wildlife Service, and from five other locations along the Minnesota River in Blue Earth, Nicollet, Redwood, and Yellow Medicine counties.

Bats Along the River Valley

Bats are common travelers of the Minnesota River valley and adjoining tributaries. All seven species of bats that occur in Minnesota have been documented in the Minnesota River valley counties, including two state special concern species, Northern Myotis and Eastern Pipistrelle. During MCBS

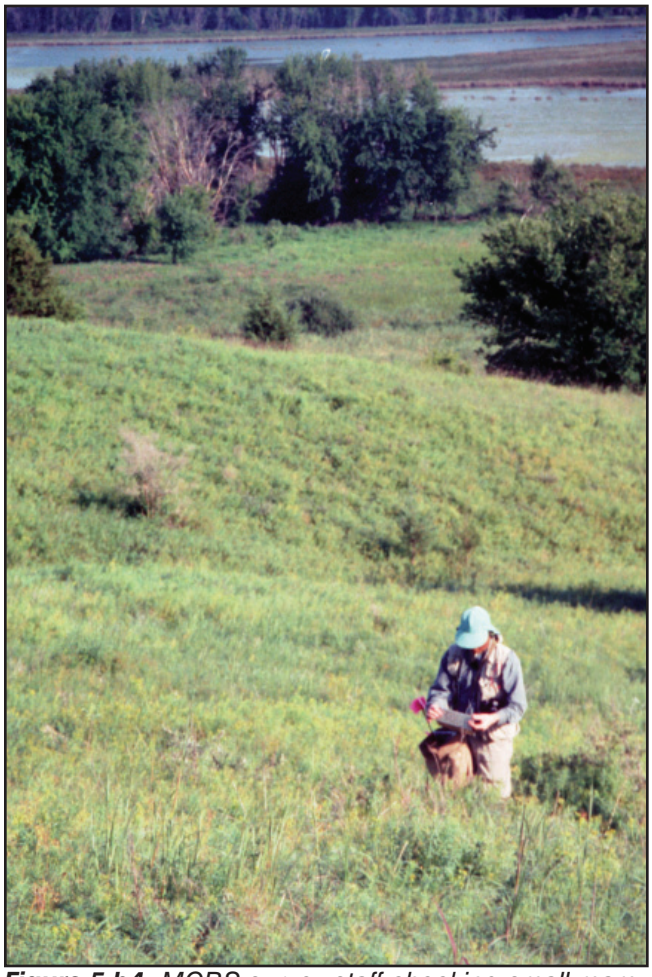

Figure 5.b4: *MCBS survey staff checking small mammal traps near Flying Cloud Airport, Hennepin County. MNDNR photo by Gerda Nordquist.*

summer surveys, all bat species except the Eastern Pipistrelle and Silver-haired Bat were recorded. In the winter, all four hibernating bats were found, including Little Brown Myotis, Northern Myotis, Big Brown Bat, and Eastern Pipistrelle.

In the open areas of the region, bats are widely dispersed and relatively uncommon. However , stop along any river bridge at night during the summer and bats will likely be f ying along the shoreline or above the tree canopy (Figure 5.b5). The large, hollow cottonwoods and silver maples at the river's edge provide protected cavities for female bats to rear their young during early summer . Females without young and solitary males utilize the foliage of trees and shrubs as roosting sites during the day. Insects swarming along the edge of the treeline at dusk and dawn are the tar gets of foraging bats that cruise the riverway at those times. Manmade structures also serve as important roosting sites for bats during the summer . Sepp's Mill at Minneopa State Park supports a lar ge maternity colony of Big Brown Bats. However, using buildings can become a liability when bats are not welcome or the structures are destroyed, as was the case at the Lawrence Unit of the Minnesota Valley State Recreational Area.

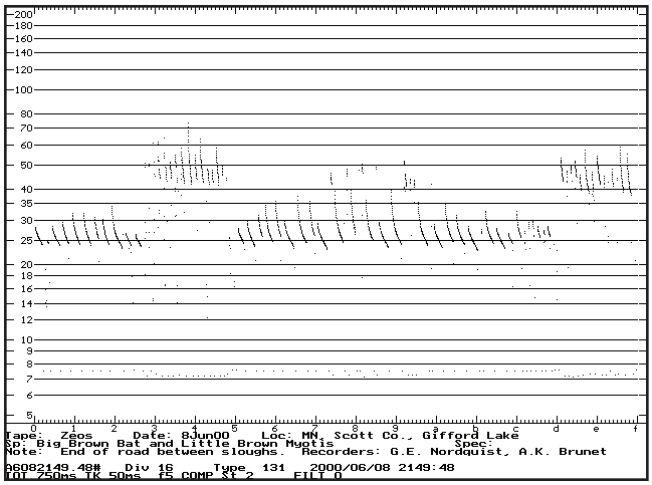

Figure 5.b5. *Call sequences of a Big Brown Bat and a Little Brown Myotis in Scott County.*

The banks of the riverway are the source of winter shelter for bats, as well. Natural caves and manmade sewers, utility conduits, and beer cellars are present among the sandstone and limestone clif fs of the river valley. Some of these are large enough to provide a protected, stable environment for hibernating bats during the winter (Figure 5.b6). Natural caves along the Minnesota River f gured prominently in the f rst known survey of cave bats in the state, in the early 1940' s (Rysgaard 1941). Rysgaard found our rarest bats hibernating in Seven Caves, near St. Peter, and in Jordan Cave.Today, both caves are gone. Seven Caves was destroyed to make way for expansion of Highway 169; Jor - dan Cave became the back of an apartment/artisan shop building. Bats over -wintering in the under - ground sand mines in St. Paul have faired no better. Both state-listed species have been found hibernating among the once numerous and extensive sand mines along the Minnesota and Mississippi rivers (Nordquist 2000). Human folly and maliciousness have resulted in both the direct death of the bats and the permanent closure of most of the mines. At this time, there are no protected hiber - nating sites for bats among the Minnesota River valley counties.

Figure 5.b6: *Eastern Pipistrelles hibernating in a natural cave in Dakota County. Photo by Gerda Nordquist.*

The Invisible Skunk

The Eastern Spotted Skunk *(Spilogale putorius)*, a state-threatened species, is distinctly different in appearance and habit from its abundant cousin, the Striped Skunk (Figure 5.b7). Known to many as a "civet cat," in the 1950s it was described as "extend[ing] its range northward, so that now it is commonly found in the southern half of the state and occasionally as far north as the Canadian border in the northwest" (Gunderson and Beer 1953). Ask any trapper when was the last time they saw a civet cat and they will usually say the 1960s. What transpired between that period, when spotted skunks were numerous, and today, when they are almost never seen, is not known. Speculation points to a rabies epidemic among skunks in the 1960s or changes in land-use patterns from small farms with open corncribs to large-scale agribusinesses that store grain in closed silos and grain elevators.

Sightings of this species, most of them unverified, occur infrequently and efforts by MCBS to find spotted skunks have been unsuccessful. However, every five to ten years a good record appears for this species and over the last decade these have come from the Minnesota River valley counties. In 1968, a spotted skunk was found in the barn of an old homestead near Mankato (Nicollet County) and in 1992, one was found dead along a roadside in Minnetonka (Hennepin County). In 2002, a Blue Earth County farmer saw a spotted skunk near an abandoned farm along the Watonwan River and then recalled that he had a 1995 photo of one that was found dead in the back of an abandoned truck on his farm four miles to the west. This spring (2007), DNR area wildlife staff found a road-killed spotted skunk in Lac Qui Parle County, near an old farmstead site.

The Eastern Spotted Skunk is clearly present in Minnesota. But how a species can be so rare that almost no one ever sees it, yet continue to exist in the state, is a great mystery. Of the eight records in the NHIS Rare Features database, five are from Minnesota River valley counties.

Figure 5.b7: *Eastern Spotted Skunk.*

5.c. BREEDING BIRDS OF THE MINNESOTA RIVER VALLEY COUNTIES

Steven P. Stucker

The Minnesota County Biological Survey (MCBS) surveyed breeding birds within the Minnesota River valley counties in 1988, 1992–93, and 1997–99. A total of 167 bird species were documented during the breeding season in these counties (Figure 5.c1). Locations of 27 rare bird species tracked in the Minnesota Natural Heritage Information System (NHIS) of the Minnesota DNR were recorded within the Minnesota River counties by MCBS. These species are listed in Appendix B and described below according to the habitats in which they were documented. The sections below on major habitats for breeding birds also include lists of some of the common bird species documented by MCBS during surveys in the Minnesota River valley counties.

Figure 5.c1*: MCBS field staff conducting bird point-count bird survey. All birds heard or seen within a 50-meter radius during a 5-minute interval are recorded. MNDNR photo by Carol Hall.*

The Minnesota River valley provides a corridor of native habitats within an otherwise largely disturbed or human-influenced landscape. Important bird habitats in the Minnesota River valley include both upland and lowland (floodplain) deciduous forests, grasslands, and wetlands. This variety of habitats supports a high diversity of birds. In the Minnesota River valley, deciduous forests extend far west into the prairie region, and several bird species dependent on this habitat reach or are near their western or southwestern distributional limit here.

Deciduous Forest

Deciduous forests in the Minnesota River valley counties are included in the Fire-Dependent Forest/Woodland, Mesic Hardwood Forest, Floodplain Forest, and Wet Forest systems recognized in the Minnesota DNR's native plant community classification (MNDNR 2003, 2005b, 2006c). Most of Minnesota's typical deciduous-forest bird species are found in the Minnesota River valley, with several reaching their western range limit along the valley. Common or widespread deciduous forest species in the Minnesota River valley include Eastern Wood-Pewee, Great Crested Flycatcher, Red-eyed Vireo, American Redstart, Ovenbird, and Scarlet Tanager. Less common species documented in the Minnesota River valley counties were Barred Owl, Chimney Swift, Pileated Woodpecker, Blue-gray Gnatcatcher, and Wood Thrush.

Several regionally rare species, including Least Flycatcher, Winter Wren, Brown Creeper, Veery, and Mourning Warbler, were found at scattered locations in deciduous forests in the Minnesota River valley. In northern Minnesota these species are more common and widespread, but in the Minnesota River valley counties they are mostly restricted to larger tracts of high-quality forest.

Floodplain forests along the Minnesota River have a bird species composition similar to that of upland forests. Several species more common in floodplain forests than in the upland forests include Warbling Vireo, House Wren, and Baltimore Oriole. These birds were probably common in this habitat

historically due to naturally-occurring disturbances (i.e., flooding), which create brushy openings, downed wood, and cavities for nesting. One regionally uncommon species, the Prothonotary Warbler occurs in the Minnesota River valley as far west as Redwood County. Prothonotary Warblers are a floodplain forest specialist, preferring flooded forests dominated by silver maple, where they nest in cavities over the water.

State-listed rare species found by MCBS in deciduous forests of the Minnesota River valley counties were Red-shouldered Hawk (Figure 5.c2), Acadian Flycatcher, Cerulean Warbler (Figure 5.c3), Louisiana Waterthrush (Figure 5.c4), and Hooded Warbler. Records of these species from the Minnesota River valley counties generally decreased in number from east to west, with most found in the Big Woods ECS subsection. Brief descriptions of these rare species follow.

Red-shouldered Hawk *(Buteo lineatus)* State Special Concern
This species was found at scattered locations in the Minnesota River valley counties, most frequently at sites outside the actual valley of the Minnesota River (e.g., Murphy-Hanrehan Park Reserve in Scott County, Wood Rill SNA and Wolsfeld Woods SNA in Hennepin County). Red-shouldered Hawks prefer larger tracts of mature deciduous forest, both upland and lowland hardwood, that have marshes, wet meadows, or other wetland openings required for hunting prey such as frogs, toads, snakes, and small mammals. Red-shouldered Hawks are very rare and sparsely-distributed in the Minnesota River valley proper. The rarity of this bird in the Minnesota River valley may be a consequence of the severe reduction of the once-continuous band of floodplain forest into small, isolated fragments. West of Mankato, MCBS biologists observed this species only twice: in larger tracts of forest along the Minnesota River in Chippewa and Yellow Medicine counties.

Acadian Flycatcher *(Empidonax virescens)* State Special Concern
Acadian Flycatchers were found at several widely-scattered sites in the Minnesota River valley counties in larger tracts of mature, closed-canopy forest. Acadian Flycatchers were most often found in upland forests, associated with small streams or small pothole wetlands, but they were occasionally found in floodplain forests as well.

Cerulean Warbler *(Dendroica cerulea)* State Special Concern
Like Red-shouldered Hawks and Acadian Flycatchers, Cerulean Warblers were found in larger tracts of mature forests in both upland and lowland settings in the Minnesota River valley

Figure 5.c2: *Red-shouldered Hawk. Photo by Anthony Hertzel.*

Figure 5.c3: *Cerulean Warbler. Photo by David Cahlander.*

counties east of Redwood County (Figure 5.c3). Cerulean Warblers are often loosely associated with rivers, streams, or other wetland openings, perhaps because forests in these areas typically have structurally diverse canopies. Locations for breeding season observations of this species included Flandrau State Park in Brown County; along Barney Fry Creek and in Seven Mile Woods County Park in Nicollet County; Carver Park Reserve and a floodplain forest stand near Kelly Lake in Carver County; and Murphy-Hanrehan Park Reserve in Scott County.

