ABSTRACT

DEVELOPING A POLLINATOR EDUCATION PROGRAM FOR METROPARKS OF BUTLER COUNTY

by Anna Jean Petroff

The MetroParks of Butler County, Ohio offers a wide variety of education programs, with topics ranging from pioneer life to recycling. In response to the recent decline in pollinator populations, MetroParks would like to update its current insect programming to include information about the pollinator decline. This report summarizes the research and methods I used to provide MetroParks with a new education program that teaches the importance of pollinators as part of a healthy ecosystem. After examining the current status of pollinator populations, I studied how to design an effective education program that incorporates Ohio Science Education Standards. Activities were selected to create a lesson plan structured around the Biological Science Curriculum Study’s 5E Instructional Model. The resulting BEE Program teaches students about what pollinators are, why they are important to our ecosystem, and ways humans can help their declining populations.
DEVELOPING A POLLINATOR EDUCATION PROGRAM FOR METROPARKS OF BUTLER COUNTY

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by
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DEVELOPING A POLLINATOR EDUCATION PROGRAM FOR METROPARKS OF BUTLER COUNTY

by

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1.0 Introduction

MetroParks of Butler County (MetroParks) owns and manages over 3,000 acres of park land throughout Butler County, Ohio (MetroParks, 2017a). MetroParks aims to maximize the community’s quality of life by providing a park system focused on recreation, conservation, and education (MetroParks, 2016). Ten parks, with unique natural features, important historical sites, and outdoor recreational areas, are open daily throughout Butler County (Figure 1) (MetroParks, 2017a; MetroParks, 2017b).

MetroParks recreational areas allow visitors to boat, fish, camp, kayak, hike, and play (MetroParks, 2017c). For example, Gilmore MetroPark’s wetland habitat provides habitat for breeding and migrating waterfowl, making it a popular destination for birders (MetroParks, 2017d; Audubon, 2017). Because of this, the 268-acre Gilmore MetroPark has been recognized as an Audubon Ohio Important Birding Area and is designated as a Watchable Wildlife Viewing Site by the Ohio Department of Natural Resources (ODNR) (ODNR, 2012; Audubon, 2017). MetroParks is also home to some of Butler County’s only public horse riding trails at Sebald MetroPark, which also provides hiking trails and fishing areas (MetroParks, 2017e).

At least 80% of MetroParks land holdings are managed in a way that preserves natural landscapes and increases native plant and wildlife diversity (MetroParks, 2016). Conservation initiatives at MetroParks promote the preservation and protection of drinking water sources, watersheds, wildlife habitat, important birding areas, and plant and animal diversity, while also educating the public about current conservation issues (MetroParks, 2017f). Some of these initiatives include controlling for invasive species and completing ecological restoration projects. The MetroParks Land Stewardship Unit uses prescribed fire, hand-pulling, herbicide application, and mechanical removal methods to remove invasive plants, which are non-native species that currently harm or are likely to harm the economy, environment, or human health (Exec. Order No. 13112, 1999; Dumyahn, 2017; MetroParks, 2017f). Current restoration projects include reforestation of areas previously infested with honeysuckle or dead ash trees by planting native shrubs (Dumyahn, 2017). The Land Stewardship Unit also recently converted 88 acres of row crops at Forest Run MetroPark into prairies, which is expected to have a positive impact on wildlife in the area (Dumyahn, 2017).

In accordance with its mission and conservation objectives, MetroParks has recently engaged in a cooperative conservation project with The Trust for Public Land, the Richard J. Fitton Family Foundation, Three Valley Conservation Trust, and the Ohio Public Works Commission for the
maintenance of Timberman Ridge, which is a part of the Forest Run MetroPark (MetroParks, 2017g). MetroParks has also recently acquired the former Weatherwax Golf Course in Middletown, Ohio with the intention of converting it into a natural area park for the public (Richter, 2015), by combining it with the adjacent Sebald MetroPark to create Elk Creek MetroPark. The old Weatherwax Golf course, now called the Meadow Ridge Area, is scheduled to open in 2018. The residents of Butler County hope to use the new park for hiking, horseback riding and sports events, such as cross country meets, triathlons, and equestrian events (Richter, 2015; Riva, 2016).

1.2 Education at the MetroParks

MetroParks offers a variety of free and fee-based educational programs for all ages (MetroParks, 2017c). In the spring/summer 2017, public programs include guided nature hikes and instructional classes/workshops in orienteering, fly fishing, stream biology, and birding (MetroParks, 2017h). The 4th annual BIG WEEK of Birding in Butler County, led by Miami University’s Dr. David Russell, is a week-long, free program that welcomes people of all ages and birding abilities to bird watch at different park locations throughout the week (MetroParks, 2017h). Another free program offered by MetroParks, Family Fun Fridays, is delivered in conjunction with local partners: Butler County Soil and Water Conservation District and Ohio State University Extension educators (MetroParks, 2017h). This program offers a different free program every Friday in June: Let’s Break it Down with Recyclers, We’ve got the Sun Power, Pollination Domination, and Connection with Food Chains (MetroParks, 2017h).

MetroParks also offers fee-based educational programs led by MetroParks educators and volunteers trained in natural and cultural history. Whole day (2-4 hours) and half day (1-2 hours) field trips occur at different park locations and focus on one of two subject areas: social studies & cultural history, or natural history & science. Hourly programs (1 hour) can be scheduled either at the park or off-site at the participating organization’s facility, such as a school or scout group meeting place. MetroParks offers programs for school age (grades K-5) and preschool age children covering a variety of topics ranging from pioneer life, to fossils, to recycling (Appendix I) (MetroParks, 2017c). The Insect Ecology program, for example, teaches students about insect body parts and their adaptations through examples and demonstrations. The teacher can request one of the following three topics to include in the Insect Ecology program: Stinky Bugs and Slimy Slugs, Bug Bites: Entomophagy, and Busy Bees: Pollinators.

These hands-on educational field trips and hourly programs are aligned with the Ohio Department of Education’s (ODE) Revised Science Education Standards and Model Curriculum (Science Standards) for PreK-8 and high school (MetroParks, 2017c). Adopted by ODE in July 2011, the Science Standards were informed by international and national studies and developed with input from educational stakeholders and academic content experts (ODE, 2011). These Science Standards describe the knowledge and skills that ODE believes all students should have in order to become scientifically literate (ODE, 2011). The Science Standards encourage inquiry-based teaching that develops “21st Century Skills,” which are skills that should allow each student to be prepared for higher education and workplace success in the twenty-first century (ODE, 2011; ORC 3301.079). 21st Century Skills include creativity and innovation, critical thinking, technological literacy, leadership, and real-world learning opportunities (ODE, 2011).
In evaluating its current educational program offerings, MetroParks has determined it would like to expand the existing insect programming. One reason is that in recent years, there has been a major decline in wild and managed pollinator populations (Williams and Osborne, 2009; Potts et al. 2010a; Steinhauer et al. 2014). This has gained significant attention for its ecological and economic ramifications (McGregor, 1976; Kearns et al, 1998; Ashman et al, 2004; Klein et al. 2007; National Research Council (NRC), 2007; Aizen and Harder, 2009; Aizen et al, 2009; Potts et al, 2010b; Brosi and Briggs, 2013; Obama, 2014; Steinhauer et al, 2014).

Many organizations, from federal and state agencies to non-profit groups, have been involved in conducting more research on the issue, as well as developing education programs to raise awareness and teach the public about actions they can take in their local community to counteract the decline (NRC, 2007; Obama, 2014; Pollinator Health Task Force (Task Force), 2015a; Task Force, 2015b; Pollinator Partnership, 2016a, Task Force, 2016; Xerces, 2017a). MetroParks would like to join these efforts by creating an education program that is fully dedicated to teaching the importance of pollinators as part of a healthy ecosystem.

1.3 Project Description

MetroParks offers a wide selection of education programs that cover topics ranging from pioneer life to recycling. In response to the recent decline in pollinator populations, MetroParks has determined that it would like to update the current insect programming to include information about the pollinator decline.

Project Goal

Develop a one-hour-long education program for preschool and K-5th grade children about the importance of pollinators as part of a healthy ecosystem, which adheres to the appropriate Ohio education standards.

Project Objectives

1. Understand pollination ecology and the status of pollinator populations in the U.S.
2. Research and understand how to design an effective education program that incorporates Ohio Science Education Standards.
3. Explore existing pollinator lesson plans and programs to determine the best models and activities.
4. Identify learning objectives and activities that are best suited for MetroParks.
5. Develop recommendations for effective implementation.

This report summarizes the research and methods I used to complete the project objectives and provide MetroParks with a new pollinator-education program, which I call the BEE Program, for PreK-5th grade students. Section 2 describes the importance of pollinators in a healthy ecosystem, the current status of pollinator populations, and current federal, state, and private actions being taken to address the population decline. Section 3 explains the methods used to develop the BEE Program objectives and activities. Section 4 provides an explanation of the BEE Program. Finally, Section 5 describes recommendations to help MetroParks implement the BEE Program in its parks and provides ideas for future enhancement.
2.0 Pollinators

2.1 Importance of Pollinators as part of a Healthy Ecosystem

Pollination, the process of moving pollen from the male part of a flower to the female part of a flower, is essential to plant reproduction (Merriam-Webster, 2017). This process can be facilitated by the wind or mechanical vibrations, but approximately 87.5% of global flowering plants rely on pollinating animals, such as honeybees, wild bees, moths, flies, wasps, beetles, butterflies, bats, and hummingbirds, to transfer pollen from one plant to the next (Ollerton et al. 2011).

Without insect and vertebrate animal pollinators, the majority of flowering plants would not receive proper amounts or types of pollen required for sexual reproduction, therefore reducing seed quality and quantity (e.g. Figure 2) (Ashman et al. 2004). Even the elimination of just one pollinating species has been shown to reduce plant reproduction success (Brosi and Briggs, 2013). Not only does this pollen limitation reduce reproductive success, but it also reduces the amount of food available for human consumption. Estimates show a potential 3-8% reduction in agricultural production in the absence of animal pollinators (Aizen et al. 2009).

Of the pollinators responsible for pollinating crops for human consumption, almost 96% are insects (Klein et al. 2007). Globally, insect pollination has been valued at approximately $182 billion (Potts et al. 2010a). In the United States, managed honeybees (Apis mellifera) alone are responsible for over $15 billion annually in fruit and vegetable crop pollination, including apples, oranges, onions, broccoli, berries, and almonds (Sass, 2011). Both wild and managed bees are critical to the production of many of the foods we eat and without them we risk losing most global fruit, vegetable, seeds, and commodity crop production (Klein et al. 2007; NRC, 2007). The key ecosystem service provided by bees maintains both wild plant communities and agricultural productivity (McGregor, 1976; Kearns et al. 1998; Ashman et al. 2004).

2.2 Pollinator Decline

In recent years, both wild and managed bee populations in the United States and Europe have been experiencing declines (Williams and Osborne, 2009; Potts et al. 2010b; Steinhauer et al. 2014). Proposed drivers of pollinator decline include land use/cover change, introduction of non-native species, viruses and pathogens, as well as pesticide, herbicide, and insecticide application (Williams and Osborne, 2009; Potts et al. 2010a).
**Wild bees**

Habitat fragmentation, loss, and degradation resulting from the anthropogenic conversion of natural pollinator habitat to agricultural fields or urbanized areas have led to decreased habitat complexity and resource diversity, causing declines in wild bee richness and abundance (Winfree et al. 2009). As distance to natural habitat increases, pollinator species richness has been shown to decrease as well (Ricketts et al. 2008).

Introduction of non-native species (including non-native plants, pollinators, pests, and pathogens) may also contribute to wild bee decline. Studies have shown that introduced animal-pollinated plants can decrease wild pollinator population growth through competitive displacement of the preferred host of the native pollinator (Traveset and Richardson, 2006). Introduced pollinators, including honeybees, may outcompete native pollinators and increase the risk of spreading pathogens, pests, and diseases throughout native populations (Williams and Osborne, 2009; Potts et al. 2010a).

**Managed bees**

While the managed honeybee, *Apis mellifera*, may outcompete native bees and is not native to the United States, it is critical to the production of at least 90 commercially grown crops (NRC, 2007). In recent years, beekeepers in the United States have reported substantial colony losses. In 2014, beekeepers reported an average winter colony loss of 44.8%, which is much higher than their acceptable average winter colony loss of 19.1% (Lee et al. 2015).

One of the explanations for the observed honeybee decline has been termed Colony Collapse Disorder (CCD) which is characterized by the loss of adult worker bees, the absence of dead bees in the hive, a small group of newly emerged bees tending a live queen, and pollen and honey stores in the hive (Johnson and Corn, 2015). CCD has been associated with a number of factors, including the *Nosema ceranae* pathogen, Israeli acute paralysis virus (IAPV), varroa mite, and pesticide use (Cox-Foster et al. 2007, Frazier et al. 2008; Higes et al. 2009; Stavely et al. 2014).

It is important to note, however, that CCD is not the reason for all honeybee mortalities (Williams et al. 2010, United States Environmental Protection Agency (US EPA), 2016). In many cases, these mortalities have been directly related to over exposure to pesticides, known parasites, and beekeeper management issues (Williams et al. 2010; US EPA, 2016). It is thought that a combination of parasites, disease, and pesticide exposure, along with decreased availability of floral resources due to land use/cover change, is responsible for the observed bee declines (Goulson et al. 2015).

**2.3 Addressing the Decline**

Local wild and managed pollinator scarcity, combined with other factors such as adverse weather, pesticide application, and mites, have caused reduced harvest quantity and quality of several different crops in certain years around the world, such as almonds (California), blueberries (New Brunswick), cherries (Ontario), alfalfa seed, pumpkins (New York), and cashew nuts (Borneo) (Allen-Wardell et al. 1998). Several approaches have been proposed to counteract some of the drivers of pollinator decline, including using best management practices...
when applying pesticides and planting pollinator-friendly plants on or at the border of agricultural and residential property (Obama, 2014). Besides enhancing pollinator diversity, there are several other benefits to improving pollinator habitat, including natural pest reduction, protection of soil and water quality through runoff mitigation, and prevention of soil erosion (Wratten et al. 2012).

