Newest Research on the Value of Habitat for Pest Management

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IPM Specialist

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Pollinator Conservation Specialist

Photo: Adam Varenhorst

The Xerces Society for Invertebrate Conservation

The Society conducts education, conservation, research, and advocacy to protect invertebrates and their habitat.

Photos: Don Keirstead; Paul Jepson; Dick Dewey

The Xerces Society: Education and Training

Education and Outreach

- Outreach to 45,000 professionals since 2008.
- Training in 50 U.S. states, Canada, Mexico, Europe, and Asia.

Photos: The Xerces Society

The Xerces Society: Restoration Ecology

Habitat Experts

- Habitat restoration specialists located in 10+ states.
- Supporting 250,000+ acres of habitat in the U.S. since 2008.
- Restored habitat for dozens of rare species.

Photos: The Xerces Society

The Xerces Society: Pollinator and Ag Biodiversity Team

Xerces Pollinator Team

- Staff in CA, MA, MN, NC, NE, NJ, OR, TX, VT, WI, WA
- Several joint Xerces / USDA-NRCS positions

Professional Backgrounds

- Beekeeping
- Farming
- Insect pest management
- Native seed production
- Conservation biocontrol
- Research entomology
- Restoration ecology
- Rangeland management

Photo from Xerces Society

The Xerces Society: Acknowledgments

USDA Natural Resources Conservation Service (NRCS)
Cascadian Farm
Ceres Trust
Cheerios
CS Fund
Disney Conservation Fund
The Dudley Foundation
Endangered Species Chocolate, LLC
Gaia Fund
General Mills
Irwin Andrew Porter Foundation
J.Crew
Minnesota Environment and Natural Resources Trust Fund
The Monarch Joint Venture
National Co+op Grocers
Nature Valley
Sarah K. de Coizart Article TENTH Perpetual Charitable Trust
Sustainable Agriculture Research and Education (SARE) program
Turner Foundation, Inc.
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U.S. Department of Agriculture National Institute of Food and Agriculture
Whole Foods Market and its vendors
Whole Systems Foundation
Xerces Society Members

Photo credit: Debbie Roos

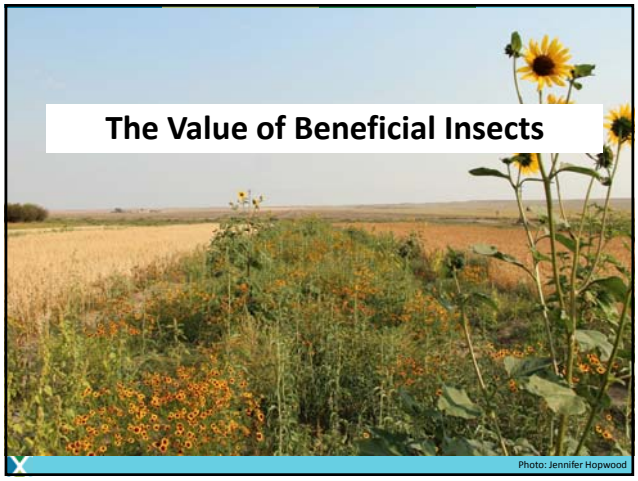


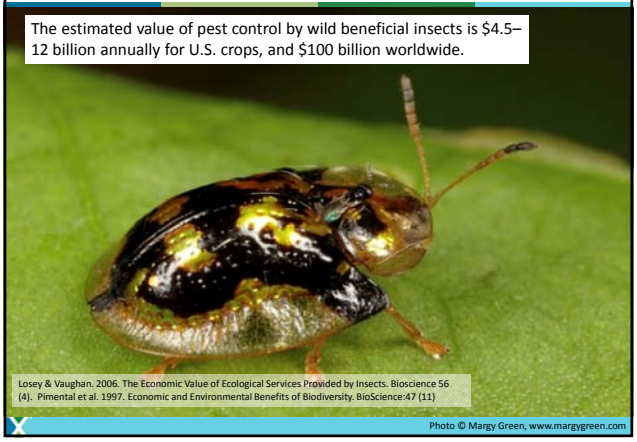
Photo: Jennifer Hopwood

The Value of Beneficial Insects

Photo: Nancy Adamson

The Value of Beneficial Insects

The estimated value of pest control by wild beneficial insects is $4.5–12 billion annually for U.S. crops, and $100 billion worldwide.



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)

Photo © Margy Green, www.margygreen.com

The Value of Beneficial Insects

The estimated value of pest control by wild beneficial insects is $4.5–12 billion annually for U.S. crops, and $100 billion worldwide.