Louisiana Waterthrush *(Seiurus motacilla)* State Special Concern
Louisiana Waterthrushes are usually associated with small, swiftly-flowing streams within steep-sided valleys forested with mature, closed-canopy forest (Figure 5.c4). This species also occurs along more sluggish streams and backwater channels within larger tracts of mature floodplain forest. Louisiana Waterthrushes are quite rare in the Minnesota River valley counties; they were found by MCBS along tributary streams within steep-sided ravines. It is unknown if this species is successfully nesting in the Minnesota River valley, or if most occurrences are of unpaired singing males. Breeding season observations of this species were recorded in Minneopa State Park in Blue Earth County, Seven Mile Creek County Park in Nicollet County, and Fort Snelling State Park in Dakota County.

Figure 5.c4*. Louisiana Waterthrush. Photo by David Cahlander.*

Hooded Warbler *(Wilsonia citrina)* State Special Concern
In the Minnesota River valley counties, this species regularly breeds only at Murphy-Hanrehan Park Reserve, which straddles the border between Scott and Dakota counties. Hooded Warblers prefer mature deciduous forest with areas of dense, shrubby understory. This is the only known breeding population of Hooded Warblers in Minnesota.

Fragmented "Edge" Habitats, and Dry Oak Woodland/Savanna

Human-disturbed, fragmented habitats, with a mix of cultivated fields, non-native grassland, shrubs, and trees, are widespread in the Minnesota River valley counties. Common species tolerant of these habitat conditions included Red-tailed Hawk, Mourning Dove, Northern Flicker, Eastern Kingbird, Eastern Bluebird, Gray Catbird, Brown Thrasher, Yellow Warbler, and Indigo Bunting.

One type of habitat somewhat unique or characteristic of the Minnesota River valley consists of dry, south-facing slopes and areas of rock outcrops, with a mix of dry prairie grasses, shrub patches, red cedar, and sometimes bur oak. An interesting assemblage of uncommon bird species occurs here, including Whip-poor-will, Eastern Towhee, Lark Sparrow, and occasionally Bell's Vireo. Although some of these areas are heavily-grazed, they are perhaps important surrogate habitats for what was once native oak savanna and oak woodlands.

Two other regionally rare birds, Chestnut-sided Warbler and Blue Grosbeak (Figure 5.c5), were found at a few locations in the Minnesota River valley counties. During pre-settlement times the Chestnut-sided Warbler occurred in oak woodland-brushland in much of southern Minnesota. They are now quite rare in the Minnesota River valley counties, but remain common in young, shrubby forests in the northern and central parts of the state. The Blue Grosbeak is most common in Minnesota in the Prairie Coteau region of extreme southwestern Minnesota. MCBS documented what appears to be a disjunct population in the Minnesota River valley

region in southwestern Brown County , and one even more isolated location in Renville County.

Figure 5.c5: *Blue Grosbeak. Photo by Patrick Beauzay.*

Grassland and Prairie

The most extensive native prairies remaining in the Minnesota River valley are in the Lac Qui Parle WMA/Big Stone NWR area at the west end of the valley, as the prairies elsewhere in the valley have been reduced to small fragments. Other grasslands, such as grazed pastures, old f elds, and brome f elds, are also important if extensive in area or adjacent to native prairie remnants.

Typical grassland birds common in most grasslands in the Minnesota River valley include Eastern Kingbird, Sedge Wren, Savannah Sparrow, Grasshopper Sparrow , Bobolink, and Western Meadowlark. Less common species, often associated with more extensive grasslands, particularly prairie or larger pastures, are Northern Harrier, Upland Sandpiper (Figure 5.c6), Western Kingbird, and Brewer's Blackbird.

State-listed or tracked rare species found by MCBS in grassland habitats in the Minnesota River valley were Marbled Godwit (Figure 5.c9), Loggerhead Shrike (Figure 5.c7), Henslow' s Sparrow, and Chestnut-collared Longspur (Figure 5.c8). Burrowing Owls and Short-eared Owls have been found in the past, but none were located by MCBS. Also, the Greater Prairie-Chicken has

Figure 5.c6: *Upland Sandpiper. Photo by David W. Klein*

recently been reintroduced to the Lac Qui Parle prairie area. These species are rare because of the severe reduction and fragmentation of their once-extensive prairie grassland and wetland habitats.

Loggerhead Shrike *(Lanius ludovicianus)* State Threatened

Loggerhead Shrikes have been declining in numbers and disappearing from lar ge portions of their historic range in the U.S (Figure 5.c7). This state-threatened species was a survey priority for MCBS, as well as the DNR Nongame Wildlife Program, and considerable survey ef fort was directed to documenting this species in the 1990s. Results from these ef forts showed that the overwhelming majority of recent sightings of Loggerhead Shrikes was in Dakota CountyTypical breeding habitat consists of open grasslands interspersed with small trees that are used as nest sites and hunting perches. In Dakota County , this species was associated with small grassland tracts, located on slopes too steep for cultivation, within agricultural areas (MCBS 1992). Other important concentrations of shrike records were from the large grassland tracts encompassed by Lac Qui

Parle WMA and Big Stone NWR, in Lac Qui Parle, Swift, and Chippewa counties, and from Kasota Prairie SNA and adjacent grasslands in Le Sueur County. Few records exist elsewhere among the Minnesota River valley counties for this species.

Figure 5.c7: *Loggerhead Shrike. Photo by David Cahlander.*

Henslow's Sparrow *(Ammodramus henslowi)* State Endangered

MCBS documented several locations of this species scattered across the Minnesota River counties. Of those, half occurred in native prairie and the remaining from other grassland habitats. An individual Henslow's Sparrow that was recorded in the Lawrence Wayside of the Minnesota Valley State Recreation Area in Scott County could not be relocated on several subsequent visits and probably did not nest or otherwise remain in area.

Chestnut-collared Longspur *(Calcarius ornatus)* State Endangered

The NHIS Rare Features database contains only two records of this species in the Minnesota River Valley counties, both from the 1980s in Big Stone County on uplands north of the Minnesota River valley. MCBS observed this species in the southeastern part of the county on a lar ge pasture containing a mosaic of dry upland prairie with low wet swales. The earlier observation was in a large, annually hayed prairie that later became Clinton Prairie SNA (Figure 5.c8).

Figure 5.c8: *Chestnut-collared Longspur. Photo by Patrick Beauzay.*

Marbled Godwit *(Limosa fedoa)* State Special Concern

With only two exceptions, all of the records of this species in the Minnesota River Valley counties are from the extensive prairies and wetlands on Minnesota River terraces in Big Stone, Lac Qui Parle, Swift, and Chippewa counties, such as in Lac Qui Parle WMA, Big Stone National Wildlife Refuge, and Chippewa Prairie Preserve (Figure 5.c9).

Figure 5.c9: *Marbled Godwit. Photo by Sparky Stensaas/stoneridgepress.com.*

Wetlands

In the region, open wetlands important to birds are primarily lakes and emer gent marshes. Wetland birds in the Minnesota River valley included the ubiquitous Red-winged Blackbird, several duck species, Pied-billed Grebe, Western Grebe, Sora, American Coot, Marsh Wren, Common Yellowthroat, Swamp Sparrow, and Yellow-headed Blackbird. Uncommon species documented by MCBS in wetland habitats included American Bittern (Figure 5.c10), Red-necked Grebe, Eared Grebe, Sandhill Crane, and Black Tern.

Figure 5.c10: *American Bittern. Photo by David W. Klein*

Rare bird species documented by MCBS in open wetlands included Wilson's Phalarope, Trumpeter Swan, American White Pelican, Wilson's Phalarope (Figure 5.c11), Franklin's Gull, and Forster's Tern. The marshes of the region also provide potential habitat for the Common Moorhen, a species requiring emergent marshes, although the species was not documented in the region by MCBS. The amount of available habitat for these species has been severely reduced by extensive draining of wetlands throughout Minnesota's prairie region.

Trumpeter Swan *(Cygnus buccinator)* State Threatened

Trumpeter Swans have been reintroduced and are breeding in Minnesota River valley counties in the Twin Cities area. The species had not bred in Minnesota for 80 years until its reintroduction by the Hennepin County Park Reserve District (now Hennepin Parks) in the 1960s.

American White Pelican *(Pelecanus erythrorhynchos)* State Special Concern

The largest breeding colony of white pelicans in Minnesota is located on a few islands at Marsh Lake, in Lac Qui Parle WMA. This species can be seen on most lakes and marshes throughout western Minnesota, and in some Minnesota River backwaters, but American White Pelicans are not known to nest at these areas.

Wilson's Phalarope *(Phalaropus tricolor)* State Threatened

This species breeds primarily in small prairie wetlands. In the Minnesota River counties, all but one of the breeding season records are concentrated at the far west end of the region in Big Stone, Lac Qui Parle, and Yellow Medicine counties (Figure 5.c11). The other record is in a shallow wetland in a large pasture in the southwestern corner of Brown County.

Figure 5.c11: *Wilson's Phalarope. Photo by Sparky Stensaas/stoneridgepress.com.*

Franklin's Gull *(Larus pipixcan)* State Special Concern

Non-breeding birds of this species often are present during the summer in western Minnesota River valley counties. There are no recently documented breeding colonies in the Minnesota River counties—the species was last recorded nesting in the region at Swan Lake in Nicollet County in 1965.

Forster's Tern *(Sterna forsteri)* State Special Concern

Forster's Terns have been documented breeding at scattered locations in the Minnesota River valley counties in wetlands with a high degree of interspersion of cattails and open water, such as at Swan Lake WMA in Nicollet County.

5.d: RARE AMPHIBIANS AND REPTILES OF THE MINNESOTA RIVER VALLEY COUNTIES

Carol D. Hall

Eight species of state-listed herpetofauna occur within the Minnesota River valley, including one endangered amphibian and seven reptiles listed as special concern. Three additional species documented along the river are tracked in the Natural Heritage Information System (NHIS) Rare Features Database, although they are not currently listed. The rarity and secretive nature of many of these species makes them challenging to document, particularly given limited time available for field surveys and weather constraints on herp activity. Of the 50 species of amphibians and reptiles known to occur in Minnesota, 40 species (17 amphibians, 23 reptiles) have been documented within the Minnesota River valley (Table 5.d1). This surprisingly large diversity is based on the wide range of terrestrial and aquatic habitats that once flourished along this river corridor.

Terrestrial Habitats

Upland habitats with dry, well-drained soils provide favorable conditions for several species of reptiles. During the retreat of the glaciers, gravel and sand were deposited as outwash and terrace landforms within the Minnesota River valley. These are the areas most likely to be inhabited by many of the rare turtles, lizards, and snakes of the region.

Figure 5.d1: *MCBS field staff conducting a herp search along wetland edge. Herp searches involve surveying a particular habitat or site and recording all herpetofuana observed. MNDNR photo by Carol Hall.*

Sand Prairies and Savannas

Sand prairies and savannas provide important habitat for a variety of reptile species including three rare species of snakes, the Eastern Racer, Western Hog-nosed Snake, and Gophersnake. Land-use has greatly reduced these habitats, in both size and number through residential and commercial development, agricultural expansion, and mining and gravel excavation. Remaining tracts of suitable habitat are widely separated and continued habitat loss threatens these sites. Animals dispersing from these habitat islands often encounter busy roads where snake and turtle mortality is likely, reducing the viability of isolated populations.

Eastern Racer *(Coluber constrictor)* State Special Concern

In Minnesota, the Eastern Racer is associated with grassland, brushland, and open woodland habitats. In Minnesota it is most common in the bluffands of the southeast but has been documented elsewhere in eastern counties. Populations appear to be localized and individuals have been encountered only occasionally during surveys conducted by the Minnesota County Biological Survey (MCBS). In the Minnesota River valley a disjunct population occurs in Le Sueur and Blue Earth counties—nearly 100 miles from the nearest records to the east, in Dakota County (Levell 1998). The mix of prairie and woodland habitat in this area is associated with well-drained soils of the Minnesota River terraces. Intensive farming has eliminated hedgerows and other suitable cover throughout much of this species' range.