**Federal Strategy to Promote Health of Honey Bees and Other Pollinators**

Recognizing the dire implications of the observed pollinator decline, Former President Barack Obama issued a presidential memorandum in June 2014, creating a federal strategy to promote the health of honeybees and other important pollinators. In this memorandum, President Obama established a Pollinator Health Task Force (Task Force), co-chaired by the United States Department of Agriculture (USDA) and Environmental Protection Agency (US EPA), the purpose of which is to develop a national pollinator health strategy including a pollinator research action plan, public education plan, and recommendations for developing public-private partnerships to help encourage the protection of pollinators (Obama, 2014). The presidential memorandum also called for Task Force members to create a plan to increase and enhance pollinator habitat (Obama, 2014). This directive states that the Task Force implement plans for the “application of pollinator-friendly best management practices and seed mixes” on Task Force member agencies “managed lands and facilities” (Obama, 2014).

In May 2015, the Task Force issued the National Strategy to Promote the Health of Honey Bees and Other Pollinators, hereafter referred to as Pollinator Strategy. The Pollinator Strategy identified the following overarching goals for pollinator health in the United States:

1. **Honeybee health**: Reduce honeybee overwintering mortality to 15% by 2025, which is approximately a 50% reduction of the mortality level experienced in hives in the U.S. at publication (Task Force, 2015a). The Task Force hoped to achieve this reduction in two stages by reducing losses to 22% in 5 years and another 15% in 10 years (Task Force, 2015a).

2. **Monarch butterfly conservation**: increase Eastern monarch butterfly populations to 225 million butterflies, covering approximately 15 acres in the overwintering grounds in Mexico by 2020 (Task Force, 2015a).

3. **Pollinator habitat conservation restoration, and enhancement**: Offset annual pollinator habitat losses by restoring and enhancing seven million acres of pollinator-friendly habitat (Task Force, 2015a). This includes providing new nectar and pollen resources by identifying habitats that are most valuable as pollinator resources (Task Force, 2015a).

To reach these goals, the Task Force created the Pollinator Research Action Plan and the Pollinator Partnership Action Plan as separate components of the Strategy:

- **Pollinator Research Action Plan (PRAP)**: Issued in May 2015, the PRAP outlines a plan for federally funded research on pollinator health. The PRAP distinguished ten research areas: status and trends; habitat, nutrition; pollinator pathogens and pests; pesticides and toxins; genetics, breeding, and biology; native plant development and deployment; economics; collections and informatics; and models, tools, and best practices (Task
Within these ten areas, the PRAP identified key research themes, existing research, and knowledge gaps for each (Task Force, 2015b). The PRAP also assigned roles to government agencies for planned priority actions for 2015 (Task Force, 2015b).

- **Pollinator Partnership Action Plan (PPAP):** Issued in June 2016, the PPAP supports the three overarching goals of the Strategy by outlining ongoing Federal partnerships, successful past partnerships, and priorities for future partnerships (Task Force, 2016).

The Strategy states that as more research becomes available, actions of the Task Force will undergo adaptive management to adjust to new information (Task Force, 2015a).

**Private organizations that promote pollinator health**

Private organizations are also dedicated to protecting pollinators through scientific research, on-the-ground conservation programs, and education programs. Two of the main nonprofit organizations in the U.S. that have the protection of pollinators as a specific goal are the Pollinator Partnership and Xerces Society.

**Pollinator Partnership**

Since their founding in 1997, the Pollinator Partnership has been devoted to promoting the health of pollinators through conservation, education, and research (Pollinator Partnership, 2016a). The Pollinator Partnership has funded over 30 research grants examining honeybee health, sponsored several scientific publications about pollinators, and is currently collecting data on native pollinators in the Gulf Coast and Northern Plains (Pollinator Partnership, 2016b). Pollinator Partnership’s website provides a Learning Center page with links to these studies, as well as other information, external resources, and news articles about a variety of topics (Figure 3) (Pollinator Partnership, 2016c). Each topic leads the reader to another page with further information and/or external links (Figure 4). For example, the Education learning portal provides useful links to pollinator education programs and curriculum, educational posters and books, learning activities, and other helpful links (Figure 4).

*Figure 3. Pollinator Partnership’s Learning Center resource page. SOURCE: www.pollinator.org/usefuleresources.htm*
In addition to cataloging helpful resources and information about pollination, the Pollinator Partnership also delivers many programs and initiatives, such as fundraising campaigns, online pesticide training modules, and school garden kits (Pollinator Partnership, 2016d). Three signature initiatives are the North American Pollinator Protection Campaign (NAPPC), Pollinator Week, and Ecoregional Native Planting Guides for Pollinators (Pollinator Partnership, 2016b).

NAPPC is a collaborative body of over 160 government, corporate, nonprofit, academic, and private partners that focuses on raising public awareness and educating the public to promote conservation, protection, and restoration of pollinator habitat (Pollinator Partnership, 2016e). Together with the Pollinator Partnership, NAPPC has created 36 ecoregional planting guides for the United States and Canada (Pollinator Partnership, 2016f). These guides are tailored to specific areas in the United States and Canada and provide information on plants and pollinators that are native to that area (Pollinator Partnership, 2016f). NAPPC is also responsible for initiating National Pollinator Week, a week in June that is dedicated to the celebration of pollinators (Pollinator Partnership, 2016g). The USDA and United States Department of the Interior have designated June 19-25, 2017 as National Pollinator Week.

Figure 4. Examples of information provided by Pollinator Partnership in the Learning Center portal. Left, detailed information about bee issues; Right, a list of useful resources about education. SOURCE: www.pollinator.org/education, www.pollinator.org/beeissues.
Since 1971, The Xerces Society for Invertebrate Conservation has strived to protect “wildlife through the conservation of invertebrates and their habitats” (Xerces Society, 2017a). Xerces Society researches, advocates, and educates about a number of conservation issues, including habitat conservation and restoration, species conservation, pollinator protection, watershed health, and pesticide use (Xerces Society, 2017a). Its website provides a variety of information, such as links to books, educational brochures, scientific research, and news articles relevant to its conservation interests to share with the public.

In 2008, Xerces Society started the Pollinator Conservation Program, which provides support for farmers, gardeners, land managers, and others who are interested in habitat restoration and land management for pollinators (Xerces Society, 2015). Through this program, Xerces Society translates scientific research on pollinator conservation, habitat restoration, and biological pest control into conservation policy and practice (Xerces Society, 2015). As part of this conservation program, Xerces Society established the Bring Back the Pollinators Campaign, asking the public to sign a pledge to protect pollinators and their habitats using four simple steps (Figure 5) (Xerces Society, 2017b). Xerces Society also provides a Pollinator Conservation Resource Center that directs the user to region-specific information about recommended pollinator plants, planting guides, native pollinator plant nurseries, bee identification, and pollinator policy (Figure 6) (Xerces Society, 2017c).

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**Figure 5.** Four simple steps to bringing back the pollinators. **SOURCE:** xerces.org/bringbackthepollinators
Xerces Society also provides online resources for educators, including guidelines, fact sheets, and other resources developed by Xerces Society staff, links to online curricula from other organizations, and information about citizen science monitoring projects (Xerces Society, 2017d).
3.0 Developing the BEE Education Program for MetroParks of Butler County

This section describes the process I used to develop the BEE Program for the MetroParks. Before creating the BEE Program, I examined the Ohio Revised Science Education Standards and Model Curriculum (Science Standards), researched relevant educational theory and instructional methods, and reviewed ten lesson plans to understand the best format and content ideas.

3.1 Incorporating Ohio Revised Science Education Standards and Model Curriculum

To satisfy the client’s request, I incorporated The Ohio Department of Education’s Revised Science Education Standards and Model Curriculum (Science Standards) into the BEE Program. The Science Standards serve as a basis for what all students in Ohio should know and be able to do by the end of high school. These standards apply to grades PreK-8 and high school, although there are no specific standards for Pre-K. Upon high school graduation, students should be proficient in the following tasks:

- “Know, use, and interpret scientific explanations of the natural world;
- Generate and evaluate scientific evidence and explanations, distinguishing science from pseudoscience;
- Understand the nature and development of scientific knowledge;
- Participate productively in scientific practices and discourse” (ODE, 2011).

The Science Standards are organized into three disciplines: Earth and Space Science, Physical Science, and Life Science. Each of these disciplines has a specific topic at every grade level, which explains the main focus for educational content at that level (Table 1). For example, in the Life Science discipline, each grade level covers different aspect of life science, such as behavioral traits of living things in Kindergarten and basic needs of living things in Grade 1 (Table 1).

Table 1. Ohio Revised Science Education Standards for Life Science topics and descriptions of each topic (ODE, 2011)

<table>
<thead>
<tr>
<th>Grade Level and Life Science (LS) Topic</th>
<th>The topic focuses on:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kindergarten:</strong> Physical and Behavioral Traits of Living Things</td>
<td>Observing, exploring, describing, and comparing living things in Ohio</td>
</tr>
<tr>
<td><strong>Grade 1:</strong> Basic Needs of Living Things</td>
<td>The physical needs of living things. Energy from the sun or food, nutrients, water, shelter, and air are some of the physical needs of living things</td>
</tr>
<tr>
<td><strong>Grade 2:</strong> Interactions within Habitats</td>
<td>How ecosystems work by observations of simple interactions between the biotic/living and abiotic/nonliving parts of an ecosystem. Just as living things impact the environment in which they live, the environment impacts living things</td>
</tr>
<tr>
<td><strong>Grade 3:</strong> Behavior, Growth, and Changes</td>
<td>Explores life cycles of organisms and the relationship between the natural environment and an organism’s traits, which affect its ability to survive and reproduce</td>
</tr>
<tr>
<td><strong>Grade 4:</strong> Earth’s Living History</td>
<td>Using fossil evidence and living organisms to observe that suitable habitats depend upon a combination of biotic and abiotic factors</td>
</tr>
<tr>
<td><strong>Grade 5:</strong> Interactions within Ecosystems</td>
<td>Foundational knowledge of the structures and functions of ecosystems</td>
</tr>
</tbody>
</table>
Stemming from these general topics and the goals for each grade, the Science Standards provide a very specific standard for each grade to achieve. These are called the condensed content standards. The sampling of condensed content standards in Table 2 are the ones I felt are most relevant to the program I was asked to develop.

Table 2. Life Science condensed content standards achieved by BEE Program

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>LS Condensed Content Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>Living things have physical traits and behaviors, which influence their survival</td>
</tr>
<tr>
<td>Grade 1</td>
<td>Living things have basic needs, which are met by obtaining materials from the physical environment Living things survive only in environments that meet their needs</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Living things cause changes on Earth</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Plants and animals have life cycles that are a part of their adaptations for survival in their natural environments</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Changes in an organism’s environment are sometimes beneficial to its survival and sometimes harmful</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Organisms perform a variety of roles in an ecosystem</td>
</tr>
</tbody>
</table>

3.2 Inquiry-based Teaching and the 5E Learning Cycle

Scientific inquiry is a key overarching concept in the Science Standards, which allows students to develop skills in systematic discovery by observing and asking questions about the natural environment (ODE, 2011).

Inquiry-based learning broadly refers to 1) the processes used by scientists to study the natural world and provide explanations based on evidence derived from their work, and 2) the activities of students during which they develop knowledge and understand scientific ideas (NRC, 1996). More specifically, an inquiry-based learning approach requires students to engage themselves in actual scientific practices rather than merely learning about them through lecture (NGSS Lead States, 2013).

The inquiry cycle

Research has shown that science learning is a cumulative process that is linked to prior knowledge and experience, interest, and motivations (Dierking et al. 2003; Falk and Storksdiek, 2005; Bybee, 2006). Learning occurs when a student is allowed to develop his or her own understanding of a concept over time by connecting prior knowledge and experience to the current learning situation (Falk, 2005; Bybee, 2006). This process of developing, testing, and applying ideas is referred to as the inquiry cycle (Figure 7).

As explained by Feinsinger (Figure 7), every scientific inquiry begins with the student making an observation of his or her surroundings, which they place in context of a broader concept or previous experience (Feinsinger, 2001). Placing this observation in context engages the student to develop a question about his or her surroundings

Figure 7. The simple inquiry cycle, as proposed by Peter Feinsinger. SOURCE: Feinsinger, 2001
The next step of the inquiry cycle is to take action to answer the question. This usually results in findings or data that provides a specific answer to that particular question (Feinsinger, 2001). The third step, reflection, requires the student to evaluate the significance and validity of their findings in relation to the original question (Feinsinger, 2001). After thorough reflection, the fourth and final step is for the student to apply his or her findings to a larger scale and at future times (Feinsinger, 2001). This requires the student to generalize his or her results to phenomena that might happen or have already happened in another place or at another time (Feinsinger, 2001).

**The 5E instructional model**

Since 2002, ODE has encouraged teachers to incorporate scientific inquiry by using an instructional model called *The 5E Instructional Model (5E’s)*, developed by the Biological Science Curriculum Study (Bybee et al. 2006; ODE, 2011). This instructional model focuses more on understanding and less on the memorization of facts and definitions (Bybee, 2006). The 5Es, which are widely used in both formal and informal science education, provide instructors with the framework required to guide students through the inquiry cycle by framing their own questions, interpreting data, creating explanations, and critiquing explanations (Bybee et al. 2006; Primary Connections, 2008; ODE, 2011). The five E’s include: *Engage, Explore, Explain, Elaborate*, and *Evaluate*. These steps are explained below:

**Engage:** Generate interest and spark curiosity in a new concept by making connections between past and present learning experiences (Bybee, 2006; Bybee et al. 2006; Primary Connections, 2008). In this phase, the instructor establishes a context for the new material and encourages students to raise questions for inquiry (Primary Connections, 2008). This can be done through open questions, drawing, or acting out understanding, but can also be done through storytelling, short anecdotes, or song with younger children (Primary Connections, 2008; Robinson, 2017).

