Project Description

a. Project Director(s), Project Title, and Project Type

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Project Title: Minimizing the Impact of Pesticide Applications on Pollinators; A Train-the Trainer Program for Extension Educators and Master Gardeners

Project Type: IPM Issues

b. Project Summary

Pollinators are not only vital players for agricultural and natural environments, but are also strong barometers of the level of sustainability in production systems. While their complete role in the natural environment is inestimable, in agriculture pollinators are responsible for the production of every third bite we eat. The ongoing decline in many pollinator species represents a worldwide environmental and economic threat. Recently, the US National Research Council's Committee underlined the magnitude of this threat and recommended that "as part of their outreach, federal granting agencies should make an effort to enhance public understanding of the importance of pollination as an ecosystem service through support for citizen-scientist monitoring programs, teacher education, and K-12 and general public education efforts that center on pollination". Northeast stakeholders from several IPM Working Groups have also raised the need for outreach efforts in pollinator education programs.

In this project, Extension Horticultural Educators and Master Gardeners will be provided with a train-the-trainer program on the most up-to-date pollinator-friendly IPM practices. The program will be delivered at nine sites (six in Pennsylvania and three in Maryland) for approximately 360 attendees, and each session will be broadcasted as a webinar for a total estimated 2,000+ off-site participants. At each site, the trainees will be provided with an intensive, full-day (8 hour) workshop covering pollinator biology, ecology, taxonomy, habitat requirements, and how to minimize the impact of pesticide applications on pollinators. Additionally, the participants will be provided with reference material that can be utilized in future educational programming. By participating in a train-the-trainer program, Extension Horticulture Educators and Master Gardeners will have the chance to improve their knowledge on pollinator species and importance; and how to better manage pollinators and their vital environmental services.

c. Background and Justification.

Animal pollinators have an immense ecological and commercial value. Throughout their estimated 140 to 180 million years of existence (Bell, Soltis, & Soltis, 2007), flowering plant species have coevolved with animals and have achieved mutual dependency. Worldwide, more than 200,000 flowering plant species (National Research Council,

2007), representing 75% of all angiosperms (Davies et al., 2004), rely on animal pollinators for vectoring sexual genetic information (pollen gametes) between plants of the same species located in the same or far apart plant populations. With animal pollination, plants are more likely to cross-pollinate and acquire a more heterogeneous genetic pool, which improves their adaptability to environmental variableness.

The pollination services provided to the environment by animal pollinators are vital, but often unquantifiable. However, various attempts have been made to put a pecuniary value on pollination services delivered by animals, herein mostly bees, to cultivated crops. It is estimated that a third of the human diet relies directly or indirectly on biotic pollination (Klein et al., 2007). Animal pollinators contribute 9.5% to the global agricultural output, which is valued at $153 billion, (Gallaia, Sallesc, Setteled, & Vaissière, 2008). In the United States, the value of pollination services has been estimated as much as $18.9 billion (Levin, 1983) for honeybees and $3 billion for wild bees (Losey & Vaughan, 2006). In crops that require bee pollination (e.g. cucurbits), if bees are not present or are in low numbers the flowers will abort or set small, misshaped, flavorless and very perishable fruit. Many other crops can be pollinated by wind (e.g. tomatoes), but they will have better yields when bees augment the pollination process.

Recently, Maryann Frazier, Senior Extension Educator, along with a Penn State team of scientists studying CCD, has indicated that honeybees involved in pollinating agricultural crops are contaminated with a record high number of pesticides. The research has analyzed108 pollen samples collected from various sources, but mainly from large beekeeping operations involved in providing pollination services, some of which were affected from Colony Collapse Disorder (CCD). The samples were checked for 171 chemicals and some metabolites. With a total of 52 different pesticides and metabolites discovered, all but three samples contained on average five pesticide residues, with one pollen sample having a high record number of 17 different chemicals. About 61% of all compounds were either insecticides or insecticide metabolites, with pyrethroids and carbamates being most prevalent. The report concluded with raising concerns about the possibility that pesticides could have lethal and sublethal synergistic effects on the health of bees, under both acute and chronic exposure (Frazier, Mullin, & Frazier, 2008).

Because it is based on a system of intensive monocropping, modern agriculture is frequently identified as having the most detrimental impact on the pollinator populations due to lack of diversity and heavy pesticide reliance. Even on the Northeast's small and diversified farms, pesticide application remains the single, major threat for both managed and wild bee populations (Vaughan, Shepherd, Kremen, & Black, 2007). However, more than 140 million acres (6% of US land) are developed for urban and suburban use (Wuerthner, 2002), with about 40 million acres devoted to lawns (Tallamy, 2007). This land development not only reduces pollinator-rewarding plants and nesting site availability, but also relies heavily on pesticide use. Pesticides are used in 78 million American households, with more than 90 million pounds of herbicide 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 on their crops (U.S. Fish & Wildlife Service, 2000).

