Date of Status Update: September 8, 2016

Final Report

Date of Work Plan Approval: June 4, 2014

Project Completion Date: June 30, 2016

PROJECT TITLE: Wild Bee Pollinator Surveys in Prairie-Grassland Habitats

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Location: Statewide for scientific collections and literature review; for field surveys, the Minnesota Prairie Region*, including and/or impacting Becker, Big Stone, Blue Earth, Brown, Chippewa, Clay, Cottonwood, Dodge, Douglas, Faribault, Freeborn, Grant, Kandiyohi, Kittson, Jackson, Lac Qui Parle, LeSueur, Lincoln, Lyon, Mahnomen, Marshall, Martin, McLeod, Meeker, Morrison, Mower, Murray, Nicollet, Nobles, Norman, Otter Tail, Pennington, Pipestone, Polk, Pope, Red Lake, Redwood, Renville, Rice, Rock, Roseau, Sibley, Stearns, Steele, Stevens, Swift, Todd, Traverse, Waseca, Watonwan, Wilkin, Yellow Medicine counties.

*As delineated in the Minnesota Prairie Conservation Plan. 2011. Minnesota Prairie Plan Working Group, 55 pp.

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$370,000**
	Amount Spent:	**$368,831**
	Balance:	**$1,169**

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 05(i)

Appropriation Language:
$370,000 the second year is from the trust fund to the commissioner of natural resources to assess the current status and distribution of wild bee pollinators in prairie-grassland habitats of Minnesota.

I. PROJECT TITLE: Wild Bee Pollinator Surveys in Prairie-Grassland Habitats

II. PROJECT STATEMENT: Wild bees are important for their pollination services and also for their contributions to species diversity in prairie-grasslands. Many prairie plant species require pollinators for seed production and bees are often cited as the most important pollinator group. Native prairies once covered a third of Minnesota, but less than two percent of this habitat remains today. The Minnesota Prairie Conservation Plan seeks to protect or reestablish functional prairie systems, which are measured by "stable or increasing native plant diversity and condition." The importance of plant-pollinator interactions is recognized by prairie restoration efforts, but there are large gaps in our knowledge of Minnesota's wild bees. For example, Minnesota's first and only statewide list of bee species was published in 1919. It reported only 88 species, compared to neighboring Wisconsin that reported 388 bee species in 2008. The state list of Species of Greatest Conservation Need (2006) does not include any native bees due to a scarcity of information about their distribution and status. However, the Xerces Society lists at least two bumblebee species that are perceived to be declining in Minnesota and smaller, less noticeable species may face similar declines. A compilation of bee survey and research efforts that have occurred since the 1919 list was published is clearly needed. A more complete list of bee species occurring in Minnesota and a registry of survey efforts and researchers will form a foundation from which future pollinator research can benefit.

Assessment of the current status and distribution of bee species requires field surveys. Proposed surveys throughout the prairie region of western Minnesota will document the diversity and distribution of wild bees on prairie-grasslands and form the basis for measuring differences in the bee fauna documented from prairies in the past to those found on native and restored prairies today. These surveys will complement efforts to resurvey historical locations in southeastern Minnesota by the University of Minnesota (*Enhancing Pollinator Landscapes, ENRTF 146-F*). The findings from both projects will be used to augment the state list of bees, provide natural history information for bee species status assessments, and inform revisions to the state list of Species of Greatest Conservation Need, scheduled for completion in 2015.

The effects on bee species diversity of various prairie restoration efforts needs to be assessed so that appropriate choices of native plant species are made that benefit wild bees. This project will conduct paired surveys of bees on native prairie and restored prairie-grasslands. Associated data on the vegetation composition and quality, and the abundance and richness of plants in flower during the surveys, will be documented. The information obtained by these paired surveys, in coordination with the findings of floral resource surveys planned by the University of Minnesota (*Enhancing Pollinator Landscapes, ENRTF 146-F*), will refine restoration decisions to enhance both the bee pollinator populations and the prairie-grassland habitat. It may also inform native plant choices for the proposed Pollinator Garden at the Minnesota Landscape Arboretum (*Bee Discovery Center at the Minnesota Landscape Arboretum, ENRTF 073-C*) and community pollinator projects proposed by Pheasants Forever (*Minnesota Pollinator Partnership, ENRTF 072-C*).

III. PROJECT STATUS UPDATES:

Project Status as of January 1, 2015
NOTE: ENRTF Budget figures for Activities 1-3, below, were adjusted to match those in the Budget spreadsheet.
Since the beginning of this project, efforts focused on augmenting the list of Minnesota's wild bees with existing information. Bee specimens were examined at three museum collections and data were received from another. Records also were obtained from personal collections, student theses, informal reports and published literature. The resulting list of 425 species of wild bees in Minnesota greatly exceeds the previous report of 66 species in *Hymenoptera of Minnesota* (F. Washburn, 1919). Development of a working list of Minnesota's bees and a map showing the number of bee species in each county are underway (refer to MNDNR's *Native Bees of Minnesota's Grasslands* webpage (http://www.dnr.state.mn.us/mbs/grasslandbees.html).

Planning and preparation for the 2015 bee field surveys was initiated. Survey protocols were developed and bee traps were constructed. Minnesota Biological Survey (MBS) plant ecologists were consulted about high-quality native prairie sites and how to assess floral resources. Biometricians were consulted about site selection, the number of replicates for native prairie/restored grassland comparisons, and suggestions for long-term monitoring of these sites.

Preliminary field surveys of native prairie sites were conducted in late summer/fall 2014 to test and refine survey protocols. Approximately 100 bee specimens collected from these surveys were prepared and labeled for inclusion into the Insect Collection at the University of Minnesota. Because specimen data from this collection are only available from labels, a project was initiated to enter data into an electronic format with the help of citizen volunteers. To date, they have entered over 2,000 records of the estimated 27,000 bee specimens from the University of Minnesota collection. This database is compatible with MNDNR's Natural Heritage Information System and will incorporate new records obtained during this project.

Project Status as of July 1, 2015
Work continues on compilation of existing records for bees in Minnesota. Minnesota bee holdings from several collections in the Upper Midwest were examined. Data were recorded from the oldest and most recent specimens of each species represented for a county. To date, state distributional records have been obtained from approximately 29,000 specimens. With the help of volunteers and a collaborator from the ENRTF-funded *Enhancing Pollinator Landscapes* project, information from bee specimens at the University of Minnesota's Insect Collection are being entered into databases. To date 9,200 specimens have been entered. These records will be compiled and displayed as distribution maps for Minnesota's bee species (refer to Attachment 1).

A specimen of the bee species, *Trachusa zebrata*, was collected from Pine County in 1909. This specimen is the type specimen on which the species was originally described.

Survey sites were selected, transects of bowl traps were established, and field surveys were conducted regularly to document wild bees and associated flowering plants. Under Activity 2, high quality native prairie habitat was sampled throughout the Minnesota Prairie Region (see Attachment 3). Under Activity 3, a subset of high quality prairie sites in the southern half of the region was paired with nearby grasslands that have undergone some restoration to native vegetation. In addition to running transects, field teams targeted other areas for hand-netting. Nearly 3,000 bees have been collected thus far and prepared as voucher specimens.

The yellow-banded bumble bee (*Bombus terricola*) was documented in Stevens County during surveys. This species has suffered severe declines over much of its range in the eastern and central United States. In the process of documenting bee species, this project has collected 15 county records of native plants from 8 counties.

The current tally of Minnesota bee species now stands at 426 species.

Amendment Request (08/28/2015):
Expenditures for out-of-state travel to museum collections were less than the estimated amount. We request that the remaining $5,008 from Activity 1/Other category be moved to Activity 2/Field survey equipment. This will address an anticipated need for additional field survey and specimen preparation supplies.
Amendment Approved by LCCMR 09/01/2015

Project Status as of February 11, 2016
The state species list of Minnesota bees continues to be compiled – current tally stands at 426 species, with 29 problematic species requiring expert opinion. DNR volunteers and staff working under the ENRTF grant *Enhancing Pollinator Landscapes* have databased 14,000 bee specimens, to date, from the University of Minnesota Insect Collection. Additional specimens were submitted from the Minnesota Biological Survey and Three Rivers Park District. Discussions are ongoing with Dr. Dan Cariveau, University of Minnesota, and staff from the DNR data governance and Natural Heritage Information System about data sharing and storage.

Field surveys of wild bees and flowering plants in native prairie and restored grasslands were conducted during this period. Pan-trap transects were run from May through October on eleven prairie sites in the Lake Agassiz Aspen Parklands and Red River Valley ecological sections. Eight prairie and eight restored grassland transects were run in the North-central Glaciated Plains ecological section. Thirteen additional transects were added at restored grasslands across the prairie region to collect county records. Approximately 6,400 bee specimens were collected from these transects and more than 1,400 bee specimens were collected from expanded surveys in other parts of the prairie region. Voucher specimens were prepared; labeling and data entry are ongoing. In addition, 17 plant county records were obtained from the vegetation surveys associated with the bee transects.

Amendment Request (02/11/2016):
Expenditures for professional contracts will be handled by in-house staff. We request that $5,000 from Activity 2/statistical guidance and $5,000 from Activity 3/vegetation analysis be moved to Activity 2/Personnel. This will allow the project to utilize internal resources to address statistical guidance and vegetation analysis.

Expenditures for in-state travel in Activity 3 were less than the requested amount. We request that $12,000 from Activity 3/Travel expenses in Minnesota be moved to Activity 2/Field survey equipment and $20,000 be moved to Activity 1/Personnel. This will address an anticipated need for additional staff, field survey equipment, and specimen preparation supplies during the 2016 field season.
Amendment Approved by LCCMR 02/22/2016

Amendment Request (06/17/2016)
Due to the previous amendment request to change professional contracts to in-house staff, the Direct & Necessary charges will increase. We request that $2,000 from Activity 2/Personnel be moved to Activity 2/Direct & Necessary.

We anticipate that expenditures for in-state travel in Activity 3 will exceed that category's remaining budget. We request that $7,000 from Activity 2/Personnel be moved to Activity 2/Travel expenses in Minnesota.

Overall Project Outcomes and Results
Wild bees are important for their pollination services and also for their contributions to species diversity in prairie-grasslands. Many prairie plant species require pollinators for seed production and bees are often cited as the most important pollinator group. Native prairies once covered a third of Minnesota, but less than two percent of this habitat remains today. The impact of this habitat loss to wild bees is unknown due to large gaps in our knowledge of Minnesota's wild bees. The primary objective of this project was to fill in these knowledge gaps. This was accomplished by compiling existing records of wild bees statewide and conducting surveys of wild bees in prairie-grassland habitats of western Minnesota. The association of wild bees with native plant species and the effects of prairie restoration efforts on bee species diversity are poorly understood. To address these information needs, both native prairie and restored grassland sites were surveyed for bees and associated flowering plants.

To build upon the 1919 publication, *The Hymenoptera of Minnesota,* by Frederic Washburn that listed only 66 bee species, 11 museum collections in the Upper Midwest were accessed for bee specimens from Minnesota. Numerous personal collections, reports and publications were reviewed. Distributional data was obtained for

over 30,000 bee specimens, resulting in a preliminary Minnesota wild bee list that presently stands at 418 reported species with an additional 29 species requiring expert evaluation (Attachment 1, Appendix 1, Appendix 2). In addition, the statewide distribution of known species was greatly expanded. For example, a common sweat bee (*Halictus ligatus)* was known from only one county in 1919, but this project has compiled records from an additional 44 counties (Attachment 2).

Surveys for wild bees were conducted at 75 locations in western Minnesota, May through October 2015 and May through June 2016 (Attachment 3). Fifty-five native prairie sites distributed across western Minnesota and eight restored grassland sites were sampled every three weeks to obtain seasonal information on bees and flowering plants, and comparative information on bees found in native prairie versus restored grassland. The remaining twelve sites were sampled every three weeks to augment county records. Over 10,000 bee specimens were collected through this effort. Specimens have been prepared and data entered into databases that will be used to inform researchers and land managers.

Important bee and plant records were obtained. The rare and declining yellow banded bumble bee (*Bombus terricola*) was documented in Stevens County. This is a county record for the species and also the first time this bee has been recorded visiting snowberry plants, genus *Symphoricarpos*. Equally notable is the absence of another declining species, the rusty patched bumble bee (*Bombus affinis*). Twenty-eight county records for plants were collected during these surveys, as well as information on blooming phenology (Attachment 4).

Project Results Use and Dissemination

Data collected from this project is stored in the MNDNR Natural Heritage Information System and bee specimens are beingdeposited in the Insect Collection at the University of Minnesota. These will be available to researchers, land managers, and the public.

Several MNDNR websites were developed that summarize the goals and accomplishments of this project and address wild bees and other pollinators:

- *Native Bees of Minnesota's Grasslands* presents the goals and accomplishments of this project (http://www.dnr.state.mn.us/mbs/grasslandbees.html).
- *Minnesota's Pollinators* webpage (http://www.dnr.state.mn.us/pollinators/index.html)
- *Minnesota Pollinator Resources* webpage (http://www.dnr.state.mn.us/pollinator_resources/index.html).
- *Pollinator Resource Values for Upland & Wetland Prairies* webpage and booklet (http://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet.pdf).

The project coordinator/bee specialist (Crystal Boyd) has delivered information on this project through presentations, publications, interviews and educational events. She co-organized a Tallgrass Prairie Bee Identification Workshop and has highlighted Minnesota's wild bees at a wide variety of public venues (refer to the Supplementary Materials).

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Species List of Wild Bees in Minnesota

Description: Existing information on the statewide distribution, habitat association, and natural history traits of wild bees (including native and non-native species) found in Minnesota will be compiled from regional and national repositories, published literature, and unpublished reports. The data from specimen examination and literature review will be compiled in species summaries, distribution maps and a statewide bee species list.

