

Pollinator Conservation Short Course
Penn State University, State College, PA



Presented by
Mace Vaughan, Xerces Society for Invertebrate Conservation and USDA NRCS
Kelly Gill, Xerces Society for Invertebrate Conservation and USDA NRCS (NJ)
David Biddinger, Penn State University, Fruit Research and Extension Center

Photo: Brian Cooper

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Thank You!!**

Special thanks to:
 Christina Grozinger, Kim Swistock, David Biddinger, Neelendra Joshi, and Ed Rajotte (Penn State University) and **Ashley Minnerath** (Xerces Society)

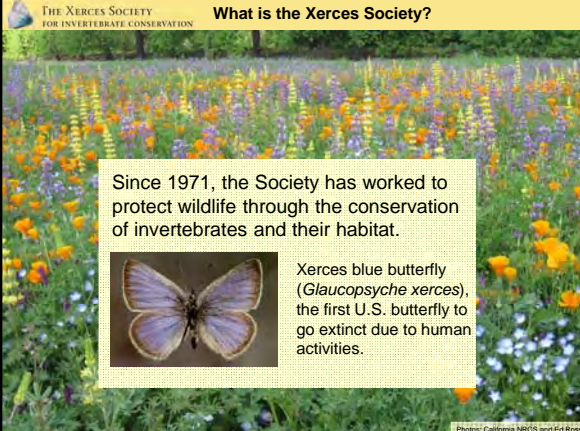








Photo: Mace Vaughan

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **What is the Xerces Society?**







Since 1971, the Society has worked to protect wildlife through the conservation of invertebrates and their habitat.



Xerces blue butterfly (*Glaucopsyche xerces*), the first U.S. butterfly to go extinct due to human activities.

Photo: California NRCIS and Ed Ross

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **What is the Xerces Society?**

 Pollinator conservation	 Endangered species
 Butterfly conservation	 Aquatic conservation

Photos: Joel Sartore, Matthew Shephard, Carly Vaughn, David Funk

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **New Aquatic Invertebrates Conservation Program**

Migratory Dragonfly Partnership
<http://www.xerces.org/dragonfly-migration/>



common green damner
Anax junius



wandering glider
Pantala flavescens
(11,000 km roundtrip!)

Photo: Greg Lasky

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **What is the Xerces Society?**

The Xerces Society's Pollinator Conservation Program

- Habitat restoration
- Technical guides and trainings
- Documenting at-risk pollinators
- Applied restoration research

Joint Staff Biologist Positions

- USDA-Natural Resources Conservation Service (NRCS)
- University of Minnesota Extension

Staff Backgrounds

- Farming, entomology, teaching, wildlife conservation, habitat restoration, beekeeping, and native seed production




Photo: Eric Meador

BRING BACK THE POLLINATORS
A Xerces Society Conservation Campaign

Three Steps You Can Take to Bring Back the Pollinators

1. Sign the Pollinator Protection Pledge.
2. Install a Pollinator Habitat sign.
3. Spread the word!

BRING BACK THE POLLINATORS

Photo: Matthew Shepherd

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Short Course Outline**

Overview of today:

- Importance of pollinators
- Bee biology and i.d.
- Bee-friendly farming

Break

- PA Case Study: reducing bee risk from pest management
- Assessing pollinator habitat

Lunch (12 to 1) and field tour

- Habitat restoration
- Bee conservation and USDA Farm Bill programs
- Additional resources
- Wrap up: raffle and evals.

Photo: Nancy Adamson (Xerces Society)

Module 1. The Importance of Pollinators

Photo: Bruce Newhouse

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Insect Pollinators: An Ecological Keystone**

More than 80 percent of flowering plants (~240,000 sp.) require an insect to move pollen.

Cherrier, J. R., Winfree, and S. Yarranto. 2011. How many flowering plants are pollinated by animals? *Oikos* 120: 321-326. doi: 10.1111/j.1365-0706.2010.18644.x

Potts, S. G., J. C. Stronach, C. Kremen, R. Neumann, R. Schwegler, and W. E. Kunin. 2010. Global pollinator declines: trends, impacts and drivers. *Trends in Ecology and Evolution*, 25(6): 346-353.

Photo: Eric Meyer

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bugs Drive the System**

Benefits to Other Wildlife:

- Pollinator-produced fruits and seeds comprise 25% of the bird and mammal diets
- Pollinators are food for wildlife (e.g. 89% of birds feed on insects)
- Pollinator habitat is compatible with the needs of other wildlife, such as songbirds

Photo: Steve Haskett

Photo: iStockphoto

Photo: iStockphoto

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Importance of Pollinators: Human Nutrition**

Pollinators provide an ecosystem service that enables plants to produce fruits and seeds.

- 35% of crop production, worldwide
- Over \$18 to \$27 billion value of crops in U.S. (\$217 billion worldwide)
- Most of our vitamins and minerals are from insect-pollinated plants
- One in three mouthfuls of food and drink we consume

Jeppa et al. 2011. Contribution of Pollinator-Mediated Crops to Nutrients in Human Food Supply. *PLoS ONE*

Henig, M. A. Gardeners' NY. 2000. The value of honey bees as pollinators of U.S. crops in 2000. *Bee Culture* 128: 1-15.

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

Photo: USDA ARS/Healy Gribb

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Importance of Pollinators: Human Nutrition




SHARE THE BUZZ™



Your produce choices with bees

Your produce choices without bees

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Whole Foods Produce With Bee Pollinated Crops

A third of our crops depend on insect pollinators—*primarily bees*



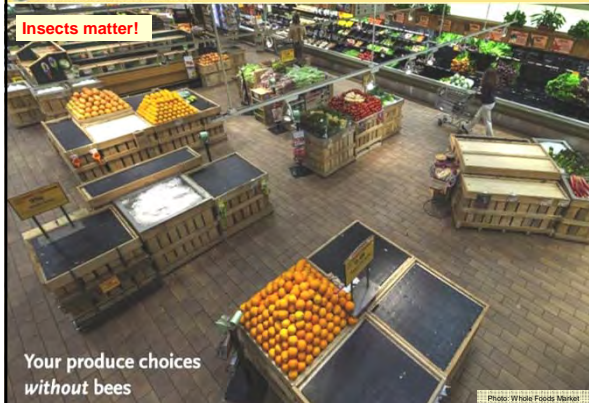
Your produce choices with bees

Photo: Whole Foods Market

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Whole Foods Produce *Without* Bees

Insects matter!



Your produce choices without bees

Photo: Whole Foods Market

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Importance of Pollinators: USDA's Organic Rule

Organic Ag Defined by the USDA:

- "A production system that is managed...by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity" (7 CFR 205.2)

Organic Food Production Act, 1990

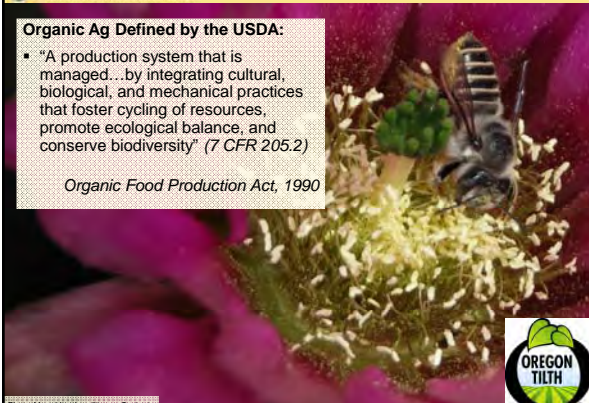




Photo: Mace Vaughan (Xerces Society)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Main Groups of Pollinators



Photos: Mace Vaughan, Bob Hammond, David Inoué, Bruce Nashhouse

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Bees: The Most Important Pollinators

- Bees actively collect and transport pollen
- Bees exhibit flower constancy
- Bees regularly forage in area around nest



Photo: Edward R. Ross

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee Diversity: Native Bees**

North America is home to approximately 4,000 species of native bees



Native sunflower bee (*Svastra* sp.)

Photo: Roger Coville

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Crop Pollination by Bees**

The European honey bee – the most familiar managed crop pollinator

We are reliant on a pollinator that is experiencing many problems.



Photo: USDA ARS/Scott Bauer

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Crop Pollination: Honey Bees in Decline**

Fewer Honey Bees Available

- 50% decline in managed hives since 1950
- 70-100% decline in feral colonies

Causes: Disease, pests, honey prices, loss of habitat, pesticides and...




Varroa mite

National Research Council. 2007. Status of Pollinators in North America. National Academies Press. 326 pgs. Photo: USDA-ARS/Scott Bauer

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Honey Bees: Colony Collapse Disorder**

Colony Collapse Disorder

In 2006-7, about 25% of beekeeping operations in the U.S. lost an average of 45% of hives.



Van Engelsdorp, D., R. Underwood, B. Carron, J. Hayes, Jr. 2007. An Estimate of Managed Colony Losses in the Winter of 2006-2007. A Report Commissioned by the Apiary Inspectors of America, Inc. Bee Journal 47: 370-603. Photo: Eric Mader

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Honey Bees: New Annual Loss Rates**

Annual losses...

Pre-CCD (1995-2006):
15% - 22% per year

Post-CCD (2006-today):
29% - 36% per year

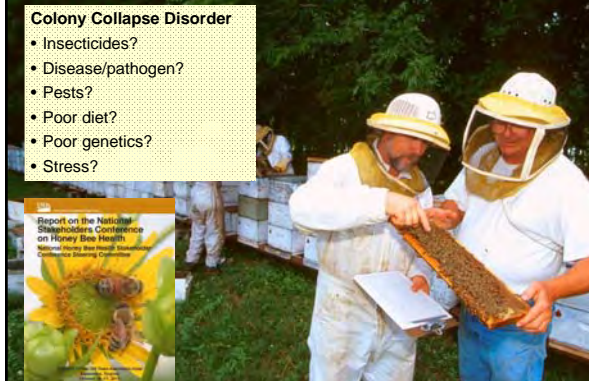


Photo: USDA-ARS/Scott Bauer

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Possible Causes of Colony Collapse Disorder**

