Pollinators, Plants, and People:

What pollinators do for us and what we can do for pollinators

XERCES SOCIETY
for Invertebrate Conservation

Jennifer Hopwood
Senior Pollinator Conservation Specialist

Photo: Keith Fredrick

Kansas roots

Introduction to the Xerces Society

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

Now-extinct Xerces blue butterfly (*Glaucopsyche xerces*)

Major Programs:

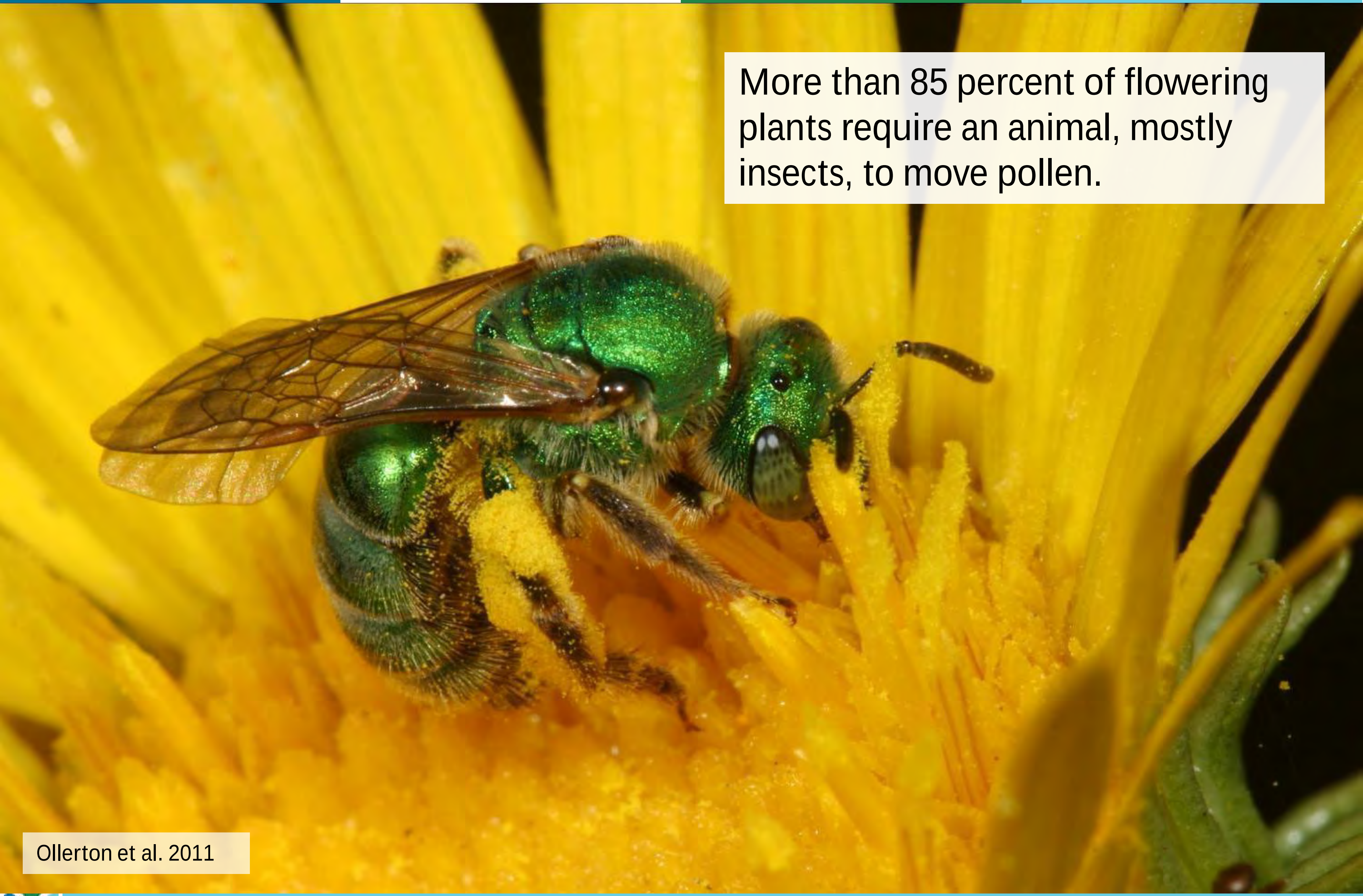
- Endangered species
- Aquatic invertebrates
- Pollinator conservation
- Pesticide program
- Citizen science

Photos: Anne Averill, H. Ballard, Ed Ross

Part 1. Why we need pollinators

Photo: Nancy Adamson

Pollinators and flowering plants



More than 85 percent of flowering plants require an animal, mostly insects, to move pollen.

Ollerton et al. 2011

Photo: Rollin Coville

Pollinators and ecosystem health

Pollinators are keystone species

- Fruits and seeds are a major part of the diet of about 25% of birds, and many mammals
- Pollinators are food for wildlife (89% of birds)

Photo: MJ Hatfield, Jeff Vanuga, Marie Reed, Karen Ward, NPS

Pollinators and human health

Pollinators are valuable to our economy and our nutrition.

- 35% of crop production, worldwide
- Over $18 to $27 billion value of crops in U.S. ($217 billion worldwide)
- Many of our vitamins and minerals are from insect-pollinated plants

Morse and Calderone 2000; Klein et al. 2007; Eilers et al. 2011

Photo: USDA-ARS/Peggy Greb

Pollinators and human health

Photo: Whole Foods Market

Pollinators and human health

Photo: Whole Foods Market

Meet the pollinators

Photos: Mace Vaughan, Bob Hammond, David Inouye, Bruce Newhouse

Meet the pollinators: Butterflies

Photo: Jennifer Hopwood

Meet the pollinators: Moths

Photo: MJ Hatfield

Meet the pollinators: Flies

Photos: Mace Vaughan/Xerces Society; Alex Wild

Meet the pollinators: Beetles

Photo: Debbie Roos

Meet the pollinators: Wasps

Photo: Betsy Betros

Bees: The most efficient pollinators

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

Photo: Rollin Coville

Honey Bees: Not Your Average Bee

The European Honey Bee – a unique species

- Social bees, caste system (queen, workers, drones), cooperative care
- Perennial colony, overwinters by feeding on honey stores
- Colonies managed for crop pollination: temporarily brought to farms to provide crop pollination

Photo: Robert W. Matthews, University of Georgia; Bugwood.org

Meet our native wild bees


Nearly 3,600 species of native bees in the U.S., 5000 species in North America


Photos: Rollin Coville, Betsy Betros

Life Cycle of a Solitary Bee

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

Photos: Dennis Briggs

Ground nesting bees

Nearly 70% of native bees nest underground

May be found in turf, more often on bare, exposed ground.

Nest chambers may be lined with waxy glandular secretions, and can sometimes even resist flooding

Photos: Eric Mader, Rollin Coville, Dennis Briggs

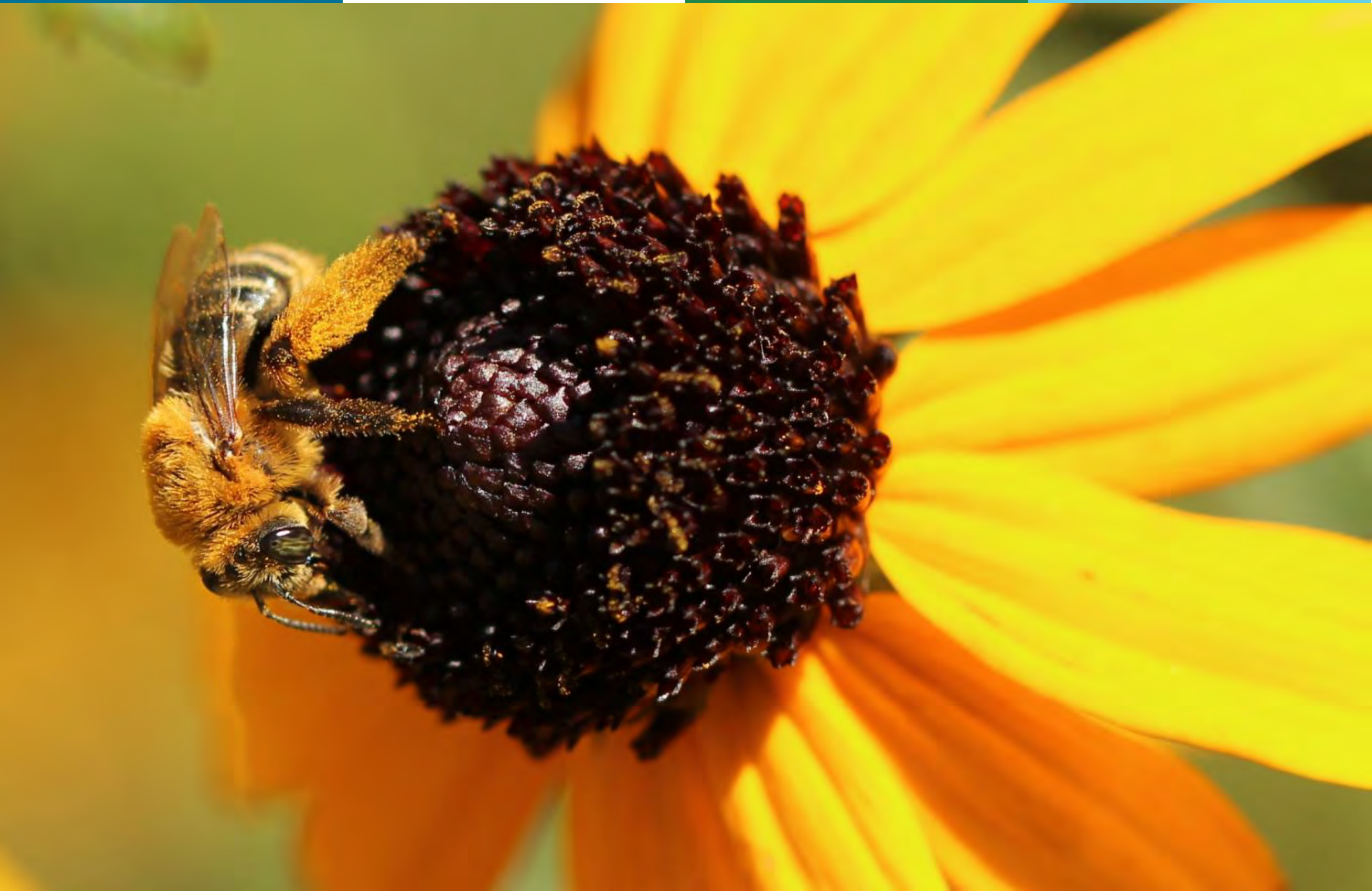
Native Bee Diversity: Tiny sweat bees

Photo: Rollin Coville

Native Bee Diversity: Miner Bees (Tickle Bees)

Photo: Betsy Betros

Native Bee Diversity: Digger bees



Native Bee Diversity: Long-Horned Bees

Photo: Rollin Coville

Tunnel nesting bees

Tunnel-nesting bees (about 30% of species)

- Old beetle tunnels in snags, stumps, and brush piles
- Hollow or pithy plant stems (e.g. box elder, cane fruit, or elderberry)
- Nest tunnel partitions constructed of mud, leaf pieces, or sawdust

Photos: Edward Ross, Darrin O'Brien, Jennifer Hopwood

Native Bee Diversity: Leaf-cutter bees

Photos: Rollin Coville, Jennifer Hopwood/Xerces Society

Native Bee Diversity: Mason bees

Photos: Betsy Betros

Native Bee Diversity: Small carpenter bees

Photo: Sarah Foltz Jordan/Xerces Society

Bumble bees

45 species in U.S.

