Why IPM Matters:

Finding a balance between neonicotinoid use and beneficial insects in corn and soybean

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Conservation Biological Control Specialist

Practical Farmers of Iowa
Annual Conference 2019

Photo credit: 13-spotted lady beetle on soybean, Thelma Heidel-Baker

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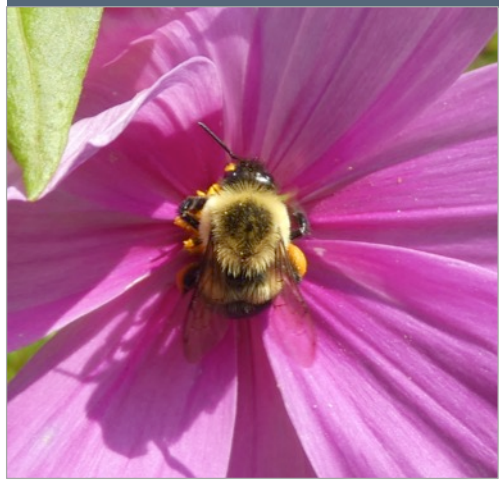
Introduction to the Xerces Society

Major Programs

- **Pollinator conservation and agricultural biodiversity**

Conservation, education, research, & advocacy to protect invertebrates and habitat



- **Pesticide policy and regulation**
- **Endangered species**
- **Aquatic conservation**

Photos: Greg Lasley; Dana Ross; Justin Ross, NRCS

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Photos: Xerces Society / Nancy Adamson and Matthew Shepherd

Introduction to the Xerces Society

Xerces Pollinator and Agricultural Biodiversity Team

- Staff in over 12 states across the U.S.

Conservation Education

- Outreach to 80,000+ farm and agency professionals since 2008
- Training events in all 50 states, Europe, Asia, Latin America

Habitat Restoration

- Our work has led to 690,000+ acres of habitat created or contracted in the U.S. since 2008

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What Are Neonics

Photo: No till soybeans and trticale by Joel Gruver

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Neonicotinoid Overview

- Agricultural, urban, and veterinary medicine uses
- Mode of action: Blocks neural pathway in insects by binding to nicotinic acetylcholine receptors
- Highly toxic to insects
- Water soluble
- **Can persist from months to years in plants and soil**

Nitroguanidine Neonicotinoid Group:

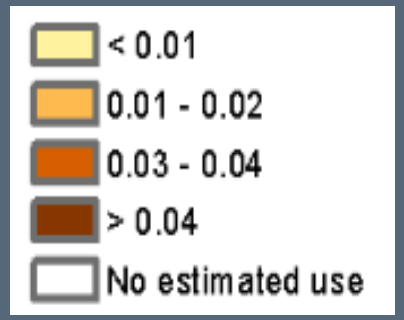
- **Clothianidin**
- **Thiamethoxam**
- **Imidacloprid**
- **Dinotefuran**

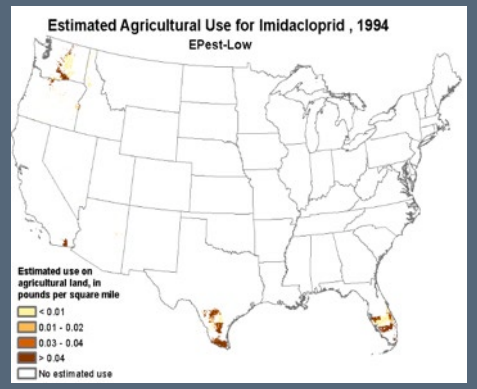
Photo credit: Ryan Afflerbaugh via flickr, Adam Varenhorst

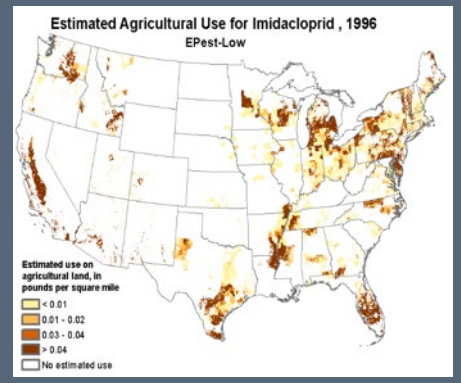
The Rise of Neonicotinoids

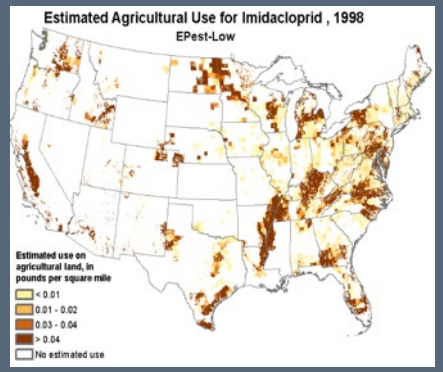
Range of use from 1994 to 2013

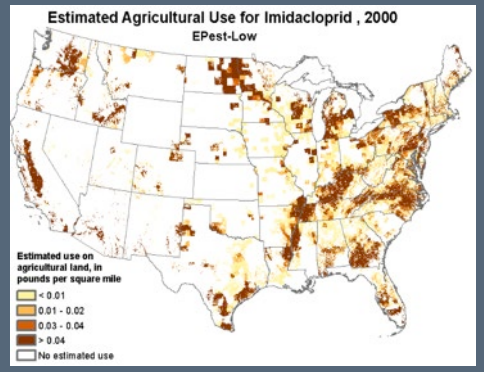
Estimated use on agricultural land, in pounds per square mile

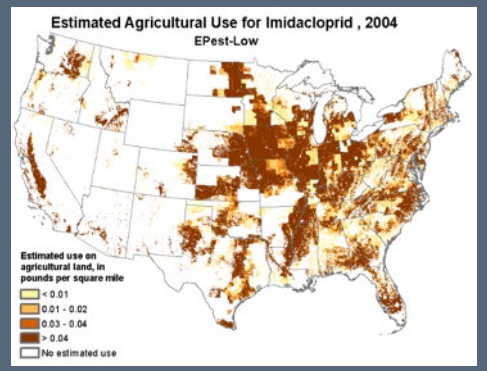


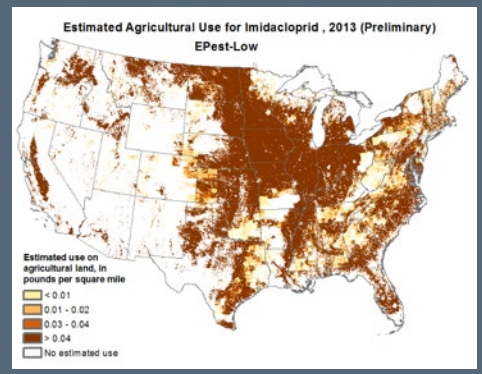












U.S. Geological Survey

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Photo credit: Soybean aphids on soybean, Thelma Heidel-Baker

Neonics in Soybean

- Applied as a seed treatment
- First introduced for soybean aphid control
  - Effective? NO!