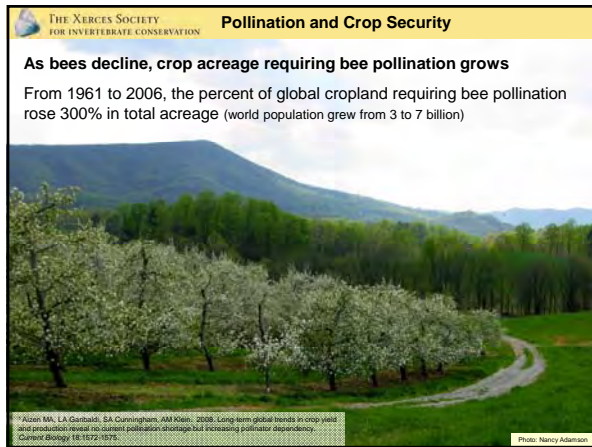
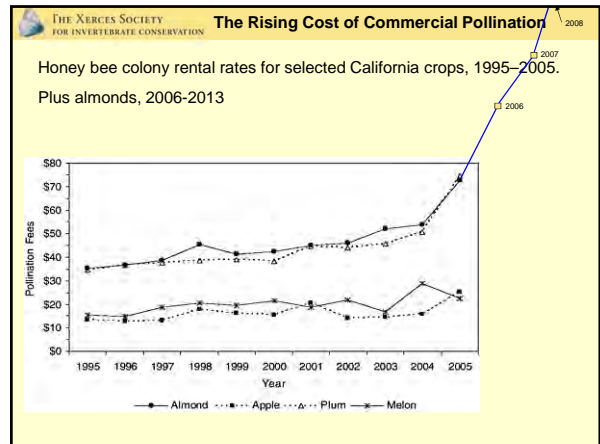
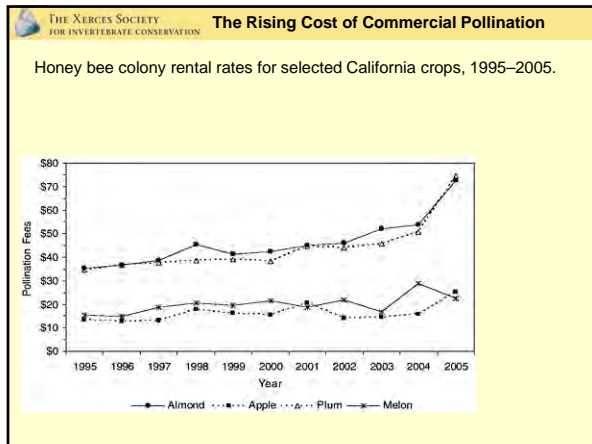
Colony Collapse Disorder

- Insecticides?
- Disease/pathogen?
- Pests?
- Poor diet?
- Poor genetics?
- Stress?



Report on the National Stakeholders Conference on Honey Bee Health: National Honey Bee Health Symposium, National Honey Bee Health Symposium, Community Steering Committee

Photo: USDA ARS/Scott Bauer



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Other Important Bees in Decline**

Honey Bee Declines Are Only Part of the Story

Native Bees Also in Decline

Imperiled bumble bees

Some teetering on the brink of extinction

Disease spread by commercial bumble bees

Yellow-banded

Franklin's

Rusty patched

Western

Evans, E.R., Thorp, S., Jepsen, and S. Hoffman Black, 2008. Status Review of Three Formerly Common Species of Bumble Bee in the Subgenus *Bombus*. Xerces Society.

Cameron et al. 2011. Patterns of widespread decline in North American bumble bees. PNAS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Crop Pollination: Important to Diversify**

Fewer Honey Bees Available

- Important to diversify pollinators for agriculture
- Important to strengthen habitat and pesticide protection for all bees (honey and native)

Photos: Toby Alexander, VT ABC's, Bob Hammond, CSU Coop Ext.

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Crop Pollination: Important to Diversify**

Hundreds of species of native bees contribute significantly to crop pollination.

- \$3 billion/year

Losey, J. and M. Vaughan. 2006. The Economic Value of Ecological Services Provided by Insects. *BioScience* 56(4). Photo: USDA, APIS/Scott Baker & Ernest McCann

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Crop Pollination: Important to Diversify**

Contribution of native bees to crop pollination:

- 80+ species visit berry crops in New England
- 100+ species visit blue berry in Michigan
- 100+ species visit WI cranberries
- 100+ species visit apples in NY and PA
- 60+ species visit CA tomato, sunflower, or watermelon

Photo: Mace Vaughan

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Specialist Solitary Bees**

Example: Squash Bees

- Ground-nesting under squash plants
- Active in early morning (before sunrise)
- Pollinate flowers before honey bees begin foraging¹
- 67% of sites studied across the U.S. had all pollination needs met by squash bees²
- Excellent at locating new, isolated squash plantings

1. Tapachin, V. J. 1981. The pollination efficiency of the squash bee (Pezomachus grossus) and the honey bee (Apis mellifera) on summer squash (Cucurbita pepo). *Journal of the Kansas Entomological Society* 54:320-327. 2. Jim Cane (USDA ARS Logan Bee Lab). 2011. Personal communication. Photo: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Buzz Pollination by Native Bees**

Example: Cherry Tomatoes

When native bees were present, the production of Sungold cherry tomatoes almost tripled.

Greenleaf, S. S. and C. Kremen. 2006. Wild bee species increase tomato production and respond differently to surrounding land use in Northern California. *Biological Conservation* 132:81-87. Photo: Anne Bebbinger; Mace Vaughan

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Native Bee Diversity in Agriculture**

Example: Blue Orchard Bee

- 250 to 750 females/acre compared to 1 to 2.5 hives of honey bees
- Make contact with anther and stigma on almost every visit
- Active at low light levels and low temperatures
 - 33+ hours foraging in 5 days
 - 15+ hours by honey bees

Bosch, J. and W. Kemp. 2001. How to Manage the Blue Orchard Bee as an Orchard Pollinator. Sustainable Agriculture Network. Beltsville, MD. 89pp. Photo: Mace Vaughan, Eric Martin

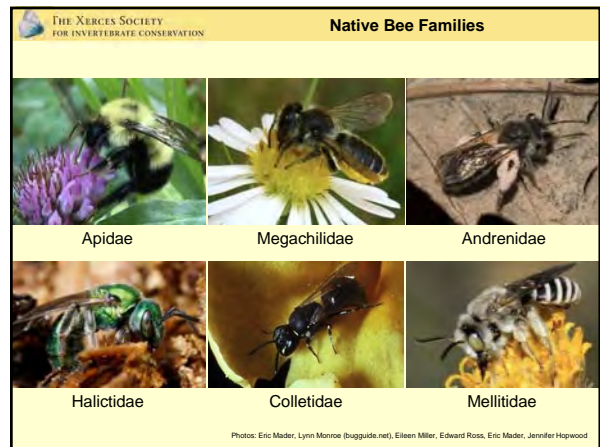
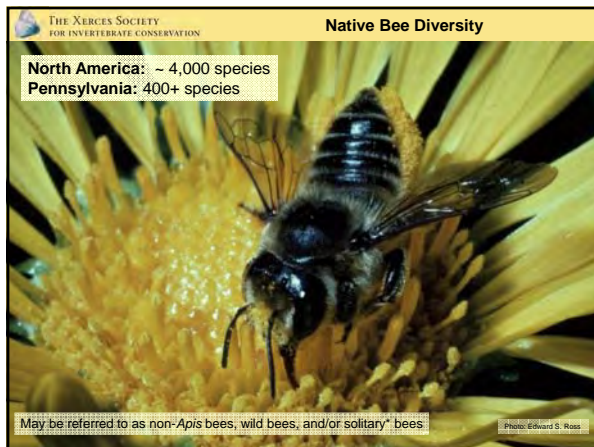
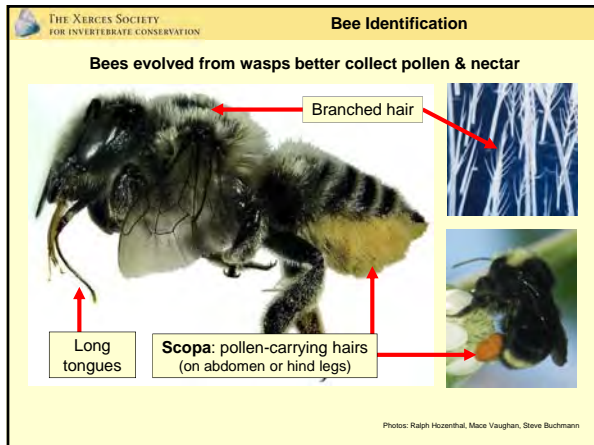
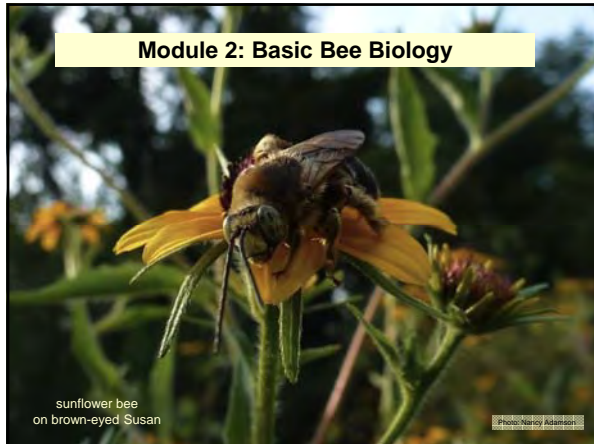
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Wild Pollinators: Better Quality Pollination**

Recent study of 41 crops around the globe:

- Wild pollinators improved fruit set at **twice** the rate of honey bees
- Wild pollinators and honey bees promote fruit set independently

mining bee on peach

Gumbold, L. A. et al. 2013. Wild pollination enhances fruit set of crops regardless of honey bee abundance. *Science* 339 (6127): 1608-1611. Photo: Nancy Adamson



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Body Size and Shape

Overall body shape: →

Slender Moderate Robust

Body size: →

Small (4 – 8mm) Medium (9 – 14mm) Large (15 - 25mm)

Photos: Edward S. Ross, Betsy Betros, Jennifer Hopwood

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Native Bee Diversity

Photo: Stephen L. Buchmann

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Three Broad Groups of Native Bees

Ground-nesting bees (solitary)

Tunnel-nesting bees (solitary)

Bumble bees (social)

Photos: Marco Vaughan (Norton), Edward Ross

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Life Cycle of a Solitary Bee

Mining bee (*Andrena* sp.): a year in its underground nest as egg, larva, and pupa before emerging to spend a few weeks as an adult.

Photos: Dennis Briggs

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Ground Nesting Bees

70% of native bee species nest in the ground

- Resemble ant-nests from above ground
- Very common bees
- May aggregate nests
- Conserve sandy soil, bare ground

Photo: Eric Mader

Source: Stephen, Bohart, and Torchio, 1967

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Ground Nesting Bees

Nest chambers are lined with waxy glandular secretions, and can sometimes even resist flooding.


THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Ground nesting: Mining or digger bees


Andrena

- Early spring (generally)
- Nest in well-drained soils, aggregate
- Important for tree fruit and berries

Scout for & conserve nesting sites



apple



blueberry

males often smaller than females

Photos: Nancy Adamson, Eric Mader, Jim Carle, International Pollination Services


THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Ground nesting: Squash bees

Peponapis pruinosa, Xenoglossa strenua & X. kansensis


- Specialize on cucurbit pollen: summer & winter squash, melon, cucumber
- Nest in or near crop
- Active early a.m., summer

Avoid deep tilling whenever possible



yellow "trousers" on male

male



long tongue

female

ground nesting—but males sleep in squash flowers

Photos: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Ground nesting: Green sweat bees

Agostemon, Augochlora pura*, Augochlorella, Augochloropsis

- Generalists, short-tongued, buzz
- Some nest communally, but each female builds and provisions her brood cells

*Augochlora also nests in rotting wood

Conserve nesting sites & avoid deep tilling



blueberry



tomato



Photos: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Ground nesting: Sweat bees

Halictus & Lasioglossum/Dialictus

- Small, black, dark green, dark blue, with bands of white on abdomen
- Solitary, communal (aggregate nests) to semi-social (daughters help care for young)
- Many generalists, active all season

Conserve nesting sites & avoid deep tilling



swamp rose, Rosa palustris



Halictus ligatus on yarrow, Achillea millefolium



serviceberry, Amelanchier sp.



melon



Photos: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Tunnel-Nesting Bees

Roughly 30% of native species

- Nest in hollow or pithy plant stems, or old beetle borer holes
- Nest tunnel partitions constructed of mud, leaf pieces, or sawdust
- Artificially managed for some crops
- **Conserve snags, brush piles**
- **Pithy-stemmed plants (e.g. box elder, cane fruit, or elderberry)**

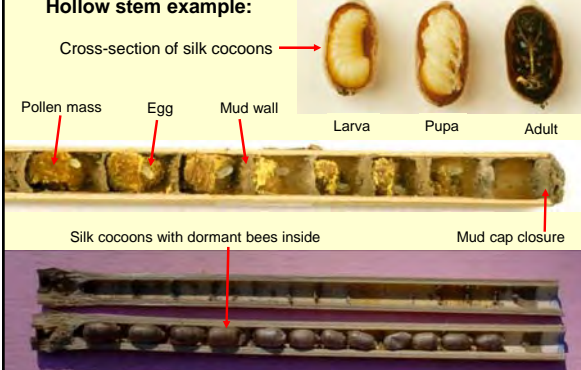
Photos: Edward Ross, Darrin O'Brien, Matthew Shepherd

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Tunnel-Nesting Bees

Hollow stem example:

Cross-section of silk cocoons



Pollen mass Egg Mud wall Larva Pupa Adult

Silk cocoons with dormant bees inside Mud cap closure

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Tunnel-Nesting Bees

Nest cells separated with mud or leaf partitions

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Tunnel nesting: Mason or orchard bees

Osmia

- Small to medium size, robust build
- Usually metallic blue or green
- Wide bodies and heads
- Scopa on underside of abdomen
- Active in spring and early summer

Conserve snags, brush piles & pithy-stemmed plants

O. collinsiae on oxalis

O. virga on apple

O. cornifrons or *O. taurus* (introduced spp.) on blueberry and male cleaning

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Tunnel nesting: Leafcutter bees

Megachile

- Small to large size
- Wide bodies and heads
- Dark, typically with pale stripes
- Scopa on underside of abdomen
- *M. rotundata* intro'd for alfalfa

Conserve snags, brush piles & pithy-stemmed plants

M. mendica on blackberry

blanket flower, *Gaillardia*

scopa

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Bumble bees, *Bombus* spp.

- 45 species in U.S., ~26 in East
- Social colonies founded by single queen
- Annual, last only one season
- Nest may contain 25-400 workers
- Nests in abandoned rodent burrows or under lodged grasses
- Conserve brush piles, un-mowed areas

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Life cycle of a bumble bee colony

Fall: Mated queens seek overwintering sites

Winter: Hibernating queen

Spring: Nest establishment and egg laying

Fall: New queens leave the nest and mate

Fall: Old queen dies

Summer: Colony peak

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Bumble bees: Excellent crop pollinators

- Pollinators of red clover, tomato, cucurbits
- More efficient than honey bees for blueberry, cranberry, cucurbits (squash, melon)
- Active in cool and wet weather & "buzz" pollinate

Bombus ternarius on blueberry, *Vaccinium* sp.

Bombus impatiens & *B. griseocollis* on squash

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NEW** Bumble bee conservation guide

Conserving Bumble Bees

Guidelines for Creating and Managing Habitat for America's Declining Pollinators




<http://www.xerces.org/bumblebees/guidelines>

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Cuckoo bees: Nest parasites (cleptoparasites)**



Adults feed on pollen & nectar, lay eggs in host nest

- Slender, wasp-like
- Small to medium size
- Bodies not hairy, no scopa
- Coloration highly variable
- May have spiky projections
- Use scent to locate and evade host



Photos: Lloyd Spalank, David Gordon, Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Other Flower Visitors**

- Flies are omnivores
- Nectar, pollen
- Other animals, carrion
- Detritus, dung



syrphid fly on scabiosa daisy

Photo: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Other Flower Visitors**

Some mimic bees / wasps

- Bigger eyes
- Shorter antenna
- 1 pair of wings
- Many fly species are natural enemies of insect pests

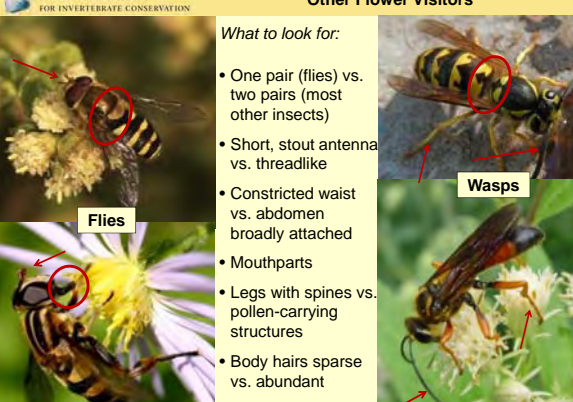


Photo: Nancy Adamson, Adam Varenhorst

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Other Flower Visitors**

What to look for:

- One pair (flies) vs. two pairs (most other insects)
- Short, stout antenna vs. threadlike
- Constricted waist vs. abdomen broadly attached
- Mouthparts
- Legs with spines vs. pollen-carrying structures
- Body hairs sparse vs. abundant



Flies

Wasps

Photos: Mick Vaughan, James Crane, MJ Hatfield, Dan Kurtz

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Other Flower Visitors**

- Adults sip nectar
- Larvae eat specific host plants
- Adult lays egg near food source



Photos: Mick Vaughan, Phil Goldenberg, Brian



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Insecticides and Pollinators**

Insecticides can negatively impact pollinator populations

Blueberry fields receiving pest control programs with higher pesticide toxicity have lower native bee abundance and richness

Kavan 1975. *Biological Conservation* 7: 301-309
 Kavan and Ploewright 1989. *Forest insect pests in Canada*, pp. 607-618
 Kavan and Ploewright 1989. *Journal of Economic Entomology* 72: 447-452

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Insecticides**

If you do use insecticides:

- Minimize their use
- Use active ingredients with least impact on bees
- Consider formulation
- Don't spray on plants in bloom
- Spray at night and when dry
- Follow label guidelines
- Remember label guidelines only apply to honey bees, not wild bees
- Communicate with nearby beekeepers

<http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf>

How to Reduce Bee Poisoning from Pesticides

Photo: SHEARIS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Insecticides: Control Drift**

Control Drift and Over Application

- Calibrate equipment annually
- Select proper nozzle type
- Use drift-reducing applicators
- Avoid temperature inversions and windy conditions
- Establish buffer strips

Photo: SHEARIS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Insecticides: Control Drift**

Windbreak Establishment
Pesticide screening example

For pesticide drift mitigation:

- Small-needle evergreen species, not attractive to pollinators (e.g. arborvitae, cypress, juniper, spruce, etc.)
- Porosity is critical: 40% open

Pines are NOT recommended—less dense growth habit and too open over time

Photo: Shear & Associates

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Neonicotinoid Insecticides**

Neonicotinoid Systemic Insecticides:

- Increasingly used on crops
- Applied as sprays, soil treatments, trunk injections, or seed coatings
- Systemic mode of action
- Residues in pollen and nectar
- Can be persistent over time in plants and soil

Photo: Regina Minich

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Neonicotinoid Insecticides

Neonicotinoid Toxicity to Bees

- Large doses are toxic to bees
- Small doses impact foraging and flight in honey bees
- Bumble bee colonies exposed to very low doses produce fewer queens, which may impact populations
- Neonics are also detrimental to many other beneficial insects

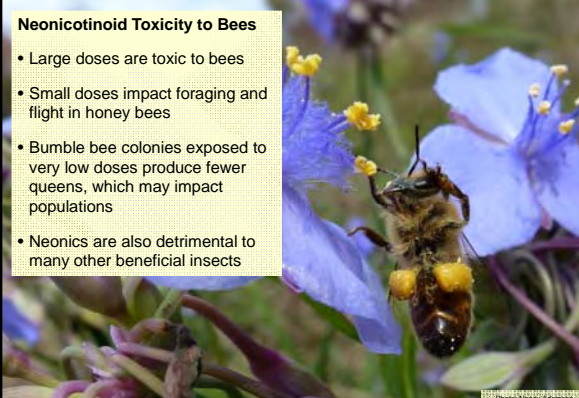



Photo: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Reducing Risk to Bees from Neonicotinoids




Annual plants:

- Use less toxic neonicotinoids: acetamiprid or thiacloprid
- Avoid application before or during bloom
- Avoid treating plants with continuous blooms
- Treatment of non-blooming crops pose little threat to bees

Photo: Jennifer Hopwood

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Reducing Risk to Bees from Neonicotinoids



Perennial crops:

- Use less toxic neonicotinoids: acetamiprid or thiacloprid
- Avoid repeated use on bee-visited or pollinator-dependent crops
- Avoid trunk injections, which may result in residues that are more concentrated and long-lasting, and thus more harmful to bees

Photo: Jennifer Hopwood

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Neonicotinoids for Ornamental plants

- Also used on ornamental plants, and lawns
- Level of application is **much** greater than on crops (12x to 60x), which **increases** the risk to pollinators
- Avoid use on pollinator-visited plants (e.g. maple trees, linden trees, roses, sedum, etc)
- Check with your nursery to make sure perennial plants you purchase have not been treated with neonicotinoids




Photo: Matthew Shepherd

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Managing Insecticides: Organic Approved



Organic-Approved Pesticides?

- Pyrethrins = Dangerous for Bees!
- Spinosad = Dangerous for Bees!
- *Beauveria bassiana* = Dangerous!


Okay when not directly applied to bees (i.e. non-blooming crops or at night):

- Insecticidal soap
- Horticultural oil
- Neem

Photo: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Managing Insecticides: Alternative Options



Safer Options:

- Bt
- Insect repellents (e.g. garlic or citrus oils)
- Kaolin clay barriers (Surround)
- Pheromone traps
- Mating disruptors

Photo: David Bidinger (Iowa State University)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Insecticides: Alternative Options**

Alternatives to Pesticides:

- Floating row covers
- Fruit bagging
- Crop rotation and diversity
- Resistant varieties
- Sanitation

Photo: Nathan Ross

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Pesticides: Conservation Biocontrol**

Conservation Biological Control

- Many of the same flowering plants that support pollinators also support predatory and parasitic insects.

Soldier beetle

Syrphid fly drinking raspberry nectar

Parasitoid wasp

Ladybird beetle

Photos: Mace Vaughan, Paul Jepson, Mario Ambrosio

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Pesticides: Conservation Biocontrol**

"The greatest single factor in preventing insects from overwhelming the rest of the world is the internecine warfare which they carry out among themselves." *Robert Metcalf, entomologist*

tomato hornworm larvae parasitized by a braconid wasp, *Cotesia congregatus*

Photo: VegEdge, UMN

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Pesticides: Conservation Biocontrol**

Conservation Biological Control

- Beneficial Insects
- Natural Enemies (of pests)
- Biological Control Agents

For latest local info, contact

- Local Extension & NRCS offices
- Visit <http://www.eXtension.org>
- Find regional Integrated Pest Management (IPM) center

This manual will be available soon, as well as a new book from the Xerces Society & Storey Publishers.

