Science For A Better Life

Pollinator Protection

Pesticide Stewardship and Best Management Practices

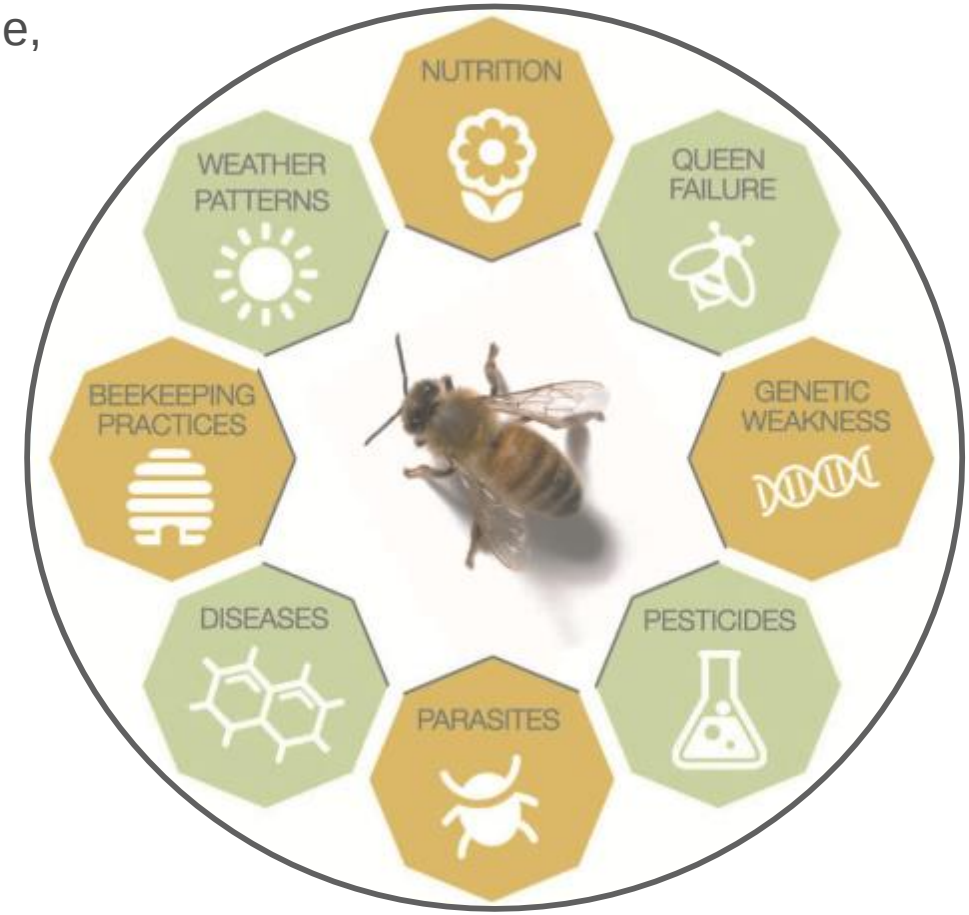
Dr. Frank Wong, Ph D.
Bayer Regulatory Affairs ● Environmental Science ● North America
Rhode Island Pollinator Working Group
November 3, 2016

Agenda

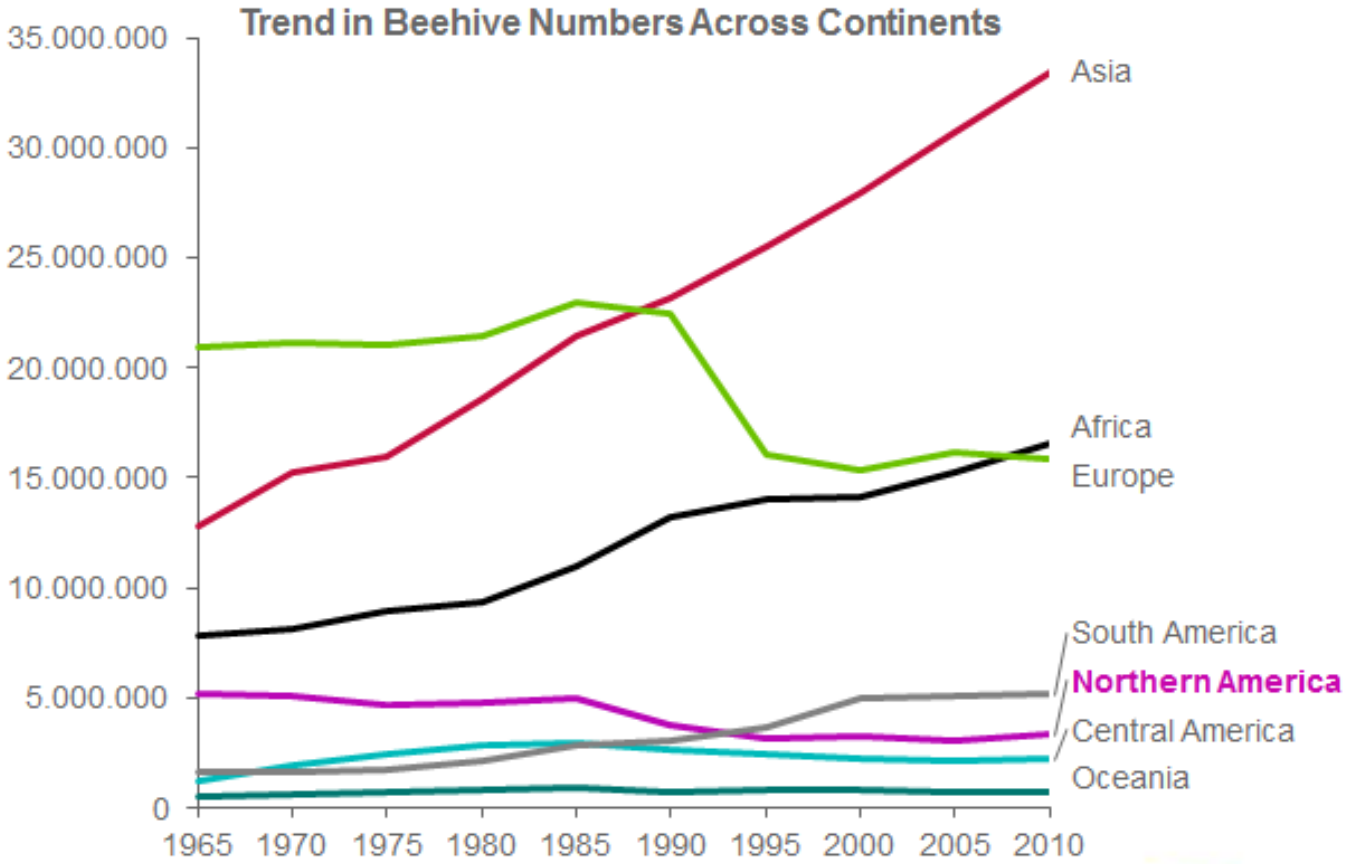
- Pollinator Health and Stressors
- Neonicotinoids
- BMPs for Pollinator Protection

The Public Atmosphere on Pollinator Protection

- *Apis mellifera*, the European honeybee, is at the center of public concern
- Native bees and other pollinators are increasingly part of the conversation
- It's a complicated issue with multiple interests
  - Beekeepers
  - Farmers
  - Environmental & Conservation Groups
  - General Public
- Science-based decisions provide the best solutions for the issue