Western Hog-nosed Snake *(Heterodon nasicus)* State Special Concern

Western Hog-nosed Snakes inhabit open grasslands associated with well-drained soils, such as the sand terraces of the Minnesota River valley and the Anoka Sand Plain. Records are located in both the upper and lower ends of the valley where extensive sand prairies still exist. MCBS documented this species in Lac Qui Parle, Swift and Hennepin counties. When threatened by a potential predator this species utilizes a distinctive defense behavior, which it shares with its close relative, the Eastern Hog-nosed Snake. When approached they hiss and

Table 5.d1: *Amphibians and Reptiles of the Minnesota River corridor*

MCBS = species documented by MCBS (observation, photo, or specimen).
X = species documented by other sources (Oldfield and Moriarty 1994, Moriarty et al. 1998, Levell 1998)

		COUNTIES ALONG THE MINNESOTA RIVER																
		Big Stone	Blue Earth	Brown	Carver	Chippewa	Dakota	Hennepin	Lac qui parle	LeSueur	Nicollet	Ramsey	Redwood	Renville	Scott	Sibley	Swift	Yellow Medicine
Salamanders																		
Necturus maculosus	Mudpuppy	X		X		X	X	X		X		X			X			X
Ambystoma laterale	Blue-spotted Salamander							X							X			
Ambystoma tigrinum	Tiger Salamander	X	MCBS	X	X	MCBS	X	X	X	X	MCBS	X	MCBS	X	MCBS	X	MCBS	MCBS
Notophthalmus viridescens	Eastern Newt						X	X										
Plethodon cinereus	Eastern Red-backed Salamander					X												
Frogs and Toads																		
Bufo americanus	American Toad	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	X	MCBS	MCBS		MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Bufo cognatus	Great Plains Toad	X		MCBS		MCBS			X		X		MCBS	MCBS			MCBS	MCBS
Bufo hemiophrys	Canadian Toad	X				MCBS			X					MCBS			MCBS	MCBS
Acris crepitans	Northern Cricket Frog							X										
Hyla chrysoscelis	Cope's Gray Treefrog		MCBS	MCBS	MCBS		MCBS	MCBS		MCBS	X		MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Hyla versicolor	Gray Treefrog			MCBS	X		MCBS			MCBS					MCBS			
Pseudacris crucifer	Spring Peeper																	
Pseudacris maculata/triseriata	Boreal/Western Chorus Frog	MCBS		MCBS	MCBS	MCBS	MCBS	MCBS		MCBS	MCBS			MCBS	MCBS	MCBS	MCBS	MCBS
Rana catesbeiana	American Bullfrog		X					X							MCBS			
Rana clamitans	Green Frog				X		MCBS	MCBS		MCBS		X			MCBS			
Rana pipiens	Northern Leopard Frog	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Rana sylvatica	Wood Frog						X	X		MCBS		X			MCBS	MCBS	MCBS	MCBS
Turtles																		
Chelydra serpentina	Snapping Turtle	X	MCBS	MCBS	MCBS	MCBS	MCBS	X	MCBS	MCBS	MCBS	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Graptemys geographica	Northern Map Turtle		MCBS				X	X		MCBS	MCBS				MCBS	MCBS		
Graptemys pseudogeographica	False Map Turtle		MCBS	MCBS			X	X		MCBS	MCBS				MCBS	MCBS		MCBS

Table 5.d1: *continued*

MCBS = species documented by MCBS (observation, photo, or specimen). X = species documented by other sources (Oldfield and Moriarty 1994, Moriarty et al. 1998, Levell 1998)		COUNTIES ALONG THE MINNESOTA RIVER																
		Big Stone	Blue Earth	Brown	Carver	Chippewa	Dakota	Hennepin	Lac qui parle	LeSueur	Nicollet	Ramsey	Redwood	Renville	Scott	Sibley	Swift	Ye llow Medicine
Turtles continued																		
Chrysemys picta	Painted Turtle	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	X	MCBS	MCBS	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Emydoidea blandingii	Blanding's Turtle		X	X			X	X		X		X			X		X	
Apalone mutica	Smooth Softshell		MCBS					X		MCBS	MCBS				MCBS	MCBS		
Apalone spinifera	Spiny Softshell		MCBS	MCBS	MCBS	MCBS	X	X	X	MCBS	MCBS	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Lizards																		
Cnemidophorus sexlineatus	Six-lined Racerunner						X											
Eumeces fasciatus	Common Five-lined Skink					X							MCBS	MCBS				X
Eumeces septentrionalis	Prairie Skink	MCBS		MCBS	MCBS	MCBS	X	MCBS	X	MCBS	X	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Snakes																		
Nerodia sipedon	Northern Watersnake						MCBS	MCBS										
Storeria dekayi	DeKay's Brownsnake		MCBS	X	X			X		MCBS	X				MCBS	MCBS		
Storeria occipitomaculata	Red-bellied Snake	X	MCBS	MCBS		MCBS	MCBS	MCBS	X	X	MCBS	X	MCBS	MCBS	MCBS	X	MCBS	MCBS
Thamnophis radix	Plains Gartersnake	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	X	MCBS	MCBS	X	MCBS	X	MCBS	MCBS	MCBS	MCBS
Thamnophis sirtalis	Common Gartersnake	X	MCBS	MCBS	MCBS	MCBS	X	MCBS	X	MCBS	MCBS	X	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS
Heterodon nasicus	Western Hog-nosed Snake	X		X		X	X	MCBS	MCBS			X			X		MCBS	X
Heterodon platirhinos	Eastern Hog-nosed Snake						X	X							X			
Coluber constrictor	Eastern Racer		MCBS				MCBS	X		MCBS								
Opheodrys vernalis	Smooth Greensnake						X	X			MCBS	X	X		X			X
Elaphe vulpina	Western Foxsnake		MCBS	MCBS		MCBS	MCBS	MCBS		MCBS	MCBS	MCBS	MCBS	MCBS	MCBS	MCBS		MCBS
Pituophis catenifer	Gophersnake		X		MCBS	X	MCBS	MCBS		X	X	X	X	X	MCBS	X		MCBS
Lampropeltis triangulum	Milksnake		MCBS	X		X	X	X		X	MCBS	X	X	X	MCBS	X		X
Crotalis horridus	Timber Rattlesnake						X											

flatten out their head (Figure 5.d2); if the invader persists the snake will roll over and play dead.

Figure 5.d2: *Western Hog-nosed Snake. MNDNR photo by Tom Jessen.*

Gophersnake *(Pituophis catenifer)* State Special Concern

Gophersnakes (often referred to as Bullsnakes) require large landscapes of relatively open grassland on well-drained soil. Due to habitat loss and degradation, occurrences are spotty along the Minnesota River. This large snake can be over five feet in length and is highly vulnerable to being hit on roads, particularly during movements associated with spring and fall migration (Figure 5.d3). Gophersnakes often occupy the same landscape as hog-nosed snakes, each exploiting different niches. Within the Minnesota River corridor both species occur where open grassland habitat exists on sand terraces. Gophersnakes were documented by MCBS in Carver, Dakota, Hennepin, Scott, and Yellow Medicine counties.

Figure 5.d3: *Drift fences are installed to capture secretive snakes and lizards moving during migration. MNDNR photo by Carol Hall.*

Woodlands and Forests

Woodland and forest habitats associated with the lower Minnesota River valley provide large blocks of habitat for forest-dwelling reptiles. This is in contrast to the narrow forested corridors that line the rivers and streams in the upper valley. Reptiles occurring within woodland and forest habitats are often associated with wooded edges where they move between the sun and shade to adjust their body temperature. The distribution and abundance of forest- and woodland-dwelling species have likely shifted through the years as fire suppression resulted in greater forest cover in the western portion of the river valley and commercial and residential developments fragmented habitats in the east.

Five-lined Skink *(Eumeces fasciatus)* State Special Concern

Five-lined Skinks reach the northwestern edge of their range in Minnesota where disjunct populations occur in southwest, southeast, and east-central Minnesota (Figure 5.d4). Records along the Minnesota River occur within 20 miles of Granite Falls and are primarily concentrated within three populations closely associated with granite outcrops and red cedars. This species is often confused with its close relative, the Northern Prairie Skink, which is common in dry grasslands.Threats to the Five-lined Skink include habitat succession, rock removal, and quarry activity on private tracts. These lizards are arboreal, climbing trees to escape predators and to feed on insects. Dense stands of cedars, however, are not suitable and proper habitat management is necessary to retain viable skink populations. DNR Scientific and Natural Area (SNA) staff conduct prescribed burns and thin cedar stands at Blue Devil Valley and Swedes Forest SNAs based on management guidelines described by Lang (1982). Loose cover rock and moderately decayed woody debris have been identified as important microhabitat features among skink populations in Canada (Howes and Lougheed 2004; Hecnar and M'Closkey 1998). Cover is necessary for thermoregulation and protection from predators. In southern Ontario, where habitat is similar to the Granite Falls area, cover rock was the most important variable for predicting presence of Five-lined

Skinks (Howes and Lougheed 2004). Skinks from the Minnesota River valley were included in recent genetics research on peripheral Five-lined Skink populations; preliminary results indicate that low genetic diversity among these populations could lead to localized extinctions (B.J. Howes, unpublished document). MCBS surveys did not locate any new Five-lined Skink records but confirmed their presence at several previously documented locations.

***Figure 5.d4**: Five-lined Skink. MNDNR photo by Tom Jessen.*

Western Foxsnake *(Elaphe vulpina)* (not listed but tracked as a rare species)

The Western Foxsnake is a large-bodied snake that is relatively common in areas along the Minnesota River. This snake reaches over five feet as an adult and is often misidentified as a Gopher-snake (Bullsnake). The rounded, copper-colored head of adult Foxsnakes helps distinguish them from Gophersnakes, which have a pointed snout and dark markings on their head and jaw (Figure 5.d5). Rock outcrops with deep crevices provide important hibernacula for foxsnakes. Documentation and protection of hibernacula is important for the future of this species. The abundance of Gophersnakes and foxsnakes in the region may have shifted through the years as the habitat adjacent to the river changed from treeless grasslands to the forested corridor that exists today. MCBS surveys located several Western Foxsnakes throughout the river valley. They are known to occur up the valley to the Granite Falls vicinity.

***Figure 5.d5:** Western Foxsnake. MNDNR photo by Carol Hall.*

Eastern Hog-nosed Snake *(Heterodon platirhinus)* (not listed but tracked as a rare species)

The Eastern Hog-nosed Snake is associated with woodland and forest-edge habitats on well-drained soil. Records exist in the lower end of the Minnesota River valley in the Anoka Sand Plain and St. Croix Moraines and Outwash Plains subsections. Due to extensive development in the metropolitan and outlying areas, the habitat for this species has drastically declined over the past 50 years. No new records were obtained in the region during the MCBS surveys.

Timber Rattlesnake *(Crotalus horridus)* State Threatened

Timber Rattlesnake populations were greatly reduced in Minnesota during the 1900s due to bounty hunting and persecution. Currently, viable populations are known to occur only in southeastern Minnesota. Within the Minnesota River valley counties, a single record exists from Dakota County. In 1980, a rattlesnake was collected in Dakota County from the Mississippi River, where it may have crossed over from Wisconsin. Past stories of rattlesnakes occurring farther west in the forests and rock outcrops near Mankato have never been confirmed. While it is possible that rattlesnakes did inhabit this area, it is more likely that Foxsnakes and Gophersnakes, which mimic the sound of a rattlesnake by "rattling" their tail in dry vegetation, were mistaken as rattlesnakes. Unfortunately this defense often results in the death of the

snake from a shovel or shotgun. The bounty was removed for Timber Rattlesnakes in the late 1980s and efforts are underway to educate landowners, monitor rattlesnake populations, and manage remaining habitat in southeastern Minnesota.

Aquatic Habitats

The Minnesota River and its tributaries have provided amphibians and reptiles with travel cor - ridors, aiding the dispersal of these species after glaciers receded. Many species of turtles inhabit these rivers and streams, utilizing sandy banks for basking and nesting. Wetlands, both temporary and permanent in nature, provide essential habitats for amphibians. Ephemeral f ooded-f elds provide breeding habitat for toads, whose eggs transform from aquatic larvae to terrestrial juveniles in a matter of days; while deep wetlands capable of withstanding long periods of drought provide critical refuges for both amphibians and reptiles. These habitats have diminished tremendously in both quality and abundance along the entire river valley, reducing the viability of species that rely on them to survive. In addition, adjacent uplands are often inhospitable for amphibians and reptiles to disperse across and repopulate distant aquatic habitats. Landscape fragmentation and loss of aquatic habitat in the region increases the importance of identifying and protecting viable populations of rare species where they still occur.

Northern Cricket Frog *(Acris crepitans)* State Endangered

During the 1980s and 1990s Northern Cricket Frog populations were greatly reduced throughout the northern portion of their range, including Minnesota. During the late 1990s a population was discovered along Nine-Mile Creek in Hennepin County (Moriarty et al. 1998). Ef forts to locate additional populations along the Minnesota River have been unsuccessful. DNA analysis of the Nine-Mile Creek population was inconclusive in determining if this is a naturally occurring or introduced population (Berendzen et al. 2003). Breeding call surveys coordinated by the Nongame Wildlife Program are conducted annually to determine the status of this isolated population.

Bullfrog *(Rana catesbeiana)* (not listed but tracked as a rare species)

The Bullfrog is native to southeastern Minnesota where it inhabits backwaters of the Mississippi River. Populations that exist outside of this area are considered introduced and this aggressive species can negatively impact local populations of native amphibians. Bullfrogs were documented in Blue Earth County in 1988, when one individual was heard and another was collected. This population is considered to be introduced. No Bullfrogs were detected at this site during MCBS surveys in 1998.

