First National Conference on Protecting Pollinators in Ornamental Landscapes

October 12-14, 2015

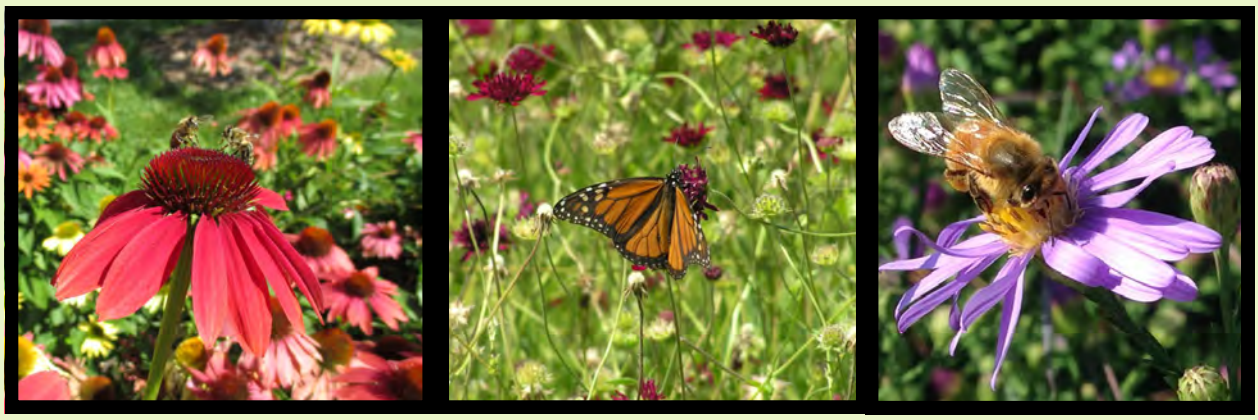
Kanuga Conference Center

Hendersonville, North Carolina

Co-organized by:

Michigan State University Extension

North Carolina State University



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Conference at a Glance

October 12, 2015	
3:00 - 6:00	**Registration and Information Table Open - Cunningham Lobby**
6:00 - 6:45	**Dinner - Dietz Dining Room**
6:45 - 7:00	**Opening Remarks - Balthis-Rodwell Building, Plenary Room**
7:00 - 7:30	**Opening Keynote**: Dave Goulson, University of Sussex, United Kingdom
7:30 - 10:00	**Mixer** (cash bar available) **- Cunningham-Nevius Pavilion**

October 13, 2015	
8:00 - 8:45	**Breakfast - Dietz Dining Room**
8:45 - 9:45	**Function of Pollinators in Ornamental Landscapes - Balthis-Rodwell Building, Plenary Room**
8:45 - 9:15	Keynote: Rufus Isaacs, Michigan State University
9:15 - 9:30	Emily Minor, University of Illinois at Chicago
9:30 - 9:45	Rebecca Irwin, North Carolina State University
9:45 - 10:00	Break - Balthis Foyer
10:00 - 11:45	**Threats to Pollinators in Ornamental Landscapes - Balthis-Rodwell Building, Plenary Room**
10:00 - 10:30	Keynote: Jane Memmott, University of Bristol, United Kingdom
10:30 - 11:00	Keynote: Kirsten Traynor, University of Maryland
11:00 - 11:15	David Tarpy, North Carolina State University
11:15 - 11:30	Margarita López-Uribe, North Carolina State University
11:30 - 11:45	Discussion
12:00 - 12:45	**Lunch - Dietz Dining Room**
12:45 - 3:30	**Pesticides and Pollinators - Balthis-Rodwell Building, Plenary Room**
12:45 - 1:15	Keynote: Nigel Raine, University of Guelph, Canada
1:15 - 1:30	James Frazier, The Pennsylvania State University
1:30 - 1:45	Pete Nowak, University of Wisconsin-Madison
1:45 - 2:00	Dave Smitley, Michigan State University
2:00 - 2:15	Break - Balthis Foyer
2:15 - 2:45	Keynote: Dan Potter, University of Kentucky
2:45 - 3:00	Cynthia Scott-Dupree, University of Guelph, Canada
3:00 - 3:15	Mike Raupp, University of Maryland
3:15 - 3:30	Discussion
3:30 - 4:00	Break - Balthis Foyer
4:00 - 5:00	**Industry Perspectives from our Sponsors - Balthis-Rodwell Building, Plenary Room**
5:00 - 6:00	Break/Poster set-up
6:00 - 6:45	**Dinner - Dietz Dining Room**
7:00 - 10:00	**Poster Session and Social** (cash bar available)**-Johnson Fireplace Lounge & Rocking Chair Porch**

Conference at a Glance

October 14, 2015	
8:00 - 8:45	**Breakfast - Dietz Dining Room**
8:45 - 10:00	**Boots on the Ground: Efforts, Challenges, and Opportunities for Protecting Pollinators - Balthis-Rodwell Building, Plenary Room**
8:45 - 9:00	Meghan Milbrath, Michigan Pollinator Initiative, Michigan State University
9:00 - 9:15	Terril Nell, American Floral Endowment
9:15 - 9:30	Dave Goulson, University of Sussex, United Kingdom
9:30 - 9:45	Casey Sclar, American Public Gardens Association
9:45 - 10:00	Discussion
10:00 - 10:15	Break - Balthis Foyer
10:15 - 11:45	**Educating the Public - Balthis-Rodwell Building, Plenary Room**
10:15 - 10:45	Keynote: Heidi Wollaeger, Michigan State University Extension
10:45 - 11:00	Connie Schmotzer, The Pennsylvania State University
11:00 - 11:15	Debbie Roos, North Carolina State University, Chatham County Extension
11:15 - 11:30	Susan Varlamoff, University of Georgia
11:30 - 11:45	Discussion
11:45 - 12:00	Break - Balthis Foyer
12:00 - 12:45	**Lunch - Dietz Dining Room**
1:00- 5:30	**Optional: Biltmore Gardens Horticultural Tour - Meet in Cunningham Lobby**
6:00 - 6:45	**Dinner - Dietz Dining Room**

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American Floral Endowment

North Carolina Nursery & Landscape Association

Conference Agenda

October 12, 2015

3:00 - 6:00 **Registration and Information Table Open**

6:00 - 6:45 **Dinner**

6:45 - 7:00 **Opening Remarks**, *Moderated by Steven Frank*

Conference Planning Committee, North Carolina State University Dean

7:00 - 7:30 **Stresses Faced by Bumblebees in Urban Landscapes**

Keynote: Dave Goulson, University of Sussex, United Kingdom

Bee declines are generally attributed to the combined stresses from lack of flowers and nesting sites, exposure to non-native parasites and diseases, and exposure to pesticides. However, bees in urban landscapes face slightly different combinations of pressures than those living in the countryside. Floral density may be high, but many of the flowers may be domesticated varieties which are not rewarding. For many bee species, nesting opportunities in urban areas may be plentiful. They are likely to be exposed to different pollutants and toxins such as traffic fumes, as well as to pesticides used by gardeners. Diseases are likely to be similar to those encountered in the countryside, although there is some evidence that prevalence may be higher in urban areas. With small changes in management, urban areas clearly have potential to become largely benign environments for pollinators.

7:30 - 10:00 **Mixer** (Cash Bar Available)

October 13, 2015

8:00 - 8:45 **Breakfast**

8:45 - 9:45 **Function of Pollinators in Ornamental Landscapes,** *Moderated by Elsa Youngsteadt*

8:45 - 9:15 **Understanding Wild Bee Biology to Guide Bee Conservation Strategies**

Keynote: Rufus Isaacs, Michigan State University

There is a vast diversity of bee species found across the United States, with varied life cycles, nutritional needs, and nesting preferences. Enhancing the resources that limit their populations can help support bees in all types of habitats, including ornamental landscapes. Rufus will review the life cycles of bees commonly seen in ornamental landscapes, and strategies for enhancing their abundance through provision of habitat for foraging and nesting.

9:15 - 9:30 **Humans, Gardens, and Bees in the City**

Emily Minor, University of Illinois at Chicago

This talk will describe ongoing research in residential gardens around Chicago (Illinois, USA). Emily will discuss socioeconomic drivers of plant and pollinator biodiversity in these gardens and how they affect plant-pollinator interactions.

9:30 - 9:45 **Pollination Services to Native Plants in Urban Landscapes**

Rebecca Irwin, North Carolina State University

By sampling bees and using observations and experiments, Rebecca Irwin and co-authors Adrian Carper, Lynn Adler, and Paige Warren show that suburban habitats hold conservation value for native bees. However, native plants growing in the suburban matrix may not reap the benefits of pollination services from those native bees, with potential effects on plant ecology and patterns of natural selection.

9:45 - 10:00 **Break**

Conference Agenda

10:00 - 11:45	**Threats to Pollinators in Ornamental Landscapes,** *Moderated by Heidi Wollaeger*

10:00 - 10:30 **The Urban Pollinators Project**

Keynote: Jane Memmott, University of Bristol, United Kingdom

Between 2011 and 2014 a team of academics, practitioners and taxonomists studied the pollinators in urban habitats asking three questions: 1) where exactly is the pollinator biodiversity in the UK – urban habitats, farmland or nature reserves; 2) where are the hot-spots of pollinator biodiversity in cities and 3) what can we do to improve pollinator biodiversity and abundance in urban habitats? This talk will explain the background to the project, the approach used, present the results and discuss the implications of the work for the conservation of pollinators.

10:30 - 11:00 **Honey Bee Health: The Complex Web of Colony Decline**

Keynote: Kirsten Traynor, University of Maryland

Colony losses remain high, with beekeepers losing 30% of their colonies over the winter and 50% annually. Large eusocial colonies have a substantial and flexible workforce that can compensate and help the colony recover from a single stressful event, but colony health may dwindle when faced with multiple challenges. Changing agricultural practices, introduced parasites, migratory stress, poor nutrition, increased pressure from viruses, and pesticide exposure all impact colony health, often interacting synergistically. Our five year National Honey Bee Disease Survey indicates a central role of the introduced parasitic mite Varroa destructor *and an increasing prevalence of a suite of honey bee viruses.*

11:00 - 11:15 **Beekeeping in the City: What Urban Living Means to Honey Bees**

David Tarpy, North Carolina State University

Beekeeping has become an increasingly popular hobby for many city dwellers, but there is little information about whether urban areas are amenable to honey bees. We will explore the challenges and benefits of urban beekeeping, from both the biological and practical standpoints.

11:15 - 11:30 **Pathogens and Immune Function of Native Bees in Urban Areas**

Margarita López-Uribe, North Carolina State University

*Pathogen pressure is one of the main drivers of bee declines. Still, pathogens and disease susceptibility in non-*Apis *bee species remain poorly studied. In this talk, I will present results on pathogen intensity and immune function of three solitary bee species sampled across a gradient of urbanization. This study is leading into a deeper understanding of the pathogen community in wild bees and the mechanistic impacts of human modified habitats on the diseases and immune responses of this highly valued group of pollinators.*

11:30 - 11:45 **Discussion**

12:00 - 12:45 Lunch

Conference Agenda

12:45 - 3:30	**Pesticides and Pollinators**, *Moderated by Dave Smitley*
12:45 - 1:15	**Pesticide Impacts on Pollinators in Complex Landscapes** **Keynote:** Nigel Raine, University of Guelph, Canada *Understanding the impacts of pesticide exposure for pollinators on a landscape scale is complex. In addition to differences in levels of toxicity and exposure profile of the pesticides, impacts will depend strongly on the ecology and life-history of pollinator species. Levels of exposure in the field are typically likely to be low but may still have appreciable and long-lasting sublethal effects on the physiology, behaviour and reproductive success of bees. The impacts of combined exposure to multiple pesticides (including insecticides, fungicides, miticides and herbicides) could be more significant and represent a likely scenario in most agricultural and ornamental landscapes.*
1:15 - 1:30	**Pesticides in the Landscape and Their Impacts on Honey Bee Colony Health** James Frazier, The Pennsylvania State University *Pesticide residues are encountered by bees in pollen, nectar, and water sources across the landscape and are impacting bee health in numerous ways. Impacts on physiology and behavior at sub-lethal levels are predominant and widespread among honey bees and native pollinators alike. Recent results will be discussed and major gaps in our understanding will be highlighted.*
1:30 - 1:45	**Valuing Neonicotinoids in the Turf and Ornamental Industry** Pete Nowak, University of Wisconsin-Madison *One way of establishing value of a phenomenon is to create a counterfactual hypothesis. This means to assume the phenomenon, neonicotinoids in this case, would no longer be available and their value will become evident in the impacts, substitutions, and adjustments that would have to occur with the elimination of this product. Values for neonicotinoids based on some econometric techniques as well as some of the unanticipated impacts will be the focus of the discussion.*
1:45 - 2:00	**How Safe are Garden Center Plants for Pollinators in the Yard and Garden?** Dave Smitley, Michigan State University *Dr. Smitley will share recent research results on how greenhouse and nursery growers can finish production of flowering plants so that they will be safe for pollinators in the yard and garden. He will also explain what the stakes and tags mean when they say "neonicotinoid free" or "save the bees."*
2:00 - 2:15	**Break**
2:15 - 2:45	**Bees, Pesticides & Politics: Challenges & Opportunities for the Green Industry** **Keynote:** Dan Potter, University of Kentucky *This talk will help attendees to better understand the controversy over bees and neonicotinoid insecticides, why it matters, and how lawn and tree care professionals and homeowners can safeguard beneficial bees when controlling pests in urban landscapes. Pollinator conservation initiatives that can benefit garden centers, urban landscapes and golf courses will also be discussed.*

Conference Agenda

2:45 - 3:00 **Non-*Apis* Bees and Pesticides: Are they Different from Honey Bees?**

Cynthia Scott Dupree, University of Guelph, Canada

*Non-*Apis *bees are increasingly being recognized for their significance as pollinators. Wild, non-*Apis *bees are key pollinators of both natural and agro-ecosystems, and several non-*Apis *species are commercially managed for agricultural crop pollination. For most crops visited by bees, pesticides are routinely used for pest management, and there is growing concern about the potential negative effects of certain pesticides on wild and managed bee populations. To date, the vast majority of pesticide toxicity studies involving bees have focused on honey bees (*Apis mellifera L.*), in part because data on honey bees are required by regulatory agencies in North America and Europe for pesticide registration and re-registration. Yet because of their pronounced differences in physiology, morphology, and behaviour, honey bees and non-*Apis *bees may not be equally susceptible to a given pesticide. This presentation will focus on the difference in response to pesticides of non-*Apis *bees compared to honey bees.*

3:00 - 3:15 **Unravelling Direct and Indirect Effects of Insecticides on Pollinators and Natural Enemies in Managed Landscapes**

Mike Raupp, University of Maryland

Applications of insecticides are one of the most commonly used tactics used by arborists to manage pests of trees and shrubs. We will explore how older classes of insecticides such as organophosphates disrupt natural enemies. Misapplications of one class of insecticides, neonicotinoids, have recently focused national attention on the tree care industry. Even when used in accordance with directions and precautions on the label, applications of insecticides can have unexpected and deleterious effects on non-target organisms. We will review the science underlying indirect non-target effects and review case studies where insecticide applications affected populations and communities of non-target organisms both positively and negatively.