Parasitoid wasp attacking a mottled tortoise beetle

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)

Photo © Margy Green, www.margygreen.com

The Value of Beneficial Insects

Conservation Biological Control

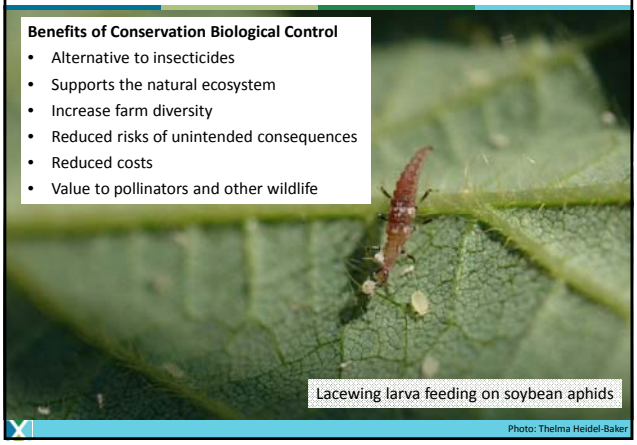
- Integrate beneficial insects back into crop pest management
- Provide what beneficial insects need

Photo: Thelma Heidel-Baker

The Value of Beneficial Insects

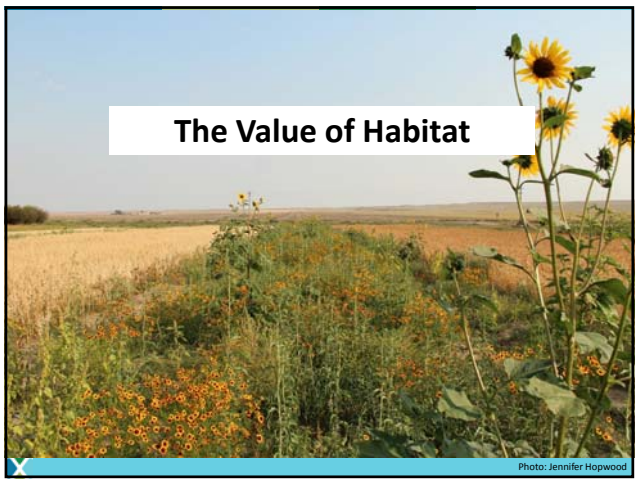
Benefits of Conservation Biological Control

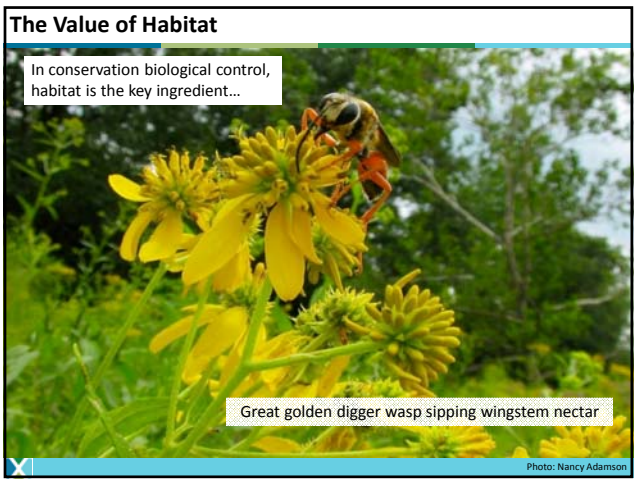
- Alternative to insecticides
- Supports the natural ecosystem
- Increase farm diversity
- Reduced risks of unintended consequences
- Reduced costs
- Value to pollinators and other wildlife