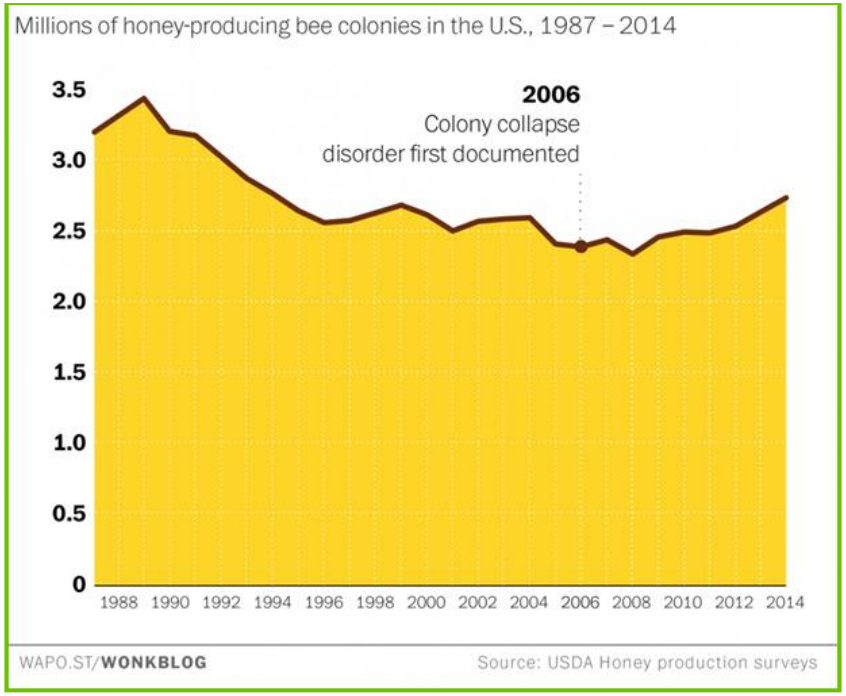


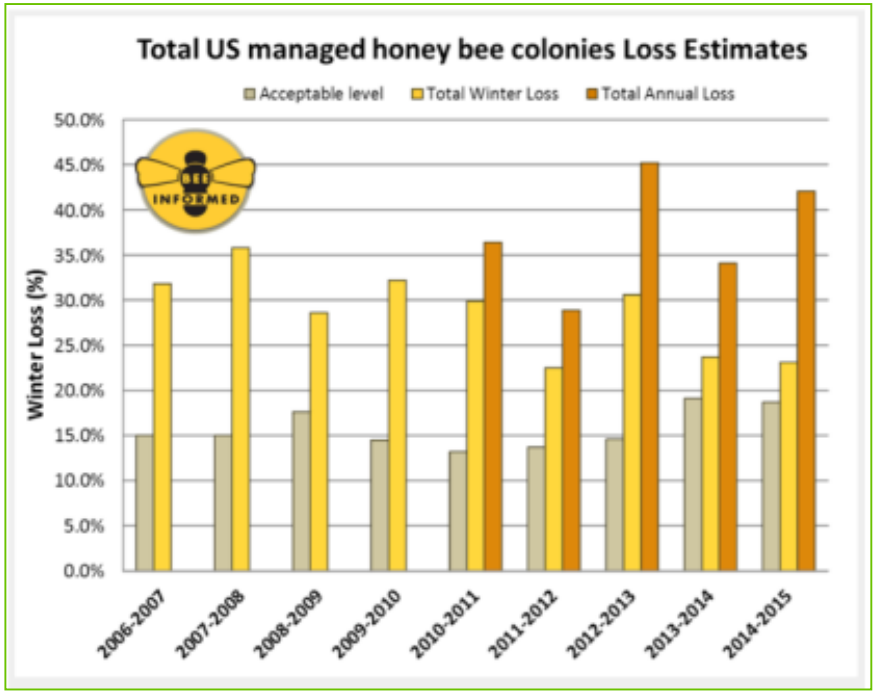
Global Honey Bee Populations & Recent US Loss Estimates



Source: UN Food and Agriculture Organization

Global Honey Bee Populations & Recent US Loss Estimates





Source: Bee Informed Partnership

- Global bee numbers are robust
- Winter losses in the US are steady
- Annual loss (winter & summer) is a recent stat that is being reported and is more variable
- No single factor identified as the sole cause of bee losses

US Government Accountability Office Report March 2016
Factors Affecting Honey Bee Health

- The US GAO provides auditing, evaluation and investigation for Congress
- The March 2016 report was critical of USDA and EPA efforts to protect pollinators
- The report highlighted 5 factors that affected pollinator health

GAO Highlighted Factors
Migratory stress from long-distance transport.
Habitat loss: degradation, fragmentation & reduced sites for nesting and breeding
Poor nutrition: decreased forage quality and diversity
Parasites and diseases
Pesticide use

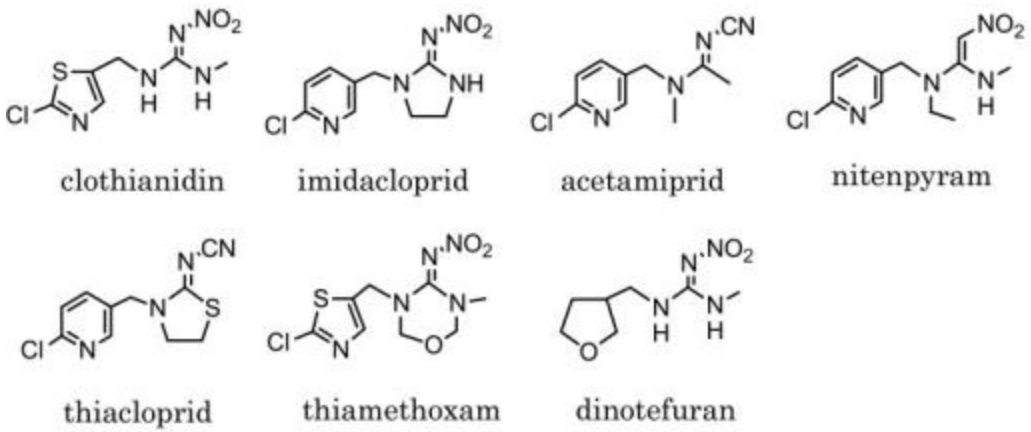
Mitigating Stressors to Pollinator Health

GAO Highlighted Factors	Mitigation
Habitat loss: degradation, fragmentation & reduced sites for nesting and breeding	Increase natural habit in agricultural and urban systems
Poor nutrition: decreased forage quality and diversity	Increase forage diversity
Parasites and diseases	Manage hive pests: Varroa mite and others Improve honey bee genetic diversity Increase state apiary services
Migratory stress from long-distance transport.	Reduce reliance on long-distance transport Improve hive health
Pesticide use	Use and steward pesticides responsibly Manage pesticide drift and exposure Develop new chemistries

Agenda

- Pollinator Health and Stressors
- Neonicotinoids
- BMPs for Pollinator Protection