3:15 - 3:30 **Discussion**

3:30 - 4:00 **Break**

4:00 - 5:00 **Industry Perspectives from our Sponsors***, Moderated by Steven Frank*

4:00 - 4:15 Bayer Crop Science

4:15 - 4:30 Valent

4:30 - 4:45 Syngenta

4:45 - 4:50 Biobest

5:00 - 6:00 **Break/Poster set-up**

6:00 - 6:45 **Dinner**

7:00 - 10:00 **Poster Session** *(Poster titles and presenters listed on pages 16-17)*

Conference Agenda

October 14, 2015

8:00 - 8:45 **Breakfast**

8:45 - 10:00 **Boots on the Ground: Efforts, Challenges, and Opportunities for Protecting Pollinators**

Moderated by Thomas Dudek

8:45 - 9:00 **The Michigan Pollinator Initiative: Coordinating Growers, Beekeepers, Researchers, and Landowners for Michigan Pollinators**

Meghan Milbrath, Michigan Pollinator Initiative, Michigan State University

Bees and other pollinators are hugely important in Michigan - it is one of the top honey producing states in the country, and grows many pollinator-dependent fruits and vegetables. The Michigan Pollinator Initiative aims to protect these important pollinators by working with beekeepers, growers, landowners, and researchers. We will discuss the progress we have made, as well as the challenges and opportunities in working with so many diverse interest groups on important issues.

9:00 - 9:15 **American Floral Endowment: Laser-Focused on Floriculture Industry's Research Needs**

Terril Nell, American Floral Endowment

The American Floral Endowment is dedicated to advancing the industry through funding floriculture research, educational grants, scholarships, and internships. More than $15 million has been funded for research projects benefiting the entire industry, and more than $600,000 has been funded in scholarships designed to attract and retain the future leaders of the industry. Details will be given of past and present research programs about protecting pollinators.

9:15 - 9:30 **Engaging the Public in Pollinator Conservation**

Dave Goulson, University of Sussex, United Kingdom

Bees and pollination are great topics with which to engage the public in learning more about the natural world, and about our dependence upon it. Involving the public in 'citizen science' projects also provides an opportunity for scientists to gather large data sets, although the quality of the data can be variable. I will introduce some recent UK initiatives intended to involve the public in monitoring pollinator numbers and pollination services, and in creating habitat for pollinators.

9:30 - 9:45 **Keep Off of the Stamen and Don't Tread on our Hives: Public Gardens Protect Pollinators**

Casey Sclar, American Public Gardens Association

Public gardens occupy a critical place in the discussion surrounding pollinator health. They perform research related to plant conservation and pollinator protection, join forces with other public or private institutions to promote awareness of the issue, and educate millions of their own visitors on this topic. This all occurs against a backdrop of intentionally designed and managed spaces where the best tools are needed to achieve the highest aesthetic value. What's best practice for a garden to do?

9:45 - 10:00 **Discussion**

10:00 - 10:15 **Break**

Conference Agenda

10:15 - 11:45	**Educating the Public**, *Moderated by Elsa Youngsteadt*
10:15 - 10:45	**Consumer Perceptions of Insect Management Strategies during Ornamental Flower Production** **Keynote:** Heidi Wollaeger, Michigan State University Extension *This talk will present results of a 2-year nationwide consumer survey that queried consumer perceptions about pest control techniques during ornamental flower production. Consumer preferences, willingness-to-buy, and barriers to altering the predominant perception among consumers will be shared.*
10:45 - 11:00	**Reaching the Public – Master Gardener Citizen Science and Outreach** Connie Schmotzer, The Pennsylvania State University *Learn about two Penn State Master Gardener statewide pollinator programs: Pollinator Preferences is a citizen science monitoring program that compares pollinator visitation of straight species and cultivars of native plants. The Pollinator Friendly Garden Program certifies gardens throughout Pennsylvania that meet criteria for protecting pollinators.*
11:00 - 11:15	**If You Plant it, They Will Come: A Multi-faceted Extension Program Enhances Pollinator Conservation and Economic Development** Debbie Roos, North Carolina State University, Chatham County Extension *Debbie will give an overview of the programs she has developed to promote pollinator conservation, including a very popular demonstration garden that attracts visitors from across the state and features 160 species, 85% of them native to the area. Other programs include workshops and garden tours, a website, and social media. She will share some of the impacts of these programs and highlight successes and lessons learned.*
11:15 - 11:30	**Attracting and Preserving Pollinators through Sustainable Gardening** Susan Varlamoff, University of Georgia *Gardeners can play an important role in attracting and maintaining pollinators in their landscapes by understanding their value to the ecosystems and using practices to sustain them. Creating a landscape of mostly diverse, native plants, avoiding monocultures including large swaths of lawn, planting flowers to attract pollinators, and practicing integrated pest management are important ways to return pollinators to home gardens. The collective effect of using these methods can transform neighborhoods into ecologically rich areas.*
11:30 - 11:45	**Discussion**
11:45 - 12:00	**Break**
12:00 - 12:45	**Lunch**
1:00	**Adjourn**
1:00- 5:30	**Optional: Biltmore Gardens Horticultural Tour** *Led by: Biltmore Gardens Horticulture Department. Moderated by: Elsa Youngsteadt, Thomas Dudek, and Heidi Wollaeger* *Participants will have the opportunity to visit the nationally renowned Biltmore Gardens. Attendees will first have a one-hour horticultural tour to learn about how the Gardens managers address pest management and consider pollinator habitats. Participants will then have a two-hour self-guided visit inside the Biltmore house, gardens, conservatory, Antler Hill Village & Farm, the legacy exhibit, and the winery. The bus will depart Biltmore at 5:00 pm and return participants back to the Kanuga Conference Center.*

Speaker Profiles

Dr. James Frazier
Professor Emeritus, Department of Entomology, The Pennsylvania State University
Email: JFrazier@psu.edu

Dr. Frazier received his PhD in Entomology with a specialty in insect physiology at the Ohio State University in 1970. He went through the academic ranks at Mississippi State University from 1970 – 1980, was a Senior Scientist at DuPont Agricultural Products from 1981 – 89, and served for 10 years as Department Head at Penn State. Dr. Frazier has done research on the chemical ecology of herbivorous insects for most of his career, but has concentrated on the impacts of pesticides on honey bees for the last 8 years together with Chris Mullin, Insect Toxicologist and Maryann Frazier, Senior Honeybee Extension Specialist at Penn State. He has served on several national level policy bodies, including the USDA-APHIS-EPA National Stakeholder Conference on Bee Health, the Pellston Conference on Pollinator Risk Assessment, and has been science advisor to the National Honey Bee Advisory Board since 2009. Dr. Frazier recently received the Friend of the Industry Award from the National Honey Producers Association, and the President's Award and the Hoopengarner Award from the National Beekeeping Federation.

Dr. Dave Goulson
Professor, University of Sussex
Email: D.Goulson@sussex.ac.uk

Professor Dave Goulson was brought up in rural Shropshire, where he developed an early obsession with wildlife. He received his bachelor's degree in biology from Oxford University, followed by a doctorate on butterfly ecology at Oxford Brookes University. Subsequently, he lectured in biology for 11 years at the University of Southampton, and it was here that he began to study bumblebees in earnest. He subsequently moved to Stirling University in 2006, and then to Sussex in 2013. He has published more than 230 scientific articles on the ecology and conservation of bumblebees and other insects. He is the author of *Bumblebees; Their Behaviour, Ecology and Conservation*, published in 2010 by Oxford University Press, and of the *Sunday Times* bestseller, *A Sting in the Tale*, a popular science book about bumblebees, published in 2013 by Jonathan Cape, and now translated into German, Dutch, Swedish, Korean, Chinese and Danish. This was followed by *A Buzz in the Meadow* in 2014. Goulson founded the Bumblebee Conservation Trust in 2006, a charity which has grown to 8,000 members. He was the Biotechnology and Biological Sciences Research Council's Social Innovator of the Year in 2010, was given the Zoological Society of London's Marsh Award for Conservation Biology in 2013, was elected a Fellow of the Royal Society of Edinburgh in 2013, and given the British Ecological Society Public Engagement Award in 2014. He lives in East Sussex with his wife and their three boys.

Dr. Rebecca Irwin
Associate Professor, North Carolina State University
Email: reirwin@ncsu.edu

Rebecca Irwin is an Associate Professor new to North Carolina State University in the Department of Applied Ecology, and she is also part of the Chancellor's Excellence Faculty Cluster in Global Environmental Change and Human Well-being. Rebecca's research interests span both foundational as well as applied questions in pollination ecology. She is particularly interested in how flowering plants face tradeoffs in pollinator attraction versus plant defense against herbivores, with a focus on resistance and tolerance at the floral interface. In addition, her research explores the ecological and evolutionary consequences of global environmental change (including urbanization, climate change, and invasive species) to bee pollinator biodiversity, plant-pollinator interactions, and plant and pollinator reproductive success.

Speaker Profiles

Dr. Rufus Isaacs
Professor and Extension Specialist, Michigan State University
Email: isaacsr@cns.msu.edu

Rufus Isaacs is Professor and Extension Specialist in the Department of Entomology at Michigan State University. His research and extension program has increasingly included studies of bee community responses to various aspects of farm management including landscape diversity, habitat enhancement, and pest management. He currently leads the Integrated Crop Pollination Project, a national effort funded by USDA-NIFA's Specialty Crop Research Initiative to develop sustainable crop pollination strategies for specialty crop producers. Findings from his lab are extended to the small fruit industries and the public by talks, publications, and through on-farm evaluation and demonstration trials, providing real-world experience with new practices. For more information: www.isaacslab.ent.msu.edu and www.projecticp.org

Margarita M. López-Uribe
North Carolina State University
Email: mmlopezu@ncsu.edu

Margarita López-Uribe is a postdoctoral researcher at North Carolina State University. She obtained her BS from Universidad de los Andes (Colombia), her MS from Universidade Federal de São Carlos (Brazil) and her PhD from Cornell University. Her research program focuses on understanding how environmental change and life-history traits affect demography and long-term persistence of wild bee populations. She has been studying the genetic diversity, levels of gene flow, and dispersal of native bees for over 10 years. She has published over 10 papers on this topic and has given over a dozen invited talks about her research. Recently, she started working with the disease ecology of social and solitary bee species in urban areas.

Dr. Jane Memmott
Professor of Ecology and Head of the School of Biological Sciences, University of Bristol, UK
Email: Jane.Memmott@bristol.ac.uk

Jane Memmott is a Professor of Ecology and Head of the School of Biological Sciences at the University of Bristol, UK. She works in a variety of research fields including the impact of alien species on natural communities, the impact of farming on biodiversity, pollination ecology, urban ecology and restoration ecology. Field sites range from UK cities to Hawaiian swamps and from Somerset farms to Caledonian Pine Forest. She is primarily a field biologist who uses ecological networks as a way of asking about the impact of environmental change and she works extensively with conservation practitioners. Major contributions include working out where biocontrol agents go when they leave the sugar cane fields in Hawaii (Henneman & Memmott, Science 2001), amalgamating 11 different types of network to make a network of networks (Pocock, Evans & Memmott, Science 2012), constructing 115 island food webs to ask how functional diversity relates to network structure (Montoya, Yallop & Memmott, Nature Communcations in press) and running the Urban Pollinators Consortium project (www.urbanpollinators.org).

Dr. Meghan Milbrath
Coordinator, Michigan Pollinator Initiative, Michigan State University
Email: milbrat2@msu.edu

Meghan Milbrath is the coordinator of the Michigan Pollinator Initiative at Michigan State University. Meghan has a doctorate in Environmental Health Sciences with a focus on environmental risk assessment, and has collaborated in projects examining environment toxicological and infectious disease hazards in both humans and honey bees. She has been a beekeeper all her life, and is currently the owner/operator of the Bending Sickle Community Farm queen-rearing operation, the president of the Ann Arbor Backyard Beekeepers Club, the District 2 representative for the Michigan Beekeepers Association and the founder of the Northern Bee Network.

Speaker Profiles

Dr. Emily Minor
Associate Professor, University of Illinois at Chicago
Email: eminor@uic.edu

Emily Minor is an Associate Professor at the University of Illinois at Chicago. Her research focuses on patterns of biodiversity and human-environment interactions in urban areas. Most recently, she has become interested in residential landscapes and how the decisions people make in their yards affect organisms such as bees. A goal of her research is to make recommendations about how urban residential landscapes can contribute to conservation of biodiversity and provision of ecosystem services.

Dr. Terril Nell
Research Coordinator, American Floral Endowment
Email: terrilnell@gmail.com

Terril A. Nell, PhD, Research Coordinator, American Floral Endowment. Previously employed at the University of Florida with specialization in production and postharvest handling of floral and foliage crops (cut and potted). Research resulted in practices minimizing or eliminating bract edge burn in poinsettias, bent neck in roses, extended flower life of cut flowers and shipping and handling practices for cut and potted flowering plants. He served as Chair of the Environmental Horticulture Department for 20 years and is now Professor and Chair Emeritus of the University of Florida. In addition to working with the American Floral Endowment, Terril serves as a consultant for the floral industry, including flower growers and retail and mass market floral outlets and he conducts technical training programs in the U.S, Ecuador, Colombia and Kenya.

