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

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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
More backlash.....

The Oregon bee kill resulted from a label violation

“This product is highly toxic to bees... Do not apply or allow it to drift to blooming crops or weeds if bees are visiting the treatment area”

More prominent “Bee Hazard” box now required on pesticide labels

Why all this attention on bees?

Swarm the EPA

What challenges and opportunities does this issue pose for sustainable urban landscapes?
Why care about bees?

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

Without bees, they'll all be off the menu

Products removed
- Apples
- Onions
- Avocados
- Carrots
- Mangos
- Lemons
- Honeydew
- Cantaloupe
- Zucchini
- Summer squash
- Eggplant
- Cucumbers
- Celery
- Green onions

Your breakfast.....

With bee pollination
- Cauliflower
- Leeks
- Bok choy
- Kale
- Broccoli
- Mustard greens
- Limes
- Cabbage
- Bell pepper
- Radishes
- Spinach

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!
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

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!**

*The Bees in Your Backyard*

**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**
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.

Yikes!!

Why else are honey bees struggling?

Exotic bee diseases

- Deformed wing virus
- Nosema fungus causes “dysentery” in bees

Good

Real honey boosts baby bees’ immune systems

Not good
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

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

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!

Climate change, too, affects bee populations

Why are ALL bees struggling?
Agricultural intensification!

Climate change, too, affects bee populations

Parasitic mites
Diseases
Climate change
Habitat Loss
Stressful management practices
Acute and chronic pesticide exposures

One stress can increase bees’ vulnerability to others

Parasites, diseases
Insecticide exposure
Other stressors

Less varied, less nutritious pollen & nectar
Acute or chronic exposure to pesticides
Public perception is that pesticides, esp. neonicotinoid insecticides are the main cause of bee decline.

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.

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

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

Before (2006)
After (2009)
Emerald Ash Borer: Toledo Ohio

Urban landscapes account for a tiny fraction of neonicotinoid use

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

Model system for lawn studies:
White clover intermixed with cool-season turf

Queens overwinter, each starts a new colony in early spring
New queens seek overwintering sites, colony dies out
Gynes emerge, mating and outcrossing
Midsummer switch to producing new queens and males
Solitary Phase (first few weeks)
Eusociality when first workers emerge
More workers produced, colony grows

Jonathan Larson, PhD 2014  Emily Dobbs, MS 2014  Bernie Mach & Adam Baker, PhD current
We compared lawn insecticides from two chemical classes:

**Neonicotinoids**
- Clothianidin
- Imidacloprid

**Anthranilic diamide**
- Acelepryn
- Chlorantraniliprole

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

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

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.

Evaluating Colony Health

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

Will bees avoid sprayed flowers?

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 treatments), and other residential and commercial indoor and outdoor uses. The agency’s proposed interim decisions for acetamiprid, clothianidin, dinoflubenz, imidacloprid, and thiamethoxam control 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

- Environ. Tox. Chem. 2017
Collecting Nectar and Foliage for Residue Analyses

- PhD student Bernie Mach collecting flowers
- Twig with blooms mounted in tubes
- Prepping flowers
- 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

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

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

Establishing KY Operation Pollinator Plots

Lakeside GC, Lexington (same site)

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

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

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

Yellowwood (Cladrastis kentukea)

Listmania!

Lack of Data on Bee-attractive Plants

What type? How bee-attractive is it?

We sampled 72 species of woody landscape plants
Five sites (replicates) per plant species

3 years, 373 sample sites!

Residential, commercial, & institutional landscapes
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?

Native v. Non-native Woody Plants

Either can attract low or high numbers of bees

Native

Flowering dogwood
Chokecherry
American yellowwood
Chaste tree
Sourwood
Winged sumac
Prunus subhirtella
Common lilac
Syringa vulgaris

Nonnative

Black gum
Yellowwood
Winged sumac
Devil’s walking stick

Examples of Bee-Attractive Native Trees

Eastern redbud
Bottlebrush buckeye
Sourwood

Chokecherry
Black gum
Yellowwood
Winged sumac
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.

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

Many of the best “bee magnets” are also nearly pest-free!
**Diversify landscapes with pest-resistant flowering plants**

Emphasize natives, but include some non-invasive exotics to fill in seasonal gaps in floral resources.

<table>
<thead>
<tr>
<th>Early spring</th>
<th>Spring/Summer</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornelian cherry</td>
<td>Bottlebrush buckeye</td>
<td>Seven sons flower tree</td>
</tr>
</tbody>
</table>

**How to Build a Bee-Friendly Landscape (Choose some from each column)**

<table>
<thead>
<tr>
<th>Spring</th>
<th>Early Summer</th>
<th>Late Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serviceberry</td>
<td>Bottlebrush buckeye</td>
<td>Bee bee tree</td>
</tr>
<tr>
<td>Crabapple</td>
<td>Climbing prairie rose</td>
<td>Winged sumac</td>
</tr>
<tr>
<td>False Indigo</td>
<td>Clethra</td>
<td>Glossy abelia</td>
</tr>
<tr>
<td>Eastern redbud</td>
<td>Hydrangea paniculata</td>
<td>Seven son flower tree</td>
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<tr>
<td>Cornelian cherry</td>
<td>St. John’s wort</td>
<td>Chaste tree</td>
</tr>
<tr>
<td>Winter king hawthorn</td>
<td>Winterberry</td>
<td>Devil’s walking stick</td>
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<tr>
<td>American yellowwood</td>
<td>Golden rain tree</td>
<td>Buttonbush</td>
</tr>
<tr>
<td>Foster’s holly</td>
<td>Amur maackia</td>
<td></td>
</tr>
<tr>
<td>Flowering cherry</td>
<td>Virginia spirea</td>
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</tbody>
</table>

**On Horticultural Research Institute Website**

To access the full article, search:

**“Plos One Potter”**

**Another great resource!**

Podcasts and other great information!
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

Queen’s Balmoral Castle, Scotland
**Take home point: Bees benefit agricultural, urban, and wild habitats**

- Bees are crucial for pollination.
- They help plants reproduce, which is essential for food production.
- Urban environments can provide additional habitats.

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

- Parasitic mites: A significant threat to bee populations.
- Diseases: Viral and fungal infections can decimate bee colonies.
- Climate change: Extreme weather can affect bee habitats.
- Habitat loss: Urbanization and agriculture can reduce bee habitats.
- Stressful management: Pesticides and intensive farming practices can stress bees.
- Pesticides: Synthetic chemicals can harm bees.

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

- Bee kills are not sustainable practices.
- Bee-friendly practices are beneficial for horticulture industries.

**Take home point: Diversify urban landscapes with pest-resistant flowering plants**

- Emphasize native plants but include some non-invasive exotics.
- Help buffer bees from seasonal gaps in floral resources.

**Conservation icons can drive positive societal change**

- Conservation icons like the bald eagle and whales can drive public interest.

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

- Educating the public can raise awareness and support for pollinator conservation efforts.
Research Supported by:

[Logos of various organizations and programs]

Thanks!

[Logos of additional organizations and programs]