- Social colonies founded by single queen
- Annual, last only one season
- Nests may contain 25-400 workers
- Bumble bees nest in existing cavities such as old rodent holes, in overgrown areas, or under brush piles

Photos: Jennifer Hopwood, Edward Ross

Meet the pollinators: Bees

Photo: Betsy Betros

Wild pollinators: Important crop pollinators

Recent study of 41 crops around the globe:

- Wild pollinators provide better quality pollination, setting fruit at ***twice*** the rate of honey bees
- Honey bees are not adequate substitutes for an entire pollinator community
- We need to conserve wild pollinators and support the health of managed pollinators

Garibaldi et al. 2013

Photo: Nancy Lee Adamson

Part 2. Status of Pollinators

Parallel Declines in Pollinators and Insect-Pollinated Plants in Britain and the Netherlands

J. C. Biesmeijer,[1*] S. P. M. Roberts,[2] M. Reemer,[3] R. Ohlemüller,[4] M. Edwards,[5] T. Peeters,[3,6] A. P. Schaffers,[7] S. G. Potts,[2] R. Kleukers,[3] C. D. Thomas,[4] J. Settele,[8] W. E. Kunin[1]

Despite widespread concern about declines in pollination services, little is known about the patte…

Plant-Pollinator Interactions over 120 Years: Loss of Species, Co-Occurrence, and Function

…M. Knight[1]

…ree to which global change over 120 years …perate forest understory community in Illinois, …work structure and function and extirpation of …

Special Collection: Long-Term Trends in Eastern North American Monarch Butterflies

Long-Term Trends in Eastern North American Monarch Butterflies: A Collection of Studies Focusing on Spring, Summer, and Fall Dynamics

ANDREW K. DAVIS[1,2] and LEE A. DYER[3]

Ann. Entomol. Soc. Am. 108(5): 661–663 (2015); DOI: 10.1093/aesa/sav070

ELSEVIER journal homepage: www.elsevier.com/locate/jip

A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them

Dennis vanEngelsdorp[a,*], Marina Doris Meixner[b]

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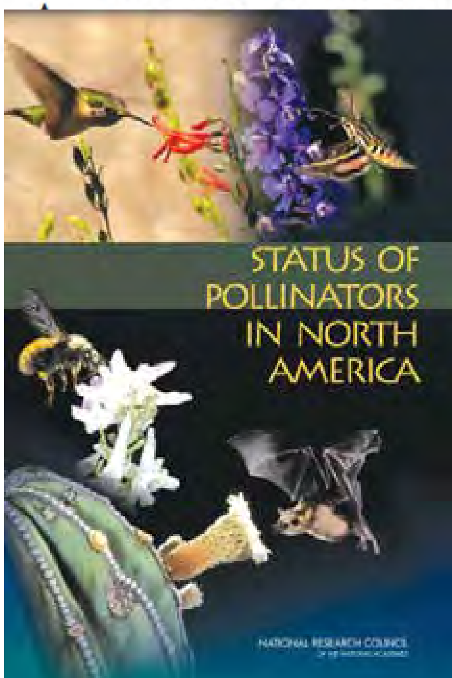
[b] LLH Bieneninstitut, Erlenstrasse 9, 35274 Kirchhain, Germany



Patterns of widespread decline in North American bumble bees

Sydney A. Cameron[a,1], Jeffrey D. Lozier[a], James P. Strange[b], Jonathan B. Koch[b,c], Nils Cordes[a,2], Leellen F. Solter[d], and Terry L. Griswold[b]

[a] Department of Entomology and Institute for Genomic Biology, University of Illinois, Urbana, IL 61801; [b] United States Department of Agriculture-Agricultural Research Service Pollinating Insects Research Unit, Utah State University, Logan, UT 84322; [c] Department of Biology, Utah State University, Logan, UT 84321; and [d] Illinois Natural History Survey, Institute of Natural Resource Sustainability, University of Illinois, Champaign, IL 61820

Edited* by Gene E. Robinson, University of Illinois, Urbana, IL, and approved November 24, 2010 (received for review October 3, 2010)

Bumble bees (*Bombus*) are vitally important pollinators of wild plants and agricultural crops worldwide. Fragmentary observations, however, have suggested population declines in several North American species. Despite rising concern over these observations in the United States, highlighted in a recent National Academy of

study in the United States identified lower genetic diversity and elevated genetic differentiation (F_{ST}) among Illinois populations of the putatively declining *B. pensylvanicus* relative to those of a codistributed stable species (19). Similar patterns have been observed in comparative studies of some European species (8), but

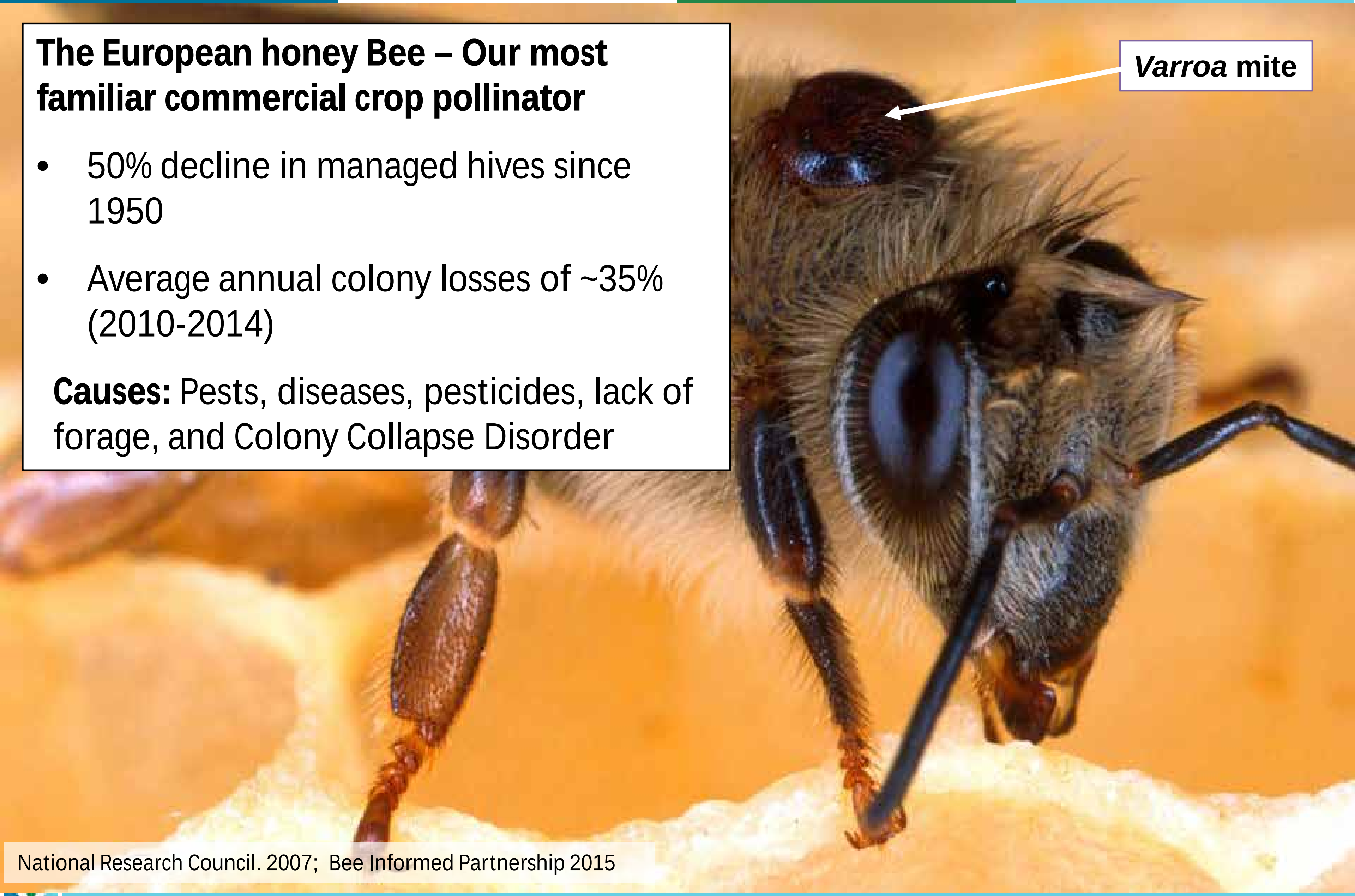
Evidence of managed and wild pollinators in decline

Honey bees in decline

The European honey Bee – Our most familiar commercial crop pollinator

- 50% decline in managed hives since 1950
- Average annual colony losses of ~35% (2010-2014)

Causes: Pests, diseases, pesticides, lack of forage, and Colony Collapse Disorder



National Research Council. 2007; Bee Informed Partnership 2015

Photo: USDA-ARS/Scott Bauer

Honey bees in decline

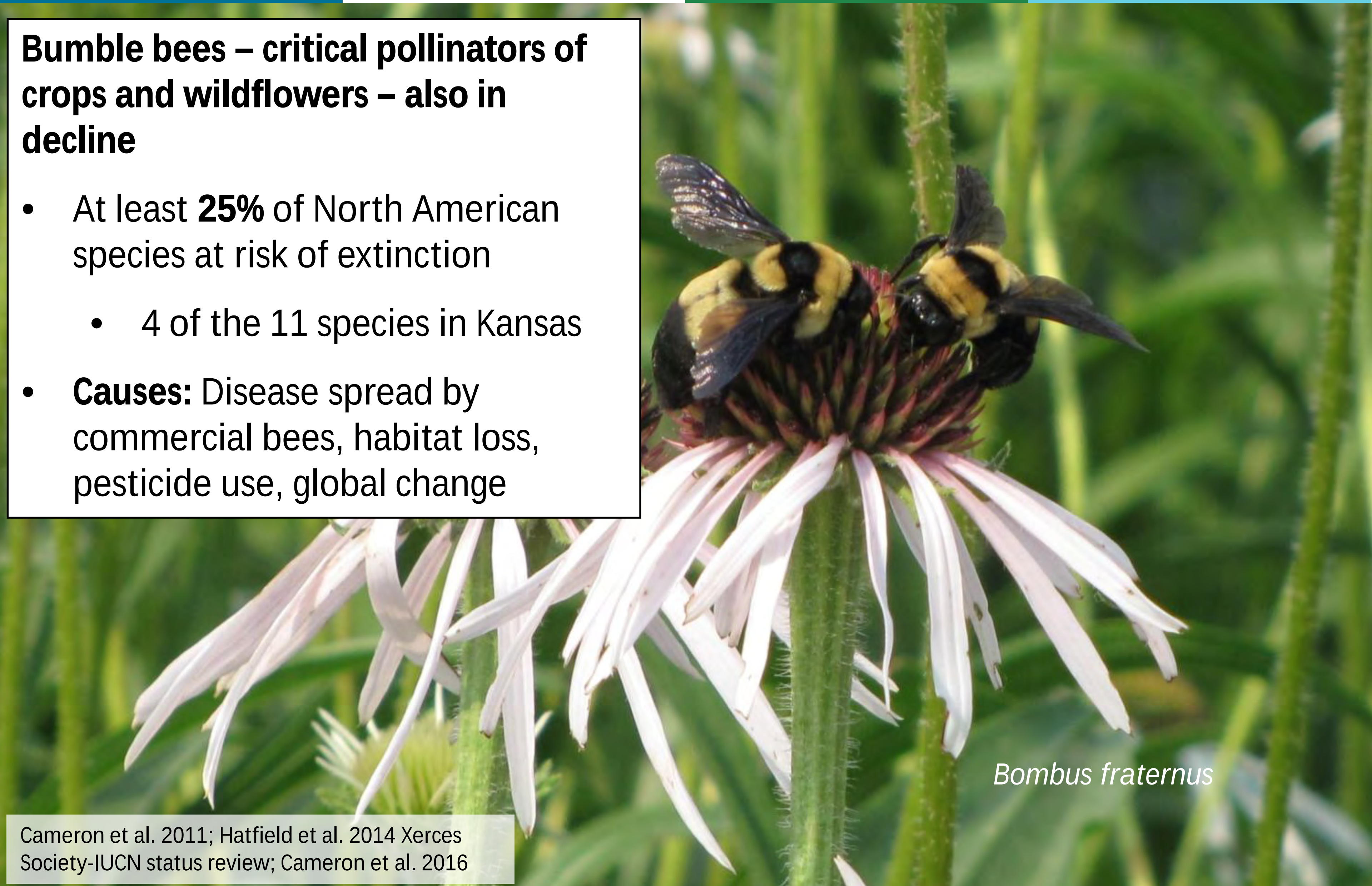
NOTE: The honey bee is NOT headed toward extinction...