Dr. Pete Nowak
Professor Emeritus, University of Wisconsin-Madison
Email: pnowak@wisc.edu

Dr. Pete Nowak earned his PhD from the University of Minnesota-St. Paul in 1977. After making rank and tenure at Iowa State University he moved to the University of Wisconsin-Madison in 1985. He served there until he became Chair of Academic Programs, Gaylord Nelson Institute of Environmental Studies (2004-2007), and has been Professor Emeritus (retired) since 2011. In 1995 he co-founded AgInfomatics, LLC, an agricultural consulting firm. In this case the product registrants of neonicotinoids hired AgInfomatics to determine the value of neonicotinoids in North American agriculture and aspects of the turf and ornamental industry. Dr. Nowak will share some of the key findings of this assessment including results from a national survey of homeowners, and a survey of the membership of four of the major professional associations in the turf and ornamental industry.

Dr. Daniel A. Potter
Professor of Entomology, University of Kentucky
Email: dapotter@uky.edu

Dr. Daniel Potter, Professor of Entomology at the University of Kentucky, has studied and taught about pests and beneficial insects in urban landscapes for nearly 40 years. He has been a keynote speaker at scientific and trade conferences all over the world. Dr. Potter is a Fellow of the Entomological Society of America and has received its highest national awards for research and teaching. His industry recognitions include the U.S. Golf Association Green Section Award, the Professional Land Care Network's Leadership Award, and the American Nursery and Landscape Association's Distinguished Career Achievement Award.

Speaker Profiles

Dr. Nigel Raine
Rebanks Family Chair in Pollinator Conservation, University of Guelph, Canada
Email: nraine@uoguelph.ca

Nigel Raine, Rebanks Family Chair in Pollinator Conservation at the University of Guelph (Canada) will discuss the risks and routes of pesticide exposure for pollinators in urban landscapes, and how these can be avoided or mitigated. His research examines the behaviour and ecology of bees, and the impacts of environmental stressors (e.g. pesticide exposure) for the conservation of sustainable pollinator populations. Nigel has been lucky enough to spend almost two decades investigating bees and their intimate relationships with flowers on three continents. He is an elected fellow of both the Royal Entomological Society (FRES) and the Linnean Society of London (FLS). In addition to excellent research, Nigel is actively engaged with a wide range of stakeholders (including policy makers, farming & grower's associations, grocery chains and beekeepers), on issues related to pollinator health and conservation.

Dr. Michael J. Raupp
Professor of Entomology and Extension Specialist, University of Maryland
Email: mraupp@umd.edu

Mike is a professor at the University of Maryland at College Park. His programs focus on invasive species, urbanization, and climate change and his outreach provides training on IPM to arborists, master gardeners, and the general public. He has more than 200 publications, 1000 presentations, and is a regular guest on television and radio. His "Bug of the Week" websites, www.bugoftheweek.com and https://www.youtube.com/user/BugOfTheWeek received more than a million visits since their inceptions. Mike has received a dozen regional or national awards including the Secretary of Agriculture's Award for Environmental Protection, the Entomological Society's Achievement Award in Extension, and the Richard Harris Authors Citation from the International Society of Arboriculture. His most recent book *26 Things that Bug Me* introduces youngsters to the wonders of insects and natural history using pictures and rhymes while *Managing Insect and Mites on Woody Landscape Plants* is a standard for the arboricultural industry.

Debbie Roos
Agriculture Agent, Chatham County Extension, North Carolina State University
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Since 1999 Debbie Roos has been an Agriculture Agent for the Chatham County Center of North Carolina Cooperative Extension where she is responsible for programming in the areas of commercial vegetable production, organic production, pollinator conservation, alternative agricultural enterprises, forestry, and beekeeping. Debbie worked for three years as an agroforestry Extension agent and technical trainer for the Peace Corps in Senegal, West Africa, and later completed graduate degrees in applied anthropology and horticulture at the University of Florida. Debbie delivers educational programming to growers through regular workshops and her award-winning Growing Small Farms website (www.growingsmallfarms.org). She also works with area farmers' markets and is involved in statewide efforts to strengthen local food systems. Debbie is passionate about pollinator conservation and has planted demonstration habitats and developed resources to teach others about the importance of bees and other pollinators to our agriculture ecosystem.

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Connie Schmotzer is the Consumer Horticulture Educator for Penn State Extension in York County, PA, where she coordinates the Master Gardener Program, the Garden Hotline, and the Mid-Atlantic Ecological Landscaping partnership (MAEscapes). She also coordinates two statewide Master Gardener pollinator programs: the Pollinator Friendly Garden Certification, and "Pollinator Preferences", a pollinator monitoring program.

Speaker Profiles

Dr. Casey Sclar
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Appointed in 2012, Casey is the Executive Director of the American Public Gardens Association (APGA). He and his team serve and support over 575 gardens and their 8000+ allied members located throughout America and 14 countries. Collectively, these gardens reach over 70 million people per year and help to realize APGA's vision – "A world where public gardens are indispensable." Casey's work experience in horticulture spans almost three decades. Prior to APGA, he served over 15 years at Longwood Gardens in Kennett Square, PA as the Plant Health Care Leader - directing the Soils and Compost, IPM, Land Stewardship, and other sustainability programs. Casey has authored many publications and has presented widely on IPM and other topics in public horticulture. He holds a B.S. degree in horticulture from Cal Poly State Univ., San Luis Obispo, as well as M.S. and Ph.D. degrees in entomology from Colorado State University. In 2011, he received the APGA's Professional Citation Award for outstanding achievements in public horticulture.

Dr. Cynthia Scott-Dupree
Professor and Bayer CropScience Chair in Sustainable Pest Management, University of Guelph, Canada
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Cynthia Scott-Dupree is a Professor and Bayer CropScience Chair in Sustainable Pest Management (2014-2019) in the School of Environmental Sciences (formerly in the Dept. of Environmental Biology) at the University of Guelph and has been a faculty member there since 1986. Dr. Scott-Dupree has supervised 38 graduate students, has edited 3 books and 5 book chapters, and published 65 refereed scientific papers, 37 refereed proceedings papers, 78 technical reports and 30 extension publications. Her current research interests include sustainable management (IPM) of insect crop pests using environmentally compatible control methods in horticultural, field and greenhouse cropping systems, management of invasive alien insect species, impact of agro-ecosystems on non-target organisms, including beneficial insects such as honey bees, bumble bees, native bees and natural enemies of insect pests (i.e., biological control agents primarily for greenhouse IPM) and the development of standardized methods for assessing the risk of insecticide exposure to non-*Apis* bees (i.e., bumble bees and leafcutter bees). Born and raised in western Canada (Brandon, Manitoba), Cynthia became acquainted with apiculture and agriculture through family beekeeping and farming operations.

Dr. Dave Smitley
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Dr. Smitley works closely with the greenhouse, nursery, landscape and turf industries in Michigan to provide safe and reliable solutions to pest problems. His current work focuses on how greenhouses and nurseries can produce high quality flowers that are safe for pollinators in the yard and garden. He is also continuing work on *Ovavesicula popilliae*, a natural pathogen of Japanese beetle. Previous projects include developing emamectin benzoate as a trunk injection for emerald ash borer, and introducing *Entomophaga maimaiga* into Michigan for long-term biological control of gypsy moth.

Speaker Profiles

Dr. David Tarpy
Professor of Entomology and Extension Apiculturist, North Carolina State University
Email: drtarpy@ncsu.edu

David R. Tarpy is a Professor of Entomology and the Extension Apiculturist at North Carolina State University since 2003, after receiving a BS from Hobart College, an MS from Bucknell University, a PhD from the University of California at Davis, and a postdoctoral fellowship at Cornell University. He maintains an apiculture web site dedicated to the dissemination of information and understanding of honey bees and their management, spearheads numerous extension projects such as the 2005 New Beekeeper Cost-sharing program that created hundreds of new beekeepers within the state, and launched the Beekeeper Education & Engagement System (BEES)—an exciting new "online learning community" for knowledge and understanding of bees and beekeeping. His research interests focus on the biology and behavior of honey bee queens in order to better improve the overall health of queens and their colonies. His work has provided some of the best empirical evidence that multiple mating by queens confers multiple and significant benefits to colonies through increased genetic diversity of their nestmates, particularly through increased tolerance to numerous diseases.

Dr. Kirsten S. Traynor
Research Associate, University of Maryland and Editor of *Bee World*
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Kirsten Traynor won her first honey bee hive in a raffle and has been fascinated by these social insects ever since. As a German Chancellor Fellow of the Alexander von Humboldt Foundation in 2006-2007, she was based at the largest German Institute of Bee Research and traveled over 55,000 miles by car to meet with honey bee scientists and bee breeders throughout Western Europe, publishing 50+ articles in bee journals. Upon her return, Kirsten enrolled in graduate school and earned her PhD in honey bee biology with Dr. Robert Page from Arizona State University. Her research focused on how pheromones influence colony dynamics, pollen foraging and honey bee physiology. Kirsten joined Dr. Dennis vanEngelsdorp's lab as a post-doc in 2014, where she investigated the impacts of disease and pesticides on honey bee health. She is the author of *Simple, Smart Beekeeping* and *Two Million Blossoms.*

Dr. Susan Varlamoff
Director of the Office of Environmental Sciences, University of Georgia
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Susan Varlamoff is the Director of the Office of Environmental Sciences for the University of Georgia's College of Agricultural and Environmental Sciences. In this position, she facilitates opportunities for research, teaching and Extension faculty to become involved in environmental issues within the state, region, and nation. Previously Ms. Varlamoff helped establish University of Georgia's Research and Education Garden, a series of research plots and demonstration gardens showcasing best practices for landscape professionals as well as home gardeners. In 2000, working with a team of research scientists, she developed best management practices for home gardeners to reduce nonpoint source pollution. The strong interest in this information by fellow Master Gardeners and home gardeners prompted Ms. Varlamoff to write a book, Sustainable Gardening in the Southeast, to empower gardeners to sustain the earth's many natural resources. The book is being published by the University Press of Florida and will be available in January 2016.

Heidi Wollaeger
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Heidi Wollaeger is a greenhouse and nursery Extension educator with MSU Extension. She provides Michigan floriculture greenhouse growers with up-to-date information and recommendations for crop production by offering educational programs, individual consultations, and publications. Her current research focus is on how to market ornamental plants appealing to niche markets. She will share research results of a two-year nationwide consumer survey that queried consumer perceptions about pest control techniques during ornamental flower production. Data presented will include consumer preferences, willingness-to-buy, and barriers to altering the predominant perception among consumers.

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Poster Titles and Presenters

Extension, Outreach, and Education

Poster Location	Presenter	Affiliation	Title
A1	Kris Braman	University of Georgia	Attitudes and Opportunities to Protect Pollinators in Southern Landscapes
A2	Natalia Bjorklund	University of Nebraska	Bee Corps: Teaching Through a Systems Approach to Improve Science and Food Literacy in Children and Adults
A3	Elsa Youngsteadt	North Carolina State University	Teaching Bee Diversity and Habitat Requirements: Tools for Outreach and Extension Master Gardeners
A4	Philip Moore	The University of Tennessee	Bee Health at eXtension.org, a Bee Line from Scientist to Society
A5	Suzanne Slack	Virginia Cooperative Extension	Protecting and Promoting Pollinators in Carroll County, Virginia
A6	Nancy Bissett	The Natives, Inc.	The Florida Milkweed Project
A7	Dennis Krusac	USDA Forest Service	The Greater Atlanta Pollinator Partnership: A Model for Urban Pollinator Conservation
A8	Connie Schmotzer	Penn State	Penn State Extension Master Gardener Pollinator Programs
A9	James Quinn	University of Missouri	Formulating a Missouri Master Pollinator Program
A10	Katherine Baldock	University of Bristol	Improving Urban Habitat Management for Insect Pollinators and People

Poster Titles and Presenters

Habitat and Ecology Research

Poster Location	Presenter	Affiliation	Title
B1	Jen O'Brien	North Carolina State University	Survey of Anthophilous Insects in Wildflower Habitat and Wildflower-free Habitat Along Interstates in North Carolina
B2	Catherine Neal	University of New Hampshire	Planting Wildfowers for Pollinators in Northern New England
B3	Bernadette Mach	University of Kentucky	Pollinator Conservation in the Urban Landscape
B4	Jaime Pawelek	UC Berkeley	The Value of Using Both Native and Non-native Plants to Attract Native Bees in Urban Gardens
B5	Rufus Isaacs	Michigan State University	Evaluation of Michigan Native Plants and 'Bee Keeper Picks' for Pollinators in Michigan
B6	Arthur (Art) Davis	University of Saskatchewan	Nectar and Pollen Production from Selected Plants Recommended for Home Gardens
B7	Maria Carolina Simao	University of Michigan	Experimental Evidence of How Ornamental Flower Density Affects Pollinator Diversity in Urban Landscapes
B9	Rachael Bonoan	Tufts University	Honey Bee Health and Nutrition: Why Do Honey Bees Like Dirty Water?
B10	April Hamblin	North Carolina State University	Do Thermal Limits Predict Wild Bee Community Response to Urban Warming?
B12	Kelsey Graham	Tufts University	Bee Battles: Are Our Native Pollinators Losing the War for Resources?
B13	Steven Frank	North Carolina State University	Can Forests Take the Heat? Managing Pests and Ecosystem Services Under Climate Change

Pesticide Research and Policy

Poster Location	Presenter	Affiliation	Title
C1	Jim Frazier	The Pennsylvania State University	A New Stage Structured Model of Honey Bee Colony Population Dynamics: Assessing Impacts of Pesticides and Other Stressors
C2	Rosemarie Radford	Pesticide Research Institute	Optimizing Pest Control for Ornamental Plants: Tools for Comparing Pesticide Impacts
C3	Juang Chong	Clemson University	A Study on the Impacts of Systemic Insecticides to Honeybees
C4	Keith Delaplane	University of Georgia	Nation-scale Analysis Shows Farmer Benefits and Pollinator Costs Associated with Imidacloprid
C5	Jennifer Tsuruda	Clemson University	Honey Bees and Systemic Pesticides Used in Ornamental Plants - Preliminary Results
C6	Jamie Breuninger	Dow AgroSciences	Use of Lab and Field Studies to Develop a Comprehensive Risk Assessment of Methoxyfenozide for Honey Bees
C7	Mary Clock-Rust	US EPA Office of Pesticide Programs	EPA's Office of Pesticide Programs' Efforts to Protect Pollinators

