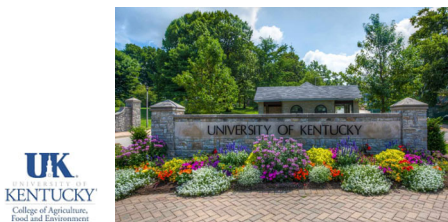


## Bees, Pesticides, and Politics Challenges and Opportunities for Sustainable Urban Landscapes

Daniel A. Potter, Professor  
Dept. Of Entomology, Univ. of Kentucky



### My Program Focus:

*Management of Pests and Beneficial Insects  
in Urban Landscapes*



86% of US population resides in urban or  
suburban areas! (US Census, 2018)

### Urban Horticulture is a >100 billion dollar industry in USA!



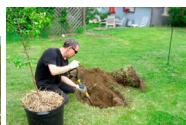
Professional Land Care



Nurseries,  
Garden Centers



Parks & Golf Courses



80 million home  
lawns/landscapes

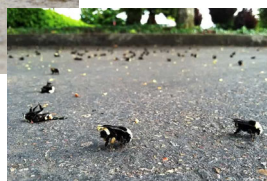
### Early one June 2013 morning at an Oregon shopping center parking lot.....



### Shortly later, as shoppers begin to arrive...



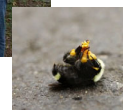
50,000 dead and dying  
bees

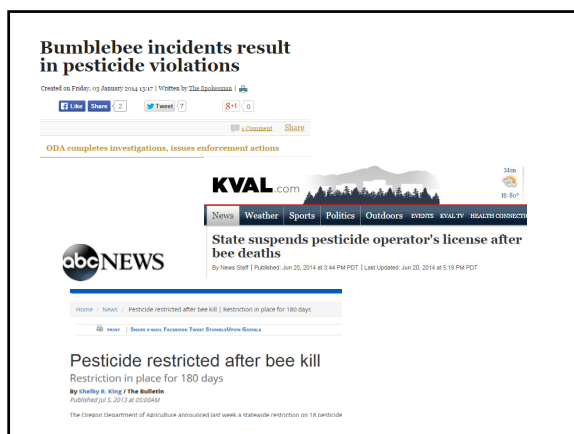
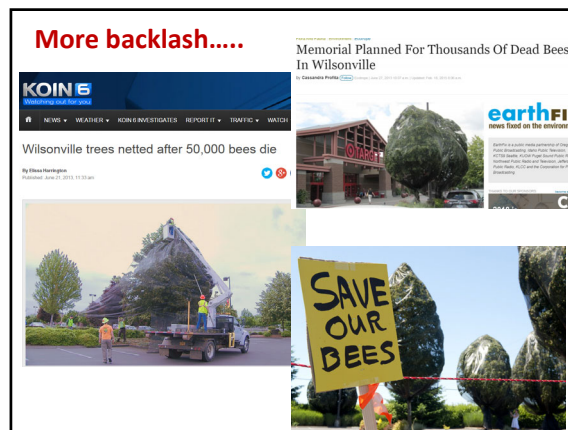


Oregon Dept. of  
Agriculture officers



Endangered species  
conservation biologists





## Why care about bees?

The worldwide economic value of insect pollination is estimated at US \$217 billion!



Tomatoes



Melons, squash



Cherries

## Without bees, they'll all be off the menu



Your produce choices with bees

Your produce choices without bees

**Products removed**

Apples	Cauliflower
Onions	Leeks
Avocados	Bok choy
Carrots	Kale
Mangos	Broccoli
Lemons	Mustard greens
Limes	
Honeydew	
Cantaloupe	
Zucchini	
Summer squash	
Eggplant	
Cucumbers	
Celery	
Green onions	

Source: Whole Foods Market

## Your breakfast.....

With bee pollination



Without bees



In parts of China, heavy agricultural spraying has nearly wiped out local bees



Farm workers must hand-pollinate millions of flowers to get fruit!



Jar of apple pollen



The California almond industry alone requires use of **1.4 million** honey bee colonies!



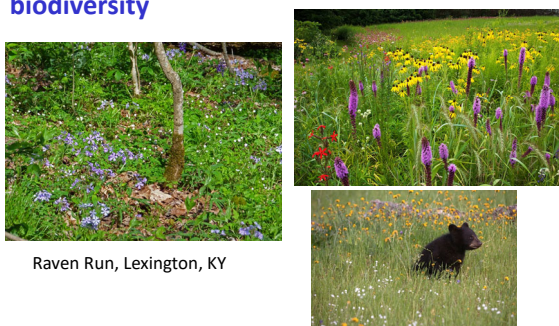
Why conserve urban bees?