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION
NRCS
USDA
Conservation Biological Control
Providing habitat for predators and parasitoids of crop pests

August 2012
The Xerces Society for Invertebrate Conservation

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Managing Insecticides: IPM**

Integrated Pest Management

- Establish economic thresholds
- Use multiple strategies to reduce pest pressure
- Scout crops before spraying
- Use the least toxic control option
- NRCS 595: Pest Management

Photo: Matthew Shapcott

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Protect Nesting Habitats**

A lack of nest sites is a major constraint on bee populations in many areas. Protect what you already have.

Photos: Jennifer Hopwood, Eric Mader

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: Protect Ground Nests**

Protect Ground Nests:

- Reduce Tillage
- Avoid soil fumigants
- Minimize plastic mulch
 - Small areas = ok!



Photo: USDA/ARS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: Protect Ground Nests**

Example: No-Till Squash

No-till farms in Virginia hosted three times more native bees than did conventional farms



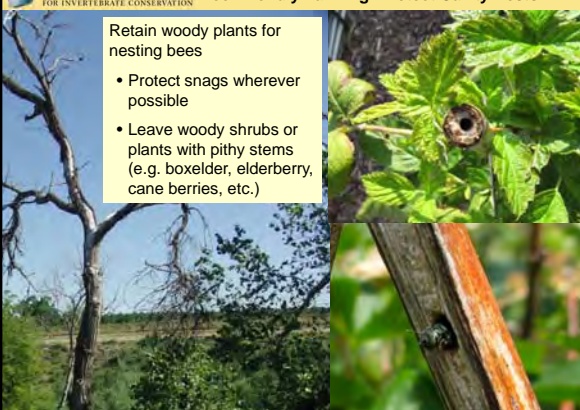
Shuler, et al. 2005. Farming Practices Influence Wild Pollinator Populations on Squash and Pumpkin. *Journal of Economic Entomology*. 98(3):790-795

Photo: Jim Davis

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: Protect Cavity Nests**

Retain woody plants for nesting bees

- Protect snags wherever possible
- Leave woody shrubs or plants with pithy stems (e.g. boxelder, elderberry, cane berries, etc.)



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: Protect Cavity Nests**

- Provide small artificial nests (bamboo, reeds, old pithy stems, holes drilled in wood)
- Maintain sanitation or phase out nests to reduce pathogen, pest loads



Photo: Mace Vaughan, Eric Moser, Katherine Ullman, Lloyd Corn, Jennifer Ho

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: Protect Cavity Nests**

- Provide small artificial nests (bamboo, reeds, old pithy stems, holes drilled in wood)
- Maintain sanitation or phase out nests to reduce pathogen, pest loads



Managing Alternative Pollinators
A Handbook for Beekeepers, Growers, and Conservationists
ERIC MOSER • NIKOLA JITEK • ELIABE ERBAS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: Protect Bumble Bee Nests**

Bumble bees build nests in:

- Cavities such as old rodent holes
- Overgrown areas
- Under brush piles or piled field stones
- Under bunch grasses
- Artificial nests are ineffective?

Conserve un-mowed areas




Photo: Mace Vaughan, Katherine Ullman, Lloyd Corn, Jennifer Ho




THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: A Midwest Case Study**

Case Study: Native Seed Producer

- Highly industrialized
- 2000 Acres across two counties
- \$25,000/year honey bee rentals
- Goal: Reduce pollination costs and increase crop pollination





THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: A Midwest Case Study**

Step 1: Reduce Pesticide Use

- Implemented IPM program
- Established economic thresholds
- Weekly crop scouting










THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: A Midwest Case Study**

Step 2: Reduce Tillage to Protect Ground-Nesting Bees




- Scouting of nest sites
- Selective herbicides
- Hooded sprayers
- Flame-weeders
- Wood chip mulch

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: A Midwest Case Study**

Step 3: Conserve Bumble Bee Nest Habitat

- Reduced mowing around farms (ditches and field borders)
- Created buffer strips between fields

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bee-Friendly Farming: A Midwest Case Study**

Step 4: Provide Nests for Wood-Nesting Bees

- Native resident bee populations
- Managed alfalfa leafcutter bees (*Megachile rotundata*)
- Also attracted beneficial predatory wasps





THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Bee-Friendly Farming: A Midwest Case Study

Case Study Results

- Honey bee rentals reduced by more than one-half
- Improved pollination; increased yields
- More targeted pesticide use
- Greater biodiversity (birds, butterflies, amphibians)

Photo: Eric Mador



PENNSTATE

Modifying Orchard Practices To Better Accommodate Pollinators

D. Biddinger, E. Rajotte, N. Joshi, M. Frazier, & D. Mortensen
- Penn State University
Mace Vaughan – Xerxes Society

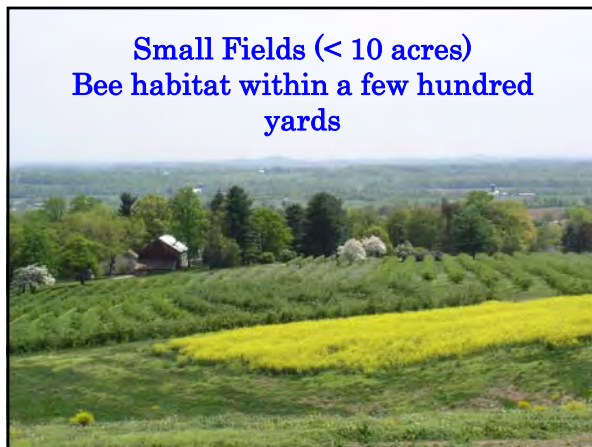
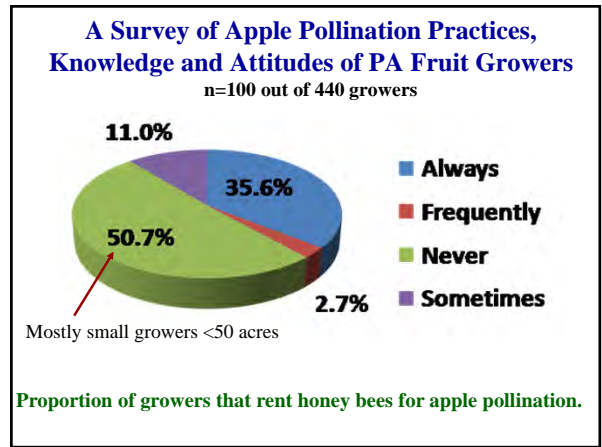
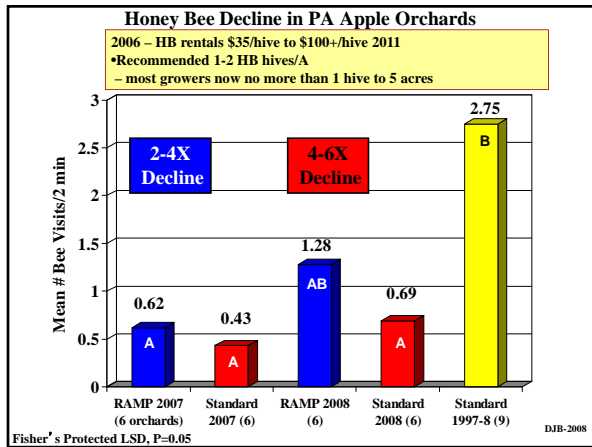
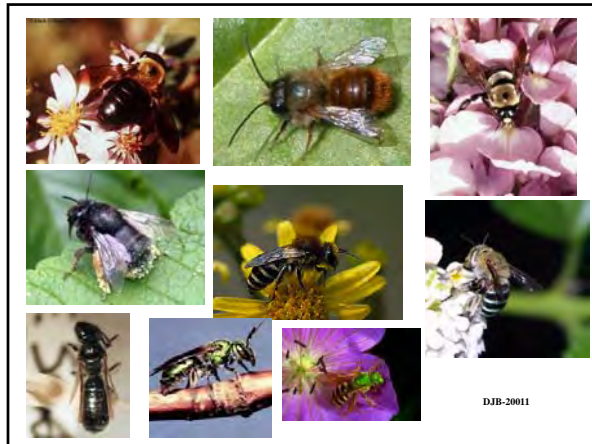
B. Hollabaugh



PREDATORS

PARASITOIDS

DJB 2003





2007-2012 Orchard Bee Survey

4,000 species in North America
~ 450 in Pennsylvania
~180 in Pennsylvania orchards
60 visiting apple bloom in NY, 45 in PA

USDA-NIFA Northeast IPM

- Cornell University
- Penn State University
- Xerces Society

WILD POLLINATORS of EASTERN APPLE ORCHARDS and how to conserve them

TOXICITY OF PESTICIDES TO BEES

Chemical	Common in Commercial Orchards	Available in Home Gardens	TOXICITY LEVEL			
			None	Low	Medium	High
Acetamiprid	Yes	Yes				
Alfathion	Yes	Yes				
Azinphos methyl	Yes	Yes				
Carbaryl	Yes	Yes				
Chlorpyrifos	Yes	Yes				
Cyfluthrin	Yes	Yes				
Deltamethrin	Yes	Yes				
Dimethoate	Yes	Yes				
Disulfoton	Yes	Yes				
Ethion	Yes	Yes				
Fenitrothion	Yes	Yes				
Fenprophate	Yes	Yes				
Fipronil	Yes	Yes				
Gamma HCH	Yes	Yes				
Imidacloprid	Yes	Yes				
Malathion	Yes	Yes				
Permethrin	Yes	Yes				
Phosalone	Yes	Yes				
Phosphamidon	Yes	Yes				
Propoxur	Yes	Yes				
Rotenone	Yes	Yes				
Spinosad	Yes	Yes				
Thiamethoxam	Yes	Yes				
Trifluralin	Yes	Yes				
Triphenylethylene pyrethroids	Yes	Yes				
Valproic acid	Yes	Yes				
Zeta-cypermethrin	Yes	Yes				

The Xerces Society for Invertebrate Conservation

Advantages of Native Bees

- Very efficient – hairy, whole body used for pollen collection
- Fly earlier, wetter, colder
- Buzz pollination – tomatoes, blueberries
- Flower constancy
- No rental fees
- Insurance for honey bee shortages

Squash Bee

Honey Bee

Osmia rufa – Serbia, Spain, & Italy

Osmia cornifrons – Eastern US, Japan, & Korea

Osmia lignaria – Western US almonds & eastern US apple

Osmia cornuta – England & N. Europe

Osmia cornifrons - Japanese Hornfaced Bee

Honey Bee

- **80+ times more efficient at pollination of apples than HB.**
- 250 *Osmia*/acre vs. 25,000 honey bees.
- A single *Osmia* can visit 15 flowers/min, setting 2,450 apples/day compared to 50 flowers set by a honey bee.
- Have been shown to double yields of cherries.