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Megan McConnell, Bartlett Tree Experts

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Notes

October 12: 7:00-7:30 pm

Stresses Faced by Bumblebees in Urban Landscapes

Dave Goulson, University of Sussex, United Kingdom

Bee declines are generally attributed to the combined stresses from lack of flowers and nesting sites, exposure to non-native parasites and diseases, and exposure to pesticides. However, most experimental research has focussed on farmed landscapes; bees in urban landscapes face slightly different combinations of pressures to those living in the countryside. For example, their exposure to insecticides may be lower on average (although this is hard to quantify), but they may be exposed to higher levels of other pollutants such as vehicle fumes, which are known to interfere with their ability to discriminate amongst flowers. They may also suffer from collisions with vehicles, though this has never been quantified, and it remains a challenge to do so. Floral density in suburban areas may be much higher than in farmland, and there is more likely to be a greater diversity and continuity of floral resources, but many of the flowers may be domesticated varieties which are not rewarding (e.g. double varieties), or may be exotic species that are of little value to native pollinators (for example hummingbird-pollinated plants grown in Europe). For many bee species, nesting opportunities in urban areas may be plentiful: for example bumblebees will commonly nest in or under man-made structures such as garden shed, bird nest boxes, under loft insulation etc. Solitary bees may nest in old walls and burrow into bare patches of ground, though the high uptake of bee “hotels” suggests that suitable sites may generally be limiting. Bees diseases are likely to be similar to those encountered in the countryside, although there is some evidence that prevalence may be higher in urban areas, probably simply because the population densities of the common species seem to be higher in urban areas than in farmland. Overall, the evidence suggests that suburban areas can be relatively benign environments for pollinators, but there is clearly room for improvement and the potential for our towns and cities to become havens for a broad range of pollinator species.

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Conserving Native Bees on Farmland

Rufus Isaacs and Julianna Tuell
Department of Entomology, Michigan State University

This fact sheet has been developed to provide information for growers of insect-pollinated crops about farm practices that can support native bees. We provide background on the biology of these bees and give practical advice to guide growers who want to increase native bee abundance on their farms. This bulletin is based on our experience with Michigan fruit farms, but the information should be relevant to growers across the eastern United States interested in managing their farms to improve sustainable pollination of their crops.

Introduction

Bees are essential pollinators of many crops. Pollination occurs when pollen is transferred from male to female parts of flowers, resulting in seed set and good crop development. Some plants have lightweight pollen that can be transferred by wind, but many crops have heavier pollen that must be transferred by animals. Insects, birds and bats can move pollen between flowers, but bees are most important for achieving pollination and maximum yields of many crop plants.

Bumble bee visiting a blackberry flower.

Crops that are highly dependent on pollinators to achieve economical yields include almond, apple, cherry, pear, cranberry, blueberry, blackberry, greenhouse tomatoes, asparagus, melon and squash. For most of these crops, bees provide most of the pollination activity as they move from flower to flower to collect food. Some crop plants with lighter pollen grains, such as strawberry, can show higher yields with the addition of honey bees because of improved pollination.

Without bees to move pollen, some crops would be far less productive, and many fruits and vegetables would not ripen as evenly or as quickly. Without complete pollination, plants produce deformed fruits and vegetables that are not marketable. Estimates suggest that a third of our food is from crops pollinated by bees, so it is important that growers consider strategies to pollinate their crops effectively.

Why conserve native bees? Since their introduction from Europe in 1622, honey bees have become the most economically important pollinator for fruit and vegetable production. Each spring, U.S. growers rent millions of beehives to pollinate their crops. The high number of honey bees brought to crop fields helps ensure that yields will reach growers' expectations. Honey bees are becoming more difficult to manage, however, because of parasites and diseases. In addition, rental costs for honey bees are increasing. As a result, more attention has been given to conserving wild native pollinators, which are adapted to the local conditions and can help pollinate many food crops.

Diversifying the pollinators that are active on a farm makes good economic sense because it spreads risk across many bee species. This can reduce the chance that poor weather conditions will reduce pollination, as sometimes happens in colder springs. Another benefit of having more kinds of bees pollinating is that, for some crops, native bees are much more efficient at shaking the flower to release pollen. For example, a bumblebee is six times more efficient than a honey bee at pollinating blueberry flowers.

Most farms already have populations of native bees living in and around fields. Our recent survey of Michigan blueberry farms found that in addition to honey bees brought in to pollinate the crop, native bees such as halictid and andrenid bees were seen on flowers when blueberry was blooming. In this situation, growers get the benefits of large numbers of rented honey bees, but during cool weather, the native bees are better able to fly and pollinate the crop, helping to ensure an abundant harvest.

Most species of native bees are small and easily overlooked. Taking some simple steps to enhance the farm environment for these beneficial insects will increase their abundance over time and can lead to more consistent crop pollination from year to year.

MICHIGAN STATE UNIVERSITY EXTENSION

Common Native Bees

Some common groups of native bees are listed below. For more details on native bees, see the resource list at the end of this bulletin.

Mason or *Osmia* bees (family Megachilidae). Small to medium-sized, deep blue metallic or black with white hair on thorax, these bees collect pollen on the abdomen. They nest in hollow plant stems or holes made by beetles, and they need mud near the nest to make their nest cells. Many mason bees are active in early spring, and some species have been successfully managed using nesting boxes so that large numbers are present to pollinate spring-blooming fruit crops. Although they will nest close to other females of their species, these are solitary bees and have a single generation per year.

Leafcutter bees (family Megachilidae). Medium-sized, black, often with a striped abdomen, these bees collect pollen on the abdomen. Their heads are large relative to their body size, with large mouthparts used to cut leaf pieces to construct nest cells in hollow plant stems or beetle holes. Leafcutter bees are first observed in late spring, and some species continue collecting pollen until the first frost. These bees are solitary and have a single generation per year.

Sweat bees (family Halictidae). Typically the most abundant group of bees around farms, sweat bees tend to be small and green or brown with stripes. All carry pollen on their hind legs, and most nest in the ground. Their common name comes from some species being attracted to the salt in human sweat. Some sweat bees are solitary, with a single generation per year. Others are social and have one to a few queens, supported by a number of female workers, producing multiple generations per year.

Andrenid bees (family Andrenidae). These are small to medium-sized bees that nest in the soil and are active early in the spring. They carry pollen on their hind legs and the sides of the abdomen. In bee surveys in Michigan blueberry farms, andrenids were some of the most common bees on flowers, and most of the pollen recovered from them was from blueberry. Because they nest in the ground, areas of undisturbed, well-drained soil are needed to build their populations. All are solitary with one generation each year, but various species emerge throughout the growing season.

Bumble bees (family Apidae). These are medium-sized (workers and drones) to large (queens), hairy black/yellow/white bees that nest in the ground in abandoned rodent burrows or other insulated cavities. A single queen emerges in the spring and produces several generations of workers through the season to build her nest. In late summer, new queens and males (drones) are produced; they mate and the new queens overwinter and begin the cycle again the following year. Unlike honey bee queens, bumble bee queens must gather nectar and pollen during early spring until their first offspring emerge. Bumble bees are very effective at pollinating many crops, and managed hives can be purchased to supplement natural populations.

Carpenter bees (family Apidae). These bees are large and often mistaken for bumble bee queens because of their similar size and markings. Carpenter bees are distinguished by their hairless, shiny black abdomens. Carpenter bees bore into wood to create their nests and are generally considered to be solitary. They can be a problem because they steal nectar through holes they cut in the sides of flowers to reach the nectar, thereby failing to pollinate the flowers.

Conserving Native Bees

Growers can follow some simple practices to make their farms and surrounding landscapes more suitable for bee pollinators. Bees need undisturbed nesting sites and access to nectar and pollen when the crop is not in bloom. They also need water, and some need materials for nest building, such as mud or leaves. Many farms have some of these resources already; increasing them should improve native bee abundance over time.

Nesting sites. Native bees such as mason and leafcutter bees nest in hollow plant stems and beetle holes in trees. Providing these resources naturally can be as easy as letting plants grow in a ditch or leaving old trees in place in woods next to crop fields.

A ditch with willows and reeds provides bee resources near a blueberry field.

For a more advanced approach, holes drilled into wooden blocks or bundles of cut plant stems can provide the necessary nesting sites that cavity-nesting bees require. In recent years, some species of *Osmia* bees have been managed in nesting blocks. One of these is the blue orchard bee, which has been successfully managed to pollinate cherry crops in Utah. Nesting blocks can be purchased from specialty businesses or constructed with commonly available equipment.

An apple grower provides nest sites for stem-nesting bees.

Bumble bees prefer to nest in the ground in abandoned rodent burrows or other dry, well-insulated cavities. Undisturbed grassy areas around fields may provide suitable underground nesting sites. Bumble bees have also been known to nest in the stuffing of abandoned mattresses and car seats. Nesting boxes can be constructed and buried to encourage them to colonize a specific area.

The majority of native bees dig nests in the ground. Adults of ground-nesting bees fly in and out of these nests many times, collecting pollen to feed to their developing larvae in the nest. Providing non-tilled areas of open ground or well-drained mounds of soil near fields can provide nesting places for these bees. In perennial fruit crops grown on sandy soils, bees may also nest in the weed-free strip under the crop plants and in bare areas of soil near fields.

Nesting materials. Mason bees and leafcutter bees build their nests in cavities using soil or leaf material to separate the individual cells. They must collect and carry these materials to their nests. Providing appropriate materials nearby can help make it easier for bees to build their nests.

Leafcutter bees prefer foliage of waxy-leaved plants such as rose, green ash, lilac and Virginia creeper for constructing their nests but will use other plants if necessary. This rarely causes significant plant injury. Mason bees need access to mud to build their nests. The mud source can be a trench with wetted bare soil during the nesting period, or a bucket of mud placed near the nest.

Opened nesting straw revealing individual cells for mason bee larvae, separated by mud partitions.

Nectar and pollen sources. Many bees are active through the growing season. When a crop that needs pollination is not in bloom, these bees still need to feed themselves and their offspring. Most native bees search for nectar and pollen within close range of their nest, so providing flowers near the crop will reduce the amount of time bees need to search for food, thus increasing the number of offspring they can raise.

As a first step, consider how abundant blooming plants are around the farm before and after crops bloom. Early-blooming woody plants such as willow, wild cherry, redbud and elderberry can provide resources for bees emerging in early spring. For flowers in late summer and early fall, herbaceous plants such as bee balm, hyssop, goldenrod and asters can be encouraged or planted around fields to provide food for bees.

Bee conservation strips can be constructed along field edges to provide a refuge for native bees when the crop is not in bloom. Two simple ways to increase the abundance and diversity of flowering herbaceous plants are to leave unmown, herbicide-free strips of land or to disturb a strip of soil to encourage germination of annual and perennial flowering plants. These flowering areas can be managed to keep them contained and to stop their flowering during the bloom period of the adjacent crop. Fallow pieces of land can also be planted with wildflower mixes for supporting bees. Seed mixes can be custom designed that contain plants that bloom outside your crop's bloom period. Native plant suppliers can help select seed or plants that will provide bees with these resources.

Every effort made toward bee conservation will help improve the farm environment for these insects. A good strategy is to start by making small changes and to then build on them over time.

Access to water. Water is often overlooked as a bee resource, but bees need access to water for survival. This is particularly important in the summer months, when there may be little rainfall. Bees can use water from streams, drainage ditches, irrigation ponds or troughs. Any water source for these insects must be clean and free from pesticides.

Bee exposure to pesticides. Bees visit crop fields to feed primarily when the crop is in bloom. Special care must be taken to protect these bees during the crop's bloom period. Avoid insecticide applications immediately before, during and directly after bloom, and if sprays are required select only the most bee-safe products. These steps are critical for native bees to emerge, lay eggs and provision their nests with food for their young. Other bee species are active throughout the season (e.g., bumble bees), and they will be exposed to pesticides used during the rest of the growing season. Selecting pesticides that are less toxic to bees should pay off over the long term by helping these native bees survive.

Insecticides can be divided into three main groups on the basis of their toxicity to bees: highly toxic, moderately toxic and non-toxic. Although pest control will be the primary factor driving pesticide selection, options that are less toxic to bees will help create a more suitable environment for bees. Applications during the late evening (once bee activity declines) will reduce risk to bees because residues can dry before bees begin foraging in the morning. Consult your local Extension sources for a list of the relative bee toxicities of pesticides, or see the links to information in this bulletin.

Summary

Bees are the primary pollinators of many important agricultural crops. Honey bees provide the majority of pollination services on most farms, but native bees can provide an important component of a sustainable pollination strategy. Most agricultural landscapes have resident populations of native bees, though their abundance may be low because of intensive farming methods that minimize availability of suitable nesting and feeding sites. Growers can adopt some relatively simple practices in and around their fields to enhance farm suitability for these important beneficial insects:

- **Provide habitat suitable for nesting.**
- **Encourage or plant flowering plants to provide blooms through the growing season.**
- **Provide access to clean water.**
- **Provide nest-building materials, including mud and waxy-leaved plants.**
- **Minimize insecticide use, avoid spraying during bloom, and switch to more bee-friendly pesticides.**

Adopting these approaches on a farm will improve the chances that native bees will increase to levels that will contribute to crop pollination. Enhancing the suitability of farm landscapes for native bees will also provide a diversified strategy for achieving good crop yields in pollination-dependent crops year after year.

Relevant Information Resources:

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Enhancing Beneficial Insects with Native Plants. Online at www.ipm.msu.edu/plants/home.htm.

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How to Manage the Blue Orchard Bee, as an Orchard Pollinator. 2001. J. Bosch and W. Kemp. Beltsville: Sustainable Agriculture Network.

