A Citizen Science Study of Solitary Bees in Coon Fork State Natural Area (#313), Wisconsin, May-September 2010

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Acknowledgements

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Introduction

In 2010, Beaver Creek Reserve Citizen Science Center worked with citizen scientist volunteers to collect and identify native bees from the Coon Fork State Natural Area (#313). The goal of this project was to gain information about native bees in the west central region of Wisconsin; data about these valuable pollinators is sparse and not readily available. This study is viewed as a baseline for tracking the populations of important bee pollinators in this State Natural Area in the future and as the beginning of a broader native bee monitoring effort throughout the area.

Decline in Bee Population

Native and managed bees together provide approximately $112 billion in pollination services annually (Kearns et al. 1998). The current decline in managed honey bee (*Apis mellifera*) populations has increased awareness of the importance of pollination services provided by native bees. The species present and sustainable populations in western Wisconsin are not well known. Habitat loss, alteration, and fragmentation, pesticide use, and introduced diseases all contribute to declines of bees. However, these declines cannot be measured and appropriate management decisions to preserve and enhance native bee populations cannot be made without baseline data on naturally occurring populations. This project hopes to provide baseline data that can be expanded upon with future research. With the collection of data from this project, evidence can be built upon to document any declines in this areas native bee populations.

What are Solitary Bees?


Halicitidae *Agapostemon* (Sweat Bee)
Image Courtesy of www.cirrusimage.com

The majority of Wisconsin's native bees are solitary bees, which do not live in colonies, as do honey bees, but rather live as one bee per nest. A solitary bee, depending on the species, will build its nest by digging into the side of a bank, in sand, logs, dried reeds, wood, mud, or use existing holes. It will live for one season during which it will bring collected pollen and nectar that will serve as food for the developing young of the next warm season. The female lays her eggs in this nest during the summer, and dies shortly after. The eggs hatch and develop during the summer, feeding on the nectar and pollen left by the female. The young will pupate and remain in the pupil stage during the winter. The new bees will emerge with the first warm days of spring. Males hatch first, and once they have mated they will die, completing their life cycle. The females will either build or find a nest and the cycle will continue. Solitary bees tend to be smaller in size than bees that form colonies. They are usually only about a quarter of the size of bumble bees or smaller and are challenging to identify. Some solitary bees are very specific and will only pollinate certain flowers and certain flowers are pollinated only by specific bees. These

dependent relationships make healthy native bee populations a crucial factor in maintaining a stable ecosystem.

The Motivation behind the Project

In the spring of 2009, two volunteers, one a hobby beekeeper (Patrick Dotson) the other an avid citizen scientist (Judy Schwarzmeier) approached the Citizen Science Center staff concerned about pollinator populations in the area. It was known that honeybee populations were declining but not much was known about native bees, in particular "solitary bees" in the region. With guidance from Citizen Science Center staff, the two new bee volunteers spent the 2009 field season researching native bees and seeking the best collection method. The bee volunteers constructed various styles of bee "traps" and tested the traps to determine which method proved most successful. Bees were collected throughout the summer and fall.

Establishing the Study Site

At the end of the season collected bee specimens were prepared and the arduous task of bee identification began. Bee identification is extremely challenging and there are limited numbers of guides and professionals that are familiar with the intricacies of bee identification. Through the winter of 2009 the bee volunteers joined with Jodi Swanson, science researcher with the Citizen Science Center, at Beaver Creek Reserve. Jodi's Masters of Sciences is in Entomology from the University of Minnesota-Twin Cities. Her M.S. research involved the study of hygienic honeybees and provided her with extensive knowledge of bees. Jodi Swanson agreed to share her expertise and became the Lead Bee Researcher to guide this project.

Methods

The objectives for this study:

(1) Meet the needs of citizen science volunteers by providing access to a researcher with experience in bee identification.
(2) Collect data about native bees, from the Coon Fork State Natural Area (#313) for which pollinator information is lacking.
(3) Establish sampling protocols that could be implemented in a continuing effort to document the native bee populations in western Wisconsin.

Study Area

Coon Fork State Natural Area (#313) was chosen as the study area because it provides numerous types of "native bee-friendly" habitat ranging from open grass prairies and savannas to pine and oak barrens. Sandy soils, coarse woody debris, and upland prairie flora provide optimum habitat for native solitary bees. The Coon Fork State Natural Area was also the target of a 2009 BioBlitz where Beaver Creek Reserve Citizen Science Center staff and volunteers collected plant, small mammal, bird, and worm data.

In May 2010 the team established two 1-hectare plots at Coon Fork State Natural Area. Site #1 was a pine barren habitat characterized by prairie grass undergrowth and abundant coarse woody debris in the form of fallen trees and stumps. Prairie flowers were scattered throughout this site. Site #2 was a prairie/savanna habitat characterized by open expanses, prairie grasses, and abundant prairie flowers.