Approach: Bee specimens in museum collections will be examined and associated information recorded. The objective is to obtain geospatial and habitat information from every county represented by a bee specimen in

each collection. In situations where counties span more than one ecological province, specimen data from each province within a county will be collected. Data from the oldest and newest specimens of a species will be recorded for historical perspective. Compilation of this information, through databases, GIS layers and webpage development, will identify data gaps that direct future survey efforts, provide baseline data that inform conservation and management priorities, and facilitate contributions from citizen scientists. This project will work closely with the new pollinator faculty position at the University of Minnesota (refer to *Enhancing Pollinator Landscapes, ENRTF 146-F*) to ensure consistency in database development and interdisciplinary access to the growing data set on Minnesota's pollinators.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 92,492
Amount Spent: $ 91,992
Balance: $ 500

Activity Completion Date: June 30, 2016

Outcome	Completion Date	Budget
1. Specimen data on bees collected from national and regional museums	April 2016	$ 29,992
2. Literature and reports reviewed for information on Minnesota bees	April 2016	$ 19,000
3. Distribution and natural history data entered into database	April 2016	$ 27,500
4. Prepare and distribute species list of bees in Minnesota	Continuing	$ 9,126
5. DNR Direct and Necessary Cost	June 2016	$ 6,874

Project Status as of January 1, 2015

Data from Minnesota bee specimens were collected at University of Minnesota – Twin Cities and Duluth, and at North Dakota State University, Fargo. A list of Minnesota bee holdings was received from the American Museum of Natural History, New York. To date, species names and distribution information have been obtained from approximately 28,000 specimens. Visits to additional collections are planned for winter 2015.

In addition to museum records, the working list of Minnesota bee species now includes records from personal collections, student theses, informal reports and published literature. Any species records that are not corroborated will remain tentative until confirmed. The current tally of bee species in Minnesota stands at 425 species. This represents a substantial increase over the 66 species reported in Frederic Washburn's 1919 report, *Hymenoptera of Minnesota*.

Compilation of these records at the county level is summarized in Attachment 5 for the University of Minnesota – Twin Cities collection. Previously, this collection information was only accessible from specimen labels. Now, however, seven citizen volunteers are helping to enter these data into a database that will benefit bee specimen management at the Insect Collection, as well as make this information readily available to researchers, resource managers and members of the public. Currently, the volunteers have databased over 2,000 of the estimated 27,000 specimens in this collection.

National data aggregators and MNDNR data managers were consulted for advice on data management strategies, resulting in the pilot database developed through this project. This database will accommodate new and historic bee information, is compatible with the MNDNR's Natural Heritage Information System, and is also being used by staff working under the ENRTF *Enhancing Pollinator Landscapes* project. File structures were created to track updates to the growing list of bees documented in Minnesota.

As illustrated in Attachment 5, the prairie region of the state has fewer species records compared to other areas in Minnesota. This is likely due to a lack of survey effort in these counties. For example, Murray County in southwestern Minnesota has no records of bees, yet it contains extensive, high-quality native prairie in the Chanarambie Creek area. Surveys of prairie-grasslands planned for summer 2015 should provide important records of bees in these underrepresented counties.

Project Status as of July 1, 2015
Additional data from Minnesota bee specimens were obtained from collections at the University of Wisconsin—Madison, Field Museum of Natural History, Illinois Natural History Survey, Iowa State University, and South Dakota State University. Data compilation and management of the bee collection at the University of Minnesota –Twin Cities is ongoing. To date, species names and distribution have been obtained from approximately 29,000 specimens. Visits to additional collections, such as Winona State University and the Science Museum of Minnesota, are planned for winter 2016.

The current tally of Minnesota bee species now stands at 426 species. This number is expected to change, as taxonomic problems are resolved and volunteers continue databasing specimens housed at the University of Minnesota Insect Collection. To date, 3,700 specimens have been databased by volunteers. Joel Gardner, a collaborator from the University of Minnesota's ENRTF-funded *Enhancing Pollinator Landscapes* project, has databased an additional 5,500 specimens. Data management strategies continue to evolve, and the project's coordinator/bee specialist (Crystal Boyd) has begun data sharing conversations with the new pollinator professor at the University of Minnesota, Dr. Dan Cariveau.

One exciting discovery is that the type specimen of *Trachusa zebrata* was originally described from a specimen collected from Pine County, Minnesota in 1909. It had been erroneously reported from Wisconsin in historical literature and Amy Wolf's 2008 publication "Bees of Wisconsin." This correction was confirmed by Dr. John Ascher, a leading bee expert from the National University of Singapore.

Project Status as of February 11, 2016
The state species list of bees currently stands at 426 species, with an additional 29 problematic species. This number is expected to change as taxonomic problems are resolved and volunteers continue databasing specimens housed at the University of Minnesota Insect Collection. To date, more than 6,400 specimens have been databased by DNR staff and volunteers. Data will be combined with an additional 7,900 historic records databased by Joel Gardner through the ENRTF-funded grant *Enhancing Pollinator Landscapes*.

A data request was sent to the Stearns County History Museum, which confirmed that it does not house any historic insect specimens. Data requests will be sent to additional museums in winter 2016, such as the Headwaters Science Center in Bemidji, Minnesota.

Bee data from collaborators contributed to more accurate species distribution maps. Staff from the Minnesota Biological Survey collected 58 bee specimens in April, June, and August 2015 in Beltrami and Lake of the Woods counties while conducting mammal and bird surveys. Three Rivers Park District also donated 364 bee specimens from 11 samples taken approximately weekly from June to September 2015 in Hennepin County. A citizen scientist submitted bumble bee specimens from the North Shore for identification, including one specimen of the declining yellowbanded bumble bee (*Bombus terricola*) from Lake County. Previous DNR surveys resulted in ~7,900 bee specimens that are currently being databased.

A series of data governance meetings were held in fall 2016, including one meeting in collaboration with Dr. Dan Cariveau from the University of Minnesota. Data-sharing strategies were discussed, and a project definition was drafted. The project coordinator (Crystal Boyd) attended Access database classes at the Science Museum of Minnesota.

Final Report Summary:
Additional distributional information on Minnesota bees was obtained from the insect collection at the Headwaters Science Center in Bemidji. Over the course of this project, data on Minnesota bees were collected

from 11 museum collections and 16 additional sources, including personal collections, student theses, informal reports, published literature, and collaborators.

The current tally of bee species in Minnesota stands at 418 confirmed bee species, with 29 additional problematic species. This represents a substantial increase over the 66 species reported in Frederic Washburn's 1919 publication, *The Hymenoptera of Minnesota*.

Management of bee specimen data continues. To date, DNR staff and volunteers have databased over 7,900 specimens from previous DNR surveys and over 9,900 specimens housed at the University of Minnesota Insect Collection. Joel Gardner, working under the ENRTF project *Enhancing Pollinator Landscapes,* has databased more than 11,900 additional bee specimens at the University of Minnesota Insect Collection. This effort has enabled digital access to label data that was previously available only through in-person visits or requests for physical specimen loans.

Washburn reported a common sweat bee (*Halictus ligatus)* from just one county in 1919, but this project has expanded the bee's known distribution to 45 counties (Attachment 2). Knowledge of the distribution of bee species in Minnesota has been greatly expanded through this project. Several examples of noteworthy discoveries are described below.

While reviewing literature, the type specimen for *Trachusa zebrata* was determined to be from Minnesota. A type specimen is the specimen on which the description of a new species is based. The type location had been erroneously reported as Wisconisin.

Examination of collections confirmed a record for the yellow banded bumble bee (*Bombus terricola*) from Lake County. This species is experiencing significant decline and is listed as a Species in Greatest Conservation Need (SGCN) in Minnesota. A photograph taken by a collaborator from the Washington County Parks District confirmed the presence of the rusty patched bumble bee (*Bombus affinis*), another declining SGCN species.

National data aggregators and MNDNR data managers were consulted for advice on data management strategies, resulting in the pilot database developed through this project. This database will accommodate new and historic bee information, is compatible with the MNDNR's Natural Heritage Information System, and is also being used by staff working under the ENRTF *Enhancing Pollinator Landscapes* project. File structures were created to track updates to the growing list of bees documented in Minnesota. A series of data governance meetings were held, including one in collaboration with the new pollinator professor at the University of Minnesota, Dr. Dan Cariveau.

ACTIVITY 2: Wild Bees Associated with Native Prairie

Description: Preliminary surveys of wild bees and associated flowering plants will be conducted on native prairie sites throughout the Minnesota Prairie Region. Survey findings will identify wild bee species associated with native prairies, as identified by the Minnesota Biological Survey, and will contribute to the comprehensive list of wild bees in Minnesota. Findings will be evaluated in terms of region, prairie classification, and spatial context. Survey techniques will be evaluated for effectiveness as a long-term monitoring protocol (see Activity 3).

Approach: Native prairie sites will be selected from Aspen Parklands, Red River Prairie and Minnesota River Prairie ecological sections. Bee trap transects will be run repeatedly at each site from April through October to maximize the diversity of bee species recorded. Survey protocol is similar to that proposed for the University of Minnesota's resurvey effort (refer to *Enhancing Pollinator Landscapes, ENRTF 146-F*), thus enabling comparison of bee fauna from other regions of the state. All *bees collected will be identified and entered into the bee database with associated habitat information. Voucher specimens will be prepared for each species at each site

and submitted to the Insect Collection at the University of Minnesota. Associated floral diversity at the bee transects will be documented.

*Bees targeted include members of six bee families in the subgroup Anthophila, order Hymenoptera. Hymenoptera not targeted by this project include wasps, hornets, ants and sawflies. Individuals from these groups, as well as other insects and arachnids, that are captured during the survey will be collected and retained for a period of time for future investigations.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 162,508
Amount Spent: $ 161,839
Balance: $ 669

Activity Completion Date: June 30, 2016

Outcome	Completion Date	Budget
1. Selection of up to 45 native prairie sites	July 2014	$ 6,000
2. Field surveys of bees and associated plant species	November 2014	$ 97,008
3. Protocol testing for long-term monitoring	November 2014	$ 5,500
4. Data entry, specimen preparation, and delivery of specimens to museum collections	April 2015	$ 33,000
5. Evaluation and refinement of survey methodology	April 2015	$ 5,500
6. Summarize findings, add to species list, and distribute to partners	June 2016	$ 5,500
7. DNR Direct and Necessary Cost	June 2016	$10,000

Project Status as of January 1, 2015
Procurement and preparation of survey equipment was initiated and preliminary surveys of selected sites were conducted from late summer through fall 2014 to test survey protocol.

Over 600 pan traps were constructed using inexpensive plastic bowls and PVC pipe. Several designs were considered to allow for adjustment of the pan traps to the height of surrounding flowering vegetation.

Preliminary field surveys were conducted at Roscoe Prairie, Otter Tail Prairie, and Sedan Brook Prairie Scientific and Natural Areas. It is noteworthy that a high density of blooming forbs at Roscoe Prairie seemed inversely proportional to the abundance of bees caught in the pan traps. This collection bias is consistent with similar observations from other bee researchers, who speculate that the pan traps are less visible or less attractive when there are many flowers in the vicinity. Specimen preparation and data management of captures are currently underway. Supplies and equipment to prepare and house bee specimens have been procured. North Dakota State University has agreed to store the non-bee specimens as bulk samples and an Eagle Scout is building vial racks to store the specimens.

Survey protocols, data forms and a field schedule are being developed and refined in preparation for 2015 bee surveys. Recommendations from other bee researchers, MBS entomologist and MBS plant ecologists/botanists have provided valuable input on survey design and diversity of native prairie plant communities. Final selection of native prairie survey sites, planned for early winter 2015, will draw from nearly 40 native prairie community types.

Project Status as of July 1, 2015
Native prairie survey sites were evaluated and site selection was finalized for eleven locations in the Lake Agassiz, Aspen Parklands and Red River Valley ecological sections in the north and eight locations in the North Central Glaciated Plains ecological section in the south portion of the Minnesota Prairie Region (see Attachment 3; refer to Activity 3 for a discussion of selection criteria). Site managers were notified, collecting permits were obtained, and field supplies were purchased. Transects were installed and GIS maps were created. Counties selected for native prairie transects were prioritized based upon the lack of species previously recorded, the

amount of high-quality prairie habitat within the county, and distance from the field stations. Bee collecting with hand nets was conducted in counties without transects to fill in knowledge gaps about the distribution of bee species.

Seasonal staff were hired and trained. Lodging, vehicles and equipment were secured, prepared, and maintained. Survey protocols, field labels, data sheets, and scheduling tools were developed and refined. Data entry devices were purchased and an app was developed to facilitate electronic data entry in the field. This app is now in the second stage of beta testing.

Surveys were conducted along transects approximately every three weeks at all sites, resulting in an estimated 2,000 bee specimens. From May to July, staff spent 22 days in 28 counties hand netting over 760 bee specimens to augment county records. Voucher specimens were pinned and labelled at the field stations. Field surveys and specimen preparation is ongoing. Non-bee specimens were preserved in ethanol for long-term storage. As part of a special project, an Eagle Scout built 30 vial racks to hold these invertebrate specimens.

One specimen of the rare and declining yellow-banded bumble bee (*Bombus terricola*) was documented near Morris at Dolven WMA in Stevens County. We suspect this is a county record for the species, and also the first time this bee species has been documented visiting the plant genus *Symphoricarpos*. Equally notable is the absence of another declining species, the rusty patched bumble bee (*Bombus affinis*); to date, this project has not recorded any sightings of this species in Minnesota's Prairie Region. This project has also documented 15 county records of native plants from 8 counties, pending confirmation from experts (see Attachment 4).

Project Status as of February 11, 2016

Native prairies were surveyed using pan-trap transects at eleven sites in the Lake Agassiz Aspen Parklands and Red River Valley ecological sections in the north and eight sites in the North-Central Glaciated Plains ecological section in the south (see Attachment 3). Bee collecting with hand nets was conducted in counties without transects to fill in knowledge gaps about the distribution of bee species.

Seasonal staff and volunteers conducted field work and prepared specimens. Survey protocols, field labels, data sheets, and scheduling tools were continually refined. An app was tested to facilitate electronic data entry in the field. IT staff spent two days trouble-shooting the app in Yellow Medicine and Lac Qui Parle counties.

Surveys were conducted along transects approximately every three weeks at all sites (see schedule below), resulting in collection of 6,400 bee specimens. From May through October, staff hand netted over 1,400 bee specimens. Voucher specimens were pinned and labelled at the field stations. Specimen identification and databasing is ongoing. Non-bee specimens were preserved in 400+ vials of ethanol for long-term storage.

2015 Transect Dates for Pan Trap Surveys

SW Sites	NW Sites
May 26-27	May 26-27
June 15-17	June 15-17
July 13-15	July 19-21
August 14-16 & 24-26	August 24-26
September 9-11	September 11-13
October 10-11	October 10-11

Nine specimens of the Couse tadpole shrimp (*Lepidurus couesii*) were collected from boat launches at Roseau River WMA and Trangsrud Public Access Landing (Roseau County). Dr. Christopher Rogers from the Kansas Biological Survey confirmed their identification. These specimens are considered the second record of this genus in Minnesota, and a "News from the Field" blog shared this important find (refer to the Supplementary Materials).