Bees pollinate our gardens and plants that provide food for urban wildlife



Why conserve native bees?

They are **keystone species** for native biodiversity



Raven Run, Lexington, KY

Honey bees are not native to America

Brought here by early colonists in the 1600s

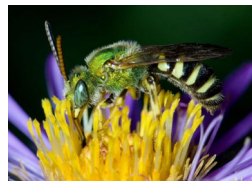


**Besides honey bees...**

**4000 species of native bees also provide pollination services in the USA!**



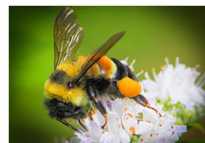
**Some Familiar Native Bees**



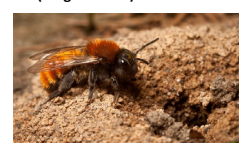
Sweat bees (Halictidae)



Mason, resin, & leafcutter bees (Megachilidae)

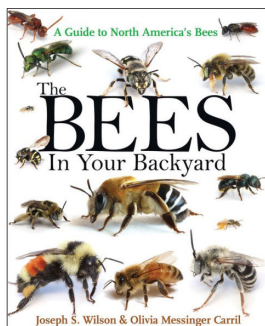


Bumble bees (Apidae)



Mining bees (Andrenidae)

## Recommended Book!



## Build a bee hotel!



## Bees and Wasps are not the same

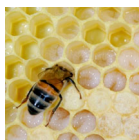


## Bees and Wasps are NOT the same

Bees feed their young on pollen and nectar



Fuzzy, with branched hairs



Feeding time!

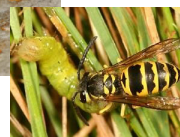
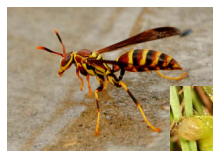
Body adapted to carry pollen



Mason bee nest

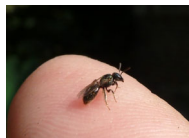
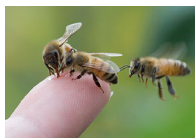
## Bees and Wasps are NOT the same

Wasps have little to no hair

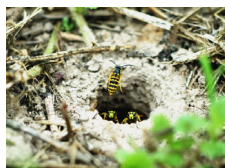


Wasps feed their young on meat!

Honey bees are docile unless their hive is threatened, and native bees rarely sting



Most stings in urban settings are from wasps!



Honey bees and native pollinators are having a tough time



## Science News

from research organizations

**U.S. beekeepers lost over 40 percent of colonies last year, highest winter losses ever recorded**

Results point to a need for increased research, extension, and best management practices

Date: June 19, 2019

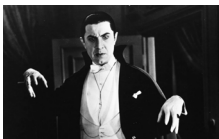
Source: University of Maryland

**Summary:** Beekeepers across the United States lost 40.7 percent of their honey bee colonies from April 2018 to April 2019, according to preliminary results of the latest annual nationwide survey conducted by the University of Maryland-led nonprofit Bee Informed Partnership. The survey results indicate winter losses of 37.7 percent, which is the highest winter loss reported since the survey began 13 years ago and 8.9 percentage points higher than the survey average.

**Why are honey bee populations struggling?**

The **Varroa mite** is considered the greatest challenge facing beekeeping worldwide

**These parasites suck blood and transmit deadly bee diseases**

**Why are honey bees struggling?****Exotic bee diseases**

Deformed wing virus



Nosema fungus causes "dysentery" in bees

**Why else are honey bees struggling?**

Smithsonian.com

**High Fructose Corn Syrup May Be Partly Responsible for Bees' Collapsing Colonies**

High fructose corn syrup, the sugary compound in soda, is also fed to bees



Good



Not good



Real honey boosts baby bees' immune systems

## Why are honey bees struggling?



## Why are honey bees struggling?

### Travel stress!



## But, most honey bees in North America are managed as semi-domesticated livestock

So beekeepers can intensify their practices to compensate for colony loss



USDA United States Department of Agriculture  
Economic Research Service

Finding: Crops

October 01, 2018

PRINT PDF EMAIL

## Despite Elevated Loss Rate Since 2006, U.S. Honey Bee Colony Numbers Are Stable

by Peyton Ferrier



## Native bee populations are declining, in North America and worldwide. *Why?*

### Patterns of widespread decline in North American bumble bees

Spillay A. Clemen<sup>1,2</sup>, Jeffrey D. Lozier<sup>3</sup>, James P. Strange<sup>4</sup>, Jonathan B. Koch<sup>5,6</sup>, Nils Corder<sup>7,8</sup>, Leifon F. Solter<sup>9</sup>, and Terry L. Griswold<sup>10</sup>

