Environmental Horticulture Program

Pollinators and Production of Ornamental Plants

Cristi L Palmer

IR-4 Environmental Horticulture Program Manager

What is IR-4?

The IR-4 Project (or Inter-Regional project number 4) was created in 1963 to facilitate registration of sustainable pest management technology for specialty crops and minor uses

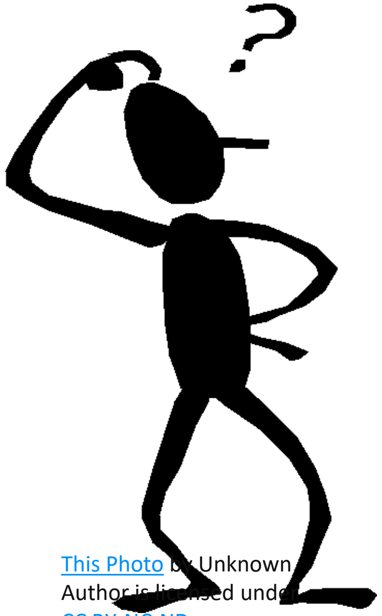
Photo by Cristi Palmer

Fruits (1963)
Vegetables (1963)
Trees (1977)
Shrubs (1977)
Flowers (1977)

IR-4 Environmental Horticulture Program Elements

Program Element	*Funding Sources*	*Funds since 2004 (20 years)*
Registration Support	NIFA IR-4 Grant 2021-34383-34848 USDA-ARS State Agricultural Experiment Stations Crop Protection Industry	~$24,500,000
Invasive Species	USDA-APHIS	$6,135,497
Pollinator Protection	NIFA SCRI Grant 2016-51181-25399 “Protecting Pollinators with Economically Feasible and Environmentally Sound Ornamental Horticulture”	$6,509,975

Pollinator Risk in Environmental Horticulture



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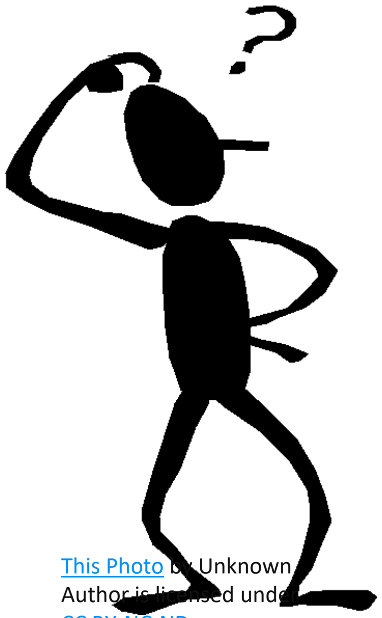

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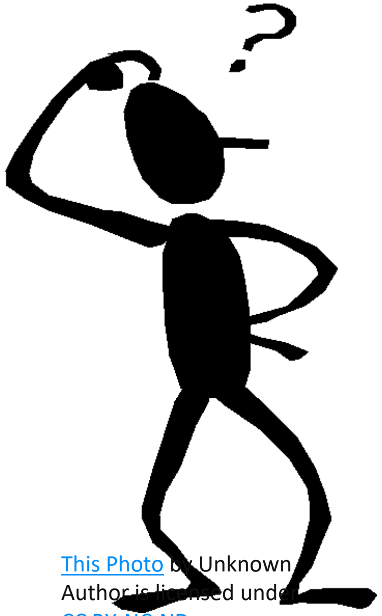

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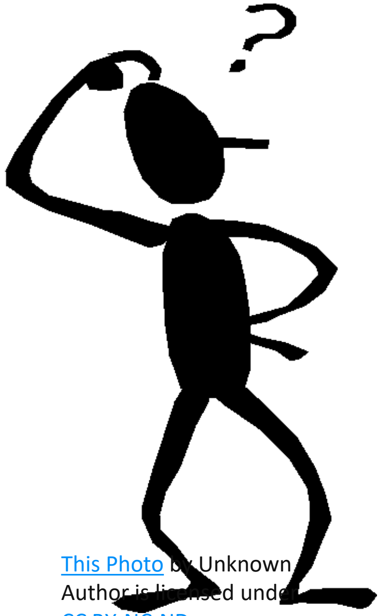

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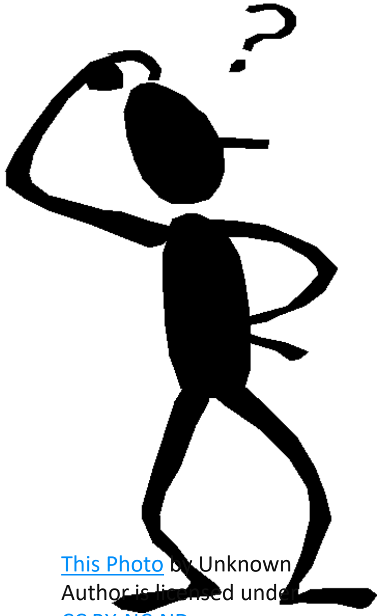

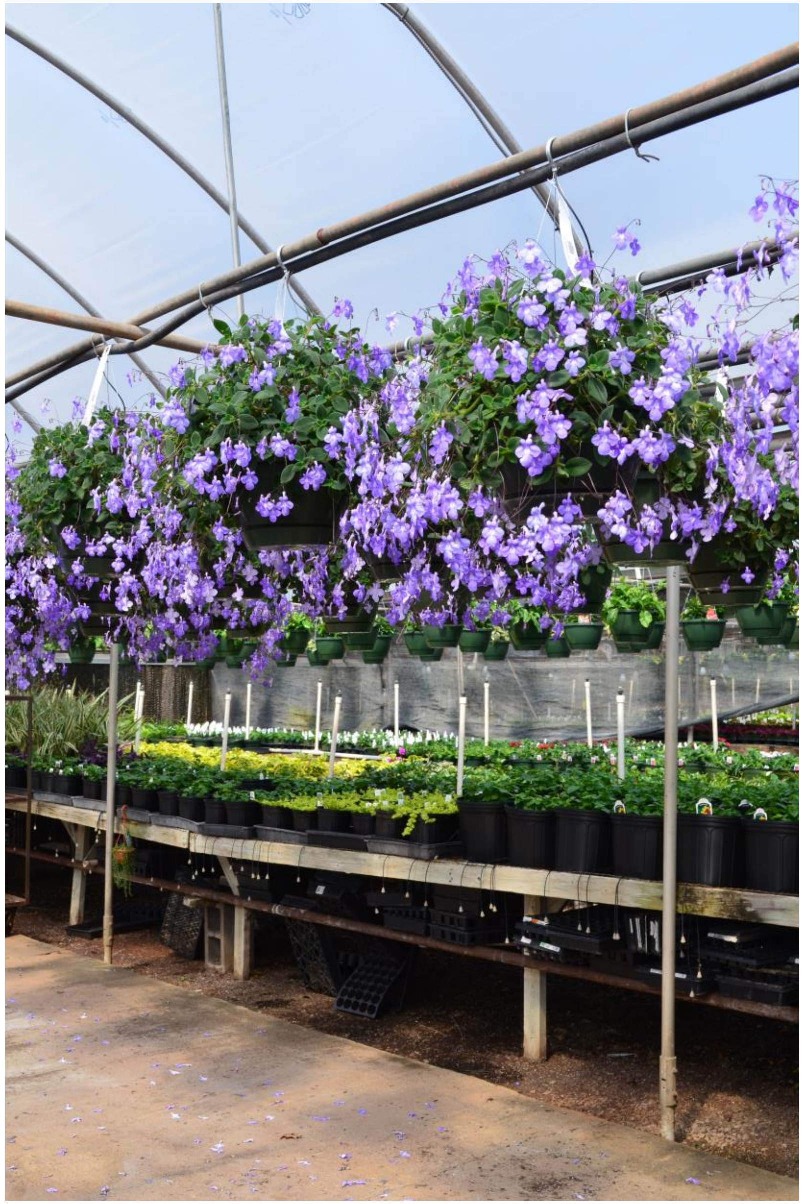

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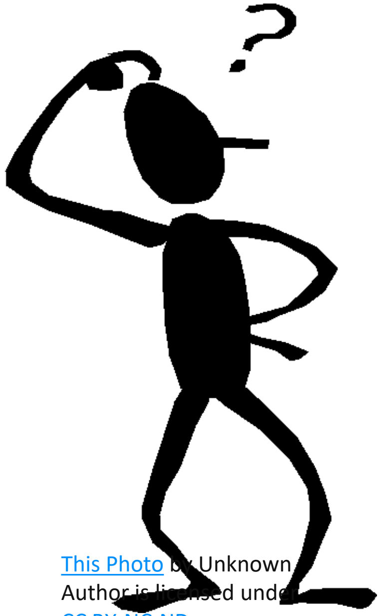