Smooth Softshell *(Apalone mutica)* State Special Concern

Smooth Softshell turtles occur in lar ge rivers including the Minnesota, Mississippi, and St. Croix (Figure 5.d6). They are a tracked species in Minnesota due to their limited range, threats related to commercial harvesting, and nesting habitat degradation related to recreational boating activities. Their close relative, the Spiny Softshell, occupies a greater variety of habitats and has a wider distribution in Minnesota. Sandy points and south-facing cutbanks provide important nesting habitat for Smooth Softshell turtles, which rarely travel far from the river 's edge. Smooth Softshells have been documented up the Minnesota River as far as Nicollet County.

Figure 5.d6: *Smooth Softshell Turtle. MNDNR photo by Tom Jessen.*

Blanding's Turtle *(Emydoidea blandingii)* State Threatened

Blanding's Turtles inhabit emergent marshes with

good interspersion of open water and aquatic vegetation. They often use streams and ditches to move between wetlands and may travel long distances overland to reach nesting sites of open, sparsely vegetated grasslands on well-drained soils. Numerous Blanding's Turtle records occur within the lower Minnesota River valley where habitat was once ideal for this species. Residential and commercial developments have greatly fragmented much of this habitat and turtle populations have been greatly reduced. High-traffic roads bisecting wetlands and nesting habitat create death traps for this species. Few records exist in the upper portion of the valley, where wetland drainage has eliminated much habitat and turtles traveling through crop fields are vulnerable to being hit by a disc or plow. While most records within the river valley are from the 1980s and 1990s, recent radiotelemetry projects are adding to our knowledge of habitat use of this species. Blanding's Turtle research along the river corridor includes radiotracking turtles at Crosby Farm Park in St. Paul (J. Dee, Como Zoo, pers. comm.) and tributaries of the river in Brown County (L. Gelvin-Innvaer, MNDNR, pers. comm.).

Snapping Turtle *(Chelydra serpentina)* State Special Concern

The Snapping Turtle occurs within a wide variety of aquatic habitats including wetlands, lakes, streams, and rivers. It has been documented in all of the Minnesota River valley counties and may be present throughout the Minnesota River valley wherever suitable habitat exists. This species was listed as state special concern in 1984 due to pressure from commercial harvesting. Recent changes to turtle harvesting rules have improved reporting by commercial harvesters and increased restrictions on trap use and design.

5.e. FISH COMMUNITIES OF THE MINNESOTA RIVER VALLEY COUNTIES

Konrad Schmidt and Nick Proulx

Overview

In the period from the late 1800s to the present, surveys by the University of Minnesota, the Minnesota Department of Natural Resources (including its predecessors: the MN Fish and Game Commission, and the MN Department of Conservation), and the Minnesota Pollution Control Agency have documented 104 fish species in 24 families in the counties adjacent to the Minnesota River (Table 5.e1). Although early fish surveys of Minnesota lakes and streams are sporadic and generally not complete enough to provide an authoritative account of the historical composition of fish communities, it appears that the aquatic habitats of the Minnesota River drainage supported a diverse assemblage of fish species in the past. These aquatic habitats included shallow lakes and low-gradient streams on the uplands flanking the Minnesota River valley, high-gradient streams where tributaries to the river descend into the valley, and the winding main stem of the Minnesota andfloodplain lakes on the valley floor.

At present, the Minnesota River drainage is one of the most degraded in the state due to intensive row-crop agriculture, wetland drainage, and channelization of tributary streams. The main stem of the Minnesota and many of its tributaries are extremely turbid, transporting enormous silt loads many miles downstream to Lake Pepin where sediment is rapidly filling the lake. Turbidity reduces light penetration, which, if severe, eliminates submerged vegetation that provides fish habitat. Sediment deposits fill in the interstitial spaces in rocky substrates, which are habitats for the invertebrate communities that feed many fish species. Also, several fishes classified as simple lithophils require clean, exposed gravel and rubble to lay their eggs and develop. If the spaces are filled, the eggs suffocate. As a result of stream degradation from turbidity and other sources such as chemical contaminants, populations of many species are likely much smaller than in the past, and twelve of the 104 species previously documented in the drainage have not been seen for more than 30 years and are likely extirpated. These species include the blackchin shiner (last reported in 1976), blacknose shiner (1926), Mississippi silvery minnow (1948), pallid shiner (1926), pearl dace (1954), pugnose shiner (1926), southern redbelly dace (1953), river redhorse (1899), skipjack herring (1920, Figure 5.e1), spotted sucker (1899), and western sand darter (1976).

Figure 5.e1: *Large schools of skipjack herring previously migrated up the Minnesota and spawned in Big Stone Lake.This species has not been seen in the Minnesota since 1920. Photo by Mary Stefansky.*

Present Status of Fish Communities

The lower reach of the Minnesota River now constitutes the longest free-flowing section of stream in the state. The first dam on the river is at Minnesota Falls, located a few miles downstream from Granite Falls and about 250 miles upstream from the river's confluence with the Mississippi at Fort Snelling. This unimpounded lower reach is by far the richest stream segment in fish species in the Minnesota River drainage. Rare species such as the paddlefish (Figure 5.e2), lake sturgeon (Figure 5.e3), blue sucker, and black buffalo (Figure 5.e4) have been documented along this part of the river. Except during severe floods, the six dams present along the river's upper reach are barriers tofish migration. As a result, fish species diversity declines significantly from Minnesota Falls to the source of the river at Big Stone Lake. Prior to the dam era, at least two rare fishes (lake sturgeon and skipjack herring) were known to migrate annually up the Minnesota River to spawning areas in the lake.

Table 5.e1: *Fish species reported from the Minnesota River.*

Scientific Name	Common Name	Family	Status	Abundance[1]
Acipenser fulvescens	lake sturgeon	Acipenseridae - Sturgeons	SPC	R
Scaphirhynchus platorynchus	shovelnose sturgeon	Acipenseridae - Sturgeons	SGCN	C
Amia calva	bowfin	Amiidae - Bowfins		U
Anguilla rostrata	American eel	Anguillidae - Eels	SGCN	R
Labidesthes sicculus	brook silverside	Atherinidae - Silversides		R
Carpiodes carpio	river carpsucker	Catostomidae - Suckers		C
Carpiodes cyprinus	quillback	Catostomidae - Suckers		U
Carpiodes velifer	highfin carpsucker	Catostomidae - Suckers		C
Catostomus commersonii	white sucker	Catostomidae - Suckers		A
Cycleptus elongatus	blue sucker	Catostomidae - Suckers	SPC	U
Hypentelium nigricans	northern hog sucker	Catostomidae - Suckers		C
Ictiobus bubalus	smallmouth buffalo	Catostomidae - Suckers		C
Ictiobus cyprinellus	bigmouth buffalo	Catostomidae - Suckers		A
Ictiobus niger	black buffalo	Catostomidae - Suckers	SPC	U
Minytrema melanops	spotted sucker	Catostomidae - Suckers	H	N/A
Moxostoma anisurum	silver redhorse	Catostomidae - Suckers		A
Moxostoma carinatum	river redhorse	Catostomidae - Suckers	H (SGCN)	N/A
Moxostoma erythrurum	golden redhorse	Catostomidae - Suckers		A
Moxostoma macrolepidotum	shorthead redhorse	Catostomidae - Suckers		A
Moxostoma valenciennesi	greater redhorse	Catostomidae - Suckers	SGCN	U
Ambloplites rupestris	rock bass	Centrarchidae - Sunfishes		U
Lepomis cyanellus	green sunfish	Centrarchidae - Sunfishes		A
Lepomis gibbosus	pumpkinseed	Centrarchidae - Sunfishes		C
Lepomis humilis	orangespotted sunfish	Centrarchidae - Sunfishes		A
Lepomis macrochirus	bluegill	Centrarchidae - Sunfishes		A
Micropterus dolomieu	smallmouth bass	Centrarchidae - Sunfishes		U
Micropterus salmoides	largemouth bass	Centrarchidae - Sunfishes		A
Pomoxis annularis	white crappie	Centrarchidae - Sunfishes		U
Pomoxis nigromaculatus	black crappie	Centrarchidae - Sunfishes		C
Piaractus brachypomus	pirapatinga	Characidae - Characins	EX	R
Alosa chrysochloris	skipjack herring	Clupeidae - Herrings	H(SPC)	N/A
Dorosoma cepedianum	gizzard shad	Clupeidae - Herrings		A
Campostoma anomalum	central stoneroller	Cyprinidae - Minnows		A
Campostoma oligolepis	largescale stoneroller	Cyprinidae - Minnows	SGCN	U
Carassius auratus	goldfish	Cyprinidae - Minnows	EX	R
Cyprinella spiloptera	spotfin shiner	Cyprinidae - Minnows		A
Cyprinus carpio	common carp	Cyprinidae - Minnows	EX	A
Hybognathus hankinsoni	brassy minnow	Cyprinidae - Minnows		A
Hybognathus nuchalis	Mississippi silvery minnow	Cyprinidae - Minnows	H (SGCN)	N/A
Hybopsis amnis	pallid shiner	Cyprinidae - Minnows	H (SPC)	N/A
Luxilus cornutus	common shiner	Cyprinidae - Minnows		A
Macrhybopsis hyostoma	shoal chub	Cyprinidae - Minnows	SGCN	U
Macrhybopsis storeriana	silver chub	Cyprinidae - Minnows		U
Margariscus margarita	pearl dace	Cyprinidae - Minnows	H	N/A
Nocomis biguttatus	hornyhead chub	Cyprinidae - Minnows		A
Notemigonus crysoleucas	golden shiner	Cyprinidae - Minnows		C
Notropis anogenus	pugnose shiner	Cyprinidae - Minnows	H (SPC)	N/A
Notropis atherinoides	emerald shiner	Cyprinidae - Minnows		A
Notropis blennius	river shiner	Cyprinidae - Minnows		U
Notropis dorsalis	bigmouth shiner	Cyprinidae - Minnows		A
Notropis heterodon	blackchin shiner	Cyprinidae - Minnows	H	N/A
Notropis heterolepis	blacknose shiner	Cyprinidae - Minnows	H	N/A
Notropis hudsonius	spottail shiner	Cyprinidae - Minnows		U
Notropis percobromus	carmine shiner	Cyprinidae - Minnows		U
Notropis stramineus	sand shiner	Cyprinidae - Minnows		A
Notropis texanus	weed shiner	Cyprinidae - Minnows		R
Notropis volucellus	mimic shiner	Cyprinidae - Minnows		U
Notropis wickliffi	channel shiner	Cyprinidae - Minnows		R
Phoxinus eos	northern redbelly dace	Cyprinidae - Minnows		U
Phoxinus erythrogaster	southern redbelly dace	Cyprinidae - Minnows	H	N/A
Pimephales notatus	bluntnose minnow	Cyprinidae - Minnows		A
Pimephales promelas	fathead minnow	Cyprinidae - Minnows		A

Table 5.e1: *continued*

Scientific Name	Common Name	Family	STATUS	ABUNDANCE[1]
Pimephales vigilax	bullhead minnow	Cyprinidae - Minnows		U
Rhinichthys obtusus	blacknose dace	Cyprinidae - Minnows		A
Semotilus atromaculatus	creek chub	Cyprinidae - Minnows		A
Fundulus diaphanus	banded killifish	Fundulidae - Killifishes		U
Esox lucius	northern pike	Esocidae - Pikes		A
Lota lota	burbot	Gadidae - Codfishes		R
Culaea inconstans	brook stickleback	Gasterosteidae - Sticklebacks		A
Hiodon alosoides	goldeye	Hiodontidae - Mooneyes		U
Hiodon tergisus	mooneye	Hiodontidae - Mooneyes		U
Ameiurus melas	black bullhead	Ictaluridae - Bullhead Catfishes		A
Ameiurus natalis	yellow bullhead	Ictaluridae - Bullhead Catfishes		C
Ameiurus nebulosus	brown bullhead	Ictaluridae - Bullhead Catfishes		U
Ictalurus punctatus	channel catfish	Ictaluridae - Bullhead Catfishes		A
Noturus flavus	stonecat	Ictaluridae - Bullhead Catfishes		C
Noturus gyrinus	tadpole madtom	Ictaluridae - Bullhead Catfishes		U
Pylodictis olivaris	flathead catfish	Ictaluridae - Bullhead Catfishes		C
Lepisosteus osseus	longnose gar	Lepisosteidae - Gars		R
Lepisosteus platostomus	shortnose gar	Lepisosteidae - Gars		C
Morone chrysops	white bass	Moronidae - Temperate Basses		C
Ammocrypta clara	western sand darter	Percidae - Perches	H (SGCN)	N/A
Etheostoma caeruleum	rainbow darter	Percidae - Perches		U
Etheostoma exile	Iowa darter	Percidae - Perches		C
Etheostoma flabellare	fantail darter	Percidae - Perches		C
Etheostoma microperca	least darter	Percidae - Perches	SPC	R
Etheostoma nigrum	johnny darter	Percidae - Perches		A
Etheostoma zonale	banded darter	Percidae - Perches		C
Perca flavescens	yellow perch	Percidae - Perches		A
Percina caprodes	logperch	Percidae - Perches		U
Percina maculata	blackside darter	Percidae - Perches		A
Percina phoxocephala	slenderhead darter	Percidae - Perches		A
Percina shumardi	river darter	Percidae - Perches		R
Sander canadensis	sauger	Percidae - Perches		C
Sander vitreus	walleye	Percidae - Perches		A
Percopsis omiscomaycus	trout-perch	Percopsidae - Trout-perches		R
Ichthyomyzon unicuspis	silver lamprey	Petromyzontidae - Lampreys		R
Lampetra appendix	American brook lamprey	Petromyzontidae - Lampreys	SGCN	R
Polyodon spathula	paddlefish	Polyodontidae - Paddlefishes	TH	U
Oncorhynchus mykiss	rainbow trout	Salmonidae - Trouts	EX	R
Salmo trutta	brown trout	Salmonidae - Trouts	EX	U
Salvelinus fontinalis	brook trout	Salmonidae - Trouts		R
Aplodinotus grunniens	freshwater drum	Sciaenidae - Drums		A
Umbra limi	central mudminnow	Umbridae - Mudminnows		C

Status
EX - exotic
H - historical (extirpated)
SGCN - species in greatest conservation need
SPC - special concern
TH - threatened

Abundance
R - rare (1-10 records)
U - uncommon (11-75 records)
C - common (76-150 records)
A - abundant (>150 records)

[1]Abundance for each species is based on the number of database records covering the Minnesota Valley counties. This is an arbitrary ranking, but does provide a general indication of the relative abundance of each species in the Minnesota River drainage.

