a. Project Directors: Alex Surcica and Steve Bogash – Penn State Cooperative Extension

Project Collaborator: Jon Traunfeld – University of Maryland

Project Title: Promoting Region-wide Bee and Wasp Conservancy through IPM-based Publication

Project Type: Regional IPM Publications

b. Project Summary

Bees and wasps are not only vital pollinators and, in the case of wasps, pest control agents for agricultural and natural environments, but they are also strong barometers of the level of sustainability in production systems. While their complete role in the natural environment is inestimable, in agriculture they are responsible for the production and pest control protection of many commercially produced commodities. The decline in both managed and non-managed pollinator species, including certain wasp species, continues to be a major reason of concern because of its potentially extensive negative implications for agriculture, the economy, and the environment. Since the onset of Colony Collapse Disorder (CCD) in 2007, multidisciplinary scientific inquiry has revealed a multitude of stressors that can synergistically affect honeybees. Pathogen and pest infestation, inadequate diet, lack of genetic variability, pesticide contamination, and intensive management are some of the most frequently mentioned potential CCD-causing factors. Some of these factors, such as pesticide misuse and land development, can negatively affect the populations of non-managed pollinators as well, but the full extent of the damage is virtually impossible to document.

According to the United States Department of Agriculture, animal-pollinated vegetable, fruit and nut crops produced in the Northeast region in 2008 accounted for 1.8 billion dollars. In the Northeast region, more than 40 horticultural crops rely on or benefit from animal pollination. Throughout the U.S. over the past three years both large and small beekeeping operations have experienced significant honeybee colony losses, with yearly averages exceeding 30%. This has created a shortage of the number of honeybee colonies available for commercial pollination, resulting in higher pollination fees for growers and, ultimately, more expensive produce prices for the consumer. As a result, stakeholders from several Northeastern IPM Working Groups have raised the need for pollinator research and/or education programs.

Currently, there are no bee and wasp field guides available for the Northeast region or other regions of the Eastern United States. Through this project, we will develop a user-friendly publication on the 40 most common bees and wasps in the Northeastern United States. Aside from full color pictures and succinct lifecycle descriptions, this publication will provide the public and vegetable and fruit growers with valuable information regarding IPM-based methods of conservation and, when needed, control.
c. Background and Justification

The ongoing pollinator crisis threatens not only the balance in our natural environments, but also our food, fiber and fodder supply. More specifically, a third of the human diet relies directly or indirectly on biotic pollination (Klein et al., 2007). Pollinators are believed to contribute 9.5% of the global agricultural output, or about $153 billion (Gallaia et al., 2008). In the U.S., the value of pollination services has been estimated at $18.9 billion (Levin, 1983) for honeybees and $3 billion for native bees (Losey & Vaughan, 2006).

Without pollinators, the flowers of biotic-pollinated crops will abort or set small or misshapen fruit that takes longer to ripen, has less flavor, and is more perishable. Recently, the National Research Council’s Committee underlined the severity of this threat by assessing the status of pollinating animals through the 2007 Status of Pollinators in North America report. Overwhelming evidence gathered from experts in academia, green industry, and nongovernmental organizations has lead to an official acknowledgment of the decline in abundance and diversity of both managed and unmanaged pollinators in North America.

A serious threat to honeybees and, consequently, to a third of our food supply, CCD is one of the most publicized threats to a pollinator species. Unfortunately, dozens of other keystone pollinator species are in decline or threatened by extinction. Some of the most prominent reasons for the loss of pollinator species are pesticide misuse, habitat destruction, and invasive plant and animal species. Worldwide, more than 23 insect pollinator species have recently become extinct (NRC, 2007), and more than 34 pollinator species are endangered in the U.S. (USFWS, 2007).