Photo: USDA-ARS/Scott Bauer

Bumble bees in decline

Bumble bees – critical pollinators of crops and wildflowers – also in decline

- At least **25%** of North American species at risk of extinction
  - 4 of the 11 species in Kansas
- **Causes:** Disease spread by commercial bees, habitat loss, pesticide use, global change



Bombus fraternus

Cameron et al. 2011; Hatfield et al. 2014 Xerces Society-IUCN status review; Cameron et al. 2016

Photo: Jennifer Hopwood

Butterflies in decline

More than 17% of North American butterfly species at risk, including habitat specialists and formerly common and widespread species

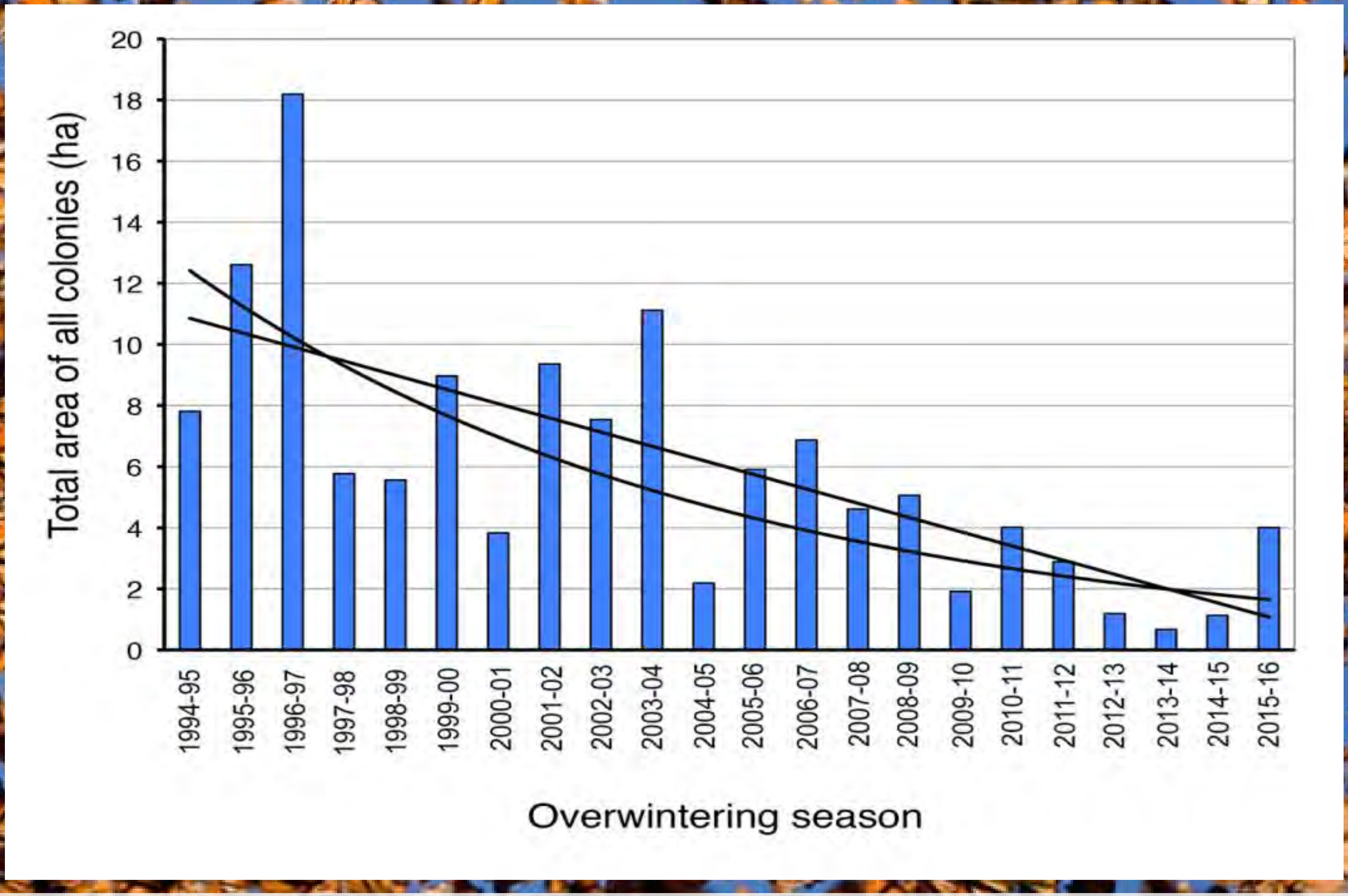
Source: NatureServe

Photo: Mace Vaughan

Butterflies in decline: Monarch butterflies

Monarch Butterfly Populations Reach New Low

Overwintering sites show an annual decline of ~9% per year for the past 22 years



Causes:
Loss of breeding habitat, logging at overwintering sites, extreme weather events

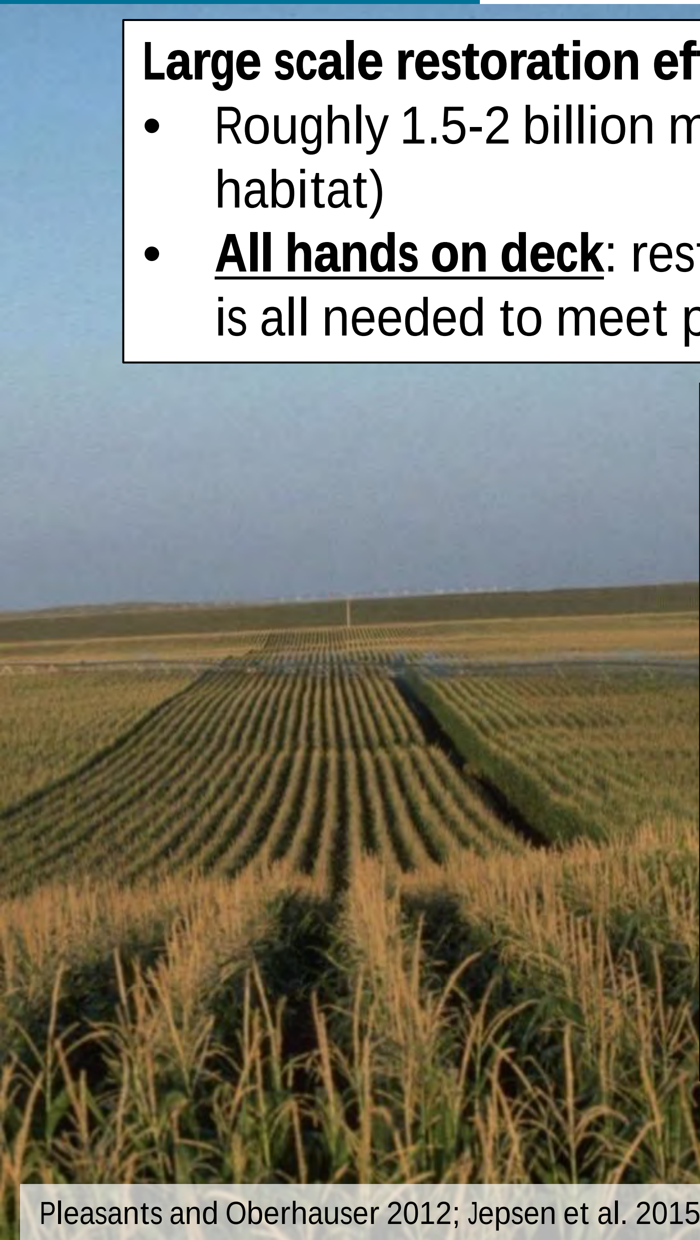
Sources: Jepsen and Young 2015 Xerces Society-NatureServe status review, Pleasants and Oberhauser 2012; Wright and Wimberly 2013

Graph courtesy of Ernest Williams, Hamilton College; Photo: World Wildlife Fund

Butterflies in decline: Monarch butterflies

Large scale restoration effort needed for monarch recovery

- Roughly 1.5-2 billion milkweed stems needed (20 million acres + of habitat)
- **<u>All hands on deck</u>**: restoration of agricultural land, gardens, roadsides is all needed to meet population recovery goal



Pleasants and Oberhauser 2012; Jepsen et al. 2015

Photos: Howard F. Schwartz; Bugwood.org; Jolie Goldenetz Dollar

Part 3. What can we do to make a difference?

Photo: Jennifer Hopwood

Habitat is the key ingredient

The amount of natural habitat in our landscapes has a direct influence on pollinator diversity and abundance.