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October 13: 10:00-10:30 am

The Urban Pollinators Project

Professor Jane Memmott, University of Bristol

In the UK urban land accounts for an area roughly equivalent to that of all protected areas. Unlike nature reserves though, urban areas are growing and, outside urban nature reserves, they offer little formal protection for biodiversity. Urban habitats do however have the potential to provide excellent conditions for pollinators. For example, half of Germany's entire bee fauna was found in Berlin and 35% of British hoverfly species were sampled in a single Leicester garden.

Floristically rich sanctuaries in an otherwise uninviting urban matrix can support substantial numbers of native pollinators. However, because urban pollinator surveys are not replicated, they provide few clues concerning the factors and processes acting as filters following urbanization. While gardens have been widely studied, there are no city-wide surveys of all urban habitats. We (a team of ecologists, conservation practitioners and taxonomists) used a systems approach to study pollinator ecology and conservation. In this context the components of the system are the plants and the pollinators with their interactions providing function in the form of an ecosystem service. The mathematics that predicts the system's response to change are models that predict the robustness of the community to change. The project asked three main questions:

Question 1 - Where exactly is the pollinator biodiversity in the UK? To answer this question we sampled urban habitats, agroecosystems and nature reserves for plants, pollinators and their interactions using a replicated and standardized approach by constructing quantitative plant-pollinator visitation networks. The sampling design consisted of twelve triplets of the three habitat types: 12 cities each with an adjacent farm and a nature reserve in the surrounding countryside. In total 36 plots, each 1km^2 in size were sampled for plants and pollinators and the results recently published in Proceeding Royal Society B.

Question 2 Where are the hot-spots of pollinator biodiversity in cities? Plant and pollinator biodiversity was quantified in detail in four British cities: Bristol, Reading, Leeds and Edinburgh. Nine different habitats were sampled in ten different regions in each city with the data gathered in the format of plant-pollinator visitation networks. The species richness and abundance of pollinators in each habitat was compared and the pollinator hotspots in each city identified. The robustness of the city-wide system has been explored and by simulating the effect of changing habitat quantity and quality we are identifying opportunities for pollinator conservation in urban areas.

Question 3: Improving the lot of the urban pollinator. We planted sixty flowering meadows, each 300m^2 in size, in the four cities in a replicated design. They were planted in urban greenspace areas including road verges, public parks and schools to test whether adding more flower resources to cities leads to increased pollinator populations.

Urban areas will continue to grow, pressures on agro-ecosystems will increase worldwide as populations grow and new agricultural markets such as biofuels develop. Realistically these are unlikely to be mitigated by an increase in nature reserves or by further funding for agri-environmental schemes. Evidence-based urban planning offers considerable promise for pollinator conservation and by understanding the suitability and spatial properties of the urban habitat mosaic we can integrate pollinator conservation into urban areas.

Throughout the project we have engaged with the public, practitioners and policymakers. We have used social media to interact with the public, worked in partnership with practitioners throughout to ensure findings are relevant to the practitioner community and our research has informed policymakers developing the National Pollinator Strategy for England. We are continuing to work with stakeholders as results emerge via a Knowledge Exchange fellowship awarded to Dr Katherine Baldock, the lead postdoctoral researcher from the project, which will ensure our findings can be used to effect action on the ground for pollinator conservation in urban areas.

October 13: 11:15-11:30 am

Pathogens and Immune Function of Native Bees in Urban Areas

Margarita M. López-Uribe, Robert R. Dunn, Steven D. Frank, David R. Tarpy
Department of Entomology, North Carolina State University

Pathogens and parasites are one of the main forces driving declines in bee populations worldwide. The most important managed pollinator, the honey bee (*Apis mellifera*), is among the insects with the highest number of described pathogens. More than 30 viruses, bacteria, fungi, protozoans and mites are known to be pathogenic for this species (*1*). Recent evidence suggests that managed honey bees are spreading diseases, such as *Nosema ceranae* and Deformed Wing Virus (DWV), to wild bee species (*2, 3*). Shared floral resources between managed and wild bees are possible foci for the spread of exotic diseases from managed *A. mellifera* to wild bee species (*4*). Still, levels of pathogen infection and disease susceptibility of honey bee pathogens in non-*Apis* bee species remain poorly studied.

Here, we characterize the immune function and pathogen prevalence of four protozoan pathogens in common native eastern North American bee species. We sampled individuals across a gradient of surface temperature and impervious surface in urban areas around Raleigh, NC. Our preliminary results show no presence of *Ascosphera* spp. in the sampled individuals, and high prevalence of *Nosema* spp. in *A. mellifera* and *Xylocopa virginica.* We also found high prevalence of two trypanosomes (*Crithidia* spp. and *Apicystis* spp.) in all sampled species. Future analyses will corroborate the species level identification of the detected pathogens, and the strength of immune function across the sampled species. These results provide novel information about (1) target pathogen species for future studies that focus on the risk of pathogen spillover across native bees and honey bees, and (2) the potential effect of climate warming and urbanization on host-pathogen dynamics in bees.

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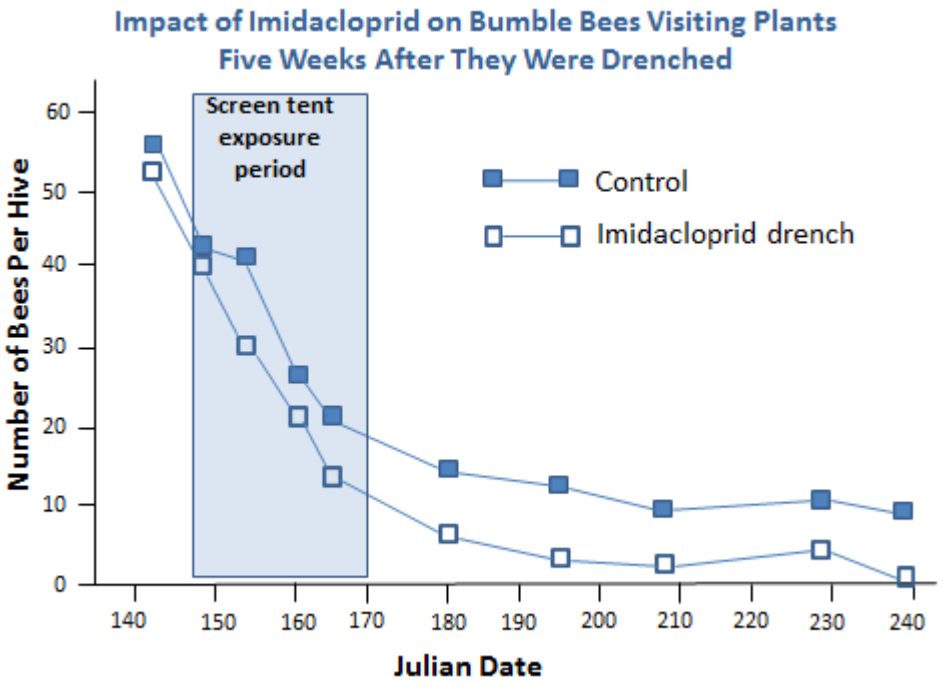
October 13: 1:45-2:00 pm

How Safe are Garden Center Plants for Pollinators in the Yard and Garden?

Dave Smitley, Michigan State University

The results from two screen cage experiments with bumble bees are shown below. In the first experiment,' ***Impact of imidacloprid drench on potted annual flowers'*** (Figure 1), one bumble bee (*Bombus impatiens* from BioBest) colony was placed into each of 16 screen tents filled with six types of popular annual flowers: petunia, verbena, geranium, marigold, portulaca, salvia and begonia. These flowers were their only source of pollen for three weeks. The potted annuals in half of the screen tents had been drenched with imidacloprid five weeks prior to the start of the experiment. Potted annuals in the other half of the screen tents were drenched with water. Bumbles bees in each colony were marked and counted throughout the summer. The results are in Figure 1 below.

Figure 1. Survival of bumble bee colonies confined in screen tents with annual flowers for three weeks in June, 2015, then moved to shelters and allowed to forage freely. Each screen tent contained 12" pots previously drenched with imidacloprid or with water (Control). Data are means of eight colonies (one per screen tent) per treatment.

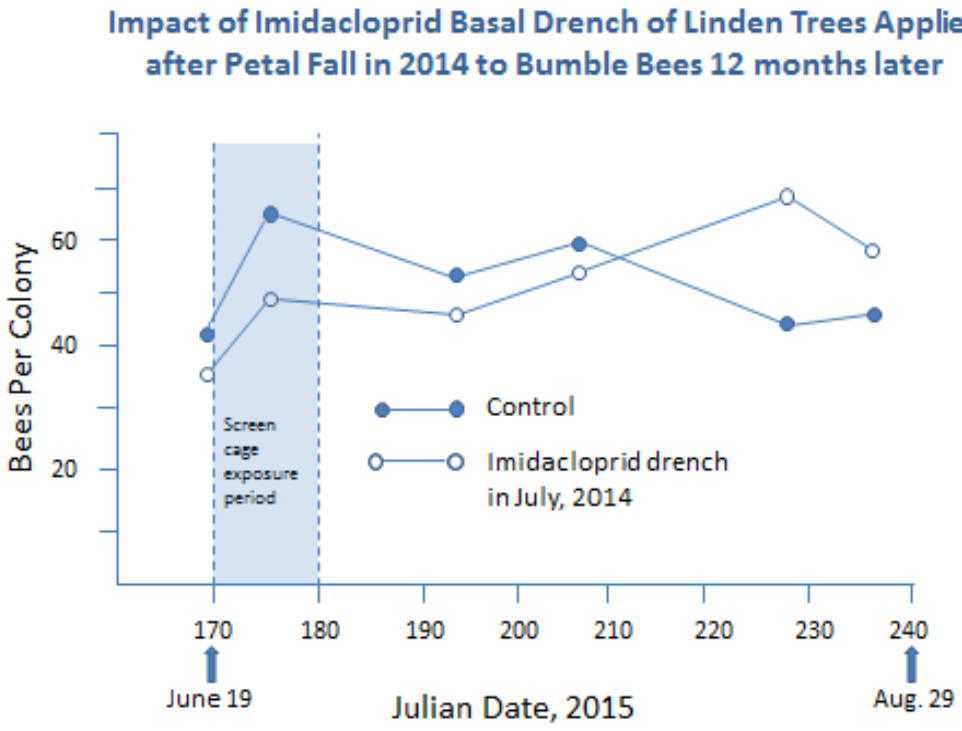


The number of bees per colony declined rapidly in both treatments. Cold weather in early June and a major thunderstorm with high winds did not help their initial establishment. Also, when compared with the excellent survival of the bumble bees in the next experiment when *Tilia* trees were put into the screen cages with the bees, it is likely that the six species of annual flowers in this experiment did not provide adequate pollen and nectar for the bumble bees. Still, recovery from the screen-tent exposure period was better for colonies in the control treatment compared with the imidacloprid drench treatment (Figure 1).

In the second experiment, '**Impact of an imidacloprid basal drench applied to base of container-grown *Tilia* trees in early July 2014, on bumble bees caged with the same trees in June 2015'** (Figure 2), *Tilia americana* and *Tilia cordata* trees were grown in pot-in-pot containers at the Horticulture Farm at Michigan State University. Half of the trees received a basal soil drench of imidacloprid, applied at the labeled rate in early July, 2014, after the trees had finished

blooming and most of the flowers had dropped. Approximately one year later, the *Tilia* trees were moved into screen tents on June 15, 2015, when they first started blooming. One bumble bee colony was placed into each screen tent at this time, and remained in the tents for 10 days. Bumble bees were counted weekly or biweekly for the rest of the summer, until August 27th. Results are shown below in Figure 2.

Figure 2. Survival of bumble bees after being caged with Tilia trees for 10 days in June, 2015, when the trees were blooming. Trees in the imidacloprid drench treatment were drenched in early July, 2014. Data are means of four colonies per treatment.



Imidacloprid drenches made in early July 2014 had no impact on the number of bumble bees per colony throughout the growing season, or on the number of queens produced per colony at the end of the summer (Figure 2). Control colonies average 7.8 queens per colony, while colonies in the imidacloprid treatment averaged 5.8 queens per colony.

Conclusions

Poor survival of bumble bees after being caged with annual flowers for three weeks limits the conclusions that can be made from the first experiment, which gave similar results in a 2014 experiment. However, failure of the bumble bee colonies in the imidacloprid drench treatment to recover from the stress created by screen-tent enclosure suggests that drenching flowers which are attractive to bees in the spring of the same year that they are sold could be harmful to bees.

Also, poor survival of bumble bees in screen tents with 6 of the most popular types of annual flowers, while survival was excellent when bees were caged with *Tilia* trees, highlights the importance of understanding the relative attractiveness of flowering plants to bees.

Excellent survival of bumble bees after being confined with *Tilia* trees which had been treated the previous year with an imidacloprid drench suggests that treatments made a year before trees are sold are not harmful to bees. Good queen production in both treatments supports this conclusion.

As research continues on how to produce greenhouse and nursery plants that will be safe for pollinators after they are sold and planted in the yard and garden, it is becoming increasing clear that growers and tree care professionals should focus their efforts on understanding which plants that are highly attractive to bees. In an extensive observational study conducted with more than 1,000 visits to Longwood Gardens and other gardens, none of the top 20 annual flowers grown in greenhouses across North America were rated higher than 2 on a scale of 1 to 5 for their attractiveness to bees (Lindtner 2014). This means that they are not good pollen or nectar sources for honey bees, and are only visited when better options are not available. However many perennials, trees and shrubs are highly attractive to bees. For these plants it is important not to spray them with any insecticide the last three weeks before shipping, and to avoid soil applications of a systemic insecticide in spring of the same year that they are sold.

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October 13: 2:15-2:45 pm

Bees, Pesticides, and Politics: Challenges and Opportunities for the Green Industry

Daniel A. Potter, Professor; University of Kentucky

Despite scientific consensus that bees and other pollinators face a "perfect storm" of interacting stress factors, much of the public perceives that pesticides, especially neonicotinoids, are the main driver for declining bee populations. This talk explores how we got to that point, and how the "bee issue" is impacting the Green Industry including lawn and landscape managers, golf courses, growers and garden centers, and private citizens. Some reasons why neonicotinoids and other systemic insecticides are used to combat urban landscape pests are reviewed. Insecticide misapplications, though not the main cause of urban bee decline, have the potential to cause acute bee kills, and to impair individual bee behavior and colony-level function. I argue that such effects can be mitigated by reducing exposure e.g., mowing or pruning to remove flower heads, or by modifying timing of applications. Case studies based on our recent research illustrate how the two IPM's, Integrated Pest Management and Integrated Pollinator Management, can be reconciled through best management practices.