Figure 5.e2: *Paddlefish, a species in decline throughout its U.S. range, were believed extirpated from the Minnesota River for decades, but several fish have been caught in deep pools in the Minnesota River since 1990. Paddlefish require free-flowing rivers with gravel bars for spawning. MNDNR photo by Carol Hall.*

Figure 5.e3: *The lake sturgeon is a rare species occasionally found in widely scattered localties of the Minnesota River. MNDNR photo by Baudette Area Fisheries Office.*

Figure 5.e4: *The black buffalo is a rare species that was first reported in the Minnesota drainage in 1990 and is increasing in frequency along the free flowing reach of the Minnesota River. MNDNR photo by Sharron Nelson.*

The lowest 25 miles of the river, from Shakopee to the Mississippi River, have been channelized and maintained for commercial navigation and this stretch is now essentially a trench with a uniform depth of 20-25 feet and a substrate of shifting sands. Bottom trawling along this part of the river in 2005 revealed shoal chubs—a species considered to be of conservation need in Minnesota (Proulx 2005, MNDNR 2006)—to be the most common species. Surveys conducted in 2006 in floodplain lakes along the lower 50 miles of the river (roughly from Belle Plaine to the confluence with the Mississippi River) documented very diverse fish communities with very different species assemblages from that present in the main stem of the Minnesota River along this part of the valley, including white crappie, bowfin, golden shiner, weed shiner, and Iowa darter.

Aquatic habitats on the uplands or "plateau" flanking the river valley include shallow and turbid lakes and also some remnant reaches of natural streams. Most streams on the uplands, however, have been channelized and maintained as county and judicial ditches. Fish communities in these lake and stream habitats generally exhibit little diversity and are often dominated by one or two very tolerant species (e.g., black bullheads and fathead minnows). At the edge of the plateau, streams increase in gradient as they descend into the valley. The higher water velocities along these segments scour the gravel and boulder substrates clean of sediments and as a result these habitats contain some of the most diverse and unique fish assemblages in the entire Minnesota River drainage. The lower reaches of the Yellow Medicine, Redwood, and Cottonwood rivers as they enter the Minnesota River valley are examples of stream segments with diverse and species-rich fish communities, including greater redhorse, rainbow darter, banded darter, carmine shiner, and smallmouth bass.

Excluding historical records (prior to 1950), state-listed fish species that have been recorded in the drainage include one Threatened species (paddlefish) and four Special Concern species (black buffalo, blue sucker, lake sturgeon, and least darter).

In addition, surveys have documented six other species considered to be of greatest conservation need in Minnesota (Proulx 2005, MNDNR 2006): American brook lamprey (Figure 5.e5), American eel, greater redhorse, largescale stoneroller, shovelnose sturgeon, and shoal chub. The paddlefish, lake sturgeon, and American brook lamprey were believed extirpated in the drainage for several decades until the early 1990s when biologists and anglers began "rediscovering" these species. During this same period, black buffalo and blue sucker were reported for the first time. Targeted surveys have shown that shovelnose sturgeon and shoal chub populations in the main stem of the Minnesota and the lower reaches of larger tributaries are perhaps the healthiest in the state, likely due to the preferences of these species for turbid streams and shifting sand substrates.

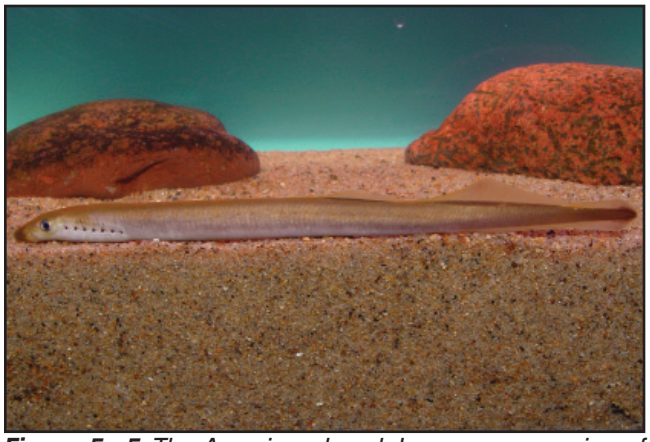

***Figure 5.e5**: The American brook lamprey, a species of small to mid-sized streams with good water clarity, was believed to be extirpated from the Minnesota River drainage but was re-discovered in Eagle Creek near Savage in 1994. MNDNR photo by K. Schmidt.*

Several game species occur in the Minnesota River and its larger tributaries and floodplain lakes. Smallmouth bass were historically abundant and widespread in the drainage, but disappeared in the early 1940s. Surveys noted the species' return in the late 1970s and continue to monitor an ongoing recovery effort that may eventually lead to a fully restored sport fishery. The river also supports healthy populations of channel catfish, flathead catfish (Figure 5.e6), walleye, sauger, and white bass. In 2006, surveys of several floodplain lakes reported impressive catches in size and numbers of black and white crappie (Figure 5.e7).

Five exotic fish species have been caught in surveys in the Minnesota River drainage; these include rainbow trout, pirapatinga, goldfish, brown trout, and common carp. Rainbow trout were stocked in coldwater streams and spring-fed lakes but never became established. The pirapatinga, or pacu, and goldfish are likely aquarium releases. The pirapatinga, found in Riley Lake, is a tropical species not adapted to Minnesota winters. Goldfish can persist but are generally restricted to ponds in larger metropolitan areas. Brown trout have been stocked in several coldwater tributaries to the Minnesota River and have persisted in a few but natural reproduction is limited. The common carp is the only exotic species that has thrived in the Minnesota River and is perhaps the most abundant species, if not in sheer numbers, then most certainly in biomass.

***Figure 5.e6:** The flathead catfish is one of several catfish species that are doing well in the Minnesota River. MNDNR photo by Carol Hall.*

***Figure 5.e7:** Black crappies can be caught in several floodplain lakes along the Minnesota River, including Long, Long Meadow, and Horseshoe lakes. MNDNR photo by Konrad Schmidt.*

Outlook

In recent decades, water quality has begun improving in the Minnesota River drainage. In describing his first surveys in the drainage during the 1950s, Dr. James C. Underhill remarked in the early 1990s while serving as Curator Emeritus of the James Ford Bell Museum fish collection (University of Minnesota), "Seine hauls frequently contained peas and carrots from canneries, human feces from untreated sewage, and not surprising, very few fish. However, today these streams have some color [from turbidity], but are damn near pristine in comparison!" Since the implementation of the Clean Water Act in the 1970s, significant improvements in point source pollution have occurred in treatment of wastewater from municipalities and food processing facilities. More recently, best management practices implemented in several watersheds have begun to address non-point sources. Likely in response to some improvements in water quality, species diversity and abundance are increasing in the Minnesota River. From 1980-1982, sixty surveys by the MNDNR Division of Ecological Resources reported 54 species and a total catch of 9,908 fish. In 2005, a smaller number of surveys (32) by the same program resulted in documentation of 60 species, a nine-percent increase over the 1980-82 results. Even more noteworthy in 2005 was the total catch of 22,500fish, a greater than two-fold increase from 1980-82. Surveys done within the last 20 years have also documented several species not previously reported in the drainage, including black buffalo, blue sucker, river darter, least darter, brook silverside, burbot, greater redhorse, channel shiner, trout-perch, and mooneye. These species may have been present in the past but were missed in surveys until recently. Continued monitoring of point source pollution and increased efforts to address nonpoint source pollution are needed if we are to see the diversity and abundance of fish species remain and expand within the Minnesota River drainage.

5.f. FRESHWATER MUSSELS OF THE MINNESOTA RIVER VALLEY COUNTIES

Bernard E. Sietman

The Minnesota River is a defining feature of the southern Minnesota landscape. Early explorers told of a river that was swift and clear, and supported an abundance of native freshwater mussels (more accurately termed unionids). George W. Featherstonhaugh was one such explorer, and he recorded observations from his 1835 journey up the Minnesota (Featherstonhaugh 1970 [1847]), or St. Peter's River as it was called at the time. With regard to mussels he writes

> *"A great profusion of unios were lying in the sandy bottom, buried to their umbones; the species called [Unio] fasciatus* [currently recognized as the mucket, *Actinonaias ligamentina;* Figure 5.f1], *with singularly beautiful nacres tinged with a brilliant carnation, being the most prevalent…some specimens of which outstripped in elegance any I had yet seen. I made a good collection of these shells…."* He goes on to write that "*…the water [was] beautifully transparent, and the unios stuck in countless numbers in the pure white sand, so that I could, by baring my arm, select them as we went along."*

Figure 5.f1: *The mucket (Actinonaias ligamentina). Based on the journal of George W. Featherstonhaugh and the prevalence of dead shells today, this was possibly the most abundant mussel in the mainstem Minnesota River (and perhaps major tributaries also) prior to European-American settlement. It is now likely extirpated from the entire drainage. MNDNR photo by D. Rose.*

Figure 5.f2*: Snorkeling and SCUBA diving are two of the best methods for surveying freshwater mussels. In murky water, such as the Minnesota River, biologists search for mussels by running their hands across the stream bottom and digging through the substrate. Sometimes the water is clear enough to see mussel siphons or shells protruding from the substrate. MNDNR photo by B. Sietman.*

Beyond this, historical accounts of Minnesota River mussels are scarce (although see Nachtrieb 1908), but it is safe to say the fauna was rich and diverse, likely equal to that of the St. Croix, our most prominent mussel river today.

In comparison with Featherstonhaugh's historical account, recent sampling for mussels in the Minnesota River drainage tells a very troubling story. This sampling, done by the Minnesota Department of Natural Resources (Figures 5.f2, 5.f3) and University of Minnesota (Bright et al. 1990, 1995) at 477 sites in the drainage between 1989 and 2006, documented contemporary mussel species richness and abundance. These surveys

Figure 5.f3: *Minnesota DNR biologists examine mussels and record data from a sample site on the Minnesota River in July 2006. MNDNR photo by A. Lindau.*

also provided information about species present in the drainage before extensive European-American settlement through documentation of relic shells that can persist in streams for decades, or even millennia after mussels die. The survey results indicate that at least 41 (and possibly 43) mussel species were present historically in the Minnesota River drainage, but only 23 species remain (Table 5.f1). Numbers of a few of the remaining species appear so low that it is uncertain if populations will persist. Of the species occurring in the river , present and past, over half are listed by the State of Minnesota as Endangered, Threatened, or of Special Concern, and three are listed by the federal government as Endangered. These observations ref ect a national (Bogan 1993, Neves 1993) and worldwide (Lydeard et al. 2004) trend of declining freshwater molluscan diversity.

The drastic decline in mussel diversity points to serious ecological problems in the watershed. However, one cannot adequately discuss mussels in an ecological context without touching on their complex life cycle. Larval mussels spend a short period of their lives as parasites on the gills or f ns of f sh, a necessary step to complete development into a free-living juvenile mussel (Figure 5.f4, Kat 1984). This fascinating reproductive strategy also illustrates one of the most serious vulnerabilities of all freshwater mussel species; if hostf sh are not present, mussels cannot reproduce. This required step in the mussel life cycle does not harm the f sh; in fact f sh can benef t by acquiring immunity to future infections by other harmful parasites (Wilson 1916, Coker et al. 1921). Thus mussels and f sh are intrinsically linked, and conditions that are detrimental to one are also detrimental to the other.