In the Northeastern United States, wild bee species alone offer can sufficient pollination services for vegetable crops (Winfree, Williams, Dushoff, & Kremen, 2007). Certain wild bee species not only provide free and sustainable pollination services, but are also more effective than honeybees on a one-on-one basis. In general, commercially important wild bees pollinate more flowers per time interval and are active in inclement weather (Xerces Society, 2007). In our region, bees are directly or indirectly needed for setting or augmenting the yields of more than 40 crops. According to the United States Department of Agriculture, animal-pollinated vegetable, fruit and nut crops produced in the Northeast region in 2008 accounted for 1.8 billion dollars (USDA, 2009).

Because it is based on an increasingly intensive monocropping system, large-scale modern agriculture is considered to have a detrimental impact on pollinator populations. Even on the Northeast region’s small and diversified farms, pesticide application remains a major threat to both managed and wild bee populations (Vaughan, Shepherd, Kremen, & Black, 2007). However, intensive farming is not the only threat to pollinators. More than 140 million acres (6% of U.S. land) are developed for urban and suburban use (Wuerthner, 2002), with about 40 million acres devoted to lawns (Tallamy, 2007). These practices not only reduce pollinator-rewarding plants and nesting site availability, but also rely heavily on pesticide use. Pesticides are used in 78 million American households, with more than 90 million pounds of herbicides applied on lawns and gardens yearly (EPA, 2004). Homeowners use on average up to ten times more pesticide per acre of lawn than farmers use per acre of crop (U.S. Fish & Wildlife Service, 2000).

Recently, a Penn State team of scientists indicated that honeybees are contaminated with a record high number of pesticides. With a total of 52 different pesticides and metabolites discovered in 108 samples, all but three samples contained an average of five pesticide residues, with one pollen sample having a high record number of 17 different chemicals. The report concluded by raising concerns about the pesticides’ ability to have sublethal synergistic effects on the health of bees, under both acute and chronic exposure (Frazier, Mullin, & Frazier, 2008).
The need for more information on bee-and-wasp-friendly IPM practices is echoed by stakeholders from several IPM Working Groups, including the Northeast Vegetable IPM Working Group (Vegetable-WG, 2009), the Southern Region IPM Center (MAAREC, 2008), and the Eco Apple Working Group (Apple-WG, 2008). While there is little information on the number of wasp species, in Pennsylvania alone there are more than 400 different species of bees. In order to be able to protect and encourage bees on their farms, growers need to know how to identify them and their biology. Providing the public and vegetable and fruit growers with an easy-to-read, yet comprehensive, field guide on the most common bees and wasps represents the first step in encouraging them to adopt IPM practices for achieving long-term sustainable agricultural and natural environments.

d. Objectives and Anticipated Impacts

The lack of a comprehensive tool that allows the public and vegetable and fruit growers to identify common bees and wasps in the Northeastern United States represents a significant gap in the IPM publication database. Such a publication is not only important in conserving and enhancing the populations of bees and wasps, but it will also facilitate a better understanding of the biology of some pestiferous bee and wasp species. This will result in less use of pesticides, a better understanding of the health and economical risks most bee and wasp species pose, and a reduction in the likelihood of accidents resulting from human conflicts with bees and wasps. As an example, in the past fall season, the project investigators of this proposal have received numerous inquiries from the public and growers regarding bee and wasp identification and the best methods to conserve or control them. More than 90% of the clients that were concerned about being stung decided not to use pesticides as a method of control after learning about bee and wasp lifecycles.

The overall goal of this project is to provide the public and vegetable and fruit growers with an easy tool for identifying bees and wasps. Additionally, the bee and wasp field guide will offer information on the most up-to-date, IPM-based practices for conserving and, when necessary, controlling bee and wasp species.

Objectives:

#1: Educate growers and the public on the importance of bees and wasps for a healthy food supply and a sustainable environment;

#2: Provide the public and vegetable and fruit growers with an easy-to-use tool for identifying and learning the lifecycle of the 40 most common bee and wasp species of the Northeastern U.S.;

#3: Inform the public and vegetable and fruit growers on the best IPM practices to conserve and, when necessary, control bee and wasp species;

#4: Provide free-of-charge bee and wasp field guides to Penn State Extension Educators and master gardeners for distributing to the public and vegetable and fruit growers at programs throughout Pennsylvania;

#5: Distribute the field guides to Maryland and other surrounding states at a price that will offset only the printing costs;
#6: Make the bee and wasp field guide available on the web for easy and free-of-charge downloading and printing;

#7: Update, over the years, the online field guide with pictures and lifecycle descriptions of other bee and wasp species that users have a hard time identifying.

