

**THE JUSTIFICATION AND DEVELOPMENT OF A
WISCONSIN NATIVE BEE EDUCATIONAL GUIDE**

A report submitted in partial fulfillment of the requirements for the degree

**MASTER OF SCIENCE
IN NATURAL RESOURCES – ENVIRONMENTAL EDUCATION**

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ABSTRACT

It is crucial people understand the indispensable ecological service native bees provide and recognize their responsibility to protect and promote this key pollinator. This research justified the development of a native bee educational guide for the La Crosse community. Rooted in recommendations from formal and non-formal educators, the researcher developed an educational guide designed for third, fourth and fifth graders. The lessons plans and educational materials within the guide were validated by educators' knowledge and suggestions. Each lesson attempts to galvanize an interest in native bees and empower students to take action to conserve native bee habitat. The guide was designed to be utilized by formal and non-formal educators alike and is appropriate for environmental education centers, afterschool programming, and summer school. Ideally, the native bee educational guide will diminish the fear and anxiety students often associate with bees and provide students and educators with resources to foster the conservation of La Crosse's native bees.

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TABLE OF CONTENTS

ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
Chapter I	1
Introduction	1
Statement of Problem	1
Sub-Problems	1
Hypothesis	2
Importance of Study	2
The Limitations	3
Definitions	3
Chapter II: Literature Review	5
The Decline of Pollinators.....	5
Native Bees	6
Instilling Responsible Environmental Behavior within Learners through Environmental Education.....	7
Protecting and Promoting Native Bees	9
Chapter III: Methodology	11
Sub-Problem 1	11
Sub-Problem 2.....	13
Sub-Problem 3.....	15
Sub-Problem 4.....	16
Chapter IV: Results	17
Sub-Problem 1	17
Sub-Problem 2.....	20
Sub-Problem 3.....	23
Sub-Problem 4.....	26
Chapter V: Conclusions and Recommendations	27
Conclusions	27

Recommendations	29
Works Cited	30
Appendix A: A Native Bee Educational Guide	32

Chapter I

Introduction

Statement of Problem

This research will assess the need and desire for a native bee educational guide to be used in formal and non-formal educational settings in La Crosse, WI. Appropriate content for such a guide will be identified, developed, and synthesized into a native bee educational guide crafted to instill knowledge and awareness on the importance of native bees.

Sub-Problems

- | | |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Sub-Problem 1 | Determine the need, desire, appropriate audience, structure, and content for a native bee educational guide in the La Crosse community. |
| Sub-Problem 2 | Identify exemplary native pollinator educational material to create a framework for a native bee educational guide. |
| Sub-Problem 3 | Determine best practices for effective environmental education in formal and non-formal settings. |
| Sub-Problem 4 | Develop a native bee educational guide. |

Hypothesis

The hypothesis is there is in fact a need for a native bee educational guide by the La Crosse community's environmental organizations and schools.

Importance of Study

The importance of this study stems from the need to conserve and promote native bees in the La Crosse community and beyond. Native bees play an important role in natural ecosystems by pollinating crop fields and flowers. Often, people, especially youth, think of the non-native honey bee when they think of pollinators. However, although the European honey bee is the most important crop pollinator in the United States, the quickly declining honey bee can no longer meet our country's pollination demands. Additionally, unlike the non-native honey bee, native bees evolved with their environment and are specialized in pollinating native flowers and cultivated flowers. Annually, it is estimated that native bees contribute to \$3 billion worth of crop pollination to the U.S. economy. Students must understand native bees are beneficial pollinators and provide good ecological services. This project attempts to (1) identify the need for a native bee educational guide (2) identify exemplary native pollinator educational material (3) determine best practices for effective environmental education in formal and non-formal settings and (4) develop a native bee educational guide which promotes awareness and knowledge on the importance of native bees to the environment.

The Limitations

- Limitation #1 The study will be limited to only using educational material on pollinators, specifically native bees.
- Limitation #2 The study will not predict the success of formal and non-formal educators implementing the educational guide.
- Limitation #3 The study will not predict any prior knowledge an individual may have regarding native bees.

Definitions

- Citizen Science The collection of data relating to the natural world by members of the universal public to be used in a collaborative study with professional scientists.
- Gratton Lab: A research lab within the Department of Entomology at the University of Madison-Wisconsin dedicated to promoting the conservation of healthy innovative science on insects and landscapes.
- Native Bee: A flying insect from the superfamily Apoidea known for their role in pollinating plants that are native to the same region.

Pollinator: Bees, butterflies and other animals which feed on flowers causing a transfer of pollen from plants of the same species, allowing for seed production.

Pollinator Partnership: The largest non-profit organization in the world dedicated to protecting and promoting native pollinators.

Xerces Society: A non-profit organization that advocates for invertebrates and their habitats by working with educators, citizens, scientists, and land managers on conservation and education practices.

Chapter II

Literature Review

This chapter reviews literature supporting (1) the decline of pollinators, (2) the importance of native bees, (3) the need to instill responsible environmental behavior in students through environmental education and (4) the need to protect native bees and promote their conservation. This literature will bolster the development of a native bee educational guide for the La Crosse, WI community.

The Decline of Pollinators

Native pollinators are crucial to our environment because they provide numerous ecological services. Two-thirds of the world's crop species depend on pollinators to reproduce. Common pollinators include butterflies, hummingbirds, bats, and some beetles. Unintentionally, pollinators move pollen from anther to stigma while feeding on nectar or pollen. In addition to feeding on nectar, bees gather the pollen and carry it with them, moving it from one flower to the next. Seventy percent of the world's flowering plants depend on the ecological pollination service (Spivak, Mader, Vaughan, & Euliss, 2011).

Recently, there have been significant declines in the diversity and abundance of insect pollinators. The decline in pollinators will likely have an impact on crop productivity and ecological biodiversity. This decline can be attributed to multiple factors including fragmentation and loss of natural habitat, decline in flower-rich plant

communities, modernizations in farming practices such as the use of chemical pesticides and fertilizers and the spread of pathogens and parasites (Wratten, Gillespie, Decourtye, Mader, & Desneux, 2012). It is crucial an effort is made to enhance native pollinator habitat.

A key pollinator is the non-native European honey bee responsible for pollinating a large portion of the crops and flowers in the United States. Due to the large amount of pollen required to sustain a colony, honey bees are continually collecting pollen and nectar while efficiently pollinating crops and flowers. However, the honey beekeeping industry is in a crisis. Since 1950 there has been a 50 percent drop in the number of managed honey bee colonies (Spivak, Mader, Vaughan, & Euliss, 2011). The decline in honey bees has been coined Colony Collapse Disorder (CCD). Honey bees have been used extensively by America's farmers for crop pollination. The decline in honey bees can be attributed modern agriculture practices. The use of pesticides and fertilizers has increased, diversity in crops has decreased and non-native honey bees have been left with a toxic and nutrient lacking diet. (Mader, Spivak, & Evans, 2010). Consequently, the role of native bees and other pollinators is now more important than ever.

Native Bees

There are an estimated 20,000 species of bees across the globe with around 4,000 native to the United States. Although the non-native European honey bee is the most important crop pollinator in the United States, the quickly declining honey bee can no longer meet our country's pollination demands. Therefore, native pollinators, such as native bees, are becoming even more valuable.