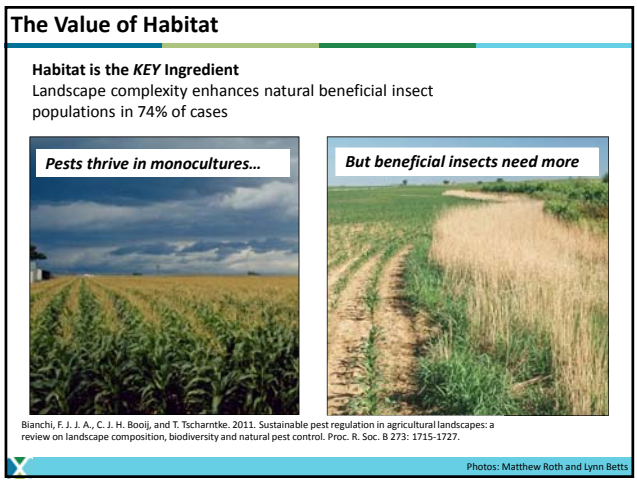


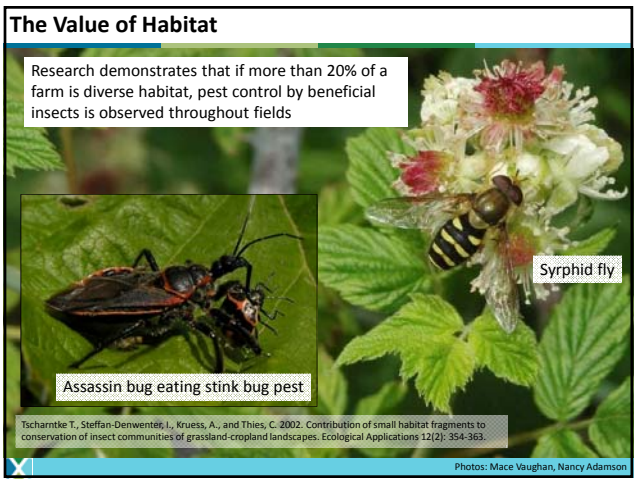
Lacewing larva feeding on soybean aphids

Photo: Thelma Heidel-Baker


The Value of Habitat
Photo: Jennifer Hopwood


The Value of Habitat
In conservation biological control, habitat is the key ingredient…
Great golden digger wasp sipping wingstem nectar
Photo: Nancy Adamson


The Value of Habitat
Habitat is the KEY Ingredient
Landscape complexity enhances natural beneficial insect populations in 74% of cases
Pests thrive in monocultures…
But beneficial insects need more
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.
Photos: Matthew Roth and Lynn Betts


The Value of Habitat
Research demonstrates that if more than 20% of a farm is diverse habitat, pest control by beneficial insects is observed throughout fields
Syrphid fly
Assassin bug eating stink bug pest
Tscharntke T., Steffan-Dewenter, I., Kruess, A., and Thies, C. 2002. Contribution of small habitat fragments to conservation of insect communities of grassland-cropland landscapes. Ecological Applications 12(2): 354-363.
Photos: Mace Vaughan, Nancy Adamson

The Value of Habitat

Natural Habitat Provides:

Food sources (pollen & nectar; alternate prey)

Shelter (over-wintering and egg-laying)

Refuge (protection from pesticides)

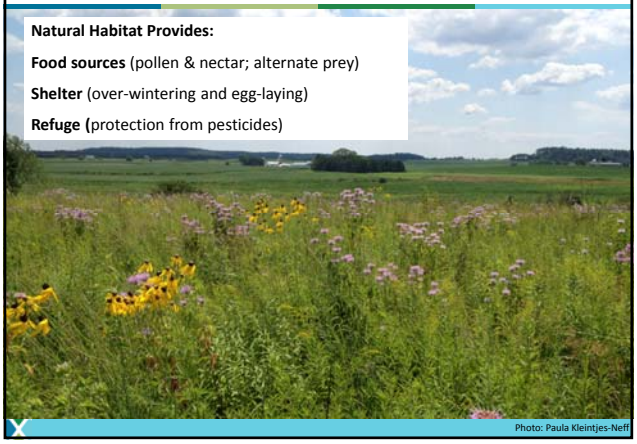
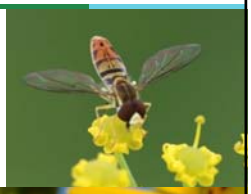


Photo: Paula Kleintjes-Neff

The Value of Habitat

Habitat: Alternate Food

- Many predatory insects eat pollen or nectar when prey are not available
- Some switch diets depending on their life stage



Lady beetle eating pollen

Predatory wasp and fly on cupplant flower

Photos: Adam Varenhorst, Thelma Heidel-Baker

The Value of Habitat

Predators need food…even when pests aren't present

Lady beetle larva on milkweed eating oleander aphid (not a crop pest)

Photo: Alex Wild

The Value of Habitat

Habitat: Shelter

Location for over-wintering & egg-laying

Lacewing eggs

Nesting Isodontia wasp (grasshopper hunter)

Photos: insecte.org; Alex Wild

The Value of Habitat

Habitat benefits extend to other wildlife

- Quality of field edge habitat can influence bird diversity and abundance
- Presence of birds provided significant control of weevil pests in California alfalfa fields

Red-winged blackbird

Savannah sparrow eating insects

Kross, et al. 2016. Field-scale habitat complexity enhances avian conservation and avian-mediated pest-control services in an intensive agricultural crop. Agriculture, Ecosystems and Envt. 225:140-149.