- Early-season soybean pests
  - Sporadic and occasional in Iowa
  - Bean leaf beelte
  - Seedcorn maggot
  - True white grubs
  - Wireworms

Krupke et al. 2017. Assessing the value and pest management window provided by neonicotinoid seed treatments for management of soybean aphid (Aphis glycines Matsumura) in the Upper Midwestern United States. Pest Management Science 73: 2184–2193

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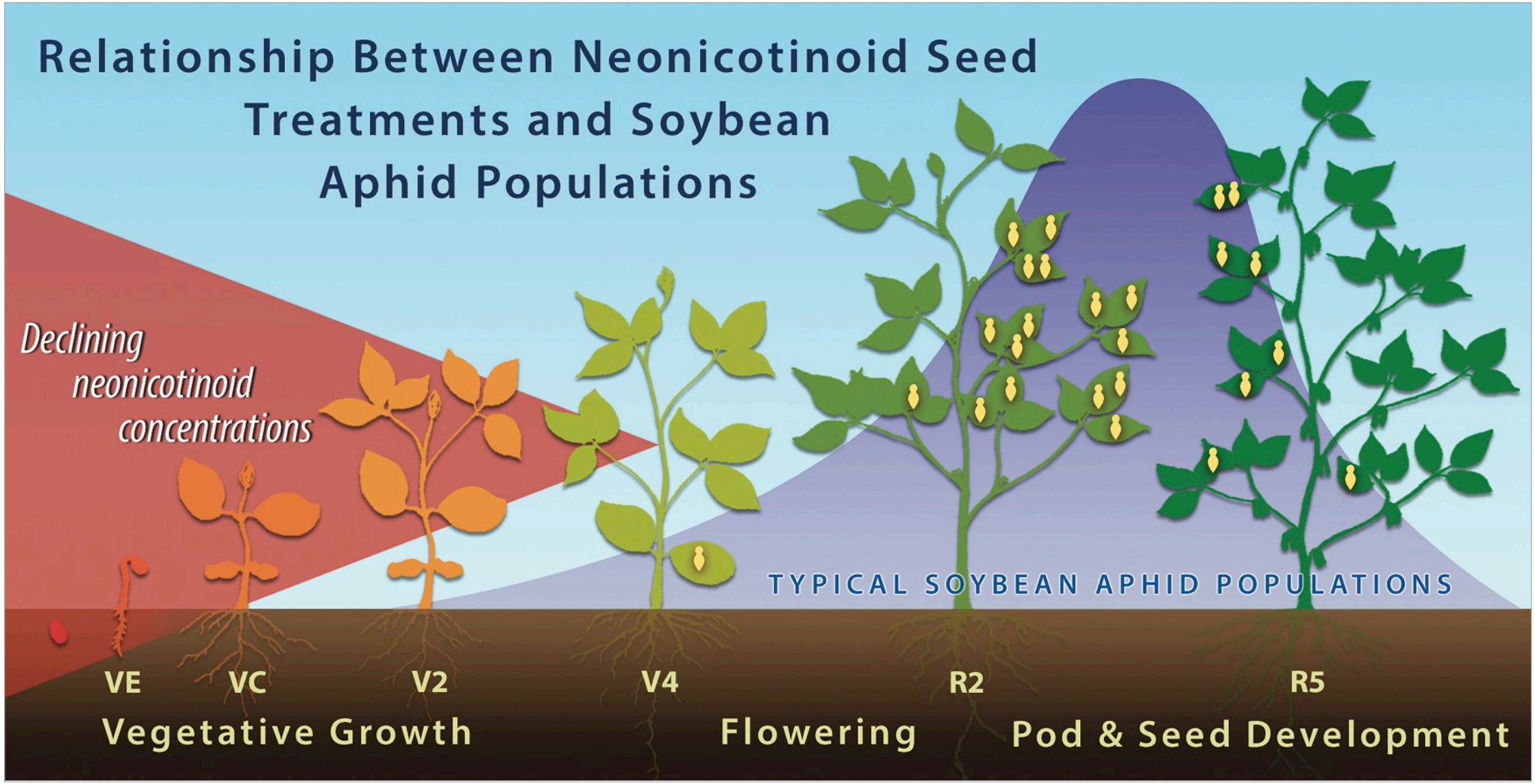

Graphic credit: Purdue Agricultural Communications/Dan Annarino

Photo credit: Jeff Laitila via flickr CC

Neonics in Corn

- Applied as a seat treatment
- Early-season corn pests
  - Sporadic and occasional in Iowa
  - Seedcorn maggot
  - True white grubs
  - Wireworms

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Concerns over extensive use

- Resistance development
- Exposure to non-target organisms

Photo credit: Thelma Heidel-Baker

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Beyond the Pest

Photo: No till soybeans and trticale by Joel Gruver

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Only a small fraction (~2%) of insects are pests.

The rest are beneficial to humans or important for food webs.