**Explore:** Provide students with a common experience of the phenomenon or concept being discussed (Bybee, 2006; Bybee et al. 2006; Primary Connections, 2008). During this phase, students may actively manipulate materials or explore their environment to discover and develop concepts, processes, and skills (Bybee, 2006).

**Explain:** Focus students on a specific aspect of their experiences in the Engage and Explore phases (Bybee, 2006; Bybee et al. 2006). In this phase, the instructor provides opportunities for students to communicate their new conceptual understandings and demonstrate their skills (Bybee, 2006; Bybee et al. 2006; Primary Connections, 2008). The instructor may also introduce formal terms or definitions in this phase (Bybee, 2006).

**Elaborate:** Challenge and extend students’ conceptual understanding in new contexts (Bybee, 2006; Primary Connections, 2008). In this phase, students develop a deeper understanding by conducting additional activities (Bybee, 2006; Bybee et al. 2006).
Evaluate: Provide an opportunity for students to reflect on their own learning and assess their understanding (Bybee, 2006; Primary Connections). This phase also provides instructors with the opportunity to assess student progress (Bybee, 2006).

Based on the MetroParks of Butler County’s interest in meeting ODE’s Science Standards, I structured my lesson plan using the 5E instructional model, which is compatible with the ODE’s Scientific Inquiry/Learning Cycle (Figure 8). The ODE Scientific Inquiry/Learning Cycle is a comprehensive cycle that is used for grades PreK-12. Each step of ODE’s Scientific Inquiry/Learning Cycle aligns with the different phases of both the inquiry cycle and the 5E instructional model by applying students’ prior knowledge to the current learning experience in order to ask questions and solve problems.

3.3 Existing Lessons Reviewed

To develop the BEE Program format, I reviewed ten environmental education lesson plans from public and private institutions (Appendix II). Interestingly, all lesson plans followed a similar format and contained similar sections. Below is a brief summary of the common sections found in the lessons plans I reviewed that seemed relevant to include in a lesson plan for MetroParks.

Background

Eight of the lesson plans reviewed included a background section that appeared to be designed to provide the instructor with some background knowledge on the topic. Each background section provided enough detail to help the instructor teach the topic with confidence. Some background sections were short, while others were several pages long. For example, the background section of Clemson University’s Pollination of Flowers by Moths is less than one page long (Figure 9) (Schwallier and
Culin, n.d.). On the other hand, the Smithsonian Center for Learning and Digital Access’s (Smithsonian) lesson, *Plants and Animals: Partners in Pollination*, has a background section that covers three pages (Figure 10) (Smithsonian, 1997). Because MetroParks has several people teaching their education programs and the programs cover a variety of topics, I felt it was important to include a background section. Since the MetroParks programs only last one hour and are not part of any long term curriculum, I felt that a three-page background was too long and instead chose to make the BEE Program’s background section shorter.

![Background Section Image](image.png)

**Figure 10.** A three-page-long background section. This image is meant to show the length of the background section, and is not meant to be read. SOURCE: Smithsonian Center for Learning and Digital Access’s *Plants and Animals: Partners in Pollination*, Appendix B.

**Learning Objectives**

Nine of the lessons reviewed included learning objectives that describe what the students are expected to know or do by the end of the lesson. There tended to be two to three concise, narrowly focused objectives at the beginning of each of these lessons. For example, The National Wildlife Federation (NWF) uses the following learning objectives as part of their online *American Bats* program:

“Students will be able to:

- List several different foods that bats eat.
- Describe anatomical features that lend themselves to particular bat diets.
- Analyze bat features to accurately predict their diets” (NWF, n.d.).

The Smithsonian’s learning objectives for their program, *Plants and Animals: Partners in Pollination* are as follows:

- “Describe the complimentary relationships between pollinators and the plants they pollinate.”
• Identify adaptations that flowers have developed to ‘encourage’ pollination” (Smithsonian, 1997).

For the lesson plans about insect pollinators, the learning objectives tended to involve plant reproduction, how pollen is transferred between plants, habitat needs of pollinators, and human dependence on pollinators for food production. For example, The Pollinator Partnership’s Nature’s Partners, Pollinators, Plants, and You lists the following objectives in its first module:

• “Understand the interdependence of certain plants and the insects that pollinate them.
• Understand the process of pollination.
• Become aware of how people depend on pollinators for food” (Pollinator Partnership, 2007).

**Standards Addressed**

Four of the ten lesson plans reviewed included a list of academic education standards that are addressed in the lesson (Figure 11). Because the client indicated that it was important to adhere to Ohio’s Science Standards, I decided to include this section in my lesson plan, even though only four of the lessons reviewed made reference to academic standards.

*Figure 11. An example of a lesson that presents academic standards that are addressed. SOURCE: Discovery Education Pollinator Parties!, Appendix B.*
Materials, Preparation, and Activity Descriptions

All lessons reviewed included a section about what materials were needed and a section outlining procedure. The materials were often organized into a bulleted list, whereas the procedures were usually numbered (Figure 12). Three of the lessons reviewed also included a section outlining any preparation required by the instructor (Figure 12). Although only three included a section about preparation, I thought it would be useful to include an explanation of any preparation that needs to occur before the BEE Program. I felt that having all the information in one section would be helpful for a MetroParks instructor to quickly check that they have all the appropriate supplies without having to read through the entire lesson.

Figure 12. An example of bulleted materials, numbered procedures, and preparation sections. SOURCE: Left, Pollinator Partnership, Nature’s Partners: Pollinators, Plants, and You; right, Smithsonian Center for Learning and Digital Access Plants and Animals: Partners in Pollination; Appendix B.
Vocabulary
Two lessons reviewed listed vocabulary used in the lesson. One lesson, Discovery Education’s *Pollinator Parties!*, listed definitions and pronunciations for terms used in the lesson (Figure 13) (Kraft, 2001). Based on the language used in the definitions, it seems that they were written for adults to translate to students. Although vocabulary was not presented in any of the other eight lesson plans reviewed, the client indicated that including a vocabulary list in the *BEE Program* would be helpful to MetroParks educators who are unfamiliar with the terms used in the lesson.

Evaluation
Three of the lessons reviewed included an evaluation section which allows the instructor to assess what the students learned. For example, one lesson in the *American Bats* program asks students to apply their newfound knowledge of bat characteristics by writing to an advertiser to explain why they think a bat would make a good mascot for the company’s product (NWF, n.d.). The Pollinator Partnership’s *Nature’s Partners, Pollinators, Plants, and You*, on the other hand, incorporates pre- and post-assessments to measure changes in knowledge, attitudes, and behaviors toward bees (Pollinator Partnership, 2007). Since evaluation is also one of the 5E’s, I chose to include a few ways to assess student learning as part of the *BEE Program*.

Lesson Extensions and Supplementary Resources
Eight lesson plans included a section with optional activities to further the learning process either in class or at home. One extension activity included in the Shelburne Farms’ *Pollination Parade* lesson plan is to have students conduct a pollination survey by observing a flower over time and noting the different types and behaviors of the pollinators that visit (Shelburne Farms, 1995). The *Pollinator Parties!* lesson offers several extension ideas, one of which is for students to design a poster that portrays bees in a positive way (Kraft, n.d.). These extensions provide many useful ideas that allowed the instructor to reinforce the concepts that the students learned during the lesson.

In addition to extension activities, five of the ten lessons reviewed included a section with additional resources, such as external links, books, and other information, that can be used to
supplement the lesson. Sometimes there were links that led to websites or articles that provided more information for the instructor. Other times, additional resources included titles of children’s books that focused on the topic of the lesson.

3.4 Developing BEE Program Learning Objectives and Selecting Activities

In order to create an effective education program, it is important to first determine the desired endpoints and measurable outcomes of the program and form them into written learning objectives (ATEEC, 2014). Effective learning objectives describe what students are expected to know or do by the end of the lesson. After they are written, learning objectives may also be used to inform which content and subject matter to include in the lesson plan (NDSU, 2016). Not only does establishing learning objectives enhance program organization and design, but it also supports program evaluation (Osters and Tiu, 2003; NOAA, 2009). Effectiveness of the lesson plan is evaluated by reflecting on learning objectives and assessing the extent to which they were achieved (Osters and Tiu, 2003).

Learning Objective Development

Learning objectives use action verbs to describe the knowledge and skills that students are expected to gain by the end of the lesson (NOAA, 2009). One set of criteria used in writing appropriate learning objectives is the SMART acronym (NOAA, 2009):

- **Specific**: Objectives should use concrete endpoint verbs, rather than process verbs, to describe specific actions, student behaviors, outcomes, or achievements (Osters and Tiu, 2003; NOAA, 2009). Action verbs such as define, describe, and categorize are more appropriate than process verbs like improve, understand, and know (NOAA, 2009).

- **Measureable**: The outcomes referred to in learning objectives should be testable. Process verbs cannot be measured (NOAA, 2009).

- **Audience**: Objectives should identify the audience to which they refer and what the audience should be able to do (NOAA, 2009).

- **Relevant**: Objectives are realistic and appropriate for specified endpoint (NOAA, 2009).

- **Time-bound**: Objectives specify a realistic time-frame (NOAA, 2009).

I chose to write the BEE Program’s learning objectives based on important information grounded in scientific research. Using relevant research in pollination ecology and input from the client, I decided that it was important that students understand the following facts upon completing the lesson:

- Pollination is the process of moving pollen from the male part of a flower to the female part. Pollination can occur through wind, many plant species require animals such as insects, birds, or bats, to ensure successful reproduction.

- Pollination is an essential component of plant reproduction, allowing for plants to become fertilized, produce seeds and fruit, and produce more plants.

- Pollinator populations have been declining in recent years due to changes that are anthropogenic in nature. To increase pollinator abundance and diversity, people can plant native plants and reduce pesticide use.
With these three facts in mind, I used action verbs to develop the following learning objectives. These learning objectives refer to specific subject content, are measurable, realistic, and time-bound:

After completing the *BEE Program*, students should be able to:
1. Describe the process of pollination.
2. Explain that pollinators are necessary for plants to make seeds, fruit, and the food we eat.
3. Describe the different ways we as humans can help pollinator populations from declining.

Methods and Activity Selection

After establishing the *BEE Program* learning objectives, I began selecting activities to fulfill those objectives. I started by assessing the activities I saw in the ten lesson plans I reviewed for format. Some of the lessons, such as *American Bats* and *Pollination of Flowers by Moths*, were not relevant to my subject and were ruled out. Two of the programs were especially well designed: the Pollinator Partnership’s *Nature’s Partners* program and the Smithsonian’s *Partners in Pollination*.

These two lesson plans contained similar activities. Pollinator Partnership’s activity, *Why pollination and how it works*, and the Smithsonian’s *How does pollination work?* both involve using colored powder as a model for pollen to demonstrate the process of pollination. Both lessons also included an activity that revolved around explaining what the world would be like without pollinators (Pollinator Partnership, *Without pollinators—what would we do without?*; Smithsonian, *Understanding how pollination affects the world’s food supply*). In these activities, students attended a pretend party at which food that depended on pollinators was taken away from them. With permission from the authors (Appendix III), I used these lessons to build the first draft of the *BEE Program*.

I planned to seek feedback from three sources: children, the client, and education professionals. Unfortunately, I was unable to pilot the *BEE Program* with children. An application to pilot the lesson plan with children was sent to Miami University’s Institutional Review Board (IRB) in February 2017, but IRB approval was not obtained with sufficient time to plan, find participants, and execute the pilot session within the allotted time frame (IRB protocol approval number: 01342r). I was, however, able to receive helpful feedback from the client and education professionals.

I presented the first draft of the lesson to the client in February 2017. The client provided feedback and edits on vocabulary and content, and requested that I include an additional introductory activity and a take-home activity. Using the client’s expertise and input from Julie Robinson, Senior Project Manager and Museum Educator at Miami University’s Hefner Museum of Natural History, I developed the second draft of the lesson.

In March 2017, I distributed this new draft of the *BEE Program* to 12 education professionals to obtain feedback on lesson plan content, organization, and visual appeal. I received feedback from eight of the 12 education professionals and garnered the following advice on:
**Formatting:** To aid in the progression of lesson, it was suggested that the Science Standards Addressed should appear after Learning Objectives. I also learned that the activity descriptions would be easier to follow if the steps were numbered instead of bulleted.

**Content:** Several wording edits and additions for clarity were suggested. Also, several respondents recommended adding a goal statement or statement of purpose at the beginning of the lesson to help set the stage for the instructor.

**Age-appropriateness:** Two of the eight respondents voiced concern that the age-span of the lesson was too wide and that some of the content may be too advanced for younger children. However, one respondent was an experienced Pre-K teacher and was confident that her students would appreciate the lesson. I brought this concern to the client’s attention and she assured me that the existing BEE Program age range (Pre-K through Grade 5) satisfies the needs of the MetroParks.

Feedback from individual respondents is summarized in Appendix IV. I used this feedback to develop the final version of the BEE Program, which I describe in the next section.
4.0 The BEE Program

As requested by the client, I developed one lesson plan that can be presented in any setting, such as a classroom or a park, and can be delivered by someone who may not be familiar with insect ecology, such as a new employee or volunteer (Appendix V).

The goal of this lesson is for students to understand the role pollinators play in a healthy ecosystem. I added a goal statement based on recommendations from experts (See Section 3.4).