Long before the arrival of the European honey bee, native bees were pollinating North America's flowering plants. Native bees occur in many habitats, are active under a variety of conditions and are highly diverse. Unlike the non-native honey bee, the unique native insects have evolved with their environment and are often specialized to pollinate specific flowers such as pumpkins, cherries, blueberries, tomatoes, cranberries, and eggplant. Native bees contribute to pollinating 80% of flowering plants (Moisset & Buchmann, 2011). Annually, it is estimated that native bees contribute to \$3 billion worth of crop pollination to the U.S. economy (Vaughan & Mader, 2008). Furthermore, the pollination service native bees provide allows for the existence of numerous environmental services such as the persistence of multiple trophic level of the food web (Gilgert & Vaughan, 2011). It is crucial students understand the indispensable ecological service native bees provide and their responsibility to protect and promote this key pollinator.

Instilling Responsible Environmental Behavior within Learners through Environmental Education

Wisconsin requires schools to integrate an environmental education curriculum into every subject area, specifically the arts, health, science, and social studies (Department of Public Instruction, 2015). According to the Wisconsin Model Academic Standards for Environmental Education, "Many Wisconsin schools integrate environmental examples into some of their coursework, thereby fostering enthusiasm for science and other disciplines. Infusing environmental education throughout the K-12 curriculum increases classroom learning. Environmental education provides a vehicle for

engendering responsible citizenship, utilizing a variety of instructional models and guidelines that have been long accepted in the field of education” (Frontier, Grady, Lee, and Marinac, 1998). Among the first to investigate variables which seem to be associated with responsible citizenship behavior in environmental education were Drs. Harold Hungerford and Trudi Volk. They identified various critical educational components to students in becoming knowledgeable and skilled environmental stewards. In the past, it was believed students’ responsible environmental behavior was seeded by providing environmental knowledge (Ramsey and Rickson, 1977). Responsible environmental behavior can be defined using the Tbilisi objectives which include: awareness, sensitivity, attitudes, skills and participation. If students are informed on environmental issues and have a greater awareness of the environment they will more inclined to practice environmental stewardship. However, Hungerford and Volk suggest, “If environmental issues are to become an integral part of instruction designed to change behavior, instruction must go beyond an awareness of knowledge of these issues. Students must be given the opportunity to develop a sense of ownership and empowerment so that they are fully invested in an environmental sense and prompted to become responsible, active citizens” (Hungerford & Volk, 1990, p. 267). Ownership and empowerment variables are critical to responsible environmental behavior. Ownership variables embed importance of environmental issues at a personal level while empowerment variables build learners self-confidence to act on these issues.

Rooted in Hungerford and Volk’s recommendations, the native bee educational guide will ideally both provide knowledge and awareness on native bees and also

empower learners to take ownership of the conservation of native bees through activities such as planting a pollinator garden and constructing native bee houses.

Protecting and Promoting Native Bees

Recently, there have been significant declines in the diversity and abundance of insect pollinators. The decline in pollinators will likely have an impact on crop productivity and ecological biodiversity. This decline can be attributed to multiple factors including fragmentation and loss of natural habitat, decline in flower-rich plant communities, modernizations in farming practices such as the use of chemical pesticides and fertilizers and the spread of pathogens and parasites (Wratten, Gillespie, Decourtye, Mader, & Desneux, 2012). It is crucial that an effort is made to enhance native pollinator habitat.

Habitat enhancement for native pollinators on farmlands and surrounding landscapes provides numerous benefits for ecological communities such as improving soil and water quality, enhancing rural aesthetics, and increasing overall ecological fitness and biodiversity (Vaughan & Mader, 2008). Around 70% of bees nest in the ground. These ground-nesting bees require bare soils with full exposure to the sun. The remaining 30% of bees are cavity nesters and may nest in existing cavities left by other mammals and insects. (Gilgert & Vaughan, 2011). An ideal habitat for bees would consist of standing dead wood, overgrown vegetation, bare ground and logs. Additionally, a key element to good pollinator habitat is the abundance of diverse flowering plants.

Many opportunities exist for communities, such as La Crosse, WI, to be involved with improving native bee habitat. Construction of wooden boxes and blocks can provide additional cavity nesting bees with suitable habitat (Shepherd, 2013). Planting native flowers and shrubs is an easy and efficient way to attract native pollinators to the La Crosse community. The native bee educational guide will incorporate resources which provide useful guides to help determine appropriate steps to take while improving pollinator habitat.

The goal of this research is to develop an educational guide which educates the next generation of citizens on the importance of native bees and inspire them to participate in native bee preservation projects. Additionally, this guide hopes to dispel fear and negativity some students associate with bees. Above all, this guide will help raise educators and learners awareness on the importance of native bees and subsequently increase community involvement in improving local habitat for bees.

Chapter III

Methodology

This research is intended to develop an educational guide on the importance of native bees for students in the La Crosse community. This chapter outlines the methods that were used to assess needs, desire, audience, structure and content for a native bee educational guide, examine existing native bee educational material, identify best practices for curriculum design, and develop a native bee educational guide.

Sub-Problem 1: Determine the need, desire, appropriate audience, structure, and content for a native bee educational guide in the La Crosse community

First, the researcher determined a need and desire for such a guide by interviewing La Crosse's formal and non-formal educators. Data for developing the educational guide were gathered by interviewing environmental educators, elementary educators, and bee experts in the La Crosse community to assess their knowledge and suggestions for the target audience, appropriate content and structure for such a guide.

The researcher identified formal and non-formal educators in La Crosse based on their professional experience and place of work. In the spring and fall of 2014, informal, semi-structured interviews were conducted with seven formal educators from Summit Environmental School, Southern Bluffs elementary school, and Harry Spence elementary school; a local entomologist from the University of La Crosse Wisconsin; and a non-formal environmental educator from a nature center.

The educators selected were asked questions regarding their knowledge, opinions, and experiences with native pollinator educational material. The interviewees were asked the following questions:

1. Please list any educational material you know of which addresses native pollinators.
2. Please list any educational material you know of which addresses native bees.
3. What have you observed to be students' prior knowledge on native pollinators?
4. In developing a native bee educational guide, what do you believe are the key concepts which should be included?
5. Would you find a native bee educational guide to be useful in your classroom?

The one-on-one interviews with formal educators were conducted in-person and over the phone and lasted approximately twenty minutes each. Answers to interview questions were recorded by hand during the interview.

In May, 2014 the researcher attended a workshop on school gardens by Green and Healthy Schools Wisconsin held at Summit Environmental School in La Crosse, Wisconsin. At the workshop, some of Wisconsin's formal and non-formal educators gathered to share ideas and learn best practices on how school gardens can be incorporated into existing school programming. At this workshop the researcher gained an understanding of teachers' personal experience with incorporating environmental education topics, such as pollination, into their existing curricula by conducting two separate interviews with a first and fourth grade teacher, which lasted approximately fifteen minutes.

After all interviews were conducted, the researcher returned to the interview transcripts and selected relevant quotes and phrases from the interviews and coded them as propositions which were assessed and analyzed to identify similarities among interviewee responses. The researcher interpreted data by identifying trends in the interviewee responses. The interpretation of data was justified by research methods of Auerbach and Silverstein, who affirm that if the researcher's interpretation is "supported by the data, then it is valid, even if there are other ways to interpret the data" (Auerbach & Silverstein, 2003, p.31). Utilizing data, the researcher composed a list of fundamental recommendations for a native bee educational guide and best practices for the development of such a guide for the La Crosse community.