The role mussels play in ecosystem function is only beginning to be revealed, but the fact that mussel biomass in healthy rivers can be an order of magnitude or more greater than that of all other invertebrates combined (Negus 1966, Vaughn and Hakenkamp 2001), suggests they are integral components of riverine ecosystems. It has even been suggested that mussels serve as "ecosystem engineers" in rivers where they are

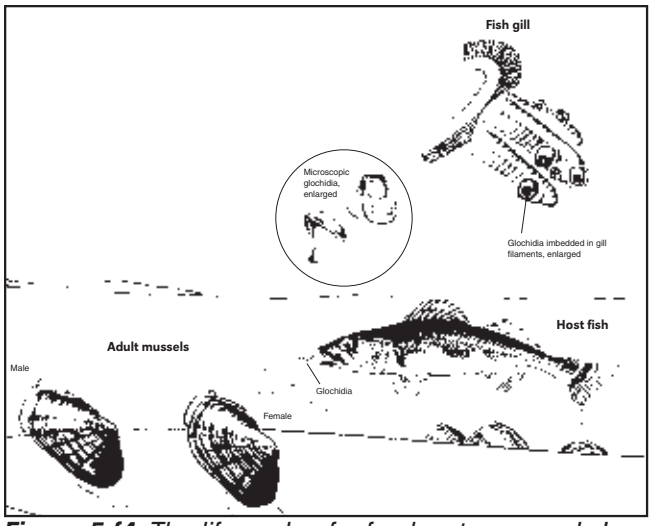

Figure 5.f4: *The life cycle of a freshwater mussel. Larval mussels (glochidia) must spend a period of time, usually a few weeks, attached to a host fish. Not all fish species are suitable hosts, and each mussel species has a specific fish species, or suite of fish species, it can use as a host. While attached, a larva will undergo a metamorphosis and transform into a juvenile mussel, then detach from the fish and fall to the river bottom where it spends the remainder of its life. Illustration by Don Luce*

abundant because they both modify the habitat and control availability of resources to other organisms (Spooner and Vaughn 2006). Mussels f lter vast quantities of water each day, cleansing it of particulates while making a living on the algae, bacteria, and other or ganic matter they consume (Figure 5.f5). A single mussel can f lter as much

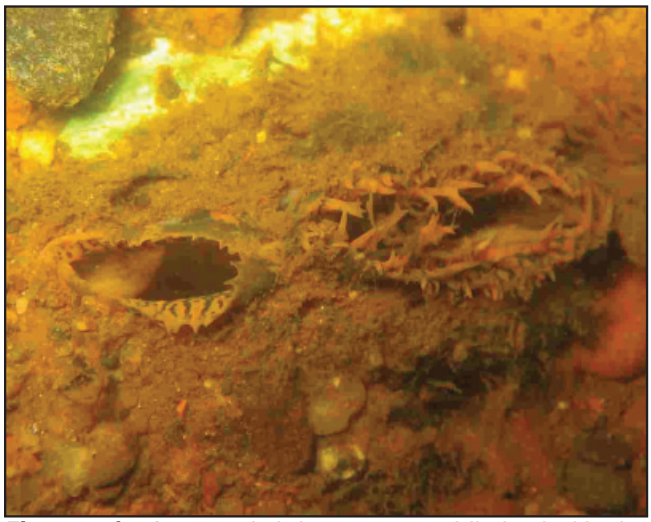

Figure 5.f5: *A mussel siphons water while buried in the substrate. Mussels are difficult to find since they are often buried in the substrate, sometimes completely below the surface. Mussels draw in water through the incurrent siphon (right) to obtain food and oxygen, then expel water through the excurrent siphon (left). MNDNR photo by B. Sietman.*

Table 5.f1: *Freshwater mussel species recorded from the Minnesota River system.*

Species	Common name	Collected Live	Likely extirpated
Federally Endangered			
Lampsilis higginsii	Higgins' eye		1
*Leptodea leptodon**	scaleshell		1
Quadrula fragosa	winged mapleleaf		1
MN Endangered			
Arcidens confragosus	rock pocketbook		1
Elliptio crassidens	elephantear		1
Fusconaia ebena	ebonyshell		1
*Lampsilis teres***	yellow sandshell		1
Plethobasus cyphyus	sheepnose		1
Quadrula nodulata	wartyback	1	
MN Threatened			
Actinonaias ligamentina	mucket		1
Alasmidonta marginata	elktoe	1	
Cyclonaias tuberculata	purple wartyback		1
Ellipsaria lineolata	butterfly		1
Megalonaias nervosa	washboard		1
Pleurobema sintoxia	round pigtoe	1	
Quadrula metanevra	monkeyface		1
Simpsonaias ambigua	salamander mussel		1
Tritogonia verrucosa	pistolgrip		1
MN Special Concern			
Elliptio dilatata	spike	1	
Lasmigona compressa	creek heelsplitter	1	
Lasmigona costata	flutedshell		1
Ligumia recta	black sandshell	1	
Obovaria olivaria	hickorynut		1
Non-Listed			
Amblema plicata	threeridge	1	
Anodontoides ferussacianus	cylindrical papershell	1	
Fusconaia flava	Wabash pigtoe	1	
Lampsilis cardium	plain pocketbook	1	
Lampsilis siliquoidea	fatmucket	1	
Lasmigona complanata	white heelsplitter	1	
Leptodea fragilis	fragile papershell	1	
Ligimia subrostrata	pondmussel		1
Obliquaria reflexa	threehorn wartyback	1	
Potamilus alatus	pink heelsplitter	1	
Potamilus ohiensis	pink papershell	1	
Pyganodon grandis	giant floater	1	
Quadrula cf. *nobilis****	Gulf mapleleaf		1
Quadrula pustulosa	pimpleback	1	
Quadrula quadrula	mapleleaf	1	
Strophitus undulatus	creeper	1	
Toxolasma parvus	lilliput	1	
Truncilla donaciformis	fawnsfoot	1	
Truncilla truncata	deertoe	1	
Utterbackia imbecillis	paper pondshell		1
Total		23	20

* Represented by only one historical record from the late 1800s at Pike Island near Mendota. The specimen is held at the Ohio State University Museum of Biological Diversity. If valid, the specimen is the only record of this species from Minnesota.

** There are two distinct yellow sandshell forms that were previously recognized as distinct species, *L. teres* and *L. anodontoides,* both were historically present in the Minnesota River main stem.

*** Previously unrecognized from Minnesota; identity unconfirmed.

as seven liters of water in a day (Stanczykowska et al. 1976), and at high densities, filtration rates can equal or exceed maximum daily stream discharge (Welker and Walz 1998, Vaughn et al. 2004). Mussels frequently live in large aggregations called "beds." A mussel bed may be a few meters long in a smaller stream or extend over a mile in a large river like the Mississippi. A healthy mussel bed can have over 100 mussels per square meter and comprise more than 30 species. Studies have shown that non-mussel invertebrate biomass (insects and worms for example) is greater in the presence of living mussels (Spooner and Vaughn 2006, Vaughn and Spooner 2006).This is due to the removal of organic matter from the water column by filtering mussels, which is then deposited on the river bottom as nutrient-rich feces and pseudofeces (mucus-bound particles rejected prior to ingestion). Living mussels and their empty shells also serve as substrate for attachment by other organisms (Becket et al. 1996), and the interstices between shells may provide refugia from predators and help stabilize fine-grained sediments during floods (McCall et al. 1979, Strayer et al. 1994, Vaughn and Hakenkamp 2001). What these studies suggest is that mussels are an influential component of the aquatic food web, which ultimately includes fish communities. Due to their complex life cycle, low mobility, and sensitivity to environmental disturbances, mussels are also good indicators of river health (Neves 1993). If populations of native mussels are flourishing, then odds are that fish and other aquatic life are healthy as well. To the contrary, catastrophic loss of mussel biomass may lead to changes in the functioning of river ecosystems (Spooner and Vaughn 2006).

Split Personality

The historically rich diversity of mussel species in the Minnesota River is related to the relatively large size of the drainage (Watters 1992). Mussel assemblages and diversity in rivers change along a river's gradient from upstream to downstream (Ortmann 1919, Van der Schalie 1938, Strayer 1983), and the Minnesota River is a textbook example of this pattern. Based on the historical distribution of mussel species, the Minnesota can be divided into two general river reaches: 1) the lower main stem of the river, roughly downstream of Belle Plaine; and 2) the upper main stem of the river and principal tributaries. Live mussels and relic shells indicate that the lower river mussel assemblage was composed of about 36 species, while the upper main stem and tributaries had 34 species (Table 5.f1). While these numbers are similar, the mussel assemblages within these two river reaches were quite different.

Most mussel species are broadly distributed within the drainage, occurring throughout most of the main stem and in some or all of the larger tributaries (Sietman 2003). The fat mucket *(Lampsilis siliquoidea),* spike *(Elliptio dilatata),* Wabash pigtoe *(Fusconaia flava),* black sandshell *(Ligumia recta),* white heelsplitter *(Lasmigona complanata),* fragile papershell *(Leptodea fragilis),* creeper *(Strophitus undulatus),* and elktoe *(Alasmidonta marginata),* are examples of widely distributed species. A small group of species is associated primarily with headwaters. These species, which are found only in the upstream reaches of the main stem or in tributaries, include the creek heelsplitter *(Lasmigona compressa),* cylindrical papershell *(Anodontoides ferussacianus),* and pondmussel *(Ligumia subrostrata).* Several other species once present in the Minnesota River constitute an assemblage of mussels characteristic of large rivers. These species were found only in the lower part of the river and are similar to assemblages present in the Mississippi River . The ebonyshell *(Fusconaia ebena),* butterfly *(Ellipsaria lineolata),* washboard *(Megalonaias nervosa*), elephant ear *(Elliptio crassidens),* sheepnose *(Plethobasus cyphyus)*, and an as of yet unconfirmed mapleleaf species (possibly the Gulf mapleleaf, *Quadrula nobilis)* were once found, and in some cases were abundant, in the lower Minnesota River The lower river was also home to three of the four Federally-Endangered mussels found (or previously found) in Minnesota, the winged mapleleaf *(Quadrula fragosa)* (Figure 5.f6), Higgins' eye *(Lampsilis higginsii)*, and scaleshell *(Leptodea leptodon)* (known only from one historical record from the late 1800s) (Sietman 2003). This assemblage of large-river mussels no longer occurs in the Minnesota River as a result of the serious degradation the system has experienced.

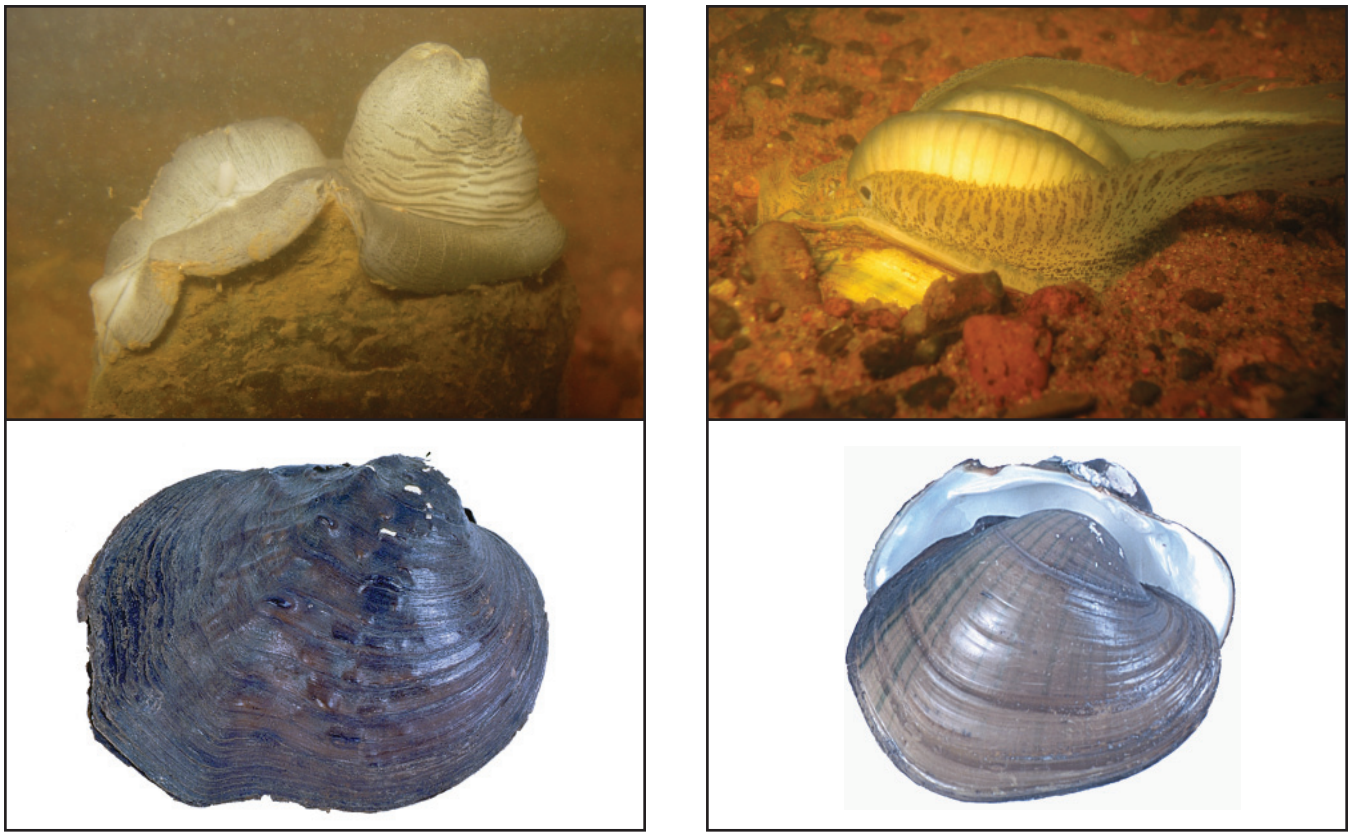

Figure 5.f6: *The mantle display of a female winged mapleleaf (Quadrula fragosa) [above left] (MNDNR University of Minnesota photo by M. Hove) and a plain pocketbook (Lampsilis cardium) [above right] (MNDNR photo by B. Sietman), and their shells (MNDNR photos by D. Rose). Females that are brooding larvae (glochidia) will distend a modified portion of mantle tissue as a lure to elicit an attack from a host fish, in the case of the winged mapleleaf, a channel catfish (Ictalurus punctatus), and for the plain pocketbook, a largemouth bass (Micropterus salmoides). Several, but not all, mussel species use lures to attract fish. The winged mapleleaf was apparently locally common in the lower Minnesota River, but is now gone from the river. The plain pocketbook is relatively common in the Minnesota River drainage. A live action video of a plain pocketbook may be viewed on the MNDNR website at http://files.mndnr.gov/natural_resources/animals/mussels/pocketbook.mov.*