Neonicotinoid Insecticides

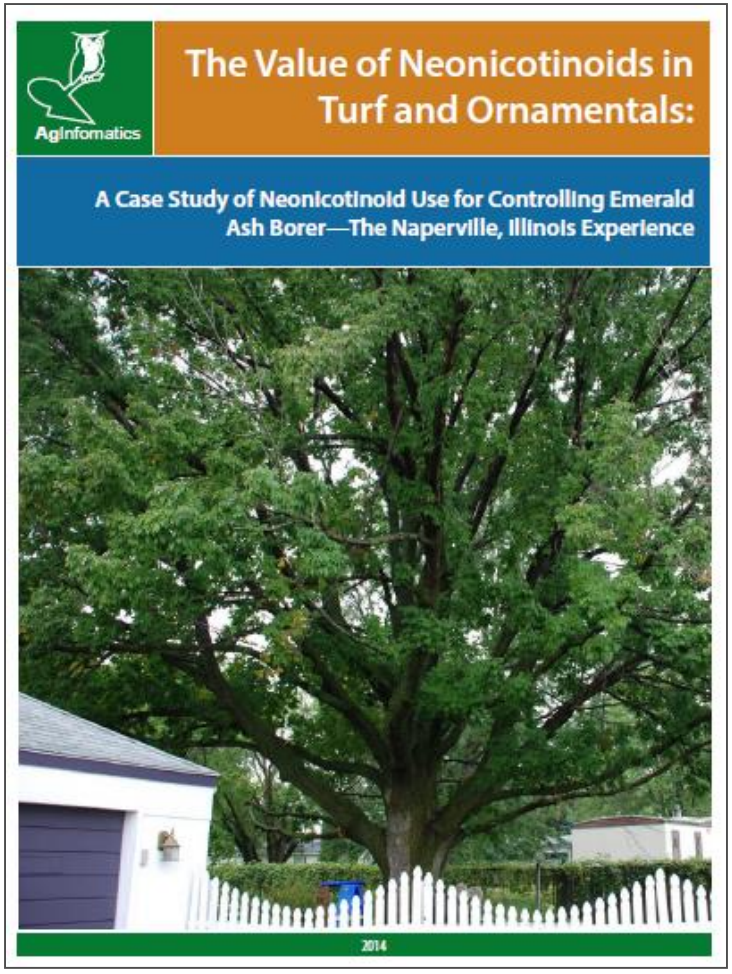


Uchigashima et al . *Sensors* 2012 doi: 10.3390/s121115858

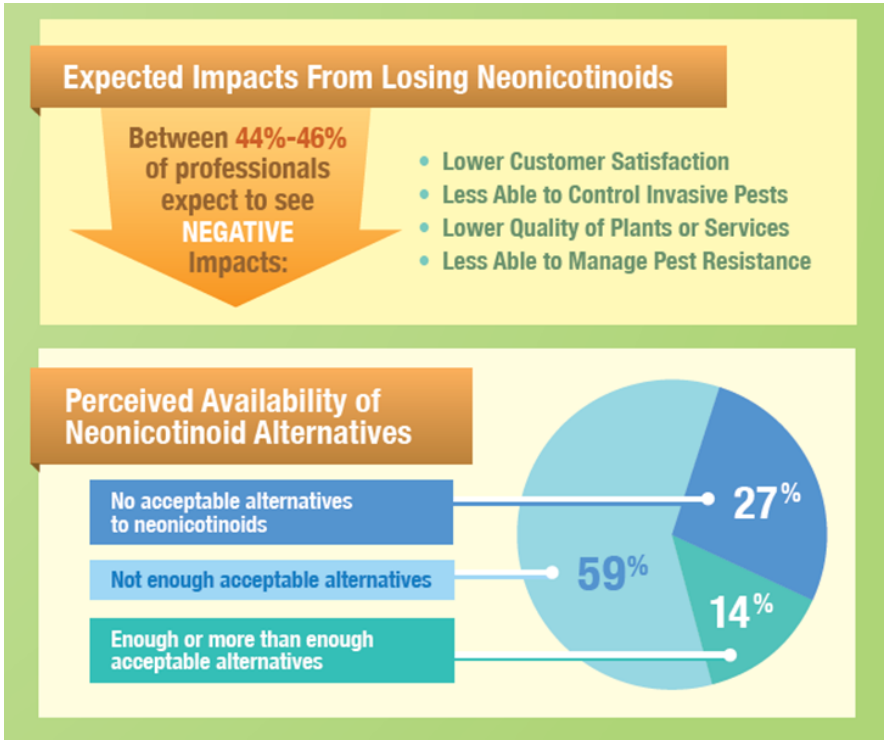
- Neonicotinoids are used in agricultural, structural pest management, home and garden and other settings
- These were discovered and developed in the 1980-90s
- Offered reduced-risk alternatives to organophosphate, carbamate, & pyrethroid insecticides
- Low mammalian effects
- Systemic properties allowed for drench application and seed treatment uses

Neonicotinoid Insecticide Benefits

www.GrowingMatters.org



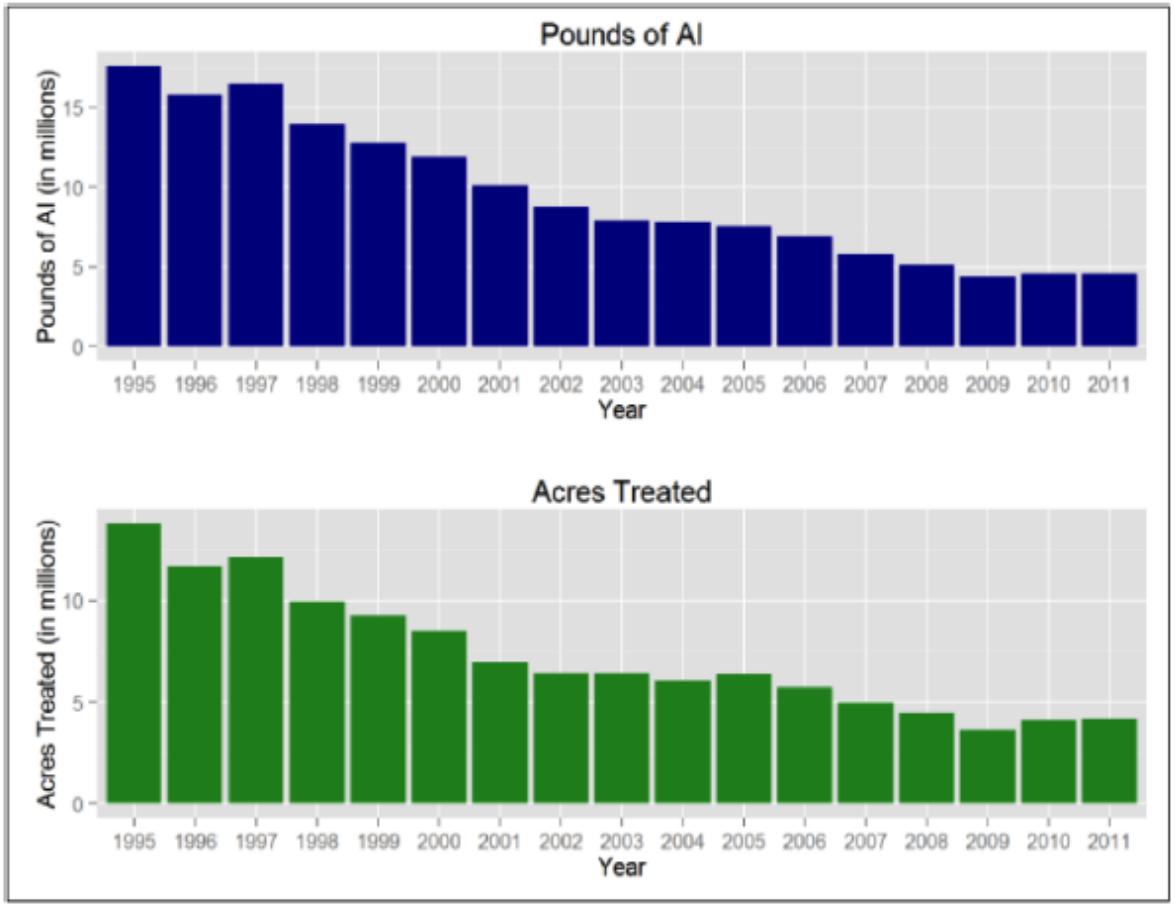
Growing Matters contains a comprehensive evaluation of the impact and benefits of neonicotinoid insecticides



Neonicotinoid Uses

Agricultural, Turf, Ornamental, Structural & Public Health Pest Control

Neonicotinoid Insecticide Benefits



800,000 lbs of neonicotinoid insecticides replaced 12 million lbs of organphosphates and carbamates