**BEE Program**

*Grade level(s):* PreK-5  
*Time estimate: 1 hour*

The purpose of this lesson is to communicate the importance of bees as part of a healthy ecosystem. Students will learn about the plant life cycle, pollination, and how to become helpful environmental stewards by participating in hands-on inquiry activities.

**Background**

Pollination, the process of moving pollen from the male part of a flower to the female part, is essential to plant reproduction. In some plants, this process is facilitated by wind or mechanical vibrations, but most flowering plants rely on pollinators, such as bees, butterflies, moths, beetles, flies, birds, and bats, to reproduce. In fact, over 87% of the world’s wild plants rely on pollinators for reproduction.1 Pollinators are critical to ecosystem health—without them, seed and fruit production, as well as overall plant fitness and diversity, are greatly reduced.2

Most pollination occurs inadvertently as a pollinator forages for nectar, a sweet substance produced in flowers to lure insects in so that the pollen can be transferred. In their search for nectar, pollinators bump up against the stamen (male parts) and get pollen stuck to their hair, scales, or feathers. When the pollinator visits the next flower in search of more nectar, some pollen from the first flower is transferred to the pistil (female part) second, therefore pollinating the second flower.

Pollinators are responsible for approximately 35% of the crops we eat, including nearly all vegetables, fruits, nuts, and even things like coffee and cocoa.1 Without pollinators, most global fruit, vegetable, seed, and commodity crops could experience production losses.3 Unfortunately, essential pollinator habitat is decreasing due to human impacts, such as pesticide use, habitat loss, and introduction of invasive species.3,5,6

Because of this, various pollinator populations have suffered serious global declines in recent years.3,5,6 Pollinator scarcity, combined with adverse weather, pesticide application, and mites, has caused reduced harvest quantity and quality of several different crops around the world, such as almonds (California), blueberries (New Brunswick), cherries (Ontario), pumpkins (New York), and cashew nuts (Borneo).8

To help these declining populations, we can reduce our pesticide use and plant pollinator-friendly plants on our property. Native plants – plants that occur naturally in a specific habitat, ecosystem, or region – are the preferred food source for native pollinators and often serve as the larval host plant for some species of pollinators. Native plants also naturally reduce pest populations and protect soil and water quality through runoff mitigation.2 By planting native plants, we can enhance pollinator diversity and promote healthy populations which will facilitate the pollination of the crops we depend on.

**Learning Objectives**

After completing the BEE Program, students should be able to:

- Describe the process of pollination
- Explain that pollinators are necessary for plants to make seeds, fruit, and food we eat.
- Describe the different ways we as humans can help pollinator populations from declining.

The learning objectives are stated here to help ensure I meet my goal. They focus on what pollinators do, why they are important, and ways we can help the declining pollinator populations (See Section 3.4).
Vocabulary

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen</td>
<td>The very tiny grains of male reproductive cells that usually appear as a fine yellow dust. Pollen is produced by the stamens (male part) of the flower. It is a source of food for bees.</td>
</tr>
<tr>
<td>Nectar</td>
<td>A sweet liquid produced by plants as a way to attract pollinators. It is a source of food for pollinators. Honeybees store surplus nectar as honey.</td>
</tr>
<tr>
<td>Pollination</td>
<td>The transfer of pollen from the stamens (male part) of a flower to the pistil (female part). This is how plants produce fruits and seeds.</td>
</tr>
<tr>
<td>Pollinator</td>
<td>An animal that transfers pollen from male to female flower parts. Most pollinators are insects (like bees, butterflies, moths, beetles, and flies), but some are birds or bats.</td>
</tr>
<tr>
<td>Stamen</td>
<td>The male part of the flower that produces pollen. The stamen is made up of an anther and a filament.</td>
</tr>
<tr>
<td>Pistil</td>
<td>The female part of a flower. Located in the center of the flower, this is where pollen is deposited and where the seed is produced. The pistil is made up of the stigma, style, and ovary.</td>
</tr>
</tbody>
</table>

Ohio Science Standards addressed

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Life Science Topic</th>
<th>Life Science Condensed Content Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>Physical and Behavioral Traits of Living Things</td>
<td>Living things have physical traits and behaviors, which influence their survival</td>
</tr>
<tr>
<td>Grade 1</td>
<td>Basic Needs of Living Things</td>
<td>Living things have basic needs, which are met by obtaining materials from the physical environment. Living things survive only in environments that meet their needs</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Interactions within Habitats</td>
<td>Living things cause changes on Earth</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Behavior, Growth, and Changes</td>
<td>Plants and animals have life cycles that are part of their adaptations for survival in their natural environments</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Earth’s Living History</td>
<td>Changes in an organism’s environment are sometimes beneficial to its survival and sometimes harmful</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Interactions within Ecosystems</td>
<td>Organisms perform a variety of roles in an ecosystem</td>
</tr>
</tbody>
</table>

Like the background, these vocabulary terms are also written for the instructor’s benefit. Descriptions that are more appropriate for children appear later in the lesson. Stamen and Pistil are included solely for the instructor’s knowledge and are not meant to be taught to the students.

The BEE Program touches on these Ohio Science Standards for K-5 (See Section 3.1). As this is only a one-hour lesson, I recognize that the Science Standards may not be fully addressed. This is simply because one hour is not very long. The BEE Program does cover each concept.
This table acts as an easy reference checklist for the instructor to know exactly what materials are needed to complete the lesson. It also provides an explanation of any preparation that needs to be done by the instructor ahead of time.

### Materials and Preparation

<table>
<thead>
<tr>
<th>Activity A: BEE Active</th>
<th>Activity B: BEE Aware</th>
<th>Activity C: BEE Helpful</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction to Nectar, Pollen, &amp; Insect Pollination</td>
<td>Activity A: BEE Active</td>
<td>Activity B: BEE Aware</td>
<td>Evaluation</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;-5&lt;sup&gt;th&lt;/sup&gt; graders: 1 long white pipe cleaner and 1 short white pipe cleaner per student</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;-5&lt;sup&gt;th&lt;/sup&gt; graders: 1 long white pipe cleaner and 1 short white pipe cleaner per student</td>
<td>Foam “garden” with pre-made slits</td>
<td>Pollinator Passport booklets, 1 per student</td>
</tr>
<tr>
<td>Pre-K – 2&lt;sup&gt;nd&lt;/sup&gt; graders: preassembled insects</td>
<td>Pre-K – 2&lt;sup&gt;nd&lt;/sup&gt; graders: preassembled insects</td>
<td>Artificial plants</td>
<td>Popsicle stick can</td>
</tr>
<tr>
<td>Flower tray stations*</td>
<td>Flower tray stations*</td>
<td>Pollinator Table poster</td>
<td>No preparation</td>
</tr>
<tr>
<td>Several colors of jell-o powder</td>
<td>Several colors of jell-o powder</td>
<td>Paper plates, 1 per student</td>
<td>No preparation</td>
</tr>
<tr>
<td>Note: darker colors work best, but avoid using red and green together</td>
<td>Note: darker colors work best, but avoid using red and green together</td>
<td>Felt or plastic play food</td>
<td>No preparation</td>
</tr>
<tr>
<td>Double sided tape</td>
<td>Double sided tape</td>
<td>Paper plates, 1 per student</td>
<td>No preparation</td>
</tr>
<tr>
<td>“No bees” symbol</td>
<td>“No bees” symbol</td>
<td>Pollinator Table poster</td>
<td>No preparation</td>
</tr>
<tr>
<td>Place 5 flower tray “garden” stations around the room</td>
<td>Place 5 flower tray “garden” stations around the room</td>
<td>Felt or plastic play food</td>
<td>No preparation</td>
</tr>
<tr>
<td>Apply tape to end of pipe cleaners</td>
<td>Apply tape to end of pipe cleaners</td>
<td>Paper plates, 1 per student</td>
<td>No preparation</td>
</tr>
<tr>
<td>Fill flower cups at each station with ~3 tbsp. of different colored jell-o powder, being careful not to get powder on sticky tape attached to pipe cleaners</td>
<td>Fill flower cups at each station with ~3 tbsp. of different colored jell-o powder, being careful not to get powder on sticky tape attached to pipe cleaners</td>
<td>Pollinator Table poster</td>
<td>No preparation</td>
</tr>
<tr>
<td>Pre-K - 2&lt;sup&gt;nd&lt;/sup&gt; graders: Pre-assemble insects using 2 pipe cleaners:†</td>
<td>Pre-K - 2&lt;sup&gt;nd&lt;/sup&gt; graders: Pre-assemble insects using 2 pipe cleaners:†</td>
<td>Artificial plants</td>
<td>No preparation</td>
</tr>
<tr>
<td>Twist long pipe cleaner into insect body, then pinch the middle and twist</td>
<td>Twist long pipe cleaner into insect body, then pinch the middle and twist</td>
<td>Artificial plants</td>
<td>No preparation</td>
</tr>
<tr>
<td>Wrap short pipe cleaner around body to form wings</td>
<td>Wrap short pipe cleaner around body to form wings</td>
<td>Artificial plants</td>
<td>No preparation</td>
</tr>
<tr>
<td>Notes: insect shape should be small enough to fit easily into the bottom of the paper cup flower. Bend antennae into clubs to help the insect pick up more powder.</td>
<td>Notes: insect shape should be small enough to fit easily into the bottom of the paper cup flower. Bend antennae into clubs to help the insect pick up more powder.</td>
<td>Artificial plants</td>
<td>No preparation</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;-5&lt;sup&gt;th&lt;/sup&gt; graders can make their own insects</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;-5&lt;sup&gt;th&lt;/sup&gt; graders can make their own insects</td>
<td>Artificial plants</td>
<td>No preparation</td>
</tr>
</tbody>
</table>

* Reference photos with detailed directions attached at the end of lesson plan
Activity Descriptions

Part I: Introduction to Nectar, Pollen, & Insect Pollination (8 Steps)

ENGAGE
1. Have the students dictate a list of insects they know. Do any of these insects help humans? Briefly discuss some benefits that insects provide, such as pest control (assassin bugs, ladybugs, etc), food for birds, bats, and other species, honey production, and pollination.
2. Focus their attention on bees. What types of things do bees do? Today you are going to be a bee and learn about how bees help plants and vice versa.

EXPLORE
3. Allow students to examine the pepper, seeds, and plant. Also hand out photos of bees and pollen. Encourage students to think of three observations and three questions related to what they are looking at.
4. After a minute of observation, allow students to share their observations and questions. Write them down on the Let's Make an Inquiry! poster with a dry-erase marker. Answer their questions as they are shared. Lead them to ask questions like:
   a. Where did these seeds come from?
   b. Where did the green pepper come from?
   c. What is all over the bee in this picture?

EXPLAIN
5. After you have answered their questions, congratulate them on their inquiry skills and explain that now you will share the whole story!
6. Introduce the concept of pollination by explaining how each insect benefits by its visits to the flowers, and how each plant benefits from these visits too.
   a. Use the pepper, seeds, plant, and laminated pictures to define the following terms:

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen</td>
<td>Small, sticky, grains that the flower makes to help the plant reproduce. Pollen is also bee food.</td>
</tr>
<tr>
<td>Nectar</td>
<td>Sugary liquid made by the flower to attract bees. Nectar is used by bees to make honey.</td>
</tr>
<tr>
<td>Pollination</td>
<td>Moving pollen from the male part of a flower to the female part.</td>
</tr>
</tbody>
</table>

ELABORATE
7. Using the visual aids, explain that the flower attracts the bee by advertising its nectar with its showy flowers. Show the picture of the bee before (without pollen) and after (covered in pollen) visiting a flower. Explain that the pollen sticks to the bee’s hairy body.
   a. Demonstrate this process using the bee finger puppet: dip your fingers into the first color of sequins. Allow the sequins to stick to your fingers.
b. Now your bee will visit another flower. Dip your fingers into the second color of sequins. What happens? Sequins from your fingers get transferred from the first flower to the second flower. This is the process of pollination!

c. Ask the students, "Why do plants need bees?" Plants are stationary and cannot move, so they need bees to move the pollen for them.

8. Explain that if it weren't for the bees, the pepper plant would not be able to produce the pepper, or the seeds inside the pepper. We would not have fruits, nor could the plant produce offspring. Different kinds of plants rely on different kinds of insects, like flies and moths, for pollination; some can only use one specific species!

_Activity A: BEE Active (5 Steps)_

1. Explain to the students that they are going to use a model of an insect to investigate how it will pollinate a flower.
   a. 3rd – 5th graders: Hand out pipe cleaners for students to create their own insect
   b. Pre-K – 2nd graders: Hand out pre-assembled pipe cleaner insects

2. Designate one station as the "Bee-Free Garden." Place the "no bees" symbol at this station. This "garden" has been sprayed with pesticides (bug spray), so any kind of insect that tries to visit this "garden" will die.

3. Explain that the students will fly their insects in and out of the flower cups at each "garden." Show them that there is pollen at the bottom of each flower. Ask the following questions:
   a. What do you think will happen to the insect when it flies into the flower?
   b. What do you think will happen to the taped pipe cleaner?
   c. Will pollen get transferred between the flowers?

4. Allow the students to touch their insect to the powder and taped pipe cleaner. What happened?

5. Lead students to reinforce the concepts introduced earlier and make inferences about pollination by asking the following questions:
   a. What did we use for the flower's pollen?
   b. What happened to the pipe cleaner insects? How many colors were on the insects?
   c. What happened to the "pollen?"
   d. How do you think this relates to real flowers?
      i. Inside the flower is a pistil that is sticky like the tape. The pollen sticks to the pistil and that's when the fruit starts to develop.
   e. Why do you think pollination is important to us?
      i. What will happen to the flowers in the Bee-Free Garden?
      ii. Without pollination, the plant cannot develop seeds - reproduce - or produce fruits and we could not have many of the foods we enjoy.