<sup>1</sup>Department of Entomology and Institute for Genome Sciences and Policy, University of North Carolina, Chapel Hill, NC 27599; <sup>2</sup>Department of Entomology, University of Maryland, College Park, MD 20742; <sup>3</sup>Department of Entomology, University of California, Davis, CA 95616; <sup>4</sup>Department of Entomology, University of Minnesota, St. Paul, MN 55108; <sup>5</sup>Department of Entomology, University of Illinois, Urbana, IL 61801; <sup>6</sup>Department of Entomology, University of Wisconsin, Madison, WI 53706; <sup>7</sup>Department of Entomology, University of Minnesota, St. Paul, MN 55108; <sup>8</sup>Department of Entomology, University of Minnesota, St. Paul, MN 55108; <sup>9</sup>Department of Entomology, University of Minnesota, St. Paul, MN 55108; <sup>10</sup>Department of Entomology, University of Minnesota, St. Paul, MN 55108

Bumble bees (Hymenoptera: Megachilidae) are vital pollinators of many crops and wildflowers. Despite their importance, bumble bee populations have declined worldwide. To understand the causes of this decline, we conducted a comprehensive review of the literature on bumble bee declines. We found that the most common cause of decline is habitat loss, followed by pesticide use, disease, and climate change. We also found that the decline is most severe in the western United States and in Europe. Our findings suggest that conservation efforts should focus on protecting and restoring natural habitats, reducing pesticide use, and managing diseases.

### Global pollinator declines: trends, impacts and drivers

Simon G. Potts<sup>1</sup>, Jacques C. Biesmeijer<sup>2</sup>, Claire Kremen<sup>3</sup>, Peter Neumann<sup>4</sup>, Oliver Schweiger<sup>5</sup> and William E. Kunin<sup>6</sup>

<sup>1</sup>Centre for Agri-Environmental Research, School of Agriculture, Policy and Development, University of Reading, Reading, UK, RG6 2AA; <sup>2</sup>Earth and Biosphere Institute and Institute of Integrative and Comparative Biology, University of Leeds, Leeds, UK, LS2 9JT; <sup>3</sup>Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720-3114, USA; <sup>4</sup>Swiss Bee Research Centre, Agroscope Liebefeld/Postaus, Research Station ALP, Schwarzenbühlstrasse 161, CH-3053 Bern, Switzerland; <sup>5</sup>Department of Community Ecology, Helmholtz Centre for Environmental Research - UFZ, Theodor-Lieser-Strasse 4, 06120 Halle, Germany

Pollinators are a key component of global biodiversity, and their decline threatens the production of many crops and wild plants. There is clear evidence of recent declines in both wild and domesticated pollinators, and parallel declines in the services they provide. However, the extent and drivers of these declines are still poorly understood. This review synthesizes the current state of knowledge on pollinator declines, focusing on the most widespread and concerning trends. We identify the main drivers of decline as habitat loss, pesticide use, disease, and climate change. We also discuss the impacts of these declines on ecosystems and human well-being, and provide recommendations for conservation and management.

## Why are Native bees declining?

### Habitat loss!



Didn't I use to live here?



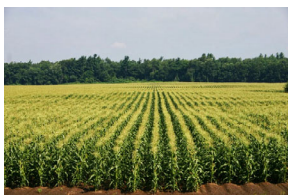
### 70% of our native bees are ground-nesters



### Many other native bees rear their young in cavities or hollow stems



### Why are ALL bees struggling? Agricultural intensification!



Less varied, less nutritious  
pollen & nectar



Acute or chronic  
exposure to pesticides

### Climate change, too, affects bee populations



SCIENTIFIC REPORTS

Climate change-driven range losses  
among bumblebee species are  
poised to accelerate

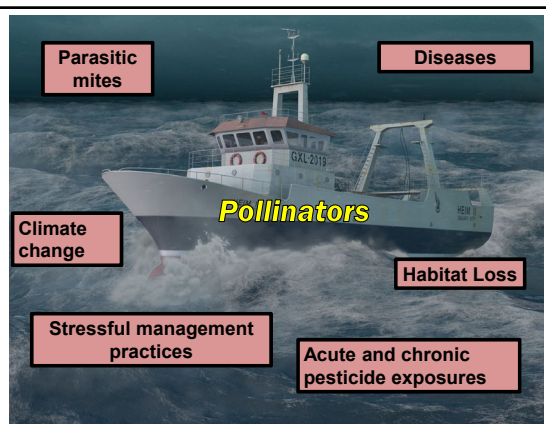
Catherine Simola Delisle<sup>1,2</sup> & Jeremy T. Kerr