Sub-Problem 2: Identify exemplary native pollinator educational material to create a framework for a native bee educational guide

Existing pollinator educational material, resources, and scholarly work were identified, analyzed and evaluated to gain a broad understanding on the structure, format and content of existing educational materials and programs pertaining to native bees. Native pollinator educational materials from Pollinator Partnership, The Xerces Society, and the University of Wisconsin Madison's Landscape Ecology of Insects and Arthropods Lab were examined for this research.

To identify appropriate content for the education guide, the researcher contacted a pollinator specialist from the Xerces Society by email. The specialist directed the researcher to Xerces' online resource center for educators which contains online curricula, brochures, fact sheets, pocket guides and additional pollinator conservation

resources. Specifically, the specialist suggested the researcher look at the Xerces' Power of Pollinators online curricula.

Additionally, the researcher conducted a semi-structured, informal interview with a bee entomologist from the University of Wisconsin La Crosse. To determine what he saw as appropriate materials for the educational guide, the following questions were asked:

- Are you familiar with any native bee educational materials used by La Crosse educators?
- What do students need to promote and protect native bees?
- What is essential to include within a native bee educational guide?

Based off his recommendations, the researcher decided to incorporate a citizen science element into the educational guide. The researcher investigated and reviewed current citizen science projects focused on pollinator conservation.

Moreover, to acquire a better understanding for suitable educational materials for third, fourth and fifth graders, the researcher contacted the Wisconsin Center for Environmental Education Resource Center and was provided with a curriculum designed for the National Science Teachers Association entitled *Buzz into Action: The Insect Curriculum Guide for Grade K-4* by David Alexander. The researcher examined this curriculum guide for resources and lessons on pollinators, specifically native bees.

Additionally, the research investigated numerous sources to detect native bee educational materials specific to Wisconsin and identified pertinent resources from The Pollinator Partnership, Xerces Society, University of Wisconsin Madison's Landscape Ecology of Insects and Arthropods Lab. Literature and educational material from these sources was reviewed to glean pertinent information for the native bee educational guide.

Sub-Problem 3: Determine best practices for effective environmental education in formal and non-formal settings

The researcher investigated strategies and best practices for effective environmental education to determine a format for delivering knowledge on native bees and instilling a sense of awareness and empowerment on how students can promote and protect native bees.

In the spring of 2014, the researcher took the course Non-Formal Environmental Education Curriculum Development offered by the University of Wisconsin Stevens Point to study exemplary methods of curricula design. Additionally, to gain resources for effective environmental program design for formal and non-formal settings, the researcher took the course Field-based Science Inquiry for Environmental Education in January, 2015, offered by the University of Wisconsin Stevens Point. This course introduced the researcher to the Better Environmental Education Teaching, Learning, Expertise and Sharing (BEETLES) project. The BEETLES project is a series of professional development modules which provide effective activities and valuable program resources for environmental educators. The professional development modules include: Questioning Strategies, Promoting Discussion, Making Observations, Engaging Students in the Natural World, Gathering Evidence and Constructing Explanations and Assessing for Learning. The researcher was provided with cutting-edge tools and ideas for designing inquiry-based educational materials.

Sub-Problem 4: Develop a native bee educational guide

Grounded in knowledge, advice, opinions, experiences, existing educational materials and best practices for environmental education collected in sub-problems one, two and three, the researcher developed an educational guide.

The following criteria were used in creating the guide:

1. Instill a sense of responsibility to protect and promote native bees.
2. Demonstrate the connection between native bees and food.
3. Inspire a sense of civic responsibility for natural landscapes.
4. Empower students to contribute to a national movement to protect and promote native bees.
5. Dissolve possible fear and negativity associated with native bees.

Although this guide will be designed and tailored to meet the needs of La Crosse community educators, the content could be utilized by educators across the state to promote Wisconsin's native bees.

Chapter IV

Results

The overarching goal of this research was to develop an educational guide which provides educators with lesson plans, activities, and additional regional resources to educate students on the importance of native bees to the natural world. This chapter reveals the research results used to understand and determine the need and feasibility, appropriate audience, content and structure for such a guide within the context of La Crosse educators and students.

The following results are reported in regards to the sub-problems to gather, analyze and interpret data for the development of the educational guide. Throughout this section, key concepts and themes are supported by exemplary quotes where pertinent.

Sub-Problem 1: Determine the need, appropriate audience, and content for a native bee educational guide in the La Crosse community

The first interview conducted was with the lead naturalist at a La Crosse area nature center in late spring of 2014. The naturalist stated, “At this time, the nature center has pollinator programming on monarch butterflies for first and second grade students.” After analyzing the interview the researcher concluded:

- The nature center has pollinator programming for K-2nd graders but a lack of pollinator-programing for 3rd-5th graders.
- The nature center would be willing to house a native bee educational guide for formal and non-formal educators.

In early May, the researcher attended the Green Schools Gardening workshop at Summit Environmental School. A first grade teacher noted, “Students do not learn about pollination until third grade.” A fourth grade teacher said, “In terms of content, I would design something for fourth or fifth graders. You could create a richer and broader product for them because of their age.”

After analyzing the interviews with the first and fourth grade teachers, the researcher concluded:

- Due to the advanced topic of pollination, an educational guide on native bees is best suited for third, fourth, and fifth grade students.
- Currently, third, fourth, and fifth grade students do not receive educational materials on native bees.
- Teachers are willing to incorporate native bee educational materials into their existing curriculum.

The data collected from formal educators validated the naturalist’s suggestion to develop an educational guide tailored for third, fourth and fifth graders. As a result, in the fall of 2014, five semi-structured interviews were conducted with third, fourth, and fifth grade educators in the La Crosse School district. The interviews allowed the researcher to determine that a native bee educational guide is desirable and beneficial for teachers and students.

“I think that a resource guide on native bees would be useful for teachers and students.”

“Personally, I have little knowledge on native bees. What is the difference between native bees and honey bees?”

“I don’t know of any native pollinator curriculum being used in classrooms”

“[In terms of educational materials on native bees] we don’t have anything like that. Students may have some awareness on pollinators but they would’ve learned that outside of school.”

After observing and analyzing the interviews, the researcher concluded the following key concepts based on teachers responses to the interview questions:

1. Educational material that addresses native pollinators:
 - Teachers have experience with native pollinator programing regarding monarch butterflies.
2. Educational material that addresses native bees:
 - Teachers were not aware of educational programing which specifically addresses native bees as important pollinators.
 - Teachers had past experience with educational programing on non-native honey bees.
3. Students’ prior knowledge on native pollinators:
 - Students’ knowledge on pollinators varies from student to student.
 - If a student is aware of native bees, they likely received this information from sources outside the classroom.
 - Although some students understand bees pollinate flowers, most are not aware of the connection between bees and food.
4. Key concepts that should be included in the native bee educational guide:
 - The difference between honey bees and native bees
 - Native bees found in the La Crosse area

- Why bees are important to the food system
 - Threats posed to native bees
 - How students can help promote native bees
5. Usefulness of a native bee educational guide in the classroom:
- Teachers believed such a guide is important and would be very useful.
 - Some teachers mentioned recent required state testing placed pressure and time constraints on the academic day. Teachers no longer have autonomy and creativity in their classroom. They believed it would be nearly impossible to find time in their busy day.
 - Some teachers believed they could infuse the guide into academic subjects.
 - It was suggested the guide be used for afterschool or summer school programing.