The Xerces Society
for Invertebrate Conservation

Native bee conservation:
Enhance habitat: nest sites

- Nest traps,
- Tunnel nest sites







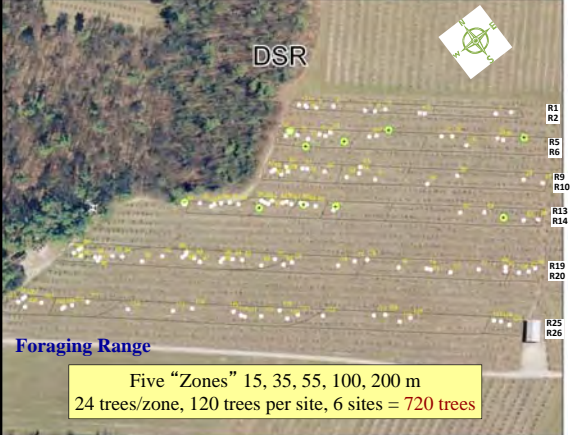

M.T. Frazier

Disadvantages of Native Bees

- Fly shorter distances
- Small colony size
- What species we have & how effective?
- Other parasites & natural enemies
- Commercially available only in limited numbers & difficult to move
- Populations of individual species fluctuate yearly.

M.T. Frazier

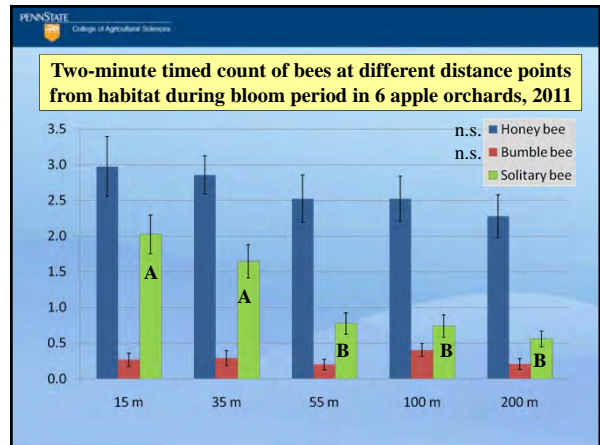


DSR

R1
R2
R5
R6
R9
R10
R13
R14
R17
R20
R25
R26

Foraging Range

Five "Zones" 15, 35, 55, 100, 200 m
24 trees/zone, 120 trees per site, 6 sites = 720 trees




Lerew Farm
100 acre

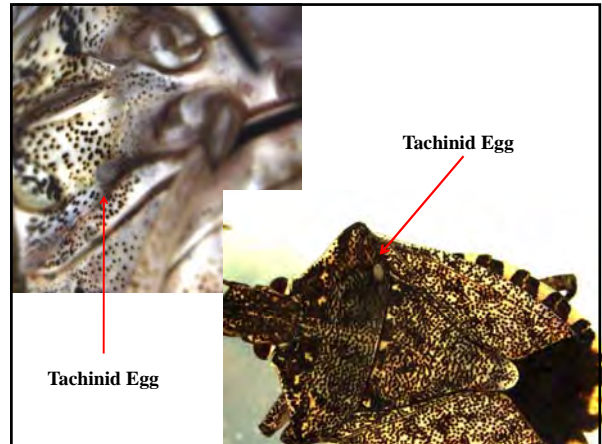
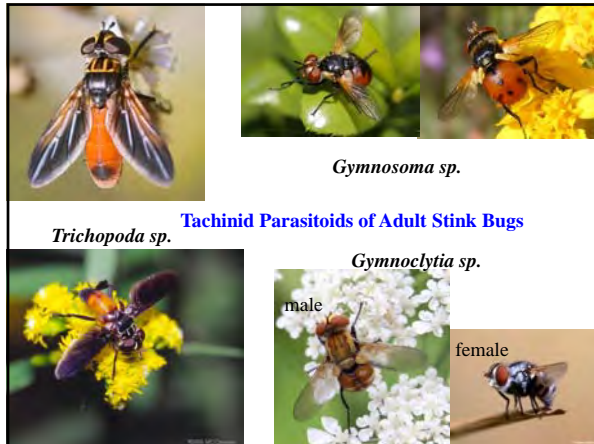
The Xerces Society
for Invertebrate Conservation

Native bee conservation:
Enhance habitat: forage

USDA-NRCS Pollinator Planting Program

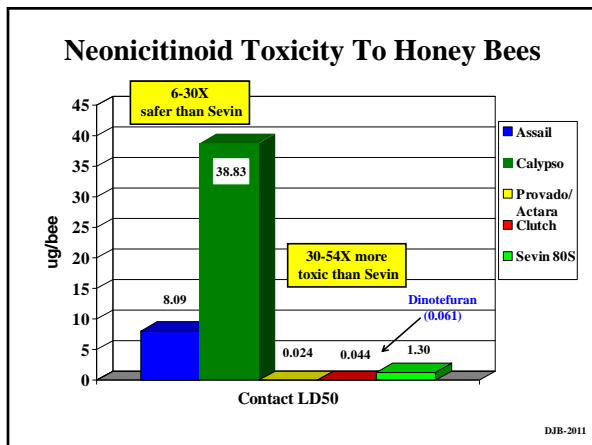
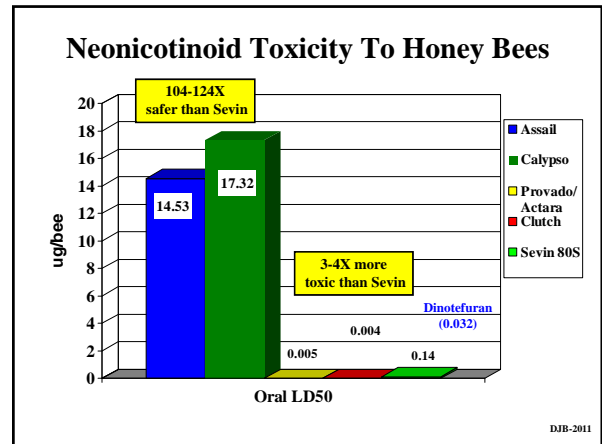


150+ acres with 22 growers



ARE NEONICOTINOIDS KILLING BEES?
A Review of Research into the Effects of Neonicotinoid Insecticides on Bees, with Recommendations for Action

- 44 page Xerces Society review of all studies on neonic impacts on bees.
- Most studies on honey bees, with a few on *Bombus*, and very few on solitary bees.
- Separate studies based on crop and method of application.
 - Seed treated field crops not pollinated by bees
 - Horticultural foliar applications
 - Ornamental and turf overdose applications
- How prophylactic applications negate IPM principles.



Honey Bee/Osmia Bioassays w/ Formulated Insecticides – Biddinger et al. 2011

Insecticide	Species	No. Tested	LC50 (ug/bee)	LC Ratio (*P=0.05)
Assail	Honey Bee	245	64.6	
	Osmia	242	5.2	- 12.3X*
Imidan	Honey Bee	250	1.9	
	Osmia	254	6.1	+ 3.3X*
Provado	Honey Bee	310	0.15	
	Osmia	522	3.82	+ 26.1X*
Warrior	Honey Bee	360	0.30	
	Osmia	466	0.91	+ 3.0X*
Dimethoate	Honey Bee	450	0.31	
	Osmia	156	0.09	- 3.7X*

Take Home Messages

- No silver bullet cure for CCD – complex problem w/ multiple factors
- Look at wild bees as a supplement to HB or replacements in some cases
- Maintain fencerows and habitat adjacent to orchards for bees
- A diverse community of native bees can provide significant crop pollination

• Consider bees with pesticide selection!!

© Mike Vaughan, Xerces Society

USDA-RAMP
State Horticultural Association of PA
USDA-SCRI
USDA-SCRI CAPS
Rick Donovan – PDA
Jim Gillis – PA NRCS

Amanda Ritz, Melanie Kammerer,
Katie Ellis, Lot Miller, Jin Li,
Nelia Scott, Jason & Kara Fissel

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Why Develop New Pollinator Habitat?

Bees Need Pollen and Nectar Before and After Crop Bloom

- Example: flight periods of native bees in relation to blueberry bloom.

TAXA	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT
Plaster Bees (<i>Colletes inaequalis, validis</i>)							
Mining Bees (<i>Andrena</i> spp.)							
Green Sweat Bees (<i>Augochlora pura</i>)							
Green Sweat Bees (<i>Augochlorella striata</i>)							
Sweat Bees (<i>Halictus</i> spp.)							
Sweat Bees (<i>Lasioglossum</i> spp.)							
Mason Bees (<i>Osmia</i> spp.)							
Bumble Bees (<i>Bombus</i> spp.)							

© Data from Steve Javorek, Agriculture Canada
 Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Honey Bees: Natural Habitat Case Study

Example: Honey Bee Health

- Honey bees also need habitat
- Diverse wildflower diets enhance honey bee disease resistance

Photo: Eric Mader, Toby Alexander

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION The Habitat Assessment Process

Assessing a Site or Landscape for Value to Pollinators

- Xerces' *Pollinator Habitat Assessment Form and Guide*
- A subjective tool
- Quantify characteristics
 - Landscape-level
 - Site-level

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Purpose:

- Educate user (landowner and/or conservationist)
- Prioritize conservation actions
- Quantify habitat or management improvements on a single farm

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 1: Landscape Features: Percent of Natural Habitat Around the Farm

1a. Percent of natural or semi-natural vegetation within 1/2 mile of project area (whether on or off farm). This land use cover includes, prairie, shrub lands, woodlands or old fields, riparian habitat and wetlands, suburban wooded areas, non-invasive weedy areas. It does NOT include lawn grass, or over-grazed pasture.

The photos below illustrate the different percent covers.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score (on treatment off farm)
>50%	1.0			
20% - 50%	0.7			
7% - 20%	0.3			
<7%	0			

Subtotal (1a)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 1: Landscape Features: Dominant Type of Vegetation

1b. Dominant vegetation in non-cropped area within 1/2 mile of project area (whether on or off farm).

SELECT ONLY ONE	Score	Before	After	Treatment to increase score (on treatment off farm)
Flower plants	1.0			
Mix of native and naturalized, non-corn/soy/alfalfa	0.7			
Non-corn flowering species (e.g., alfalfa)	0.5			
Non-corn flowering weeds	0			
End-forming grasses	0			

Subtotal (1b)

Landscape Features: Total (1a + 1b)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 2: Farmscape Features: Amount of Habitat on the Farm

2a. Percentage of farm that is in natural or semi-natural habitat (see 1a for examples)

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
10% or more	1.0			
5% - 9%	0.7			
1% - 4%	0.5			
0% - 0%	0			
Subtotal (2a)				

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 2: Farmscape Features: Additional Farm Features

2b. Additional farmscape features.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Perennial meadow with diverse wildflowers	1.0			
Buffers: 1 foot for every 20% of area within 2' feet of water features (e.g. streams, ponds, ditches, ponds, etc.) that is required	0-0.5			
Hedges, windbreaks, or fences with diverse tree/shrub species (not just oaks)	0.5			
Annual flowering cover crops allowed to bloom, except bare fallow, bedding crops	0.5			
Presence of clean surface water (non-contaminated) during growing season	0.5			
Sum all scores above for total (2b)				
Farmscape Features Total				

← (2a + 2b) →

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 3: Foraging Habitat Overall vegetative cover

3a. Percentage of vegetative cover (non-crop area) that is forbs or flowering shrubs* on farm.
The photos below illustrate some categories. See regional technical notes (link on page 8) for lists of preferred pollinator plants and other information.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
> 50% cover	1.0			
45% - 49% cover	0.7			
35% - 44% cover	0.5			
20% - 34% cover	0.3			
< 20% cover	0.1			
Subtotal (3a)				

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 3: Foraging Habitat Spring, Summer, and Fall Blooming Plants

3b. Number of species of forbs and flowering shrubs on farm that bloom in spring and support bees. This includes some crops and cover crops and does not include invasive or noxious species (see references section for examples).