Photo: Stan Lupo (flickr-CC), Elizabeth Pector (flikr-CC)

Beneficial Insects

Photo credit: Susan Ellis, bugwood.org

Beneficial Insects

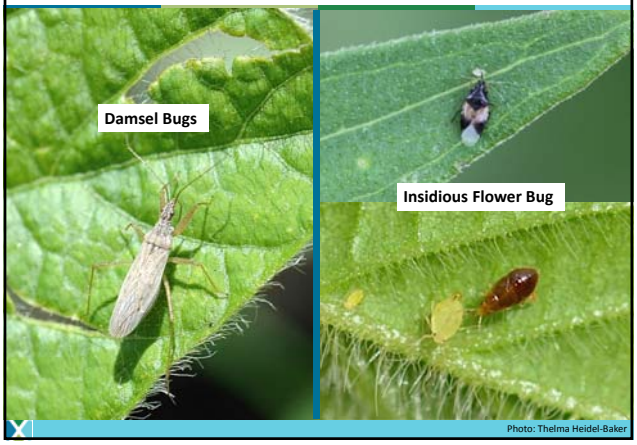
Lacewings

Lady Beetles

Parasitoid Wasps

Photo: Sarah Foltz Jordan, Thelma Heidel-Baker, Alex Wild, David Cappaert (Bugwood.org)

Beneficial Insects



Damsel Bugs

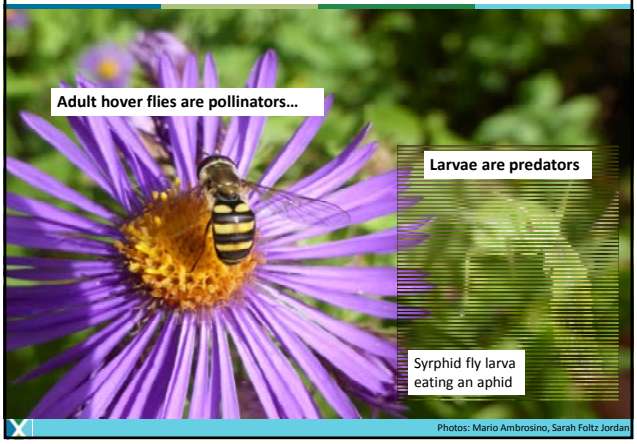
Insidious Flower Bug

Photo: Thelma Heidel-Baker

Beneficial Insects

Photo: Adam Varenhorst and Alex Wild

Beneficial Insects



Photos: Mario Ambrosino, Sarah Foltz Jordan

Beneficial Insects

Photo: Nancy Lee Adamson

Photo: Jennifer Hopwood

Farm Practices for Beneficial Insects

Agricultural practices can impact beneficial insect diversity and abundance

Photo provided by Claudio Gratton, UW-Madison

Farm Practices for Beneficial Insects

Unprecedented Scale of Habitat Loss

- 9+ Million acres of grassland/prairie converted to cropland since 2008
- *Largest conversion of habitat to cropland since just before the Dust Bowl*

Photo: Griggs Dakota

Farm Practices for Beneficial Insects

Protect Ground Nests and Ground Dwelling Insects

- Reduce Tillage
- Rotate tilled areas
- Minimize plastic mulch

Photo: USDA-ARS

Farm Practices for Beneficial Insects

Example: Tillage and Ground Beetles

- Tillage negatively impacts both larval and adult ground beetles
- Tilled areas reduced egg-laying rate by female ground beetles

Blubaugh, C and Kaplan, I. 2015. Tillage compromises weed seed predator activity across developmental stages. Biological Control. 81:76-82.

Photo: Thelma Heidel-Baker

Farm Practices for Beneficial Insects

Cover cropping can have many benefits

- Support beneficial insects
- Support pollinators
- Weed suppression
- Prevent soil erosion
- Increase water filtration
- Improve soil health
- Increase farm biodiversity
- Support IPM

Managing Cover Crops Profitably, 3rd Ed. 2012. SARE. 248 p.

Photo: Thelma Heidel-Baker

Farm Practices for Beneficial Insects

Beneficial insects must be protected from the impacts of insecticides

Ambush bug feeding on prey

Photo: Adam Varenhorst

Reducing Pesticide Impacts

Control Drift and Over Application

- Calibrate equipment annually
- Select proper nozzle type
- Avoid temperature inversions and windy conditions