_In Activity A:BEE Active, students demonstrate the process of pollination by flying insects made out of pipe cleaners into models of flowers. These flower models each have a different colored jello powder at the bottom to mimic pollen. When a student flies their insect into the flower, colored powder gets stuck to them just like pollen sticks to the hair on bees. This reinforces the first objective by demonstrating pollination._

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Part II begins with Activity B: BEE Aware, during which students have a picnic and make a lunch with play food. After being introduced to the concept of pollinator decline, the food that depends on bee pollinators is taken away and the students are instructed to make their lunch again using only the food that is in the Pollinators Not Needed category. This activity reinforces the second learning objective by connecting pollinators to the food we eat, and introduces the third learning objective involving pollinator decline and how it affects the students.

### Part II: Activity B: BEE Aware (7 Steps)

#### ENGAGE:
1. Engage students by asking them if they have ever been to a picnic or cooked out on a grill or fire. Get them thinking of a picnic by asking what they do at a picnic, what they eat, and so forth.

#### EXPLORE:
2. Explain that they are going to attend a picnic and that hot dogs, hamburgers, French fries, and fruit salad are on the menu.
   a. Lay out felt or plastic play food in the center of the room.
   b. Hand out paper plates.
   c. Using the play food, tell students they have 2 minutes to make their lunch.
3. Explain that many of the world’s bee species are dying because of pesticide use, invasive species, and habitat loss.
   a. Pesticide use: Farmers, homeowners, and other people sometimes spray bug spray on their fields or yards, which can hurt or kill bees even if they are not the intended target.
   b. Invasive species: Plants and animals that came here from another habitat. These plants and animals may harm our bees by taking away their food and homes.
   c. Habitat loss: When the places used by bees for feeding, breeding, and shelter are destroyed to make space for humans to build houses, cities, and roads, and to convert land into farmland.
4. Ask the students to imagine a world without bee-pollinated plants: the “Bee-Free Zone.”
   a. Ask the students to return their play food.
   b. Together, categorize them into two piles according to the Pollinator Table:

#### Pollinator Table

<table>
<thead>
<tr>
<th>Pollinators Needed</th>
<th>Pollinators Not Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bees</td>
<td></td>
</tr>
<tr>
<td>Almonds</td>
<td>Cherries (cherry pie)</td>
</tr>
<tr>
<td>Apples (apple pie)</td>
<td>Coffee</td>
</tr>
<tr>
<td>Blackberries</td>
<td>Cucumbers (pickles)</td>
</tr>
<tr>
<td>Blueberries (blueberry pie)</td>
<td>Green peppers</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Mustard seed (mustard)</td>
</tr>
<tr>
<td>Chocolate (chocolate cake, ice cream)</td>
<td>Onions</td>
</tr>
<tr>
<td>Carrots</td>
<td>Raspberries</td>
</tr>
<tr>
<td>Celery</td>
<td>Tomatoes (ketchup)</td>
</tr>
<tr>
<td></td>
<td>Bananas: asexual reproduction (from underground bulbs)</td>
</tr>
<tr>
<td></td>
<td>Corn: wind &amp; self-pollinated</td>
</tr>
<tr>
<td></td>
<td>Grapes: wind pollinated</td>
</tr>
<tr>
<td></td>
<td>Lettuce: self-pollinated</td>
</tr>
<tr>
<td></td>
<td>Peas: self-pollinated</td>
</tr>
<tr>
<td></td>
<td>Potatoes (French fries): asexual reproduction (from underground tubers)</td>
</tr>
<tr>
<td></td>
<td>Strawberries: wind &amp; self-pollinated</td>
</tr>
<tr>
<td></td>
<td>Wheat (buns, pasta): wind &amp; self-pollinated</td>
</tr>
</tbody>
</table>
5. Explain that now they are going to attend a Bee-Free Picnic in the Bee-Free Zone.

6. Have students make their lunch again, this time without the food pollinated by bees. Only use the food in the Pollinator Not Needed pile.

7. Have them describe the meal that remains.
   a. With a show of hands, ask students who would prefer a Pollinator Not Needed lunch over a Pollinator Needed lunch?
   b. Ask them to think about their friends and families. What kinds of foods do they like?
   c. With a show of hands, ask students how many of their friends and family members would prefer a Pollinator Not Needed lunch.

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**Activity C: BEE Helpful (4 Steps)**

**EXPLAIN**

1. Explain that they can help the pollinators by planting pollinator-friendly plants in the nature in their neighborhood. As a class, we will make a pollinator garden today using pretend plants.

**ELABORATE**

2. Allow students to “plant” flowers in the slits of the foam garden. Explain that bees like plants with flowers that grow naturally in the Eastern Broadleaf Forest, which is where we live in Ohio. Use the following tips:
   a. Bees like plants with bright white, yellow, or blue flowers because they can see those colors best with their insect eyes. Bees can’t see red!
   b. Bees like when one kind of flower is planted in big clumps because they don’t have to fly as far to eat.
   c. Clumps of difference species should be planted because different species are ready to be pollinated at different times.
   d. You and your caregiver can plant a special pollinator garden in your yard or a planter on the windowsill or porch where you live!

**EVALUATE**

3. Popsicle stick game: Allow students to pull a Popsicle stick out of the can and have them each share what they learned based on the prompt they pulled from the can. Prompts include:
   a. What I learned about bees
   b. What I learned about the food I eat
   c. What I learned about pollen
   d. What I learned about plants
   e. What I learned about pollination

4. Pass out Pollinator Passport booklet for students to color and take home with them. Tell them to share the facts and pictures in the Passport with their family, friends, and neighbors.

The Pollinator Passport booklet includes coloring pages, a word search, facts introduced during the BEE Program, and information for adults about how to help the pollinators, including references to create their own pollinator garden.
Extensions for the Teacher provides information for the school teacher about how to build a pollinator garden or start a citizen science project at their school.

Extensions for the Teacher

- Build a pollinator garden at your school
  - Purchase The Bee Smart School Garden Kit from The Pollinator Partnership and receive native seeds, directions for planting, and a series of 10 lesson plans and materials to start a pollinator program. To learn more, visit [http://www.pollinator.org/beesmart_give.htm](http://www.pollinator.org/beesmart_give.htm).
  - Create an outdoor classroom with the National Wildlife Federation’s Schoolyard Habitats Program. To learn how to design, build, and certify your wildlife habitat, visit [http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards.aspx](http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards.aspx).
- Participate in a citizen science project
  - The Great Sunflower Project: Join people from all over the country in collecting data on pollinators in their yards, gardens, schools, and parks. To start taking counts of the number and types of pollinators visiting plants, visit [http://www.greatsunflower.org/quickguide](http://www.greatsunflower.org/quickguide).
  - BeeSpotter: Take pictures of the bees in your neighborhood and upload them to an online database. Try to identify your bees using keys on the website, or leave it for an expert to identify. To learn more, visit [https://beespotter.org/](https://beespotter.org/).

Resource library

- Children’s Books:
  - “What if there were no bees?” By Suzanne Slade
  - “The buzz on bees: Why are they disappearing?” By Shelley Rotner
- Gardening for Pollinators: [https://www.fs.fed.us/wildflowers/pollinators/gardening.shtml](https://www.fs.fed.us/wildflowers/pollinators/gardening.shtml)

The Resource library provides supplementary information for the school teacher. This section provides children’s book titles and links to informative lists of native plants.
The final page of the BEE Program includes reference photos for the pipe cleaner insects and flower cups required for Activity A: BEE Active, as well as step-by-step directions for assembly.

*Reference photos for Part I, Activity A: BEE Active

![Reference photos from the BEE Program]

**Figure 1.** Make a flower with one small paper cup and one short white pipe cleaner: (1) Poke the end of the pipe cleaner through the bottom of the cup, (2) Bend the end of the pipe cleaner around the bottom of the cup and tape it into place, (3) Wrap double-sided tape around the end of the pipe cleaner that is inside the cup, (4) Fill with ~3 tbsp. of jell-o powder, being careful not to get any powder on the tape.

**Figure 2.** Make an insect with two white pipe cleaners: (1) Bend the long pipe cleaner in half then twist the ends together to create an insect shape, (2) Pinch the center of the body and twist to create the insect abdomen, (3) Bend the ends of the antennae into a club shape, (4) Twist the short pipe cleaner into a circle, (5) Place the insect body from Step 3 through the circle, and (6) Twist the circle around the body to form wings.

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5.0 Recommendations

The following recommendations are designed to help MetroParks implement the *BEE Program* and provide options to enhance it in the future.

1. **Pilot test the *BEE Program***

Pilot testing is an important step that should occur before implementation to catch any problems that may arise during the lesson, such as timing issues, insufficient materials, or student confusion. Before delivering the *BEE Program* for the first time, I suggest MetroParks first tests the lesson with its instructors to ensure that they can follow the directions and properly assemble the materials.

After testing with instructors, I think it would be beneficial for MetroParks educators to treat the first couple times they teach the lesson as a pilot and adjust the lesson plan as they see fit. All materials will be given to MetroParks in Microsoft Word and PDF formats so that the client can easily modify the lesson. While teaching, MetroParks instructors should take special attention to the time, as there is the possibility that the lesson could last longer than one hour.

My original goal was to test the *BEE Program* with children to gain feedback on the lesson and practice teaching children in an informal educational setting, but since this is a research project I first needed to obtain IRB approval. While I did receive IRB approval (IRB protocol approval number: 01342r), it was not until March 27, 2017, which was not sufficient time to plan a pilot session and recruit participants. Instead, I sought feedback from eight education professionals.

2. **Build a pollinator garden at a MetroParks location**

I recommend that MetroParks build a pollinator garden that contains a wide variety of native flowering plants and pollinator nesting sites, and is located in a place that can be used for the *BEE Program*. To provide enough food for pollinators throughout the year, a good pollinator garden should include a diverse array of flowering plants that bloom during different times of the year (Xerces Society, 2014). These flowers should be planted in clusters, rather than individually, to attract more pollinators (Xerces Society, 2014). In addition to flowering plants, MetroParks should provide nest sites for native bees by including nest blocks, bare ground, and nest boxes (Xerces Society, 2008). Finally, the MetroParks should avoid using pesticides to protect the pollinators that will visit this garden (Xerces Society, 2014).

Planting a pollinator garden fits within the mission of MetroParks to promote conservation and education by protecting wildlife habitat and promoting plant and insect diversity while providing unique opportunities for conservation education. MetroParks could use the pollinator garden for a number of learning opportunities, which are detailed below in Recommendation 3.

There are several online resources for selecting appropriate, native, pollinator friendly plants. Here are a few helpful resources that I have come across in my research:
• Pollinator Partnership’s guide to selecting plants for pollinators in the Eastern Broadleaf Forest: [http://www.pollinator.org/PDFs/Guides/EBFContinentalrx13FINAL.pdf](http://www.pollinator.org/PDFs/Guides/EBFContinentalrx13FINAL.pdf)
• PlantNative is a private organization that provides an online directory of plant nurseries that sell native plants. The following website lists local nurseries that sells native plants: [http://www.plantnative.org/](http://www.plantnative.org/)
• The National Wildlife Federation maintains a database of native plants organized by zip code. The following website and lists native plants by zip code: [http://www.nwf.org/NativePlantFinder/](http://www.nwf.org/NativePlantFinder/)

3. **Alternatives and extensions to the BEE Program**

*Outdoor class*

The *BEE Program* was designed to be taught in any location, whether that is in an indoor classroom or outdoors at a park. If the class is being taught outdoors, I recommend modifying *Introduction to Nectar, Pollen, and Insect Pollination* to include a pollinator observation period. Ideally, this would take place in a pollinator garden at times where bees and butterflies are most active, such as a warm sunny day between late spring and early fall, with little to no wind. I propose that during the *Explore* section, students be instructed to make observations about the insect activity in the garden. After a few minutes of observation, students can share their observations and questions and write them down on the *Let’s Make an Inquiry!* poster. This alternative activity could also be used to extend the *BEE Program* for a field trip, as described in the next section.

It is important to note that there are risks associated with holding the *BEE Program* outside in a pollinator garden, specifically the risk of stinging bees. Therefore, I recommend MetroParks takes precautions towards children with bee allergies or those who are afraid of bees. Children who have a history of bee allergy should carry an emergency epinephrine auto-injector (such as an EpiPen) and wear long pants, long-sleeved shirts, and close-toed shoes when participating in the *BEE Program* (Moffitt et al. 2004). In the event that a child does get stung by a bee, a MetroParks instructor should remove the stinger, wash the sting area with soap and water, and apply a cold compress to the affected area to reduce swelling (Mayo Clinic, 2017). If the child is experiencing a severe allergic reaction, administer the EpiPen and seek medical attention immediately (Mayo Clinic, 2017). To prevent bee stings, children should be instructed not to touch the bees, get too close to them, or grab the flowers they are visiting. If they get scared, tell them to close their mouths to avoid accidentally swallowing a bee and calmly walk away from the garden. Since bees can enter a can or cup and sting when swallowed, students should also not have open sugary soda or fruit beverages with them.
Field trip extensions

MetroParks offers whole day and half day field trips which are often extensions of their hourly programs. If MetroParks wishes to extend the BEE Program into a field trip, I recommend they incorporate an outdoor pollinator observation period (as mentioned above), as well as a citizen science component that requires students to collect observational data to help scientific researchers track pollinators in our area.

Two possible citizen science programs for the Butler County, Ohio area are The Great Sunflower Project (www.greatsunflower.org) and BeeSpotter (https://beespotter.org/). The Great Sunflower Project helps students contribute to nationwide pollinator dataset by conducting counts of the numbers and types of pollinators on plants in the yard or park. BeeSpotter also involves an online dataset, but requires the citizen scientists to take photos of the bees they see in the garden. The BeeSpotter website provides identification keys for citizen scientists to identify bees on their own, but there is also an option to have the bees identified by an expert.