Kremen et al. 2004; Winfree et al.. 2008; Morandin and Winston 2006; Garibaldi et al 2011; Blauuw and Isaacs 2014

Photo: Jennifer Hopwood

Protect existing habitat and create new habitat

Protect natural areas

- Restore degraded areas
- Control invasive species
- Provide intermediate disturbance
- Protect from pesticide drift

Williams et al. 2011; Fiedler et al. 2012

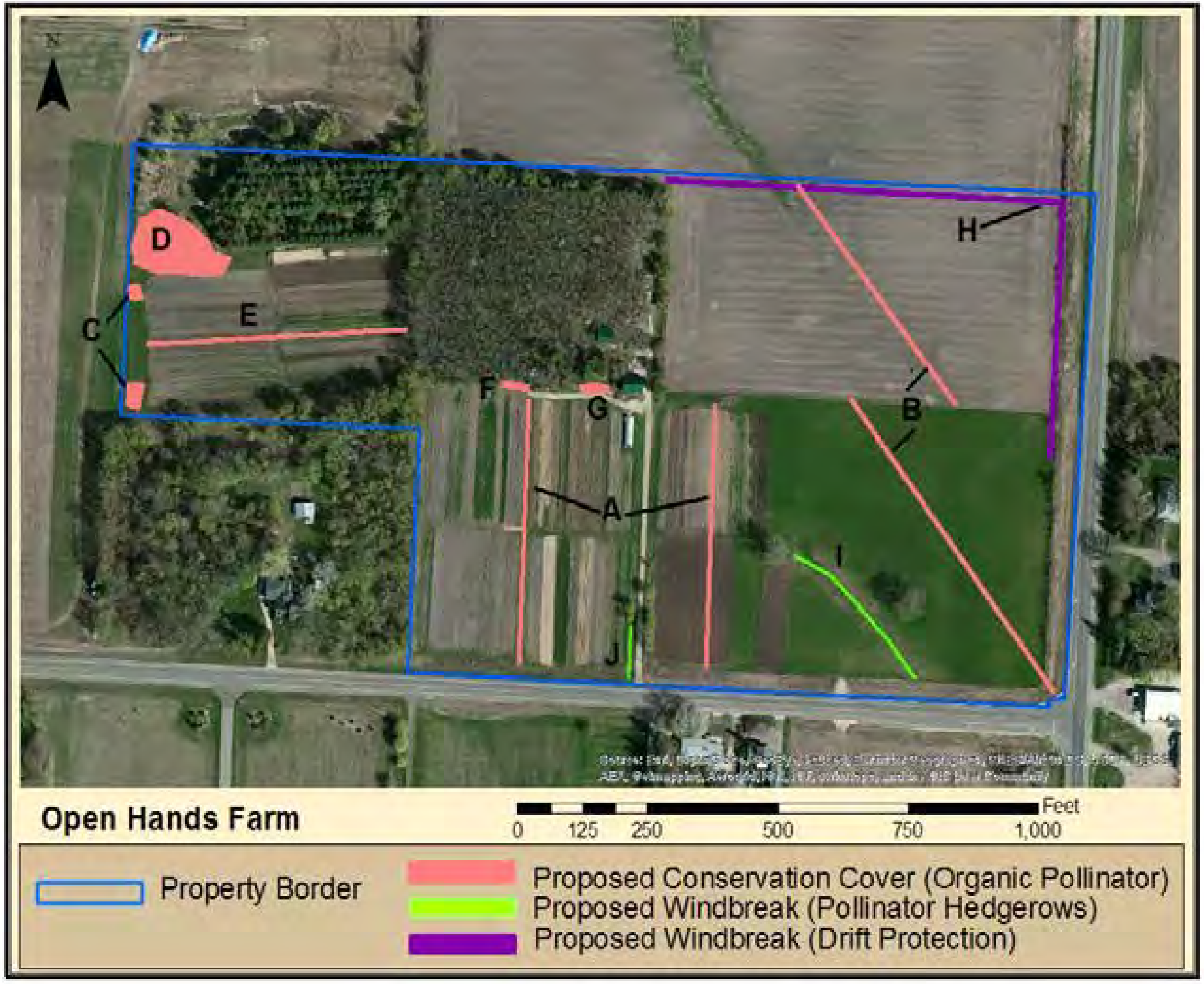
Find opportunities for new habitat

- Assess your landscape
- Identify deficiencies
- Prioritize habitat enhancements

Photos: Jennifer Hopwood, Eric Lee-Mader

Habitat to support pollinators: Idle spots

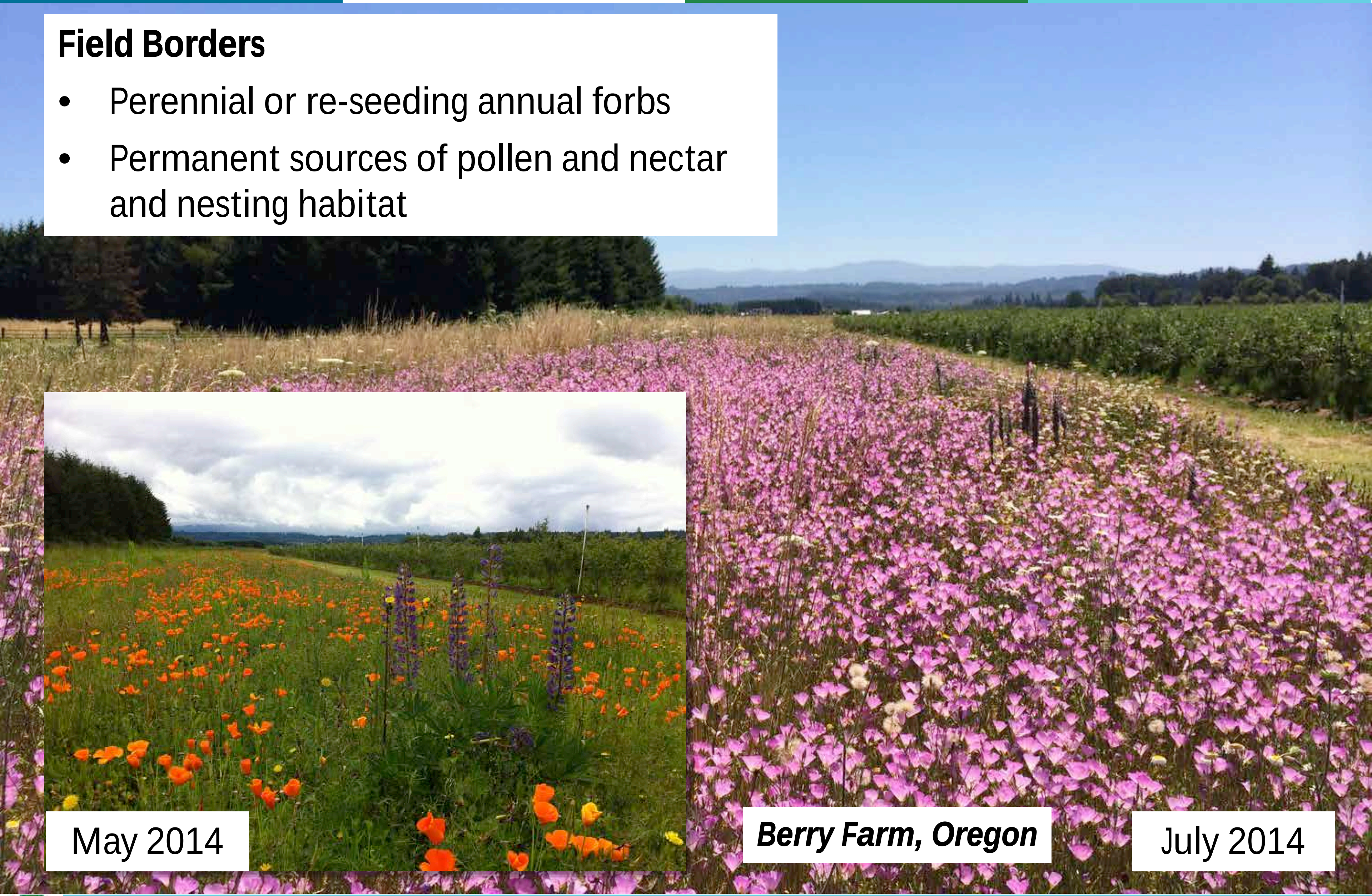
There are idle spots on every farm, and every highway is bordered by an idle strip as long as it is…the full native flora…could be part of the normal environment of every citizen.   - *Aldo Leopold*



Where to plant on farms: Field borders

Field Borders

- Perennial or re-seeding annual forbs
- Permanent sources of pollen and nectar and nesting habitat



May 2014

Berry Farm, Oregon

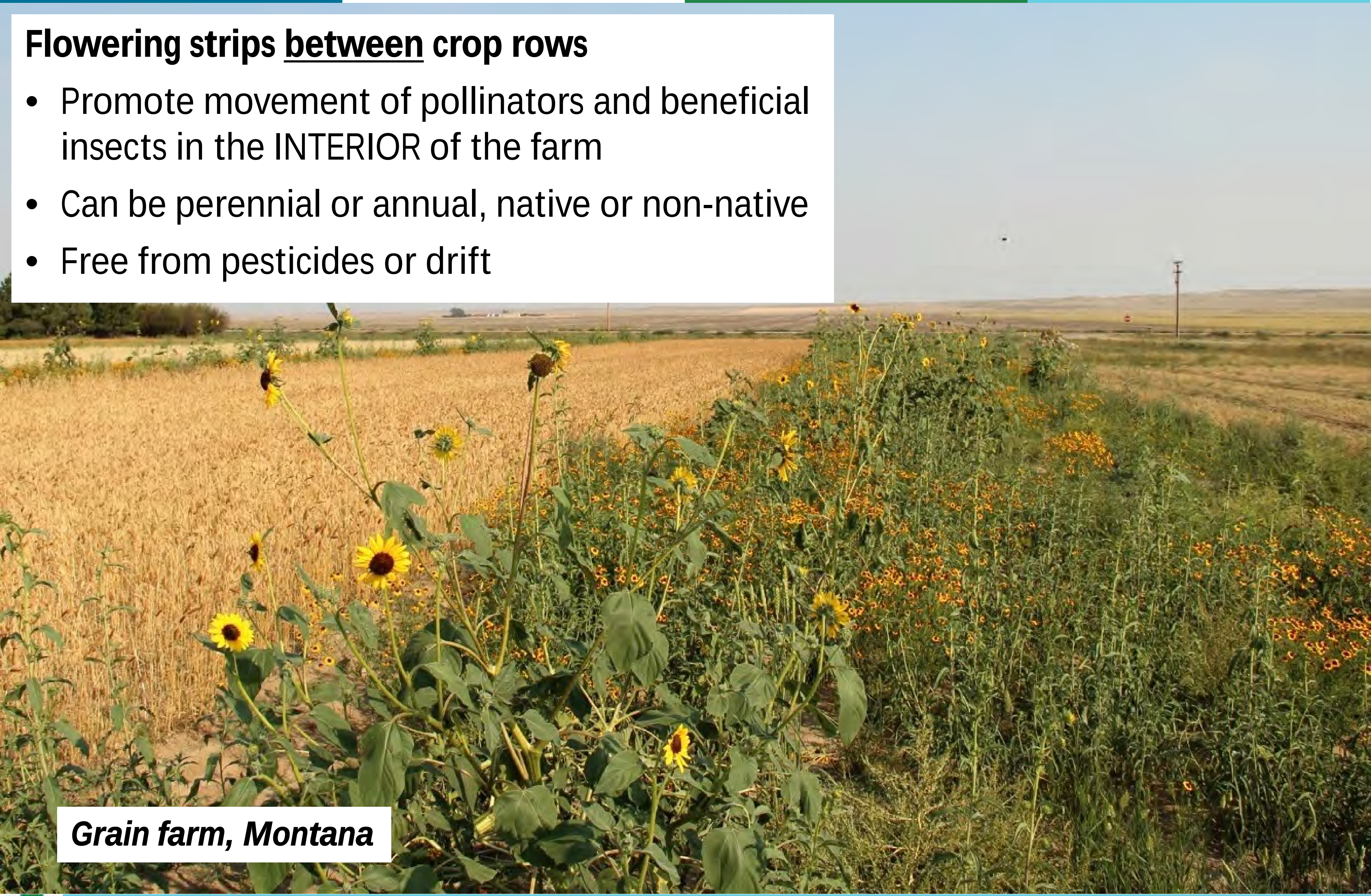
July 2014

Photos: Eric Lee-Mäder, Xerces Society

Farm Planning: Perennial Insectary Strips

Flowering strips <u>between</u> crop rows

- Promote movement of pollinators and beneficial insects in the INTERIOR of the farm
- Can be perennial or annual, native or non-native
- Free from pesticides or drift



Grain farm, Montana

Photo: Jennifer Hopwood, Xerces Society

Farm Planning: Annual Insectary Strips

- Temporary mass wildflower plantings between row crops
- Low cost, quick-growing flowers

Vegetable farm, California

Photo: Jessa Kay Cruz, Xerces Society

Habitat Options: Cover Crops

- **Multipurpose:** Pest control, insect forage, nitrogen-fixing, weed control, added biodiversity, soil health
- **To benefit pollinators**: Allow cover crop to bloom before incorporating or mowing

Photo: Toby Alexander, NRCS

Farm Planning: Understory Plantings

Permanent or temporary ground cover that can be added to vineyards and orchards. Need to reduce pesticides/drift.