In addition to these key findings, the researcher noted some educators were not familiar with native bees as pollinators and would benefit from supplementary educational materials.

Sub-Problem 2: Identify exemplary native pollinator educational resources to create a framework for a native bee educational guide

Based on the methodologies and criteria described in chapter III, the researcher determined exemplary educational materials for the educational guide. The Xerces Society, the Great Sunflower Project, the Pollinator Partnership, and the Gratton Lab provided exemplary and appropriate educational materials for the guide.

The Xerces Society's pollinator specialist recommended the *Power of Pollinators* online curricula developed cooperatively by the Xerces Society, The University of Wisconsin-Madison Center for Integrated Agricultural Systems, and The Ohio State University Bee Lab. *Power of Pollinators* provides educators with materials and resources to teach about pollination, pollinators, and student's role in pollinator conservation. This online curricula provides slides, notes and resources within three distinct modules: 1.) Why Pollinators Matter, 2.) Bee Biology and Identification and 3.) Gardening for Pollinators. Guided by teacher interviewees' recommendations to focus on the importance of pollinators and the difference between native bees and honey bees, the researcher believed this would be a useful tool to provide teachers with information on native bees. Instructions to access this online curriculum are provided in the educational guide.

The researcher conducted a formal interview with a bee entomologist at the University of Wisconsin La Crosse. He suggested including a citizen science monitoring component in the educational guide. He stated, "How little is understood on native bees as pollinators is a potential issue. It is important people recognize the impacts native foragers have on the land. Consider a citizen science experiment to connect students with their natural landscape." Informed by the expert's recommendation, the researcher investigated pollinator citizen science monitoring projects and selected the Great Sun Flower Project, the largest citizen science project focused on pollinators, as a primary resource for the educational guide.

The Great Sunflower Project is an online community of gardeners, beekeepers, birders and naturalists who contribute to a growing database by providing information about their local pollinators. Participants focus on a particular site or set of sites and

perform a pollinator count on any of the plants in that space. In time, observations reveal pollinator species in a given location, pollinator's plant preference and how seasonal changes in vegetation influence pollinator's food sources. The Great Sunflower Project will provide a platform for the native bee educational guide to contribute to a citizen science monitoring project on native bees.

Through methodologies described in chapter three, sub-problem three, the researcher evaluated *Buzz into Action: The Insect Curriculum Guide for Grades K-4*. This educational guide was designed for classroom teachers, homeschool educators, naturalist and camp leaders by environmental educator David Alexander. The lessons and activities within *Buzz into Action* provide an interdisciplinary approach to core subject areas and have been reviewed and tested by educators in both formal and informal learning environments. This guide provided the researcher with formatting suggestions and content to include for third, fourth and fifth graders.

Additionally, the researcher discovered “Nature’s Partners: Pollinators, Plants and You”, a curriculum on pollinators for third, fourth, fifth and sixth grade students. Lessons within this curriculum offer activities designed to engage learners in investigative science using the learning cycle. This curriculum was designed to educate on the connection between pollinators, people and food and inspire students to protect and promote pollinators. Therefore, the lessons and educational material within this curriculum served as an ideal resource for the native bee educational guide.

Lastly, the researcher identified and analyzed a native bee field guide specific to Wisconsin, the *Wisconsin Spring Bee Guide*. This guide was produced by the Grafton Lab at the University of Wisconsin-Madison to understand how land-use and agricultural

affect native bee diversity and abundance and how native bees contribute to Wisconsin's crop pollination. The Wisconsin Spring Bee Guide will provide an ideal educational tool for the native bee educational guide to inform students on native bees in the La Crosse area.

Sub-Problem 3: Determine best practices for effective environmental education in formal and non-formal settings

The Non-Formal Environmental Education Class introduced the researcher to curriculum development. Generally, learners have one dominant style of learning new information which may change from subject to subject. The researcher gained valuable knowledge and experience in designing curriculum to meet the needs of the visual, auditory, and kinesthetic learning styles.

Visual learners:

- Use visual aids such as graphs, illustration, and charts
- Outline the lesson on the board
- Write new vocabulary words and definitions on the board
- Have learners draw pictures or write stories

Auditory learners:

- Introduce new material with a short explanation of the lesson and conclude with a summary of what has been covered

- Use questions to encourage learners to reflect on personal knowledge and experiences
- Practice brainstorming, pair and share, and debrief activities

Kinesthetic learners:

- Use movement and hands-on activities
- Play music when appropriate
- Guide learners through a visualization of complex topics through stories or songs.

Lesson plans within the native bee educational guide incorporated the mentioned key teaching strategies to meet the needs of different learning styles.

Additionally, the Science and Inquiry-based Learning course increased the researcher's knowledge of best practices for teaching and learning environmental education programs.

The researcher acquired valuable approaches, activities and tools for an inquiry-based educational guide. The teaching and learning practices emphasized in this course focused on instilling a sense of curiosity and wonder to lead students to develop both a love for learning and the natural world. It is believed these practices will empower students to explore and care for their natural landscapes.

Based on this course, the researcher found that to design an educational guide which would foster inquiry-based learning the following teaching practices should be incorporated into the native bee educational guide:

The Learning Cycle: The Learning Cycle is a model developed by researchers and educators which represents the learning process in five distinct phases: invitation,

exploration, concept invention, application, and reflection. Lessons within the native bee educational guide were developed according to the Learning Cycle due the learner-centered and inquisitive approach to learning.

Foster a spirit of inquiry and investigation: Educators can set a tone of inquiry and exploration by encouraging students to consider what they know about native bees and share it with the class. To stimulate discussion and help students construct their own conceptual understandings, an educator can:

1. Ask a broad question
2. Listen to response and thinking
3. Ask for further explanation
4. Ask for other ideas and/or opinions
5. Ask a question circling back to the main question

Examples of questions and statements which invite students to make observations in the field, foster open discussion, and deepen their reasoning include:

- “What happens if...”
- “I wonder about...”
- “This reminds me of...”
- “What makes you think of...”
- “Can you give an example of...”

Encourage peer-to-peer talk: Educators can empower students to be responsible for the learning of their peers by encouraging students to pair and share experiences, ideas, questions, and knowledge. This peer-to-peer teaching and learning facilitates student-centered learning. Hopefully, this practice will help students make connections between

existing knowledge and the new topic and establish a culture where students feel empowered to teach their peers.

Sub-Problem 4: Develop a native bee educational guide

The native bee educational guide encourages multi-generational involvement in promoting and protecting the La Crosse community's native bees. Based on interviews and literature review, it was determined that the educational guide should introduce students and educators to native bees through inquiry-based, hand-on learning through five module lessons. The researcher adapted lessons from *Buzz Into Action: The Insect Curriculum Guide* and *Pollinators, Plants and You Curriculum*.