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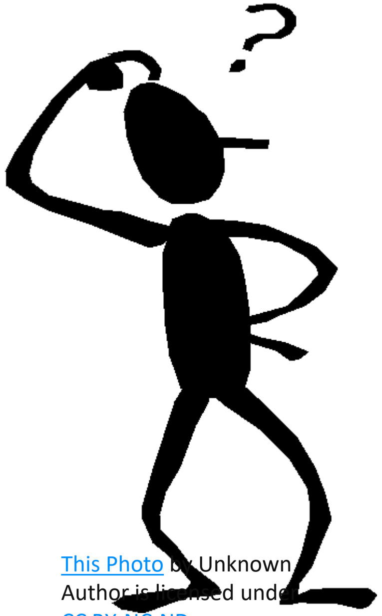
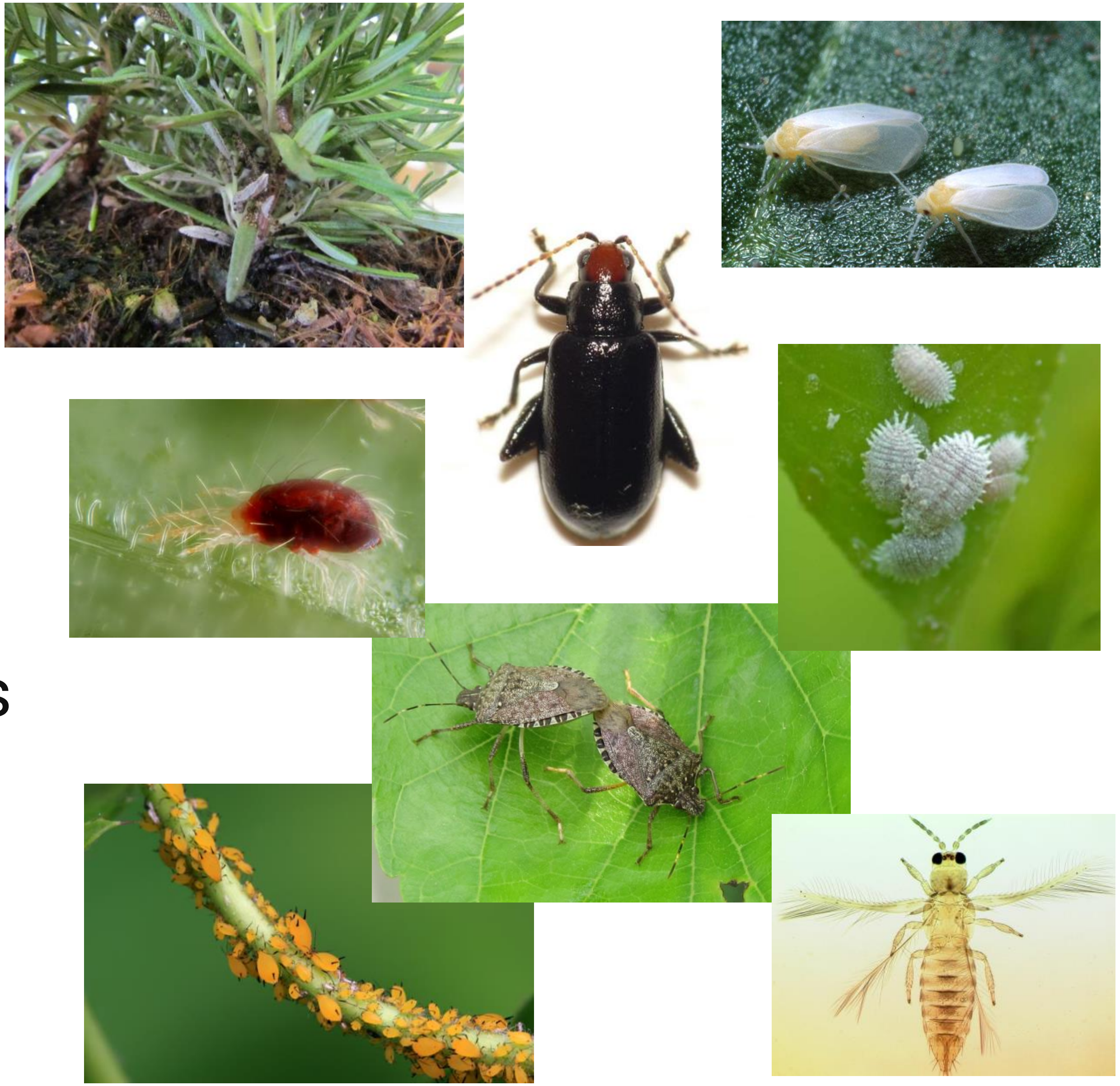


- Aphids
- Thrips
- Whiteflies
- Scale
- Mealybugs
- Mites
- Psyllids
- Leafminers
- Lepidopterans
- Beetles
- Borers
- Leafhoppers
- Planthoppers



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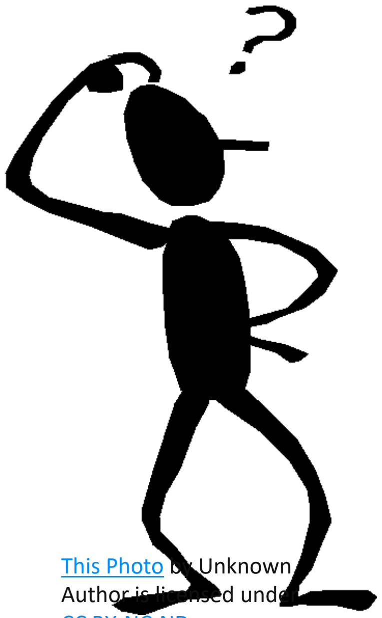