**Anticipated impacts:**

*Minimizing incidence of conflict between bees/wasps and humans:*

Every year, on average, 50 people in the United States die as a result of being stung by bees and wasps. About one in 200 people are extremely allergic to bee and wasp stings. As a result, most people are afraid of bees and wasps and are quick to control them, often before properly identifying them. This project will minimize these conflicts by providing the public and vegetable and fruit growers with a tool for bee and wasp identification and a description of their lifecycles. (More than 90% of bees and wasps are virtually harmless to humans.)

**Agricultural benefits:**

Currently, very few growers have the knowledge or a tool for identifying bees and wasps. An improved ability to properly identify bees and wasps important for the food production system is an essential step to having a proper IPM program. A case in point is the squash bee, *Peponapis pruinosa*. A study done by Ohio State University has revealed that only 1% of vegetable growers were aware of the important role the squash bee plays in pollinating *Cucurbita spp.* crops. Research has shown that squash bees are the main pollinators for pumpkins and, because growers cannot distinguish between them and honeybees, they often rent honeybees even though they do not need them for pollination. Providing growers with a bee and wasp field guide will allow them to correctly identify bees and assess when honeybee rental is necessary. Furthermore, learning about the lifecycle of the most common bee and wasp species will allow growers to better time their sprayings and avoid contaminating them with pesticides.

**Adoption of IPM-based practices:**

The field guide will provide the public and vegetable and fruit growers with a series of IPM-based recommendations on how to conserve and, when necessary, control bees and wasps. Informed decisions resulting from use of this field guide will minimize unnecessary bee and wasp extermination and will promote sustainable agricultural and urban/suburban environments.

e. **Approach and Procedures**

**April 1st to April 15th, 2011.** Determine the 40 most common bee and wasp species.

The list of the 40 most common bee and wasp species will be developed primarily with insect samples received for identification by the 67 Penn State Cooperative Extension offices in 2010. Further input will come from the entomology departments of Penn State University and the University of Maryland, as well as the PA and MD Departments of Agriculture.
April 15th to May 31st, 2011. Develop the beta version of the bee and wasp field guide.

The project directors will use their extensive personal image database for selecting pictures used in the field guide. Additional pictures will be obtained from Penn State University and University of Maryland faculty, Extension educators, and master gardeners. A beta version of the bee and wasp field guide will be developed and shared with the Penn State Center for Pollinator Research. (The Center for Pollinator Research is comprised of a dynamic group of 27 independent faculty, researchers, educators, extension specialists, and outreach coordinators spanning multiple departments and colleges.) Center members have also forged numerous partnerships with academic, government, and industry-related colleagues nationally and internationally (http://ento.psu.edu/pollinators). Additionally, 50 master gardeners from Penn State University and the University of Maryland will receive the beta version of the bee and wasp field guide via email and will be asked to express their opinions. The project directors will make modifications as needed according to the feedback received.

June 1st to June 30th, 2011. Fine tune the bee and wasp field guide.

The project directors will organize two field days, one with 20 fruit and vegetable growers and the other with 20 master gardeners. The usability of the field guides in the field will be assessed. Final adjustments to the beta version field guide will be made according to the feedback received during the field days.

July 1st to August 31st, 2011. Formatting and printing hardcopies of the bee and wasp field guide.

The beta version of the field guide will go through Penn State University's channels for review and approval. The final version of the field guide will be developed and copies used for Penn State Extension programs will be printed by the Penn State Publications Department at no charge to the granting agency.

For a better investment return and easier utilization, the publication will have bee and wasp pictures grouped together and separate from the information on their biology, conservation, and IPM recommendations. Bee and wasp photographs will be organized based on how similar different species appear. This will allow users to effectively and quickly identify different but similar-looking species.