Photos: USDA-ARS

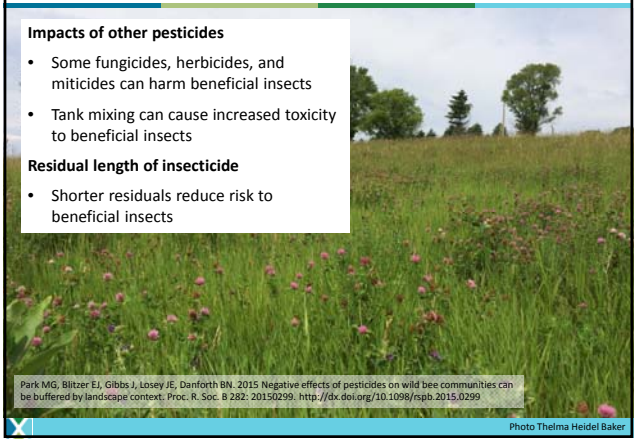
Reducing Pesticide Impacts

Impacts of other pesticides

- Some fungicides, herbicides, and miticides can harm beneficial insects
- Tank mixing can cause increased toxicity to beneficial insects

Residual length of insecticide

- Shorter residuals reduce risk to beneficial insects



Park MG, Blitzer EJ, Gibbs J, Losey JE, Danforth BN. 2015 Negative effects of pesticides on wild bee communities can be buffered by landscape context. Proc. R. Soc. B 282: 20150299. http://dx.doi.org/10.1098/rspb.2015.0299

Photo Thelma Heidel Baker

Reducing Pesticide Impacts

Alternatives to Pesticides

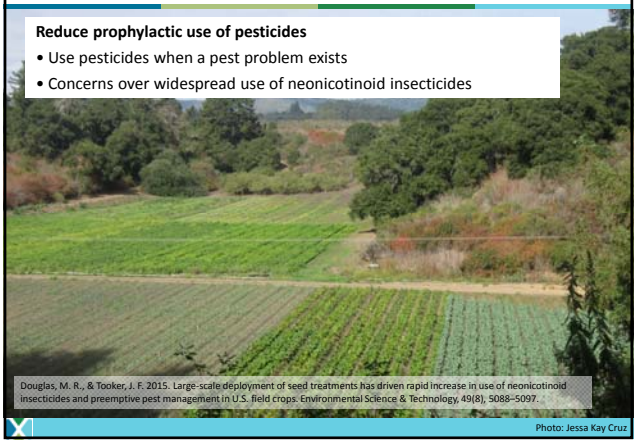
- Floating row covers
- Fruit bagging
- Crop rotation
- Crop diversity
- Resistant varieties
- Sanitation
- Planting date

Photo: Thelma Heidel-Baker

Reducing Pesticide Impacts

Reduce prophylactic use of pesticides

- Use pesticides when a pest problem exists
- Concerns over widespread use of neonicotinoid insecticides



Douglas, M. R., & Tooker, J. F. 2015. Large-scale deployment of seed treatments has driven rapid increase in use of neonicotinoid insecticides and preemptive pest management in U.S. field crops. Environmental Science & Technology, 49(8), 5088–5097.

Photo: Jessa Kay Cruz

Reducing Pesticide Impacts

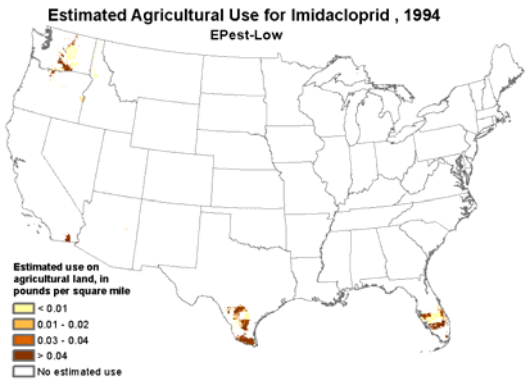


Photo: USGS

Reducing Pesticide Impacts

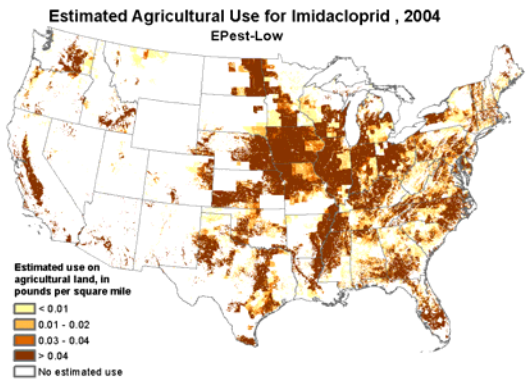


Photo: USGS

Reducing Pesticide Impacts

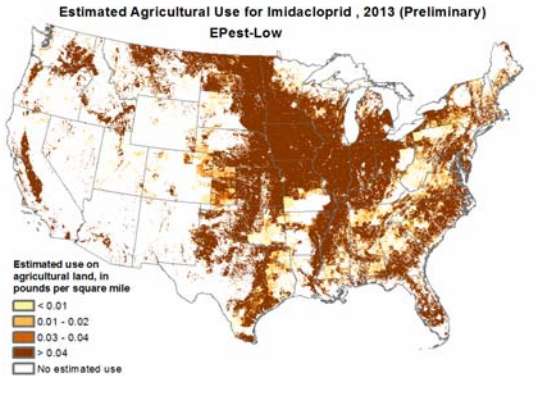


Photo: USGS

Reducing Pesticide Impacts

As other beneficial insects decline, pests increase

The loss of predatory ground beetles in insecticide-treated soybean crops causes greater slug outbreaks

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.