- Aceria sp. (Eriophyid Mite (Aceria))
- Aculus ligustri (Hedge Privet Rust Mite)
- Aedes aegypti (Mosquito, Dengue)
- Aedes albopictus (Mosquito, Dengue)
- Agrilus anxius (Bronze Birch Borer)
- Aphis gossypii (Aphid, Melon)
- Asterolecanium puteanum (Scale, Holly Pit)
- **Aulacaspis yasumatsui (Scale, Cycad)**
- Balanococcus diminutus (Phormium Mealybug)
- **Bemisia tabaci B-biotype (Sweet Potato Whitefly - B-biotype)**
- **Bemisia tabaci Q-biotype (Sweet Potato Whitefly - Q-biotype)**
- Ceroplastes floridensis (Florida Wax Scale)
- Chrysobothris femorata (Flatheaded Apple Tree Borer)
- Chrysomphalus aonidum (Florida Red Scale)
- Chrysomphalus bifasciculatus (False Florida Red Scale)
- Coccus hesperidum (Brown Soft Scale)
- Dendrothrips ornatus (Privet Thrips)
- Diaspidiotus ostreiformis (Scale, Oystershell)
- **Duponchelia fovealis (European Pepper Moth)**
- Endelomyia aethiops (Rose Slug Sawfly)
- Epitrix sp. (Flea Beetle, Garden, Epitrix sp.)
- Eriococcus lagerstroemia (Crape Myrtle Bark Scale)
- Eulecanium cerasorum (Scale, Calico)
- **Exomala (Anomala) orientalis (Oriental Beetle)**
- **Ferrisia virgata (Mealybug, Striped)**
- **Fiorinia externa (Scale, Elongate Hemlock)**
- **Fiorinia theae (Scale, Tea)**
- Frankliniella occidentalis (Thrips, Western Flower)
- Gynaikothrips uzeli (Gynaikothrips uzeli)
- **Halyomorpha halys (Brown Marmorated Stink Bug)**
- Hemiberlesia rapax (Greedy Scale)
- Icerya purchasi (Cottony Cushion Scale)
- Lepidosaphes camelliae (Camelia Scale)
- Lepidosaphes pallida (Maskell Scale)
- Lepidosaphes yanagicola (Winged Euonymus Scale)
- Liriomyza sp. (Liriomyza Leafminers)
- Lopholeucaspis japonica (Japanese Maple Scale)
- Lygus sp. (Plant Bugs)
- Melanaspis deklei (Wax Myrtle Scale)
- **Melanaspis tenebricosa (Gloomy Scale)**
- **Miscanthiococcus miscanthi (Miscanthus Mealybug)**
- **Myllocerus undatus (Sri Lankan Weevil)**
- **Myzus persicae (Green Peach Aphid)**
- Neolecanium cornuparvum (Magnolia Scale)
- Neopulvinaria innumerabilis (Cottony Maple Scale)
- Oligonychus ilicis (Mite, Southern red)
- Oligonychus ununguis (Spider Mite, Honeylocust, Spruce)
- Ophiomyia kwansonis (Leafminer, Daylily)
- Orchestes alni (European Elm Flea Weevil)
- Orius insidiosus (Orius insidiosus)
- Otiorhynchus sulcatus - adults (Black Vine Weevil - adults)
- Otiorhynchus sulcatus - grubs (Black Vine Weevil - grubs)
- Paratachardina pseudolobata (Lobate Lac Scale)
- Paria fragariae ssp. Fragariae (Strawberry Rootworm)
- Parthenolecanium fletcheri (Fletcher Scale)
- Phenacaspis pinifoliae (Pine Needle Scale)
- **Phenacoccus gossypii (Mexican Mealybug)**
- **Phenacoccus madeiresis (Madeira Mealybug)**
- Planococcus citri (Citrus Mealybug)
- Podosesia aureocincta (Banded Ash Clearwing Borer)
- Podosesia syringa (Lilac Borer)
- Polyphagotarsonemus latus (Broad Mite)
- **Popillia japonica - adults (Japanese Beetle - adults)**
- **Popillia japonica - grubs (Japanese Beetle - grubs)**
- Pseudaulacaspis cockerelli (False Oleander Scale)
- Pseudaulacaspis pentagona (White Peach Scale)
- Pyrrhalta viburni (Viburnum Leaf Beetle)
- Raoiella indica (Red Palm Mite)
- Ripersiella hibisci (Root Mealybug, Hibiscus)
- Saissetia coffeae (Scale, Hemispherical; brown shield)
- **Scirtothrips dorsalis (Chilli Thrips, Yellow Tea Thrips)**
- Stratiolaelaps (Hypoaspis) miles (Hypoaspis miles)
- Synanthedon exitiosa (Peachtree Borer)
- Systena frontalis (Red Headed Flea Beetle)
- Tetranychus urticae (Spider Mite, Two-Spotted)
- Thrips simplex (Gladiolus Thrips)
- **Thysanococcus pandani (Hala Scale)**
- Trialeurodes vaporariorum (Greenhouse Whitefly)
- Unaspis euonymi (Euonymus Scale)
- **Xyleborus glabratus (Ambrosia Beetle, Redbay)**
- **Xylosandrus crassiusculus (Ambrosia Beetle, Granulate/Asian)**
- Xylosandrus germanus (Ambrosia Beetle)

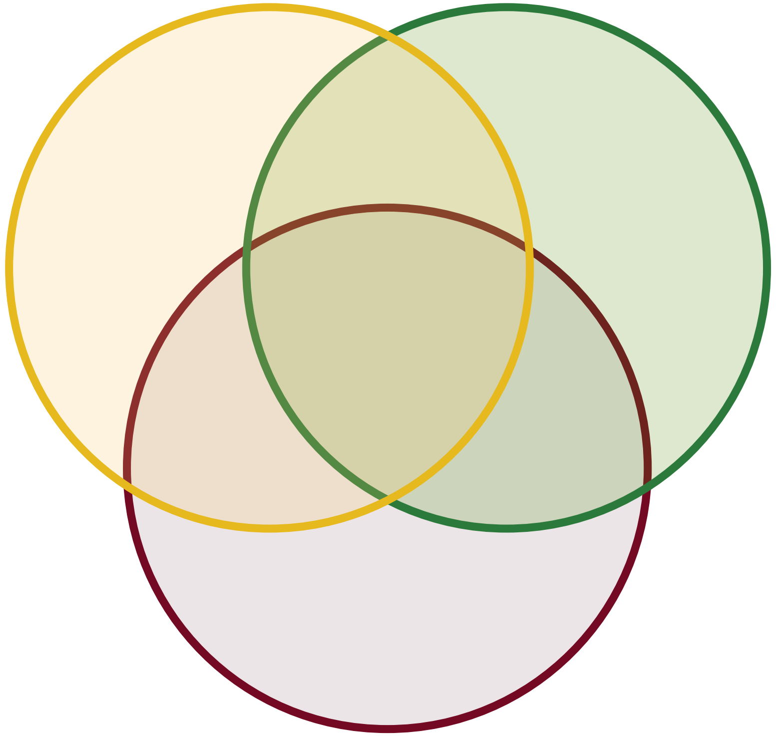
Systemic Insecticides and Pollinator Risk

Pollinator

What and how much do insect (bee) pollinators eat?

What are pollinator foraging patterns?

Are they social or solitary?



Plant

Are plants good forage materials for insect (bee) pollinators?

How many are available in the landscape?

Are plants treated to manage pest insects?

Pest

How impactful is the active to pollinator health?

When are applications needed to manage pests, protect pollinators?

How much is needed?

Systemic Insecticides and Pollinator Risk

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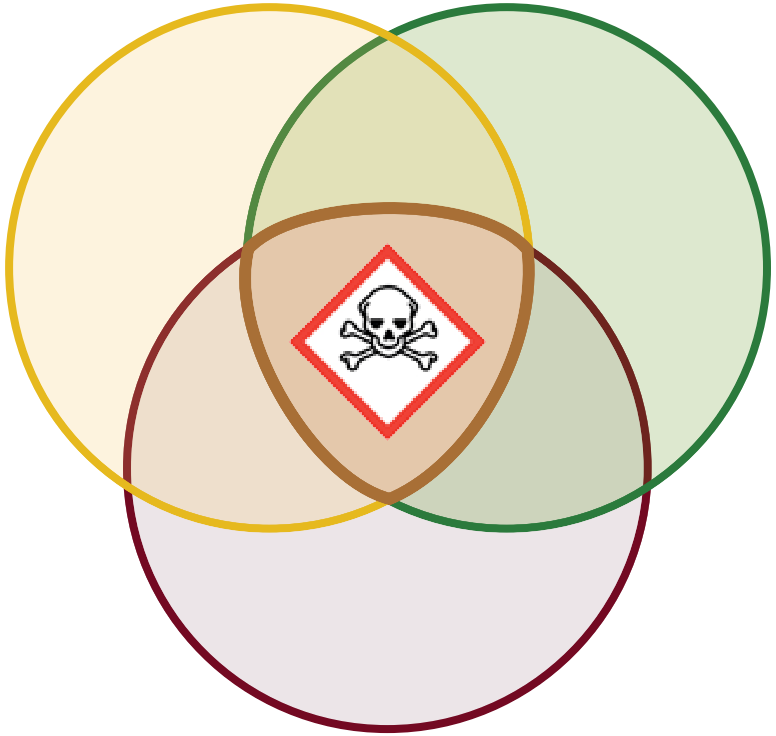

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SCRI Protecting Pollinators Team

NIFA SCRI Grant 2016-51181-25399

Researcher Team

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Brian Eitzer (Connecticut Agricultural Experiment Station)
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  Elizabeth Leonard

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Terril Nell, American Floral Endowment
Randy Oliver, Scientific Beekeeping
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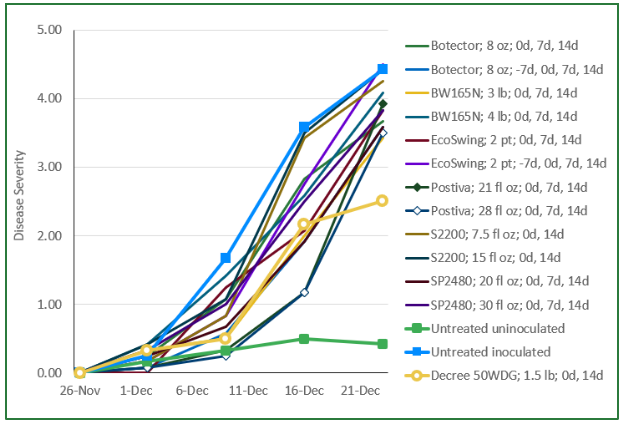
Jay Overmyer, Syngenta Crop Protection
Casey Sclar, American Public Gardens Association
Becky Sisco, IR-4 Western Region
Tim Tucker, Amer. Beekeeping Federation
Mark Yelanich, Metrolina Greenhouses, Inc.
Vickie Wojcik, Pollinator Partnership
Ex officio: Thomas Harty, Tom Moriarty, Tom Steeger, EPA