The following represents a preliminary draft of the field guide:

- Cover page – name of the publication with the NE IPM logo;
- page 1 – The Publication title and the NE IPM Mission;
- page 2 – Authors and contributors;
- page 3 to 4 – Table of contents;
- Page 5 to 8 – Bee and wasp evolution;
- Page 9 & 11 – Hymenoptera taxonomy;
- Page 12 & 13 – Bee and wasp taxonomic classification;
- Page 14 to 17 – Social vs. Solitary: Lifecycle and behavior;
- Page 18 to 19 – Different nesting strategies;
- Page 20 to 40 – Standardized pictures of the 40 most common bees and wasps – similar-looking specimens will be grouped together;
- Page 40 to 50 – Conservation recommendations for bees and wasps;
- Page 50 to 60 – Control recommendations based on the most up-to-date IPM practices;
- Page 60 – Further readings.
September 1st to October 1st, 2011. Promoting and distributing the bee and wasp field guides.

Once the digital version of the field guide is available, the project directors will post it on the Penn State Center for Pollinator Research website. Additionally, they will contact the publication departments of the other land-grant universities in the region and share the link for the field guide. Requests for printing field guides for other states in the Northeast region will be processed at a fee that will cover only the printing costs. On an as-needed basis, free field guide copies will be available at all 67 Penn State Cooperative Extension offices.

f. Project Evaluation Plan

**Situation:** Provide the public and fruit and vegetable growers with a field guide that will allow them to correctly identify the 40 most common bees and wasps in the Northeast region and make informed decisions regarding conserving or controlling them.

**Priorities:** Reduce human conflicts with bees and wasps, minimize pollinator decline, and foster agricultural and environmental sustainability.

**(Program Action—Logic Model)**

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The project directors will identify pollinator-related programs delivered by Extension educators and master gardeners from Penn State University and the University of Maryland in the fall of 2011. Through these programs, 400 field guides and will be distributed free-of-charge to the public and vegetable and fruit growers. Mail and email addresses will be collected for sending surveys that will assess the short-, medium-, and long-term impacts. The short-term impact will be assessed one month after the field guides
have been distributed. Users will be asked to provide information regarding their ability to identify bees and wasps as a result of using the field guide. The users' knowledge of the proper methods of conservation and control will also be tested.

December 15th, 2011.

Two months after the first round of surveys have been answered, a second round of surveys will be sent out to determine the field guide users’ ability to minimize conflict incidence with bees/wasps. In our region, yellowjackets (social wasps) become more aggressive at the end of the growing season. Therefore, this is an ideal period to determine the medium-term impact this project has on the users.

Both surveys will contain both close-ended and open-ended questions formulated to register the publication’s impact. The following represents a set of proposed inquiries:

1) What is the audience’s understanding of the importance of bees and wasps;  
2) What is the audience’s ability level in distinguishing between aggressive and non-aggressive bees and wasps; 
3) How prepared is the audience in dealing with possible hymenoptera stinging accidents; 
4) Did the audience access new research-based information on bees and wasps; 
5) How proactive is the audience in conserving and enhancing bee and wasp populations on their property.

Two weeks after the second survey is sent out, the results of the two surveys will be summarized and submitted to Northeastern IPM Center.

g. Cooperation, Institutional Units and Key Personnel Involved

Alex Surcica, Ag Eng (MS) – Horticulture Extension Assistant for Penn State Cooperative Extension Project Director

Alex will be responsible for managing the day-to-day activities, designing the field guide, sending out surveys, gathering feedback, and developing and submitting the final report.

Steve Bogash – Regional Horticulture Educator for Penn State Cooperative Extension Co-Project Director

Steve will oversee the project, provide technical expertise, and help prepare the final report.

Jon Traunfeld – Extension Specialist & Maryland State Master Gardener Coordinator Project Collaborator

Jon will provide feedback and expertise and will help project directors distribute the bee and wasp field guide to the targeted audience residing in Maryland.
Bibliography