Another option for extending the BEE Program into a field trip is to incorporate more scientific inquiry by collecting data to draw conclusions. For example, during an outdoor pollinator observation period, students could make predictions about how many pollinators they expect to see on different types of flowers. Depending on their interests, they can base their investigation on flower species, color, or size. Students could then gather data and organize it into a figure to come to a conclusion based on their evidence. This method could also be used to modify Activity B: BEE Aware. Students could make a prediction about how much of the class would prefer a Pollinators Needed lunch over a Pollinators Not Needed lunch. As a class, students could create a bar chart by each placing a sticker on a graph based on their lunch preference (Figure 14). Students could then compare the number of stickers in each category to come to a conclusion about the class’s overall food preferences. Incorporating these data collection and graphing components would further fulfill the ODE Science Standards.

Materials for teachers

I recommend that the MetroParks provides teachers with optional materials to supplement their regular lessons. These materials could be used pre-MetroParks visit to prepare students for the lesson, or post-MetroParks visit to help reinforce learning objectives. I suggest that the MetroParks program instructors provide teachers with the information in Extensions for the Teacher and Resource library sections of the BEE Program.
The two extensions I provide in the BEE Program are to build a pollinator garden at your school and participate in a citizen science project. To help teachers create a pollinator garden at their school, the Pollinator Partnership offers The Bee Smart School Garden Kit, which provides native seeds, directions for planting, and a series of 10 lesson plans and materials to start a pollinator program. The National Wildlife Federation also offers a wildlife habitat certification program, called the Schoolyard Habitats Program, which encourages schools to link their garden projects with the community. As another option to extend the BEE Program lesson at school, I selected two citizen science projects: The Great Sunflower Project and BeeSpotter. While I only presented these two options in the BEE Program, I found many different options through my research that MetroParks could add as additional activities.
6.0 IES Reflection

I feel that my experience at the Institute for the Environment and Sustainability (IES) has effectively prepared me for both this practicum and for my professional career. While working as part of an interdisciplinary team on my Professional Service Project (PSP), I became a more confident writer, a more detailed editor, and a better communicator. PSP taught me how to effectively use Microsoft Word and PowerPoint to write reports, make presentations, and create illustrations. I also discovered both the benefits and challenges of working on a team. I learned that I could ask others for help if I needed it, and delegate work to others who had different skills than I did. I learned how to deal with and resolve conflict within my team while ensuring tasks still were completed in a timely manner. I think that working on a team of six helped me discover my leadership style and perfect my interpersonal skills.

Both the core curriculum and area of concentration coursework I completed at IES also helped to prepare me for this practicum and my professional career. Specifically, I think I will take the most away from Environmental Law and Environmental Protocols. In Environmental Law, I learned valuable information about current issues in the environment and the federal environmental statues in place to regulate those issues. In Environmental Protocols, I wrote full-length scientific reports in a short period of time. I have always had writer’s-block issues, so being required to write a large volume in a short amount of time was great practice.

Having never taken an education class, I chose to complete this practicum project with the MetroParks of Butler County in order to gain more experience engaging the community in conservation education. Through my research, I learned about educational theory and practice, as well as how to write an effective lesson plan. Through my collaboration with Miami’s Institutional Review Board (IRB) to pilot a version of the BEE Program with children, I learned first-hand about the precautions involved when working with children. I learned to be respectful of their rights and cautious of my actions towards them. By working on the BEE Program, I was able to practice communicating with the public in a way that I had never done before.

I am proud of my accomplishments at IES and very thankful for the instructors that I have had the pleasure of working with. I have no doubt that my experiences with this project and at IES will help shape my future professional career.
References


Kraft, Jesse. 2001. “Pollination Parties!” *Discovery Education.*
http://www.discoveryeducation.com/teachers/free-lesson-plans/pollination-parties.cfm#top


North Dakota State University (NDSU). 2016. “10 steps for planning educational programs: Guidelines to help you complete the worksheet and develop quality programs.” 1-7. [https://www.ag.ndsu.edu/programplanning/program-planning-resources/tenstepsguidelines](https://www.ag.ndsu.edu/programplanning/program-planning-resources/tenstepsguidelines)


http://www.pollinator.org/nappc/PDFs/curriculum.pdf


Natural History & Science

Animals Alive!
Live animals and sensory items such as bones, skulls, furs, seeds, skins, puppets, pictures, games and songs are used.

Choose one of the topics below:
- Our Natural World - Ohio Wildlife
- Predator Prey Relationships - The Food Chain
- Animal Tracking
- Animal Olympics - Athleticism of Animals
- Migrate, Hibernate, Tolerate (seasonal)
- Adaptations for Survival
- Wake Up Sleepy Heads (seasonal)
- Hibernation

Myths, Fables and Facts
Bust the myths that you have heard about animals in nature. Hear animal tales from other cultures. Interactive experiences and activities. Live animals are used in this program.

Insect Ecology (seasonal)
Incomplete and complete metamorphosis are explained through examples and demonstrations. Observe insects & discuss their adaptations.

Choose one of the topics below:
- Stinky Bugs and Slimy Slugs
- Bug Bites: Entomophagy
- Busy Bees: Pollinators

Fossil Find
Compare and describe fossils from Ordovician Period. Identify dinosaur characteristics through games and activities. Understand the work of a paleontologist and dig up fossils.

Reduce, Reuse, Recycle and Reap the Rewards - The 5 R’s
Become recyclers through fun games, activities and experiments. Observe live animal recyclers in action.

Water in Pleasantville
Explore the water cycle, and the three stages of water: gas, solid and liquid. Interactive model demonstrating watershed, water bodies and pollution. Live animals are used in this program.

Pizza Parts
Investigate where food comes from through songs, games, sensory activities and imagination. Learn the life cycle of plants from seed to plant to plate. Plant a seed to grow a part of a pizza.

Common Sense Survival
Learn common sense survival techniques. Stories, active scenarios, and fun hands-on activities such as building a small lean-to. Make a survival kit to take home.

- 30 participants or less. Additional $3/person if over 30 participants.

Cultural History

The One-room School House (Grades 3 - 5)
Experience 1830’s schooling through the 4 R’s, mannerisms, chores and discipline. Pioneer craft.

Pioneer Life
Experience life in the 1800s through activities, historical objects and games. Pioneer craft.

The Earliest Americans
Discover the lifestyles of pre-historic peoples through authentic artifacts pictographs, sign language and games. Native Peoples’ craft.

It’s the Amish-Mennonite Way
Delve into the daily life of the historic Amish-Mennonites in Butler County. Fun hands-on activities that represent the chores done by a young Amish-Mennonite child on a busy farm in the late 1800s.

Follow the Drinking Gourd: Underground Railroad (Grades 4 – 5)
Experience life as a runaway slave through first-person interactions. Learn abolitionist signals, songs and methods of moving slaves to free states.

School Age (K - 5) Hourly Programs

Adapted for this appendix and 2/2/2016 from MetroParks of Butler County brochure. MetroParks Education page: http://www.yourmetroparks.net/education.asp
MetroParks brochure: http://www.yourmetroparks.net/documents/forms/k-5-hourly-programs-brochure.pdf

Appendix I: MetroParks School Age (K-5) and Preschool Age Hourly Programs
**Program List**

**Pioneer Life**
Experience life in the 1800s through activities and games. Comparison of historic and modern items & schooling. Pioneer craft.

**Fun on the Farm**
Recognize different examples of farms, animals and their uses. Compare adult to young farm animals. Go on an egg hunt, use a wheelbarrow and pick vegetables.

**The Earliest Americans**
Discover the lifestyles of pre-historic peoples through authentic artifacts photographs, sign language and games. Native Peoples' craft.

**Astro Kids**
Recognize planet Earth and other planets and moon. Solar system, milky way galaxy. Stars and constellations.

**Animals Alive**
Live animals and sensory items such as bones, skulls, fur, seeds, skins, puppets and pictures are used. Adaptations for survival, predator-prey relationships, food chain or backyard wildlife will be discussed.

**Garden Art**
Conduct a garden themed science experiment. Investigate the natural world through arts & crafts.

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**Pre-School Age Hourly Programs**

**Animal Olympics**
Discover the athleticism of a number different animals. Students will actively emulate the movement of animals. Live animal presentation.

**Dino Stomp and Fossil Find**
Pretend to be a paleontologist and dig up fossils. Compare and describe fossils from Ordovician Period. Identify dinosaur characteristics through games and activities.

**Pizza Parts**
Investigate where food comes from through songs, games, sensory activities and imagination. Learn the life cycle of plants from seed to plant to plate. Plant a seed to grow a part of a pizza.

**Color Our World**
Recognize order of colors of rainbow. Explore colors in nature. Compare primary versus secondary colors. Songs, games and activities.

**Weather For All Seasons**
Compare weather types, hot and cold, dry and wet. Colors of rainbow and cloud experiment. Recognize four seasons and what causes day and night. Songs, games and activities.

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**Seasonal Programs**

**Stinky Bugs and Slimy Slugs**
Incomplete and complete metamorphosis are explained through examples and demonstrations. Observe insects, discussing their adaptations.

**Fall Confetti**
Explore autumn season through plants and animals. Understand what chlorophyll is and what causes leaf colors. Preparation for winter activities.

**Feathers, Fat and Fur**
Explore how animals survive cold weather. Experiments, skis, fur, live animal. Hibernate, tolerate, and migrate.

**Pilgrims and Turkey Talk**
Explore the Pilgrims and Native Peoples’ costumes & the Mayflower. Look at the makings of a 3-sisters garden. Recognize importance of turkeys then and now.

**Summer Games**
Explore the origins of the Olympics. Be in a parade and play summer games. Receive a "medal".

**Busy Bees**
Explore the world of pollinators and pretend to be a beekeeper working with a beehive. Learn what plants are pollinated that humans eat and drink. Snack or craft.

**What FALLS from an Apple Tree?**
Discover how apple trees are pollinated and the many uses of apples. Learn about Johnny Appleseed. Taste dehydrated & fresh apples.
<table>
<thead>
<tr>
<th>Title</th>
<th>Background</th>
<th>Learning Objectives</th>
<th>Standards Addressed</th>
<th>Materials</th>
<th>Preparation</th>
<th>Vocabulary</th>
<th>Activity Descriptions</th>
<th>Evaluations</th>
<th>Extensions</th>
<th>Supplementary Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Nature’s Partners, Pollinators, Plants, and You: A comprehensive pollinator curriculum for grade 3-6</td>
<td>Background</td>
<td>&quot;Participants will&quot;</td>
<td>Materials needed</td>
<td>Getting ready</td>
<td>Action</td>
<td>Pre- and post-assessment projects</td>
<td>Going further</td>
<td>Supplementary resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Here come the sunflowers!</td>
<td>Background</td>
<td>Objectives</td>
<td>Materials</td>
<td>Activity</td>
<td>Extensions</td>
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<tr>
<td>3 Africanized honey bee education project</td>
<td>Introduction</td>
<td>Materials</td>
<td>Teacher prep</td>
<td>Activity</td>
<td>Additional resources</td>
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<tr>
<td>4 Insect experiments for the classroom: Pollination of flowers by moths</td>
<td>Background</td>
<td>Objective</td>
<td>Science standards covered</td>
<td>Materials</td>
<td>Procedure</td>
<td>Additional resources, further information</td>
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<tr>
<td>5 American bats: Online activity guide</td>
<td>Background</td>
<td>Learning objectives</td>
<td>Materials</td>
<td>Preparation</td>
<td>Procedure</td>
<td>Assessment</td>
<td>Extensions</td>
<td>Further Resources</td>
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<tr>
<td>6 Pollination Parade</td>
<td>Objective</td>
<td>Materials</td>
<td>Directions</td>
<td>Extension</td>
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<tr>
<td>7 Pollination Parties</td>
<td>Objectives</td>
<td>Standards</td>
<td>Materials</td>
<td>Vocabulary</td>
<td>Procedures</td>
<td>Evaluation</td>
<td>Extensions</td>
<td>Suggested readings, links</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Plants and animals: Partners in pollination</td>
<td>Introduction</td>
<td>Objectives</td>
<td>Materials</td>
<td>Procedure</td>
<td></td>
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<tr>
<td>9 The butterfly project pollinator curriculum guide</td>
<td>Background information</td>
<td>Objectives</td>
<td>Standards</td>
<td>Materials list</td>
<td>Procedure</td>
<td>Extensions</td>
<td></td>
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<tr>
<td>10 Pollinator Gardens and Habitat Program</td>
<td>Information</td>
<td>Lesson Objectives</td>
<td>Science Content Standards</td>
<td>Materials</td>
<td>Vocabulary to Review</td>
<td>Procedure</td>
<td>Extension</td>
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2 USDA; Ag in the Classroom. n.d. “Here come the sunflowers!” Accessed April 16, 2017. [http://forces.si.edu/ltop/pdfs/PreK-1-HereComestheSunflower.pdf](http://forces.si.edu/ltop/pdfs/PreK-1-HereComestheSunflower.pdf)
4 Schwaller, Marriah and Joe Culm. n.d. “Insect experiments for the classroom: Pollination of flowers by moths.” Department of Entomology, Clemson University, 1-4. [https://pollinatorlive.org/pdf/MothMoonflowerPollinationGame.pdf](https://pollinatorlive.org/pdf/MothMoonflowerPollinationGame.pdf)
8 Smithsonian Center for Learning and Digital Access (Smithsonian). 1997. “Plants and animals: Partners in pollination.” Smithsonian in your Classroom, November/December 1997: 1-13. [http://learninglab.si.edu/plc/er3GDtc6Mx03gqrB](http://learninglab.si.edu/plc/er3GDtc6Mx03gqrB)
Question about using curriculum and activity guide
2 messages

Petroff, Anna Jean <petrofa2@miamioh.edu> Thu, Jan 5, 2017 at 1:38 PM
To: info@pollinator.org

Hello,

My name is Anna and I am a Master's student at Miami University's (Ohio) Institute for the Environment and Sustainability. For my practicum project, I am developing a pollinator education program for the MetroParks of Butler County for children in grades Pre-K through 5. In my research, I came across the Coevolution Institute's Pollinator Gardens and Habitat Program Curriculum and Activities (https://www.pollinator.org/Resources/Coe%20Gardens%20Curriculum.pdf).