This project has also documented 17 plant county records, which were confirmed by experts, vouchered at the UMN Herbarium, and added to the DNR's MNTaxa database (see Attachment 4).

Final Report Summary:
Survey equipment was procured and prepared. Over 900 pan traps were constructed using inexpensive plastic bowls and PVC pipe. Several designs were considered to allow for adjustment of the pan traps to the height of surrounding flowering vegetation. Survey protocols, data forms, field labels, and a field schedule were developed. Lodging, vehicles, and equipment were secured, prepared, and maintained. Seasonal staff were hired and trained. Data entry devices were purchased and an app was developed to facilitate electronic data entry in the field. MnIT staff spent two days trouble-shooting the app in Yellow Medicine and Lac Qui Parle counties. This app is now in the second stage of beta testing.

Preliminary field surveys were conducted from late summer through fall 2014 to test survey protocols. A high density of blooming forbs at Roscoe Prairie seemed inversely proportional to the abundance of bees caught in the pan traps. This collection bias is consistent with similar observations from other bee researchers, who speculate that the pan traps are less visible or less attractive when there are many flowers nearby.

Survey design and site selection was conducted with input from other bee researchers, MBS entomologists, and MBS plant ecologists/botanists. Counties selected for native prairie transects were prioritized based upon the lack of bee species previously recorded, the amount of high-quality prairie habitat within the county, and distance from the field stations. Native prairie survey sites were evaluated, and final site selection drew from nearly 40 native prairie community types. In 2015 and 2016, there were 19 and 36 high-quality native prairie sites, respectively (see Attachment 3).

Field surveys began once site managers were notified, collecting permits were obtained, transects were installed, and GIS maps were created. In counties without transect sites, bees were collected with hand nets to fill knowledge gaps about the distribution of bee species. From May through October 2015, staff hand-netted over 1,400 bee specimens. From May through June 2016, our project overlapped with other ENRTF projects -- *Effects of Grazing Versus Fire for Prairie Management* and *Data Driven Pollinator Conservation.* Bee data from all projects will be shared.

In 2015, native prairies were surveyed using pan-trap transects at eleven sites in the Lake Agassiz, Aspen Parklands, and Red River Valley ecological sections in the north and eight sites in the North-Central Glaciated

Plains ecological section in the south. Seasonal staff conducted surveys along transects approximately every three weeks at all sites (see schedule below), resulting in collection of 6,400 bee specimens.

2015 - Transect Dates for Pan Trap Surveys

SW Sites	NW Sites
May 26-27	May 26-27
June 15-17	June 15-17
July 13-15	July 19-21
August 14-16 & 24-26	August 24-26
September 9-11	September 11-13
October 10-11	October 10-11

In 2016, native prairies were surveyed using pan-trap transects at 12 sites in the Lake Agassiz Aspen Parklands and Red River Valley ecological sections in the north and 24 sites in the North-Central Glaciated Plains ecological section in the south (see Attachment 3). Seasonal staff conducted surveys along transects approximately every three weeks at all sites (see schedule below), resulting in collection of over 3,800 bee specimens.

2016 - Transect Dates for Pan Trap Surveys

W Sites	Central Sites
May 18-21	May 21-22
June 6 – 9	June 7 - 8
June 27 - 30	July 1 – 2 (part of ENRTF project, M.L. 2016-03(b)

Specimen preparation and data management of captures is ongoing. Supplies and equipment to prepare and house bee specimens were procured. Seasonal staff and volunteers prepared voucher specimens at the field stations. Databasing was completed in winter 2015-2016. Specimens were prepared for long-term storage at the University of Minnesota Insect Collection. Final specimen identification is ongoing and non-bee specimens were preserved in vials of ethanol for long-term storage at North Dakota State University. An Eagle Scout built 30 vial racks to hold these non-bee specimens.

Several important records of bee species were documented during field surveys (see Attachment 4). One specimen of the rare and declining yellow banded bumble bee (*Bombus terricola*) was documented near Morris at Dolven WMA in Stevens County. This is a county record for the species and also the first time this bee has been recorded visiting snowberry plants, genus *Symphoricarpos*. Equally notable is the absence of another declining species, the rusty patched bumble bee (*Bombus affinis*); to date, this project has not recorded any sightings of this species in Minnesota's prairie region. A state record of *Nomia universitatis* was collected in Faribault County, pending confirmation by experts.

Many plant county records were also obtained during field surveys (see Attachment 4). In 2015, this project documented 17 county records of plants, which were confirmed by experts, vouchered at the UMN Herbarium, and added to the DNR's MNTaxa database. In 2016, an additional 10 plant county records were collected, pending confirmation from experts. Data was also sent to DNR experts about the location and blooming phenology of small white lady's slipper (*Cypripedium candidum*), an orchid listed as Special Concern in Minnesota. Locality data about *C. candidum* was also sent to land managers to protect it from trampling by conservation grazing.

Observations of other animals were recorded during field surveys. For example, the Couse tadpole shrimp (*Lepidurus couesii*) was collected from boat launches in Roseau County, remarkably documenting only the

second record of this genus in the state. Spiders nesting in bee traps were identified by experts, revealing county records of the starbellied orbweaver (*Acanthepeira stellata*), slender crab spider (*Tibellus oblongus*), and a jumping spider (*Phiddipus clarus*). Bird observations included a sighting of American woodcock (*Scolopax minor*, a SGCN) in Redwood County and the first observation of a breeding hooded merganser (*Lophodytes cucullatus*) in Grant County. Rare mammal observations of Franklin's ground squirrel (*Spermophilus franklinii*) and moose (*Alces alces*) in northwestern Minnesota were reported to DNR experts.

ACTIVITY 3: Comparison of Wild Bee Fauna in Prairie-Grasslands

Description: The wild bee fauna and associated plant species will be compared among native prairie sites (surveyed in Activity 2) and restored prairie-grassland sites. The focus of these surveys is to identify mutually beneficial relationships between native or restored prairie-grasslands and bee pollinators. Other habitats present in the Prairie Region, such as agricultural fields, flower gardens and nurseries, will not be included in this project. Survey protocols will be refined to use for long-term monitoring of grassland management. Findings will form the basis for development of management recommendations to enhance diversity of prairie flora and associated pollinators.

Approach: Field surveys, specimen vouchering and data management will follow procedures described in Activity 2. Statistical comparisons of bee species richness and abundance and floral resource diversity will be performed and evaluated between native prairie and restored prairie-grassland sites. These findings, augmented by those from the University of Minnesota's floral resource assessment (refer to *Enhancing Pollinator Landscapes, ENRTF 146-F*), will inform best management practices in grassland habitats that promote wild bees.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 115,000
Amount Spent: $ 115,000
Balance: $ 0

Activity Completion Date: June 30, 2016

Outcome	Completion Date	Budget
1. Refinement of survey and monitoring protocol and selection of up to 90 sites; 45 native prairie and 45 restored prairie-grassland	April 2015	$ 9,000
2. Field surveys of bees, associated plant species, and vegetation description	November 2015	$ 36,000
3. Data entry, specimen preparation, and delivery of specimens to museum collections	April 2016	$ 25,000
4. Results summarized and evaluated, species list updated	June 2016	$ 7,000
5. Second field season of surveys conducted	Continuing	$ 28,000
6. DNR Direct and Necessary Cost	June 2016	$ 10,000

Project Status as of January 1, 2015

Work is underway to refine selection criteria for paired comparisons between high-quality native prairie and restored/managed grasslands. Native prairie survey sites will be selected from the MNDNR Native Plant Community database, from native prairie plant communities with condition ranks of B or higher, and length sufficient to contain a bee pan-trap transect. Selection will be stratified by subsections for the prairie region. This will include the Aspen Parklands, Red River Prairie, Minnesota River Prairie, Coteau Moraines, and Inner Coteau subsections (MNDNR Ecological Classification System), and will be weighted by total acreage in each subsection. An ArcGIS tool was developed to randomly select sites while maintaining a minimum separation distance between sites of 6 miles. Once the native prairie community sites have been selected, restored/managed grassland sites will be identified for the paired comparisons.

One problem that has slowed final selection of the native prairie sites is that some known prairie communities of high quality do not have a condition rank and/or are contained within native plant community complexes and thus not selectable by the criteria described above. We are working with MBS plant ecologists with experience in the prairie region to identify these sites for inclusion.

Project Status as of July 1, 2015

Several iterations of the ArcGIS tool were run to select potential native prairie sites. After review by MBS prairie ecologists, it was decided that for the purposes of this project expert opinion and knowledge of the sites was the preferred way to select high-quality native prairie. Eight high-quality prairie sites were selected in the North Central Glaciated Plains ecological section and paired with a nearby grassland restoration site (Attachment 3). Efforts were made to maintain a minimum separation distance of six miles between high-quality prairie sites and their paired restoration to avoid sampling overlap for the flight ranges of bees.

As described in Activity 2, site managers were contacted and permits obtained. Transects were established and surveys conducted approximately every three weeks at these 16 sites. All specimens were pinned and labelled at the field stations. Final specimen processing is ongoing and non-bee specimens are preserved in ethanol for future study. Data analysis is scheduled for winter 2015-2016.

Project Status as of February 11, 2016

Restored grasslands were paired with native prairie sites and surveyed using pan-trap transects at eight sites in the North-Central Glaciated Plains ecological section. In July, an additional eight pan-trap transects were added to Wildlife Management Areas in the North-Central Glaciated Plains ecological section. Similarly, five transects were added to the Lake Agassiz Aspen Parklands and Red River Valley ecological sections. These were “county record” sites that aided bee collecting with hand nets to fill knowledge gaps about the distribution of bee species.

As described in Activity 2, surveys were conducted approximately every three weeks. All specimens were pinned and labelled at the field stations. Specimen identification and databasing is ongoing, and non-bee specimens are preserved in ethanol for future study. A plant ecologist evaluated the quality of prairie along all pan-trap transects. Data analysis is scheduled for winter 2016.

Final Report Summary:

Site selection began by developing an ArcGIS tool to randomly select sites, but review by MBS prairie ecologists revealed that expert opinion was the preferred method for the purposes of this project. Eight high-quality prairie sites were selected in the North Central Glaciated Plains ecological section and paired with a nearby grassland restoration site (Attachment 3). Efforts were made to avoid sampling overlap in the flight ranges of bees.

Additional sites were added in 2015 to fill knowledge gaps about the distribution of bee species. Eight pan-trap transects were added to wildlife management areas in the North-Central Glaciated Plains ecological section and five transects were added to the Lake Agassiz Aspen Parklands and Red River Valley ecological sections. A plant ecologist evaluated the quality of prairies and grasslands along all transects.

Field surveys were conducted as described in Activity 2. Site managers were contacted and permits obtained. Transects were established and surveys conducted approximately every three weeks in 2015. All specimens were pinned and labelled at the field stations. Databasing was completed in winter 2015-2016. Specimens were prepared for long-term storage at the University of Minnesota Insect Collection. Final specimen identification is ongoing, and non-bee specimens are preserved in ethanol for future study.

V. DISSEMINATION:

Description: Data collected from this project will be stored in the Minnesota Department of Natural Resources (MNDNR), Division of Ecological and Water Resources information system. This information will take the form of

databases, GIS layers, maps, and web-based summaries. They will be linked to other databases within the MNDNR and will be shared with our partners working on separate bee and pollinator projects.

Publications, presentations and web-based products will be developed to provide information to a variety of audiences. A webpage on wild bees will be developed within the MNDNR's Minnesota Biological Survey website (http://www.dnr.state.mn.us/mbs/index.html). This webpage will include updates on project activities and findings, provide a state species list of bees in Minnesota, statewide distribution maps for each bee species, and species accounts that summarize natural history traits and habitat associations. The page will link to the MNDNR Nongame Wildlife Program and other external websites that feature bees.

Coordination and information exchange with other pollinator groups and projects will strengthen our knowledge of Minnesota's pollinators and identify additional needs for conservation and management. These collaborators include, but are not limited to, MNDNR Pollinator Habitat Project, University of Minnesota (UM) Bee Squad, Enhancing Pollinator Landscapes (UM, ENRTF 146-F), Minnesota Pollinator Partnership (Pheasants Forever, ENRTF 072-C), Protecting Bees by Understanding Systemic Insecticides (UM, ENRTF 151-F), Bee Discovery Center at the Minnesota Landscape Arboretum (ENRTF 073-C), Prairie Butterfly Conservation, Research and Breeding Program (MN Zoological Garden and MNDNR, ENRTF 017A).

Physical collections of bees will be prepared and deposited into the Insect Collection at the University of Minnesota; plant collections will be deposited into the J.F. Bell Museum of Natural History's Herbarium. Data associated with bee specimens will be stored in the MNDNR Observation Database and the UM Insect Collection's database, and will be available for inclusion in international databases.

Project Status as of January 1, 2015

Working with the MNDNR Natural Heritage Information System's data managers, a database module for bees was developed to accommodate bee specimen information. This database is being used to enter bee specimen data from the Insect Collection, University of Minnesota, and is available for use by other ENRTF-funded bee projects, other researchers and educators. Work is ongoing to develop a linked database for flowering plant data that will be collected in association with the bee surveys.

The goals and accomplishments of this project are presented in the MNDNR's *Native Bees of Minnesota's Grasslands* webpage (http://www.dnr.state.mn.us/mbs/grasslandbees.html) that was developed by the project's coordinator/bee specialist and MBS graphic/web-design specialist. They also developed, with input from the MNDNR Pollinator Team, the webpages on *Minnesota's Pollinators* (http://www.dnr.state.mn.us/pollinators/index.html) and *Minnesota Pollinator Resources* (http://www.dnr.state.mn.us/pollinator_resources/index.html). They collaborated with other MBS staff to produce a draft *Pollinator Resource Values for Upland & Wetland Prairies* (http://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet.pdf). Planning is underway to post the state's list of wild bees and associated density map of species records (see Appendix 1, Attachment 1, and Attachment 5). The websites, species list and map will be updated regularly as new information is obtained.