This guide will provide lessons and resources which ideally:

- Address the importance of pollinators, specifically native bees
- Eliminate misunderstanding and fear associated with bees
- Identify native bees of Wisconsin
- Distinguish between native bees and honey bees
- Instill awareness on the connection between bees and the food system
- Identify threats posed to native bees
- Provide tools for students to promote native bees

Although this guide is designed for La Crosse community educators, it can be modified and utilized by all formal and non-formal educators. Refer to Appendix A for the complete native bee educational guide.

Chapter V

Conclusions and Recommendations

The purpose of this research was to determine if there was a need for a native bee educational guide for schools and environmental organizations in the La Crosse community. The research confirmed the hypothesis that there was in fact a need for such a guide. Thus, the researcher designed and developed a native bee educational guide informed by formal and non-formal educators' recommendations. The lessons plans and educational materials within the guide were validated by educators' interview responses as stated in Chapter IV. This educational guide will ideally conserve native bees as pollinators by instilling awareness and knowledge on the important ecological services native bees provide and empower students to promote and protect native bee habitat. Refer to Appendix A for the complete native bee educational guide. What follows are conclusions on how to implement the guide in formal and non-formal educational settings and recommendations for further development.

Conclusions

The native bee educational guide is for both educators and students to learn about native bees. The researcher noted educators expressed an interest in personally learning more about the importance of native bees. Thus, prior to utilizing lessons and educational material within the guide, it is recommended educators first refer to the Xerces Society for Invertebrate Conservation's *Power of Pollinators* online curricula to increase knowledge and an understanding of native bees as pollinators.

The guide contains numerous opportunities for students to develop a sense of responsibility for protecting native bees. Activities such as planting a native pollinator garden and building native bee boxes will ideally empower and excite students about native bee conservation work. Moreover, a citizen science component, the Sun Flower Project, is embedded within the guide to allow students to contribute their work and knowledge to a national database. Hopefully, entitling students as citizen scientists inspires them to approach native bee conservation with curiosity, determination, and pride in their work.

The guide was designed to be used by formal and non-formal educators alike. Due to educators' limited time during the school day, this guide is flexible and can be easily modified. Lessons can stand alone or be used as whole. Additionally, the guide is appropriate for afterschool programming, summer school, homeschoolers, and environmental education centers.

Each lesson is designed to galvanize an interest in native bees and empower students take responsibility in protecting these pollinators.

Lessons within the guide include:

- Pollinators and Plants
- The Life of a Bee
- Native Bees and Honey Bees
- A Plate without Bees

Recommendations

The design and development of this guide was limited by time constraints to both expand and implement the guide. It is recommended that the guide be used as a starting point and platform for education on native bee pollinators. This educational guide could be more comprehensive if it contained additional lessons which complemented a classroom's curricula. For example, the lesson *Plants and Pollinators* could be supplemented by additional lessons and material on the topic of pollination. Additionally, each lesson could have Wisconsin Common Core state standards addressed to further embellish the guide and provide a way of assessing students' comprehension of material.

The use of materials found on the *Resources for the Protection and Promotion of Native Bees* is contingent on amount of available classroom time for the topic. If the guide were used during an afterschool program or summer school program, materials within this section should be explored with greater detail. The lessons within the guide could be expanded upon and used during Pollinators Week which happens every year in June.

At the very least, the native bee educational guide will illuminate bees in positive light and diminish the fear and anxiety student often associate with bees. Optimistically, this guide will encourage students to link native bees to flowers and food rather than bee stings and provide educators with resources to foster the conservation of La Crosse's native bees.

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Appendix A
A Native Bee Educational Guide

Introduction

The guide is for both educators and students to learn about the importance of native bee pollinators to the natural world. Each lesson is designed to galvanize an interest in native bees and empower students take action to conserve native bee habitat. The guide was designed to be used by formal and non-formal educators alike and is appropriate for afterschool programming, summer school, homeschoolers, and environmental education centers.

Resources to Protect and Promote Native Bees within the guide contain a wealth of information to educate on native bees and inspire students to conserve these important pollinators. Activities such as planting a native pollinator garden and building native bee boxes will ideally empower and excite students about native bee conservation work. Additionally, a citizen science component, the Sun Flower Project, is embedded within the guide to allow students to contribute their work and knowledge to a national database. Hopefully, entitling students as citizen scientists inspires them to approach native bee conservation with curiosity, determination, and pride in their work.

At the very least, the native bee educational guide will illuminate bees in positive light and diminish the fear and anxiety student often associate with bees. Optimistically, this guide will encourage students to link native bees to flowers and food rather than bee stings and provide educators with tools to foster the conservation of La Crosse's native bees.

This guide was developed by Ms. Rebecca Rand while she was in UW-Stevens Point Graduate Fellowship for Residential Environmental Education.

Pollinators and Plants

Lesson plan and resources for introducing the process of pollination and the connection between pollinators and plants

CLASS DESCRIPTION:

Total Time: 60 minutes

Audience: 3rd-5th grade students

Location: Indoors & Outdoors

GOALS:

1. To identify local pollinators and plants
2. To understand the partnership between pollinators and pollination

OBJECTIVES:

By the end of the lesson, students will be able to do the following:

1. List three different pollinators
2. Describe the process of pollination
3. Describe how the outdoors would look without pollinators

CLASS OUTLINE:

- I. **Invitation:** What do we know about plants and insects? (15 min)
- II. **Exploration Activity:** Outdoor Field Observation (20 minutes)
- III. **Concept Invention and Application:** Pollinator Partnership (15 minutes)
- IV. **Reflection:** Pollinators in your backyard (10 minutes)

BACKGROUND INFORMATION FOR TEACHER

The availability of pollinators is as important as moisture, sunlight, and soil fertility to the reproductive success of the world's flowering plants. Pollination is also vital to the well-being of humans. The most obvious example of our link to pollination is agriculture. Pollination, by managed honey bees and wild pollinators, is a key factor in the productivity of the seed, fruit, and fiber crops that we depend upon. Almost all fruit and grain crops require successful pollination in order to produce the harvested crop. While it is true that some very important agricultural crops, such as rice, corn, and wheat, are self- or wind-pollinated, the majority requires the services of pollinators. Over 150 food crops in the United States depend on pollinators and thirty percent of the food we eat is dependent upon pollinators for production!

INVITATION: WHAT DO WE KNOW ABOUT PLANTS AND INSECTS?

The purpose of this activity is to determine what students think right now about the relationship between flowering plants and insects, and to begin stimulating their curiosity. In this activity you will review what they already know about plants and insects and the interaction between them. Encourage peer-to-peer talk for students to share experiences, ideas, questions, and knowledge and establish a culture where students feel comfortable in group discussion.

Materials Needed:

- What Do We Know about Plants chart copied onto board
- Felt-tipped marker
- Plants and flowers

Getting Ready:

Prepare a large version of the *What Do We Know about Plants?* chart on white board. This will help organize the students' answers and be a visual learning tool of what they know and think about pollination at this point in their experience.

Activity:

1. Display the chart on the board.

Introduce activity: "We are going to be talking about how plants and certain insects depend on each other and why that is important".

2. Students brainstorm about all the plants they can name. Write the plant names on the chart. Prompt questions:

- What kinds of plants do you see in your yard? On the playground?
- Do you have vegetable gardens in your yard or neighborhood? What are some of the plants you see?