Photos: Penn State

Reducing Pesticide Impacts

Adopt and Practice IPM

- Focus on pest prevention
- Use multiple management strategies
- Use insecticides only when there is a *demonstrated need*
- Scout and monitor for pests *AND* beneficial insects
- Use established thresholds
- Choose pesticides carefully

Photo: Thelma Heidel-Baker, Jason Miller, NRCS

Reducing Pesticide Impacts

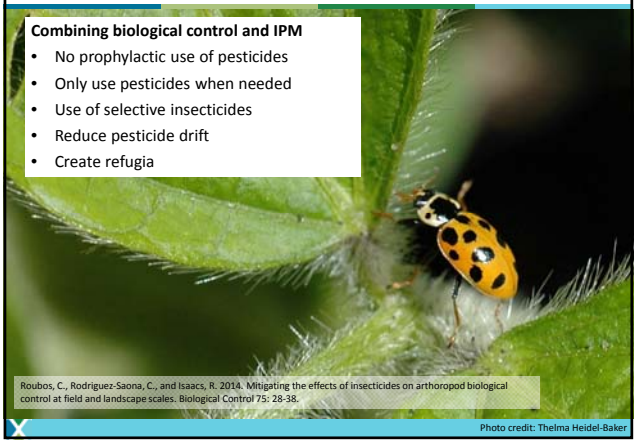
"Biological control ….provides one of the highest returns on investment available in IPM, yet its economic value is rarely estimated."

-Naranjo et al. 2015

Naranjo, S., Ellsworth, P., and Frisvold, G. 2015. Economic value of biological control in integrated pest management of managed plant systems. Annual Review of Entomology: 60:621-645.

Photo: Thelma Heidel-Baker

Reducing Pesticide Impacts



Combining biological control and IPM

- No prophylactic use of pesticides
- Only use pesticides when needed
- Use of selective insecticides
- Reduce pesticide drift
- Create refugia

Roubos, C., Rodriguez-Saona, C., and Isaacs, R. 2014. Mitigating the effects of insecticides on arthoropod biological control at field and landscape scales. Biological Control 75: 28-38.

Photo credit: Thelma Heidel-Baker

Providing Farm Habitat for Beneficial Insects

Photo: Jennifer Hopwood

Providing Habitat on Farms

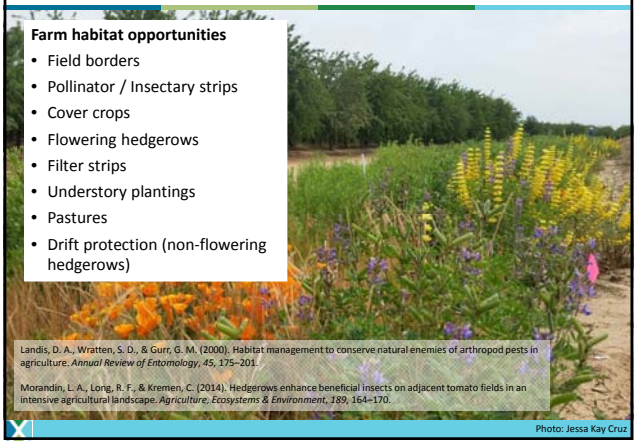
Habitat is the key ingredient

Photo: Jessa Cruz

Providing Habitat on Farms

Farm habitat opportunities

- Field borders
- Pollinator / Insectary strips
- Cover crops
- Flowering hedgerows
- Filter strips
- Understory plantings
- Pastures
- Drift protection (non-flowering hedgerows)



Landis, D. A., Wratten, S. D., & Gurr, G. M. (2000). Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology*, *45*, 175–201.

Morandin, L. A., Long, R. F., & Kremen, C. (2014). Hedgerows enhance beneficial insects on adjacent tomato fields in an intensive agricultural landscape. *Agriculture, Ecosystems & Environment*, *189*, 164–170.

Photo: Jessa Kay Cruz

Providing Habitat on Farms

Annual insectary strips can provide benefits for pest control in potatoes

- Increased natural enemy abundance and diversity
- Increase of aphid natural enemies (lady beetles, lacewings, and hoverflies)

Tschumi et al. 2016. Tailored flower strips promote natural enemy biodiversity and pest control in potato crops. Journal of Applied Ecology. In press.