A serious threat to honeybees and, consequently, to a third of our food supply, Colony Collapse Disorder (CCD) is one of the most publicized decline threats to a pollinator species. Unfortunately, dozens of other keystone pollinator species are either in decline or becoming extinct. Prominent reasons for the loss of animal pollinators are pesticide misuse, habitat destruction, and invasive plant 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. alone (USFWS, 2007). By learning and adopting proper IPM practices, both growers and homeowners can reverse the current trend, and acquire long-term environmental sustainability.

In the Northeastern United States, wild bees alone offer sufficient pollination services for vegetable crops (Winfree, Williams, Dushoff, & Kremen, 2007). Wild bees not only provide free and sustainable pollination services, but are more effective than honeybees by pollinating more flowers per time interval and being active in inclement weather (Xerces Society, 2007). In this region, bees are directly or indirectly needed for setting or augmenting yields for more than 40 crops. According to the United States Department of Agriculture, the commercial bee pollinated vegetable, fruit and nuts crops produced in the Northeast region in 2008 accounted for 1.8 billion dollars (USDA, 2009). As a result, the need for more information on pollinators and on pollinator-friendly IPM practices is echoed by stakeholders from several IPM Working Groups, including the Northeast Vegetable IPM Working Group (Vegetable-IWG, 2009), Southern Region IPM Center (MAAREC, 2008), Eco Apple Working Group (Eco-Apple-IWG, 2008), Northeast PMSP (Richards, 2006). In Pennsylvania alone, there are more than 400 different species of bees, and in order to be able to protect and encourage them on their farms, growers need to know how to identify them and their biology.

In 2009 alone, 490 Penn State Master Gardeners serving the Garden Hotline (a free service that provides the general public with diagnosis and recommendations on various household and garden topics) in 47 counties have received 2,975 insect-related questions, and 1,229 insect samples. Particularly in the fall season, Master Gardeners respond on a daily basis to inquiries from the general public on methods for exterminating “bees”, an appellative often used to describe yellowjackets. By participating in a train-the-trainer program, both Extension Horticulture Educators and Master Gardeners will have the chance to improve their knowledge on different types of pollinators and their importance, and to educate growers and the general public how to better manage pollinators and their vital environmental services.

Example: James is an Extension Horticultural Educator who needs to provide growers with information regarding the pollination needs of pumpkin crops. As a result of attending the train-the-trainer program, James knows what the most important pollinators for pumpkins are, and how to assess their populations in the field. Furthermore, he is able to make recommendations to the growers regarding the need of renting bees, the type of bees (honeybees or bumblebees) needed, the number of hives

per acre, and the methods through which the grower can increase the wild bees on his farm. James's expertise allows the grower to become more profitable and sustainable, which benefits the region at large.

Example: Linda is a Master Gardener who volunteers for the Garden Hotline. Late in fall, she receives a phone call from a client who claims that he has a swarm of bees in his wall. Not only will she be able, through a few simple questions, to properly identify the "bees" as yellowjackets, but she will also be able to tell him the best steps (often requiring no pesticides) to take to mediate the problem. Linda's knowledge on the biology of different hymenopteran will cut pesticide use and will make a positive change in the general public attitude towards bees and wasps—a group of insects that are much too often unfairly targeted as aggressive nuisances.

c. Objectives and Anticipated Impacts

The main objective of this educational program is to provide Extension Horticultural Educators and Master Gardeners with research-based information on how pesticides and habitat affects our pollinator populations and what garden practices the general public can implement to provide a safe habitat for both native and introduced (honey bees) pollinators. The trainees will be provided with all the necessary materials and references needed for further training their colleagues and clients. The anticipated impact is that this information will reach green industry personnel and the general public, having a ripple effect in the society, and bringing a positive change to the current trend of decline in pollinator species.

The following represent some of specific aims of the proposed effort:

- Educate the trainees about different types of pollinators and their biology;
- Teach the participants about the foraging and nesting habitats different pollinators need;
- Enhance the attendees' ability to distinguish between different types of pollinators, with an emphasis on native bees
- Instruct participants about how they can use knowledge about pollinator biology and habitat requirements for achieving pollinator friendly IPM;
- Instruct the participants on what IPM practices have the most positive impact on pollinators;
- Inform trainees about what the higher risk pesticides are and what softer alternatives are in the IPM tool box.