The project's coordinator/bee specialist maintains contact with people on other bee and pollinator projects and collaborates on special projects, such as the Tallgrass Prairie Bee Identification workshop; is a member of multi-disciplinary teams addressing pollinator best management practices and prairie conservation; and has established a good working relationship with the Insect Collection at the University of Minnesota. This project has purchased needed supplies and equipment for permanent storage of bee specimens collected through this grant at the Insect Collection.

Bee specimen preparation and identification is ongoing. At this time, over 2,500 collected bee specimens are pinned, labeled and awaiting inclusion into the Insect Collection at the University of Minnesota. Data entry of

bee specimens already housed by the collection continues. Volunteers have databased over 2,000 of the estimated 27,000 bee specimens in the collection.

The project's coordinator/bee specialist has responded to numerous inquiries about bees and requests to participate in workshops, make presentations, and provide information for news reports and articles (see below).

Bee workshops, symposia and educational programs:
Tallgrass Prairie Bee Identification Workshop (co-organized with bee specialists working under ENRTF-funded Enhancing Pollinator Landscapes project).
Minnesota Nursery and Landscape Association Pollinator Symposium
MNDNR Silviculture Program Annual Meeting
Pesticide Recertification Training
State Fair – MNDNR and MPCA stages
Project Earth

Presentations about bees:
Minneapolis Audubon Society
Community of Practice
Minneapolis Public Library
Golden Valley Historical Society
Minneapolis Pollinator Party
Big Brothers, Big Sisters Annual Picnic
Ebenezer Care Center's Mini State Fair

News interviews and reports about the project and bee conservation:
Minnesota Public Radio
WTIP North Shore Radio
St. Cloud Times
Outdoor News (2 articles)
Scientific and Natural Area newsletter
Concordia College newsletter

Project Status as of July 1, 2015
Bee specimen data continues to be added to databases. Thus far, volunteers have entered label information from 3,700 specimens previously housed at the University of Minnesota Insect Collection. Current fieldwork generated an additional 5,200 bee specimens that are pinned, labelled, and awaiting inclusion in the collection. Identification work is ongoing. Databases linking flowering plant data to field collections are in the second stage of beta testing.

Support continues for the MNDNR's *Native Bees of Minnesota's Grasslands* webpage (http://www.dnr.state.mn.us/mbs/grasslandbees.html) and its associated pages. New county record maps are being developed for 20 bumble bee species (see Attachment 1) and the draft *Pollinator Resource Values for Upland & Wetland Prairies* (http://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet.pdf) is being distributed.

The project's coordinator/bee specialist maintains collaborations with other Minnesota pollinator projects and served as co-organizer of the successful 2015 Tallgrass Prairie Bee Identification Workshop. This five-day workshop welcomed 21 participants from 8 states, and reached 90 members of the public through three special events. The project coordinator contributed to finalizing the DNR's Operational Order 130: Pollinator Habitat and communicates regularly with those working on other ENRTF-funded bee projects. A positive working

relationship has been established with the University of Minnesota Insect Museum and Herbarium and supplies and equipment have been procured for both through this grant.

The project's coordinator continues to respond to numerous inquiries about bees and requests to participate in workshops, give presentations, and provide information for news reports and articles (see below).

Workshops, symposia, and tools:
Tallgrass Prairie Bee Identification Workshop (co-organized with bee specialists working under ENRTF-funded *Enhancing Pollinator Landscapes* project)
Meet and Greet at Minnesota Zoo
Minnesota Department of Agriculture, Pollinator Consortium
Xerces Pollinator Habitat Assessment Tool

Presentations about bees:
University of Minnesota, Environmental Science and Society
University of Minnesota, Pollinator Protection in Managed Landscapes
MNDOT, Environmental Stewardship Conference
St. Paul Audubon Society, Warbler Weekend
Science Rocks! Event
MNDNR, Division of Wildlife Conference
Minnesota Landscape Arboretum, Pollinator Cubed
Minnesota Master Gardener Conference
Minneapolis Parks & Recreation, Pollinator Party

News interviews and reports about the project and bee conservation:
July/August 2015 Minnesota Conservation Volunteer, feature article: "A Bounty of Wild Bees"
ArcCollector Story Map of bumble bee declines
"News from the Field" blog entries

Technical Guidance (internal):
State Wildlife Action Plan, input on status of monarch butterflies and bumble bees
SNA permit review for bee research
DNR pollinator listserv

Technical Guidance (external partners):
Minnesota Department of Agriculture, State Fair seed packets and Pollinator Consortium planning
Monarch Joint Venture, helped obtain official partnership with MNDNR
Wisconsin DNR, provided information about honeybees and public lands

Project Status as of February 11, 2016
Bee specimen data continues to be added to databases. Thus far, staff and volunteers have entered label information from 6,400+ specimens previously housed at the University of Minnesota Insect Collection. Current fieldwork generated a total of ~7,900 bee specimens that are pinned, labelled, and awaiting inclusion in the collection, similar to an additional ~7,900 specimens from previous fieldwork. Identification work is ongoing. Databases and data flow are being configured to capture bee specimen data before entry into the DNR's Observation Database.

Work continues on the MNDNR's *Native Bees of Minnesota's Grasslands* webpage (http://www.dnr.state.mn.us/mbs/grasslandbees.html), county record maps for Minnesota's bumble bee species (see Attachment 1), and the draft *Pollinator Resource Values for Upland & Wetland Prairies* (http://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet.pdf).

The project's coordinator/bee specialist collaborates with other Minnesota pollinator projects and communicates regularly with those working on other ENRTF-funded bee projects. Supplies and equipment continue to be secured for both the University of Minnesota Insect Museum and Herbarium.

The project's coordinator continues to respond to numerous inquiries about bees and requests to participate in workshops, give presentations, and provide information for news reports and articles (see below).

Workshops and Symposia:
Meet and Greet at University of Minnesota

Presentations about bees:
Kandiyohi County Master Gardeners
Town Hall Forum with Senator Kari Dziedzic, Representative Phyllis Kahn, and Representative Diane Loeffler
Golden Valley Rotary Club
DNR's Citizen Advisory Committee
Eagan Ecology Commission
Stearns History Museum
Stillwater Honey Bee Club
Science Rocks!, St. Cloud State University
Front Porch, DNR Roundtable
North Central Beekeepers Association
University of Minnesota, Conservation Biology Seminar
University of Minnesota, Environment Science and Society Class

News interviews and reports about the project and bee conservation:
Cook County News Herald, "U.S. Fish and Wildlife to Study Status of Four Midwest Wildlife Species," 10/3/15
Star Tribune, "Wild Bees Losing Out to Corn in Minnesota and Upper Midwest, Says U of Vermont Study," 12/21/15
Minnesota Conservation Volunteer, technical guidance on bee queens, December 2015
"News from the Field" blog entries

Technical Guidance (internal):
State Wildlife Action Plan, input on status of monarch butterflies and bumble bees
SNA permit review for bee research
DNR pollinator listserv

Technical Guidance (external partners):
Minnesota Department of Agriculture, Pollinator Summit planning
ENRTF-funded *Minnesota Native Bee Atlas*, project collaboration
USGS, coordinated site selection meeting between DNR and ENRTF-funded *Effects of Grazing Versus Fire for Prairie Management*
Hastings High School, provided instructions for building pan traps

Final Report Summary:
In collaboration with the MNDNR Natural Heritage Information System's data managers, a database module for bees was developed to accommodate bee specimen information. This database is being used to enter bee specimen data from the University of Minnesota Insect Collection and is available for use by other ENRTF-funded bee projects, other researchers, and educators. Work is ongoing to develop a linked database for flowering plant data that will be collected in association with the bee surveys.

The project coordinator/bee specialist (Crystal Boyd) and MBS web-design specialist, in collaboration with the MNDNR Pollinator Team and other MBS staff, developed several MNDNR webpages related to this project:

1. *Native Bees of Minnesota's Grasslands* webpage to present the goals and accomplishments of this project (http://www.dnr.state.mn.us/mbs/grasslandbees.html).
2. *Minnesota's Pollinators* webpage (http://www.dnr.state.mn.us/pollinators/index.html)
3. *Minnesota Pollinator Resources* webpage (http://www.dnr.state.mn.us/pollinator_resources/index.html).
4. *Pollinator Resource Values for Upland & Wetland Prairies* webpage and booklet (http://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet.pdf).

These websites will be maintained and updated as new information is obtained. This includes posting updates to the state species list of bees (see Appendix 1) and county record maps for Minnesota's bumble bee species (see Attachment 2). The booklet *Pollinator Resource Values for Upland & Wetland Prairies* continues to be distributed.

The project coordinator/bee specialist collaborates with other Minnesota pollinator projects and communicates regularly with those working on other ENRTF-funded bee projects. The project coordinator co-organized the successful 2015 Tallgrass Prairie Bee Identification Workshop, which was a five-day workshop welcoming 21 participants from 8 states and reaching 90 members of the public through three special events. The project coordinator also contributed to finalizing the DNR's *Operational Order 130: Pollinator Habitat* and established a good working relationship with the University of Minnesota Insect Collection. Supplies and equipment continue to be secured for both the University of Minnesota Insect Collection and Herbarium to support permanent storage of bee specimens and plant county records.

Bee specimen data continues to be added to databases. Thus far, DNR staff and volunteers have entered label information from over 9,900 specimens previously housed at the University of Minnesota Insect Collection. In 2015, this project generated over 7,800 bee specimens that are pinned, labelled, and awaiting inclusion in the collection. An additional 7,900+ specimens from previous DNR bee surveys were incorporated. In 2016, this project generated an estimated 3,800 specimens that are currently being processed. Identification work is ongoing. Databases and data flow are being configured to capture bee specimen data before entry into the DNR's Observation Database.

The project coordinator responded to numerous inquiries about bees and over 120 requests to participate in workshops, give presentations, and provide information for news reports and articles. Of these requests, 64 were accepted and 56 were declined due to limited capacity. Activities are listed below.

<u>Workshops, symposia, educational programs, and tools</u>:
Tallgrass Prairie Bee Identification Workshop (co-organized with bee specialists working under ENRTF-funded *Enhancing Pollinator Landscapes* project)
Minnesota Nursery and Landscape Association Pollinator Symposium
MNDNR Silviculture Program Annual Meeting
Pesticide Recertification Training
State Fair – MNDNR and MPCA stages
Project Earth
ENRTF Pollinator Projects, Meet and Greets at DNR, Minnesota Zoo, and University of Minnesota
Minnesota Department of Agriculture, Pollinator Summit
Xerces Pollinator Habitat Assessment Tool
MNDNR Division of Ecological and Water Resources All-Staff Meeting

<u>Presentations about bees</u>:
Minneapolis Audubon Society

MNDNR Community of Practice
Minneapolis Public Library
Golden Valley Historical Society
Minneapolis Parks and Recreation, Pollinator Party, 2014 & 2015
Big Brothers, Big Sisters Annual Picnic
Ebenezer Care Center's Mini State Fair
University of Minnesota, Environmental Science and Society
University of Minnesota, Pollinator Protection in Managed Landscapes
MNDOT, Environmental Stewardship Conference
St. Paul Audubon Society, Warbler Weekend
Science Rocks! Event
MNDNR, Division of Wildlife Conference
Minnesota Landscape Arboretum, Pollinator Cubed
Minnesota Master Gardener Conference
Kandiyohi County Master Gardeners
Town Hall Forum with Senator Kari Dziedzic, Representative Phyllis Kahn, and Representative Diane Loeffler
Golden Valley Rotary Club
DNR's Citizen Advisory Committee
Eagan Ecology Commission
Stearns History Museum
Stillwater Honey Bee Club
St. Cloud State University, Science Rocks!
MNDNR Roundtable, Front Porch
North Central Beekeepers Association
University of Minnesota, Conservation Biology Seminar
University of Minnesota, Environment Science and Society Class
Town Hall Forum with Senators Scott Dibble and Patricia Torres Ray, Representatives Jim Davnie, Frank Hornstein, and Jean Wagenius, and Council Members Andrew Johnson and John Quincy
Audubon Society, Alexandria
League of Women Voters, White Bear Lake Area
St. Croix Riverway Speaker Series
Mount Zion Brotherhood
League of Women Voters, Park Rapids
MNDNR State Parks Annual Meeting

News interviews and reports about the project and bee conservation:
Minnesota Public Radio
WTIP North Shore Radio
St. Cloud Times
Outdoor News (2 articles)
Scientific and Natural Area newsletter
Concordia College newsletter
Minnesota Conservation Volunteer, feature article: "A Bounty of Wild Bees," July/August 2015
ArcCollector Story Map of bumble bee declines
"News from the Field" blog entries
Cook County News Herald, "U.S. Fish and Wildlife to Study Status of Four Midwest Wildlife Species," 10-3-15
Star Tribune, "Wild Bees Losing Out to Corn in Minnesota and Upper Midwest, Says U of Vermont Study," 12-21-15
Minnesota Conservation Volunteer, technical guidance on bee queens, December 2015
"News from the Field" blog entries
WJON St. Cloud, "Bees, Pollinator Populations Struggling Across Minnesota," 3-28-16

Burnsville Plant Sale Video, "Beautify Yards and Help the Environment by Planting Native Plants!" March 2016
The Wake Magazine, "When Dead Bugs Do the Legwork," 5-2-16

Technical Guidance (internal):
State Wildlife Action Plan, input on status of monarch butterflies and bumble bees
SNA permit review for bee research
DNR pollinator listserv

Technical Guidance (external partners):
Minnesota Department of Agriculture, State Fair seed packets and Pollinator Summit planning
Monarch Joint Venture, helped obtain official partnership with MNDNR
Wisconsin DNR, provided information about honeybees and public lands
ENRTF-funded *Minnesota Native Bee Atlas*, project collaboration
USGS, coordinated site selection meeting between DNR and ENRTF-funded *Effects of Grazing Versus Fire for Prairie Management*
Hastings High School, provided instructions for building pan traps
Updated MNDNR Native Plant Suppliers webpage

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Explanation
Personnel:	$250,126	1 project coordinator/entomologist at 100% FTE for 2 years; 1 zoology data manager at 30% FTE for 1 year; 1 graphics/web design specialist at 10% FTE for 2 years; 1 seasonal entomologist at 60% FTE for 1.5 years; 2 seasonal botanists at 30% for 1.5 years
Professional/Technical/Service Contracts:	$0	Contractual agreements with technical experts for statistical guidance, database development and vegetation analysis.
Equipment/Tools/Supplies:	$32,008	Field equipment and supplies to be used for data recording, bee collection, specimen preparation; cell phone rental for field coordination and safety.
Travel Expenses in MN:	$55,000	Mileage and seasonal lease of MNDNR fleet vehicles, lodging and meals to visit state repositories with Minnesota bee specimens and to conduct field surveys.
Other: Travel Expenses outside MN:	$ 3,992	Mileage, lodging, meals to Midwest collections with Minnesota bee specimens. Important records of bees collected from Minnesota reside in collections held by Midwest institutions in Wisconsin, Iowa, North Dakota, South Dakota, and Illinois. It is critical to the objective of this project -- *to compile specimen data on Minnesota bees* -- that the project coordinator be allowed to visit these institutions to record these data.