The second half of the talk explores how the "bee issue" is a teachable moment providing opportunities for progressive organizations, small business owners, and everyday citizens to engage in and benefit from pollinator conservation initiatives. Programs such as Operation Pollinator for Golf Courses highlight how industry-university-stakeholder partnerships can contribute to pollinator conservation and outreach education. A new research project documenting native and non-native woody trees and shrubs that are attractive to pollinators suggests opportunities for growers, garden centers, and landscapers to profit from public demand for bee-friendly plant materials, as well as chances to diversify landscapes with horticulturally-desirable, but heretofore under-utilized plant species. Micro-clover lawns, too, may become an acceptable alternative to a monoculture turfgrass lawn. Polar bears, bald eagles, whales, and other charismatic iconic species have been drivers for environmentalism and social change. Pollinator conservation provides a similar opportunity to nurture a sociocultural shift toward more sustainable urban land care practices.

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October 13: 2:45-3:00 pm

Non-*Apis* Bees and Insecticides: Do they respond differently than honey bees (*Apis mellifera*)?

Dr. Cynthia Scott-Dupree – Professor, Bayer CropScience Chair in Sustainable Pest Management; School of Environmental Sciences – University of Guelph

Summary

There is growing concern about declines in non-*Apis* bee populations and the implications for agroecosystems and natural ecosystems. Bees may unintentionally be exposed to insecticides during or after foliar spray application while foraging in crops and nesting in hedgerows adjacent to treated fields, or by consuming nectar and pollen from flowering plants that contain insecticide residues. Non-*Apis* bees are particularly vulnerable to foliar insecticides because, unlike honey bees, nesting sites cannot be moved or protected during spray applications, and different foraging behaviours may bring non-*Apis* bees into contact with insecticides applied at times designed to reduce foraging honey bee exposure.

Research conducted using only honey bees as the indicator bee pollinator species does not adequately reflect the risk posed by insecticides to non-*Apis* bees because of their unique biology and differential susceptibility. Furthermore, risk assessment of specific insecticides to non-*Apis* bees cannot be verified by laboratory (Tier 1) studies alone. It is imperative that semi-field (Tier 2) or large scale field studies (Tier 3) be conducted to determine the impact of the insecticides on non-*Apis* bees under realistic exposure scenarios.

In a laboratory study (Scott-Dupree et al., 2009) undertaken to investigate the direct contact toxicity of 5 technical grade insecticides (i.e., not formulated insecticides) – imidacloprid, clothianidin, deltamethrin, spinosad and novaluron, on 3 non-*Apis* bees – *Bombus impatiens* (common eastern bumble bee), *Megachile rotundata* (alfalfa leafcutting bee) and *Osmia lignaria* (orchard mason bee) considerable variation in susceptibility to these insecticides was observed. The descending order of contact toxicity to *B. impatiens* was clothianidin > imidacloprid > deltamethrin > spinosad > novaluron; to *M. rotundata* it was clothianidin > deltamethrin ≥ imidacloprid > spinosad > novaluron; to *O. lignaria* it was imidacloprid > clothianidin > spinosad > > deltamethrin. Novaluron was not tested for *O. lignaria*. If we combined these results with those of Bailey et al. (2005), who used the same bioassay technique to determine the direct contact toxicity of clothianidin, imidacloprid and spinosad to honey bees, we can see some signficant difference in species susceptibility to insecticides once again. Although clothianidin was highly toxic to honey bees, imidacloprid and spinosad were only moderately toxic (deltamethrin was not tested in this study). In the Scott-Dupree et al. (2009) study *O. lignaria* and *M. rotundata* were more susceptible to the neonicotinoids than honey bees. The results of studies like this make it clear that using honey bees as the indicator/surrogate bee pollinator species may not adequately reflect the risks posed by insecticides, and consequently, including non-*Apis* bee species representative of the agroecosystem under investigation becomes critical.

However, it also is important to take the results of laboratory studies (Tier 1) and when necessary undertake field studies (Tier 2 and 3) that will present the exposure scenario in a more realistic manner. In other words, effect characterizations established in laboratory studies need to be confirmed with field studies that focus on exposure characterization before risk/hazard assessment can be completed and policy established. In the Scott et al. (2009) study, clothianidin was the most toxic to *B. impatiens* in direct contact toxicity laboratory studies. Cutler and Scott-Dupree (2014) conducted a study where commercial *B. impatiens* hives were placed during pollen shed in corn fields that were grown from "conventional" seed (n= 4 fields) that was treated with neonicotinoids (i.e., clothianidin and thiamethoxam), or "organic" seed that was not treated with insecticides (n=4 fields). Pollen samples were collected from

the corn plants for neonicotinoid residue analysis, pollen types carried by workers were identified, and in autumn hives were dissected to measure various enpoints that serve as markers of colony vigor. Clothianidin was detected (0.1-0.8 ng/g) in pollen from conventional corn fields, but was not detected in pollen from organic corn fields. Hives appeared healthy after assessing 10 different colony endpoints including queen, drone and worker numbers, colony weight to name a few. However, the most interesting result was that regardless of conventional or organic field location, corn pollen was collected at only 3 (2 conventional and 1 organic) of 8 sites (mean % total pollen collected = 0.7%; range = 0.8 – 2.6%) by bumble bee foragers. Instead, pollen recovered from bees at all sites (n=8) were dominated by *Solanum dulcamara* (bittersweet nightshade) (mean % total pollen collected = 61%; range = 23.4 – 96.4%). This field study suggests that exposure to corn grown from neonicotinoid-treated seed during pollen shed poses low risk to *B. impatiens*. So despite the fact that clothianidin in laboratory direct contact toxicity studies is highly toxic to adult bumble bees, field studies indicate the potential for exposure is negligible. Thus the importance of confirming laboratory results with field realistic studies.

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October 13: 3:00-3:15 pm

Unravelling Direct and Indirect Effects of Insecticides on Pollinators and Natural Enemies in Managed Landscapes

Michael Raupp[1], Adrianna Szczepaniec[2], and Scott Creary[3]

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One practice commonly used in the landscape maintenance industry is the scheduled application of pesticides to trees and shrubs. Surveys of landscape maintenance professionals, property owners, and property managers indicate that roughly 30% of pesticide applications in landscapes were applied as blanket treatments often on a predetermined schedule whether pests were known to be present or not (Gerstenberger 1991, Braman et al. 1998). In addition to applications made to individual commercial and residential landscapes by commercial and private applicators, government sponsored insecticide applications aimed at allaying nuisance problems with biting flies or eradicating non-native invasive pests have disrupted natural enemy community structure and function resulting in outbreaks of insect and mite pests on trees and shrubs (Raupp et al. 2001, 2010).

Many taxa of insect pollinators provide the additional ecosystem service of biological control either as adults, larvae, or both. The abundance and activities of these dual service providers can be reduced and disrupted by direct exposure to insecticides or their residues commonly used in the landscape maintenance industry. To determine the direct impact of organophosphate insecticides on natural enemies in tree canopies we applied two foliar sprays of organophosphate insecticides and horticultural oil to landscape trees infested with scales. Horticultural oil applications had little or no impact on beneficial insects, but trees treated with organophosphate insecticides harbored significantly fewer beneficial insects. Populations of lacewings, aphelinid wasps, and ants were suppressed for several weeks following the application of organophosphate insecticides (Raupp et al. 2001).

The advent of systemic insecticides for use in landscapes heralded a breakthrough in conserving beneficial insects by eliminating direct exposure of natural enemies to sprays and their residues on the surfaces of leaves and bark. However, the mobility and persistence of these insecticides in plants resulted in exposure of natural enemies and pollinators to lethal and sublethal levels of toxicants in plant tissues such as nectar and pollen. Several researchers discovered that primary consumers, the arthropod pests that feed on plants, could become tainted after consuming plant tissues. In turn, secondary consumers, the predators and parasitoids attacking these pests, could be indirectly exposed to insecticide residues with adverse effects on their behaviors and survival.

With the arrival of Asian Longhorned Beetle in New York City, government agencies mounted an eradication program. In addition to removing trees, hundreds of thousands of systemic applications of the neonicotinoid insecticide imidacloprid were applied to trees in Central Park over a period of several years. The eradication program proved successful but resulted in massive secondary outbreaks of spider mites in parts of the park where trees were treated systemically with imidacloprid. We investigated mechanisms underlying these outbreaks and found that elm trees treated with imidacloprid fostered greater fecundity in spider mites likely through compromising natural plant defenses. We also investigated the possibility that spider mites could become tainted after consuming plants treated with soil applications of imidacloprid. Using bioassays with two model insect predators, the spider mite destroyer *Stethorus punctillum* and the green lacewing *Chrysoperla rufilabris,* we investigated how consuming spider mites from plants treated with imidacloprid affected behavior and survival of these beneficial insects. Feeding rates and mobility of adult *S. punctillum* and larval *C. rufilabris* were reduced when they consumed spider mites from trees treated with imidacloprid. Moreover, mortality of both species increased by approximately 90% when they consumed spider mites from trees treated with

imidacloprid (Szczepaniec et al. 2011). To determine if this result was robust we investigated the same question in a different system involving boxwood spider mites feeding on imidacloprid treated boxwoods. As in the previous study, soil applications of imidacloprid resulted in outbreaks of spider mites on boxwoods. Mite fecundity was elevated when they consumed foliage from treated plants (Szczepaniec and Raupp (2012). Using the model system with *S. punctillum* and *C. rufilabris*, we found that feeding rates and mobility of both predators was reduced when they consumed spider mites from boxwoods treated with imidacloprid (Creary 2008).

Our results demonstrate that insecticides such as organophosphates applied topically to foliage and neonicotinoids applied systemically through the soil can have deleterious effects on beneficial insects. These negative effects include reductions in predator and parasitoid abundance through direct exposure to insecticides, and impaired mobility, foraging behavior, and lower survival through indirect exposure to systemics through tainted prey. The conundrum for arborists, landscape managers, government agencies, and others attempting to manage arthropod pests in landscapes is that insecticidal intervention even when performed according to label requirements can have adverse effects on the structure and function of communities of natural enemies and pollinators.

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October 14: 9:00-9:15

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships

American Floral Endowment:

Laser-Focused On The Floriculture Industry's Research Needs

The floriculture industry faces complex issues that research funded by the American Floral Endowment helps address. See what the current research is telling us about pest management, postharvest handling and more.

by **TERRIL A. NELL**

WITH challenges ranging from pest control to sustainability and social marketing, the American Floral Endowment (AFE) deliberately directs research funds to scientists who are most capable of producing answers for the floriculture industry.

The floriculture industry faces complex issues today that seem unrelated to day-to-day flower production and sales — availability of water and disposal of waste water, environmental sustainability, marketing and increased public interest in organic and low-level pesticide plants. And the need to continually replenish the supply of qualified and trained young people in the floriculture industry cannot be overlooked.

Terril A. Nell

Worldwide production of fresh cut flowers has become a reality, bringing with it the need for improved shipping and handling procedures and technology to reduce postharvest insect and disease problems. Bedding and potted plant growers, along with plant breeders, seek new and exciting plants for homes, landscapes and offices. The desire to increase flower and plant sales continues, with much of the discussion revolving around how to engage GenX and millennials in flower buying and gardening. Internet and mass-market sales have gained a larger share of the market.

Research projects on many of these topics are currently being funded by the American Floral Endowment. AFE is an industry-supported endowment that supports research at universities throughout the U.S. The AFE Board is committed to focusing research where it is most needed by growers, wholesalers, shippers and retailers. Research benefits everyone in the industry.

Thrips are lured to marigold plants and killed by a fungus on the plant.

Marigold guardian plant system in a greenhouse.

Latest Findings

Pest Management. Projects have been funded to test the effectiveness of banker plants, biocontrols and pesticides for control of aphids, thrips, downy mildew and powdery mildew on roses, gerbera daisy, coleus and verbena. In the past, use of beneficial insects required repeated releases of insects over time — a costly practice for growers. Now, one banker plant system

uses flowering marigold plants with predatory mites released on the flowers and foliage; a millet-based granular formulation of an insect-killing fungus, which is mixed into the surface of the potting mix; and a thrips pheromone lure attached to a wire stake. This system is based on the concept that adult thrips are attracted out of the crop to the flowering marigolds, where they will reproduce.

As University of Vermont researcher, Margaret Skinner, says "This is a low cost, easy to use, non-chemical pesticide system that suppresses thrips populations through a holistic 'ASK' approach: attract, sustain and kill."

Postharvest Handling. Care and handling guidelines and shipping techniques have and are continually being refined, and postharvest disorders of some crops, such as gerbera, have been studied. Gerbera stem bending is a postharvest nightmare for wholesalers and retailers. The stem bends about 3 to 4 inches below the flower, and may break. Hydrating the stems in a specialized container where the stems do not touch the bottom of the container eliminated stem bending. Other projects involved solving leaf-yellowing of geraniums, use of calcium and silicon to reduce botrytis on poinsettias and the importance of maintaining flower food solutions with low microbial activity.

Production Technology. Many of the production-oriented projects concentrated on cost savings for growers and environmental sustainability. AFE-supported research provides some of the initial results with LED lighting in greenhouses. LED lighting was successfully substituted for incandescent photoperiodic lighting, thus saving growers 70 to 80 percent of electrical costs. In an effort to conserve water, research demonstrated that root zone moisture sensors effectively controlled soil moisture levels while reducing leaching.

With poinsettias, reduced energy usage resulted when poinsettias were finished under cold greenhouse conditions. Timing, height and bract size were not affected. In addition, the use of cold finishing temperatures reduced use of plant growth regulators and improved postharvest performance.

Consumer Preferences. What do consumers really want when they purchase plants and flowers? Flower longevity and vase life guarantees were shown to be among the highest priorities for people buying cut flowers. And most customers preferred to have a guarantee tag on the flowers they purchase.