3. Identify characteristics of the plants listed, placing a "yes", "no", or "?" in the appropriate column

Prompt questions:

- Which plants have flowers?
- Which of these plants produce fruit or vegetables? At what time of year?
- Which of these plants have seeds? Where do we find the seeds?

4. Identify insects found near plants and flowers

Prompt questions:

- What insects do we see around these plants?
- Why do you think we see insects near plants?

- Which insects pay a lot of attention to flowers?
 - What time of the day do the insects have an interest in the flowers?
 - How do these plants and flowers help insects?
 - How do these insects help plants?
5. Transition to the next activity with the statement,
 “As we learn more about how plants and insects depend on each other, we will find answers to some of the things we were not sure about and learn new things about plants and insects”
- Transition questions:
- What do bees make you think of?
 - What do you feel when you see a bee?
 - How do you think bees help flowers and plants?

EXPLORATION: DISCOVERING THE PARTNERSHIP BETWEEN PLANTS AND INSECTS

In this activity participants will observe interactions between plants and insects and become familiar with the terms pollen, pollination, and pollinator. This activity will require a suitable area for field observation amongst plants and flowers. Students will be divided into small groups and assigned a 5'x5' square area to observe for 5-10 minutes. Volunteer adult helpers may be helpful to accompany students during the field observation.

Materials Needed:

- Nature’s Helpers: Pollinators and Plants Observation Sheet, 1 per participant
- Bee Courteous, Bee Safe Handout
- Enlarged copy of Nature’s Partners: Pollinators and Plant Group Observation Record
- Tape and markers

Observational Activity:

Prepare the participants to be good observers by discussing what they should be looking for.

Prompt questions for each team:

- What do you see the insects doing?
- What part of the flower do you see the insect on?

- How long does the insect stay on the flower?
- Does the insect visit the flower only once or do they return to the same flower several times?
- What do you think attracts the insects to the flowers?
 - What color is the flower?
 - What is the shape of the flower?
 - How would you describe the scent of the flower?
- What do you think the insects is doing on the plant?
- Is the insect helping the plant?

Have groups share their findings and record them on the enlarged version of the observation sheet. Reflect on their observations using the questions asked during the field observation activity.

CONCEPT INVENTION AND APPLICATION: POLLINATOR PARTNERSHIP

As a whole group, introduce, define, and discuss the flowing terms: pollen, pollination and pollinator

Prompt questions:

- How does the insect benefit from visiting flowers?
- What do you think the flowers and plants get from the insects?
- Who are the pollinators?
- Can a flower reproduce without an insect pollinator?
- What would happen if there were no pollinators?
- What is the insect doing when it visits many different flowers?

Refer to the Pollinators and Plants Group Observation Record they created and ask if they have any new questions or ideas about their observations.

REFLECTION: POLLINATORS IN YOUR BACKYARD

Have the students reflect on their observations and encourage them to make predictions about their observations.

- How do you think plants and pollinators, such as bees, are partners?
- Why do you think plants and pollinators, such as bees, are partners?

Ask students to write about their favorite pollinator. Provide them with following writing prompts:

- What is your favorite pollinator?
- Imagine the outdoors without this pollinator. What would it look like?
- Would we still have flowers?

- How can we make a healthy and happy home for pollinators?
Discuss planting flowers and/or a garden as a way for students to attract pollinators to their backyard.

REFERENCE MATERIALS:

This lesson plan was designed from Nature's Partners: Pollinators, Plant and You by the North American Pollinator Protection Campaign.

Refer to *Resources to Protect and Promote Native Bees* for additional activities and material.

The Life of a Bee

Lesson plan and resources for introducing students to the basics of native bees

CLASS DESCRIPTION:

Total Time: 60 minutes

Audience: 3rd-5th grade students

Location: Indoors & Outdoors

GOALS:

1. To provide a basic understanding of bees
2. To lessen fear associated with bees

OBJECTIVES:

By the end of the lesson, students will be able to do the following:

1. Describe what bees eat
2. Describe where bees live
3. Share the ideal habitat for a bee

CLASS OUTLINE:

- I. **Invitation/Exploration:**
What do we know about bees? (15 min)
- II. **Concept Invention:** An interview with a bee expert (20 min)
- III. **Application:** Basic needs of a bee (15 minutes)
- IV. **Reflection:** Ideal bee habitat (10 minutes)

BACKGROUND INFORMATION FOR TEACHER

Often times, students think of honey bees when they think of bees. However, there are an estimated 20,000 species of bees across the globe with around 4,000 native to the United States. These bees nest in the ground, in trees or in vegetation. Native bees are very important because they have co-evolved with our native plants and are specialized at pollinating them. Most students associate bees with stinging. However, native bees rarely sting because they do not live in colonies like the non-native honey bee.

INVITATION/EXPLORATION: WHAT DO WE KNOW ABOUT BEES

The purpose of this activity is to determine what students think right now about bees, and to begin stimulating their curiosity. In this activity you will review what they already know about bees. Encourage peer-to-peer talk for students to share experiences, ideas, questions, and knowledge and establish a culture where students feel comfortable in group discussion.

Begin with an introduction to bees:

“Bees are very important to the health of schoolyard gardens and habitats but are often-misunderstood creatures because they can sting. However, bees will only sting if they feel threatened because they are protecting their hive.

Bees pollinate more flowers than any other creatures on Earth as they collect nectar and pollen to nourish themselves and their young.”

Write the following questions on the board

1. How do bees eat?
2. What do bees eat?
3. Where do bees live?
4. How do bees travel?
5. When are bees awake?

Have students partner up and talk about the questions for five minutes. Then come back together for a whole group discussion on questions, recording students’ thoughts on the board.

CONCEPT INVENTION: AN INTERVIEW WITH A BEE EXPERT

In this activity a “bee expert” will visit the class. This individual could be another staff member, parent, or community member who has a basic understanding of native bees. This activity will serve as a fun and welcoming introduction to bees. You want to emphasize bees are not scary and are very important to our natural world.

1. Divide the class into 5 groups
2. Write the questions on notecards numbered 1-5 and distribute to groups accordingly
3. Each group will be responsible for asking the Bee Expert the question on their note card and recording the answer.
4. Once all questions are answered, ask the students to come up with a creative way of sharing this information with the class. This can be through a picture, a poem, or a play.

Questions for Bee Expert:

1. *How do bees eat?*

Bees use a feeding tube in their mouths called a proboscis (a long feeding tube) to get the sweet liquid called nectar from the flower.

2. *What do bees eat?*

Bees eat nectar and pollen from flowers. Nectar is a sweet liquid and pollen is a yellow powder found in flowers. Bees carry nectar and pollen back to their hive or nest. You can sometimes see yellow pollen on a bees back legs.

3. *Where do bees live?*

Many people think that bees only live in hives. However, only a small amount of bees build hives. In Wisconsin, the honey bee and bumble bee are the only bees to build hives. Most bees live in individual nests, in the soil, in vegetation or trees cavities.

The only bees in Wisconsin which live with other bees are the honey bee and bumble bee. All the other bees live alone. Therefore, they have no need to protect their hive and will rarely sting.

4. *How do bees travel?*

Bees fly with two pairs of wings and walk.

5. *When are bees awake?*

Bees are awake during the daytime and have good eyes to see the sun, trees, and flowers. They feel with their antennae and are attracted to bright colors.