Photo credit : Piotr Naskrecki

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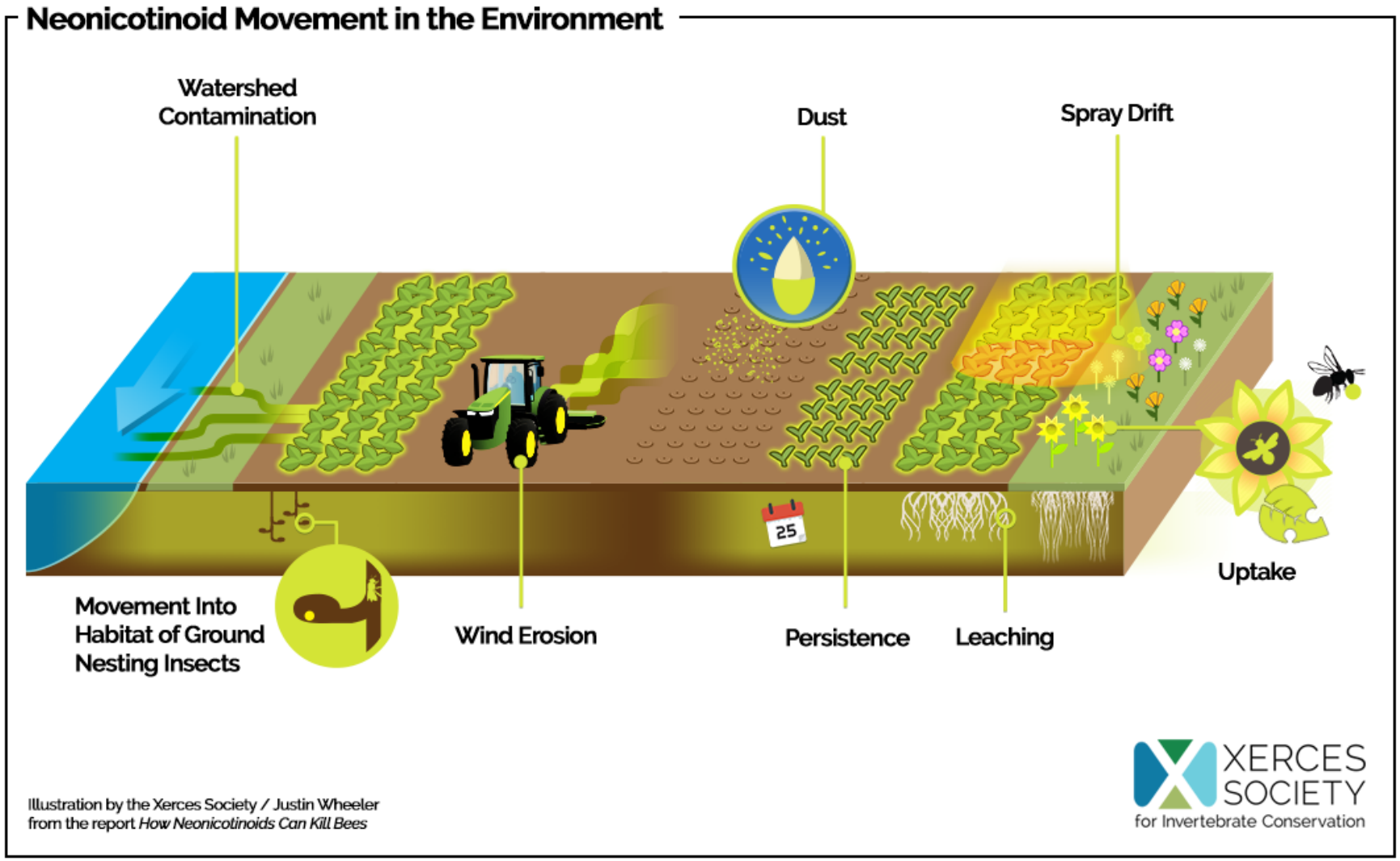
Multiple methods of neonicotinoid exposure



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Unintended consequences

As Beneficial Insects Decline, Pests Increase

Pennsylvania: Loss of predatory beetles makes slug outbreaks worse

Predatory Beetles:

Primary predators of slugs; susceptible to insecticides

Slugs:

Not a pest of soybeans until recently; immune to neonicotinoids

Photos: Penn State University

Douglas et al. 2015. “Neonicotinoid Insecticide Travels through a Soil Food Chain, Disrupting Biological Control of Non-Target Pests and Decreasing Soya Bean Yield.” J Appl Ecol 52 (1): 250–60.

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Soil Biodiversity Matters

Neonic seed treatments impacted detritivores and predatory groups of soil organisms.

Atwood et al. 2018. Evidence for multi-trophic effects of pesticide seed treatments on nontargeted soil fauna. Soil Biology and Biochemistry. 125: 144-155.

Photo: Red velvet mite - Ton Rulkens via flickr

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Insects for Pest Management

- Only a small fraction are pests
- $4.5 - $12 billion annual value of natural pest suppression
- Many dwell at or beneath the soil surface

Photo: Wolf spider female with young - Ian Marsman Via flickr

Losey & Vaughan. 2006. The Economic Value of Ecological Services Provided by Insects. Bioscience 56 (4).
Pimental et al. 1997. Economic and Environmental Benefits of Biodiversity. BioScience:47 (11)

Bianchi, F. J. J. A., C. J. H. Booij, and T. Tscharntke. 2011. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control. *Proc. R. Soc. B* 273: 1715-1727.

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Insects as Pollinators

- 85% of terrestrial plant species require pollinators
- 4,300+ native bee species in North America
- Majority of bees nest underground

Photo: Eric Lee-Mäder

Klein et al. 2007. Importance of pollinators in changing landscapes for world crops. Proc. R. Soc. B 274: 303-313.

Ollerton et al. 2011. How many flowering plants are pollinated by animals? Oikos 120: 321-326.

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Insects as Ecosystem Engineers

- First processors in decomposition of soil organic matter
- Insect mineralization of soils may sequester carbon
- Mass scale soil churning: tons/acre/year

Photo: Magnus Robinson

Dorn, R. 2014. Ants as a powerful biotic agent of olivine and plagioclase dissolution. Geology. 42(9):771-774.

Nardi, J. 2007. Life in the Soil. University of Chicago Press. 195-196.

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Value to Other Wildlife

- 25% of the bird and mammal diets consist of pollinator-produced seeds/fruit
- Insects are food for wildlife
- Pollinator habitat compatible with needs of other wildlife

Photo credit: Western bluebird, Marcel Holyoak via flickr

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IPM and Neonics

Photo: Lady beetles on soybean, Thelma Heidel-Baker

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Photo: Thelma Heidel-Baker

What is Integrated Pest Management?

"An ecologically based pest control strategy that relies heavily on natural mortality factors and seeks out control tactics that disrupt these factors as little as possible."

-Flint and van den Bosch,1981

IPM seeks to "address the underlying sources of the pest problem, rather than focusing only on the symptoms (i.e. the pest)."