Bee Bowl with Catch

Field Methods

Two methods of collection were used; bee bowls and sweep netting, as explained in the following methodology. These two methods of sampling were employed to maximize the number of species collected and were done so in accordance with the protocols recommended in A Standardized Method for Monitoring Bee Populations – The Bee Inventory (BI) Plot by LeBuhn et al. Collections occurred once every two weeks between June and August for a total of seven sampling dates.

Bee Bowls

Within each site two 50 meter transects were established. Transects ran perpendicular to each other and intersected in the center of the plot. A single bee bowl was placed every 5 meters along both transects at each site for a total of 20 bee bowls per site. Bee bowls were simply PB6-0099 plastic Solo ™ cups painted fluorescent blue, yellow and white.

The cups were filled with a solution of Dawn dish detergent and water. This solution is made from a mixture of 1 tsp detergent to 1 gallon water or a 1:768 ratio detergent:water. The bees are attracted to the fluorescent colors of the bowls and the detergent breaks down the water surface tension so that the bees and other alighting insects sink and drown. Bowls were filled with the detergent solution prior to 9:00 am and collected after 3:00 pm the same afternoon, allowing bowls to be active for a minimum of 6 hours. Bees collected in the bowls were returned to the lab where they were gently rinsed until free of detergent, appropriately labeled and preserved in 70% ethanol until identified.

Sweep Netting
Image courtesy of Judy Schwarzmeier

Sweep netting

Sweep net collections occurred on the same day that bee bowls were deployed. Two surveyors walked over the entire sample area (separately) in meandering pattern sweeping an insect net through the vegetation continuously for 30 minutes apiece for a total of one hour of sampling at each site. Sweep net collections were carefully transferred to quart jars. Upon returning to the lab, the sweep net jars were placed in the freezer to kill the contents. The sweep net material was then sorted to remove debris and all bees were preserved in 70% ethanol until identified.

<u>Identification Process</u>

Bees were identified to the genus level using <u>The Bee Genera of North and Central America (Hymenoptera: Apoidea)</u> by C. Michener, R. McGinley and B. Danforth. A table of specimens identified to date follows below. Bee identification requires a high-powered microscope with a good light source to see minute details. As previously stated bee identification can be extremely challenging, identifying characteristics include the number and thickness of veins in the wings, the angles and size of the antennae and locators, and the placement of the legs as well as color and hair patterns. Some bee specimens were pinned and preserved as a collection for the Citizen Science Center and for future research. Picture examples with the common and scientific names of the bees identified are included with this report (Appendix A).

Halicitidae *Agapostemon* (Sweat Bee)
Image courtesy of www.cirrusimage.com

Species list of solitary bees collected and identified from Coon Fork State Natural Area 2010

Sampling Period - Date	Site	Bowl/Net	Halictidae *Augochloropsis*	Halictidae *Dieunomia*	Xylocopinae *Ceratina*	Halictidae *Agapostemon*	Colletidae *Colletes*	Apidae *Bombus*	Apidae *Anthophora*	Total
25-May	1	B								0
25-May	1	N								0
25-May	2	B	1				7			8
25-May	2	N						1		1
9-Jun	1	B	1				14			15
9-Jun	1	N	1	3						4
9-Jun	2	B					24			24
9-Jun	2	N			1		2			3
29-Jun	1	B								0
29-Jun	1	N								0
29-Jun	2	B	2		3		3			8
29-Jun	2	N			1		1			2
19-Jul	1	B	21		4		2		1	28
19-Jul	1	N	1					1	1	3
19-Jul	2	B	8							8
19-Jul	2	N	1					2		3
3-Aug	1	B	1		1		3			5
3-Aug	1	N	1							1
3-Aug	2	B		2	4		10			16
3-Aug	2	N			9		4	6		19
17-Aug	1	B	1							1
17-Aug	1	N					1			1
17-Aug	2	B	1		4					5
17-Aug	2	N	4				3	4		11
1-Sep	1	B	1				3			4
1-Sep	1	N								0
1-Sep	2	B	1	2	1	2	1			10
1-Sep	2	N								0
Total			46	7	28	2	78	14	2	177

Results

Bee Bowls (Appendix B)
The bee bowl collection method was the best method for collecting bees with 129 bees collected out of a total of 177 (73%). Halictidae *Augochloropsis* (sweat bee), *Agapostemon* (sweat bee) and Colletidae *Colletes* (cellophane/digger bee) had the highest numbers collected using the bee bowl method. *Agapostemon* was only collected using the bee bowl method and never by sweep netting.

Sweep Netting (Appendix C)
The sweep net collection method garnered 50 bees out of a total of 177 (28%). The bee that was most abundant in sweep net samples was Apidae *Bombus* (bumble bee). Fourteen bumble bees were collected using sweep netting methods but none were collected in bee bowls.