Protecting Pollinators Requires a Multi-prong Approach

- **Pollinator Attractiveness** of Environmental Horticulture Crops
- **Risk Assessment** Data Gaps
- Economic, **Efficacy**, and **Toxicological Comparisons** of Alternatives
- Public Perception of Management Practices & Point-of-Purchase Display Materials
- Development of New BMPs
- Outreach

Efficacy & Toxicological Comparisons

Efficacy Experiments



Product/Active List

Label Rate & Maximum Application Limits

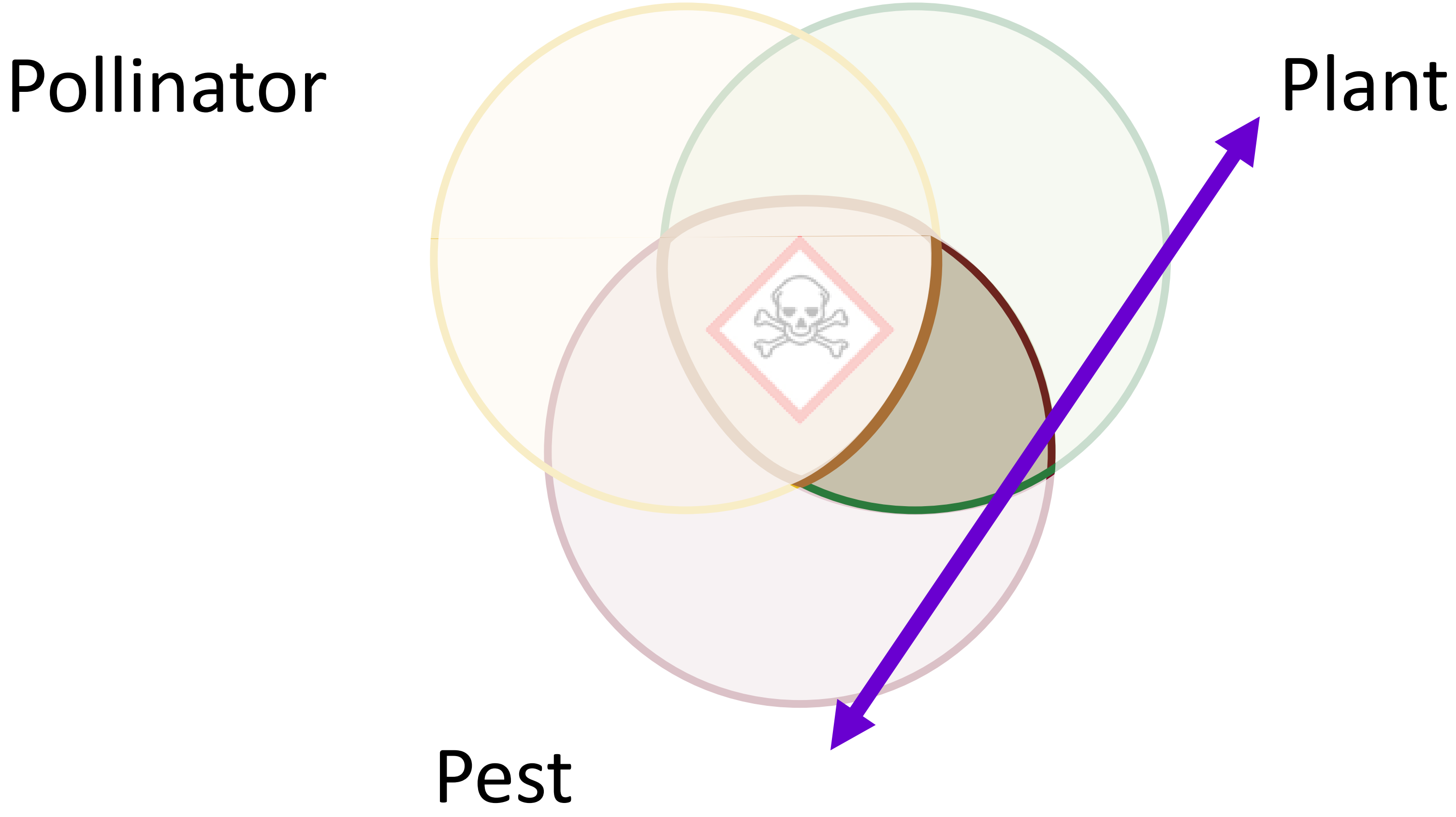
Risk Quotients for Wildlife Species with Aquatic Diets

	At Application Site		Across 20-ft. Buffer	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Representative Species	**Mammalian**			
fog/water shrew	<0.01	<0.01	<0.01	<0.01
rice rat/star-nosed mole	<0.01	<0.01	<0.01	<0.01
small mink	<0.01	<0.01	<0.01	<0.01
large mink	<0.01	<0.01	<0.01	<0.01
small river otter	<0.01	<0.01	<0.01	<0.01
large river otter	<0.01	<0.01	<0.01	<0.01
Representative Species	**Avian**			
sandpipers	<0.01	<0.01	<0.01	<0.01
cranes	<0.01	<0.01	<0.01	<0.01
rails	<0.01	<0.01	<0.01	<0.01
herons	<0.01	<0.01	<0.01	<0.01
small osprey	<0.01	<0.01	<0.01	<0.01
white pelican	<0.01	<0.01	<0.01	<0.01

Risk Quotients for Wildlife Species with Terrestrial Diets

	At Application Site		Across 20-ft. Buffer	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Diet Category	**Small (20-g) Bird**			
Short Grass	0.22	12.89	<0.01	0.09
Tall Grass	0.10	5.91	<0.01	0.04
Broadleaf plants	0.12	7.25	<0.01	0.05
Fruits/pods	0.01	0.81	<0.01	<0.01
Arthropods	0.09	5.05	<0.01	0.03
Seeds	<0.01	0.18	<0.01	<0.01
Diet Category	**Medium (100-g) Bird**			
Short Grass	0.10	3.96	<0.01	0.03
Tall Grass	0.04	1.82	<0.01	0.01

Systemic Insecticides and Pollinator Risk



When can applications of systemic insecticides be applied for pest management and still protect pollinators??

CA2019 Snapdragon. L. Corkidi

NJ2018 Snapdragon. C. Palmer

Snapdragon
Systemic Insecticide
Residue Experiments

Snapdragon Residue Methodology Differences

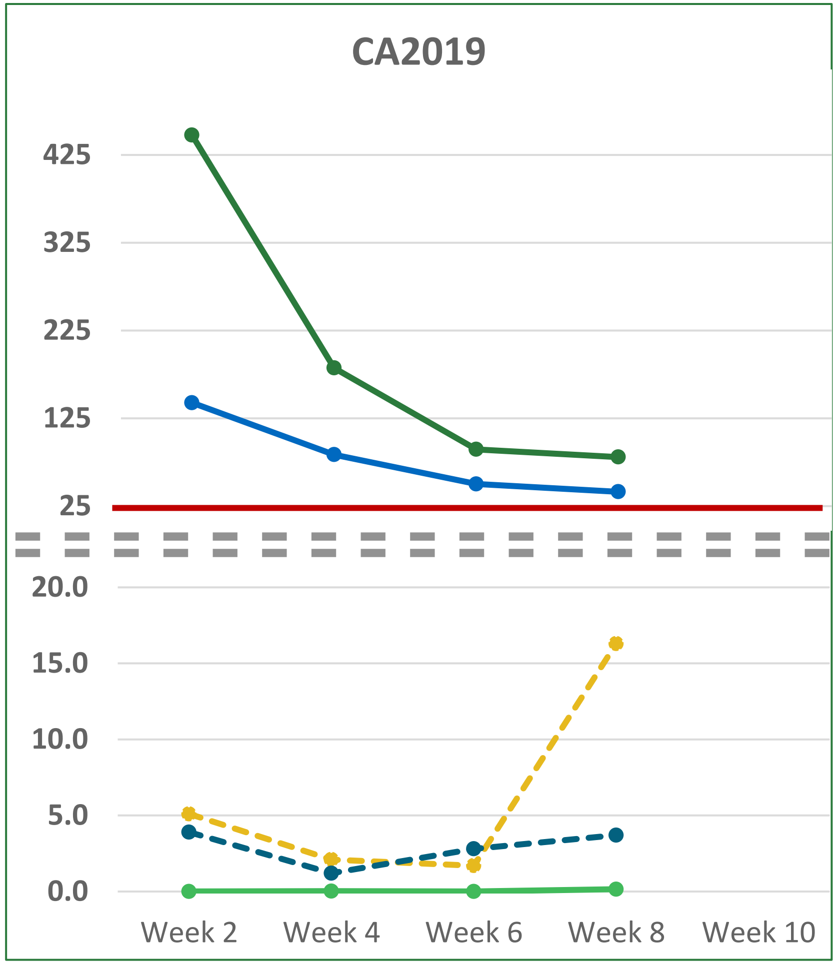
	CA2019	NJ2018	NJ2019
Cultivar/Pot Size	Sonnet White in 4" Deepots	Sonnet Yellow in 1.5 gal pots	Sonnet Yellow in 1.5 gal pots
Application Timing	**Applied sprays or drenches when flower buds had developed on majority of plants**		
Volume per Nominal Gal of Soil	4 fl oz	4 fl oz	4 fl oz
Collection Timing	2, 4, 6, 8 weeks after treatment	2, 6, 10 weeks after treatment	
Collection Methodology	Harvest flowers and collected nectar in the lab	Pipette nectar from flowers with multiple collections over time	
Range of Volume Collected	0.1 to 0.5 ml	0.6 to 1 ml	0.4 to 0.5 ml