Photo: Sarah Foltz Jordan

Providing Habitat on Farms

Example: Ayrshire Farm, North Carolina

- Lettuce, fennel, and greens intercropped with crimson clover
- **Multipurpose:** Pest control, insect forage, nitrogen-fixing, weed control, added biodiversity, soil health

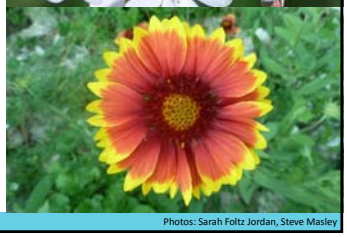
Photo: Debbie Roos

Providing Habitat on Farms

Useful species for insectary strips

- Partridge pea
- Plains coreopsis
- Annual blanket flower
- Buckwheat
- Dill
- Cilantro
- Bachelor's button*
- Cosmos*
- Sunflower
- Alyssum
- Phacelia

*Can be invasive

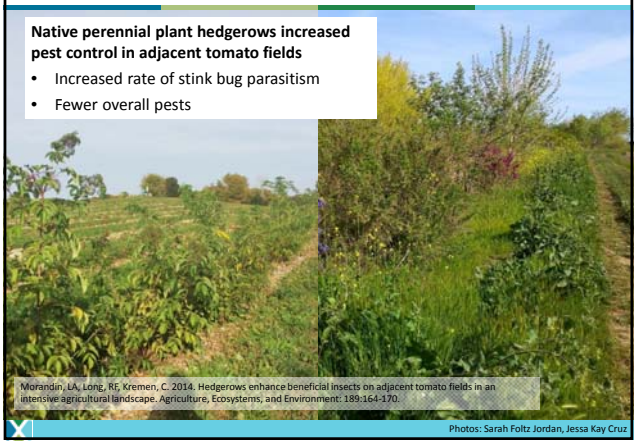


Photos: Sarah Foltz Jordan, Steve Masley

Providing Habitat on Farms

Native perennial plant hedgerows increased pest control in adjacent tomato fields

- Increased rate of stink bug parasitism
- Fewer overall pests

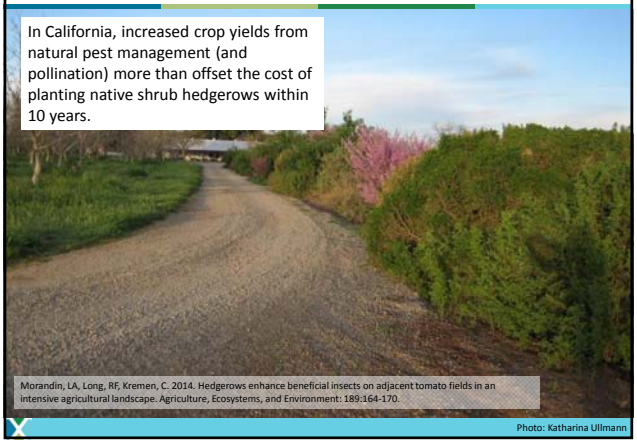


Morandin, LA, Long, RF, Kremen, C. 2014. Hedgerows enhance beneficial insects on adjacent tomato fields in an intensive agricultural landscape. Agriculture, Ecosystems, and Environment: 189:164-170.

Photos: Sarah Foltz Jordan, Jessa Kay Cruz

Providing Habitat on Farms

In California, increased crop yields from natural pest management (and pollination) more than offset the cost of planting native shrub hedgerows within 10 years.



Morandin, LA, Long, RF, Kremen, C. 2014. Hedgerows enhance beneficial insects on adjacent tomato fields in an intensive agricultural landscape. Agriculture, Ecosystems, and Environment: 189:164-170.

Photo: Katharina Ullmann

Providing Habitat on Farms

Useful hedgerow species for beneficial insects

- **Willow** (*Salix* spp.)
- **Dogwood** (*Cornus* spp.)
- **Currants** (*Ribes* spp.)
- **Juneberry** (*Amelanchier* spp.)
- **Elderberry (black and red)** (*Sambucus* spp.)
- **Highbush cranberry** (*Vibernum trilobum*)
- **Nannyberry** (*Vibernum lentago*)
- **Cockspur Hawthorn** (*Crataegus crus galli*)
- **Wild plum** (*Prunus americana*)
- **Aronia** (*Aronia melanocarpa*)
- **New Jersey Tea** (*Ceanothus americanus*)
- **Lead plant** (*Amorpha canescens*)
- **False indigo** (*Amorpha fruticosa*)
- **Prairie Rose** (*Rosa arkansana*)
- **Meadowsweet** (*Spirea alba*)