*DNR Direct & Necessary Cost	$28,874	Direct and necessary costs: HR Support (~$6,257); Safety Support (~$1,475); Financial Support (~4,777); Communications Support (~1,236); IT Support (~$13,970); Planning Support (~$829); and Procurement Support (~$235) necessary to accomplishing funded programs/projects.
TOTAL ENRTF BUDGET:	**$ 370,000**	

***Direct and Necessary** expenses include both Department Support Services (Human Resources [~$6,257], Safety Support [~$1,475], Financial Support [~$4,777], Communications Support [~$1,236], IT Support [~$13,970], Planning Support [~$829], and Procurement Support [~$235] and Division Support Services. Department Support Services are described in the agency Service Level Agreement, and is billed internally to divisions based on rates that have been developed for each area of service. These services are directly related to and necessary for the appropriation. Department leadership services (Commissioner's Office and Regional Directors) are not assessed. Division Support Services include costs associated with Division business offices and clerical support. Those elements of individual projects that put little or no demand on support services such as large single-source contracts, large land acquisitions, and funds that are passed-through to other entities are not assessed Direct and Necessary costs for those activities.

Calculations for this project are as follows:

Funding request before D&N = $341,221
Total Direct & Necessary = $28,779
Total Project Costs - $369,999
Sum of FTE-Year Units = 4.3
Sum of User ID Units = 5

Explanation of Use of Classified Staff: Any classified staff paid through this project (1) will be a technical expert needed to incorporate incoming data into existing information systems, or (2) will delay, eliminate or complete work normally performed by this position.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: Approximately 4.3 FTEs over the 2-year period of this project.

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: None.

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State			
RIM Critical/Heritage Enhancement	$ 24,000	$22,303/$3,591	Project manager salary
TOTAL OTHER FUNDS:	**$ 24,000**	**$ 25,894**	

VII. PROJECT STRATEGY:

A. Project Partners: This request does not include funding for the following partners: land managers and owners of survey sites, including the MNDNR divisions of Ecological and Water Resources, Fish and Wildlife,

Parks and Trails, U.S Fish and Wildlife Service, The Nature Conservancy, counties and private landowners; institutions supporting the project, containing Minnesota bee specimens and/or serving as repositories for specimens collected by this project, including American Museum of Natural History, University of Minnesota's Insect Collection and J. F. Bell Museum of Natural History, Science Museum of Minnesota. This request complements the project addressing pollinators submitted by Dr. Marla Spivak and Dr. Clarence Lehman (*Enhancing Pollinator Landscapes, ENRTF 146-F*).

B. Project Impact and Long-term Strategy: The duration of this project is insufficient to account for the yearly fluctuations of insect populations. Similarly, this timeframe will produce results that can stand alone or act as the beginning phase of a long-term monitoring scheme. Continuation of the prairie-grassland monitoring component would enable differences between sites to be statistically significant. Additionally, extending the bee survey to the forested and forest-transition regions would add to our knowledge of the state's bee fauna.

C. Spending History: N/A

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): See attached.

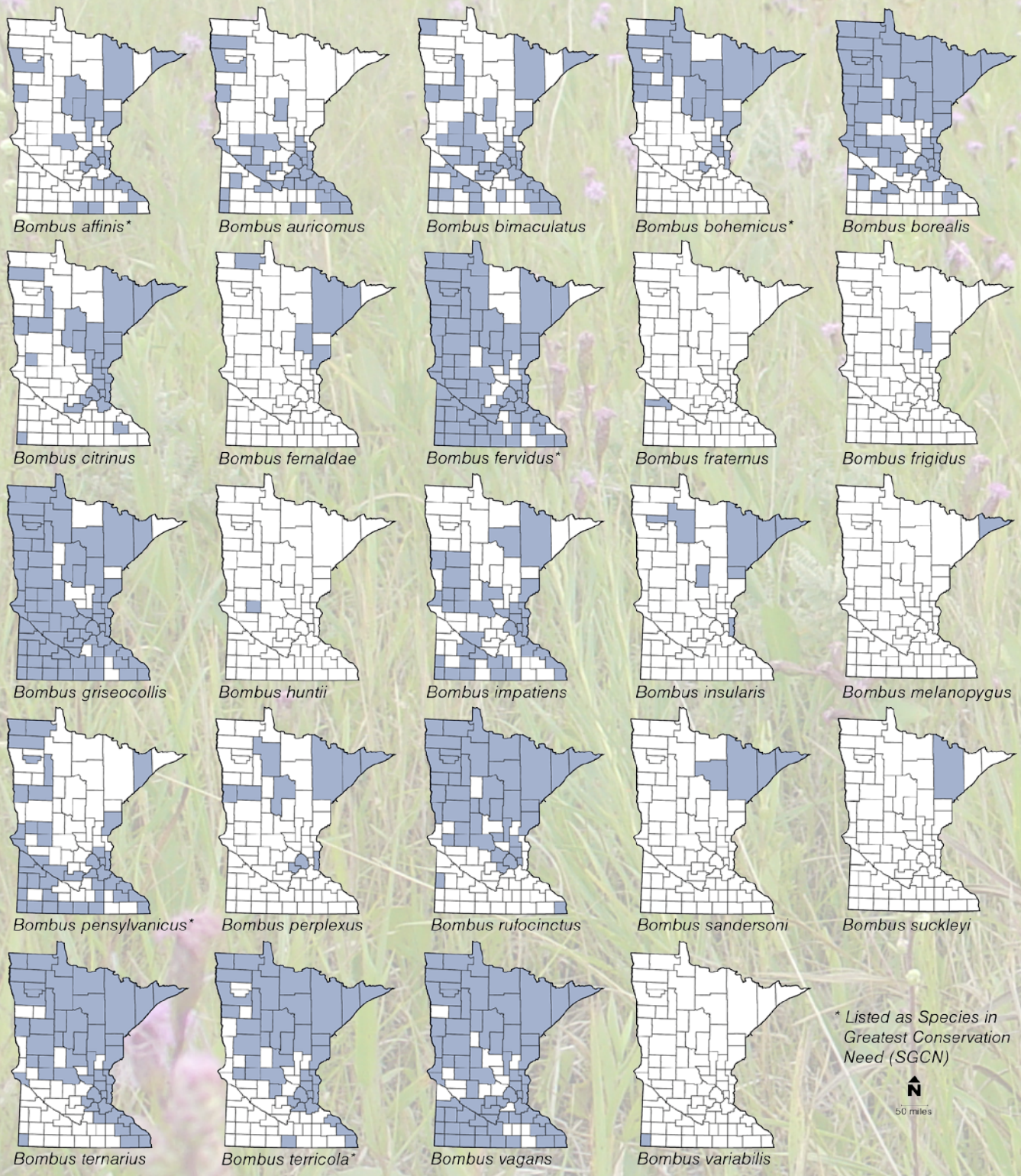
X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: N/A

XI. RESEARCH ADDENDUM: N/A

XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than January 2015, July 2015, and January 2016. A final report and associated products will be submitted between June 30 and August 15, 2016.

Attachment 1. Preliminary County Records of Minnesota Bumble Bees

In 2009, experts estimated that Minnesota had 12 to 13 species of bumble bees (*Bombus* sp). Thanks to this project in collaboration with others, we now know that Minnesota has at least 24 species of bumble bees.



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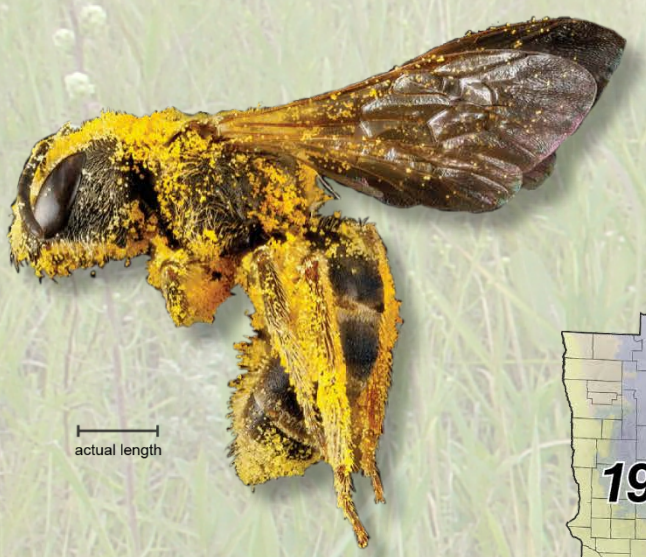
Partial funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative–Citizen Commission on Minnesota Resources (LCCMR).

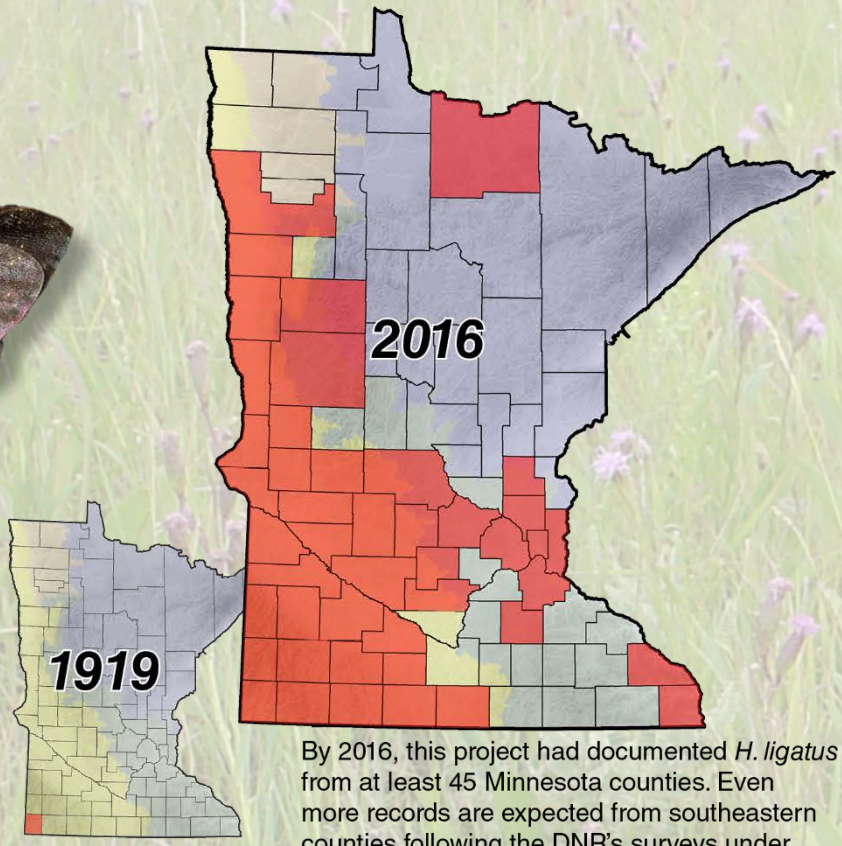
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Attachment 2. This project has dramatically increased knowledge about Minnesota's native bees.

This sweat bee, *Halictus ligatus*, is just one example of how this project has greatly expanded baseline knowledge about the distribution of native bees.

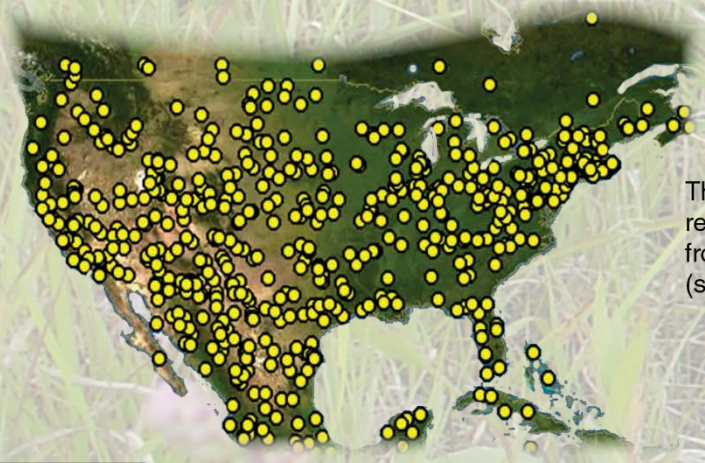


This common sweat bee, *Halictus ligatus,* (shown here dusted with pollen) has been under-surveyd for more than a century.