Do I have permission to use some of these activities in my lesson plan? I would of course give you full credit in my final report. Do you have any specific wording you would like me to use in giving your organization credit?

Since this is a research project, my work is under the guidance of Miami's institutional review board. If you have any questions or concerns, you are welcome to contact my academic advisor, Suzi Zazycki, at zazycks@miamioh.edu.

Thank you,
Anna Petroff

--
Anna Jean Petroff
Graduate Teaching Assistant, Department of Biology
Master's Candidate | Miami University's Institute for the Environment & Sustainability
937-408-9537

Evan Cole <ec@pollinator.org> Thu, Jan 5, 2017 at 1:54 PM
To: "Petroff, Anna Jean" <petrofa2@miamioh.edu>

Hi Anna,

Thank you for contacting us. You do have our permission to draw from our curriculum in developing your educational program. Please provide attribution to Pollinator Partnership wherever appropriate – we do not have any preferred language for this.

You may also wish to reference our School Garden Kit and Nature's Partners Curriculum, and recommend these as resources for participants to become further involved.

Best of luck finishing up your Master's!

Sincerely,

Evan Cole
Program and Development Associate
Hello,

My name is Anna and I am a Master's student at Miami University's (Ohio) Institute for the Environment and Sustainability. For my practicum project, I am developing a pollinator education program for the MetroParks of Butler County for children in grades Pre-K through 5. In my research, I came across a lesson plan from a 1997 issue of Smithsonian in your Classroom, Plants and Animals: Partners in Pollination (http://www.smithsonianieducation.org/images/educators/lesson_plan/partners_in_pollination/pollen.pdf).

Do I have permission to use some of these activities in my lesson plan? I would of course give you full credit in my final report. Do you have any specific wording you would like me to use in giving your organization credit?

Since this is a research project, my work is under the guidance of Miami's institutional review board. If you have any questions or concerns, you are welcome to contact my academic advisor, Suzi Zazycki, at zazycks@miamioh.edu.

Thank you,
Anna Petroff

--
Anna Jean Petroff
Graduate Teaching Assistant, Department of Biology
Master's Candidate | Miami University's Institute for the Environment & Sustainability
937-408-9537

Dear Anna,

Yes, please feel free to use. Credit is: “Smithsonian Center for Learning and Digital Access.” Thanks for writing to ask!

Best wishes,

Stephen Binns

From: Learning
Sent: Thursday, January 05, 2017 1:59 PM
To: Binns, Stephen <sbinns@si.edu>
Appendix IV: Feedback from Education Professionals

After the BEE Program activities and other content were developed, I tested the lesson plan to determine its effectiveness. I distributed the BEE Program to 12 education professionals in March 2017 to obtain feedback on lesson plan content, organization, and visual appeal.

I received feedback from eight of the 12 education professionals. The education professionals I interviewed possessed expertise ranging from Pre-Kindergarten, Elementary, or Special Education, to informal education, to higher education. The feedback was as follows:

**Respondent 1: Special Education educator**
In order to help the students make connections between the questions asked at the beginning of the lesson and the content introduced during the lesson, Respondent 1 suggested I use a “KWL Chart.” She explained that a KWL Chart helps lead discussion throughout the lesson by guiding students to vocalize what they already know about the new topic (K), what they want to know about that topic (W), and what they learned about that topic at the end of the lesson (L). Respondent 1 provided a picture of one of the KWL Charts she recently created with her students (Figure 15).

I chose not to include a KWL chart because I felt that with the combination of the Let’s Make an Inquiry! poster and the Popsicle Stick Game, I achieved the same effect. Through the Let’s Make an Inquiry! poster, students share what they observe (K) and any questions they have (W). The Popsicle Stick Game requires students to reflect and share what they have learned (L).

**Respondent 2: Pre-Kindergarten educator**
An experienced Pre-K educator, Respondent 2 provided specific advice for teaching young children. She explained that young children would enjoy making their own pipe cleaner insects in Activity A. She also suggested that Activity C take place outside, stating “Children would love to plant real plants! A chance to play in dirt in school!” Finally, Respondent 2 suggested that the lesson be followed by a story about pollination and recommended two books: 1) For younger children: “What if there were no bees?” By Suzanne Slade, and 2) For older children: “The buzz on bees: Why are they disappearing?” By Shelley Rotner.

Since MetroParks wanted a program that could be taught indoors, I did not include an outdoor element that would require students to play in the dirt. I did, however, include the respondent’s book suggestions in the BEE Program Resource Library.

**Respondent 3: 7th Grade Math and Science educator**
While Respondent 3 is not an educator in the target grade range of PreK-5, she considers herself “an expert in the outline and progression of learning activities.” Respondent 3
provided many formatting suggestions, including putting the “Ohio Science Standards addressed” section after the “Learning Objectives” section, numbering the activity descriptions instead of bulleting, and adding more extensions for the teacher. Since all activities are meant for all grade levels, Respondent 3 suggested I provide an explanation of “differentiation strategies” for the grade levels that elaborates on what to expect or do in a session with younger students compared to a session with older students. Finally, Respondent 3 expressed that as a teacher, she would appreciate an activity she could do with her students at school to prepare for the BEE Program.

I accepted this respondent’s formatting suggestions and edited the BEE Program accordingly. I discussed “differentiation strategies” with the client, and together we decided that an explanation of such strategies was not needed in the lesson plan. I addressed Respondent 3’s request for a pre-MetroParks visit activity by including it in a recommendation.

**Respondent 4: Museum educator**

Respondent 4 provided many helpful comments, edits, and suggestions on the BEE Program content, definitions, and wording. He made several suggestions that would help focus the lesson on native bees. Since the only bee most people know is the honey bee, he suggested the beginning of Part I includes a review of the native bees in the area. As Respondent 4 pointed out, this would require the instructor to familiarize themselves with the diversity of bees that could be found in the area.

I accepted many of Respondent 4’s edits, but did not change the BEE Program’s focus to native bees based on the client’s request to focus on bees in general.

**Respondent 5: University educator**

Respondent 5 thought it would be helpful to begin with a goal statement before the background section that describes the purpose of the lesson. He also suggested I specify a time estimate along with the age range for the lesson. After students list the insects they know in Part I, Respondent 5 suggested the instructor ask, “Do any of these insects help humans?” This would introduce a discussion about the benefits insects provide, such as pest control, food for other animals, and honey production, and would also lead into the topic of pollination. Respondent 5 also suggested that the instructor asks the students “why do plants need bees?” after introducing the concept of pollination. Asking this question would get students to think about how plants are stationary and need the bees to move the pollen for them.

I included all of Respondent 5’s comments and changes in the BEE Program.

**Respondent 6: Former superintendent of public school district**

Respondent 6 proposed that I include an “anticipatory set” in the BEE Program by inserting a short paragraph at the beginning of each section that explains what is going to happen in that particular section. As Respondent 6 explained it, “Tell them what you’re going to tell them. Tell them. Then tell them you told them!” By setting the stage for the instructor, you allow them to anticipate the upcoming activity. Respondent 6 also shared one formatting suggestion in the Materials and Preparation table.
I did not include a true anticipatory set, but instead chose to set the stage by including a goal statement at the beginning of the BEE Program.

**Respondent 7: Elementary educator**
Respondent 7 appreciated the parts of the lesson that instructed older students to do something different than the younger students. She claimed that the layout of the lesson was easy to follow and stated, “I feel certain a substitute teacher could teach this program without any questions.” Respondent 7 did not provide any suggestions or alternatives.

**Respondent 8: Elementary school Principal**
Respondent 8 liked the hands-on inquiry methods used in the lesson plan, and thought that the organization and visual appeal was both attractive and easy for the teacher to follow. Respondent 8 voiced concern that the terms and concepts might be too advanced for preschoolers, but visualized it working well for 2-5th grade students. Respondent 8 suggested I begin the background section by first describing the need for the lesson, then explaining the concepts that will be addressed. Finally, she suggested that at the end of the lesson, I emphasize that we all have a responsibility to reduce our pesticide use, not only farmers.

As Respondent 8 was the third education professional to suggest adding a statement before the background section, I included a goal statement. I also took her advice to emphasize that everyone has the obligation to reduce pesticide use. I brought Respondent 8’s concern about age-appropriateness to the client, who felt confident that the BEE Program’s current age range (PreK-5) satisfies the MetroParks needs. Feedback from Respondent 2, a Preschool teacher, gave me further assurance that the BEE Program is age-appropriate.

This feedback was valuable for evaluating the effectiveness of the BEE Program. I incorporated this feedback into the BEE Program and consulted with the client to develop the final version.
Appendix V: The BEE Program and Materials

The BEE Program

Grade level(s): PreK-5
Time estimate: 1 hour

The purpose of this lesson is to communicate the importance of bees as part of a healthy ecosystem. Students will learn about the plant life cycle, pollination, and how to become helpful environmental stewards by participating in hands-on inquiry activities.

Background

Pollination, the process of moving pollen from the male part of a flower to the female part, is essential to plant reproduction. In some plants, this process is facilitated by wind or mechanical vibrations, but most flowering plants rely on pollinators, such as bees, butterflies, moths, beetles, flies, birds, and bats, to reproduce. In fact, over 87% of the world’s wild plants rely on pollinators for reproduction! Pollinators are critical to ecosystem health—without them, seed and fruit production, as well as overall plant fitness and diversity, are greatly reduced.

Most pollination occurs inadvertently as a pollinator forages for nectar, a sweet substance produced in flowers to lure insects in so that the pollen can be transferred. In their search for nectar, pollinators bump up against the stamen (male parts) and get pollen stuck to their hair, scales, or feathers. When the pollinator visits the next flower in search of more nectar, some pollen from the first flower is transferred to the pistil (female part) second, therefore pollinating the second flower.

Pollinators are responsible for approximately 35% of the crops we eat, including nearly all vegetables, fruits, nuts, and even things like coffee and cocoa. Without pollinators, most global fruit, vegetable, seed, and commodity crops could experience production losses. Unfortunately, essential pollinator habitat is decreasing due to human impacts, such as pesticide use, habitat loss, and introduction of invasive species. Because of this, various pollinator populations have suffered serious global declines in recent years.

Pollinator scarcity, combined with adverse weather, pesticide application, and mites, has caused reduced harvest quantity and quality of several different crops around the world, such as almonds (California), blueberries (New Brunswick), cherries (Ontario), pumpkins (New York), and cashew nuts (Borneo).

To help these declining populations, we can reduce our pesticide use and plant pollinator-friendly plants on our property. Native plants — plants that occur naturally in a specific habitat, ecosystem, or region — are the preferred food source for native pollinators and often serve as the larval host plant for some species of pollinators. Native plants also naturally reduce pest populations and protect soil and water quality through runoff mitigation. By planting native plants, we can enhance pollinator diversity and promote healthy populations which will facilitate the pollination of the crops we depend on.

Learning Objectives

After completing the BEE Program, students should be able to:

- Describe the process of pollination
- Explain that pollinators are necessary for plants to make seeds, fruit, and food we eat.
- Describe the different ways we as humans can help pollinator populations from declining.
Vocabulary

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen</td>
<td>The very tiny grains of male reproductive cells that usually appear as a fine yellow dust. Pollen is produced by the stamens (male part) of the flower. It is a source of food for bees.</td>
</tr>
<tr>
<td>Nectar</td>
<td>A sweet liquid produced by plants as a way to attract pollinators. It is a source of food for pollinators. Honeybees store surplus nectar as honey.</td>
</tr>
<tr>
<td>Pollination</td>
<td>The transfer of pollen from the stamens (male part) of a flower to the pistil (female part). This is how plants produce fruits and seeds.</td>
</tr>
<tr>
<td>Pollinator</td>
<td>An animal that transfers pollen from male to female flower parts. Most pollinators are insects (like bees, butterflies, moths, beetles, and flies), but some are birds or bats.</td>
</tr>
<tr>
<td>Stamen</td>
<td>The male part of the flower that produces pollen. The stamen is made up of an anther and a filament.</td>
</tr>
<tr>
<td>Pistil</td>
<td>The female part of a flower. Located in the center of the flower, this is where pollen is deposited and where the seed is produced. The pistil is made up of the stigma, style, and ovary.</td>
</tr>
</tbody>
</table>

Ohio Science Standards addressed

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Life Science Topic</th>
<th>Life Science Condensed Content Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>Physical and Behavioral Traits of Living Things</td>
<td>Living things have physical traits and behaviors, which influence their survival</td>
</tr>
<tr>
<td>Grade 1</td>
<td>Basic Needs of Living Things</td>
<td>Living things have basic needs, which are met by obtaining materials from the physical environment Living things survive only in environments that meet their needs</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Interactions within Habitats</td>
<td>Living things cause changes on Earth</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Behavior, Growth, and Changes</td>
<td>Plants and animals have life cycles that are part of their adaptations for survival in their natural environments</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Earth's Living History</td>
<td>Changes in an organism’s environment are sometimes beneficial to its survival and sometimes harmful</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Interactions within Ecosystems</td>
<td>Organisms perform a variety of roles in an ecosystem</td>
</tr>
</tbody>
</table>
## Materials and Preparation