All of the species that constitute the lar ge-river fauna are now rare in Minnesota and the upper Midwest in general. The winged mapleleaf, for instance, was once widespread in the eastern United States, but is now one of the rarest mussels in North America. A small stretch of the St. Croix River below Taylor's Falls holds one (Hornbach et al. 1996) of the three (or possibly four; seeVaughn 2005) known populations remaining (USFWS 2004). The Minnesota DNR found dozens of relic winged mapleleaf shells at the town of Carver. Another apparently abundant species in the lower Minnesota River was the ebonyshell, the quintessential lar ge-river mussel. This was historically the most abundant mussel in the upper Mississippi River mainstem, but is now nearly gone from the entire upper Mississippi River drainage (Kelner and Sietman 2000). Thousands of bleached shells of these and many other species litter the riverbed and banks of the Minnesota River.

The loss of species has not been limited to the main stem of the Minnesota River . Some species that were once widespread throughout much of the drainage, such as the mucket *(Actinonaias ligamentina)* and f uted shell *(Lasmigona costata)*, have also likely been extirpated (eliminated) from the entire system. Populations of other species are very low. The elktoe *(Alasmidonta marginata)*, spike *(Elliptio dilatata)*, deertoe *(Truncilla donaciformis)*, black sandshell *(Ligumia recta)*, and round pigtoe *(Pleurobema sintoxia)* are quite rare and their outlook within the Minnesota River drainage is uncertain. The Blue Earth drainage, the largest tributary of the Minnesota River , has

been especially degraded. Of the 25 recorded species only 13 were found alive. Even species that are currently considered common or stable in the Minnesota River drainage as a whole are apparently extirpated or rare in the Blue Earth system. The fat mucket for example, which in terms of relative abundance of live individuals was the most common mussel found in the Minnesota River drainage, was collected alive at only one site (2 live individuals) in the entire Blue Earth drainage compared to 62 sites where it was found dead. Similarly , populations of the threeridge *(Amblema plicata)* and Wabash pigtoe are seemingly stable in Minnesota River drainage, but both are apparently extirpated from the Blue Earth River system where they were historically common and widely distributed. In a survey of 138 sites in the Blue Earth drainage in 1972, Chelberg (1974) found no live specimens of fat mucket, and live specimens of threeridge and Wabash pigtoe at only one site (Figure 5.f7).

Reasons for the decline of mussels in the Minnesota River are complex, but the primary causes are pollution and land-use disturbances that result in degraded stream habitat. Loss of riparian corridor, draining of wetlands, and tiling of farmland, among other insults, has resulted in rapid water level fluctuations, riverbank erosion, and an increase in sediment entering the river . Several species of mussels are particularly sensitive to these disturbances, and juvenile mussels are more susceptible than adults (Keller and Zam 1991, Goudreau et al. 1993, Jacobson et al. 1993). Furthermore, if host fishes are negatively affected by habitat degradation, a direct consequence is interruption of the mussel life cycle (Neves 1993). Additionally, dams on the Mississippi River and within the Minnesota River watershed prevent fish from moving freely among river reaches, which inhibits mussel population connectivity and potential for recovery (Watters 1996, Vaughn and Taylor 2000).

In terms of its mussel resources, the Minnesota is currently a shell of a river . But despite the loss of species and the degraded condition of the river, there are reasons for optimism. Headwater tributaries such as the Lac qui Parle, Pomme de Terre, Chippewa, Yellow Medicine, and Cottonwood retain better than half of their original mussel assemblages, including populations of some of the rarest species remaining in the drainage. Species such as the elktoe, round pigtoe, spike, and creek heelsplitter , all of which were once widespread in Minnesota but are now listed by the state as Threatened or Special Concern species, have populations remaining in some of these tributaries. This good news is tempered by the fact that population size of these and other species of several of the remaining species in these tributaries appear to be low (Figure 5.f8).

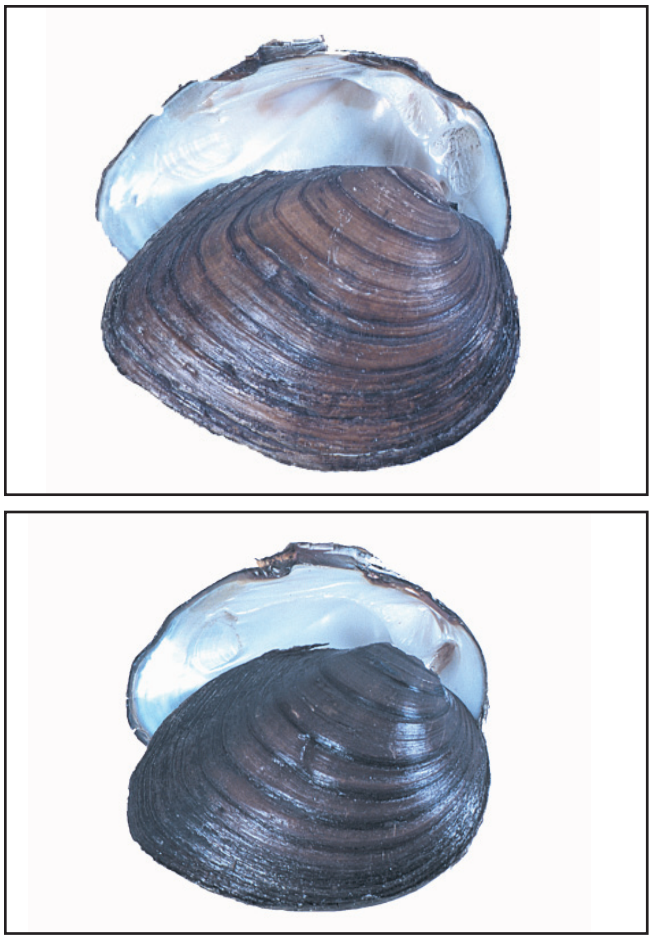

Figure 5.f7: *The Wabash pigtoe (Fusconaia flava) [above] and round pigtoe (Pleurobema sintoxia) [bottom]. Though these species look nearly identical, populations of Wabash pigtoe in the Minnesota River drainage are apparently stable while the round pigtoe is nearly extirpated from the system. Both species use minnows (Cyprinidae) as hosts. MNDNR photos by D. Rose.*

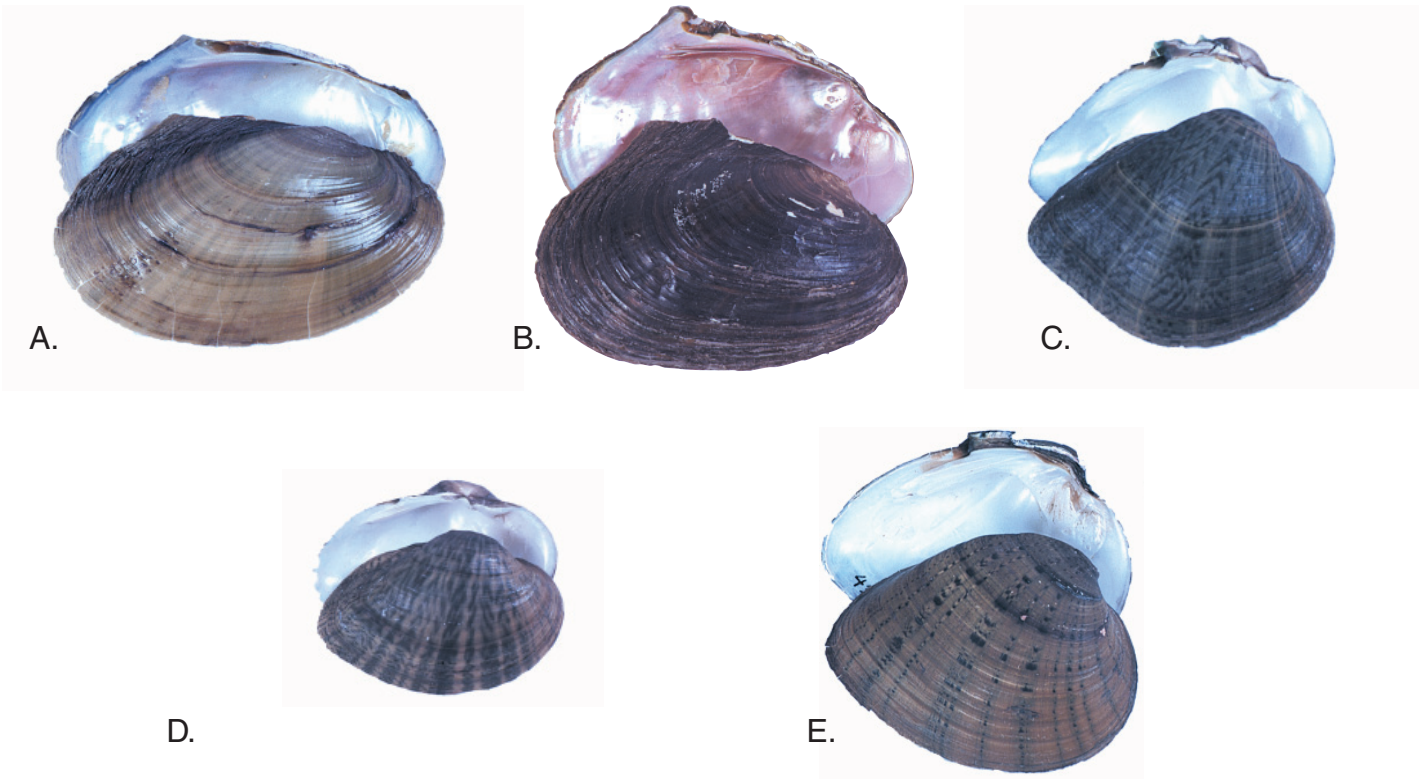

Figure 5.f8: *The fragile papershell (Leptodea fragilis) [A], pink heelsplitter (Potamilus ohiensis) [B], and deertoe (Truncilla truncata) [C] are currently the three most common mussel species in the Minnesota River mainstem, whereas the fawnsfoot (Truncilla donaciformis) [D] and butterfly (Ellipsaria lineolata) [E] are rare and extirpated, respectively. All five of these species are thought to exclusively use the freshwater drum or sheepshead (Aplodinotus grunniens) as a host. Thus, a lack of host availability is clearly not the reason why the fawnsfoot and butterfly are doing poorly in the Minnesota River. Rather, the difference in status of these mussels illustrates the differential sensitivity to habitat disturbance among mussel species. MNDNR photos by D. Rose.*

Recovery of decimated mussel communities is not unprecedented (Henley and Neves 1999, Sietman et al. 2001), and the main stem of the Minnesota River is also showing some encouraging signs. The wartyback *(Quadrula nodulata),* another State Threatened species, is reproducing in the main stem of the river , suggesting some level of recovery. Additionally, a comparison of surveys of the main stem Minnesota between 1989 and 2006 suggest a nearly six-fold increase in mussel abundance, although the number of live species was basically equal (20 versus 19, respectively; Figure 5.f9). It is not yet clear if this apparent increase in abundance is real or a statistical anomaly . Future monitoring should help clarify questions such as this. In any case, continued efforts to improve the

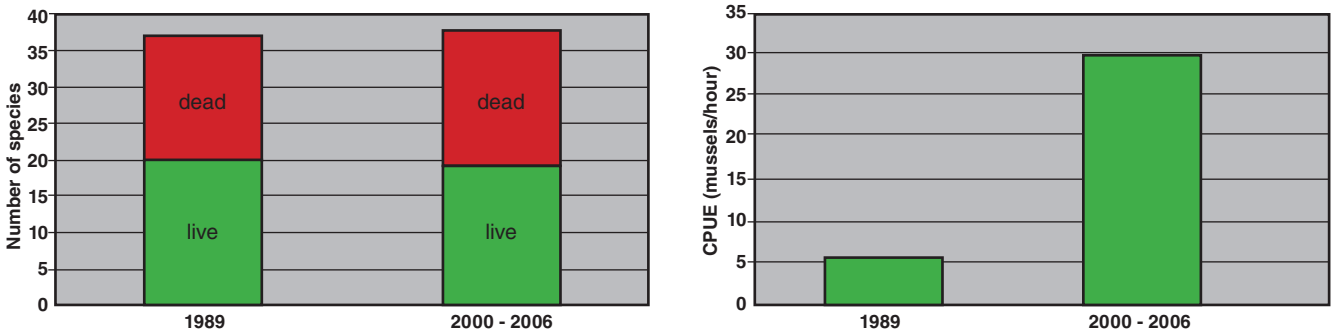

Figure 5.f9: *[Above left] number of live and dead mussel species collected in the mainstem Minnesota River. [Above right] abundance of live mussels collected (catch per unit effort (CPUE) – number caught per hour) in the main stem Minnesota River. Source: surveys by the University of Minnesota (1989) and the Minnesota DNR (2000-2006).*

water quality and land use practices, especially along stream corridors, will go a long way toward the goal of recovery for the river that bears our state's name.