Frederic Washburn reported *H. ligatus* from only Rock County in his 1919 publication *The Hymenoptera of Minnesota.*

By 2016, this project had documented *H. ligatus* from at least 45 Minnesota counties. Even more records are expected from southeastern counties following the DNR's surveys under the ENRTF project M.L. 2016-03(b) *Native Bee Surveys in Minnesota Prairie and Forest Habitats.*



This bee is abundant across North America, but even recently was under-reported from Minnesota. This map from 2016 shows only 1 record from MN. (source: www.DiscoverLife.org)

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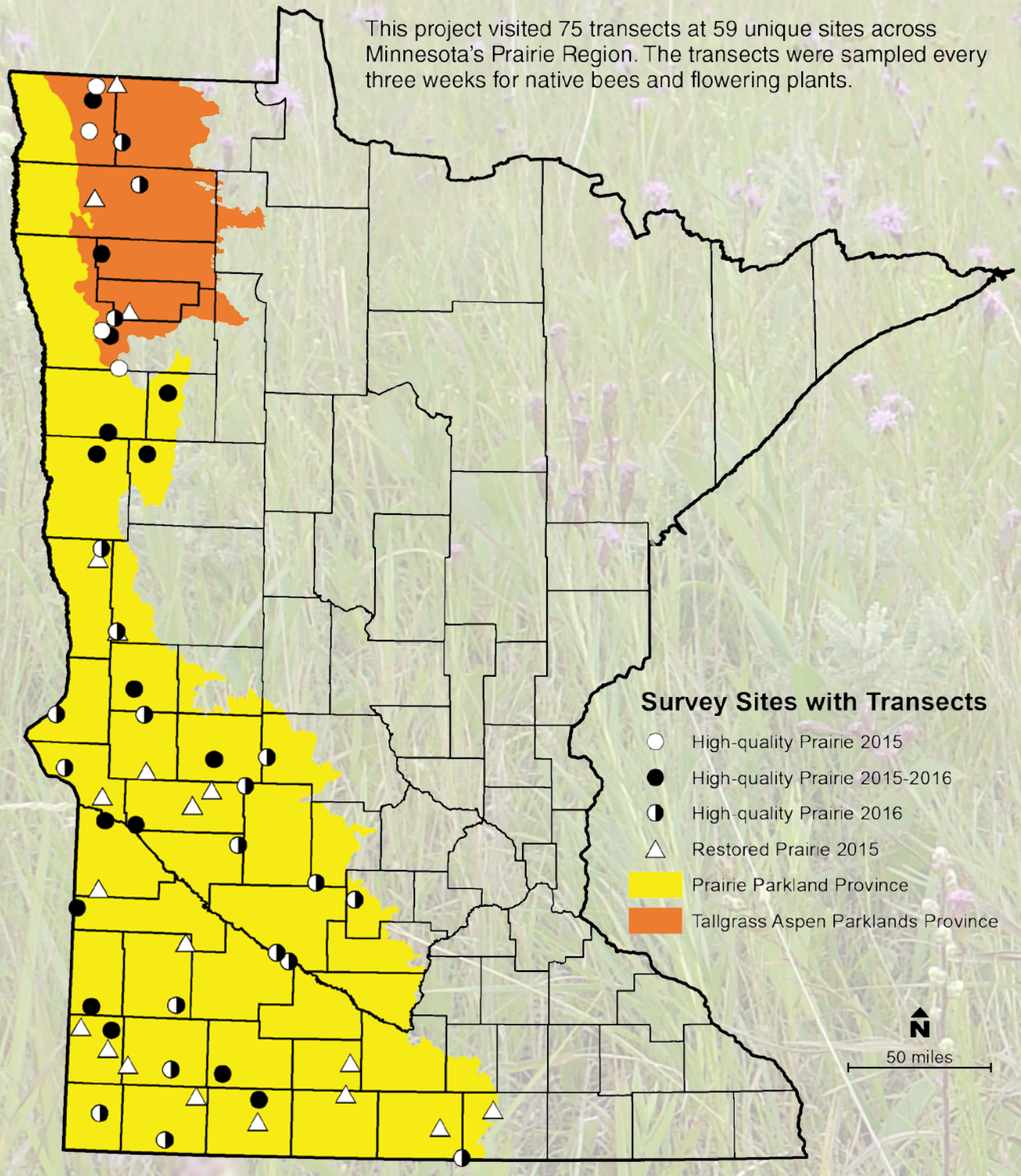
Attachment 3. Project Site Map



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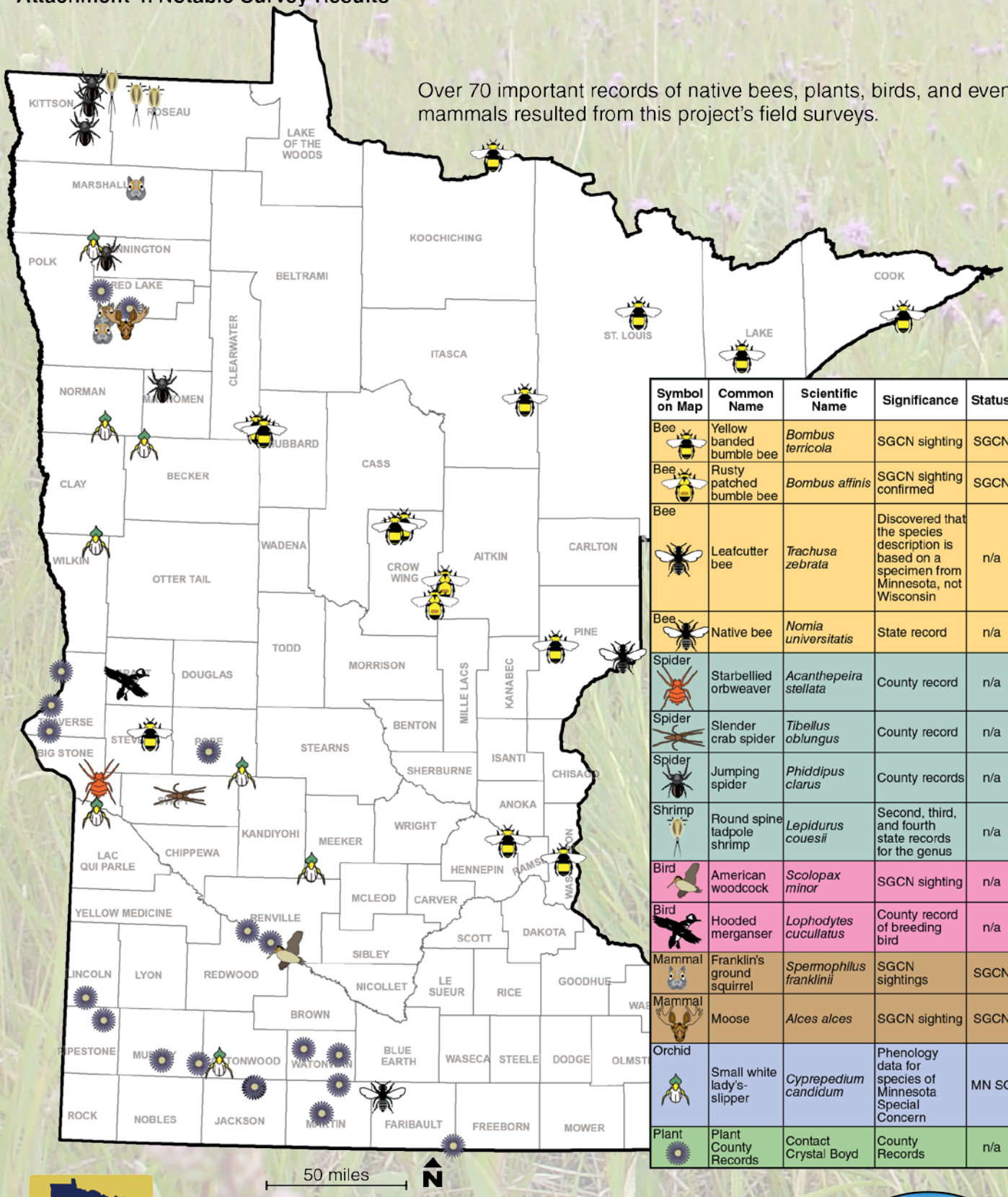
Attachment 4. Notable Survey Results

Over 70 important records of native bees, plants, birds, and even mammals resulted from this project's field surveys.



Symbol on Map	Common Name	Scientific Name	Significance	Status
Bee	Yellow banded bumble bee	*Bombus terricola*	SGCN sighting	SGCN
Bee	Rusty patched bumble bee	*Bombus affinis*	SGCN sighting confirmed	SGCN
Bee	Leafcutter bee	*Trachusa zebrata*	Discovered that the species description is based on a specimen from Minnesota, not Wisconsin	n/a
Bee	Native bee	*Nomia universitatis*	State record	n/a
Spider	Starbellied orbweaver	*Acanthepeira stellata*	County record	n/a
Spider	Slender crab spider	*Tibellus oblungus*	County record	n/a
Spider	Jumping spider	*Phiddipus clarus*	County records	n/a
Shrimp	Round spine tadpole shrimp	*Lepidurus couesii*	Second, third, and fourth state records for the genus	n/a
Bird	American woodcock	*Scolopax minor*	SGCN sighting	n/a
Bird	Hooded merganser	*Lophodytes cucullatus*	County record of breeding bird	n/a
Mammal	Franklin's ground squirrel	*Spermophilus franklinii*	SGCN sightings	SGCN
Mammal	Moose	*Alces alces*	SGCN sighting	SGCN
Orchid	Small white lady's-slipper	*Cyprepedium candidum*	Phenology data for species of Minnesota Special Concern	MN SC
Plant	Plant County Records	Contact Crystal Boyd	County Records	n/a

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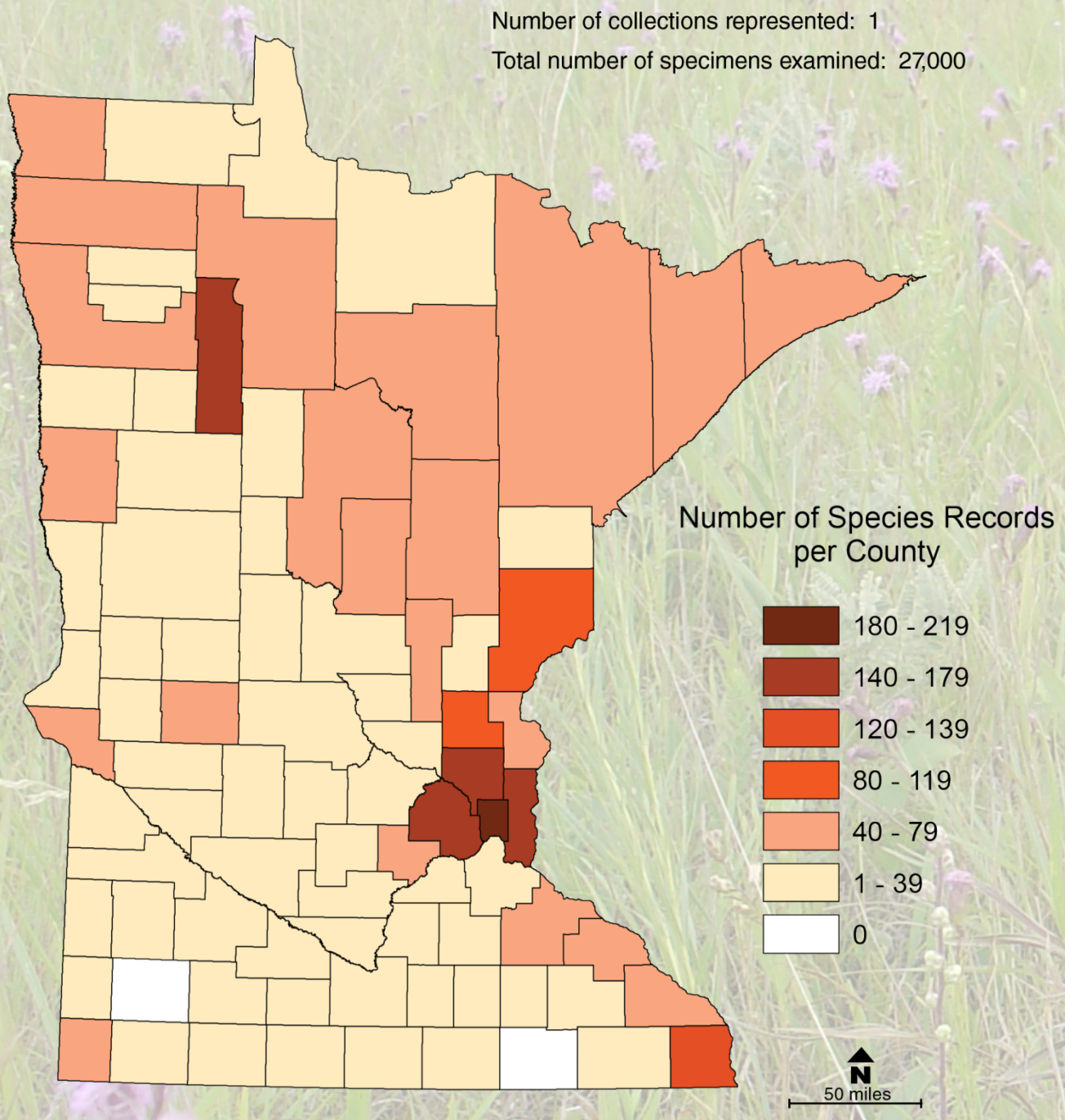
Attachment 5. Number of bee species per county, based on museum specimens as of January 1, 2015.



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ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Appendix 1. Preliminary State Species List of Minnesota Bees

Only 66 bee species were reported for Minnesota when Frederic Washburn published *The Hymenoptera of Minnesota* in 1919.

Through this project, the state species list of Minnesota bees now stands at 418 species. An additional 29 problematic species are listed in Appendix 2.

Please note: This is a preliminary list. Species are expected to be added or removed as surveys are completed and specimen identifications are confirmed.

In compiling this list, the project coordinator/bee specialist (Crystal Boyd) consulted 11 museum collections and 16 additional sources, including personal collections, student theses, informal reports, published literature, and recent survey data from collaborators.

The list was made possible through fieldwork and databasing efforts of MNDNR staff and volunteers. Joel Gardner with the ENRTF project *Enhancing Pollinator Landscape* also contributed to databasing and identifying museum specimens. A special thanks to the numerous collection managers who provided access to historical specimens. In particular, data was collected from large collections of Minnesota bees at the University of Minnesota Insect Collection, the American Museum of Natural History, and the Illinois Natural History Survey.

All data on flight season, nesting, sociality, and host plants/bees was compiled by John Ascher and simplified by MNDNR.

Flight Season: Numbers indicate months when a species is known to fly across its entire range. This data is not specific to Minnesota. For example, Minnesota has a shorter flight season than more southern states, and bees do not fly prior to April. Brackets indicate atypical months.

Nest: Categories include Burrow, Cavity, Hive, Pithy Stems, Soil, and Wood. Some bees parasitize other bee species, and their host's nesting habits are listed in brackets.

Sociality: Categories include Solitary, Communal, Subsocial, Eusocial, and Parasite.

Plant [or Insect] Host: Some bees—including species called oligoleges—collect pollen from only certain plant taxa, which are listed here. Some bees parasitize other bee species, and their host taxa are listed in brackets.