Scape bending of 'Testarrosa' gerbera was eliminated when stems were supported during hydration (left) compared to hydration without support (right)

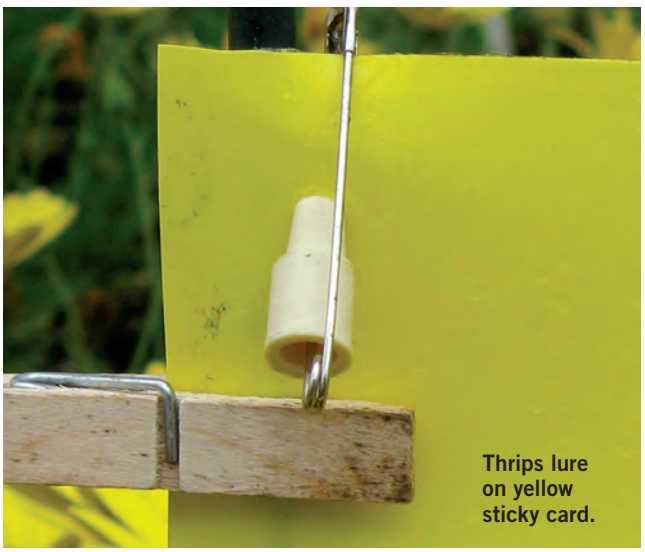
In other projects, color and fragrance preferences of young adult buyers were identified. Of the people participating in the studies, 66 percent had a preference for fragrance while 79 percent had a color preference. Most participants preferred the fragrance characteristic of rose oil.

Special reports providing useful information about the projects mentioned here and more can be found at Bit.ly/AFEReports.

Looking To The Future

For more than 50 years, AFE has funded more than $14 million in research. Our mission is to continue to support research on the most important issues facing the floriculture industry. Based on feedback from the industry, the following topic areas will be the focus of future research projects.

Biocontrols. Evaluation of effective, commercially feasible biocontrol practices. Pest management strategies that can combine biocontrol measures with the careful and strategic use of pesticides will highlight ongoing projects. Development of these pest management strategies will help the industry meet consumer and retail interests for reduced pesticide application. Development of these practices may prove to enhance pollinator health.



Thrips lure on yellow sticky card.

Breeding. Development of flowers and plants with resistance to production and postharvest diseases and enhanced post-harvest quality, and performance will be beneficial to the industry.

Continued on page 94

State Of The Industry Research

Example of a physical support system for hydration of gerbera.

New Technology. Innovative techniques and technology may lead to increased flower and plant quality, improved production and postharvest efficiencies and reduced energy consumption.

Pest And Disease. Pest management is always a critical issue for the industry. The goal will be to identify control practices for significant reduction in aphids, leaf miners, thrips and whiteflies. Also, controlling Botrytis during production and postharvest and downy mildew and powdery mildew will remain a focus for future projects. AFE will remain flexible to support new and emerging insect and disease issues as they arise.

Postharvest. Consumers want high-quality and long lasting flowers and plants. Projects that can reduce postharvest shipping, storage and postharvest losses for the industry while improving postharvest and garden performance for consumers will be a strong area of interest.

Getting Research Results To The Floriculture Industry

In 2015, AFE will launch an electronic newsletter highlighting ongoing projects and research findings from funded projects. This is in addition to the quarterly AFE Bulletin. Additionally, AFE-funded researchers will be asked to publish updates in industry trade magazines. Information on funded projects and final research reports are always available to the industry (free) on the AFE website: Endowment.org.

Future opportunities are exciting for the industry. Researchers throughout the U.S. are ready and willing to address industry needs. AFE welcomes feedback and suggestions from the floriculture industry. Help us identify the key research needs and consider a tax-deductible contribution to the American Floral Endowment as part of your support for our industry. **GG**

Terril A. Nell (**terrilnell@gmail.com**) is the research coordinator for the American Floral Endowment. A professor emeritus from the University of Florida, Nell also serves as a production and postharvest consultant to the floriculture industry.

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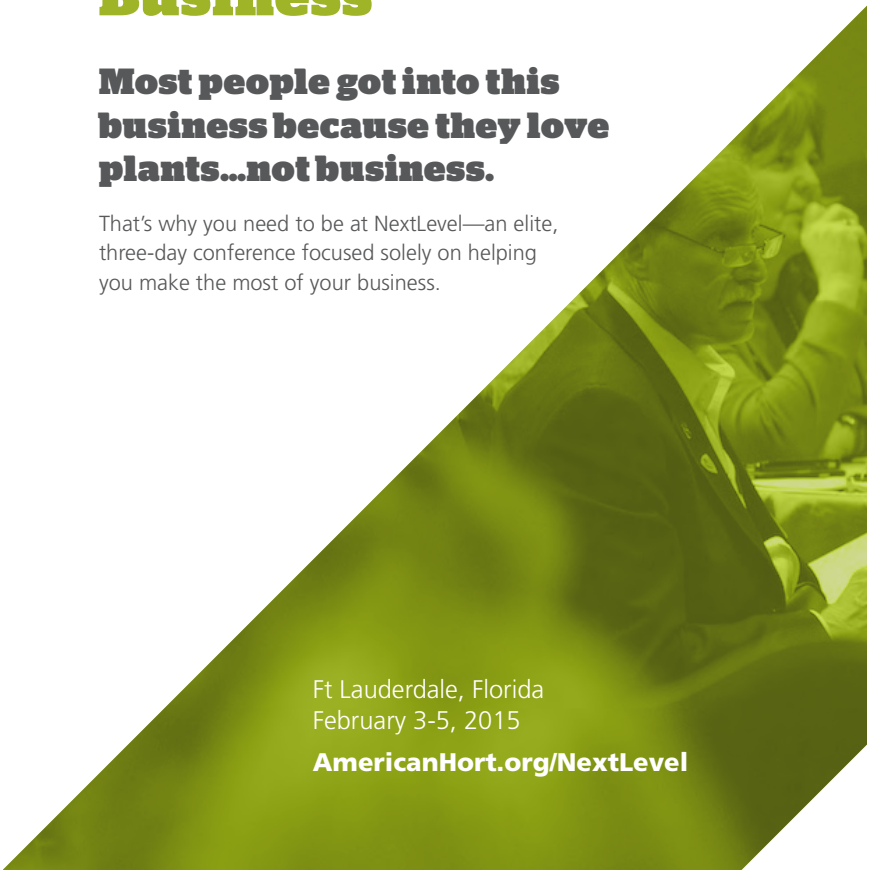

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October 14: 9:15-9:30 am

Engaging the Public in Pollinator Conservation

Dave Goulson, University of Sussex, United Kingdom

Bees and pollination are great topics with which to engage the public in learning more about the natural world, and about our dependence upon it. Involving the public in 'citizen science' projects also provides an opportunity for scientists to gather large data sets, although the quality of the data can be variable. This could fill a major knowledge gap, for at present we have poor data on wild pollinator populations, and no long-term data on their trends, so it is hard to prioritise conservation actions appropriately. I will introduce some recent UK initiatives intended to involve the public in monitoring pollinator numbers and pollination services, and in creating habitat for pollinators. The Bumblebee Conservation Trust is one such initiative, a membership-based charity that now has over 8,000 members, and is actively involved in promoting wildlife-friendly gardening and has created >1,000 ha of flower-rich habitat for bees so far. Beewalks is a scheme modelled on a very successful butterfly monitoring scheme, in which 300 volunteers walk a transect every month and count and identify the bumblebees. More recently, we have launched "The Buzz Club", an organisation devoted to engaging the public in finding out more about changing pollinator populations. This organisation is currently running two schemes, a pan trapping network aimed at gathering data on the more obscure pollinators, and "Bees and Beans", which is attempting to quantify pollination services across the UK. The aim of the latter is to see if crop yields are currently being limited by inadequate pollination. Aside from the valuable scientific data generated, the main benefit of these schemes is in encouraging large numbers of people to engage with and appreciate pollinators and nature more generally. Unless we can ensure that future generations care about wildlife, we have little chance of saving it.

October 14: 9:30-9:45 am

Keep Off of the Stamen and Don't Tread on our Hives: Public Gardens Protect Pollinators

Dr. Casey Sclar, Executive Director, American Public Gardens Association

Through research, communication, policy, and practice - public gardens are excellent collaborators on pollinator issues. Our 575+ member gardens regularly share their practices for attracting and nurturing pollinators while maintaining world class horticultural displays. Interpretation plays an important role in the gardens to describe these practices. APGA's programs offer several ways for gardens to promote awareness. The Sentinel Plant Network contributes to plant and pollinator conservation by engaging public garden professionals, volunteers, and visitors in the detection and diagnosis of serious pests and diseases. Our Climate Change and Sustainability program showcases the best practices used by gardens, so that all our members can emulate them.

Public Gardens are also involved in many facets of research related to pollinator preference and habit. From collecting and conserving rare plants, studying co-evolutionary relationships between plants and pollinators, to investigating, specifying, developing, and recommending eco-regionally specific plants and cultivars for enhanced pollinator habitats, gardens are on the cutting edge.

Gardens are also instrumental in driving policy. The Plant Conservation Alliance (PCA) is a public-private partnership of organizations that share the same goal: to protect native plants by ensuring that native plant populations and their communities are maintained, enhanced, and restored. The PCA Federal Committee developed the "National Seed Strategy for Rehabilitation and Restoration 2015-2020." The Seed Strategy goals provide guidance for national initiatives such as the National Strategy to Promote the Health of Honey Bees and Other Pollinators (White House Pollinator Health Task Force 2015). Our Association and our members look to long-term relationships with federal agencies as the best influence we can have on pollinator preservation.

However, we and others also support a public facing strategy. The Million Pollinator Garden Challenge (MPGC) is a nationwide call to action to preserve and create gardens and landscapes that help revive the health of pollinators across America. From individuals, to schools, community groups, and businesses, everyone is challenged to plant a pollinator garden and register that garden or landscape on the S.H.A.R.E map, from the smallest window box to the longest stretch of highway or largest plot of land.

October 14: 10:15-10:45 am

Consumer Perceptions of Insect Management Strategies during Ornamental Flower Production

Heidi Wollaeger, Michigan State University Extension

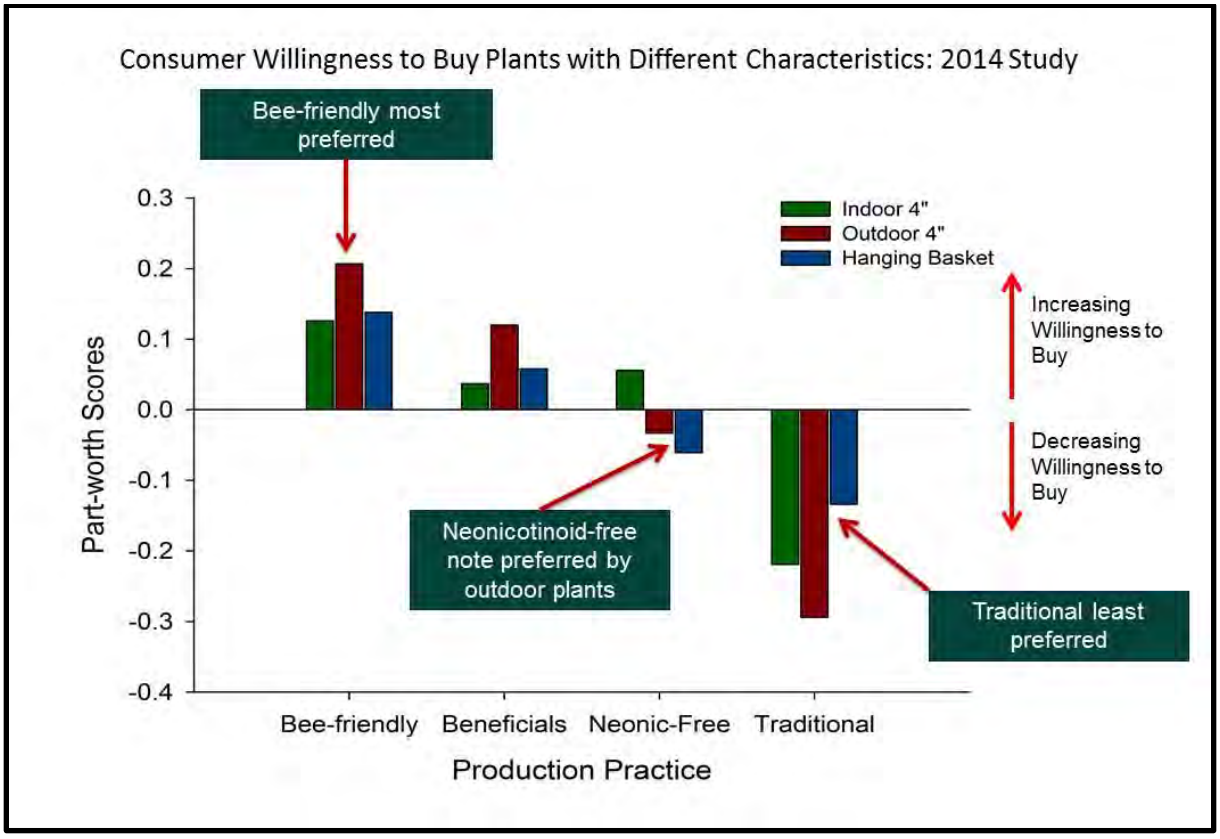
As a result of emerging scientific evidence and social and political pressures, retailers are asking or demanding that plant producers reduce or eliminate the use of neonicotinoid insecticides in ornamental plant production. The reduction in the number of systemic insecticides that growers can use for pest control, particularly for aphids, is especially challenging in hanging basket production where the challenges of bringing the crop down to spray them is both costly and inefficient. For plant retailers, there are both challenges and opportunities in requiring their growers to alter their pest management practices. The greatest opportunity is that retailers can begin to market their plants with the alternative pest management practice. By marketing insect management practices, retailers are providing the consumer with another extrinsic characteristic (price, potting media etc.) with which to make their purchasing decision. The objectives of the study were to: gauge general consumer's understanding of pest control techniques, understand the most important factors contributing to purchasing behavior, and identify a willingness to pay a premium for plants with different pest control methods and other eco-practices.