–Bio-Integral Resource Center, 2005

Flint, M. and van den Bosch, R. 1981. Introduction to integrated pest management. New York: Plenum Press. 240p.

BIRC, Introduction to Integrated Pest Management Curriculum. 2005

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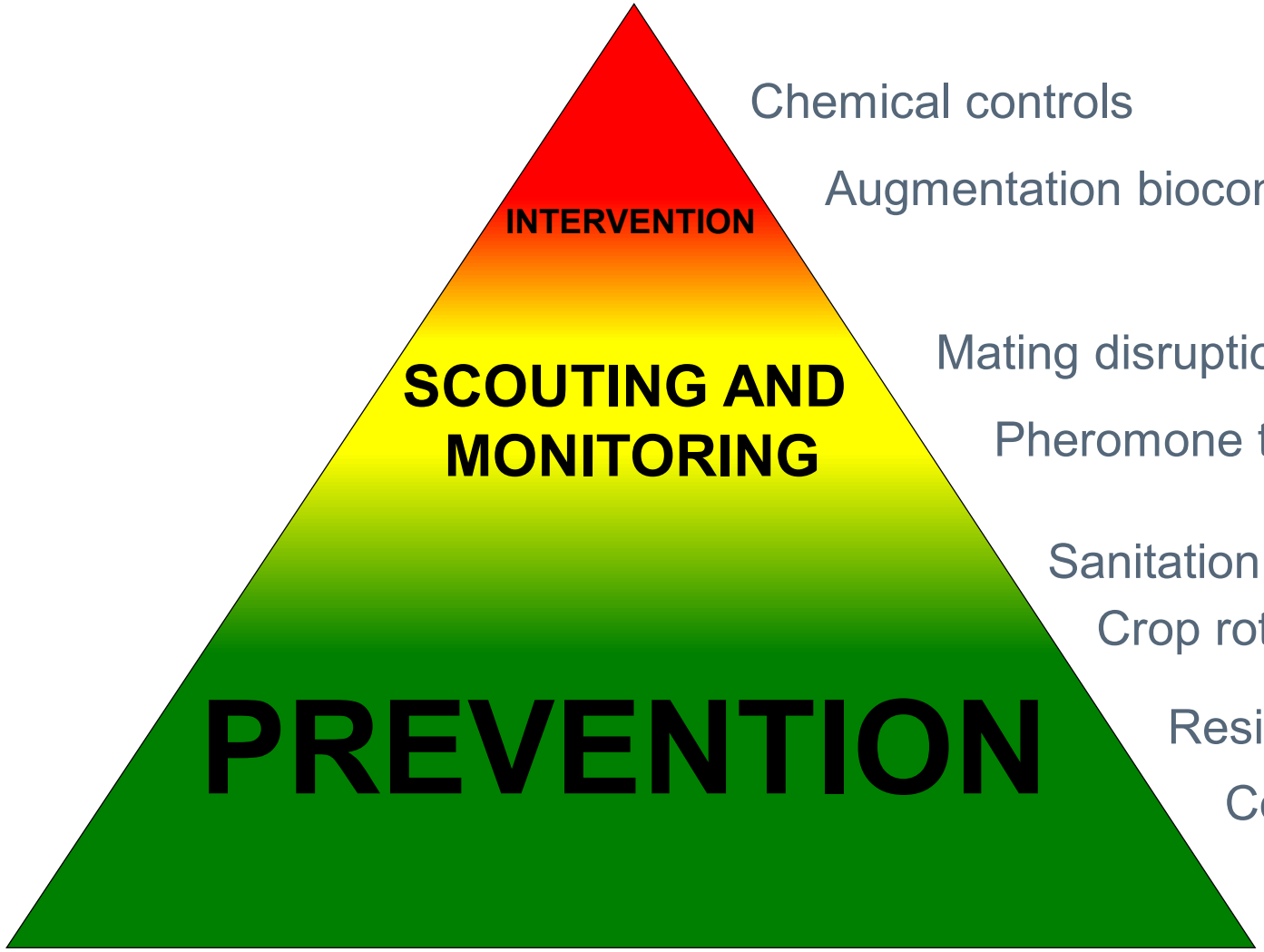
Integrated Pest Management (IPM)



Chemical controls

Augmentation biocontrol

Mating disruption

Pheromone traps

Sanitation

Crop rotation

Resistant varieties

Conservation biocontrol

Optimum plant health

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Photo: Xerces Society / Thelma Heidel-Baker

Steps of IPM

1. Prevention: reduce conditions that favor pest development
2. Regular monitoring and scouting
3. Identify insects (pests and beneficials)
4. Use thresholds to make treatment decisions
5. Control pests with targeted, reduced-risk practices only when needed
6. Evaluate the efficacy of treatment actions

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Protection from Pesticides

Pesticides can be important tools for protecting crops and other plants BUT their impact on non-target organisms like pollinators can be devastating.

Insecticides pose the greatest risk to insects

Photo: Anna MacDonald

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Pesticide Risks

A wide variety of pesticides, including insecticides, herbicides, and fungicides can harm beneficial insects:

- Broad spectrum insecticides
- Fungicides
- Pesticide mixtures
- Multiple methods of exposure

Photo: Parasatized ahpids, by David Cappaert / Bugwood.org

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Photo: Lacewing eating soybean aphids, Thelma Heidel-Baker

Neonicotinoid Concerns

- Direct toxicity effects
- Sublethal effects
  - Reduced reproduction, longevity, foraging, mobility
- Loss of alternative prey and hosts
- Secondary pest outbreaks

Cloyd, R. A., & Dickinson, A. (2006). Effect of insecticides on mealybug destroyer and parasitoid *Leptomastix dactylopii*, natural enemies of citrus. *Journal of Economic Entomology*, *99*(5), 1596–1604.

Kim et al. 2006; Cloyd et al. 2009; Kunkel et al. 2001; See Hopwood et al. 2013 for more.

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Chlorantraniliprole….what?!!