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>= 5 species	1.0			
3 - 4 species	0.5			
1 - 2 species	0.3			
0 species	0			
Subtotal (3b)				

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 3: Foraging Habitat Spring, Summer, and Fall Blooming Plants

3c. Number of species of forbs and flowering shrubs on farm that bloom in summer and support bees. This includes some crops and cover crops (see references section for examples).

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>= 5 species	1.0			
3 - 4 species	0.5			
1 - 2 species	0.3			
0 species	0			
Subtotal (3c)				

3d. Number of species of forbs and flowering shrubs on farm that bloom in fall and support bees. This includes some crops and cover crops (see references section for examples).

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>= 5 species	1.0			
3 - 4 species	0.5			
1 - 2 species	0.3			
0 species	0			

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Pollinator Habitat Assessment Guide

Section 4: Nesting Habitat Ground-nesting bees

4a. Sites for ground-nesting bees.
Ground-nesting bees are often marked by a small mound of excavated soil, but may also be nesting even when a small hole in the ground. Bees may be dug to have soil, areas of patchy vegetation, or hollow among plants, including at the base of crop plants such as squash. They are usually in emergent areas such as ditch banks or trash piles, and frequently can be found close to buildings or other structures. (If you believe you have a nest place.)

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Areas of farm with suitable, well-drained bare ground, or with sparse vegetation	A=0.5, M=0.1, S=0.1 (A=0.25%, M=0.25%, S=0.25%)			
Areas with empty to sandy bases and	A=0.5, M=0.1, S=0.1 (A=0.25%, M=0.25%, S=0.25%)			
1 foot for every 10% of area established on farm or ranch	0-1.0			
Areas with bare but compacted soil, or scattered soil (ground only, ground=0.5)	0.5			
Sum all scores above for total (4a)				

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Pollinator Habitat Assessment Guide**

Section 4: Nesting Habitat

Wood- and Cavity-nesting bees

4b. Sites for wood- and cavity-nesting bees.
The great majority of wood- and cavity-nesting bees do not excavate their own nests; they occupy pre-existing tunnels or cavities in wood. The location of piping (horizontal) should be in both piles. Bees do not frequently nest in individual wood borers or similar camp-forming wood grubs. (Photos below illustrate some such cases.)

SCORE ALL OPTIONS THAT APPLY

Score	Before	After	Treatment to increase score
A = 0-2 M = 0-3 S = 0-1 (A = 0 or more, M = 2 to 4, S = 0 to 1)			
A = 0-3 M = 0-3 S = 0-1 (A = 0 to 20 plants, M = 0 to 5 plants)			
A = 0-3 M = 0-3 S = 0-1 (A = 0 to 20%, M = 0 to 20%, S = 0 to 1)			

Sum all scores above for individual sites

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Pollinator Habitat Assessment Guide**

Section 5: Farm Practices

Pesticide use practices

5a. Use of pollinator-toxic pesticides

SCORE ALL OPTIONS THAT APPLY

Score	Before	After	Treatment to increase score
0-1 (No use of insecticides (excluding organic-approved products))			
1-2 (If that program is in place that specifically addresses pollinator pesticides)			
0-2 (No use of fungicides)			
0-2 (If insecticides are used, sprayed only outside of flight)			
0-2 (If insecticides are used, sprayed only outside of crop life management)			
0-2 (If insecticides are used, spray with carefully restricted)			
0-2 (If insecticides are used, avoid application of spray equipment)			

Sum all scores above for individual sites

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Pollinator Habitat Assessment Guide**

Section 5: Farm Practices

Land management

5b. Land management techniques on the farm or in project area

SCORE ALL OPTIONS THAT APPLY

Score	Before	After	Treatment to increase score
1-6 (Mowing, weeding, or tilling in less than 1% of area each year)			
1-6 (Creating piles that encourage wildflower diversity/abundance)			
0-2 (No disturbance or cultivation of field borders)			

Sum all scores above for individual sites

Farm Practices Total (5a + 5b)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Pollinator Habitat Assessment Guide**

Sum it all up...

Total Score for Habitat Assessment
 The figures entered into this summary table will be calculated during completion of the assessment.

	Before	After
Section 1: Landscape Features (max score 2.0)		
Section 2: Farmscape Features (max score 3.5)		
Section 3: Foraging Habitat (max score 4.0)		
Section 4: Nesting Habitat (max score 3.8)		
Section 5: Farm Practices (max score 8.0)		
OVERALL SCORE		

Module 5: Habitat Restoration

Photo: Larry K. Altman

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Why Develop New Pollinator Habitat?**

Habitat restoration for sustained pollination

- Diversify pollinators for agriculture
- To strengthen habitat and pesticide protection for all bees (honey and native)

Photo: Bob Hammond, CSU Coop Ext.

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Why Develop New Pollinator Habitat?**

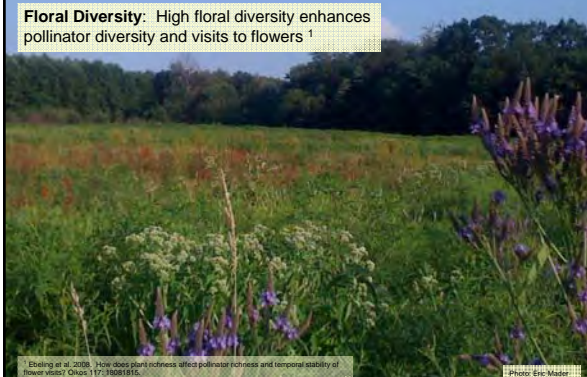
The value of natural areas
The amount of natural habitat on or close to the farm has a direct influence on pollinator diversity and abundance



Photos: Paul Jepson, Bruce Neerhouse

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bees Need Floral Diversity**

Floral Diversity: High floral diversity enhances pollinator diversity and visits to flowers¹



Ebeling et al. 2008. How does plant richness affect pollinator richness and temporal stability of flower visits? Oikos 117: 1808-1815.

Photo: Eric Mader

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Installation Guides**

Xerces Habitat Installation Guide www.xerces.org


- Conservation Cover (wildflower meadow)
- Hedgerow Planting
- Guides for PA and other regions of the U.S.
- Many other practices can include benefits to pollinators



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Installation Guides**

Site specific considerations:

- Plant selection
- Site Preparation
- Planting
- Short-term management
- Long-term maintenance



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Plant Selection**

Important considerations for plant selection

- Native, perennial species
- Succession of bloom
- Site appropriate
- Documented quality nectar and pollen source



Photo: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Best Plants for PA**



Pollinators need a succession of bloom: spring, summer, and fall

Photos: Elaine Hays NRCS, Marissa Shuchart-Marco USGS, Eric Mader, Jan McMillan NRCS, Barry Truitt's Garden, Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Hedgerow Planting**

A combination of native herbaceous and woody species for pollinators



Snyder Farm, NJ

Photo: Jake Golobetz Deitz

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Site Characteristics**

Key site characteristics

- Weed pressure
- Soil type, drainage
- Pest Management
- Placement



Former crop field




07/17/2010 14:30


THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Restoring Pollinator Habitat: Site Characteristics**

Key site characteristics

- Weed pressure
- Soil type, drainage
- Pest Management
- Placement



Overgrown, unmanaged area



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Seeding New Habitat: Keys to Success**

Seeding new wildflower meadows

- Remove weeds prior to planting
- Do not disturb dormant weed seed
- Make a clean seed bed
- Use appropriate planting technology
- Plant seed during the dormant season (usually)
- Manage weeds




Photos: Joe Fahay and Don Keenstead

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Site Prep: Remove Weeds Prior to Planting**

Site preparation for conventional farms:

Chemical fallow (glyphosate) for a full growing season



Photo: Erinna Borenstein

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Site Prep: Remove Weeds Prior to Planting**

Site preparation for organic farms:

- Treatment for at least 1 year
- (Tillage trials are ongoing but have demonstrated limited success)

Solarization



Photo: Nancy Adamsport

Smother crop (Buckwheat)



Horticultural vinegar (20% acetic acid)



Photo: Joe Fahay

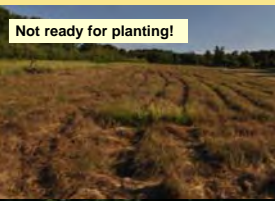
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Seeding: Create a Clean Seed Bed

Seed bed Preparation:

- Burn or rake off debris
- Light harrowing is ok – deep tillage is not!
- Do not to bring more dormant weed seeds to the surface!

Not ready for planting!



Ready for planting!




Photo: Mike Vaughan Photo: Don Keistead

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Seeding: Preparing the Seed Mix

Preparing to Seed:

- Plant in the dormant season
- Bulk up the seed mix with an inert carrier (e.g. sand) – for broadcasting





Photo: Brian Borders

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Seeding: Appropriate Technology

Use the seeding technology that you have

- Native Seed Drills
- Brillion Drop Seeder
- Broadcast Seeder/Spreaders
- Hand Seeding














Photo: Nancy Adamson Photo: Jesse Guisti Photo: Matthew Sheppard

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Seeding: Appropriate Technology

Hand Seeding/Broadcasters

- Seed bulked inert material for even distribution
- Requires clean, exposed seed bed
- Seed on soil surface – Do not bury the seed






Photo: Nancy Adamson Photo: Jesse Guisti Photo: Matthew Sheppard

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Short Term Habitat Management

Immediately After Seeding:

- Roll seed into soil surface



Photo: Don Keistead

The Year After Seeding:

- Weed treatments as needed
 - Grass-selective herbicides
 - Mow to prevent annual weeds from re-seeding
 - Hand weeding!

Mow the wild radish to find...



wildflower seedlings underneath!