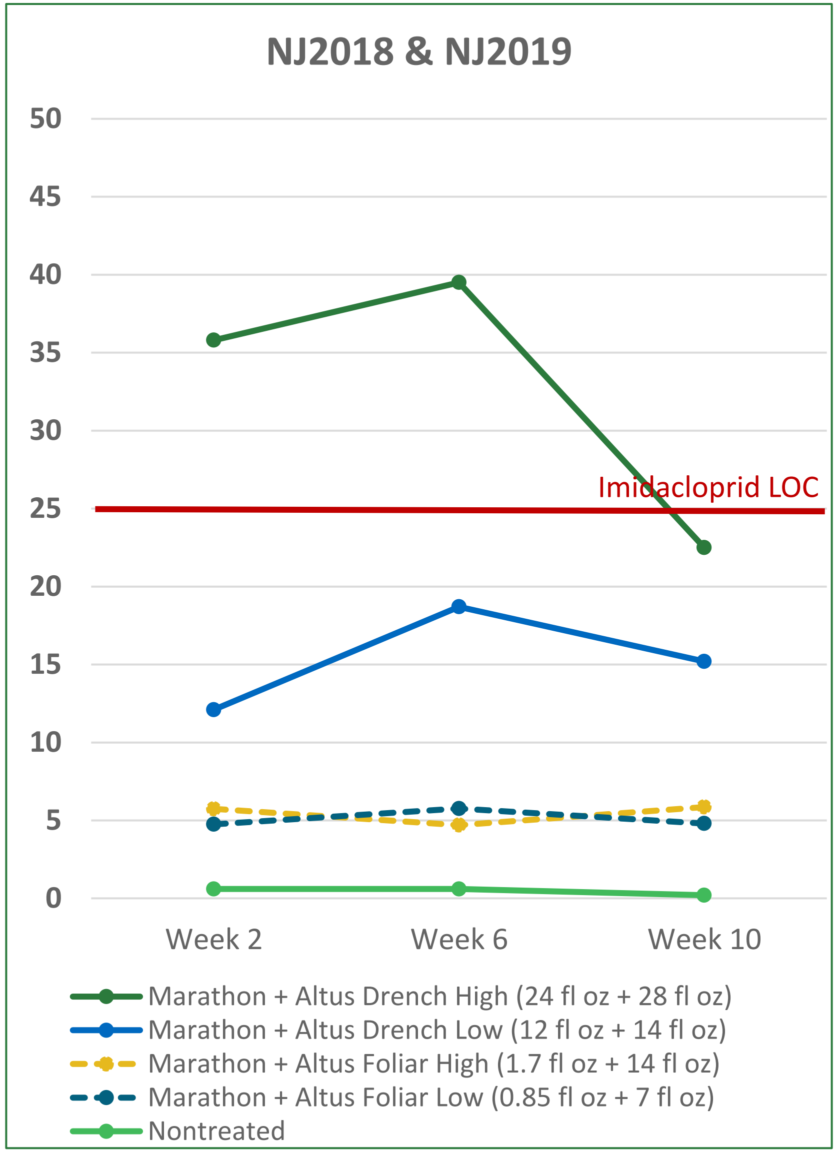
NJ2018 Snapdragon. C. Palmer

CA2019 Collected Nectar. L. Corkidi

Imidacloprid + Olefin (ppb) Residues in Snapdragon Nectar

– adjusted to average brix in experiment and using half LOQ where residues had been detected in at least one rep