EVOLUTIONARY ECOLOGY

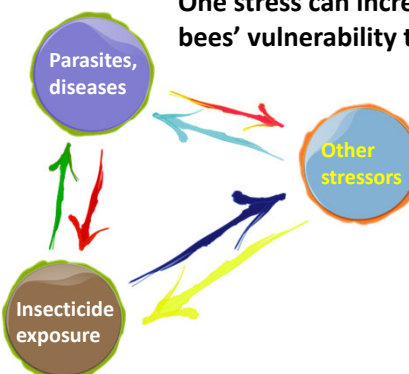
Functional mismatch in a bumble bee  
pollination mutualism under  
climate change

Nicole E. Miller-Strommann,<sup>1,2\*</sup> Jennifer C. Gell,<sup>3</sup> James D. Franklin,<sup>4</sup> Peter G. Kevan,<sup>5</sup>  
Elizabeth M. Holsinger,<sup>6</sup> Maria Elena Soto,<sup>7</sup> Jessica M. Lyles,<sup>8</sup> Jessica A. Krombein,<sup>9</sup>  
Elizabeth Holsinger,<sup>10</sup> Candace Gates<sup>11</sup>

Science 349 (6255), 1541-1544.



### One stress can increase bees' vulnerability to others



Public perception is that **pesticides**, esp. **neonicotinoid insecticides** are the main cause of bee decline



It's no longer a mystery.  
We know what's killing the bees.



Tell the EPA to Ban Neonicotinoid Pesticides  
Before They Devastate the U.S. Bee Population  
[facebook.com/organicconsumers](https://facebook.com/organicconsumers) [www.organicconsumers.org](http://www.organicconsumers.org)

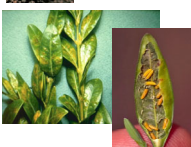
Neonicotinoids are a class of synthetic insecticides chemically related to nicotine

They are selectively much more toxic to insects than to mammals, including humans



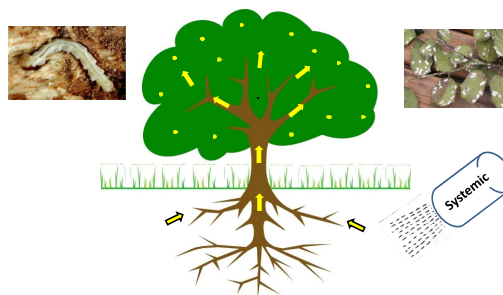
Why are neonicotinoids used?

It's not so easy bein' green...



Neonicotinoids are **systemic insecticides**

They move upward in the plants' vascular system to all parts of the plant



Neonicotinoids are relatively persistent in plants, providing extended pest control



Emerald ash borer



White grubs

Systemic applications are often more practical and less hazardous than sprays

This.....



Or this...



**Fact:**

*All insecticides effective in managing emerald ash borer are systemic, and intrinsically toxic to bees*



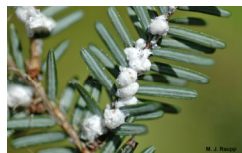
Before (2006)

After (2009)

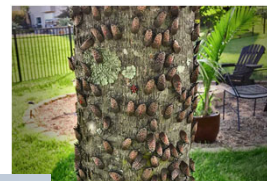
Emerald Ash Borer: Toledo Ohio

Photos: D. Herms

**In many cases, systemics are the most effective available tools for managing invasive pests**



Hemlock woolly adelgid

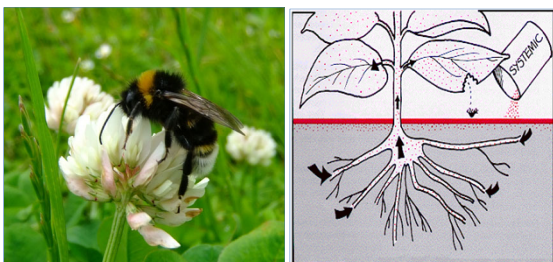


Spotted lanternfly

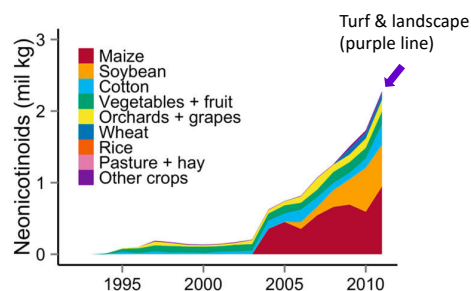


Emerald ash borer

**Bees can potentially be exposed via contact or systemic transference into pollen and nectar**



**Urban landscapes account for a tiny fraction of neonicotinoid use**



Douglas &amp; Tooker Environ. Sci. Technol. 2015

**But, the Horticulture Industry is “low-hanging fruit” in debates about banning pesticides**



**The “bee issue” has become the new driver for those pressures**



**Between the Devil and the Deep Blue Sea...**



Managing Pests

Safeguarding Pollinators

### Difficult Questions...

*Is there an acceptable threshold for bee hazard from insecticides?*

*If so, how should it be balanced against the pest management benefits?*



### Dozens of studies show:

At high enough dosages, neonicotinoids can kill bees outright or impair colony function