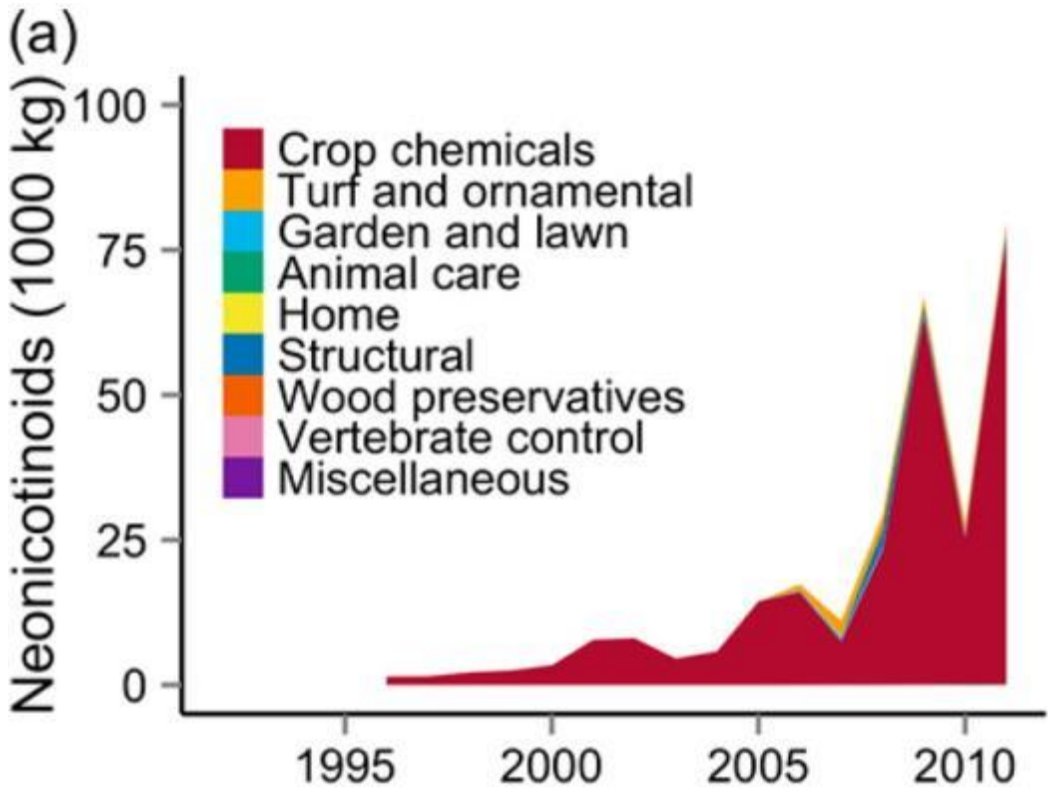
growingmatters.org

Neonicotinoid Use

Neonicotinoids have wide uses

- Agriculture
- Animal Care
- Home & Garden
- Structural Pest Control
- Turf & Ornamentals

Majority of use is for production agriculture



Source: Douglas & Tooker, Environ. Sci. Tech. 2015

Neonicotinoid Exposure

Residues in Honeybee Hives

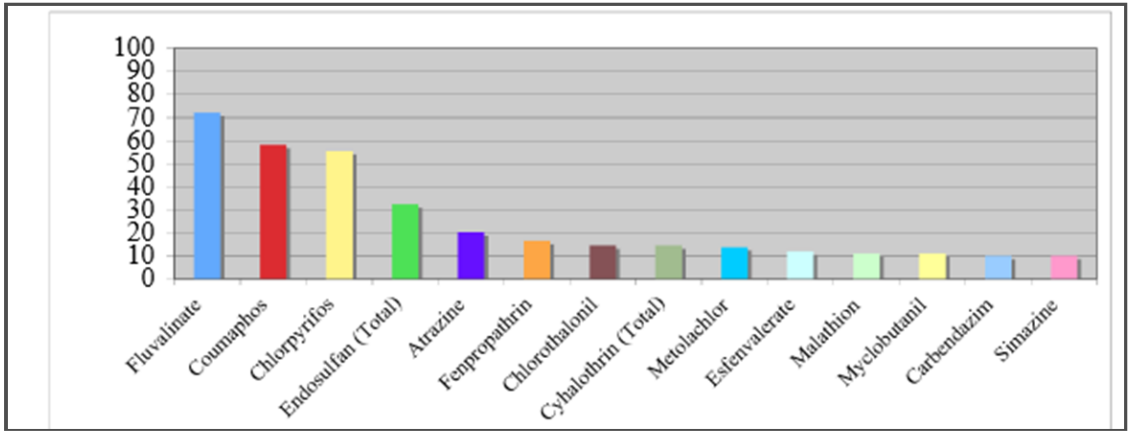
OPEN ACCESS Freely available online

PLoS one

High Levels of Miticides and Agrochemicals in North American Apiaries: Implications for Honey Bee Health

Christopher A. Mullin[1]*, Maryann Frazier[1], James L. Frazier[1], Sara Ashcraft[1], Roger Simonds[2], Dennis vanEngelsdorp[3], Jeffery S. Pettis[4]

1 Department of Entomology, The Pennsylvania State University, University Park, Pennsylvania, United States of America, 2 National Science Laboratory, United States Department of Agriculture - Agricultural Marketing Service, Gastonia, North Carolina, United States of America, 3 Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania, United States of America, 4 Bee Research Laboratory, United States Department of Agriculture - Agricultural Research Service, Beltsville, Maryland, United States of America



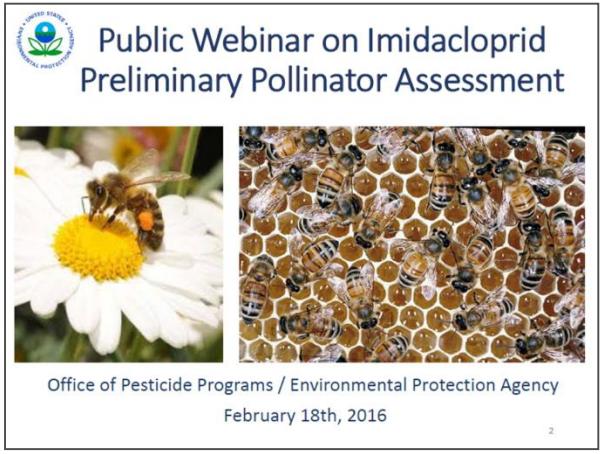
Studies indicate that neonicotinoids are not found at frequencies or at levels in honeybee hives (stored pollen or in wax) to demonstrate harm, or as the dominant pesticide residues

- Mullin et al 2010. PLos One 5: 1-19
- Lawrence et al. 2016 Journal of Economic Entomology 109: 520–528
- Long and Krupke 2016 Nature Communications 7

2016 EPA Imidacloprid Pollinator Assessment

Evaluation of Agricultural Use Risk

- Assessment of agricultural uses published in January 2016
- Non-ag use assessments to be published in December 2016
- Key EPA findings in the January assessment
  - No Observed Adverse Effect Concentration = 25 ppb imidacloprid
  - Lowest Observed Adverse Effect Concentration = 50 ppb in nectar
    - 2 of14 foliar application use patterns posed a risk
    - 1 of 17 soil application use patterns posed a risk
    - 0 of 8 seed treatment use patterns posed a risk
- Impact: No clear risk for many types of applications; unclear risks can be further lowered by following BMPs to reduce exposure



Agenda

- Pollinator Health and Stressors
- Neonicotinoids
- BMPs for Pollinator Protection

Risk is a Function of Hazard and Exposure

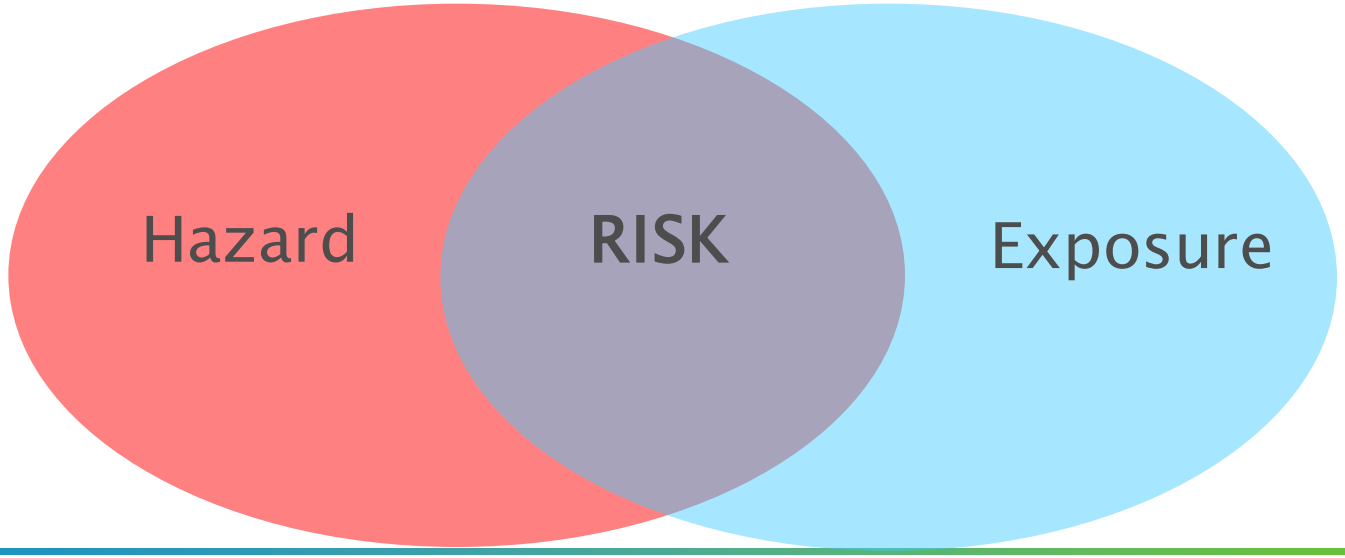
Pesticide hazard is:

- An intrinsic property of the compound (can not be altered).