Site #1 (Pine Barren) (Appendix D)
There were 62 bees (35%) collected from Site #1. The bee species most abundant at Site #1 was *Augochloropsis* (sweat bee) and Apidae *Anthophora* (digger bee). The digger bee was only collected at Site #1.

Site #2 (Prairie/Savanna) (Appendix E)
Site #2 had higher bee activity with a collection of 115 (65%) bees. Xylocopinae *Ceratina* (carpenter bee), *Colletes* (cellophane/digger bee) and *Agapostemon* (sweat bee). *Agapostemon* was only collected at Site #2 and never in Site #1.

Discussion

The Citizen Science Study of Solitary Bees in Coon Fork Natural State Area (#313) could potentially impact the future study of bees over the coming years. This project will add valuable information to our knowledge about current solitary bee populations at Coon Fork State Natural Area. This knowledge can in turn be used to monitor changes in future populations. This project was also able to set sampling protocols to be used by citizen science volunteers in future studies on other properties.

This project was not completed without challenges. The main difficulty encountered during this project was the recruitment of volunteers. Throughout the course of the project there were only two volunteer citizen scientists and Jodi Swanson that could participate. Having only three participants made it challenging to set field days and to accomplish necessary work in the time allotted. Also, limited availability of sufficiently powerful microscopes restricted identification acquisition skills of the volunteers. These challenges notwithstanding, the team was able to complete the sampling within the time frame specified.

The second challenge was the relatively small sample sizes, making data insufficient to be statistically significant. With a larger sample size studies could potentially test which types of bees thrive best in which types of habitat. Data collected at Site #2, the prairie/savanna site may suggest that open prairie is a better habitat for most solitary bee species then a wooded area, but sample sizes were too small to test this hypothesis.

Future study goals include finding non-lethal collection methods, such as using cooling methods to keep the solitary bees alive. However, this would require identification of the bees in the field. At present, the expert skills are beyond the current abilities of our volunteers.

Identifying the flowers at collection site.
Image courtesy of Judy Schwarzmeier.

The project deliverables included a brief report about the data collected from the State Natural Area, which was shared with the Eau Claire County Forester, the DNR Forester, the Natural Heritage Program, the Besadny Foundation, and other interested groups. In addition, the bee specimens were preserved in perpetuity for use by future researchers and as a potential donation to an entomological collection.

Conclusion

The Citizen Science Study of Solitary Bees is adding valuable data to the scientific communities' knowledge of solitary bee populations at Coon Fork State Natural Area(#313) in particular and in west-central Wisconsin in general. The data collected may serve as a baseline for monitoring population changes in the future. Optimal sampling techniques were developed during this study. A combination of sweep netting and bee bowls proved to be successful for collecting bees. This information will be used as a model for future studies aimed at documenting solitary bee populations using citizen scientists along with the assistance of staff researchers at Beaver Creek Reserve.

Beaver Creek Reserve Citizen Science Center intends to continue monitoring populations of solitary bees in years to come. More volunteers will need to be recruited to assist in collection of bees, identification of bees and data entry. Funding will also be sought to assist in the continuation of the project. Future sites throughout western Wisconsin will be considered for future bee studies including the Henke Farm. The Henke Farm would provide a location where research could be conducted throughout future years, while allowing for exploring the effects of diverse habitats on the solitary bees at these sites. These studies could potentially help elucidate bee relationships to plant succession and the role of native bees in prairie establishment efforts.

Bees and other insect-pollinators (not including domestic honey bees) contribute approximately $3 billion to the United States economy with crops that they pollinate (Losey 2006). Also, many of the bees collected in this study are the primary pollinators of important food crops such as the muskmelon, tomato, strawberry, pepper and watermelon (McGlynn, Page 5). Without the superior pollination skills of these solitary bees, these crop yields could be significantly diminished, making the monitoring of their bee pollinators an economically important but neglected area of study.

Overall, the objectives of this project were met. Citizen science volunteers were provided access to a researcher with experience in bee identification, which helped them strengthen their own understanding and practice of bee identification. Data were collected about solitary bees, an important pollinator group, from the Coon Fork State Natural Area for which pollinator information is lacking and the team was able to use these data to establish a rudimentary baseline of bee populations present in this area. The team also developed sampling protocols that will be implemented in a continuing effort to document native bee populations in western Wisconsin.

Native and solitary bees have a significant impact on the environment. It is important to continue collecting data on these seemingly insignificant insects in order to develop a clear understanding of how human interactions with the bee's environment affect the bee's populations.