Photo: Don Keistead Photo: Don Keistead

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Post Seeding: Ensuring Success

Post Seeding: Mow perennial seeded areas first and second year, before annual and biennial weeds produce seed

Mow when between 10–12" to 6–8" (as often as needed) to let light reach new seedlings w/o smothering

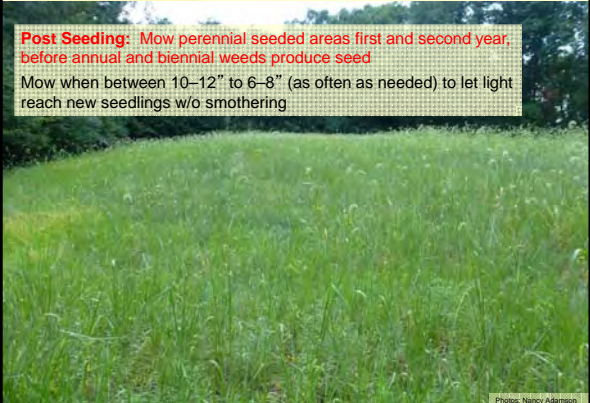


Photo: Nancy Adamson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Landscape Plugs, Shrubs, and Trees

Transplants:

- Supplemental irrigation
- Mulch / Fabric
- Animal guards
- Mechanical transplanters






Photo: Shook, University of Maryland

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Landscape Plugs, Shrubs, and Trees



Cape May PMC, NJ

Photo: Jolie Galsworthy Doty

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Landscape Plugs, Shrubs, and Trees




Snyder Farm, NJ

Photo: Jolie Galsworthy Doty

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Habitat Restoration: Shrubs and Wildflowers

A combination of native herbaceous and woody species for pollinators



Snyder Farm, NJ

Photo: Jolie Galsworthy Doty

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Managing Habitat: Considerations

Long Term Habitat Management

- Tree encroachment
- Herbicides
- Mowing, Fire, and Grazing



Photo: Whitney Greenhaw (Colorado State University)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Managing Habitat: Tree Encroachment

At sites where trees or shrubs are encroaching, they should be removed as soon as possible, before they grow larger and reproduce.




Photo: Toby Anderson

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Managing Habitat: Herbicides

When applied with care, herbicides can be a useful habitat management tool.

However, they can also dramatically change plant communities and decrease the usability of habitat for pollinators.

Focus on spot treatment

Photo: USDA-NRCS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Managing Habitat: Limit Disturbance

Mowing, grazing, burning, disking are best at infrequent intervals

- Disturbance to no more than 1/3 of habitat area each year
- Time management for when most effective against target, or during dormant season
- Early successional habitat is ideal; too much disturbance favors grasses over forbs

Photo: USDA-ARS, Auburn, California

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Developing New Nest Habitat: Ground Nests

A lack of nest sites is a constraint on bee populations in many areas

Photo: David Walsh, WSU

Nests of alkali bee, *Nomia melanderi*, in western Colorado

Photo: Bob Hammond, CO Coop Ext

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Developing New Nest Habitat: Ground Nests

Ground-Nesting Bees Need:

- Access to bare, sandy soil
- Areas without tillage
 - Mulch or landscape fabric?

Photo: Matthew Sheppard

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Developing New Nest Habitat: Bumble Bees

Bumble Bees Build Nests in:

- Cavities such as old rodent holes
- Overgrown areas
- Under brush piles
- Under bunch grasses
- Artificial nests are ineffective

Conserve un-mowed areas

Photo: Mark Vignelli, Northern California, Sonoma County

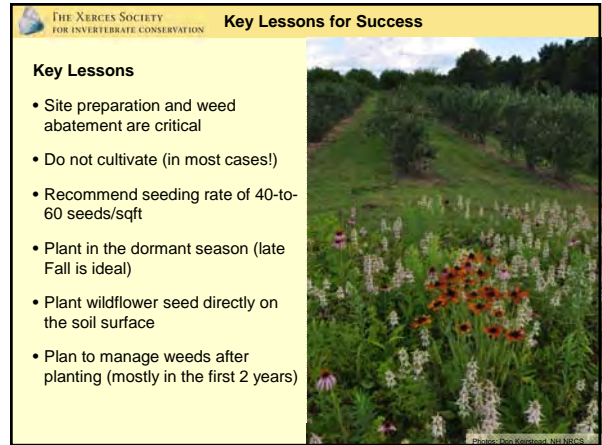
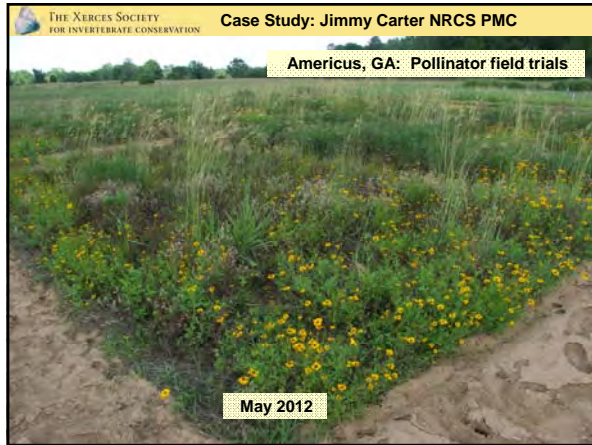
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

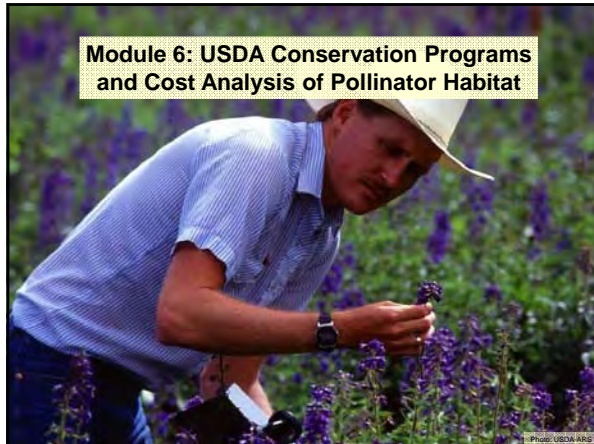
Recognize Habitat: Wood-Nesting Bees

Wood-Nesting Bees Use:

- Snags, stumps, and brush piles
- Hollow or pithy plant stems (e.g. box elder, elderberry, cane fruit)
- Artificial nests?

Photo: Eric Moller, Kalmiowa Uman





THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **2008 Farm Bill: Pollinator Habitat Provisions**

2008 Farm Bill

- Makes pollinators a priority for every USDA land manager and conservationist
- Identifies pollinator habitat as a priority for EQIP
- Requires that pollinators are considered in the review of Practice Standards
- Encourages the inclusion of pollinators in all USDA conservation programs

Photo: Katharina Ullrich

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Farm Bill Implementation: Practices for Pollinators**

USDA Natural Resources Conservation Service (NRCS)

Technical and Financial Assistance Programs:

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

Practices for Pollinators

- Conservation Cover
- Field Border
- Hedgerow Planting
- Upland Wildlife Habitat Management
- Tree/Shrub Establishment
- Cover Cropping
- Pest Management

Technical Note No. 78
 USDA National Conservation Service
Using Farm Bill Programs for Pollinator Conservation
 April 2008

Photo: USDA-ARS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Conservation Cover Practice Standard (327): Establish permanent vegetation (adjacent to agricultural fields or beneath perennial crops)

Photo: Eric Mader and Don Kierstead

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Field Border Practice Standard (386): Can include a diverse mix of native and low cost non-native plants

Photo: USDA-NRCS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Hedgerows Practice Standard (422): Plant a succession of flowering shrubs (can be designed for multiple benefits, e.g. screening)

Photo: Ranier Long (UC Davis, Coop Ext.)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Filter Strip Practice Standard (393): Use pollinator plants to control run-off and reduce erosion along streams and ditches.

Photo: Katharina Ulman (UC Davis)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Cover Crop Practice Standard (340): Can include diverse flowering forbs such as clover, mustard, buckwheat, phacelia, or partridge pea.

Photo: Eric Medler

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Cover Crop Practice Standard (340)

Buckwheat
(*Fagopyrum esculentum*)

Partridge Pea
(*Chamaecrista fasciculata*)

Lacy Phacelia
(*Phacelia tanacetifolia*)

Photo: David Borchert (Purdue University) & Eric Medler (The Xerces Society)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Critical Area Planting (342): Establishes permanent vegetation on highly erodible sites

Photo: Eric Medler (Xerces Society)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practices**

Herbaceous Weed Control (315) Oregon Example

Before: Non-native grasses killed along fenceline

After: Replanted with native forbs

Photo: William Woodley

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Practice**

Integrated Pest Management Practice Standard (595):


- Protecting pollinators from pesticides
- Establishing habitat for other beneficial insects

Photos: David Borchert (Purdue University), Eric Medler (The Xerces Society), and William Woodley

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Planning Example**

Diversified Organic Farm

- 24 Acres
- Fruits and vegetables
- Conventional farm neighbors
- Potential resources concerns
 - Pollinators
 - Pest management
 - Avoiding drift
 - Weed control in fallow ground



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **NRCS Conservation Planning Example**


NRCS Practices

Field Border
Diverse native forb plantings

Hedgerow
Diverse flowering native shrubs

Cover Crop
Phacelia tanacetifolia, crimson clover, buckwheat

Conservation Cover
Mixture of low cost native and non-native forbs




THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Farm Bill Implementation: CRP**

Conservation Reserve Program (CRP)
Administered by the USDA Farm Service Agency with technical assistance from NRCS

Pollinator Initiative (CP 42)

- 10% of acreage in parcels of pollinator-friendly shrubs, forbs, legumes, or
- At least 1 acre for CRP acreage less than 10 acres
- Pollinator parcels must be at least 20 feet wide
- Parcels must have a minimum of 9 species with at least 3 blooming species for each growing season
- Should be primarily natives
- No more than 25% grasses in pollinator parcels



Questions?



Photo: Marco Vaughan

Module 7: Additional Resources

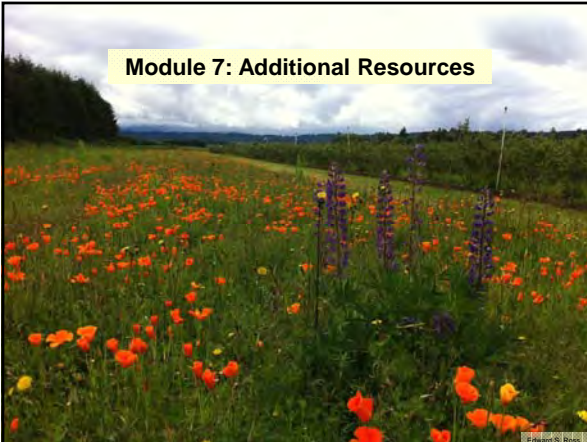


Photo: USDA-NRCS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Additional Resources: The USDA-NRCS**

The USDA Natural Resources Conservation Service

- Technical Assistance
- Financial Support for Conservation

Find out more at: www.nrcs.usda.gov




Photo: USDA-NRCS, USDA-ARS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Penn State Center for Pollinator Research

Penn State Center for Pollinator Research

Center for Pollinator Research

AgSci » Entomology » Center for Pollinator Research » Public Outreach

Public Outreach

The Center for Pollinator Research is committed to providing timely and accurate information to the public on pollinator conservation and management. We are in the process of developing information and data sheets to support our outreach mission. These activities are funded in part by a generous donation from Haagan Ozzes.