Pesticide exposure is:

- Something that varies with use pattern (can be altered via label directions, use patterns, and management practices).

Risks are managed by reducing exposure



Pesticide Stewardship

Existing Neonicotinoid Mitigations

Neonicotinoid insecticides labels have advisory pollinator language to reduce pollinator exposure

- EPA mandated “Pollinator Protection Box”
- On all clothianidan, dinotefuran, imidacloprid & thiamethoxam products for foliar use
- Excludes low-risk granular use products

Pre-existing label language and use instructions mitigate exposure

- Pesticide drift and Run-off advisories
- Targeted pests and use sites

Additional non-label mitigations

- Industry Best Management Practices (BMPs)
- University Extension bulletins
- State and Tribal Managed Pollinator Protection Plans

THE NEW EPA BEE ADVISORY BOX

On EPA's new and strengthened pesticide label to protect pollinators

PROTECTION OF POLLINATORS

APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to: www.aapco.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.

The new bee icon helps signal the pesticide's potential hazard to bees.

Makes clear that pesticide products can kill bees and pollinators.

Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.

Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.

Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.

The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.

EPA

Read EPA's new and strengthened label requirements: http://go.usa.gov/jHH4

EPA Pollinator Protection Box

Advisory Label Statement Merit 75WSP Insecticide

PROTECTION OF POLLINATORS

APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon  in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at: http://pesticidestewardship.org/PollinatorProtection/Pages/default.aspx.

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state, go to: www.aapco.org/officials.html. Pesticide incidents should also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

SEE INDIVIDUAL SITES FOR SPECIFIC POLLINATOR PROTECTION APPLICATION RESTRICTIONS. IF NONE EXIST UNDER THE SPECIFIC SITE, FOR OUTDOOR FOLIAR APPLICATIONS, FOLLOW THESE APPLICATION DIRECTIONS.

NON-AGRICULTURAL USES

Do not apply Merit® 75 WSP Insecticide while bees are foraging. Do not apply Merit 75 WSP Insecticide to plants that are flowering. Only apply after all flower petals have fallen off.

EPA Proposed List of Pesticides to be Restricted During Bloom for Commercial Honey Bees (Contact LD_{50} < 11 ug/bee)

Carbamates

Aldicarb
Carbofuran
Carbaryl
Methiocarb
Methomyl
Propoxur
Oxamyl

Neonicotinoids

Acetamiprid
Dinotefuran
Clothianidin
Thiamethoxam
Imidacloprid

Organophosphates

Dicrotophos
Dimethoate
Dichlorvos
Acephate
Ethoprop
Malathion
Fenitrothion
Chlorethoxyfos
Chlorpyrifos
Profenofos
Diazinon
Naled
Phosmet
Phorate
Tetrachlorvinphos
Pirimiphos-methyl
Chlorpyrifos methyl

Naturals

Azadirachtin
Spinosad
Spinetoram
Rotenone
Arsenic acid

Pyrethroids

Alpha-cypermethrin
Phenothrin
Beta-cyfluthrin
Bifenthrin
Tefluthrin
Cyfluthrin
Cypermethrin
Prallethrin
Cyphenothrin
Deltamethrin
Pyrethrins
Esfenvalerate
D-trans-allethrin
Fenpropathrin
Etofenprox
Tetramethrin
Fluvalinate
Gamma-cyhalothrin
Lambda-cyhalothrin
Imiprothrin
Zeta-cypermethrin
Momfluorothrin
Permethrin
Resmethrin

Miticides

Abamectin
Amitraz
Pyridaben
Chlorfenapyr
Emamectin benzoate

Herbicides

Bensulide
Sethoxydim
Diuron

Others

Sulfoxaflor
Metaflumizone
Fosthiazate
Fipronil
Tolfenpyrad
Fenazaquin
Bifenazate
Endosulfan
Cyantraniliprole
Indoxacarb

Common Home, Landscape and Garden Products & Hazard to Bees[1]

Chemical Name	Sample Product Name	Chemical Class	Acutely Toxic to Honey Bees?[2]
Acephate	Orthene, Isotox IV	Organophosphate	Yes
Azadiractin	Neem	Botanical	Yes
Bacillus thringiensis	Dipel, Thuricide	Microbial	
Bifenthrin	Bug B Gone Max, Scotts Step 3	Pyrethroid	Yes
Capsaicin	Hot pepper wax insect repellent	Botanical	
Carbaryl	Sevin, Bug-B-Gone	Carbamate	Yes
Cyfluthrin	Tempo, several Advanced Garden products	Pyrethroid	Yes
Cypermethrin	Deep Reach Fogger	Pyrethroid	Yes
d-Limonene	Citrus Home Pest Control	Botanical	
Deltamethrin	Termite & Carpenter Ant Dust/Killer	Pyrethroid	Yes
Diatomaceous Earth(DE)		Mechanical desiccant	
Dimethoate	Cygon	Organophosphate	Yes
Esfenvalerate	Bug-B-Gone	Pyrethroid	Yes
Fipronil	Combat	Phenylpyrazoles	Yes
Garlic	MiteX	Botanical repellent	
Imidacloprid	Merit, Advanced Season Long Grub Control	Neonicotinoid	Yes
Lambda-cyhalothrin	Triazide, Hot Shot	Pyrethroid	Yes
Malathion	malathion	Organophosphate	Yes
Potassium Salts of fatty acids	Insecticidal soap, eg. Safer		
Prallethrin	Roach, Ant & Spider Killer	Pyrethroid	Yes
Permethrin	Numerous	Pyrethroid	Yes
Petroleum oil	Volck, Scaleicide, Horticultural Oil	Mechanical sufficant	
Pyrethrin	Numerous	Botanical	Yes
Resmethrin	Whitefly & Mealybug Spray	Pyrethroid	Yes
Rotenone	Rotenone	Botanical	Yes
Tetramethrin	Numerous	Pyrethroid	Yes
Triclorfon	Dylox	Organophosphate	Yes

[1]Modified from http://www.ipm.iastate.edu/ipm/info/articles/insecticides-home-landsape-and-garden

[2]As proposed in EPA's Proposal to Mitigate Exposure to Bees from Acutely Toxic Pesticide Products (May 2015)

Neonicotinoid Alternatives: Examples of Newer Chemistries

Chlorantraniliprole

DuPont molecule

- anthranilic diamide
- ryanodine receptor modulator
- IRAC MOA 28

Bee LD_{50}: >100 ug/bee
(acute contact)

Range of activity: beetle grubs, caterpillars

Soil use for turf only in T&O

Flupyradifurone

Bayer molecule

- butenolide
- nicotinic acetylcholine receptor modulators
- IRAC MOA 4

Bee LD_{50}: 49 ug/bee
(acute contact)

Range of activity: sucking insects - aphids, whitefly, scales, thrips, psyllids

Foliar application product only

New insecticides may lack broad spectrum effectiveness and still need to be integrated with other chemistries for IPM and resistance management programs