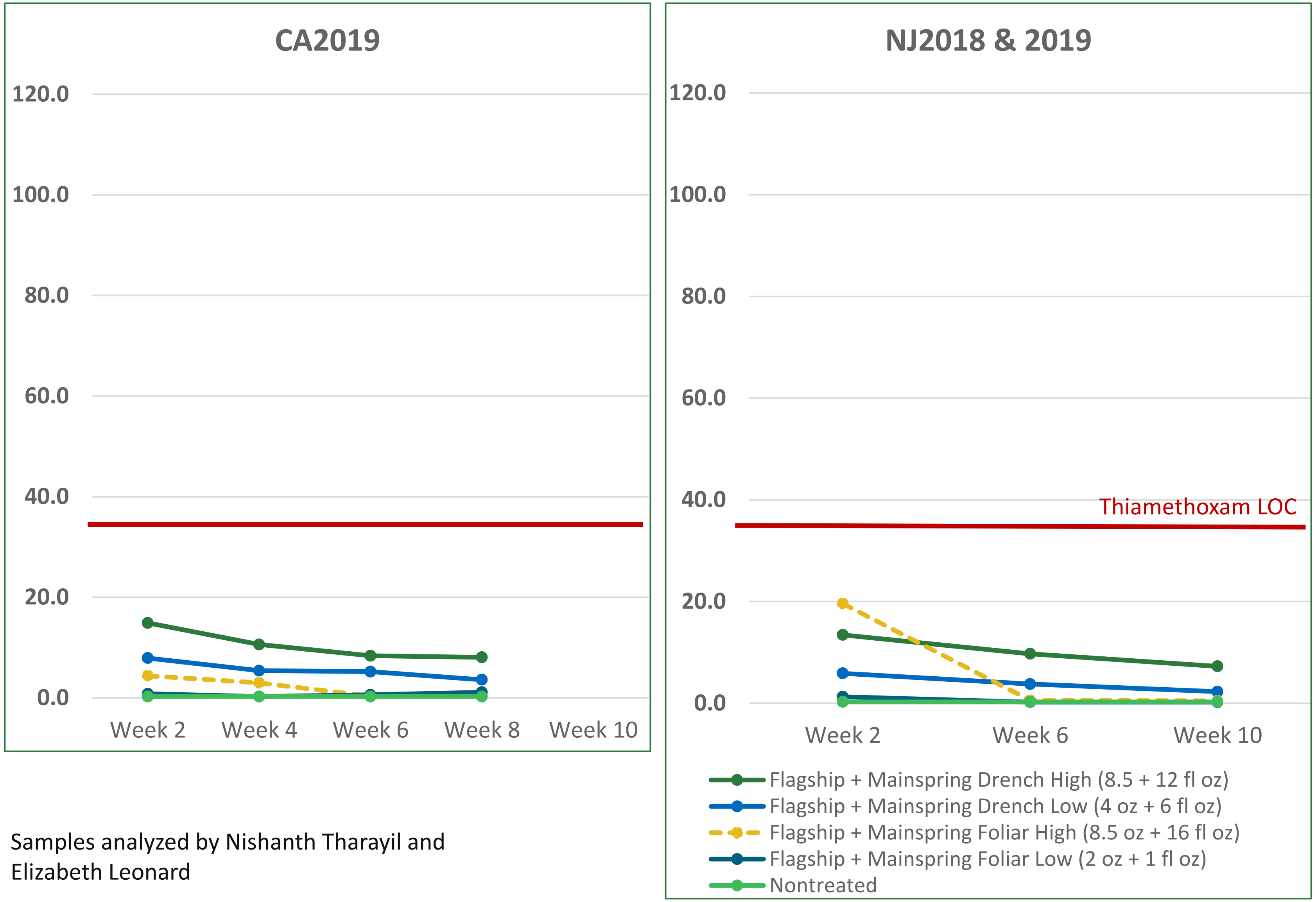




Samples analyzed by Nishanth Tharayil and Elizabeth Leonard

Cyantraniliprole (ppb) Residues in Snapdragon Nectar

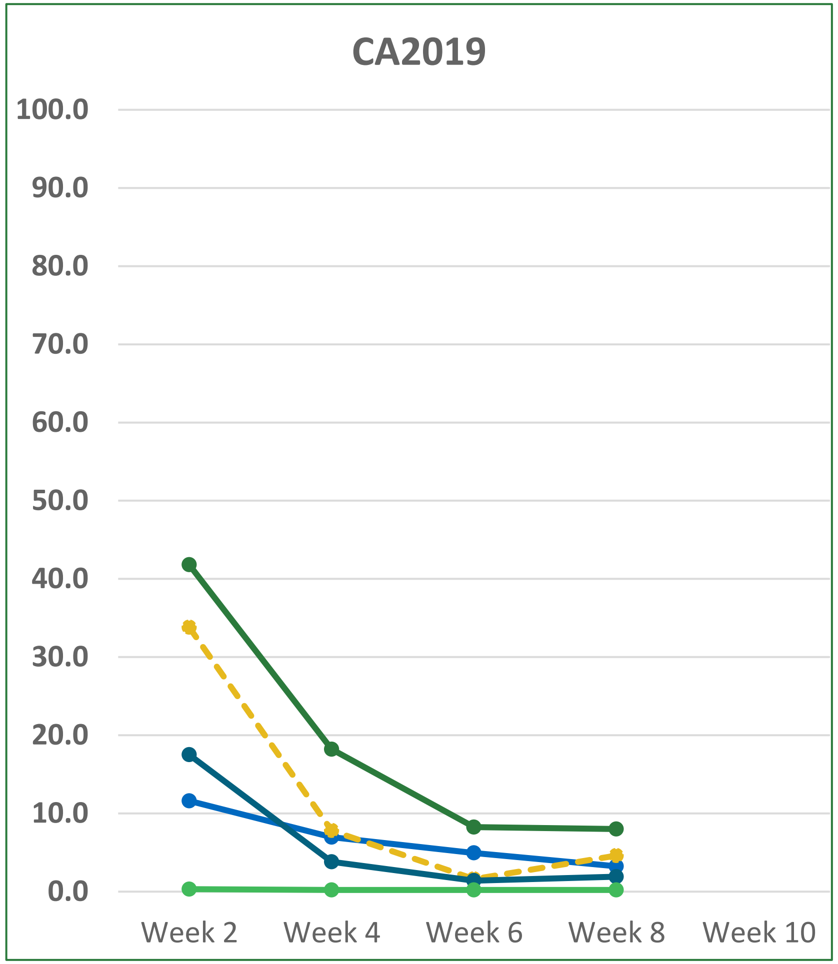
– adjusted to average brix in experiment and using half LOQ where residues had been detected in at least one rep

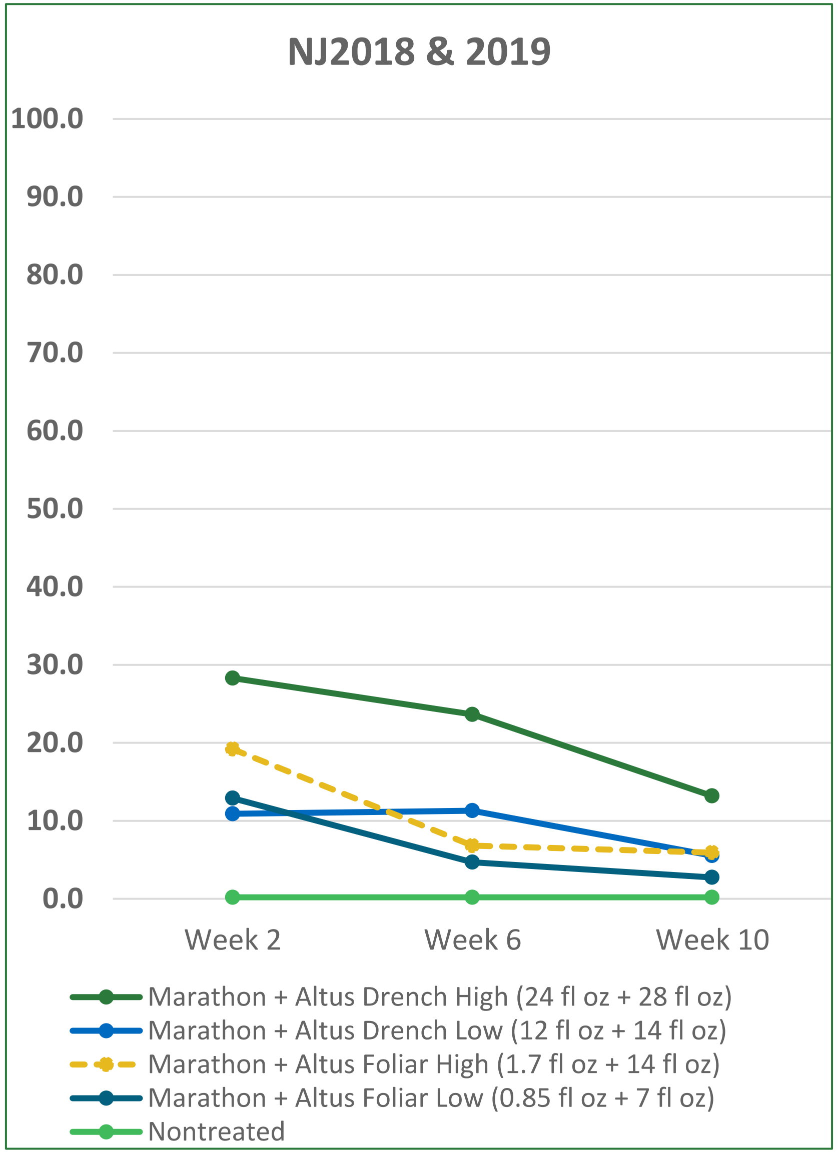


Samples analyzed by Nishanth Tharayil and Elizabeth Leonard

Flupyradifurone (ppb) Residues in Snapdragon Nectar

– adjusted to average brix in experiment and using half LOQ where residues had been detected in at least one rep





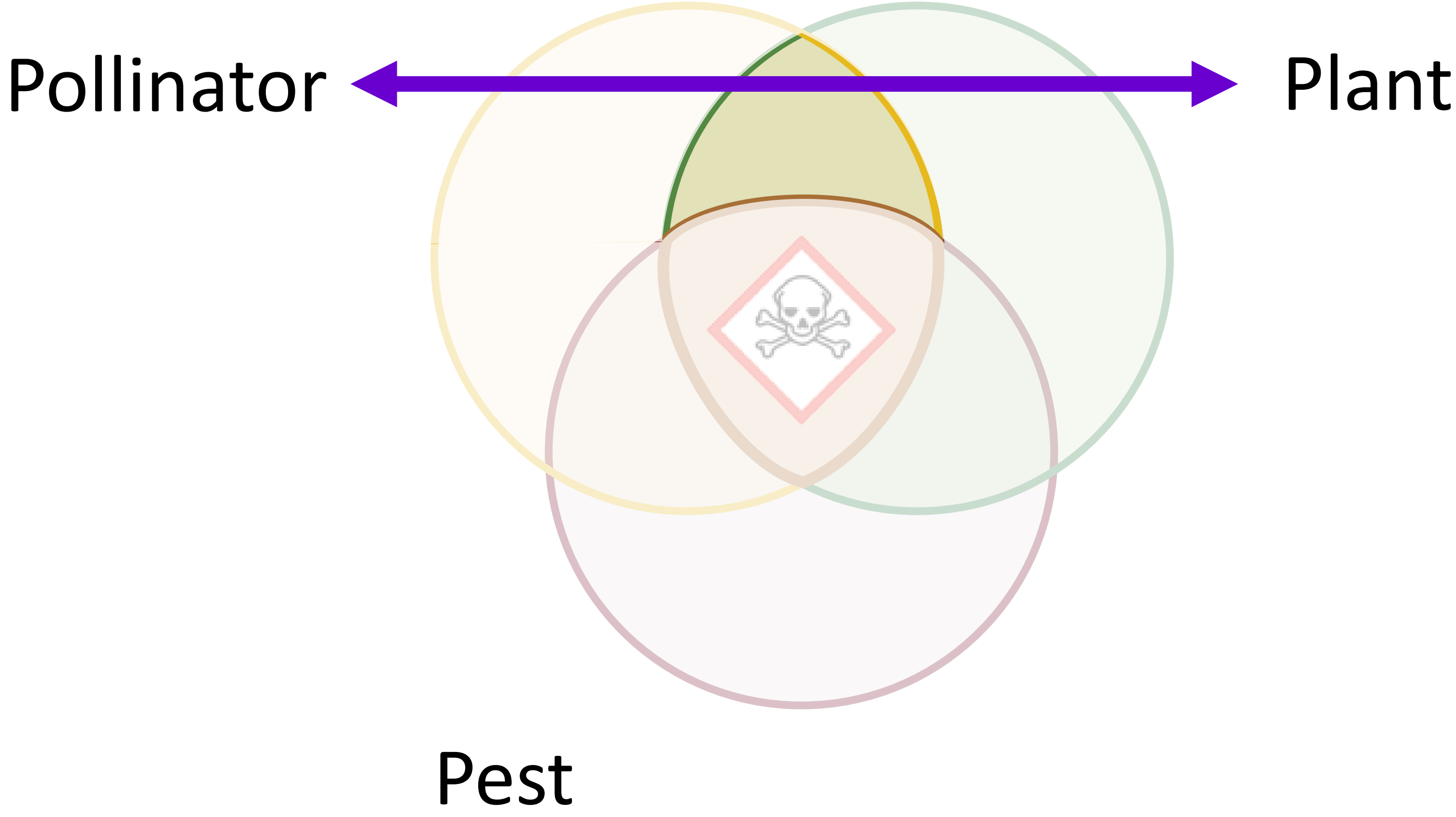
Samples analyzed by Nishanth Tharayil and Elizabeth Leonard