### Hazard = Toxicity x Exposure



High exposure  
High hazard

Low exposure  
Low hazard



### My Lab's recent research focus

Assess insecticide hazard to urban bees and find ways to reduce it

Use pollinator conservation to promote more sustainable landscapes



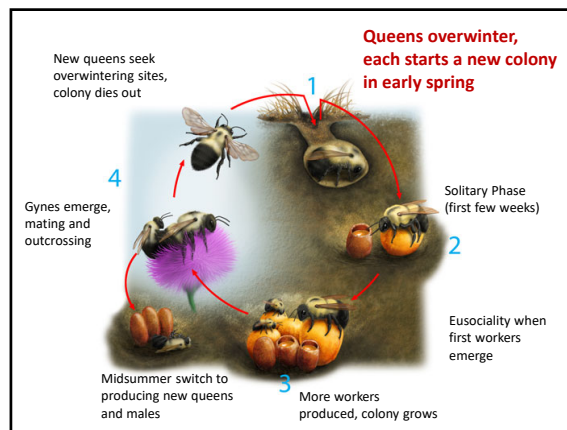
Jonathan Larson, PhD 2014

Emily Dobbs, MS 2014

Bernie Mach & Adam Baker, PhD current

### Model system for lawn studies:

White clover intermixed with cool-season turf



We compared lawn insecticides from two chemical classes:

#### Neonicotinoids



Clothianidin

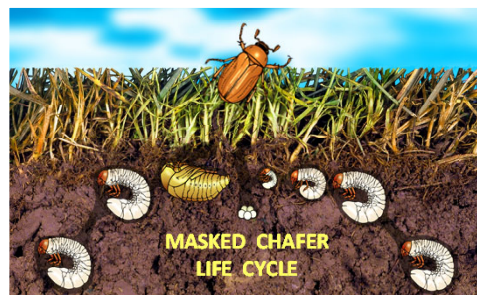


Imidacloprid

#### Anthranilic diamide



Chlorantraniliprole



JAN FEB MAR APR MAY JUN JUL AUG SEPT OCT NOV DEC

Applications were at typical timing for preventive grub control

Insecticides were applied at label rate and watered in; bees were introduced 1 day later

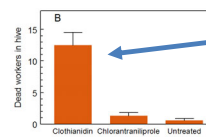
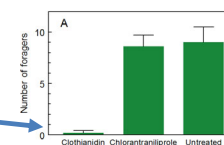


Hives started with queen & 20 workers

30 open-bottom cages

Within a few days, colony exposure to neonic-contaminated weedy turf resulted in:

Almost no foraging



High worker mortality

- Larson et al. (2013) PLOS ONE  
- Larson et al. (2014) Ecotoxicology

#### To assess effects on reproduction:

We exposed colonies to treated weedy turf for 6 d

We then moved them to "safe site" to forage and develop until late summer



6-day exposure

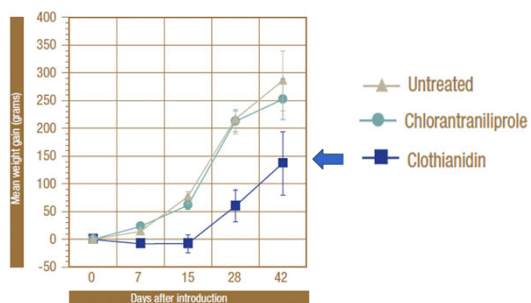


Gainesway Horse Farm – no pesticides used here!



Weighing colonies in the field

Colonies that had foraged for 6 days on neonic-treated weedy turf struggled to grow



Larson et al PLOSOne 2013

## Evaluating Colony Health



The neonic-exposed colonies were too weak to reproduce (i.e., no new queens)



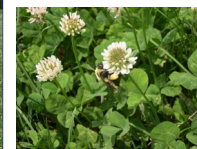
Larson et al. 2013 PLOS ONE

Will bees avoid sprayed flowers?