Critical BMPs for Pesticides

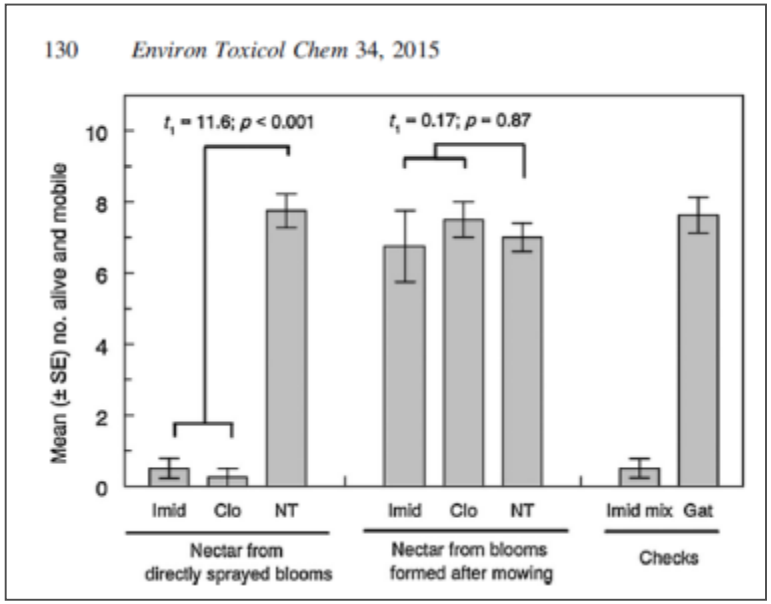
- Read and follow all label instructions
- Do not spray acutely toxic insecticides directly on foraging pollinators
- Apply only to targeted plants or sites
- Minimize spray drift and run-off

Neonicotinoid BMPs: Turf and Lawn Applications

- Do not apply foliar applications when bees are foraging on lawn weeds
- Mow off clover and flower weeds before insecticide application
  - Incorporate pre- and post-emergent weed control in lawns
  - U of KY studies showed no significant effects from clover flowers formed after mowing & application
- Water-in applications
  - Moving the insecticide into the soil targets grubs and moves it away from bees (wait 1 hr before watering in for max. pest control)
  - Granular applications watered into the soil have the least risk to bees (water in within 24 hrs)

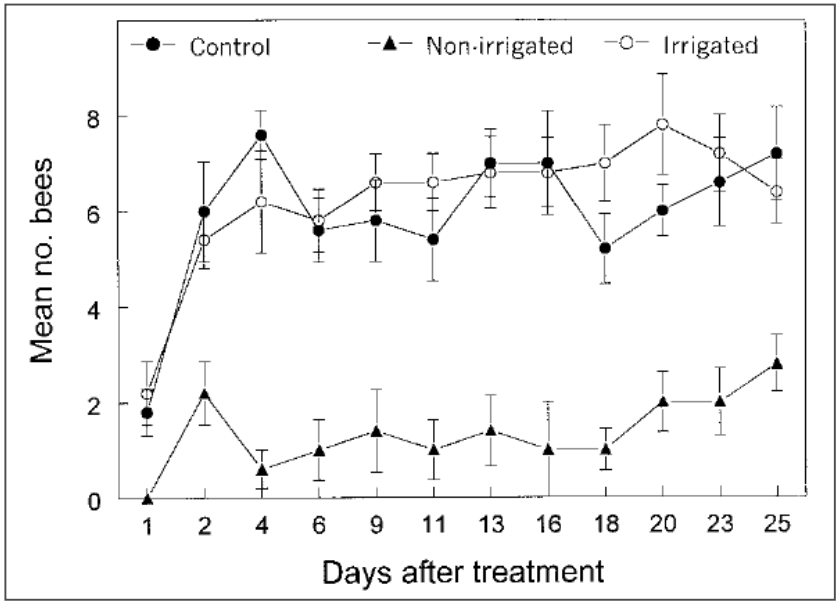
Neonicotinoid BMPs: Turf and Lawn Applications

Simple mitigations such as those proposed by University of Kentucky Researchers can significantly reduce exposure



Controlling or mowing weeds before application reduced exposure by >99%

Larson et al 2015 *Environmental Toxicology*



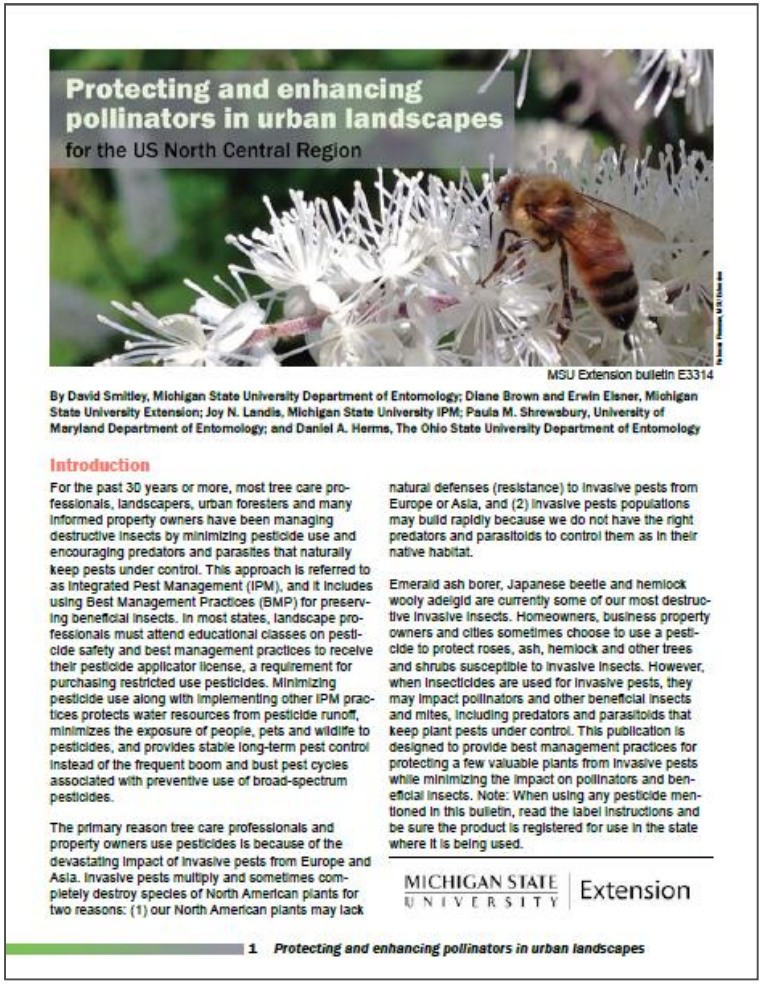
Watering-in applications or using granular forms resulted in no significant effect on pollinators

Larson et al. 2013 *PLos One*

Neonicotinoid BMPs:
Tree and Shrub Products

- Pollinator-attractive Flowering Trees and Shrubs
  - Do not apply foliar applications immediate pre-bloom through bloom
  - Wait until plants have completed flowering until foliar application
  - No neonicotinoid products on Linden, Basswood, or other *Tilia* species – use other insecticides with care
  - Systemic and soil applications are low risk when used according to the label
- Wind-pollinated Flowering Trees and Shrubs (conifers, grasses, etc)
  - Minimal risk to pollinators, use products at labeled rates and according to use instructions

BMPs: Tree and Shrub Products



Protecting and enhancing pollinators in urban landscapes

for the US North Central Region

MSU Extension bulletin E3314

By David Smitley, Michigan State University Department of Entomology; Diane Brown and Erwin Elsner, Michigan State University Extension; Joy N. Landis, Michigan State University IPM; Paula M. Shrewsbury, University of Maryland Department of Entomology; and Daniel A. Herms, The Ohio State University Department of Entomology

Introduction

For the past 30 years or more, most tree care professionals, landscapers, urban foresters and many informed property owners have been managing destructive insects by minimizing pesticide use and encouraging predators and parasites that naturally keep pests under control. This approach is referred to as Integrated Pest Management (IPM), and it includes using Best Management Practices (BMP) for preserving beneficial insects. In most states, landscape professionals must attend educational classes on pesticide safety and best management practices to receive their pesticide applicator license, a requirement for purchasing restricted use pesticides. Minimizing pesticide use along with implementing other IPM practices protects water resources from pesticide runoff, minimizes the exposure of people, pets and wildlife to pesticides, and provides stable long-term pest control instead of the frequent boom and bust pest cycles associated with preventive use of broad-spectrum pesticides.