Another systemic insecticide in the pipeline of pesticides

Photo credit: Ryan Afflerbaugh via flickr

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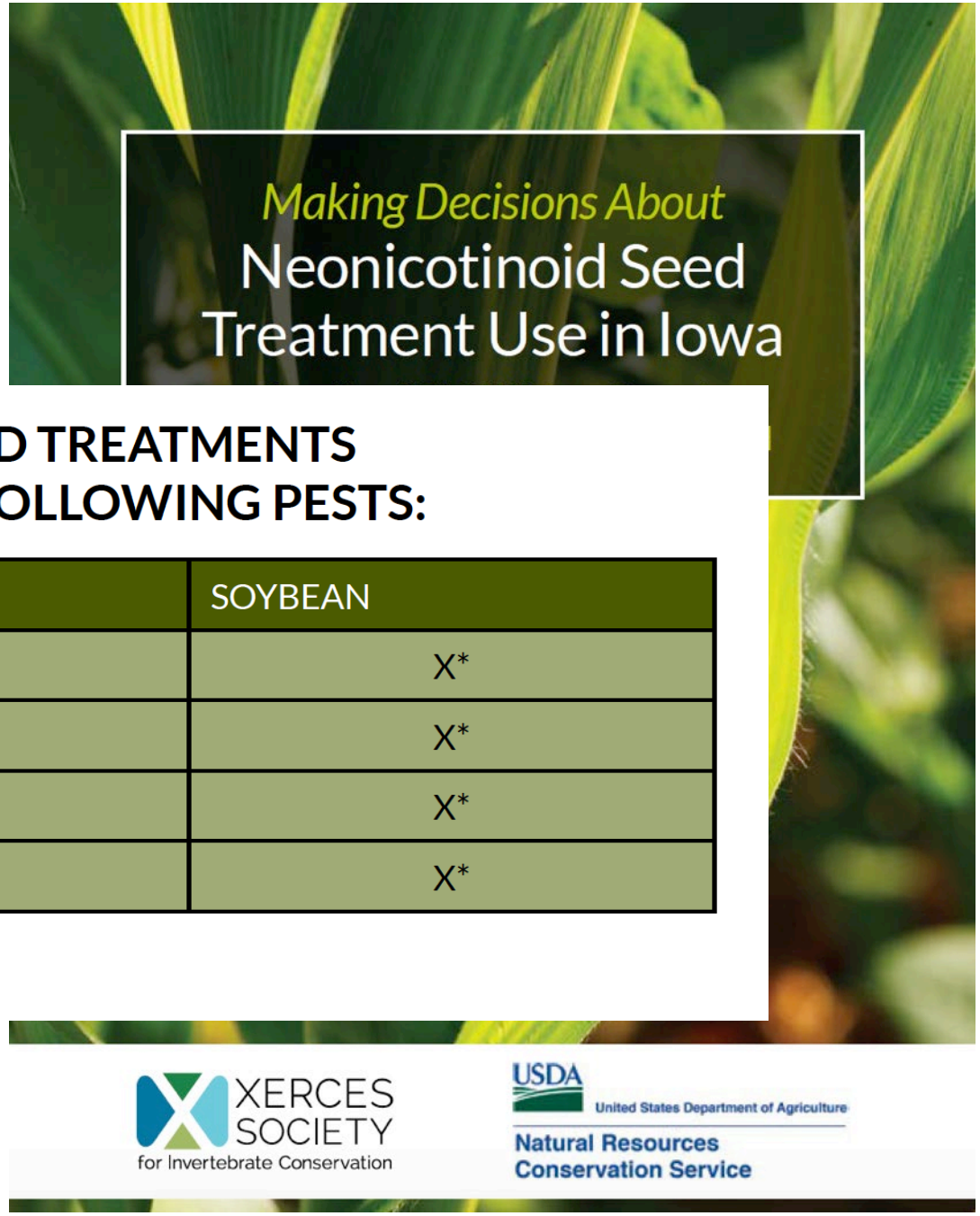
Scouting with a purpose



NEONICOTINOID SEED TREATMENTS MAY BE USED FOR THE FOLLOWING PESTS:

EARLY-SEASON INSECT PEST	CORN	SOYBEAN
Bean leaf beetle		X*
Seedcorn maggot	X*	X*
True white grubs	X*	X*
Wireworms	X*	X*

*Not a frequent economic pest in Iowa

Neonicotinoid seed treatments are not recommended for the following pests:

Black Cutworm — Corn

Because black cutworm does not overwinter in Iowa, scouting the previous season does not inform about potential cutworm problems for the following spring. Research also indicates variable efficacy of seed treatments on suppressing this pest. Only early season scouting after corn emerges could inform whether a seed treatment is needed for this pest, and seed treatment decisions at this point are impossible. Other cultural and chemical control strategies should be pursued for this insect pest.

Corn Flea Beetle — Corn

Corn flea beetle is not often a serious early season economic pest of corn in Iowa. Only in combination with Stewart's wilt (a disease caused by a bacterium vectored by the corn flea beetle) does this insect become a cause for greater concern. Stewart's wilt has not been a significant problem in Iowa for over 10 years, and unless Stewart's disease becomes a more frequent issue in Iowa, seed treatments are not recommended for this insect. Iowa State University has developed prediction models for Stewart's wilt based on overwintering temperatures.

Corn Rootworms — Corn

Neonicotinoid concentration levels in corn are reduced after about three weeks. Seed treatments are not recommended because corn rootworms typically hatch in the soil after this 3-week period.

Support for IPM Practices

Photo credit: Tim McCabe, USDA-NRCS Arkansas

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Support through the Farm Bill

NRCS Technical and Financial Assistance Programs

- Conservation Technical Assistance (CTA)
- Environmental Quality Incentives Program (EQIP)
- Conservation Stewardship Program (CSP)

Jennifer Hopwood (Xerces Society)

https://directives.sc.egov.usda.gov/opennonwebcontent.aspx?content=38006.wba

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Environmental Quality Incentives Program (EQIP)

- Addresses natural resource concerns on agricultural land and private forestland
- Includes protecting, improving or creating habitat for beneficial insects
- Includes crop-based practices that can protect ground insects

Photo credit: Kelly Gill

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Conservation Stewardship Program (CSP)

- Rewards producers who are already implementing good stewardship practices
- Incentivizes adoption of additional enhancements

Photo credit: Nancy Adamson

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USDA-NRCS: Conservation Practices for Beneficial Insects

EQIP: Cover Crop (340)

CSP Enhancements (e.g. E34013Z):

Cover crops can include a mixture of grasses and/or flowering forbs such as buckwheat, clover, partridge pea, or sunflower.