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Appendix A

Halicitidae *Augochloropsis* Sweat Bee (ground nester, diggers)	Halicitidae *Dieunomia* Sweat Bee (ground nester, rotten wood)
Image Courtesy of www.cirrusimage.com 	Image Courtesy of www.discoverlife.org Sheryl Pollock 
Xylocopinae *Ceratina* Carpenter Bee (rotting wood, hollow tubes)	Halicitidae *Agapostemon* Sweat Bee (ground nester, wood)
Image Courtesy of www.cirrusimage.com 	Image Courtesy of www.cirrusimage.com 
Colletidae *Colletes* Cellophane Bee, Digger Bee (ground, wood)	Apidae *Bombus* Bumble Bee
Image Courtesy of www.bugguide.net Jillian H. Cowles 	Image Courtesy of www.cirrusimage.com 
Apidae *Anthophora* Digger Bee (wood, rocks, ground)	Image Courtesy of www.cirrusimage.com 

Appendix B

Species list of solitary bees collected and identified from Coon Fork State Natural Area 2010
Bowls Only at Both Sites

Sampling Period - Date	Site	Bowl/Net	Halictidae *Augochloropsis*	Halictidae *Dieunomia*	Xylocopinae *Ceratina*	Halictidae *Agapostemon*	Colletidae *Colletes*	Apidae *Bombus*	Apidae *Anthophora*	Total
25-May	1	B								0
25-May	2	B	1				7			8
9-Jun	1	B	1				14			15
9-Jun	2	B					24			24
29-Jun	1	B								0
29-Jun	2	B	2		3		3			8
19-Jul	1	B	21		4		2		1	28
19-Jul	2	B	8							8
3-Aug	1	B	1		1		3			5
3-Aug	2	B		2	4		10			16
17-Aug	1	B	1							1
17-Aug	2	B	1		4					5
1-Sep	1	B	1				3			4
1-Sep	2	B	1	2	1	2	1			7
Total			38	4	17	2	67	0	1	129

Appendix C

Species list of solitary bees collected and identified from Coon Fork State Natural Area 2010
Sweep Nets Only at Both Sites

Sampling Period - Date	Site	Bowl/Net	Halictidae *Augochloropsis*	Halictidae *Dieunomia*	Xylocopinae *Ceratina*	Halictidae *Agapostemon*	Colletidae *Colletes*	Apidae *Bombus*	Apidae *Anthophora*	Total
25-May	1	N								0
25-May	2	N						1		1
9-Jun	1	N	1	3						4
9-Jun	2	N			1		2			3
29-Jun	1	N								0
29-Jun	2	N			1		1			4
19-Jul	1	N	1					1	1	3
19-Jul	2	N	1					2		3
3-Aug	1	N	1							1
3-Aug	2	N			9		4	6		19
17-Aug	1	N					1			1
17-Aug	2	N	4				3	4		11
1-Sep	1	N								0
1-Sep	2	N								0
Total			8	3	13	0	11	14	1	50

Appendix D

Species list of solitary bees collected and identified from Coon Fork State Natural Area 2010
Site 1 (Pine Barren)

Sampling Period - Date	Site	Bowl/Net	Halictidae *Augochloropsis*	Halictidae *Dieunomia*	Xylocopinae *Ceratina*	Halictidae *Agapostemon*	Colletidae *Colletes*	Apidae *Bombus*	Apidae *Anthophora*	Total
25-May	1	B								0
25-May	1	N								0
9-Jun	1	B	1				14			15
9-Jun	1	N	1	3						4
29-Jun	1	B								0
29-Jun	1	N								0
19-Jul	1	B	21		4		2		1	28
19-Jul	1	N	1					1	1	3
3-Aug	1	B	1		1		3			5
3-Aug	1	N	1							1
17-Aug	1	B	1							1
17-Aug	1	N					1			1
1-Sep	1	B	1				3			4
1-Sep	1	N								0
Total			28	3	5	0	23	1	2	62

Appendix E

Species list of solitary bees collected and identified from Coon Fork State Natural Area 2010
Site 2 (Prairie/Savanna)

Sampling Period - Date	Site	Bowl/Net	Halictidae *Augochloropsis*	Halictidae *Dieunomia*	Xylocopinae *Ceratina*	Halictidae *Agapostemon*	Colletidae *Colletes*	Apidae *Bombus*	Apidae *Anthophora*	Total
25-May	2	B	1				7			8
25-May	2	N						1		1
9-Jun	2	B					24			24
9-Jun	2	N			1		2			3
29-Jun	2	B	2		3		3			8
29-Jun	2	N			1		1			2
19-Jul	2	B	8							8
19-Jul	2	N	1					2		3
3-Aug	2	B		2	4		10			16
3-Aug	2	N			9		4	6		19
17-Aug	2	B	1		4					5
17-Aug	2	N	4				3	4		11
1-Sep	2	B	1	2	1	2	1			7
1-Sep	2	N								0
Totals			18	4	23	2	55	13	0	115