The primary reason tree care professionals and property owners use pesticides is because of the devastating impact of invasive pests from Europe and Asia. Invasive pests multiply and sometimes completely destroy species of North American plants for two reasons: (1) our North American plants may lack natural defenses (resistance) to invasive pests from Europe or Asia, and (2) invasive pests populations may build rapidly because we do not have the right predators and parasitoids to control them as in their native habitat.

Emerald ash borer, Japanese beetle and hemlock wooly adelgid are currently some of our most destructive invasive insects. Homeowners, business property owners and cities sometimes choose to use a pesticide to protect roses, ash, hemlock and other trees and shrubs susceptible to invasive insects. However, when insecticides are used for invasive pests, they may impact pollinators and other beneficial insects and mites, including predators and parasitoids that keep plant pests under control. This publication is designed to provide best management practices for protecting a few valuable plants from invasive pests while minimizing the impact on pollinators and beneficial insects. Note: When using any pesticide mentioned in this bulletin, read the label instructions and be sure the product is registered for use in the state where it is being used.

MICHIGAN STATE UNIVERSITY | Extension

1 Protecting and enhancing pollinators in urban landscapes

General BMPs such as those in the 2016 Michigan State University publication provide regional information on

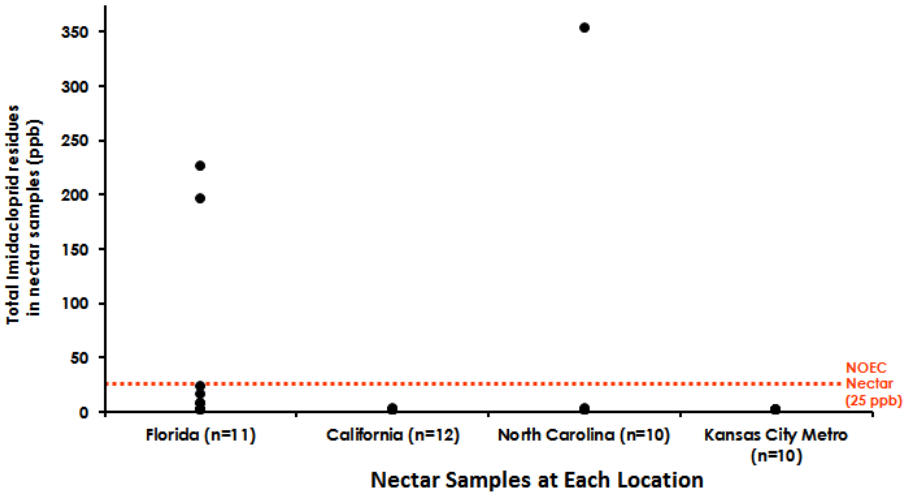
- Pollinator-attractive plants
- Timing of pesticide applications to avoid pollinator exposure
- Habitat improvement for pollinators
- Plant selection, planting & care
- Integrated pest management

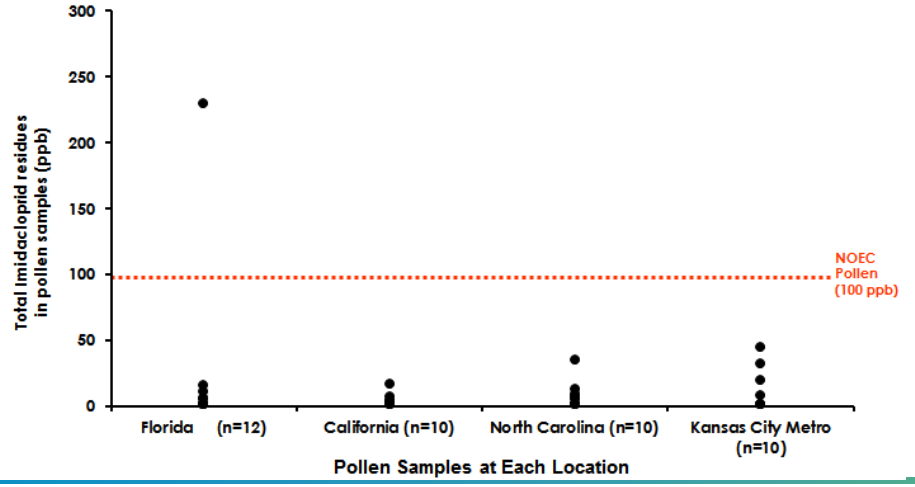
Neonicotinoid BMPs: Nursery Plants

- Most relevant for pollinator attractive plants
- Preliminary work from Dr. David Smitley at MSU indicates systemic insecticide residues can be at acceptable levels if applications are timed correctly
  - Do not spray flowers in the last 2 –3 weeks before shipping
  - Do not apply soil drenches of imidacloprid to hanging baskets any later than 5 weeks before shipping.
- Bayer is working to determine residues in nursery stock to improve BMPs and application timings

Retail Garden Center Bedding Plants:

Imidacloprid Residue Analysis in Pollen and Nectar





Recent studies examining imidacloprid residues in bedding plants indicated <5% of pollen and nectar samples had residues above levels of concern for the tested matrices

- likely that high residues were from foliar application immediately prior to shipping
- adoption of industry BMPs for nursery production would help address this issue
- AmericanHort and other industry groups are funding research to develop comprehensive BMPs for commercial nurseries

Stewardship Resources

Example: CURES

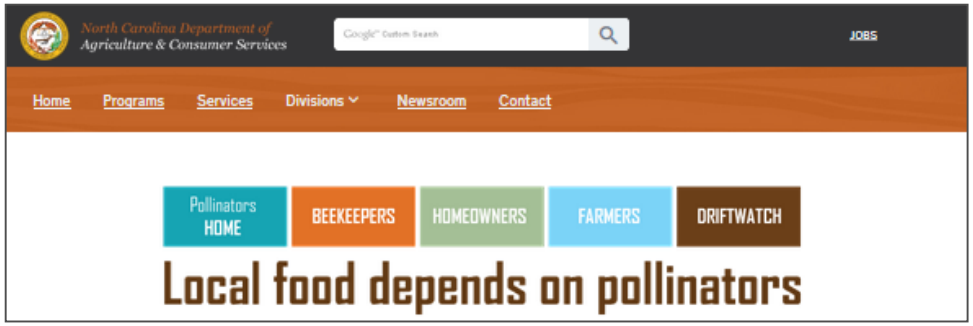
Private-public partnerships such as the Coalition for Urban/Rural Environmental Stewardship provide BMPs & promote environmental responsibility

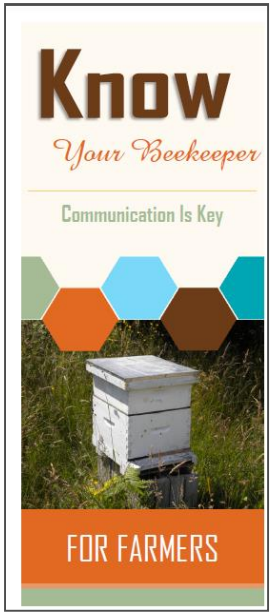
- Worker protection
- Pesticide drift management
- Watershed protection
- Nutrient management
- Pollinator protection
- Others

www.curesworks.org

Stewardship Resources

Example: NC Dept of Ag & Consumer Services





Public education for pesticide stewardship and pollinator health is crucial to reinforce existing information

- Pesticide labels and proper use
- Honeybee health management
- Native pollinators
- Communication between beekeepers and applicators