Example: Almond orchard in California

Photo: Jessa Kay Cruz, Xerces Society

Habitat Options: Filter Strips

- Capture sediment, excess nitrogen, and increase infiltration to reduce flooding
- Natural vegetative filter strips 1-to-2 yards wide can reduce *E. coli* and *Cryptosporidium* in run-off by as much as 99%.

Knox, A., Tate, K., Dahlgren, R. Atwill, E. 2007. Management reduces E. coli in irrigated pasture runoff. California Agriculture. 61:4. 159.
Atwill, E. Tate, K. Pereira, M. 2006 Efficiency of natural grass buffers for removal of Cryptosporidium parvum in rangeland runoff. J Food Protect. 69:177-84
Tate, K. Atwill, E. Bartholome, J. Nader, G. 2006. Significant E. coli attenuation by vegetative buffers on annual grasslands. J Env Qual. 35:795-805

Photo: Mace Vaughan, Xerces Society

Farm Planning: Flowering Hedgerows

Example: Fong Farms, California

- Early spring forage (e.g. willows)
- Nesting resources for stem nesting insects
- Wind protection
- Possibly harvestable fruit (e.g. elderberry)

Photo: Rachel Long, UCCE

Habitat can pay for itself

- Habitat increases pollinators and beneficial insects but does not increase pests
- Increased blueberry yields pay off costs of adjacent wildflower plantings in 4 years
- Increased pollination and reduced pests pay off hedgerows within 10 years

Morandin et al. 2014., Blauuw et al. 2015

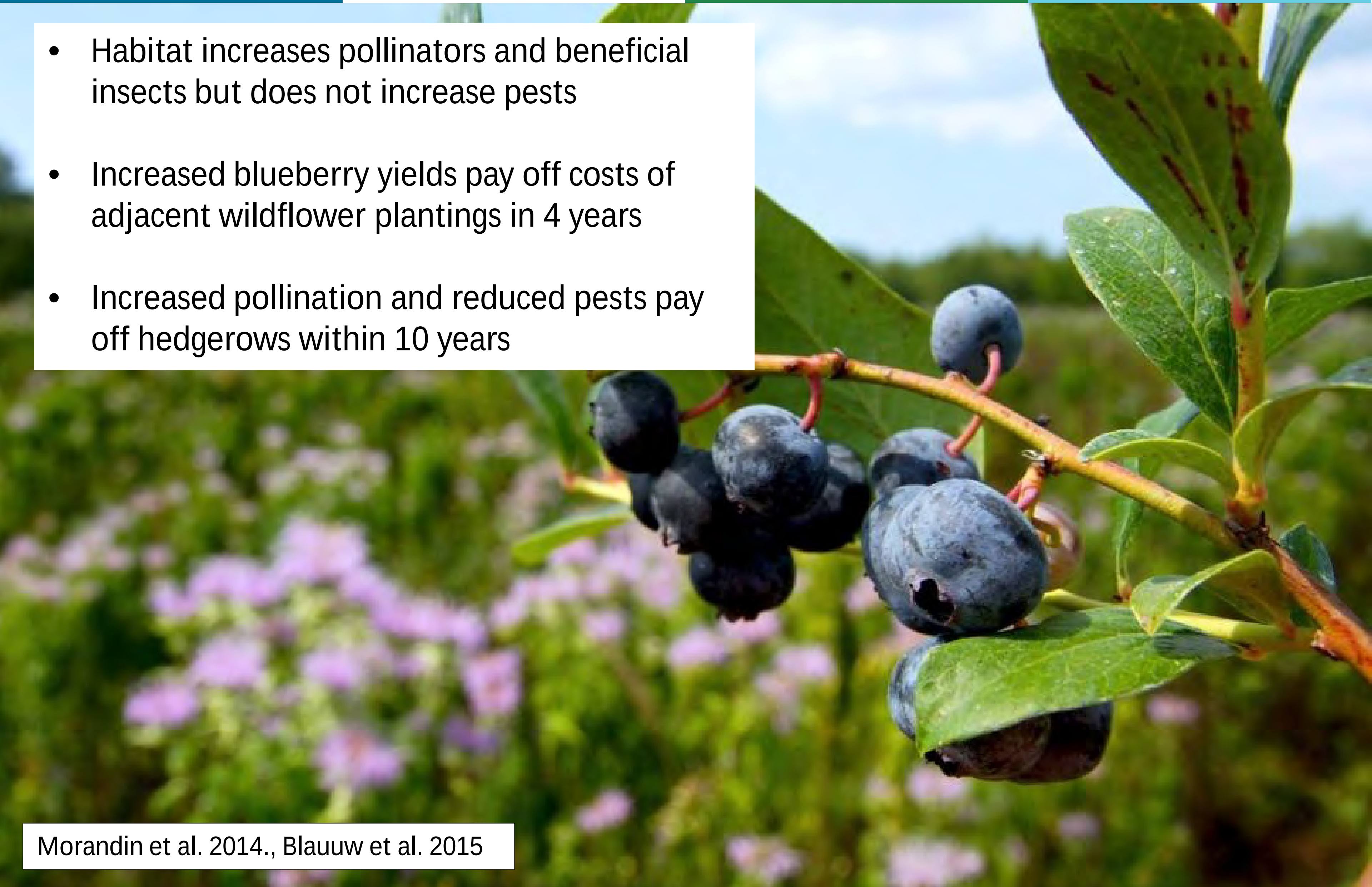
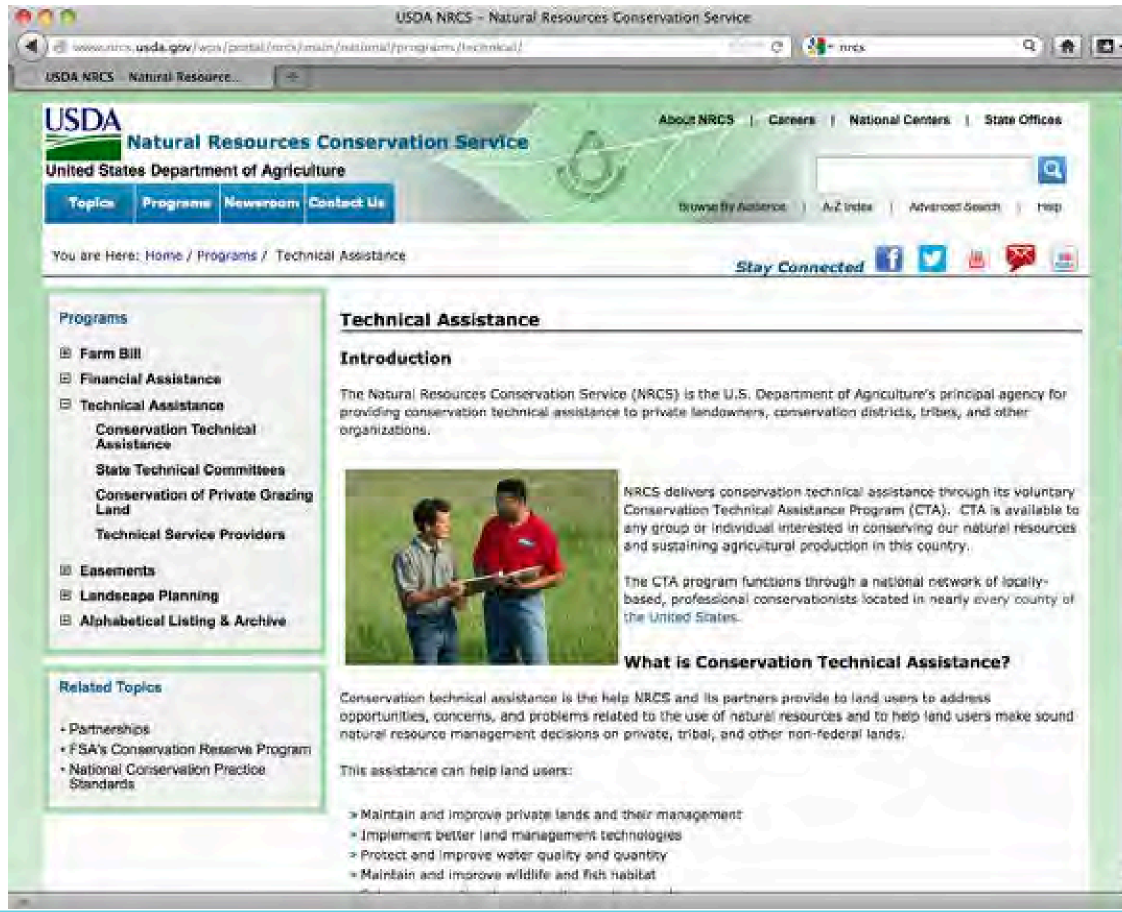


Photo: Brett Blaauw

Technical and Financial Support: USDA-NRCS

USDA Natural Resources Conservation Service

- Technical and financial support for pollinator conservation



Habitat to support pollinators: Roadsides

Roadsides provide pollinators with food, shelter, and connectivity to other habitat

17+ million acres of roadsides in the U.S.

Sources: Way 1977; Dirig and Cryan 1991; Munguira and Thomas 1992; Ries et al. 2001; Saarinen et al. 2005; Valtonen and Saarinen 2005; Soderstrom and Hedblom 2007; Skorka et al. 2013. More in Hopwood et al 2015.