Spraying plots

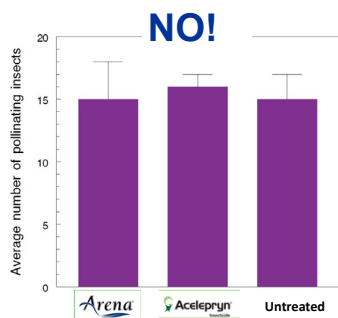


Counted bees for each day for 1 week



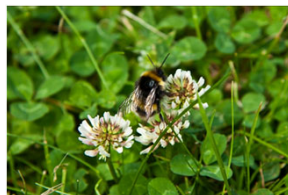
Larson et al PLOS One 2013

Will bees avoid sprayed flowers?



Take home point:

**Direct exposure to neonic residues on flowering lawn weeds is harmful to bees!**



### In other trials, we identified some ways to reduce neonic bee hazard in lawn care:



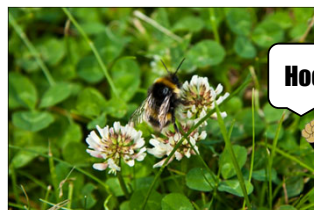
Mow off or control flowering weeds before treating for grubs



Granular formulations pose less hazard than sprays

### More importantly:

We identified an effective, non-neonic lawn insecticide that is non-hazardous to bees



Hooray!



We've shared these findings with thousands of practitioners, helping them to adopt more "bee-friendly" land care



Scotts replaced the neonic in GrubEx with Acelepryn



### EPA is proposing **cancelling all spray uses of imidacloprid** (e.g., Merit®) on residential turf



#### EPA Releases Proposed Interim Decisions for Neonicotinoids

For Release: January 30, 2020

EPA is taking the next step in its regulatory review of neonicotinoid pesticides - a group of insecticides used on a wide variety of crops, turf, ornamentals, pets (for flea treatment), and other residential and commercial indoor and outdoor uses. The agency's proposed interim decisions for acetamiprid, clothianidin, dinotefuran, imidacloprid, and thiamethoxam contain new measures to reduce potential ecological risks, particularly to pollinators, and protect public health.

### How can we reduce systemic insecticide hazard to bees on woody landscape plants?



### Residue Studies with Woody Landscape Plants

#### Environmental Toxicology

#### Uptake and Dissipation of Neonicotinoid Residues in Nectar and Foliage of Systemically Treated Woody Landscape Plants

Bernadette M. Mach,<sup>a</sup> Svetlana Bondarenko,<sup>b</sup> and Daniel A. Potter<sup>a\*</sup>

<sup>a</sup>Department of Entomology, University of Kentucky, Lexington, Kentucky, USA

<sup>b</sup>Valent U.S.A., Dublin, California

- Environ. Tox. Chem. 2017

### Collecting Nectar and Foliage for Residue Analyses



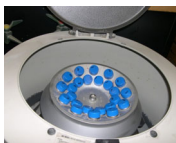
PhD student Bernie Mach collecting flowers



Prepping flowers



Twigs with blooms mounted in tubes



Centrifugation

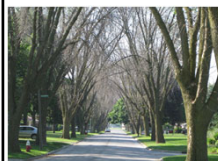


Nectar from 200-300 flowers extracted per tube

### Main take home points:

Neonics hang around for at least a year in nectar and pollen of trees and shrubs

**Don't use them on bee-attractive plants** unless there is no other way to protect them



### Lots of folks are about pollinators



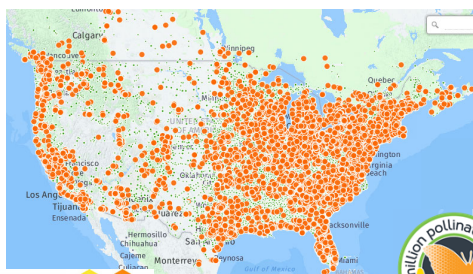
My granddaughters Adele and Evie; Halloween 2017

### Pollinator-friendly land care is good for the industry



### Million Pollinator Garden Challenge

**1,040,000** Gardens Registered in just 3 years!



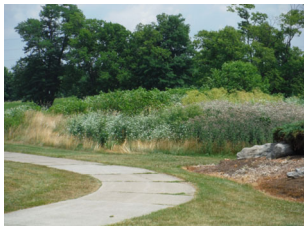
### The best way to help urban pollinators is to give them more and better food!