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Appendix 1. Preliminary List of Minnesota Bees

Scientific Name		Flight Season	Nest [parasitic]	Sociality	Plant [or Insect] Host	
					Family	*Genus*
Plasterer, Yellow-faced Bees -- Family Colletidae						
Colletes	*aberrans*	6-8	Soil	Solitary		
Colletes	*albescens*					
Colletes	*americanus*					
Colletes	*andrewsi*					
Colletes	*brevicornis*	3-6	Soil	Solitary		
Colletes	*compactus*					
Colletes	*consors*	4-8	Soil	Solitary		
Colletes	*hyalinus*	4-10	Soil	Solitary		
Colletes	*impunctatus*	6-7	Soil	Solitary		
Colletes	*inaequalis*	3-7 [8-9]	Soil	Solitary		
Colletes	*kincaidii*	6-9	Soil	Solitary		
Colletes	*latitarsis*	3-9	Soil	Solitary	Solanaceae	*Physalis*
Colletes	*nudus*					
Colletes	*phaceliae*	6-9	Soil	Solitary		
Colletes	*robertsonii*	6-8	Soil	Solitary		
Colletes	*rufocinctus*	8-9	Soil	Solitary		
Colletes	*simulans*	1, 5-11	Soil	Solitary	Asteraceae	
Colletes	*solidaginis*	7-9	Soil	Solitary		
Colletes	*speculiferus*	4-11	Soil	Solitary		
Colletes	*susannae*	7-8	Soil	Solitary		
Colletes	*willlistoni*					
Colletes	*wilmattae*	6-9	Soil	Solitary		
Hylaeus	*affinis*	4-10	Cavity	Solitary		
Hylaeus	*annulatus*	4-10	Cavity	Solitary		
Hylaeus	*basalis*	5-8	Cavity	Solitary	Rosaceae	
Hylaeus	*fedorica*	6-7	Cavity	Solitary		
Hylaeus	*floridanus*	4-10	Cavity	Solitary		
Hylaeus	*illinoisensis*					
Hylaeus	*leptocephalus*					
Hylaeus	*mesillae*	4-10	Cavity	Solitary		
Hylaeus	*modestus*	5-9	Cavity	Solitary		
Hylaeus	*rudbeckiae*	5-10	Cavity	Solitary		
Hylaeus	*saniculae*	6-8	Cavity	Solitary		
Hylaeus	*sparsus*					
Hylaeus	*verticalis*	4-8	Cavity	Solitary		
Mining Bees -- Family Andrenidae						
Andrena	*algida*					
Andrena	*aliciae*	7-9	Soil	Solitary	Asteraceae	
Andrena	*alleghaniensis*	4-7	Soil	Solitary		
Andrena	*andrenoides*	3-8	Soil	Solitary	Salicaceae	*Salix*
Andrena	*asteris*	8-10	Soil	Solitary	Asteraceae	

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Appendix 1. Preliminary List of Minnesota Bees

Andrena	*barbilabris*	3-7 [8-9]	Soil	Solitary		
Andrena	*bisalicis*	2-9	Soil	Solitary		
Andrena	*bradleyi*	3-9	Soil	Solitary	Ericaceae	
Andrena	*brevipalpis*	5-10	Soil	Solitary		
Andrena	*canadensis*	8-10	Soil	Solitary	Asteraceae	
Andrena	*carlini*	3-7 [8]	Soil	Solitary		
Andrena	*carolina*	4-7	Soil	Solitary	Ericaceae	*Vaccinium*
Andrena	*ceanothi*	5-6	Soil	Solitary		
Andrena	*chromotricha*	7-9	Soil	Solitary	Asteraceae	
Andrena	*clarkella*	3-8	Soil	Solitary	Salicaceae	*Salix*
Andrena	*commoda*	4-7	Soil	Solitary		
Andrena	*cragini*	5-6	Soil	Solitary		*Amorpha*
Andrena	*crataegi*	3-8	Soil	Solitary		
Andrena	*cressonii*	3-8	Soil	Solitary		
Andrena	*distans*					
Andrena	*dunningi*	2-7 [8]	Soil	Solitary		
Andrena	*erigeniae*					
Andrena	*erythrogaster*	2-7	Soil	Solitary	Salicaceae	*Salix*
Andrena	*erythronii*	3-6	Soil	Solitary		*Erythronium*
Andrena	*forbesii*	4-6	Soil	Solitary		
Andrena	*frigida*	2-7	Soil	Solitary	Salicaceae	*Salix*
Andrena	*geranii*	4-7	Soil	Solitary		
Andrena	*helianthi*	7-9	Soil	Solitary	Asteraceae	
Andrena	*helianthiformis*					
Andrena	*hippotes*	4-6	Soil	Solitary		
Andrena	*hirticincta*	8-10	Soil	Solitary	Asteraceae	
Andrena	*illinoiensis*	3-7	Soil	Solitary		
Andrena	*imitatrix*	3-7	Soil	Solitary		
Andrena	*integra*	5-8	Soil	Solitary	Cornaceae	*Cornus (Svida)*
Andrena	*krigiana*	3-7	Soil	Solitary	Asteraceae	
Andrena	*lupinorum*	5-8	Soil	Solitary		
Andrena	*macoupinensis*					
Andrena	*mandibularis*	3-7	Soil	Solitary		
Andrena	*mariae*	4-7	Soil	Solitary	Salicaceae	*Salix*
Andrena	*melanochroa*	3-7	Soil	Solitary	Rosaceae	
Andrena	*milwaukeensis*	3-8	Soil	Solitary		
Andrena	*miranda*	5-8	Soil	Solitary		
Andrena	*miserabilis*	1-7 [8-9]	Soil	Solitary		
Andrena	*nasonii*	3-7	Soil	Solitary		
Andrena	*nigrae*	3-7	Soil	Solitary		
Andrena	*nigrihirta*	3-8	Soil	Solitary		
Andrena	*nivalis*	2-8	Soil	Solitary		
Andrena	*nubecula*	7-10	Soil	Solitary	Asteraceae	

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Appendix 1. Preliminary List of Minnesota Bees

Andrena	*nuda*					
Andrena	*peckhami*	9	Soil	Solitary	Asteraceae	
Andrena	*perplexa*					
Andrena	*persimulata*	4-7	Soil	Solitary	Cornaceae	*Cornus (Svida)*
Andrena	*placata*	7-9	Soil	Solitary	Asteraceae	
Andrena	*platyparia*	5-7	Soil	Solitary	Cornaceae	*Cornus (Svida)*
Andrena	*polemonii*					
Andrena	*quintilis*	4-7	Soil	Solitary		
Andrena	*regularis*	4-7	Soil	Solitary		
Andrena	*robertsonii*	4-8	Soil	Solitary		
Andrena	*robervalensis*					
Andrena	*rudbeckiae*	6-8	Soil	Solitary	Asteraceae	
Andrena	*rufosignata*	4-8	Soil	Solitary		
Andrena	*rugosa*	3-6	Soil	Solitary		
Andrena	*runcinatae*	7-10	Soil	Solitary	Asteraceae	
Andrena	*salictaria*	3-6	Soil	Solitary	Salicaceae	*Salix*
Andrena	*sigmundi*	5-7	Soil	Solitary	Salicaceae	*Salix*
Andrena	*simplex*	7-9	Soil	Solitary	Asteraceae	
Andrena	*spiraeana*	6-8	Soil	Solitary		
Andrena	*thaspii*	4-8	Soil	Solitary		
Andrena	*tridens*	3-7	Soil	Solitary		
Andrena	*vicina*	3-7 [8-9]	Soil	Solitary		
Andrena	*virginiana*	6-8	Soil	Solitary		
Andrena	*wellesleyana*	3-7	Soil	Solitary	Salicaceae	*Salix*
Andrena	*wheeleri*	4-7	Soil	Solitary		
Andrena	*wilkella*	4-9	Soil	Solitary		
Andrena	*w-scripta*	2-9 [10]	Soil	Solitary		
Andrena	*ziziae*	4-6 [7, 9]	Soil	Solitary		
Andrena	*wilmattae*	5-7	Soil	Solitary		
Calliopsis	*andreniformis*	4-10	Soil	Solitary	esp. Fabaceae	
Calliopsis	*coloradensis*	6-10	Soil	Solitary	Asteraceae	
Calliopsis	*nebraskensis*	6-9	Soil	Solitary	Verbenaceae	*Verbena*
Perdita	*albipennis*	6-9	Soil	Solitary	Asteraceae	*Helianthus*
Perdita	*bequaerti*	7-10	Soil	Solitary	Asteraceae	
Perdita	*bruneri*					
Perdita	*halictoides*					
Perdita	*maculigera*	3-7	Soil	Solitary	Salicaceae	*Salix*
Perdita	*octomaculata*	7-10	Soil	Solitary	Asteraceae	
Perdita	*perpallida*	7-8	Soil	Solitary		*Petalostemon*
Perdita	*swenki*	7-9	Soil	Solitary	Asteraceae	
Protandrena	*bancrofti*					
Pseudopanurgus	*aestivalis*	8-9	Soil	Solitary	Asteraceae	
Pseudopanurgus	*albitarsis*					

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Appendix 1. Preliminary List of Minnesota Bees

Pseudopanurgus	*andrenoides*	8-10	Soil	Solitary	Asteraceae	
Pseudopanurgus	*labrosus*	7-9	Soil	Solitary	Asteraceae	
Pseudopanurgus	*parvus*					
Pseudopanurgus	*pauper*	7	Soil	Solitary	Rhamnaceae	*Ceanothus*
Pseudopanurgus	*simulans*		Soil	Solitary	Asteraceae	
Sweat Bees -- Family Halictidae						
Agapostemon	*sericeus*	4-10	Soil	Solitary, Communal		
Agapostemon	*splendens*	4-8	Soil	Solitary, Communal		
Agapostemon	*texanus*	4-9	Soil	Solitary, Communal		
Agapostemon	*virescens*	5-10	Soil	Solitary, Communal		
Augochlora	*pura*	4-10	Wood	Solitary		
Augochlorella	*aurata*	4-10	Soil	Eusocial		
Augochlorella	*persimilis*	3-9	Soil	Eusocial		
Augochloropsis	*metallica*	3-11	Soil	Solitary		
Augochloropsis	*sumptuosa*					
Dieunomia	*heteropoda*	6-10	Soil	Solitary, Communal	Asteraceae	*Helianthus*
Dieunomia	*triangulifera*	8-10	Soil	Solitary, Communal		
Dufourea	*marginata*	6-9	Soil	Solitary	Asteraceae	
Dufourea	*monardae*	7-8	Soil	Solitary	Lamiaceae	*Monarda*
Dufourea	*novaeangliae*					
Halictus	*confusus*	4-10	Soil	Eusocial		
Halictus	*ligatus*	1-12	Soil	Eusocial		
Halictus	*parallelus*	3-8	Soil	Eusocial		
Halictus	*rubicundus*	3-9	Soil	Eusocial		
Lasioglossum	*acuminatum*	4-10	Soil	Solitary, Communal		
Lasioglossum	*admirandum*	3-9	Soil	Eusocial		
Lasioglossum	*albipenne*	5-9	Soil	Eusocial		
Lasioglossum	*anomalum*	5-9	Soil	Eusocial		
Lasioglossum	*athabascense*	4-10	Soil	Solitary, Communal		
Lasioglossum	*birkmanni*	4-9	Soil	Solitary		
Lasioglossum	*bruneri*					
Lasioglossum	*callidum*	3-10	Soil	Eusocial		
Lasioglossum	*cinctipes*	3-9	Soil	Eusocial		
Lasioglossum	*coeruleum*	3-10	Wood	Eusocial		
Lasioglossum	*comagenense*	6-7	Soil	Eusocial		
Lasioglossum	*coriaceum*					
Lasioglossum	*coriaceum*	3-10	Soil	Solitary, Communal		
Lasioglossum	*cressonii*	3-10	Wood	Eusocial		
Lasioglossum	*dreisbachi*	5-8	Soil	Eusocial		
Lasioglossum	*ellisiae*		Soil	Eusocial		
Lasioglossum	*ephialtum*	6-9	Soil	Eusocial		
Lasioglossum	*foveolatum*					
Lasioglossum	*foxii*	4-9	Soil	Solitary		

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Appendix 1. Preliminary List of Minnesota Bees

Lasioglossum	*hartii*	5-8	Soil	Eusocial		
Lasioglossum	*heterognathum*	4-9	Soil	Eusocial		
Lasioglossum	*imitatum*	4-10	Soil	Eusocial		
Lasioglossum	*inconditum*		Soil			
Lasioglossum	*laevissimum*	3-10	Soil	Eusocial		
Lasioglossum	*leucocomum*	5-8	Soil	Eusocial		
Lasioglossum	*leucozonium*	5-10	Soil	Solitary, Communal		
Lasioglossum	*lineatulum*	4-10	Soil	Eusocial		
Lasioglossum	*lustrans*					
Lasioglossum	*macoupinense*	6-7	Soil	Solitary		
Lasioglossum	*nelumbonis*	3-11	Soil	Solitary	Nymphaeales	
Lasioglossum	*nigroviride*					
Lasioglossum	*nymphaearum*	4-10	Soil	Eusocial		
Lasioglossum	*oblongum*	3-10	Wood	Eusocial		
Lasioglossum	*obscurum*	4-10	Soil	Eusocial		
Lasioglossum	*paradmirandum*	4-9	Soil	Eusocial		
Lasioglossum	*paraforbesii*	4-10	Soil	Solitary, Communal		
Lasioglossum	*pectinatum*					
Lasioglossum	*pectorale*	3-11	Soil	Solitary		
Lasioglossum	*perpunctatum*	4-9	Soil	Eusocial		
Lasioglossum	*pictum*	4-9	Soil	Eusocial		
Lasioglossum	*planatum*					
Lasioglossum	*platyparium*	10-11	[Soil]	Parasite	[Halictidae]	*[Lasioglossum]*
Lasioglossum	*pruinosum*	3-10	Soil	Eusocial		
Lasioglossum	*quebecense*	3-9	Soil			
Lasioglossum	*semicaeruleum*	8	Soil	Eusocial		
Lasioglossum	*subversans*					
Lasioglossum	*succinipenne*		Soil	Eusocial		
Lasioglossum	*swenki*		Soil	Solitary		
Lasioglossum	*testaceum*	7	Soil	Eusocial		
Lasioglossum	*texanum*	4-12	Soil	Solitary, Communal	Onagraceae	*Oenothera*
Lasioglossum	*truncatum*	3-10	Soil	Eusocial		
Lasioglossum	*versans*	4-10	Soil	Eusocial		
Lasioglossum	*versatum*	4-11	Soil	Eusocial		
Lasioglossum	*vierecki*	4-9	Soil	Eusocial		
Lasioglossum	*zephyrum*	3-10	Soil	Eusocial		
Lasioglossum	*zonulum*	4-10	Soil	Solitary, Communal		
Nomia	*melanderi*					
Nomia	*nortoni*					
Sphecodes	*atlantis*	5-9	[Soil]	Parasite		
Sphecodes	*banksii*	4-9	[Soil]	Parasite		
Sphecodes	*confertus*	3-8	[Soil]	Parasite		
Sphecodes	*coronus*	6-9	[Soil]	Parasite		