Photo: Stephen Thomforde; Sarah Foltz Jordan

Providing Habitat on Farms

Beetle Bank at Grinnell Heritage Farm, Iowa

- Permanent native grass strips intercropped with vegetables
- Provides habitat for ground beetles

***Pasimachus* ground beetle**

Firefly beetle

Photo: Grinnell Heritage Farm; Bugwood

Providing Habitat on Farms

Permanent ground cover at Lost Nation Apple Orchard, New Hampshire

- Native wildflowers, herbs, medicinals, weeds, in orchard understory

Golden Alexanders
(*Zizia aurea*)

Photos: Eric Mader and Robin Dobson

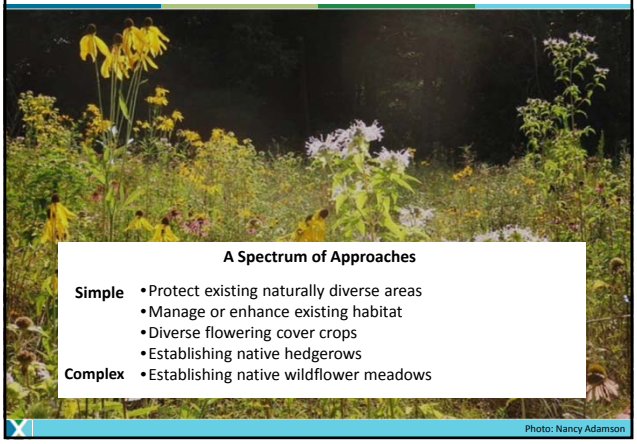
Providing Habitat on Farms

Create a farming environment that supports beneficial insects

Tschumi, M., Albrecht, M., Bartschi, C., Collatz, J., Entling, M., and Jacot, J. 2016. Perennial, species-rich wildflower strips enhance pest control and crop yield. Agriculture, Ecosystems, and Environment. 220:97-103.

Photo: Jessa Kay Cruz

Providing Habitat on Farms



A Spectrum of Approaches

Simple
- Protect existing naturally diverse areas
- Manage or enhance existing habitat
- Diverse flowering cover crops
- Establishing native hedgerows

Complex
- Establishing native wildflower meadows

Photo: Nancy Adamson

Providing Habitat on Farms

Site Preparation and Solarization

June 2015

July 2015

Photos: Thelma Heidel-Baker

Providing Habitat on Farms

Seeding a native wildflower mix

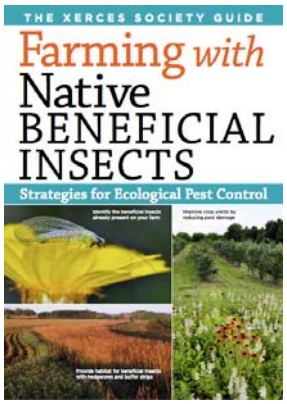
Broadcast seeding (fall 2015)

Photos: Thelma Heidel-Baker, Kerry Lynch

Additional Resources

ECOLOGICAL PEST MANAGEMENT BOOK

- Installation guidelines for hedgerows, beetle banks, native plant field borders, insectary strips, cover cropping, and more
- Pesticide risk mitigation guidance
- Based upon Xerces Society & UC Berkeley CIG-funded project
- Real world case studies from across the U.S.



Additional Resources

NEW for 2016

- Farm practices and habitat structures
- Reducing pesticide impacts
- Important beneficial insect groups
- Plants that support beneficials

Additional Resources

Short Courses on Conservation Biological Control

- Value of conservation biocontrol
- Overview beneficial insect groups
- Farm practices to support beneficial insects
- Pesticide risk mitigation
- Beneficial Insect Habitat Assessment Guide
- Designing and implementing farm habitat
- NRCS practices to support beneficial insects

SARE Sustainable Agriculture Research & Education

Additional Resources

Short Courses on Conservation Biological Control

- Value of conservation biocontrol
- Overview beneficial insect groups
- Farm practices to support beneficial insects
- Pesticide risk mitigation
- Beneficial Insect Habitat Assessment Guide
- Designing and implementing farm habitat
- NRCS practices to support beneficial insects

States for 2016:

- California (pending)
- Illinois
- Indiana (pending)
- Michigan (pending)
- Nevada (pending)
- New York (pending)
- Washington
- Vermont

www.xerces.org/events

SARE Sustainable Agriculture Research & Education

Additional Resources

www.xerces.org

Thank you!

For more information:

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Photo: Kelly Gill