The recent national pollinator crisis emphasizes more than ever the need for outreach efforts that will educate growers and the general public about the importance of pollinators. Extension Horticultural Educators and Master Gardeners provide an invaluable service to their communities by answering inquiries concerning plants, plant diseases, insects, wildlife and cultural practices. They provide non-biased and research-based information that allows growers and the general public to make choices that both protect the environment and promote successful growing techniques. In 2009, Penn

State Master Gardeners have established more than 18,000 contacts. Providing Extension Educators and Master Gardeners with valuable training on pollinator-friendly IPM practices will have a strong, positive impact on how their clients protect and encourage pollinators.

Completing a 3 month post evaluation will provide impact data on number of outreach events occurred after the train the trainer classes and how many more people might adopt IPM practices as a result of the educational programming.

d. Approach and Procedures

In this project, Extension Horticultural Educators and Master Gardeners will be provided with a train-the-trainer program on the most up-to-date IPM pollinator-friendly practices. In collaboration with University of Maryland – Cooperative Extension, personnel from Penn State University – Cooperative Extension, and Penn State University – Entomology will deliver the proposed program at nine sites for approximately 360 attendees, and each session will be broadcasted as a webinar for a total estimate of more than 2,000 off-site participants. At each site, the trainees will be provided with an intensive, full day workshop that will cover pollinator biology, ecology, taxonomy, habitat requirements, and how to minimize the impact of pesticide applications on pollinators. Additionally, the participants will be offered references and contacts that will satisfy their future need for information on pollinators. The following represents the program schedule, the sites where it will be presented, and the number of people expected to be trained on-site:

Pennsylvania

1) March 15th, 2010 – Lackawanna County Coop. Ext. – 40 on-site
2) March 16th, 2010 – Berks County Coop. Ext. – 40 on-site
3) March 22nd, 2010– Clinton County Coop. Ext. – 40 on-site
4) March 23rd, 2010– Venango County Coop. Ext. – 40 on-site
5) March 24th, 2010 – Westmoreland County Coop. Ext. – 40 on-site
6) March 25th, 2010 – Cumberland County Coop. Ext. – 40 on-site

Maryland

1) April 13th, 2010 – Harford County Coop. Ext. – 40 on-site
2) April 14th, 2010 – Queen Anne's County Coop. Ext. – 40 on-site
3) April 15th, 2010 – Washington County Coop. Ext. – 40 on-site

For each of the above-mentioned sites, the program will be comprised of four main sessions (1.5 hours each), and will adjourn with a panel session (1 hour) that will answer questions on various pollinator topics.

1) Identifying Pollinators for a Proper IPM, Instructor John Baker

Description: The instructor will elaborate on the diverse types of pollinators in our area, their importance, and how they can be identified. In the second part of the session, he

will provide a hands-on workshop on monitoring bees, bee pinning and preserving bees, and on taxonomic identification techniques. Furthermore, the attendees will be provided with the basic tools and references that will satisfy future identification needs. This session will enhance the participants' general knowledge of pollinator identification, allowing them to make appropriate control or non-control decisions.

2) How Landscape Design affects pollinator health, Instructor Ginger Pryor

Description: The instructor will inform attendees on how the pollinators' natural foraging habitat has changed through industrial, residential and agricultural development. In the second part of the session, she will provide tips and landscape design techniques that can support pollinator health and survival through diverse, consistent, and stable food and water sources.

3) Developing Pollinator-nesting Habitats, Instructor Alexandru Surcica

Description: The instructor will present the audience with information on the nesting needs for various pollinators present in the Northeast region, with a focus on bee nesting habitat. In the second part of the program, he will present a workshop on how to build manmade nesting habitats for cavity- and wood-nesting bees. The participants will be presented with blue prints and a list of instructions regarding how to care for the bee domiciles.

4) Understanding Pesticide Impacts on Pollinators, Instructor Maryann Frazier

Description: The instructor will present the audience with research-based information regarding the lethal and sub-lethal synergistic effects of pesticides on pollinators under both acute and chronic exposure. In the second part of the session, she will inform the participants on softer alternatives to the currently favored pesticides for agricultural and garden settings, which are highly toxic to bees.

5) Panel of discussions with all the Instructors

The instructors will provide a one hour-long session that will cover the participants' questions regarding pollinators and IPM practices.