CONCEPT APPLICATION: THE BASIC NEEDS OF A BEE

As a whole group, introduce, define, and discuss the basic needs of a bee: food and shelter.

Prompt questions:

- Do all bees prefer the same flower or plants?
- Can a flower reproduce without the help of a bee?
- Do all bees live in the same type of home?

Discuss with students that nectar and pollen from different flowers have different nutrient types. Some bees prefer one type of flower while others prefer another. A diversity of flowers in a garden will attract a diversity of bees! Just like we enjoy having a wide variety of foods, bees appreciate many types of flowers so they can have a diversity of nectar and pollen.

REFLECTION: THE PERFECT HOME FOR A BEE

1. Reemphasize bees are very important to our natural area and bees will only sting if they feel threatened to protect their home.
2. Remind students many bees do not live in hive boxes but instead in vegetation, trees and soil. Ask students to share their favorite fun fact they learned about bees today.

3. After sharing, have students draw the perfect bee home. What would it look like? What would surround the home? What does a bee need to be a productive, busy bee?
4. Display drawings on the wall or board to remind students what they learned about bees.

REFERENCE MATERIALS:

This lesson plan was designed from *Bee, Flowers and Pollination* by the National Gardening Association.

Refer to *Resources to Protect and Promote Native Bees* for additional activities and materials.

Native Bees and Honey Bees

Lesson plan for distinguishing between the non-native European honey bee and native bees

CLASS DESCRIPTION:

Total Time: 60 minutes

Audience: 3rd-5th grade students

Location: Indoors & Outdoors

GOALS:

1. To explain the difference between honey bees and native bees
2. To introduce students to native bees of Wisconsin
3. To empower students to promote native bees

OBJECTIVES:

By the end of the lesson, students will be able to do the following:

1. Describe how honey bees are different than native bees
2. List two native bees to Wisconsin
3. Describe how you can attract native bees to your backyard

CLASS OUTLINE:

- I. **Invitation:** What do we know? (15 min)
- II. **Exploration Activity:** Bee Ball cards (15 minutes)
- III. **Concept Invention and Application:** What is the difference between native and non-native bees? (15 minutes)
- IV. **Reflection:** Wisconsin Native Bees (15 minutes)

BACKGROUND INFORMATION FOR TEACHER

There are an estimated 20,000 species of bees across the globe with around 4,000 native to the United States. Many people are aware of the non-native European honey bee which is an essential pollinator in the United States. However, due to changes the modernization in agricultural practices, parasites, and a limited diet, honey bees are drastically declining. Native bee populations are also declining for reasons similar to honey bees. However, there are numerous ways to promote and protect these key pollinators. Educators can instill knowledge and awareness on the important ecological service native bees provide and simultaneously attempt to dissolve the misunderstanding that all bees sting and are bad. Hopefully, this change in perception of bees will foster native bee conservation.

INVITATION: WHAT DO WE KNOW?

The purpose of this activity is to determine what students think right now about native and non-native bees, and to begin stimulating their curiosity. Encourage peer-to-peer

talk for students to share experiences, ideas, questions, and knowledge and establish a culture where students feel comfortable in group discussion.

Getting Ready:

For this activity, you will write the words honey bee and native bees on the board.

Activity:

1. Ask students to talk with a partner about why a honey bee is not considered a native bee

Prompt questions:

- Where did honey bees come from?
- Do honey bees act the same way as native bees?
- Do honey bees have the same home as native bees?

2. Identify characteristics of native bees and honey bees

Prompt questions:

- Do native bees make honey?
- Do honey bees live with other bees? Do native bees live with other bees?

3. Transition to the next activity with the statement,

“As we learn more about the difference between honey bees and native bees, we will find answers to some of the things we were not sure about and learn new things about native bee pollinators”.

Transition questions:

- What is the first thing that comes to mind when you hear the word bee?
- What do you think of when you see a bee?
- How many different kinds of bees do you think live on our playground or in your backyard?

EXPLORATION: BEE BALL CARDS

This activity introduces students to the idea that there are many other kinds of bees, not just the honey bee. Educators should use Bee Ball cards found on *The Great Sun Flower Project's* homepage. Refer to the *Resources for Native Bee Protection and Promotion* within the guide for directions how to access these cards. The observe cards are designed to foster nature observation by providing key traits and techniques necessary for students to make scientific observations about native bees in the La Crosse area. Educators should use the cards as they see appropriate given time constraints and students' existing knowledge of native bees.

CONCEPT INVENTION AND APPLICATION: WHAT IS THE DIFFERENCE BETWEEN NATIVE AND NON-NATIVE BEES?

As a whole group, introduce, define, and discuss the following terms: native bee, non-native bee

Prompt questions:

- Where did the honey bee come from? Europe.
- Where did the carpenter bee come from? The mason bee? United States
- Do you notice similarities between the honey bee and other bees we observed on the cards?
- Does the mason bee live with other bees? Does the honey bee live with other bees?

You can print off pictures of Wisconsin Native bees from the *Spring Guide to Native Bees* which can be found on the *Resources to Protect and Promote Native Bees*.

REFLECTION: NATIVE BEE AND HONEY BEE

Review key differences between native bees and the honey bee using *Wisconsin Spring Bee Guide* to remind students of the many kinds of native bees found in the area

Read one of the following:

“The Bee Tree” by Patricia Polacco

“Buzzy the Bumble Bee” by Denise Brennan-Nelson

“Are you a Bee” by Judy Allen

REFERENCE MATERIALS:

Refer to *Resources to Protect and Promote Native Bees* for additional activities and materials.

A Plate without Bees

Lesson plan and resources for introducing students to the connection between food and bees

CLASS DESCRIPTION:

Total Time: 60 minutes

Audience: 3rd-5th grade students

Location: Indoors & Outdoors

GOALS:

1. To address the importance of bees to our food system
2. To instill awareness and knowledge on the ecological services bees provide

OBJECTIVES:

By the end of the lesson, students will be able to do the following:

1. List three fruits or vegetables that require a bee pollinator
2. Describe a landscape without bees

CLASS OUTLINE:

- I. **Invitation:** What do we know about bees and our food? (10 min)
- II. **Exploration:** The connection between bees and food (20 min)
- III. **Concept Invention & Application:** A world without bees (20 min)
- IV. **Reflection:** Give back to the bees (10 minutes)

BACKGROUND INFORMATION FOR TEACHER

Native pollinators are crucial to our environment because they provide numerous ecological services. Two-thirds of the world's crop species depend on pollinators to reproduce. Common pollinators include butterflies, hummingbirds, bats, and some beetles. Unintentionally, pollinators move pollen from anther to stigma while feeding on nectar or pollen. In addition to feeding on nectar, bees gather the pollen and carry it with them, moving it from one flower to the next.

There are an estimated 20,000 species of bees across the globe with around 4,000 native to the United States. Although the non-native European honey bee is the most important crop pollinator in the United States, the quickly declining honey bee can no longer meet our country's pollination demands. Therefore, native pollinators, such as native bees, are becoming even more valuable.