Residue Analysis Take Aways

- Foliar applications of neonicotinoids to snapdragon were less than EPA levels of concern even as early as 2 weeks after application
- Drench applications of neonicotinoids may exceed EPA levels of concern
- Cyantraniliprole residues when detected are lower than the EPA level of concern for imidacloprid (25 ppb)
- Flupyradifurone residues are well below the EPA level of concern of 10,000 ppb in nectar

➢ **Potential for applications early in crop cycle of systemic insecticides with contact insecticides applied later in crop cycle plus use of biologicals**

Systemic Insecticides and Pollinator Risk



How many environmental horticulture plants are forage for pollinators?

Pollinator Visitation

Scientists in six locations throughout the United States are studying the top 20 to 25 annuals and perennials grown in the US. They are counting the number of each pollinator group visiting of 3 to 5 cultivars of each plant species.

Researchers: Drs. Jim Bethke, Christine Casey, JC Chong, Christina Grozinger*, Harland Patch*, Dan Potter, Dave Smitley, Kim Stoner*

States: CA, CT, KY, MI, PA, SC

2017 MSU Pollinator Attractiveness Plots for Annuals.

2016 PSU Pollinator Attractiveness Plots for Annuals. Photo by Nick Sloff.

USDA NASS Census of Horticulture 2014: Top Crops by Units Sold

Top 25 Annual & Seasonal Potted Crops

1. **Pelargonium**
2. **Viola (Pansy)**
3. **Petunia**
4. *Euphorbia (poinsettia)*
5. **Begonia**
6. **Impatiens**
7. **Tagetes**
8. *Phalaenopsis*
9. *Chrysanthemum / Dendranthema*
10. **Catharanthus**
11. *Lilium*
12. *Rosa (miniature roses in pots)*
13. Gerbera
14. Kalanchoe
15. **Calibrachoa**
16. *Hibiscus*
17. **Solenostemon (Coleus)**
18. *Caladium*
19. *Tulipa*
20. *Rhododendron (greenhouse pots of azalea)*
21. *Hydrangea*
22. *Saintpaulia*
23. Cyclamen
24. **Zinnia**
25. **Salvia**

26. Pentas, 27. Verbena, 28. Dahlia, 29. Antirrhinum, 34. Celosia, 35. Portulaca, 37. Lobularia

Top 25 Herbaceous Perennial Crops

1. **Chrysanthemum/ Dendranthema**
2. Hosta
3. **Hemerocallis**
4. **Sedum**
5. **Dianthus**
6. **Salvia**
7. **Phlox**
8. **Coreopsis**
9. **Lavandula**
10. **Echinacea**
11. **Heuchera**
12. **Rudbeckia**
13. Leucanthemum
14. **Astilbe**
15. Delphinium
16. Gaillardia
17. Aquilegia
18. **Veronica**
19. **Iris**
20. **Paeonia**
21. **Penstemon**
22. Digitalis
23. **Perovskia**
24. **Hibiscus**
25. **Achillea**

Pollinator Visitation – Data Review

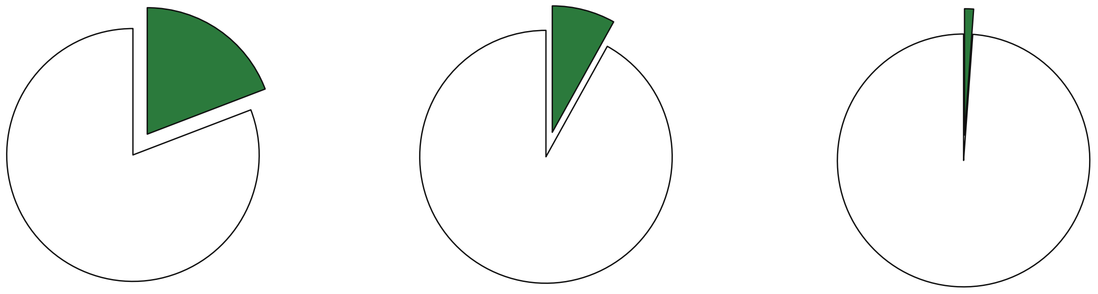
- 43 published manuscripts
- 4 years of non-published field plot data from research team
- Average pollinator visitation rating is based on applying a scale of high (3), moderate (2), low (1), or virtually no (0) visitors

Rating	Numerical	Number Visitors per 10 Minutes
High	3	10 or more pollinators
Moderate	2	3 to 10 pollinators
Low	1	1 to 3 pollinators
Virtually None	0	Less than 1 pollinators

- A relative scale was employed for identification of pollen collected by bumble bees, honeybees, and mason bees.

Percent Crop Genera Attractive to Bees & Syrphid Flies for All Plants Screened/ Reviewed

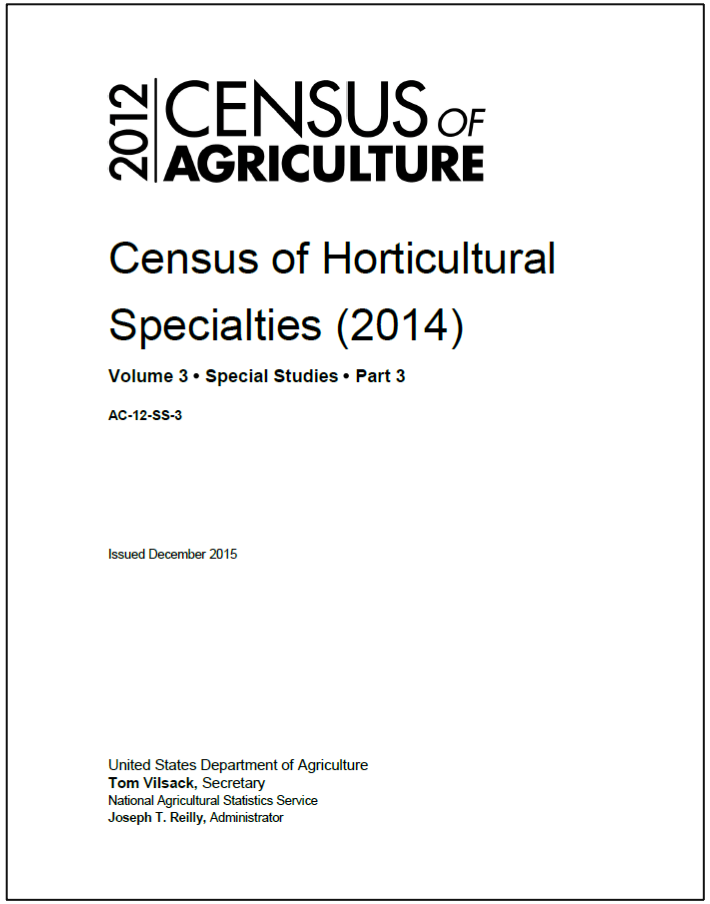
Crop Type (#)	Moderately Attractive (2.0)
Annuals (54)	10%
Herbaceous Perennials (82)	30%
Woody Perennials (65)	8%
Combined (202)	19%
Rating scale	3 or more bees in 10 min