For more information on Minnesota mussels you can obtain a copy of *Field Guide to the Freshwater Mussels of Minnesota* (Sietman 2003) from the Minnesota DNR; an order form is available at http://f les.mndnr.gov/eco/nhnrp/mussel_survey/mussel_orderform.pdf

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Appendix A: Checklist of Plants Collected in the Minnesota River Valley Counties.

This checklist is not included in the printed version of the report. Please go to the version of this report on the compact disk (cd) to see this checklist.

Appendix B. Checklist of Rare Animals Documented From Counties Along the Minnesota River.

Information based on records from the Natural Heritage Information Sytem, Minnesota Department of Natural Resources.

State Status Codes

END Endangered
THR Threatened
SPC Special Concern
TrkNot listed, tracked by NHIS

Occurrence Categories

Symbol	Meaning
X	post-1987 record (since MCBS)
*	pre-1987 record (before MCBS)
	no information
o	shell, no live specimen (mussels, only)

COUNTIES ALONG THE MINNESOTA RIVER (arranged from west to east)

Common Name	Scientific Name	State Status	Big Stone	Lac Qui Parle	Yellow Medicine	Swift	Chippewa	Renville	Redwood	Brown	Nicollet	Blue Earth	Le Sueur	Sibley	Scott	Carver	Hennepin	Dakota	Ramsey
MAMMALS																			
Bats																			
Northern Myotis	*Myotis septentrionalis*	SPC									X								X
Eastern Pipistrelle	*Pipistrellus subflavus*	SPC									*				*		X		X
Carnivores																			
Eastern Spotted Skunk	*Spilogale putorius*	THR			X							X					X		
Rodents																			
Richardson's Ground Squirrel	*Spermophilus richardsonii*	Trk			X				X										
Plains Pocket Mouse	*Perognathus flavescens*	SPC		*											X		*		X
Western Harvest Mouse	*Reithrodontomys megalotis*	Trk		*	X			*	X		X	X			X	*	*	X	
Northern Grasshopper Mouse	*Onychomys leucogaster*	Trk		X		X	X										*		
Prairie Vole	*Microtus ochrogaster*	SPC		X	X												*		
BIRDS (breeding-season records, only)																			
Swans, ducks, geese																			
Trumpeter Swan	*Cygnus buccinator*	THR								X			X	X		X	X		
Partridges, grouse, turkey																			
Greater Prairie-chicken	*Tympanuchus cupido*	SPC	X	X		X	X												
Pelicans																			
American White Pelican	*Pelecanus erythrorhynchos*		X	X															
Herons, bitterns, egrets																			
American Bittern	*Botaurus lentiginosus*	Trk		X	X	X	X	X								X	X		
Eagles, hawks, falcons																			
Bald Eagle	*Haliaeetus leucocephalus*	SPC	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-shouldered Hawk	*Buteo lineatus*	SPC		X	X		X	X							X	X	X	X	X
Peregrine Falcon	*Falco peregrinus*	THR															X	X	X
Rails, cranes																			
King Rail	*Rallus elegans*	END									*								
Common Moorhen	*Gallinula chloropus*	SPC								*					X		X		
Sandhill Crane	*Grus canadensis*	Trk				X				X					X	X		X	X
Shorebirds, gulls, terns																			
Upland Sandpiper	*Bartramia longicauda*	Trk	X	X	X	X	X		X	X		X	X	*			*	X	*
Marbled Godwit	*Limosa fedoa*	SPC	X	X	X	X	X			?									
Wilson's Phalarope	*Phalaropus tricolor*	THR	X	X						X									
Franklin's Gull	*Larus pipixcan*	SPC									*								
Forster's Tern	*Sterna forsteri*	SPC	X	*	X	*					X				X		X		*
Owls																			
Burrowing Owl	*Speotyto cunicularia*	END		X	X		*												
Short-eard Owl	*Asio flammeus*	SPC	X	*	X		*												

Common Name	Scientific Name	State Status	COUNTIES ALONG THE MINNESOTA RIVER (arranged from west to east): Big Stone	Lac Qui Parle	Yellow Medicine	Swift	Chippewa	Renville	Redwood	Brown	Nicollet	Blue Earth	Le Sueur	Sibley	Scott	Carver	Hennepin	Dakota	Ramsey
BIRDS (breeding-season records, only)																			
Perching Birds																			
Acadian Flycatcher	*Empidonax virescens*	SPC								X		X		X		X	X	X	
Loggerhead Shrike	*Lanius ludovicianus*	THR	X	X		X	X				X	X	X	X		X	X		
Bell's Vireo	*Vireo bellii*	Trk																	
Cerulean Warbler	*Dendroica cerulea*	SPC								X				X	X		X		
Louisiana Waterthrush	*Seiurus motacilla*	SPC							X	X	X					X		X	
Hooded Warbler	*Wilsonia citrina*	SPC												X		*	X		
Lark Bunting	*Calamospiza melanocorys*	Trk	X	X												X	X	X	
Henslow's Sparrow	*Ammodramus henslowii*	END		X		X	X		X	X			X		X		X		
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*	SPC		X															
Chestnut-collared Longspur	*Calcarius ornatus*	END	X																
AMPHIBIANS and REPTILES																			
Frogs, toads																			
Northern Cricket Frog	*Acris crepitans*	END														X			
Bullfrog	*Rana catesbeiana*	Trk							X							X			
Turtles																			
Blanding's Turtle	*Emydoidea blandingii*	THR				X			X		X	X		X		X	X	X	
Smooth Softshell	*Apalone mutica*	SPC								X	X	X	X	X		*			
Lizards, skinks, snakes																			
Five-lined Skink	*Eumeces fasciatus*	SPC			X			X	X										
Western Hognose Snake	*Heterodon nasicus*	SPC	*	X	X	X	*							X		X		*	
Eastern Hognose Snake	*Heterodon platirhinos*	Trk												X		*	X	*	
Eastern Racer	*Coluber constrictor*	SPC									X	X				*	X		
Eastern Fox Snake	*Elaphe vulpina*	Trk			X		X	X	X	X	X	X	X	X		X	X	X	
Gopher Snake	*Pituophis catenifer*	SPC			X			*	*					X	X	X	X		
Milk Snake	*Lampropeltis triangulum*	Trk			X			*	*	X	X	X		X		*	X	*	
Timber Rattlesnake	*Crotalus horridus*	THR									*						*		
FISHES																			
Lampreys																			
American Brook Lamprey	*Lampetra appendix*	Trk												X	X		X		
Sturgeons																			
Lake Sturgeon	*Acipenser fulvescens*	SPC	*		X		X									X	X	X	
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	Trk			X		X	X	X	X	X	X	X	X	X	X	X	*	
Paddlefish	*Polyodon spathula*	THR			X		X	X	X	X	X	X	X	X	X	X	X	X	
Herrings																			
Skipjack Herring	*Alosa chrysochloris*	SPC	*													*	*		
Carps, minnows, suckers																			
Pallid Shiner	*Notropis amnis*	SPC														*	*	*	
Pugnose Shiner	*Notropis anogenus*	SPC										X			*	X	*	X	
Ozark Minnow	*Notropis nubilus*	SPC															*		
Pugnose Minnow	*Opsopoeodus emiliae*	Trk															X		
Blue Sucker	*Cycleptus elongatus*	SPC			X		X	X	X	X	X	X	X	X	X	X	X	X	
Black Buffalo	*Ictiobus niger*	SPC			X					X	X		X		X		X	X	
Pirate-perches																			
Pirate Perch	*Aphredoderus sayanus*	SPC															X		
Basses, sunfishes, perches																			
Least Darter	*Etheostoma microperca*	SPC			X							X			X	X		X	

Common Name	Scientific Name	State Status	COUNTIES ALONG THE MINNESOTA RIVER (arranged from west to east)																
			Big Stone	Lac Qui Parle	Yellow Medicine	Swift	Chippewa	Renville	Redwood	Brown	Nicollet	Blue Earth	Le Sueur	Sibley	Scott	Carver	Hennepin	Dakota	Ramsey
INSECTS																			
Skippers, fritillaries																			
Powesheik Skipper	*Oarisma powesheik*	SPC	X	X	X	X	X						*						
Dakota Skipper	*Hesperia dacotae*	THR	X	X	*	*	*												
Pawnee Skipper	*Hesperia leonardus pawnee*	Trk	X	*	*												X		
Ottoe Skipper	*Hesperia ottoe*	THR	X					*	*										
Arogos Skipper	*Atrytone arogos*	SPC	X	X	*	X	X	*					*	*					
Regal Fritillary	*Speyeria idalia*	SPC	X	X	X	X	X	X	X	X	X		X		*		*	*	
Tiger beetles																			
Crimson Saltflat Tiger Beetle	*Cicindela fulgida fulgida*	END		*															
Little White Tiger Beetle	*Cicindela lepida*	THR	*	*													*		*
Sandy Stream Tiger Beetle	*Cicindela macra macra*	SPC												X	X				
Leafhoppers																			
Red Tailed Prairie Leafhopper	*Aflexia rubranura*	SPC	X									X							
SPIDERS																			
Jumping spiders																			
A Jumping Spider	*Habronattus texanus*	SPC										*							
A Jumping Spider	*Marpissa grata*	SPC																	*
A Jumping Spider	*Paradamoetas fontana*	SPC																	*
A Jumping Spider	*Phidippus pius*	SPC										*							
MOLLUSKS																			
Freshwater mussels																			
Spectaclecase	*Cumberlandia monodonta*	THR															o		
Purple Wartyback	*Cyclonaias tuberculata*	THR														o	X	o	
Elephant-ear	*Elliptio crassidens*	END												o	o	o	X	o	
Spike	*Elliptio dilatata*	SPC			o	X	X	o	o	o	o	o			o	o	o	X	X
Ebonyshell	*Fusconaia ebena*	END											o	o	o	o	X	o	
Washboard	*Megalonaias nervosa*	THR												o	o	o	X		
Sheepnose	*Plethobasus cyphyus*	END												o	o		X	o	
Round Pigtoe	*Pleurobema coccineum*	THR		o	o	o	o	o	X	o	o	o			o	o	o	X	o
Winged Mapleleaf	*Quadrula fragosa*	END											o	o	o	o	o	o	
Monkeyface	*Quadrula metanevra*	THR			o		o			X	X	o	o	o	o	o	o	X	o
Wartyback	*Quadrula nodulata*	END								X	X	X			o	o	X	X	X
Pistolgrip	*Tritogonia verrucosa*	THR			o		o			o	o	o	o	o	o	o	o	X	o
Elktoe	*Alasmidonta marginata*	THR		o	X	X	o	X	o	o	o	o	o	o	o	o	X	o	X
Rock Pocketbook	*Arcidens confragosus*	END			o			o		o	o				o	o	o	X	o
Creek Heelsplitter	*Lasmigona compressa*	SPC		X	X	X	o	o	X	o								X	
Fluted-shell	*Lasmigona costata*	SPC		o	o	o	o	o	o	o	o	o			o	o	o	X	
Salamander Mussel	*Simpsonaias ambigua*	THR			o		o											o	
Mucket	*Actinonaias ligamentina*	THR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	X	X	X
Butterfly	*Ellipsaria lineolata*	THR													o	o	o	X	o
Snuffbox	*Epioblasma triquetra*	THR																o	
Higgins Eye	*Lampsilis higginsi*	END													o	o		X	
Yellow Sandshell	*Lampsilis teres*	END			o	o	o			o	o	o	o	o	X	X	o	o	o
Scaleshell	*Leptodea leptodon*	Trk																*	*
Black Sandshell	*Ligumia recta*	SPC	o	X	o	X	X	o	o	o	X	X		o	o	o	X	X	X
Hickorynut	*Obovaria olivaria*	SPC			o		o				o	o	o		o	o	o	X	o
Ellipse	*Venustaconcha ellipsiformis*	THR			o		o	o				o						o	

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