Long before the arrival of the European honey bee, native bees were pollinating North America's flowering plants. Unlike the honey bee, the unique native insects are often specialized to pollinate specific flowers such as pumpkins, cherries, blueberries, tomatoes, cranberries, and eggplant. Native bees contribute to pollinating a large

portion of flowering plants. It is crucial students understand the indispensable ecological service native bees provide and their responsibility to protect and promote this key pollinator.

INVITATION: WHAT DO WE KNOW ABOUT BEES AND OUR FOOD?

Group Discussion: Determine what students think right now about the connection between bees and their food. Review what they already know about bees as pollinators. Encourage peer-to-peer talk for students to share experiences, ideas, questions, and knowledge and establish a culture where students feel comfortable in group discussion.

EXPLORATION: THE CONNECTION BETWEEN BEES & FOOD

In this activity students will observe how much of our food depends on the pollination services provided by native bees.

Materials Needed:

Grocery bag full of food which required a bee pollinator such as apples, celery, cauliflower, coco, beans, strawberries, almonds, grapes, blueberries, strawberries, and much more!

Observational Activity:

1. Gather students around the table or sit in a circle on the floor. Remind them of the concept of pollination.
2. Explain that you want to see how good they are at identifying which food is produced by native bee pollination. Slowly take the food out of the grocery bag and ask students if they think the food required a native bee pollinator. As you go through the foods, students will catch on that all the food requires a native bee for pollination.
3. Discuss what it would be like if we did not have native bees in yards, gardens, and farms. What would our plates look like without native bees?

CONCEPT APPLICATION: A WORLD WITHOUT BEES

1. As a whole group, ask students to imagine a world without bee-pollinated plants.
2. Remind students that native bees not only pollinate food for people but also many other animals such as cows, pigs, and chickens.
3. Explain we are going to do an experiment to see what our plates would look like without bees. They will be “creative chefs” and are responsible for designing a menu in a world without bees.
4. Give students time to write their menus. When ready, ask for volunteers to share their menus.

5. Draw conclusions and develop statements about the need for native bee pollinators in our environment.

REFLECTION: GIVE BACK TO THE BEES

Have the students reflect on they have learned. Remind them bees provide us with tasty foods and we can provide bees with a healthy habitat. Ask students, “How would you help make a healthy home for native bees?”

REFERENCE MATERIALS:

This lesson plan was designed from Nature’s Partners: Pollinators, Plant and You by the North American Pollinator Protection Campaign.

Refer to *Resources to Protect and Promote Native Bees* for additional activities and materials.

The Great Sunflower Project

The Great Sunflower Project is an online community of gardeners, beekeepers, birders and naturalists who contribute to a growing database by providing information about their local pollinators. Participants focus on a particular site or set of sites and perform a pollinator count on any of the plants in that space. In time, observations reveal pollinator species in a given location, pollinator's plant preference and how seasonal changes in vegetation influence pollinator's food sources. The Great Sunflower Project can be used to show students how their good work in promoting native bees supports a national effort to conserve pollinators.

How to get started:

1. Visit the Great Sunflower Project website at: <https://www.greatsunflower.org/>
2. Create an account for the classroom. Here you will be provided with a variety educational tools on the topic of pollination.
3. Take the Habitat Assessment to make a plan to improve school site for pollinators.
4. Enter your classroom location and observation site. Here, you can show students the map of the United States which is dotted with other observations sites. It is a great way to show the students they are contributing to a national effort to promote native bees.
5. Select an area on the playground for students to observe. You can utilize Wisconsin Native. Spring Bee guide to help students identify bees.
6. Enter observation data. You can do this with or without students

Resources to Protect and Promote Native Bees

A collection of useful resources to educate students on the importance of native bees and inspire participation in native bee preservation projects.

Identifying Native Bees:

Guide to Wisconsin Native Bees

This online guide, by Rachel Mallginer from the Gratton Lab, is designed to help users identify wild bees commonly found in Wisconsin by their color, shape, size, and habitat. Students can learn to distinguish between different bee species and learn about the important role they play in agriculture and nature. The user can identify bees using picture matching or a dichotomous key.

Access the guide at:

<http://energy.wisc.edu/bee-guide/WI-Spring-Bee-Guide.pdf>

Bee Observer Cards:

A set of informational cards about bees created by Jessica Rykken for the Encyclopedia of Life. The cards can be printed off and used in the classroom to help students learn bee biology and identification. Access the cards through the Great Sunflower Project and download the cards at:

<https://www.greatsunflower.org/sites/default/files/Observer-Bees-ebook-EOL.pdf>

Bee Ball Cards:

A set of identification cards created by the Great Sunflower Project. Cards can be printed off, cut in half and sides glued together to create a set of learning cards to be used in the classroom. This set of cards is very informative, colorful, and easy to use. Each card provides information about different bee species' physical characteristics, food resources, and nests preferences. You must first create an account with the Great

Sunflower Project to access these cards. Download the cards at:

https://www.greatsunflower.org/system/files/registered/BeesMaster_home.pdf

Bee vs. Wasp

This is a slide show to help students learn the difference between bees, wasps, and flies. It is a very interactive and useful tool designed by the Great Sunflower Project. Access the slideshow at:

<https://www.greatsunflower.org/sites/default/files/How%20to%20tell%20a%20Bee.pdf>

Promoting Native Bee Habitat:

Selecting for Plants for Pollinators in Wisconsin

This guide, produced by the Pollinator Partnership, is a regional guide designed to provide information on how people can promote pollinators by planting gardens which provide essential habitat requirements for pollinators. Access the guide at:

<http://www.pollinator.org/PDFs/Guides/EBFContinentalrx13FINAL.pdf>

Planting a Pollinator Garden

The National Gardening Association has created the Kids Gardening organization. There are many useful resources for incorporating gardening into the classroom. Among them is *Creating a Pollinator Garden: Preserving a Precious Partnership*. This page provides information on why pollinator are important, what they need to survive, and how students can help create the perfect home for native bees.

Access gardening materials at:

<http://www.kidsgardening.org/classroom-projects/creating-pollinator-garde>

BeeSmart Pollinator App

This is a fun and easy way to quickly identify plants for pollinators in your area. You can browse through a database of nearly 1,000 native plants. Simply download the app at:

<http://pollinator.org/beesmartapp.htm>

Building Native Bee Boxes:

Constructing native bee boxes is a fun way to empower students to take ownership and responsibility of native bee conservation and connect with the community. This activity could be an afterschool activity or summer school project. The Xerces Society provides detailed instructions at:

http://www.xerces.org/wp-content/uploads/2008/11/nests_for_native_bees_fact_sheet_xerces_society.pdf

Recommended Books on Native Bees:

“The Bee Tree” by Patricia Polacco

“Buzzy the Bumble Bee” by Denise Brennan-Nelson

“Are you a Bee” by Judy Allen

Additional Resources for Educators

The *Power of Pollinators* online curriculum developed cooperatively by the Xerces Society, The University of Wisconsin-Madison Center for Integrated Agricultural Systems, and The Ohio State University Bee Lab provides educators with materials and resources to teach about pollination, pollinators, and student’s role in pollinator conservation. This online curricula provides slides, notes and resources within three distinct modules: 1.) Why Pollinators Matter, 2.) Bee Biology and Identification and 3.) Gardening for Pollinators.

Access this curriculum at:

http://www.xerces.org/wp-content/uploads/2008/09/PowerOfPollinators_lr_sec.pdf