## A Recent Project: Operation Pollinator for Golf Courses



Emily Dobbs (MS 2014)



## Many U.S. golf courses are increasing their acreage of naturalized roughs

Kearney Hills Golf Links,  
Lexington, KY



## Establishing KY Operation Pollinator Plots



Scalp



Herbicide



Scarify and rake



Seed

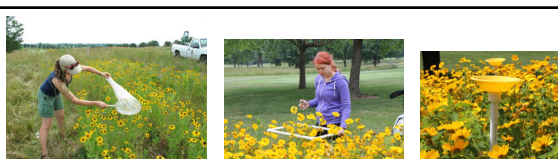
## Lakeside GC, Lexington (same site)



June 2013



July 2013



We documented 49 types of bees and butterflies, *including three declining bumble bee species*, in our plots on KY golf courses

- Dobbs and Potter 2014



Since our study, Operation Pollinator has been implemented on 300 golf courses in 30 states



Research Project: 2014-2018

## Woody Landscape Plants for Urban Bee Conservation



Bernie Mach, PhD 2018



A single tree or shrub can provide 1000s of flowers with high-quality pollen and nectar

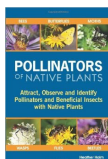
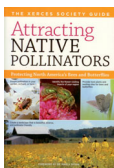
Yellowwood (*Cladrastis kentuckea*)



Summersweet (*Clethra*)



## Listmania!



## Lack of Data on Bee-attractive Plants

What type? How bee-attractive is it?

**PLANTS THAT ATTRACT POLLINATORS**  
IN THE EASTERN BROADLEAF FOREST, CONTINENTAL PROVINCE

The following chart lists plants that attract pollinators. It is not exhaustive, but provides guidance on where to start. Annuals, herbs, weeds, and cover crops provide food and shelter for pollinators, too.

Botanical Name	Common Name	Color	Height	Flower Season	Sun	Soil	Visitation by Pollinators	Is a host plant? See page 20-21
<b>Trees &amp; Shrubs</b>								
Acer spp.	Maples	red, greenish yellow	40-70'	Mar-Apr	sun to partial shade	dry to wet	bees	X
Amelanchier spp.	service berry	white	6-40'	Mar-Apr	sun to partial shade	moist, well drained	bees, flies	X

## We sampled 72 species of woody landscape plants

Five sites (replicates) per plant species



3 years, 373 sample sites!



Residential, commercial, & institutional landscapes



Arboreta



Cemeteries

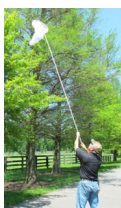


Street trees

We compared plants' attractiveness to bees by "snapshot counts"



Then collected 50-bee sample from each of 5 sites (250 bees) per plant species



Different woody ornamentals attract unique bee assemblages



Flowering crabapple

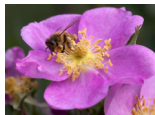


Fuzzy Deutzia



## Flower Form Matters!

Good!



Prairie rose



Hydrangea paniculata

Pretty useless



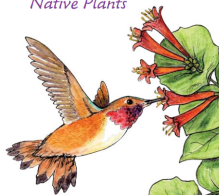
Hybrid tea rose



Hydrangea arborescens

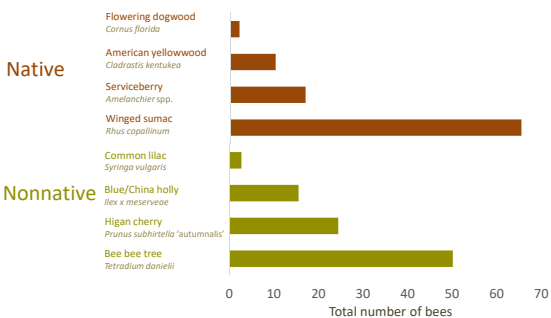
## Are natives best for bees?

Attracting Pollinators to Your Garden Using Native Plants



## Native v. Non-native Woody Plants

Either can attract low or high numbers of bees



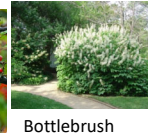
## Examples of Bee-Attractive Native Trees



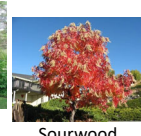
Eastern redbud



Chokecherry



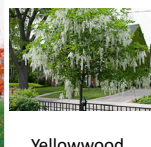
Bottlebrush buckeye



Sourwood



Black gum



Yellowwood



Winged sumac



Devil's walking stick

### Examples of Bee-Attractive Non-native Trees



Higan cherry



Amur maackia



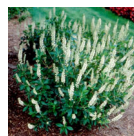
Chaste tree

Cornelian cherry  
dogwood

Beebee tree

Seven sons  
flower tree

### Examples of Bee-Attractive Native Shrubs



Summersweet

Winterberry  
holly

Buttonbush



St. John's Wort



Dwarf fothergilla



Sweetspire (Itea)

Virginia  
spiraea

False indigo

### Examples of Bee-Attractive Non-Native Shrubs



Glossy abelia



Fuzzy deutzia



Cherry laurel



Panicle hydrangea



Pyracantha

### Question:

*Do native woody plants provide higher quality floral resources than non-natives?*

### Answer:

*Both can provide quality food for bees and other pollinators*

- Mach & Potter, in prep.