Photo credit: Jessa Kay Cruz

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USDA-NRCS: Conservation Practices for Beneficial Insects

CSP Enhancements:

Pollinator/Beneficial Insect Habitat (E327137Z)

Monarch Habitat Establishment (E327136Z2)

Don Keirsted (NH NRCS), Inset photo by Eric Mader (Xerces Society)

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USDA-NRCS: Integrated Pest Management Practice (595)

EQIP Conservation Practices

Integrated Pest Management (595)

Protect beneficial insects and other natural resources from pesticides and establish beneficial insect habitat.

CSP Enhancements

Photo credit: David Biddinger (Penn State University), Mace Vaughan (Xerces Society), and Elise Fog

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United States Department of Agriculture

Conservation Enhancement Activity

E595116Z2

CONSERVATION STEWARDSHIP PROGRAM

Reducing routine neonicotinoid seed treatments on corn and soybean crops

Conservation Practice 595: Integrated Pest Management

APPLICABLE LAND USE: Crop (annual)

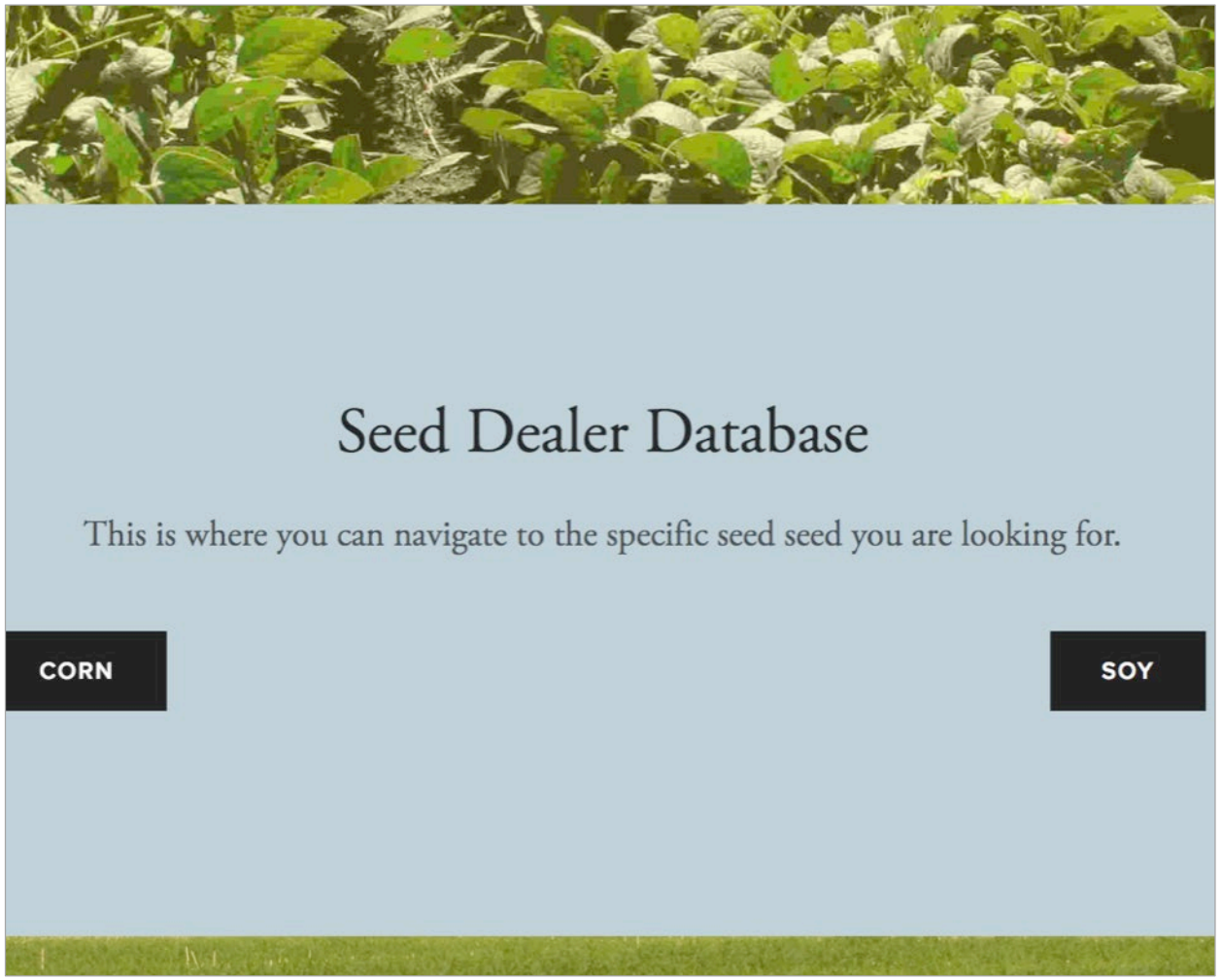
RESOURCE CONCERN ADDRESSED: Water Quality Degradation

Document source: USDA NRCS

Sourcing Untreated Seed

https://www.ecdysis.bio/seed-database

ECDYSIS FOUNDATION



Source: Ecdysis Foundation

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Supporting Beneficial Insects

Photo credit: Tim McCabe, USDA-NRCS Arkansas

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Farm Practices to Support Beneficial Insects

- IPM
- Reduced- or no-till practices
- Cover crops

Photo: Thelma Heidel-Baker

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Minimize Soil Disturbance

Frequent tillage destroys soil structure and disrupts soil life

Photo: Thelma Heidel-Baker

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Farm Habitat to Support Beneficial Insects

- **Blooming cover crops**
- **Permanent habitat strips**
- **Hedgerows**
- **Beetle banks**

Photo: Grinnell Heritage Farm

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Rethinking Neonic-Treated Seed

- Works against IPM
- Highly toxic to bees and beneficials
- Persist for years
- Water soluble
- No yield increases

Photo: Adam Varenhorst

Krupke *et al*., 2017. Assessing the value and pest management window provided by neonicotinoid seed treatments for management of soybean aphid (Aphis glycines Matsumura) in the Upper Midwestern United States. Pest Management Science.