Penn State Pollinator Programs

- Pollinator Gardens in Centre County Pennsylvania
- Beekeeping 101
- Native Pollinators
- Pollinator Garden Certification Program

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Further Information: the Xerces Society

- Xerces Society publications
- www.xerces.org



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Further Information: Publications

You will be taking this book home with you.

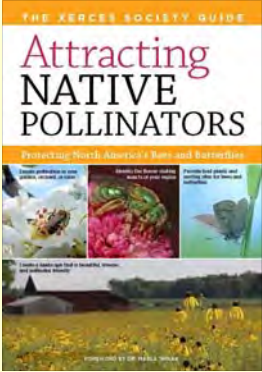
"Attracting Native Pollinators belongs on the bookshelf of everyone who values the future of the natural world."

- Douglas W. Tallamy, researcher and author of *Bringing Nature Home*

"Precise, elegant and thoughtful, the recommendations offered by the Xerces Society will become essential to advancing a healthy and diverse food production system."

- Gary Nabhan, author of *The Forgotten Pollinators* and *Renewing America's Food Traditions*

www.xerces.org/store



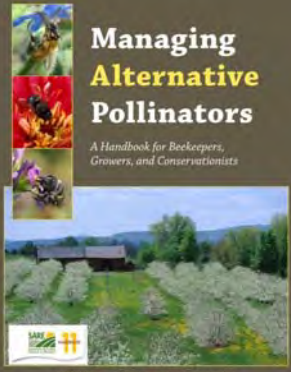
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Further Information: USDA-SARE

Sustainable Agriculture Research and Extension

New Managing Alternative Pollinators Handbook

- Bumble bee, mason bee, and leafcutter bee management methods
- Native bee conservation
- Now available!

www.sare.org or www.xerces.org/store




THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Further Information: Xerces Report

ARE NEONICOTINOIDS KILLING BEES?

Neonicotinoid Report

- Outlines threats to honey bees, bumble bees, and solitary bees
- Provides recommendations to land owners/managers on how to better protect bees
- Provides recommendations to regulators and researchers on how to assess the bee safety of systemic products

<http://www.xerces.org/pesticides>



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION Further Information: The Xerces Society

Xerces Habitat Installation Guides

Wildflower meadow and hedgerow installation guidelines for multiple regions of the U.S.


www.xerces.org



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Conserving Bumble Bees**

Conservation Guidelines for Landowners and Managers

- Outlines threats
 - Habitat Fragmentation
 - Pesticides
 - Grazing
 - Pests and Diseases
- Provides clear management recommendations to create high quality bumble bee habitat
- Gives regionally specific plant recommendations for bumble bees
- Contains regional bumble bee ID guides



Conserving Bumble Bees
Guidelines for Creating and Managing Habitat for America's Declining Pollinators

With updated terms, new color photos, and additional text and illustrations
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bumble Bee Citizen Monitoring Project**

WANTED FOR POLLINATION OF CROPS AND WILDFLOWERS

PLEASE PARTICIPATE IN THE XERCES SOCIETY BUMBLE BEE WATCH CITIZEN MONITORING PROJECT!

1. Take a pocket identification guide for the species that occurs in the region where you live
2. Look for bumble bees in the spring, summer and fall
3. If you spot a target species, email a photo to bumblebees@xerces.org

For more information, visit: www.xerces.org/bumblebees



WESTERN BUMBLE BEE A.K.A. *BOMBUS OCCIDENTALIS*

IF YOU HAVE SPOTTED THIS SPECIES PLEASE CONTACT info@xerces.org


THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Further Information: Resource Center**

Pollinator Conservation Resource Center

Region-specific Information from Xerces, Cooperative Extension, USDA-NRCS, NGO, and other sources, including:

- Regional plant Lists
- Conservation Guides
- Nest construction guides
- Links to identification guides
- Pesticide Guidelines
- Native Plant Nursery Directory

www.xerces.org/pollinator-resource-center




Pollinator Conservation Resource Center

UC DAVIS NRCS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Looking Ahead: Ecological Pest Management**

New USDA-NRCS Technical Guide

- Managing Habitat for Predators of Crop Pests
- Available soon



Conservation Biological Control
Providing habitat for predators and parasitoids of crop pests

USDA NRCS

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Looking Ahead Ecological Pest Management**

New book on Ecological Pest Management coming soon!

Storey Publishing
July 2014



Attracting NATIVE POLLINATORS
Coming soon:
Ecological Pest Management

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Native Plant Database**

Lady Bird Johnson Wildflower Center Recommended Species:

<http://wildflower.org/collections/>

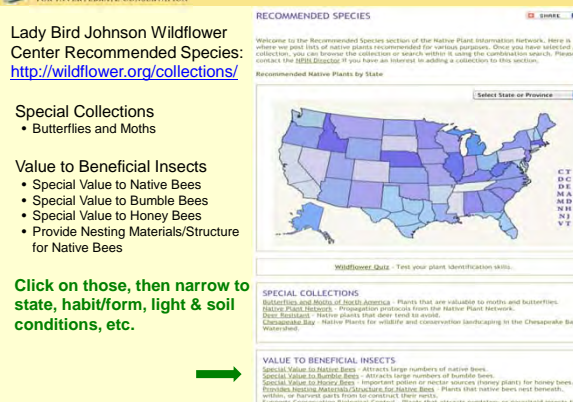
Special Collections

- Butterflies and Moths

Value to Beneficial Insects

- Special Value to Native Bees
- Special Value to Bumble Bees
- Special Value to Honey Bees
- Provide Nesting Materials/Structure for Native Bees

Click on those, then narrow to state, habit/form, light & soil conditions, etc.



RECOMMENDED SPECIES

Welcome to the Recommended Species section of the Native Plant Information Network. Here is where we post lists of native plants recommended for various purposes. Once you have selected a collection, you can browse the collection or search within it using the combination search. Please contact the help@wildflower.org if you have an interest in adding a collection to this section.

Recommended Native Plants by State

Select State or Province

Wildflower Quiz - Test your plant identification skills.

SPECIAL COLLECTIONS

Butterflies and Moths of North America - Plants that are valuable to moths and butterflies.

Native Plant Society - Propagation projects from the Native Plant Network.

Chesapeake Bay - Native plants that grow near the coast.

Chesapeake Bay - Native plants for wildlife and conservation (participating in the Chesapeake Bay Watershed).

VALUE TO BENEFICIAL INSECTS

Special Value to Native Bees - Attracts large numbers of native bees.



Special Value to Bumble Bees - Attracts large numbers of bumble bees.

Special Value to Honey Bees - Important pollen or nectar sources (many plants for honey bees).

Special Value to Native Bees - Plants that have been used for nesting, food, or harvest parts (not to construct their nests).

Special Value to Native Bees - Plants that attract predatory or parasitoid insects that prey on pest insects.

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Project Integrated Crop Pollination**

Project ICP is evaluating the performance and economics of multiple pollination strategies in fruit and vegetable crops across the U.S.

Learn more at www.icpbees.org

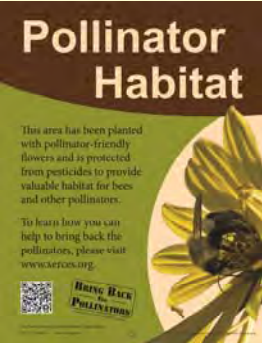
BRING BACK THE POLLINATORS
A Xerces Society Conservation Campaign



THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Bring Back the Pollinators Pledge**

To bring back the pollinators, I will:

- Grow a variety of pollinator-friendly flowers which bloom from spring through fall.
- Protect and provide bee nests and caterpillar host plants.
- Avoid using pesticides, especially insecticides.
- Talk to my neighbors about the importance of pollinators and their habitat!



Habitat signs available: \$25-30

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Take Home Message: What's old is what's new?**

GROW MORE LEGUME SEED With Pollinating Insects

These bees have been in our legume fields for years... They are making money for the farmer who harvests legume seed.

Legume and yield generally have been reduced to about one-fourth of what they once were. Lack of pollinating insects is the main reason. Yields show that you can increase seed yield 3 to 15 times if you have enough bees.

Legume seeds are badly needed for machine seedage in soil conserving crop rotation and pasture improvement. All of the following legumes are greatly benefited by insect pollination:

Alfalfa	Lucerne clover	Swainson	Red clover
Alfalfa clover	Red clover	White clover	Hairy vetch

WILD BEES ARE GOOD POLLINATORS

Years ago wild bees did most of the pollinating. But intensive cropping, cleaning up of fence rows, and uncontrolled burning have destroyed their homes and greatly reduced their number. Wild bees are the most efficient pollinators, especially for alfalfa.

You can increase the number of wild bees on your farm by protecting the following kinds of land from grazing and burning:

Drainage ditch banks	Fence rows	Field borders	Odd areas
Pond areas	Shelterbelts and windbreaks	Streambanks	Wood lots

FARMER HARVESTS SEED → **PLANTS** → **LIVING FENCE**

RED CLOVER ← **POLLINATE** ← **HABITAT FOR BUMBLEBEES**

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service, Upper Mississippi Region, Milwaukee, Wis.
PA-126 Issued June 1950

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **What's Old is What's New?**

WILD BEES ARE GOOD POLLINATORS

Years ago wild bees did most of the pollinating. But intensive cropping, cleaning up of fence rows, and uncontrolled burning have destroyed their homes and greatly reduced their number. Wild bees are the most efficient pollinators, especially for alfalfa.

You can increase the number of wild bees on your farm by protecting the following kinds of land from grazing and burning:

Drainage ditch banks	Fence rows	Field borders	Odd areas
Pond areas	Shelterbelts and windbreaks	Streambanks	Wood lots

FARMER HARVESTS SEED → **PLANTS** → **LIVING FENCE**


RED CLOVER ← **POLLINATE** ← **HABITAT FOR BUMBLEBEES**

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service, Upper Mississippi Region, Milwaukee, Wis.
PA-126 Issued June 1950

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **What's Old is What's New?**

In 1938, Dr. Patch predicted that by the year 2000

...the President of the United States would issue a proclamation claiming that land areas at regular intervals throughout the U.S. would be maintained as "Insect Gardens," under the direction of government entomologists. These would be planted with milkweed, hawthorn, and other plants that could sustain populations of butterflies and bees. She predicted that some time in the future, "Entomologists will be as much or more concerned with the conservation and preservation of beneficial insect life as they are now with the destruction of injurious insects."



Dr. Edith Patch (1916) President, Entomological Society of America

Photo: The Friends of Edith Patch (www.edithpatch.org)

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Take Home Message**

Plant flowers... as native as possible.

Conserve nest sites.

Reduce pesticide use.




Photo: Mace Vaughan

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION **Thank You!!**

Special thanks to:
 Dave Biddinger and Christina Grozinger (Penn State University),
 USDA NIFA, and the USDA NRCS

Our financial support comes from:

- Xerces Society members
- USDA-NIFA SCR1 grant
- USDA-NRCS
- CS Fund
- Disney Worldwide Conservation Fund
- Endangered Species Chocolate
- Turner Foundation
- Whole Foods Market and its vendors



Contact information:
 Mace Vaughan, mace@xerces.org

www.xerces.org