<table>
<thead>
<tr>
<th>Activity</th>
<th>Materials</th>
<th>Preparation</th>
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</thead>
</table>
| **Part I**<br>**Activity A: BEE Active**<br>Introduction to Nectar, Pollen, & Insect Pollination<br>3<sup>rd</sup>-5<sup>th</sup> graders: 1 long white pipe cleaner and 1 short white pipe cleaner per student<br>Pre-K – 2<sup>nd</sup> graders: preassembled insects<br>Flower tray stations*<br>Several colors of Jell-o powder  
  o *Note:* darker colors work best, but avoid using red and green together<br>Double sided tape<br>"No bees" symbol | • Laminated photos of bees with & without pollen  
• Peppers  
• Pepper seeds  
• Potted pepper plant  
• Bee finger puppet  
• Medium sequins: 2-3 different colors in separate containers  
• Laminated Let's Make an Inquiry! poster  
• Dry-erase marker | No preparation  
• Place 5 flower tray "garden" stations around the room  
• Apply tape to end of pipe cleaners  
• Fill flower cups at each station with ~3 tbsp. of different colored Jell-o powder, being careful not to get powder on sticky tape attached to pipe cleaners Pre-K – 2<sup>nd</sup> graders:  
• Pre-assemble insects using 2 pipe cleaners:†  
• Twist long pipe cleaner into insect body, then pinch the middle and twist.  
• Wrap short pipe cleaner around body to form wings  
• *Notes:* insect shape should be small enough to fit easily into the bottom of the paper cup flower. Bend antennae into clubs to help the insect pick up more powder.  
  3<sup>rd</sup>-5<sup>th</sup> graders can make their own insects |
| **Part II**<br>Activity B: BEE Aware<br>Felt or plastic play food<br>Paper plates, 1 per student<br>Pollinator Table poster | • Felt or plastic play food  
• Paper plates, 1 per student  
• Pollinator Table poster | No preparation |
| Activity C: BEE Helpful<br>Foam "garden" with pre-made slits<br>Artificial plants | • Foam "garden" with pre-made slits  
• Artificial plants | No preparation |
| Evaluation<br>Pollinator Passport booklets, 1 per student<br>Popsicle stick can | • Pollinator Passport booklets, 1 per student  
• Popsicle stick can | No preparation |

* Reference photos with detailed directions attached at the end of lesson plan
Activity Descriptions

Part I:  
Introduction to Nectar, Pollen, & Insect Pollination (8 Steps)

ENGAGE
1. Have the students dictate a list of insects they know. Do any of these insects help humans?  
   Briefly discuss some benefits that insects provide, such as pest control (assassin bugs, ladybugs, etc), food for birds, bats, and other species, honey production, and pollination.
2. Focus their attention on bees. What types of things do bees do? Today you are going to be a bee and learn about how bees help plants and vice versa.

EXPLORE
3. Allow students to examine the pepper, seeds, and plant. Also hand out photos of bees and pollen. Encourage students to think of three observations and three questions related to what they are looking at.
4. After a minute of observation, allow students to share their observations and questions. Write them down on the Let's Make an Inquiry! poster with a dry-erase marker. Answer their questions as they are shared. Lead them to ask questions like:
   a. Where did these seeds come from?
   b. Where did the green pepper come from?
   c. What is all over the bee in this picture?

EXPLAIN
5. After you have answered their questions, congratulate them on their inquiry skills and explain that now you will share the whole story!
6. Introduce the concept of pollination by explaining how each insect benefits by its visits to the flowers, and how each plant benefits from these visits too.
   a. Use the pepper, seeds, plant, and laminated pictures to define the following terms:

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen</td>
<td>Small, sticky, grains that the flower makes to help the plant reproduce. Pollen is also bee food.</td>
</tr>
<tr>
<td>Nectar</td>
<td>Sugary liquid made by the flower to attract bees. Nectar is used by bees to make honey.</td>
</tr>
<tr>
<td>Pollination</td>
<td>Moving pollen from the male part of a flower to the female part.</td>
</tr>
</tbody>
</table>

ELABORATE
7. Using the visual aids, explain that the flower attracts the bee by advertising its nectar with its showy flowers. Show the picture of the bee before (without pollen) and after (covered in pollen) visiting a flower. Explain that the pollen sticks to the bee’s hairy body.
   a. Demonstrate this process using the bee finger puppet: dip your fingers into the first color of sequins. Allow the sequins to stick to your fingers.
b. Now your bee will visit another flower. Dip your fingers into the second color of sequins. What happens? Sequins from your fingers get transferred from the first flower to the second flower. This is the process of pollination!

c. Ask the students, “Why do plants need bees?” Plants are stationary and cannot move, so they need bees to move the pollen for them.

8. Explain that if it weren’t for the bees, the pepper plant would not be able to produce the pepper, or the seeds inside the pepper. We would not have fruits, nor could the plant produce offspring. Different kinds of plants rely on different kinds of insects, like flies and moths, for pollination; some can only use one specific species!

**Activity A: BEE Active (5 Steps)**

1. Explain to the students that they are going to use a model of an insect to investigate how it will pollinate a flower.
   a. 3rd – 5th graders: Hand out pipe cleaners for students to create their own insect
   b. Pre-K – 2nd graders: Hand out pre-assembled pipe cleaner insects

2. Designate one station as the “Bee-Free Garden.” Place the “no bees” symbol at this station. This “garden” has been sprayed with pesticides (bug spray), so any kind of insect that tries to visit this “garden” will die.

3. Explain that the students will fly their insects in and out of the flower cups at each “garden.” Show them that there is pollen at the bottom of each flower. Ask the following questions:
   a. What do you think will happen to the insect when it flies into the flower?
   b. What do you think will happen to the taped pipe cleaner?
   c. Will pollen get transferred between the flowers?

4. Allow the students to touch their insect to the powder and taped pipe cleaner. What happened?

5. Lead students to reinforce the concepts introduced earlier and make inferences about pollination by asking the following questions:
   a. What did we use for the flower’s pollen?
   b. What happened to the pipe cleaner insects? How many colors were on the insects?
   c. What happened to the “pollen?”
   d. How do you think this relates to real flowers?
      i. Inside the flower is a pistil that is sticky like the tape. The pollen sticks to the pistil and that’s when the fruit starts to develop.
   e. Why do you think pollination is important to us?
      i. What will happen to the flowers in the Bee-Free Garden?
      ii. Without pollination, the plant cannot develop seeds - reproduce - or produce fruits and we could not have many of the foods we enjoy.
Part II:

Activity B: BEE Aware (7 Steps)

ENGAGE:
1. Engage students by asking them if they have ever been to a picnic or cooked out on a grill or fire. Get them thinking of a picnic by asking what they do at a picnic, what they eat, and so forth.

EXPLORE:
2. Explain that they are going to attend a picnic and that hot dogs, hamburgers, French fries, and fruit salad are on the menu.
   a. Lay out felt or plastic play food in the center of the room.
   b. Hand out paper plates.
   c. Using the play food, tell students they have 2 minutes to make their lunch.
3. Explain that many of the world’s bee species are dying because of pesticide use, invasive species, and habitat loss.
   a. *Pesticide use:* Farmers, homeowners, and other people sometimes spray bug spray on their fields or yards, which can hurt or kill bees even if they are not the intended target.
   b. *Invasive species:* Plants and animals that came here from another habitat. These plants and animals may harm our bees by taking away their food and homes.
   c. *Habitat loss:* When the places used by bees for feeding, breeding, and shelter are destroyed to make space for humans to build houses, cities, and roads, and to convert land into farmland.
4. Ask the students to imagine a world without bee-pollinated plants: the “Bee-Free Zone.”
   a. Ask the students to return their play food.
   b. Together, categorize them into two piles according to the Pollinator Table:

### Pollinator Table

<table>
<thead>
<tr>
<th>Pollinators Needed</th>
<th>Pollinators Not Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds</td>
<td>Cherries (cherry pie)</td>
</tr>
<tr>
<td>Apples (apple pie)</td>
<td>Coffee</td>
</tr>
<tr>
<td>Blackberries</td>
<td>Cucumbers (pickles)</td>
</tr>
<tr>
<td>Blueberries (blueberry pie)</td>
<td>Green peppers</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Mustard seed (mustard)</td>
</tr>
<tr>
<td>Chocolate (chocolate cake, ice cream)</td>
<td>Onions</td>
</tr>
<tr>
<td>Carrots</td>
<td>Raspberries</td>
</tr>
<tr>
<td>Celery</td>
<td>Tomatoes (ketchup)</td>
</tr>
</tbody>
</table>
5. Explain that now they are going to attend a Bee-Free Picnic in the Bee-Free Zone.
6. Have students make their lunch again, this time without the food pollinated by bees. Only use the food in the Pollinator Not Needed pile.
7. Have them describe the meal that remains.
   a. With a show of hands, ask students who would prefer a Pollinator Not Needed lunch over a Pollinator Needed lunch?
   b. Ask them to think about their friends and families. What kinds of foods do they like?
   c. With a show of hands, ask students how many of their friends and family members would prefer a Pollinator Not Needed lunch.

**Activity C: BEE Helpful (4 Steps)**

**EXPLAIN**
1. Explain that they can help the pollinators by planting pollinator-friendly plants in the nature in their neighborhood. As a class, we will make a pollinator garden today using pretend plants.

**ELABORATE**
2. Allow students to "plant" flowers in the slits of the foam garden. Explain that bees like plants with flowers that grow naturally in the Eastern Broadleaf Forest, which is where we live in Ohio. Use the following tips:
   a. Bees like plants with bright white, yellow, or blue flowers because they can see those colors best with their insect eyes. Bees can’t see red!
   b. Bees like when one kind of flower is planted in big clumps because they don’t have to fly as far to eat.
   c. Clumps of difference species should be planted because different species are ready to be pollinated at different times.
   d. You and your caregiver can plant a special pollinator garden in your yard or a planter on the windowsill or porch where you live!

**EVALUATE**
3. Popsicle stick game: Allow students to pull a Popsicle stick out of the can and have them each share what they learned based on the prompt they pulled from the can. Prompts include:
   a. What I learned about bees
   b. What I learned about the food I eat
   c. What I learned about pollen
   d. What I learned about plants
   e. What I learned about pollination
4. Pass out Pollinator Passport booklet for students to color and take home with them. Tell them to share the facts and pictures in the Passport with their family, friends, and neighbors.
Extensions for the Teacher

- Build a pollinator garden at your school
  - Purchase The Bee Smart School Garden Kit from The Pollinator Partnership and receive native seeds, directions for planting, and a series of 10 lesson plans and materials to start a pollinator program. To learn more, visit [http://www.pollinator.org/beesmart_give.htm](http://www.pollinator.org/beesmart_give.htm)
  - Create an outdoor classroom with the National Wildlife Federation’s Schoolyard Habitats Program. To learn how to design, build, and certify your wildlife habitat, visit [http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards.aspx](http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards.aspx)

- Participate in a citizen science project
  - The Great Sunflower Project: Join people from all over the country in collecting data on pollinators in their yards, gardens, schools, and parks. To start taking counts of the number and types of pollinators visiting plants, visit [http://www.greatsunflower.org/quickguide](http://www.greatsunflower.org/quickguide)
  - BeeSpotter: Take pictures of the bees in your neighborhood and upload them to an online database. Try to identify your bees using keys on the website, or leave it for an expert to identify. To learn more, visit [https://beespotter.org/](https://beespotter.org/)

Resource library

- Children’s Books:
  - “What if there were no bees?” By Suzanne Slade
  - “The buzz on bees: Why are they disappearing?” By Shelley Rotner
- Gardening for Pollinators: [https://www.fs.fed.us/wildflowers/pollinators/gardening.shtml](https://www.fs.fed.us/wildflowers/pollinators/gardening.shtml)
*Reference photos for Part I, Activity A: BEE Active

Figure 1. Make a flower with one small paper cup and one short white pipe cleaner: (1) Poke the end of the pipe cleaner through the bottom of the cup, (2) Bend the end of the pipe cleaner around the bottom of the cup and tape it into place, (3) Wrap double-sided tape around the end of the pipe cleaner that is inside the cup, (4) Fill with ~3 tbsp. of Jell-o powder, being careful not to get any powder on the tape.

Figure 2. Make an insect with two white pipe cleaners: (1) Bend the long pipe cleaner in half, then twist the ends together to create an insect shape, (2) Pinch the center of the body and twist to create the insect abdomen, (3) Bend the ends of the antennae into a club shape, (4) Place the insect body from Step 3 through the circle, and (5) Twist the circle around the body to form wings.

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**BEE Program**

Designed by Anna Petroff, M.En. Candidate, IES, Miami University
Pictures used during the **BEE Program**

**BEE Program**

Photos of Bees with and without pollen

*Grade level(s): PreK-5*

![Image](image1.jpg)

*Figure 1: Bombus perplexus, m, face, Centre County, PA*

![Image](image2.jpg)

*Figure 2: Apis mellifera, f, whole bee, Beltsville, Maryland*

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**BEE Program**

Designed by Anna Petroff, M.En. Candidate, IES, Miami University

Visual aids from USGS Bee Inventory and Monitoring Lab's public domain Flickr account

https://www.flickr.com/photos/usgsbiml/
Figure 1: Melissodes desponsa, f, side, Maine

Figure 3: Halictus ligatus, F, face, Morris Arboretum, Philadelphia, PA, covered in pollen from unknown plant

https://www.flickr.com/photos/usgsbiml/
Pollination is when pollen is moved from the male part of a flower to the female part.

Plants need pollinators, like bees, to make fruit, seeds, and lots of the food we eat!

Pollinators are in trouble because of bug spray (pesticides), other animals that move in (invasive species) and getting kicked out of their homes (habitat loss).

We can plant pollinator-friendly plants in our yard!

Bees like flowers that grow naturally in Ohio.

Bees like the colors white, yellow, and blue.

Bees like it when flowers are planted in clusters.

Caregiver: For a list of pollinator-friendly plants in your area, visit: https://tinyurl.com/h3m3n7z
Let’s Make an Inquiry!

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