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Additional Resources

Photo: Thelma Heidel-Baker

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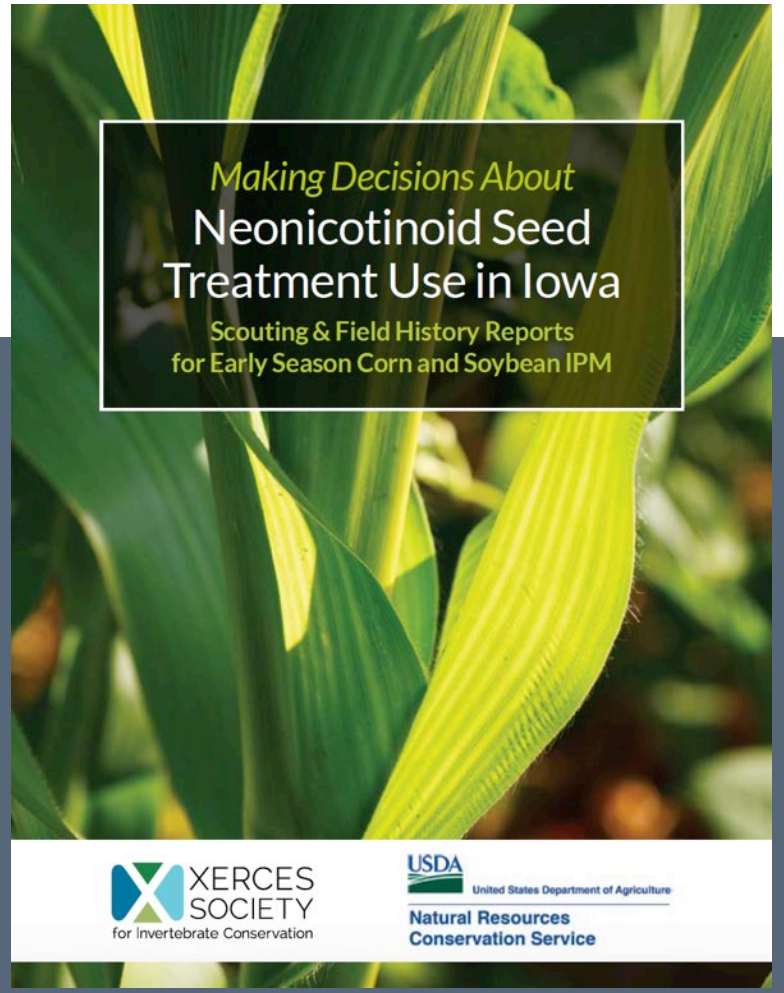
Neonicotinoid Resources



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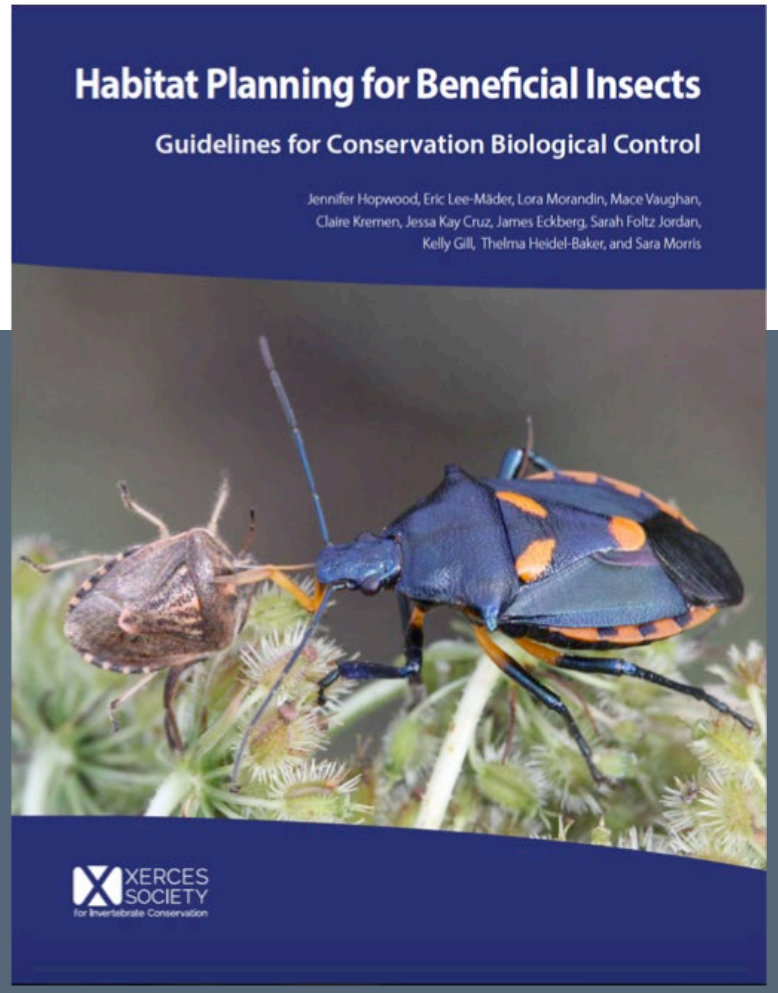
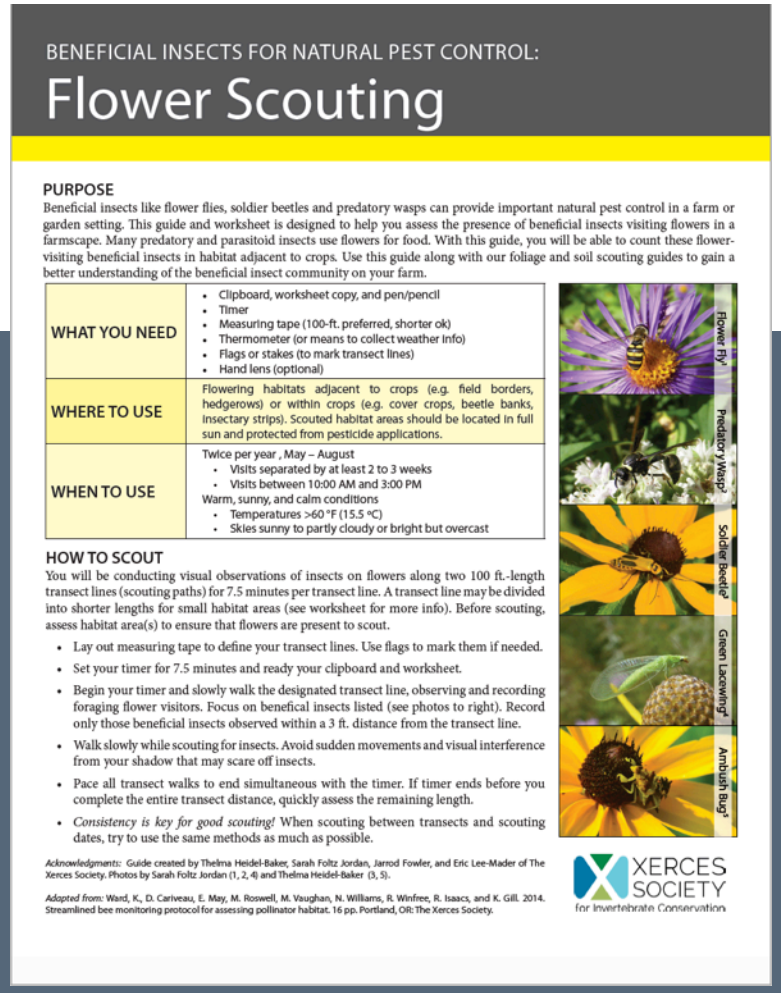
Beneficial Insects for Pest Control Resources