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Sphecodes	*cressonii*	1, 4-9	[Soil]	Parasite		
Sphecodes	*davisii*	5-10	[Soil]	Parasite		
Sphecodes	*dichrous*	4-9	[Soil]	Parasite		
Sphecodes	*fattigi*	4-8	[Soil]	Parasite		
Sphecodes	*galerus*					
Sphecodes	*heraclei*					
Sphecodes	*illinoensis*	5-10	[Soil]	Parasite		
Sphecodes	*johnsonii*					
Sphecodes	*levis*	5-8	[Soil]	Parasite		
Sphecodes	*mandibularis*	5-8	[Soil]	Parasite		
Sphecodes	*minor*					
Sphecodes	*pimpinellae*	5-9	[Soil]	Parasite		
Sphecodes	*prosphorus*	5-9	[Soil]	Parasite		
Sphecodes	*ranunculi*	4-7	[Soil]	Parasite		
Sphecodes	*solonis*	5-8	[Soil]	Parasite		
Melittid Bees -- Family Melittidae						
Macropis	*ciliata*					
Macropis	*nuda*	6-8	Soil	Solitary	Primulaceae	*Lysimachia*
Macropis	*patellata*					
Macropis	*steironematis*	6-7	Soil	Solitary	Primulaceae	*Lysimachia*
Leaf-cutter, Mason Bees -- Family Megachilidae						
Anthidium	*manicatum*	6-10	Cavity	Solitary		
Anthidium	*oblongatum*	6-10	Cavity	Solitary		
Anthidium	*psoraleae*	7	Cavity	Solitary		
Anthidium	*tenuiflorae*					
Ashmeadiella	*bucconis*					
Coelioxys	*alternata*	6-10	[Cavity]	Parasite		
Coelioxys	*banksi*	4-9	[Cavity]	Parasite		
Coelioxys	*bisoncornua*	7-9	[Cavity]	Parasite		
Coelioxys	*funeraria*	5-9	[Cavity]	Parasite		
Coelioxys	*immaculata*					
Coelioxys	*modesta*					
Coelioxys	*moesta*	5-9	[Cavity]	Parasite		
Coelioxys	*octodentata*	5-10	[Cavity]	Parasite		
Coelioxys	*porterae*	6-9	[Cavity]	Parasite		
Coelioxys	*rufitarsis*	4-10	[Cavity]	Parasite		
Coelioxys	*sayi*	3-10	[Cavity]	Parasite		
Coelioxys	*sodalis*	4-9	[Cavity]	Parasite		
Coelioxys	*texana*	3-11	[Cavity]	Parasite		
Dianthidium	*simile*	7-9	Cavity	Solitary		
Heriades	*carinata*	4-9	Cavity	Solitary		
Heriades	*leavitti*					
Heriades	*variolosa*	4-9	Cavity	Solitary		

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Hoplitis	*albifrons*	5-8	Pithy stems	Solitary		
Hoplitis	*pilosifrons*	4-7	Pithy stems	Solitary		
Hoplitis	*producta*	4-7	Pithy stems	Solitary		
Hoplitis	*spoliata*	4-8	Pithy stems	Solitary		
Hoplitis	*truncata*	4-8	Pithy stems	Solitary		
Megachile	*addenda*					
Megachile	*brevis*	3-12	Cavity	Solitary		
Megachile	*campanulae*	2-11	Cavity	Solitary		
Megachile	*centuncularis*	5-9	Cavity	Solitary		
Megachile	*dakotensis*	7-8	Ground?	Solitary		
Megachile	*fortis*	7-8		Solitary		
Megachile	*frigida*	6-9	Cavity	Solitary		
Megachile	*gemula*	4-8	Cavity	Solitary		
Megachile	*inermis*	6-9	Cavity	Solitary		
Megachile	*lapponica*	6-8	Cavity	Solitary		
Megachile	*latimanus*	5-10	Soil	Solitary		
Megachile	*melanophaea*	5-8	Soil	Solitary		
Megachile	*mendica*	5-10	Cavity	Solitary		
Megachile	*montivaga*	4-9	Cavity	Solitary		
Megachile	*nivalis*					
Megachile	*parallela*					
Megachile	*perihirta*					
Megachile	*pugnata*	6-9	Cavity	Solitary	Asteraceae	
Megachile	*relativa*	5-10	Cavity	Solitary		
Megachile	*rotundata*	6-9	Cavity	Solitary		
Megachile	*sculpturalis*					
Megachile	*texana*	6-8	Cavity	Solitary		
Osmia	*albiventris*	5-7	Cavity	Solitary		
Osmia	*atriventris*	4-7	Cavity	Solitary		
Osmia	*bucephala*	4-6	Cavity	Solitary		
Osmia	*caerulescens*	3-8	Cavity	Solitary		
Osmia	*collinsiae*	4-6	Cavity	Solitary		
Osmia	*conjuncta*	4-7	Cavity	Solitary		
Osmia	*distincta*	5-6	Cavity	Solitary		
Osmia	*felti*	6	Cavity	Solitary		
Osmia	*lignaria*					
Osmia	*nigriventris*		Cavity	Solitary		
Osmia	*proxima*					
Osmia	*pumila*	4-7	Cavity	Solitary		
Osmia	*sculleni*		Cavity	Solitary		
Osmia	*simillima*	5-8	Cavity	Solitary		
Osmia	*subarctica*					
Osmia	*tersula*	5-7	Cavity	Solitary		

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Osmia	*virga*	4-7	Cavity	Solitary	Ericaceae	
Paranthidium	*jugatorium*	7-9	Soil	Solitary		
Stelis	*coarctatus*	6-8	[Cavity]	Parasite	[Megachilidae]	
Stelis	*foederalis*	5-7	[Cavity]	Parasite	[Megachilidae]	
Stelis	*labiata*					
Stelis	*lateralis*	3-7	[Cavity]	Parasite	[Megachilidae]	
Stelis	*nitida*					
Stelis	*subemarginata*					
Trachusa	*zebrata*					
Cuckoo, Digger, Bumble, Honey Bees -- Family Apidae						
Anthophora	*bomboides*	3-8	Burrow	Solitary		
Anthophora	*terminalis*	5-9	Wood	Solitary		
Anthophora	*walshii*	7-8	Soil	Solitary		
Apis	*mellifera*	1-12	Hive	Eusocial		
Bombus	*affinis*	4-10	Hive	Eusocial		
Bombus	*ashtoni*	5-10	[Hive]	Parasite	[Apidae]	*[Bombus]*
Bombus	*bimaculatus*	2-9	Hive	Eusocial		
Bombus	*borealis*	5-10	Hive	Eusocial		
Bombus	*citrinus*	5-10	[Hive]	Parasite	[Apidae]	*[Bombus]*
Bombus	*fernaldae*					
Bombus	*fervidus*	4-10	Hive	Eusocial		
Bombus	*fraternus*					
Bombus	*frigidus*					
Bombus	*griseocollis*	2-10	Hive	Eusocial		
Bombus	*huntii*					
Bombus	*impatiens*	1-11	Hive	Eusocial		
Bombus	*insularis*	3-10	[Hive]	Parasite	[Apidae]	*[Bombus]*
Bombus	*melanopygus*					
Bombus	*pensylvanicus*	4-10	Hive	Eusocial		
Bombus	*perplexus*	4-10	Hive	Eusocial		
Bombus	*rufocinctus*	2-10	Hive	Eusocial		
Bombus	*sandersoni*	4-10	Hive	Eusocial		
Bombus	*suckleyi*					
Bombus	*ternarius*	4-10	Hive	Eusocial		
Bombus	*terricola*	4-10	Hive	Eusocial		
Bombus	*vagans*	5-10	Hive	Eusocial		
Bombus	*variabilis*					
Ceratina	*calcarata*	3-10	Pithy stems	Subsocial		
Ceratina	*mikmaqi*					
Epeolus	*autumnalis*	7-10 [6]	[Soil]	Parasite	[Colletidae]	*[Colletes]*
Epeolus	*bifasciatus*	2-9	[Soil]	Parasite	[Colletidae]	*[Colletes]*
Epeolus	*interruptus*					
Epeolus	*lectoides*					

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Epeolus	*minimus*					
Epeolus	*scutellaris*	6-10	[Soil]	Parasite	[Colletidae]	*[Colletes]*
Eucera	*atriventris*	3-8	Soil	Solitary		
Eucera	*belfragei*					
Eucera	*dubitata*	3-6	Soil	Solitary		
Eucera	*hamata*	4-8	Soil	Solitary		
Eucera	*rosae*					
Holcopasites	*calliopsidis*	5-10	[Soil]	Parasite	[Andrenidae]	
Melecta	*separata*					
Melissodes	*agilis*	5-11	Soil	Solitary	Asteraceae	
Melissodes	*bidentis*	7-8	Soil	Solitary	Asteraceae	
Melissodes	*bimaculatus*	2-10	Soil	Solitary		
Melissodes	*boltoniae*	7-11	Soil	Solitary	Asteraceae	
Melissodes	*communis*	3-9	Soil	Solitary		
Melissodes	*confusus*	8	Soil	Solitary	Asteraceae	
Melissodes	*coreopsis*	6-10	Soil	Solitary	Asteraceae	
Melissodes	*denticulatus*	5-10	Soil	Solitary	Asteraceae	
Melissodes	*dentiventris*					
Melissodes	*desponsus*	6-10	Soil	Solitary	Asteraceae	*Cirsium*
Melissodes	*druriellus*	5-11	Soil	Solitary	Asteraceae	
Melissodes	*gelida*					
Melissodes	*grindeliae*		Soil	Solitary	Asteraceae	
Melissodes	*illatus*	7-9	Soil	Solitary	Asteraceae	
Melissodes	*menuachus*	7-10	Soil	Solitary	Asteraceae	
Melissodes	*niveus*	7-10	Soil	Solitary	Asteraceae	
Melissodes	*rivalis*	5-10	Soil	Solitary	Asteraceae	*Cirsium*
Melissodes	*subagilis*			Solitary	Asteraceae	
Melissodes	*subillatus*	6-9	Soil	Solitary	Asteraceae	
Melissodes	*tinctus*	8-12	Soil	Solitary	Asteraceae	
Melissodes	*trinodis*	7-10	Soil	Solitary	Asteraceae	
Melissodes	*wheeleri*	4-10	Soil	Solitary	Asteraceae	
Nomada	*aquilarum*	7-8	[Soil]	Parasite		
Nomada	*articulata*	5-7	[Soil]	Parasite	[Halictidae]	*[Agapostemon]*
Nomada	*australis*	4-6	[Soil]	Parasite	[Halictidae]	*[Agapostemon]*
Nomada	*banksi*					
Nomada	*bella*	3-4	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*besseyi*	7-9 [4]	[Soil]	Parasite		
Nomada	*bethunei*					
Nomada	*cressonii*	4-7	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*cuneata*	6 [10]	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*depressa*	4-7	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*erigeronis*	5	[Soil]	Parasite		
Nomada	*fervida*	6-8	[Soil]	Parasite	[Halictidae]	*[Agapostemon]*

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Nomada	*florilega*					
Nomada	*gracilis*	4-6	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*illinoensis*	4-6	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*imbricata*	4-6	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*lehighensis*	4	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*lepida*	5-7	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*louisianae*	5	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*luteoloides*	4-7	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*maculata*	4-6	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*obliterata*	5-6	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*ovata*	5-6	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*perplexa*	6-7	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*pygmaea*	4-6 [8]	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*rubi*		[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*rubicunda*	5-7	[Soil]	Parasite		
Nomada	*sayi*	4-7	[Soil]	Parasite	[Andrenidae]	*[Andrena]*
Nomada	*vegana*					
Nomada	*vincta*	7-9	[Soil]	Parasite		
Peponapis	*pruinosa*					
Svastra	*obliqua*	4-11	Soil	Solitary		
Triepeolus	*concavus*	5-10	[Soil]	Parasite	[Apidae]	*[Svastra]*
Triepeolus	*cressonii*	6-10	[Soil]	Parasite		
Triepeolus	*distinctus*	5-10	[Soil]	Parasite	[Halictidae]	*[Dieunomia]*
Triepeolus	*donatus*	7-10	[Soil]	Parasite		
Triepeolus	*helianthi*	6-10	[Soil]	Parasite	[Apidae]	*[Melissodes]*
Triepeolus	*lunatus*	3-10	[Soil]	Parasite		
Triepeolus	*obliteratus*	7-10	[Soil]	Parasite		
Triepeolus	*pectoralis*	5, 7-11	[Soil]	Parasite		
Triepeolus	*rhododontus*	8	[Soil]	Parasite		
Triepeolus	*simplex*	7-8	[Soil]	Parasite	[Apidae?]	*[Svastra?]*
Xenoglossa	*kansensis*	6-9	Soil	Solitary	[Cucurbitaceae]	*[Cucurbita]*
Xenoglossa	*strenua*					
Xeromelecta	*interrupta*		[Soil]	Parasite	[Apidae]	

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Appendix 2. List of Problematic Bee Records in Minnesota

	Scientific Name
Plasterer, Yellow-faced Bees Family Colletidae	*Colletes mandibularis*
	Colletes validus
Mining Bees Family Andrenidae	*Andrena pruni*
	Perdita albipennis palidipennis
	Pseudopanurgus perlaevis
	Pseudopanurgus piercei
	Pseudopanurgus solidaginis
Sweat Bees Family Halictidae	*Agapostemon femoratus*
	Augochlorella gratiosa
	Lasioglossum cattellae
	Lasioglossum cephalotes
	Lasioglossum forbesii
	Lasioglossum nymphale
	Lasioglossum pilosum
	Lasioglossum tegulare
	Lasioglossum viridatum
	Sphecodes carolinus
	Sphecodes clematidis
	Sphecodes shawi
	Sphecodes stygius
Leaf-cutter, Mason Bees Family Megachilidae	*Stelis vernalis*
Cuckoo, Digger, Bumble, Honey Bees Family Apidae	*Bombus pascuorum*
	Ceratina dupla
	Epeolus banksi
	Eucera speciosa
	Nomada graenicheri
	Nomada luteola
	Nomada tiftonensis
	Triepeolus remigatus

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