Comparing Plants Sold with Visitation Ratings

Pollinator Attractiveness Ratings for Crops

Numerical Rating	Description	# Bees per 10 Minutes
0	Not or virtually not attractive	< 1
1	Minimally attractive	1 < 3
2	Moderately attractive	3 < 10
3	Highly attractive	10 +


2012 CENSUS OF AGRICULTURE

Census of Horticultural Specialties (2014)

Volume 3 • Special Studies • Part 3

AC-12-SS-3

Issued December 2015

United States Department of Agriculture
Tom Vilsack, Secretary
National Agricultural Statistics Service
Joseph T. Reilly, Administrator

Overview of commercial plant attractiveness to pollinators for all crops listed in the 2014 USDA-NASS Census of Horticulture

Crop Type	Number Crops included in NASS 2014 Census of Horticulture [z]	Units Sold of Listed Crops	Units Sold Excluding those without Visitation Data [z]	Units Sold (Percent) with Moderate (2.0) or Higher Attractiveness Rating Average to any "Bee"
Annuals	70	523,660,691	444,579,051	897,899 (**0.2%**)
Herbaceous Perennials	37	134,241,000	130,141,000	9,242,000 (**7.1%**)
Woody Perennials	45	195,065,571	143,066,423	23,755,693 (**16.6%**)
Combined	152	858,350,262	806,370,937	33,895,592 (**4.8%**)

[z] Number of crop per category do not equal total crops because some genera are included in multiple categories.
Units sold were excluded to better estimate percentage of units attractive to bees based on whether attractiveness data were available with the exception of species grown primarily as houseplants, conifers, and other trees primarily pollinated via wind.
[y] Roses attractive to bees are those that have single open flowers. A large but unknown percentage of roses in the US market have double flowers with nectaries and pollen largely unavailable for foraging. If 25% of the rose units sold are included the percent attractive increases to 20.2% for woodies and 5.6% for all crops.
[x] Sedum nomenclature has recently split this genus into multiple genera. Some are attractive to bees, in particular *Hylotelephium spectabile* 'Autumn Joy'. Without knowing the actual units sold, we assumed 50% of the perennial Sedum units were attractive.

Pollinator Visitation Take Aways

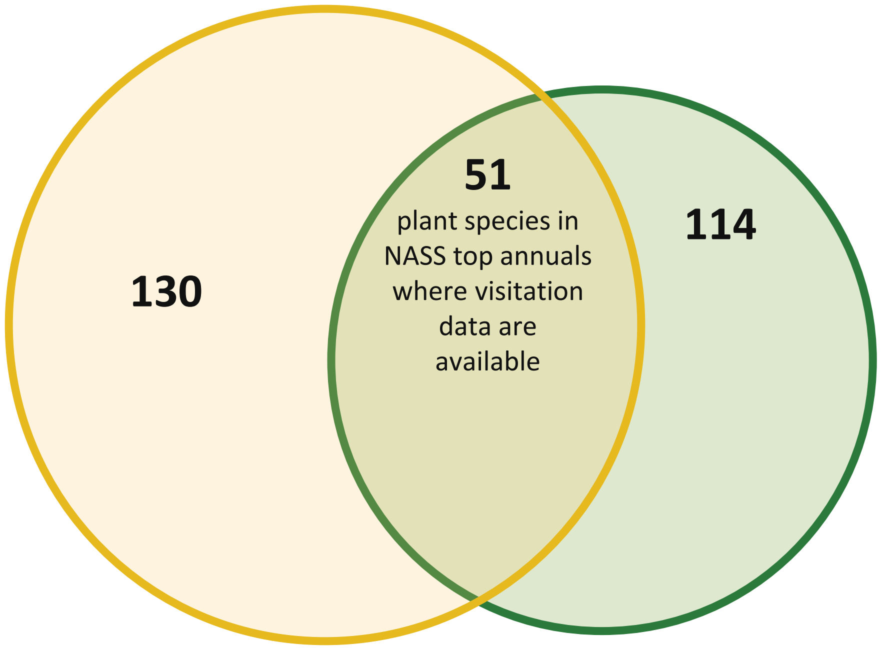
- A majority of plants sold in the trade are not good pollinator forage
  - Woodies > herbaceous perennials > annuals
  - Some annuals are pollinator forage such as some cultivars of lobularia, snapdragon, zinnia and more
- Flower form is important with open accessible single flowers versus doubles
- Non-native plants can support pollinator abundance and diversity

➢ **Opportunity for growers to shift to producing more pollinator forage**

Systemic Insecticides and Pollinator Risk: Annuals

Pollinator

~130 annual plant species where visitation data are available



Plant

~114 plant species in NASS top "25" annuals

Systemic Insecticides and Pollinator Risk: Annuals

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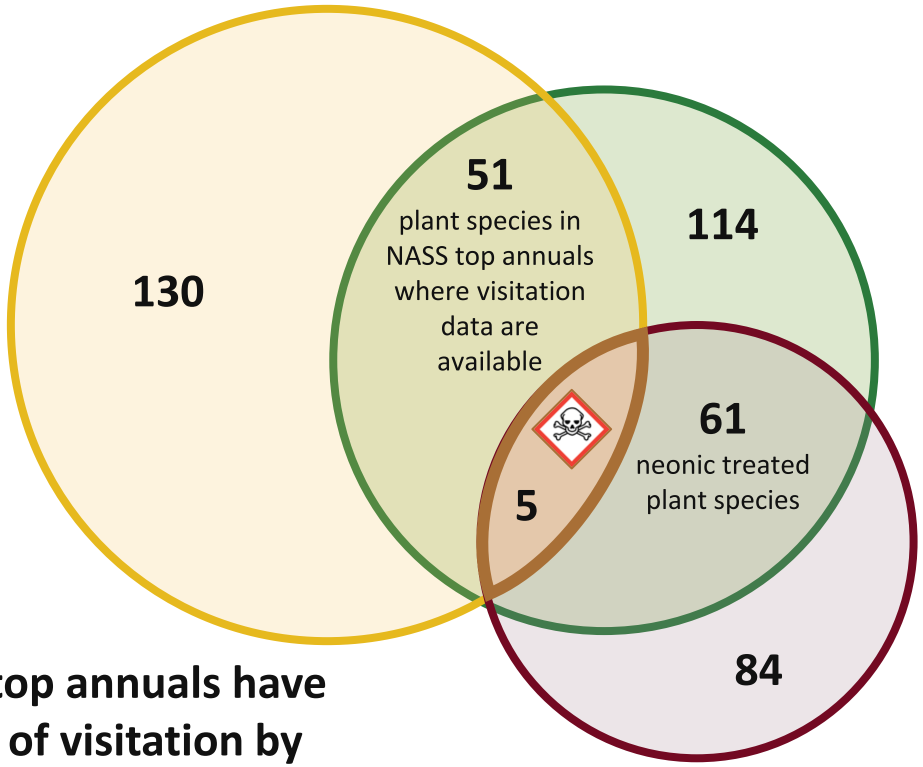

Plant

~114 plant species in NASS top “25” annuals

5 plant species in NASS top annuals have at least moderate level of visitation by bee pollinators and have pests typically managed by neonics –
3 are woodies used as cutflowers

Pest

84 plant species where pest species information is available;
105 pest species for top NASS Annuals;
36 pest species typically treated with neonics

Resources

- IR-4 Project: www.ir4project.org Go to Environmental Horticulture page!
- ProtectingBees: www.protectingbees.njaes.rutgers.edu
- Oregon Bee Project: www.oregonbeeproject.org
- Penn State Center for Pollinator Research: www.ento.psu.edu/research/centers/pollinators
- Pollinator Partnership: www.pollinator.org
- AmericanHort Horticultural Research Institute: www.hriresearch.org/Pollinate-Research-and-Resources
- IR-4 Site for Project Information Sheets: www.ir4project.org/ehc/ehc-registrationsupport-research/env-hort-extension-resources

Photo by Cristi Palmer

Thank you!

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