BENEFICIAL INSECTS FOR NATURAL PEST CONTROL:

Flower Scouting

PURPOSE

Beneficial insects like flower flies, soldier beetles and predatory wasps can provide important natural pest control in a farm or garden setting. This guide and worksheet is designed to help you assess the presence of beneficial insects visiting flowers in a farmscape. Many predatory and parasitoid insects use flowers for food. With this guide, you will be able to count these flower-visiting beneficial insects in habitat adjacent to crops. Use this guide along with our foliage and soil scouting guides to gain a better understanding of the beneficial insect community on your farm.

WHAT YOU NEED	• Clipboard, worksheet copy, and pen/pencil • Timer • Measuring tape (100-ft. preferred, shorter ok) • Thermometer (or means to collect weather info) • Flags or stakes (to mark transect lines) • Hand lens (optional)
WHERE TO USE	Flowering habitats adjacent to crops (e.g. field borders, hedgerows) or within crops (e.g. cover crops, beetle banks, insectary strips). Scouted habitat areas should be located in full sun and protected from pesticide applications.
WHEN TO USE	Twice per year , May – August • Visits separated by at least 2 to 3 weeks • Visits between 10:00 AM and 3:00 PM Warm, sunny, and calm conditions • Temperatures >60 °F (15.5 °C) • Skies sunny to partly cloudy or bright but overcast

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for Invertebrate Conservation

HOW TO SCOUT

You will be conducting visual observations of insects on flowers along two 100 ft.-length transect lines (scouting paths) for 7.5 minutes per transect line. A transect line may be divided into shorter lengths for small habitat areas (see worksheet for more info). Before scouting, assess habitat area(s) to ensure that flowers are present to scout.

- Lay out measuring tape to define your transect lines. Use flags to mark them if needed.
- Set your timer for 7.5 minutes and ready your clipboard and worksheet.
- Begin your timer and slowly walk the designated transect line, observing and recording foraging flower visitors. Focus on benefical insects listed (see photos to right). Record only those beneficial insects observed within a 3 ft. distance from the transect line.
- Walk slowly while scouting for insects. Avoid sudden movements and visual interference from your shadow that may scare off insects.
- Pace all transect walks to end simultaneous with the timer. If timer ends before you complete the entire transect distance, quickly assess the remaining length.
- *Consistency is key for good scouting!* When scouting between transects and scouting dates, try to use the same methods as much as possible.

Acknowledgments: Guide created by Thelma Heidel-Baker, Sarah Foltz Jordan, Jarrod Fowler, and Eric Lee-Mader of The Xerces Society. Photos by Sarah Foltz Jordan (1, 2, 4) and Thelma Heidel-Baker (3, 5).

Adapted from: Ward, K., D. Cariveau, E. May, M. Roswell, M. Vaughan, N. Williams, R. Winfree, R. Isaacs, and K. Gill. 2014. Streamlined bee monitoring protocol for assessing pollinator habitat. 16 pp. Portland, OR: The Xerces Society.

Opportunities in Agriculture

CONTENTS

Available at: www.sare.org/cover-cropping-for-pollinators or order free hard copies at (301) 779-1007.

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Cover Cropping for Pollinators and Beneficial Insects

Doug Crabtree uses many tools to make his Montana farm bee friendly. – *Photo by Jennifer Hopwood.* Phacelia is an attractive pollinator cover crop. – *Photo by John Hayden.* Clover fixes nitrogen and provides bee forage. – *Photo by Judson Reid*

DOUG AND ANNA CRABTREE'S VILICUS FARM RESTS on more than 2,000 acres in northern Montana, and it is a model of how cover crops can be a foundation of pollinator and beneficial insect management. Like many farmers, their approach to cover cropping began with an interest in soil health and quickly grew to encompass much broader goals as they recognized the additional benefits cover crops could provide.

"We want to implement pollinator conservation at the field-level scale," Doug says. "Anyone can create a small wildflower strip, but as we scale up, we need conservation areas distributed across the entire operation."

While the Crabtrees have established permanent native wildflower strips around many of their fields to provide a skeleton of habitat throughout the farm, extensive cover crop rotations provide the muscle that makes their operation a rich landscape for bees and other beneficial insects.

This commitment to cover cropping is having clear and positive impacts. Flax, sunflower and safflower are just a few of the Crabtrees' regular crops that either require or strongly benefit from insect pollination. And, because of their commitment to integrating habitat for wild pollinators throughout their holdings, the Crabtrees have never needed to bring honey bee hives onto the farm for pollination. Instead, a walk through their fields quickly reveals an abundance of wild bumble bees, longhorn bees, sweat bees and more—all supported by the farm's habitat. A farm's ability to support its own pollinator community provides security, especially if managed honey bee hives become scarce or expensive.

In addition to supporting the pollinator community, cover crops have many traditional uses on a farm. These range from preventing erosion and improving soil health to managing weeds and serving as an additional source of income when part of a double-crop system. With cover

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Thank You!

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Photo credit: Native pink lady beetle, Thelma Heidel-Baker