Photo: Jeff Norcini

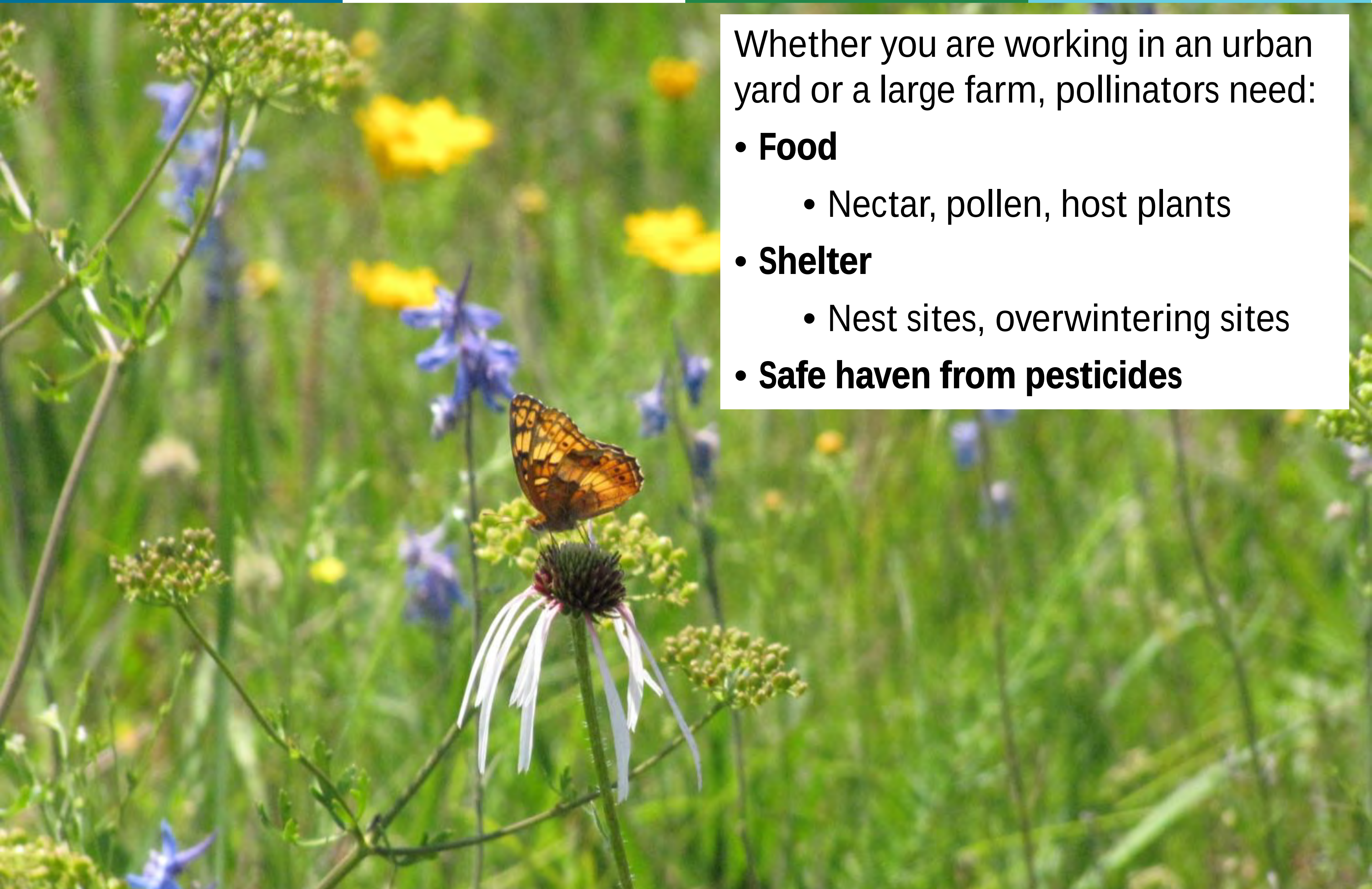
Habitat to support pollinators: Gardens and yards

Gardens may be small but they can be great habitat

Hagen et al. 2011. Goulson et al. 2010.

Photo: Matthew Shepherd

Pollinator habitat needs



Whether you are working in an urban yard or a large farm, pollinators need:

- **Food**
  - Nectar, pollen, host plants
- **Shelter**
  - Nest sites, overwintering sites
- **Safe haven from pesticides**

Photo: Jennifer Hopwood

Pollinator habitat needs: Pollen and nectar



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




Photos: Elaine Haug NRCS, Matthew Shepherd; Mace Vaughan, Eric Mader, Jeff McMillan NRCS, Berry Botanic Garden

Pollinator habitat needs: Flowering plants

Native plants critical for wildlife

- Support more species, greater abundance
- Are resilient to climate, disease

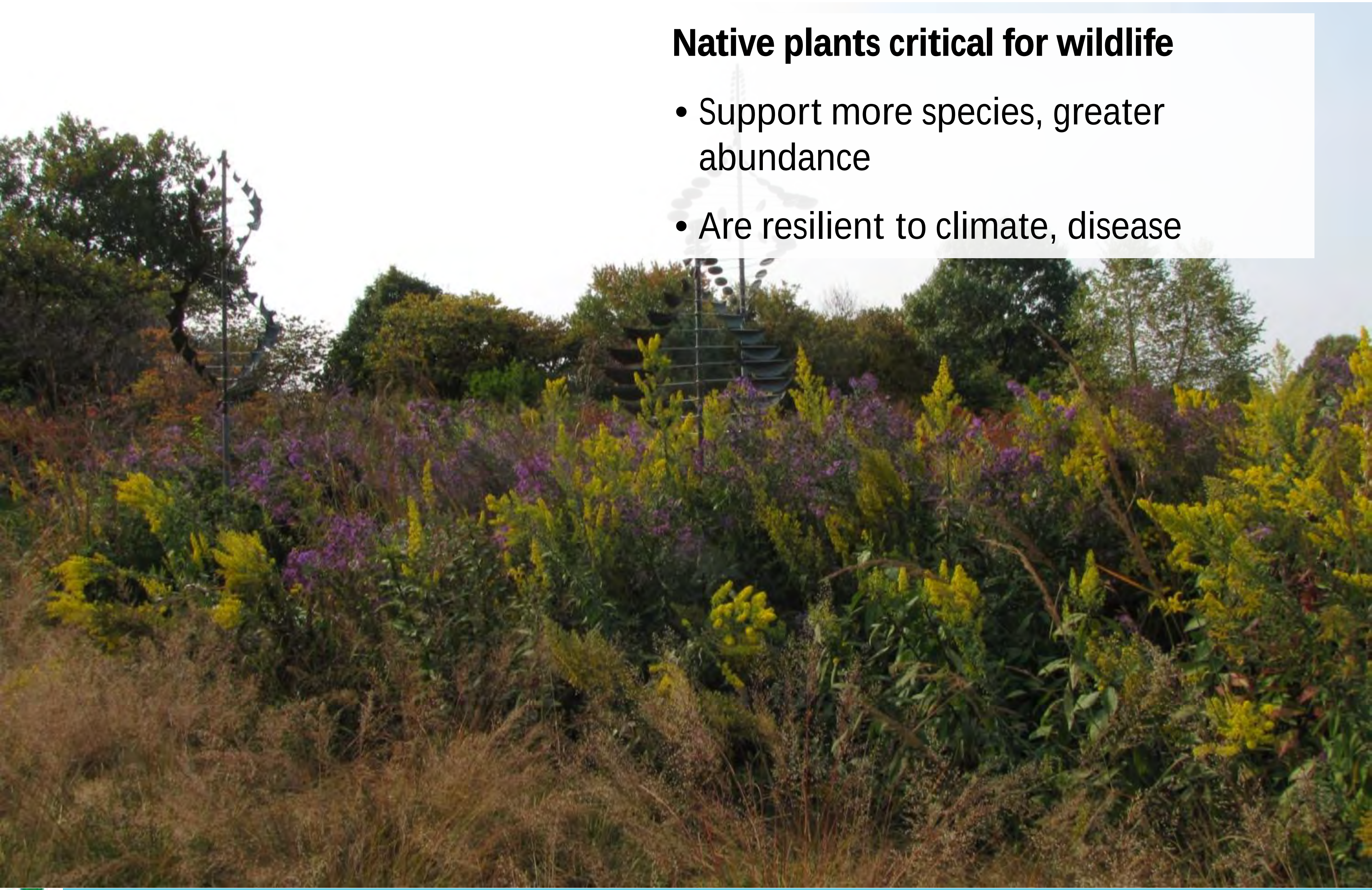


Photo: Jennifer Hopwood

Pollinator habitat needs: Choose ornamentals with care

- Garden varieties can look pretty but may offer little or no nectar or pollen
- “Doubles” are bred for showy petals in place of anthers, petals make nectar physically inaccessible
- Make sure plants are not pretreated with insecticides!

Photo: Matthew Shepherd

Butterfly habitat needs: Host plants

Include host plants whenever possible

Photo: Jennifer Hopwood

Butterfly habitat needs: Milkweed

- Obligate host plants for monarch butterfly caterpillars
    - 1.5 -2 billion stems needed for monarch recovery!
- High quality nectar, attracts beneficial insects

Photos: MJ Hatfield

Pollinator habitat needs: Shelter

- Nesting sites for bees, wasps
- Pupation and overwintering sites for butterflies, moths, beetles, and flies

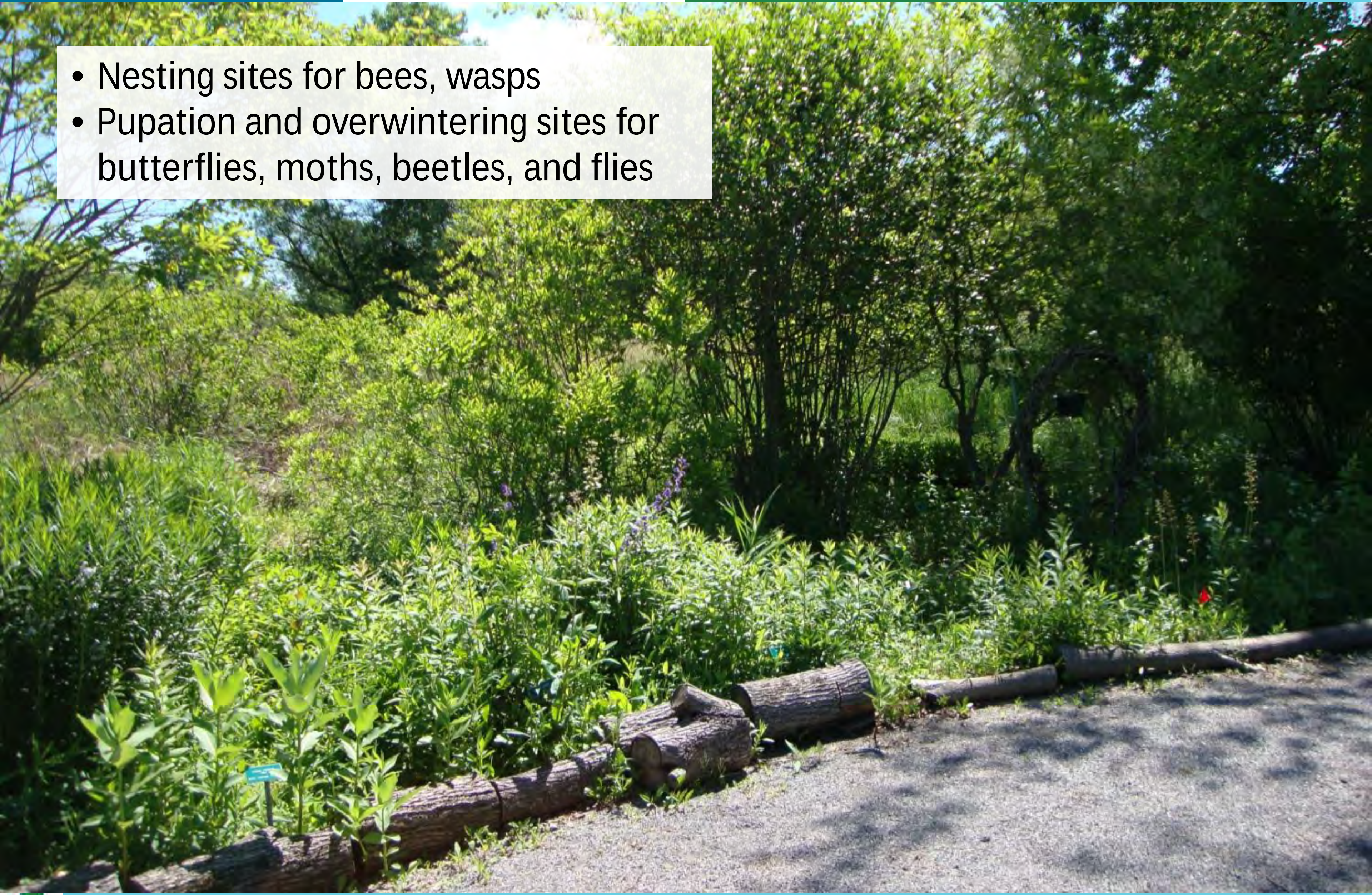


Photo: Kelly Gill

Shelter: Ground nesting bees

Protect and conserve by:

- Reducing tillage, traffic, disturbance
- Plastic mulch and landscape fabric: pros and cons

Photo: Connie Stubbs

Shelter: Tunnel-nesting bee nest sites

Protect and conserve by:

- Protect snags
- Plant or maintain woody shrubs, plants with pithy stems, such as cupplant, boxelder, elderberry, sumac cane berries, etc.
- Artificial nests useful for education

Photos: Edward Ross, Darrin O’Brien, Jennifer Hopwood

Shelter: Bumble bee nest sites

Protect and conserve by:

- Maintaining field borders, un-mown areas
- Establishing bunch grasses
- Leaving brush piles, piles of leaves

Photos: Mace Vaughan, Nancy Lee Adamson, Edward Ross

Pesticide Protection

Pesticides can be important tools for protecting crops

BUT their impact on non-target organisms like pollinators can be devastating

Photos: Matthew Shepherd, Rich Hatfield

Managing Pesticides: IPM and Beyond

Integrated Pest Management Strategies:

- Reduce conditions for pests
    - Practice good sanitation, regular crop rotation and planting of resistant varieties
- Establish clear economic thresholds
- Monitor pests and beneficial insects
    - Use degree-day modeling
    - Use pheromone trapping to assist in monitoring.
- When pest control is needed, start with the least toxic option
    - E.g. Use mating disruptors

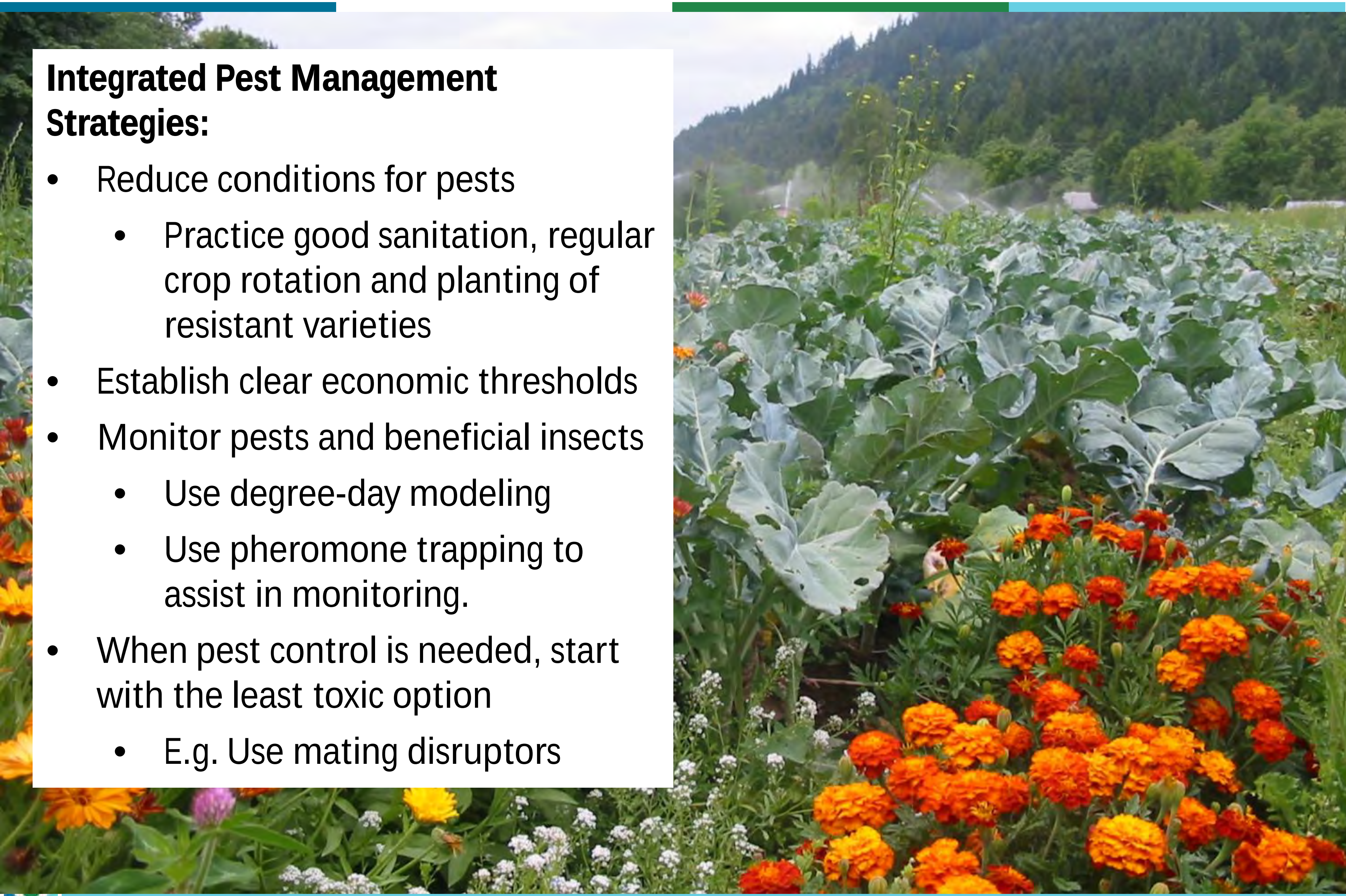


Photo: Matthew Shepherd

Alternatives to Pesticides

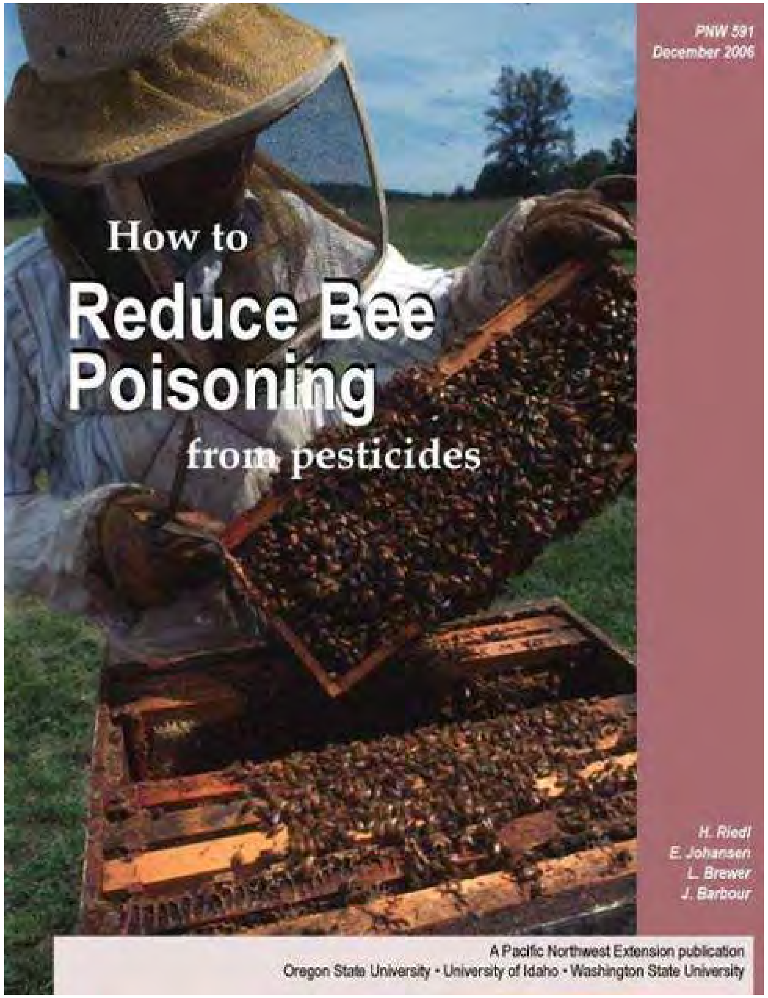
Conservation biological control

- Attracting natural enemies of crop pests
- Beetle banks, insectary strips, hedgerows
- Shared habitat needs with pollinators

Managing Insecticides: Chemical Controls

If you need to use insecticides:

- Select least toxic / most targeted
- Honey bee toxicity is usually on label
- Don't spray on plants in bloom
    - Includes crops, cover crops and weeds
    - Mow flowering understories before spraying
- Spray at night and when dry
    - Not effective for all beneficial insects
- Keep applications on target and reduce drift
- Establish buffers or setbacks
    - Unsprayed area (30' – 60')
- Pesticide drift barriers
    - 'Non-habitat' vegetative barriers (eg. conifers; dwarf Italian cypress)



Managing Pesticides: Neonicotinoids

Neonicotinoid Insecticides:

- Systemic mode of action, can be persistent over time in plants and soil
- Residues in pollen and nectar; tiny amounts can be harmful to pollinators
- Often used prophylactically; ie treatment before damage occurs
- Different neonicotinoids have different levels of toxicity (*Clothianidin, Dinotefuran, Imidacloprid and Thiamethoxam = most problematic)*

Photo: Jessa Kay Cruz

Pollinator conservation: Broader impacts

Pollinator Conservation:
Benefits to Other Wildlife

Pollinator habitat supports other valuable wildlife, including beneficial insects, song birds, game birds, and more

Dickscissel (*Spiza americana*)