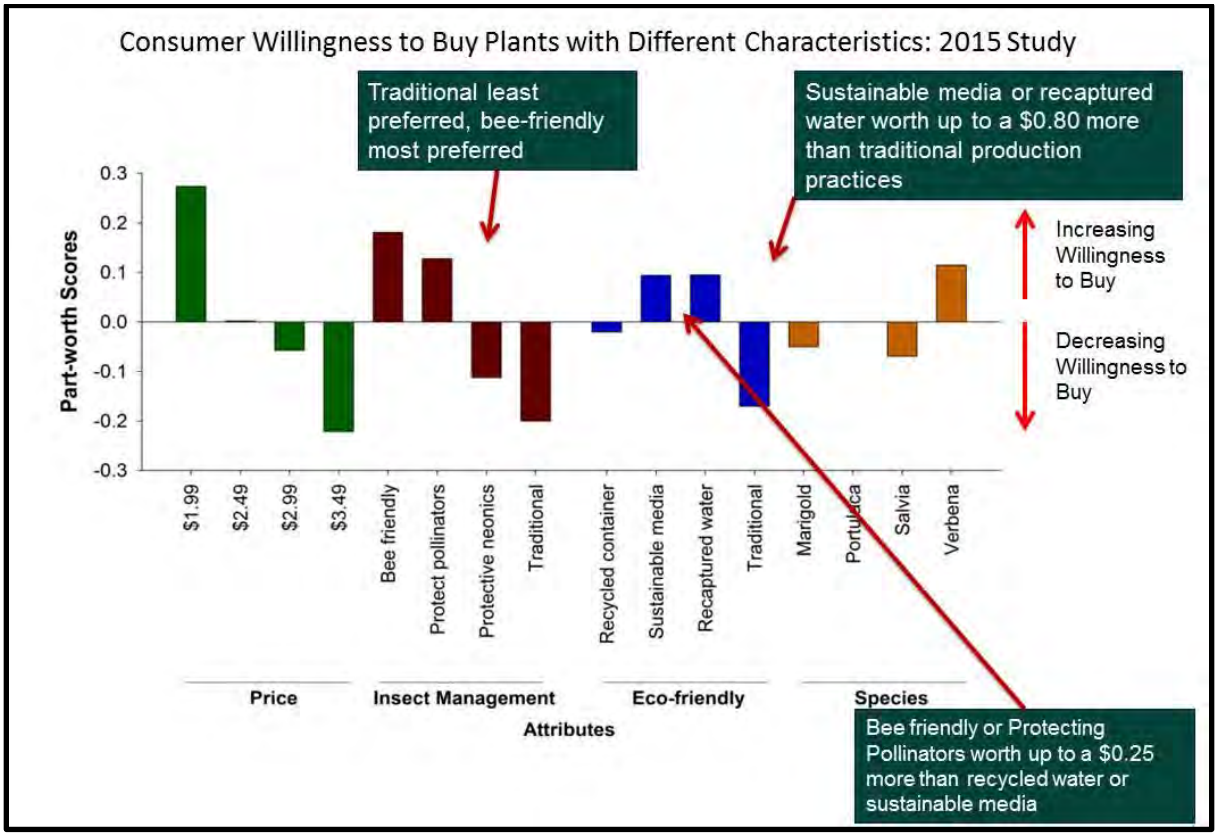
Two internet consumer surveys were developed using Qualtrics software and were administered in May 2014 and May 2015. Potential survey respondents were contacted from a pool maintained by Global Market Insite Institute [GMI (Bellevue, WA)] and invited to participate in the survey. Respondents were paid in points to redeem prizes through GMI. The survey collected measures of likeliness to buy, importance in purchasing, attitudinal measures, and demographic information from consumers. The results were analyzed using statistical analysis in SAS Version 9.3.

Factors Assessed and Their Relative Importance for 2014 and 2015 Studies:

Survey Year	Survey	Attribute	Means (SE) Total
2014	*Indoor 4-in flowering pots*		
		Price	26.02 (0.541) C*
		Production Type	32.76 (0.694) B
		Species	41.21 (0.800) A
	Outdoor 4-in flowering pot		
		Price	33.61 (0.721) A
		Production Type	33.82 (0.786) A
		Species	32.57 (0.722) A
	Outdoor 12-in flowering hanging baskets		
		Price	28.03 (0.591) B
		Production Type	35.59 (0.768) A
		Species	36.38 (0.756) A
2015	*Outdoor 10-cm flowering pot*		
		Price	25.09 (0.421) B
		Production Type	23.26 (0.446) C
		Species	31.57 (0.580) A
		Eco-friendly Practice	20.08 (0.304) D

*Means sharing the same letter within each survey are not statistically different


Consumer Willingness to Buy Plants with Different Characteristics: 2014 Study
Bee-friendly most preferred
Indoor 4"
Outdoor 4"
Hanging Basket
Increasing Willingness to Buy
Decreasing Willingness to Buy
Neonicotinoid-free note preferred by outdoor plants
Traditional least preferred
Part-worth Scores
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
Bee-friendly
Beneficials
Neonic-Free
Traditional
Production Practice


Consumer Willingness to Buy Plants with Different Characteristics: 2015 Study
Traditional least preferred, bee-friendly most preferred
Sustainable media or recaptured water worth up to a $0.80 more than traditional production practices
Increasing Willingness to Buy
Decreasing Willingness to Buy
Part-worth Scores
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
$1.99
$2.49
$2.99
$3.49
Bee friendly
Protect pollinators
Protective neonics
Traditional
Recycled container
Sustainable media
Recaptured water
Traditional
Marigold
Portulaca
Salvia
Verbena
Price
Insect Management
Eco-friendly
Species
Attributes
Bee friendly or Protecting Pollinators worth up to a $0.25 more than recycled water or sustainable media

October 14: 10:45-11:00 am

Reaching the Public- -Master Gardener Citizen Science and Outreach

Connie Schmotzer, The Pennsylvania State University

Utilizing Master Gardeners for pollinator outreach is a win-win for everyone. These lifelong learners embrace new information and learning new skills. And most importantly, they love making a difference.
Penn State Master Gardeners have been involved in statewide pollinator outreach programs since 2010. Our current efforts are concentrated in three areas.

1. The Pollinator Friendly Garden Certification program
2. Statewide citizen science pollinator monitoring
3. Bees, Bugs and Blooms – a pollinator trial

Master Gardeners are major players in a third area – the Bees, Bugs, Blooms pollinator trial.

Pollinator Friendly Garden Certification

See the website at http://ento.psu.edu/pollinators/public-outreach/cert

This is probably our most successful pollinator education outreach. The goals of the program are:

1. Create awareness about pollinators and their role in the ecosystem
2. Teach residents the elements of a pollinator friendly landscape and how to safeguard pollinator habitat

The program was launched in 2011 and to date we have certified 535 gardens statewide. New applications come in continually.

Since the goal of this program is education, our website and the application itself include extensive information about gardening for pollinators. A committee of Master Gardeners from several counties meet regularly to improve the application and website. Application approval is done by this committee. At least 3 committee members must sign off on each application.

In many cases we correspond with the applicants, offering them additional information.

This year we started a newsletter specifically for certified pollinator gardens to keep their interest, expand their knowledge and take them to the next level.

Proceeds from this program's modest application fee support the pollinator monitoring program and any other pollinator initiatives we may have.

Statewide Pollinator monitoring

This citizen science program began in 2010 with a small grant from Haagen Daas. The goal was to determine whether native plant hybrids and cultivars are as attractive to pollinators as the straight species. Over the years we have improved and modified the program.

2013-2015 monitoring program Our current monitoring program started in 2013 and is wrapping up this year. Master Gardeners in 33 counties throughout Pennsylvania participated. We supplied each county with 4 varieties of *Agastache*, 3 varieties of *Helenium* and 3 varieties of *Physostegia*. Plants were monitored weekly (when the plants were in bloom) for 4 different pollinators – Honey bees, Bumblebees, Carpenter bees, Green metallic bees. Monitoring results have

generally been consistent throughout the state. A Master Gardener who works in the environmental sciences compiles our results which will be compiled in a brochure that Master Gardeners can distribute locally.

2016-2018 program. This summer we distributed 4 varieties each of *Monarda* and *Coreopsis* to 32 different counties for planting. Pollinator monitoring for these varieties begins in 2016. We will utilize some of the data from U. of Delaware student Owen Cass's trials at Mt. Cuba to determine the insects we will monitor.

Benefits of the program include MGs education, learning about research methods, etc.

Bees, Bugs, Blooms Pollinator trial

Master Gardeners from three counties were the major players in a trial of 84 pollinator attracting plants conducted at Penn State's Southeast Research and Extension Center from 2012 to 2014. The goal was to determine the best native herbaceous perennials for farmers and homeowners to plant to attract pollinators. This replicated trial used observation and collection to determine pollinator activity. Plant data and insect data were both collected during once a week monitoring during the blooming season.

Results of this trial have been of much interest to the public. Final lists have been compiled and we have presented the results at numerous talks and conferences.

Master Gardeners are now partnering with the Xerces Society to use the trial plot to determine which plants attract specific predators and parasitoids of the brown Marmorated stink bug. We are also monitoring the plants to determine which nectar plants are preferred by monarchs on their early summer and fall migrations.

October 14: 11:00-11:15 am

If You Plant it, They Will Come: A Multi-faceted Extension Program Enhances Pollinator Conservation and Economic Development

Debbie Roos, North Carolina Cooperative Extension
debbie.roos@chathamnc.org

Chatham County Cooperative Extension Agriculture Agent Debbie Roos has been conducting pollinator conservation programs in North Carolina for about eight years. She designed and planted Cooperative Extension's Pollinator Paradise Garden in Pittsboro in 2008. The garden attracts visitors from across the state (and beyond!) and features 160 species, 85% of them native to the area. The garden is managed organically with the help of a small group of volunteers. Debbie conducts monthly public tours of the garden for hundreds of participants annually. She also offers private tours for Master Gardener Volunteers, garden clubs, students, teachers, beekeeper associations, and others. The garden has its own website which includes plant lists, a slide show, garden tour schedule, an archive of "what's in bloom" lists and photos updated every two weeks, web resources, and much more. Debbie uses social media tools such as Facebook, Twitter, and Instagram to educate and inspire followers and encourage them to appreciate the diversity of pollinators and take steps to protect and enhance habitat.

The demonstration garden has exceeded Debbie's expectations for its impacts as a teaching tool. The website and photos posted on social media help market the garden and entice visitors with regular updates showing the beautiful diversity of pollinators and other beneficial insects attracted to a well-designed and maintained garden. The garden has been very successful in inspiring and teaching visitors to create their own pollinator gardens, adopt pollinator friendly practices, and better understand and appreciate the diversity of pollinators and their important role. One positive impact was unexpected: pollinator tourism. Many visitors come from outside the county to see the garden and then spend money at local restaurants and shops. Local plant nurseries report increased sales from gardeners who have attended Debbie's workshops and tours, buying plants using her list of recommended plants. Debbie will share results from a recent survey measuring impacts of her pollinator outreach programs.

Debbie also teaches about pollinator conservation, native bees, and pollinator habitat enhancement through regular workshops and presentations each year in North Carolina and around the southern region. An annual Pollinator Day attracts hundreds of visitors of all ages with lots of activities, exhibits, and demonstrations focusing on native bees, butterflies, beekeeping and pollinator gardening. A very popular 8 week Beekeeping School offers 30+ hours of training for new beekeepers.

Links:
Pollinator Paradise Garden Website: http://go.ncsu.edu/pollinator-garden
Growing Small Farms Website: www.growingsmallfarms.org
Facebook page: www.facebook.com/debbie.roos.nc
Twitter: @GrowSmallFarms
Instagram: Debbie.Roos

October 14: 11:15-11:30 am

Attracting and Preserving Pollinators through Sustainable Gardening

Susan Varlamoff, Director, University of Georgia College of Agricultural and Environmental Sciences Office of Environmental Sciences

Pollination is a vital ecosystem service and by gardening sustainably, we attract and preserve pollinators to perform their important function. With understanding and education, gardeners can contribute substantially to the return of pollinators in urban areas.
A 2000 survey of home gardeners showed that 69 percent of gardeners wanted to protect the environment as they gardened but wanted more information on how to do it. As a result, an interdisciplinary team of scientists developed Best Management Practices for Urban Landscapes with a U.S. Environmental Protection Agency grant. The focus was to reduce nonpoint pollution in urban waterways by properly using fertilizers and pesticides on landscapes. Workshops featuring the training manual and homeowner fact sheets were very well attended and fact sheets were reprinted many times by the thousands.

The popularity of environmentally friendly gardening led to the writing of a peer reviewed book on Sustainable Gardening for the Southeast that puts an emphasis on creating landscapes to mimic the local ecology. Among the environmental issues addressed in the book are: climate change, biodiversity, water, soil health, pollinator loss, wildlife habitat, pest management and invasive and native plants. The book provides gardeners - from homeowners to Master Gardeners - practices that will help them restore ecosystem services to their landscapes.

Restoring pollinators to the home garden involves restoring their habitat, providing sufficient plants for forage and eliminating or reducing pesticide use. Among the recommended practices are:

- Reducing lawn size
- Removing nonnative invasive plants
- Planting native trees and plants
- Installing nectar and pollen producing plants to bloom throughout the seasons
- Planting flowering plants of various colors and fragrances
- Create large beds of blooming flowers
- Avoid pesticides and use natural pest control
- Leave undisturbed areas of brush and soil
- Compost yard waste and vegetable scraps to enrich beds

As people recycle, turn down their thermostats and drive fuel efficient cars, they can now adopt green landscape practices to restore the ecology to their landscapes through simple practices and in the process bring back pollinators.

Georgia has developed a pollinator protection plan and through Cooperative Extension developed outreach materials to educate the public about protecting pollinators. There are several projects underway, to create pollinator pathways through Atlanta (Georgia Institute of Technology) and from Athens to Atlanta (University of Georgia). In addition, schools are being encouraged plant pollinator patches near their vegetable gardens and the Institute of Georgia Environmental Leadership will support pollinator gardens as their legacy project.

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