State Managed Pollinator Protection Plans (MP3)

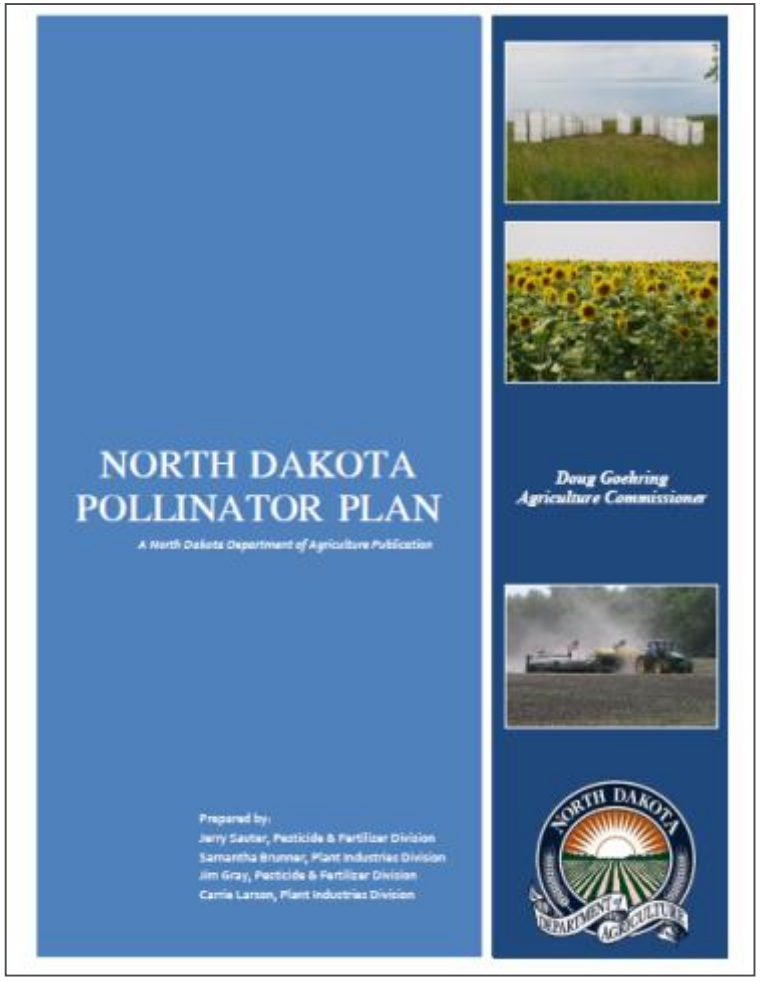
Why?

- One of EPA's tactics to meet the objectives of the 2015 White House Pollinator Task Force plan
- Reduce pesticide exposure to bees through timely communication and coordination among key stakeholders, including beekeepers, growers, pesticide applicators, and landowners
- Each state will devise their own plan to meet local needs

How?

- Engage public stakeholders in the process
- Increase grower/applicator/beekeeper abilities to locate and contact each other
- Develop BMPs to minimize risk of pesticides to bees
- Have a clear defined plan for public outreach
- Measure effectiveness and revise plans

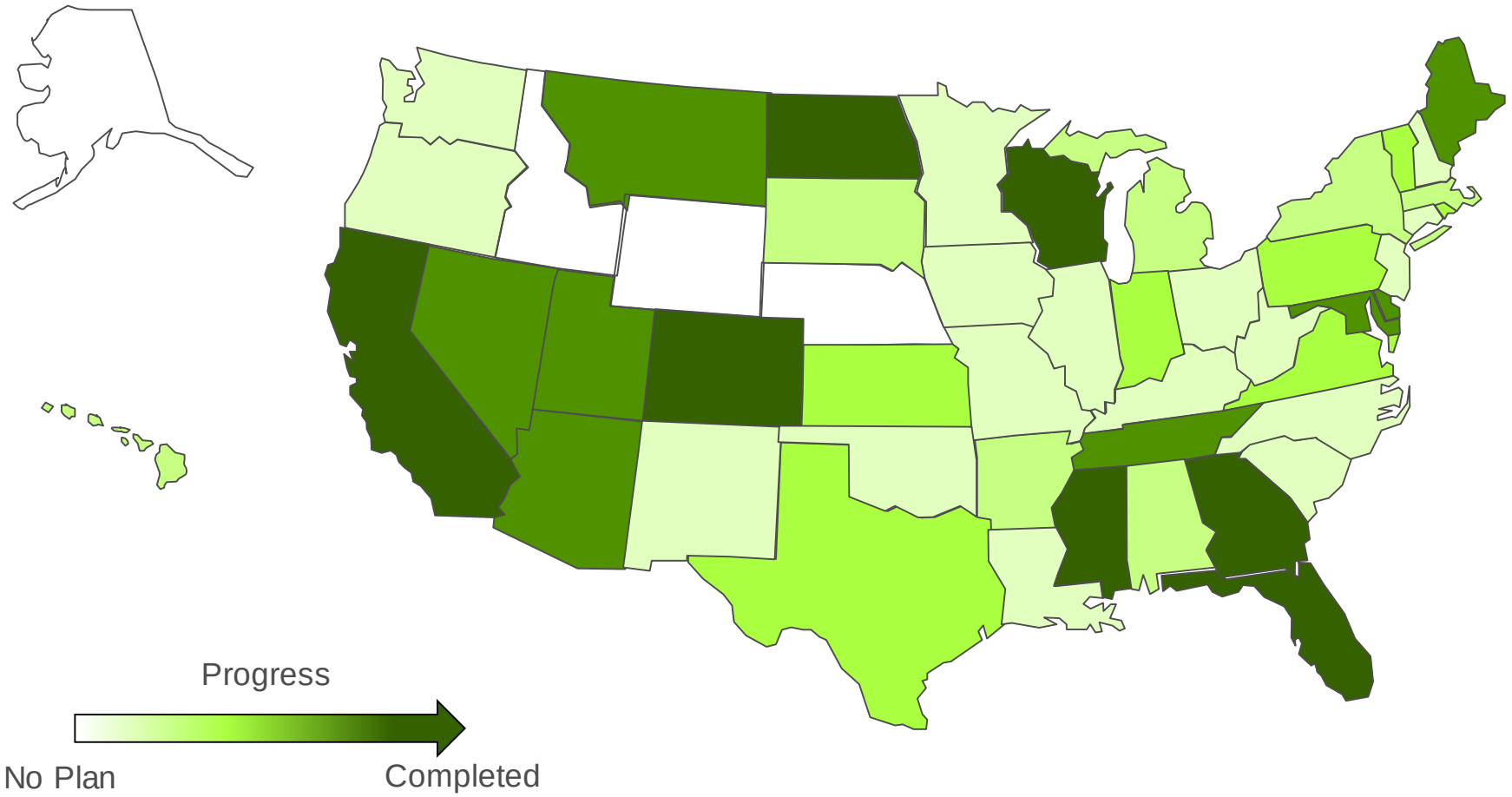
MP3s: State Managed Pollinator Protection Plans



- Each state shall set voluntary guidelines or best management practices to protect pollinator health from pesticide applications
- Driven by State Departments of Agriculture
- Vary from state to state in focus
- Main focus is on agricultural pesticide uses and managed honey bees
- Example – North Dakota focuses on agriculture, Georgia has added emphasis on urban and non-ag environments

Status of State MP3s

Updated October 2016



Takeaways

- Pollinator health is a complex issue
  - Habitat loss, long-distance movement, pests & diseases and pesticides can all negatively affect honeybees
  - Neonicotinoids are the focus of public perception but all pesticides must be stewarded
- Pesticide stewardship can mitigate pollinator exposure
  - Many mitigations and resources are in place and can work
  - Industry BMPs further reduce risk
  - Public education must reinforce stewardship practices
- Science must lead public policy – current studies do not implicate neonicotinoids as a sole concern for pollinators

Ask Me Anything

- Dr. Frank Wong
- frank.wong@bayer.com
- @turfpathology