Virginia spirea (native)



Glossy abelia (non-native)

Honey bees and monarch on Seven Sons Flower tree (non-native) in September



**Many of the best "bee magnets" are also nearly pest-free!**



False Indigo



St. John's Wort



Fuzzy sumac



Chaste Tree



Glossy abelia



Seven-Son Flower



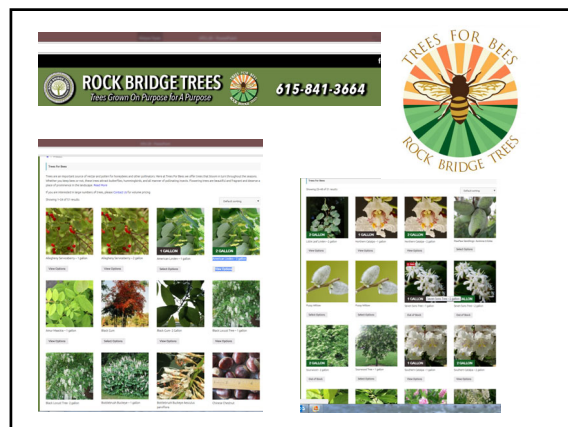
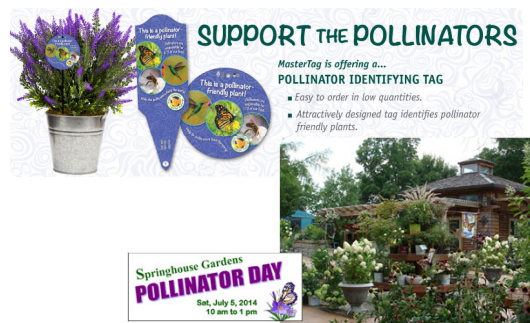
Amur Maackia



Black gum



## Marketing opportunities for growers and retailers



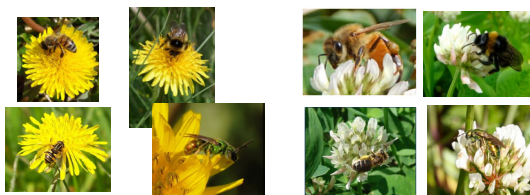
### Take home point:

### Encourage clover in low-input turf

It provides pollen, nectar, and stepping stones between remnants of natural habitat



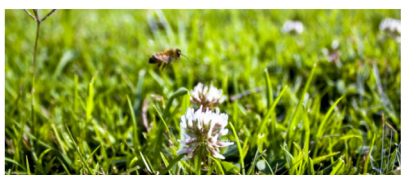
### We recorded > 50 species of pollinators foraging on dandelions and clover in Lexington KY lawns



Larson, Kesheimer & Potter 2014  
*J Insect Conservation* 18: 863-873

### Being a Lazy Lawnmower Improves Bee Habitat

Lerman et al. 2018



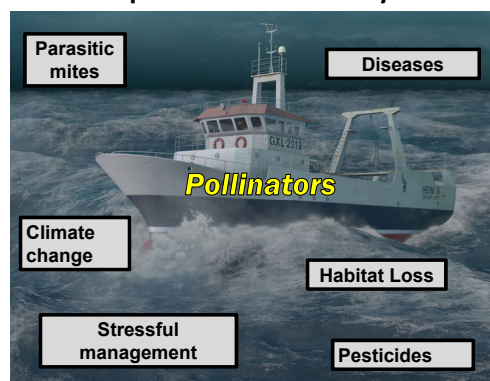
A new study finds that mowing your lawn every two weeks rather than weekly may encourage bee diversity in your yard. Image Credit: Artisticphoto-hat, licensed by cc 2.0

Putting off your lawn mowing chores could be a great way to improve bee diversity, according

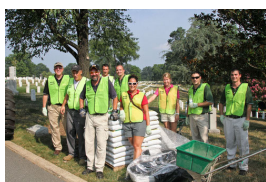


**Take home point:**

*Bees benefit agricultural, urban, and wild habitats*

**Take home point: Bees face many stressors**

**Bee-friendly land care is good for the horticulture industry**

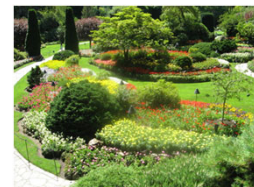


**Bee kills are not**

**Take home point:**

**Diversify urban landscapes with pest-resistant flowering plants**

Emphasize natives but include some non-invasive exotics to help buffer bees from seasonal gaps in floral resources



**Conservation icons *can* drive positive societal change**



*Can educating the public about pollinators help to turn these ..... into these?*