In addition to the workshops and educational sessions, each county representative at educational program will be provided with:

a) CD with PowerPoints that can be used by local educators and Master Gardeners
b) CD with the Penn State Pollinator Series and other relevant handouts that can be reprinted locally
c) Hard copies of the Penn State Pollinator Series and other relevant handouts.
d) Sample board with pinned native bees to be used for identification and educational purposes

Webinar

Each session will be adapted to a Webinar that will be offered to Master Gardeners and Extension Educators. Webinars well be recorded and made avaliable for future trainings. These webinars have the potential of reaching over 2000 additional trainees.

e. Evaluation Plans

The impact of this program will be evaluated through multiple avenues:
Educational sessions will be evaluated through pre- and post-session surveys asked through the use of Turning Point, an audience response system that integrates with PowerPoint presentations. Through these surveys the project coordinators will be able to statistically determine the participants' newly acquired level of knowledge on:

- Different types of pollinators and their biology;
- Foraging and nesting habitats different pollinators need;
- Distinguishing between different types and species of pollinators, with emphasis on native bees;
- How they could use the knowledge about pollinator biology and habitat requirements for achieving pollinator friendly IPM;
- What IPM practices have the most positive impact on pollinators;
- Which pesticides are considered higher risk, and what are the softer alternatives in the IPM tool box;

Additionally participants will be asked to participate in an On-line survey 3 months after training to determine:

- Number of programs delivered in local communities;
- Demographics of participants, commercial or consumer horticulture;
- What IPM recommendations were provided that could have a positive impact on pollinators

Works Cited

Bell, C., Soltis, D., & Soltis, P. (2007). The Age of the Angiosperms: A Molecular Timescale Without a Clock. *Evolution* , 1245-1258.

Eco-Apple-IWG. (2008, January). *Eco Apple Working Group Research Priorities Results – January 2008.* Retrieved December 5, 2009, from Northeast IPM Center: http://northeastipm.org/priority/2008/eco-apple.pdf

Frazier, M., Mullin, C., & Frazier, J. (2008). What Have Pesticides Got to Do with It? *American Bee Journal*, 521-523.

Gallaia, N., Sallesc, J.-M., Setteled, J., & Vaissière, B. E. (2008). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics* .

Julier, E., & Roulston, T. (2009). Wild bee abundance and pollinating service in cultivated pumpkins: farm management, nesting behavior and landscape effects. *Ecology and Behavior*, 563-573.

Levin, M. D. (1983). Value of bee pollination to U.S. agriculture. *Bulletin of the Entomological Society of America* , 59–51.

Losey, J., & Vaughan, M. (2006). The economic value of ecological services provided by insects. *Bioscience* , 311-323.

MAAREC. (2008, March). *Pest Management Strategic Plan For Honey Bees in The Mid-Atlantic States (DE, MD, NC, NJ, PA, SC, VA, WV).* Retrieved December 5, 2009, from IPM Centers: http://www.ipmcenters.org/pmsp/pdf/MidAtlanticHoneyBeePMSP.pdf

National Research Council. (2007). *Status of Pollinators in North America.* Washington: National Academy Press.

Richards, K. (2006). *Sweet Corn Pest Management Strategic Plan (Northeastern States).* State College, PA: The Pennsylvania State University.

U.S. Environmental Protection Agency. (2004). *Pesticides Industry Sales and Usage.* EPA-733-R-04-001.

U.S. Fish & Wildlife Service. (2000, July). *Homeowner's Guide to Protecting Frogs*. Retrieved August 3, 2009, from U.S. Fish & Wildlife Service: http://library.fws.gov/Pubs9/frogs_gardencare_brochure.pdf

USDA. (2009, October). *Statistics.* Retrieved October 28, 2009, from National Agricultural Statistics Service: http://usda.mannlib.cornell.edu/usda/current/CropValuSu/CropValuSu-02-13-2009.pdf

Vaughan, M., Shepherd, M., Kremen, C., & Black, S. H. (2007). *Farming for bees.* Portland: Xercy Society.

Vegetable-IWG. (2009). *IPM Needs and Priorities for Vegetable Crops and Strawberries in the Northeast Region, 2009.* Retrieved December 5, 2009, from Northeast IPM Center: http://northeastipm.org/work_vegpriority2009.cfm

Winfree, R., Williams, N., Dushoff, J., & Kremen, C. (2007). Native bees provide insurance against ongoing honey bee losses. *Ecology Letters* , 1105-1113.

Winfree, R., Williams, N., Gaines, H., Ascher, J., & Kremen, C. (2007). Wild bee pollinators provide the majority of crop visitation across land-use gradients in New Jersey and Pennsylvania, USA. *Journal of Applied Ecology* .