Photo: Bobby Harrison

Resources: Xerces Society Publications

www.xerces.org

Resources: Xerces Society Books

Final thoughts

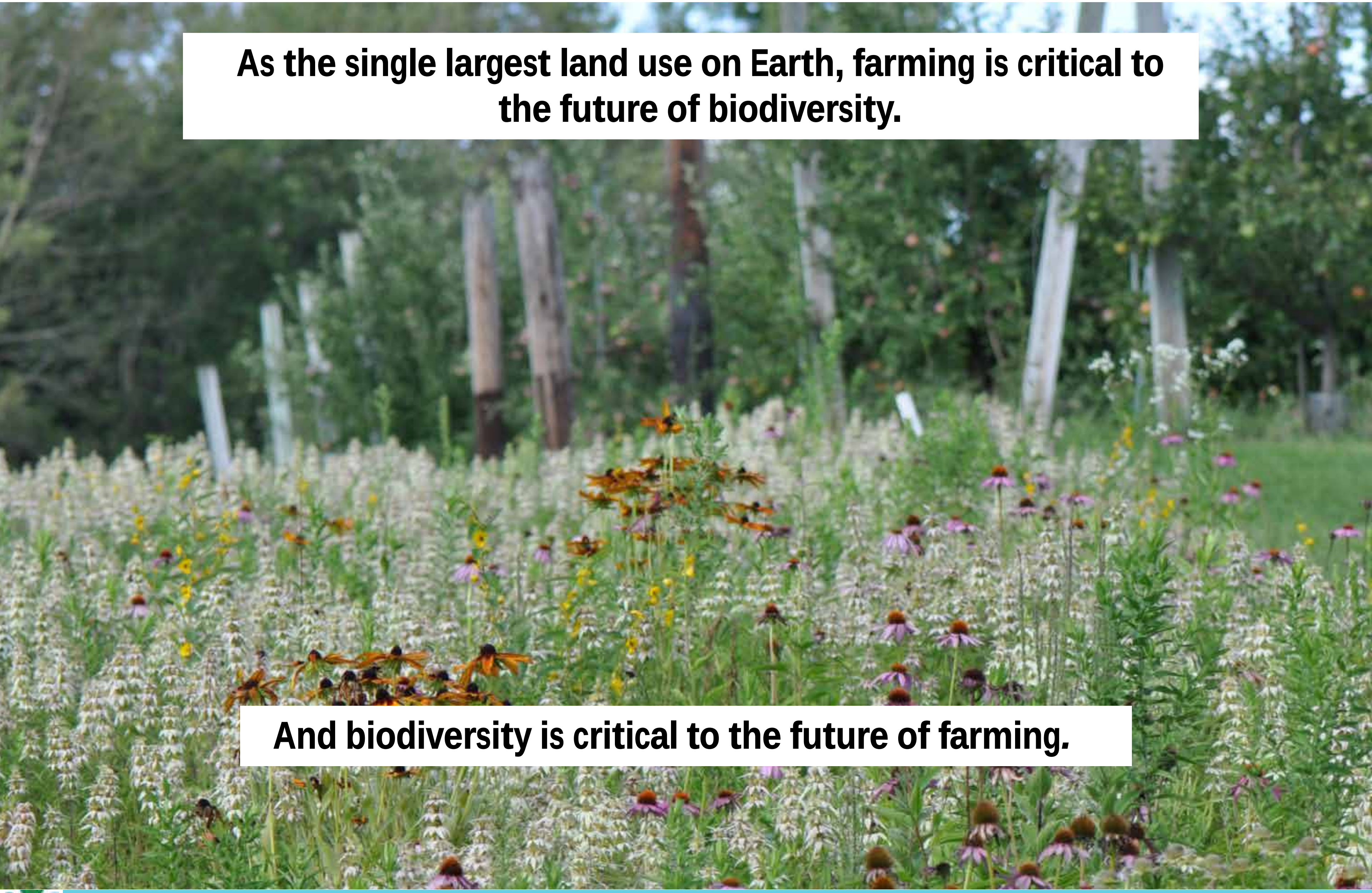


Photo: Don Keirstead

Passing on a legacy

Final thoughts

We all can integrate pollinator conservation into our lives

Habitat can be a single flower

Photo: Scott Seigfreid

Thank You!

Thank you to the many excellent scientists, conservationists, farmers, Xerces Society Members, and our funders!

Jennifer@xerces.org

www.xerces.org

Photo: John Anderson

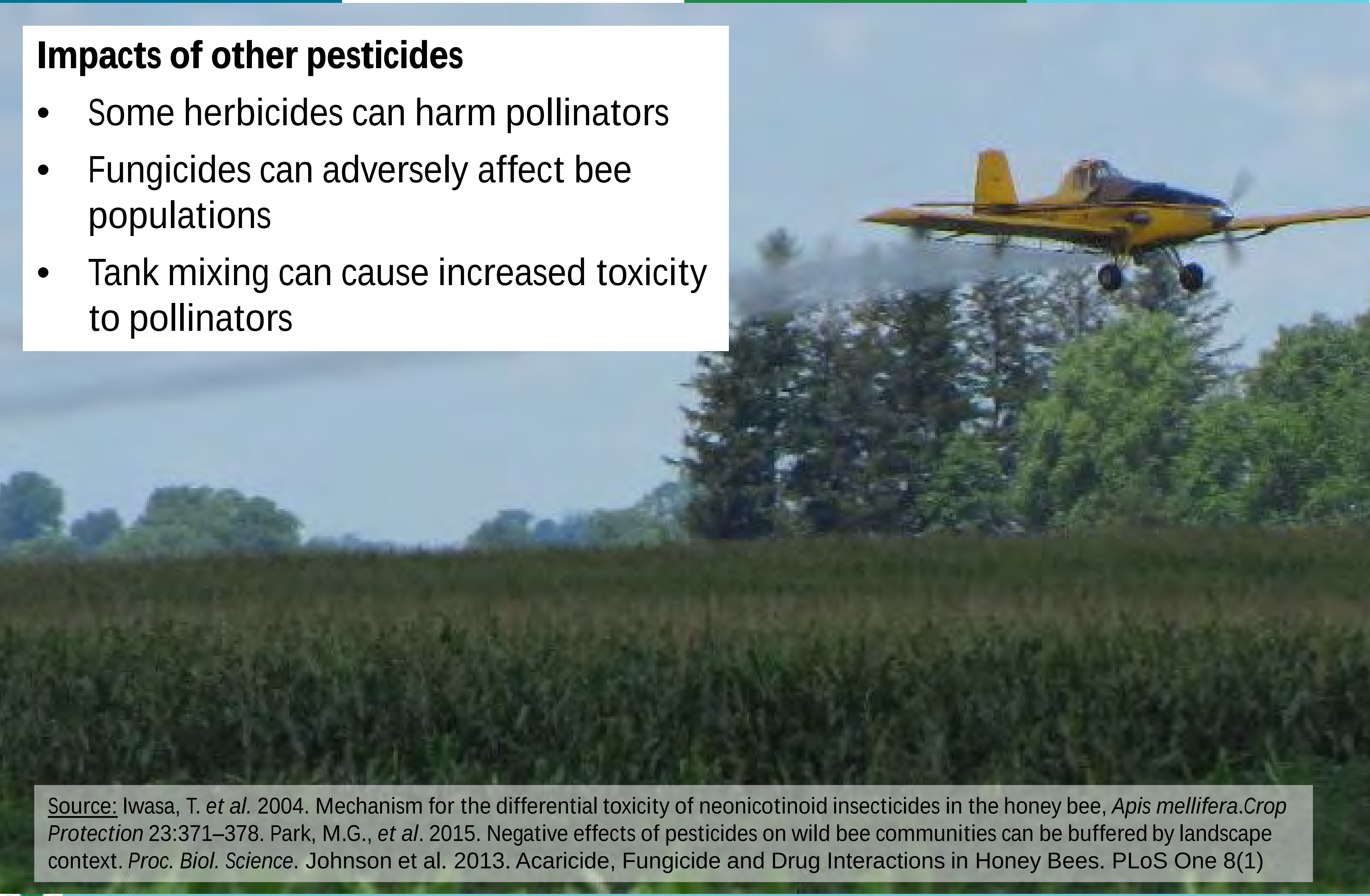
Risks of Neonicotinoids

Neonicotinoids on ornamental plants and lawns:

- Level of application can be **much** greater than on crops (up to 120x), which **increases** the risk to pollinators
- Avoid all cosmetic uses, especially to pollinator-visited plants in yards, parks (e.g. maple trees, linden trees, roses, sedum, etc.)
- Check with your nursery to make sure plants you purchase have not been treated with neonicotinoids

Photo: Matthew Shepherd/Xerces Society

Minimize Risk: Other Pesticides



Impacts of other pesticides

- Some herbicides can harm pollinators
- Fungicides can adversely affect bee populations
- Tank mixing can cause increased toxicity to pollinators

Source: Iwasa, T. *et al.* 2004. Mechanism for the differential toxicity of neonicotinoid insecticides in the honey bee, *Apis mellifera.Crop Protection* 23:371–378. Park, M.G., *et al*. 2015. Negative effects of pesticides on wild bee communities can be buffered by landscape context. *Proc. Biol. Science*. Johnson et al. 2013. Acaricide, Fungicide and Drug Interactions in Honey Bees. PLoS One 8(1)

Photo: USGS

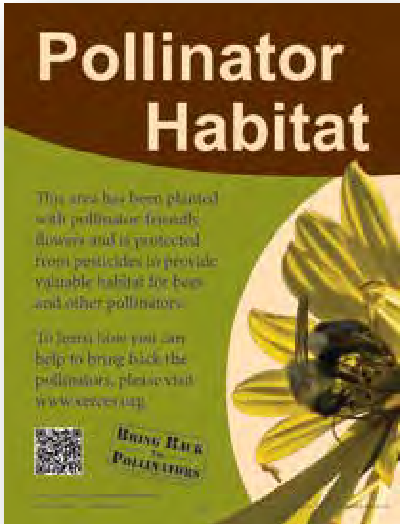
Minimize Risk: Herbicides

Minimize herbicide risk

- When applied with care, herbicides can be a useful habitat management tool
- Use targeted applications
- Maintain some flowering resources for pollinators

Photo: USDA-ARS

Resources: Pollinator Pledge



http://www.xerces.org/pollinatorprotectionpledge/

million pollinator garden challenge

XERCES SOCIETY for Invertebrate Conservation

national pollinator garden network

Resources: Citizen Science Opportunities

Bumble Bee Watch

Bumble Bee Identification Guide

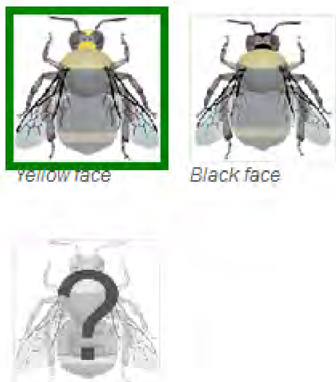
How to use this guide

This is an identification guide to help you determine the species of bumble bee in your ph
comprehensive as there are many additional color forms, and many look alike species. Se
anatomy. To use the ID guide, compare your photo(s) on the left to the illustrations and se
match the features on the bee in your photograph. Once you have chosen the correct fea
this identification guide, watch this video.

Mouse your cursor over your photo to see more detail.

Identification Guide

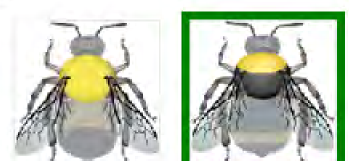
Face:



Yellow face *Black face*

Not Sure

Thorax:



All yellow *Yellow in front*

Dragonfly migration

Habitat to support pollinators: Schools

Sabin Elementary School: Portland, Oregon

Illustration: Ken Rumbaugh

Final Thoughts

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)

Loss of habitat

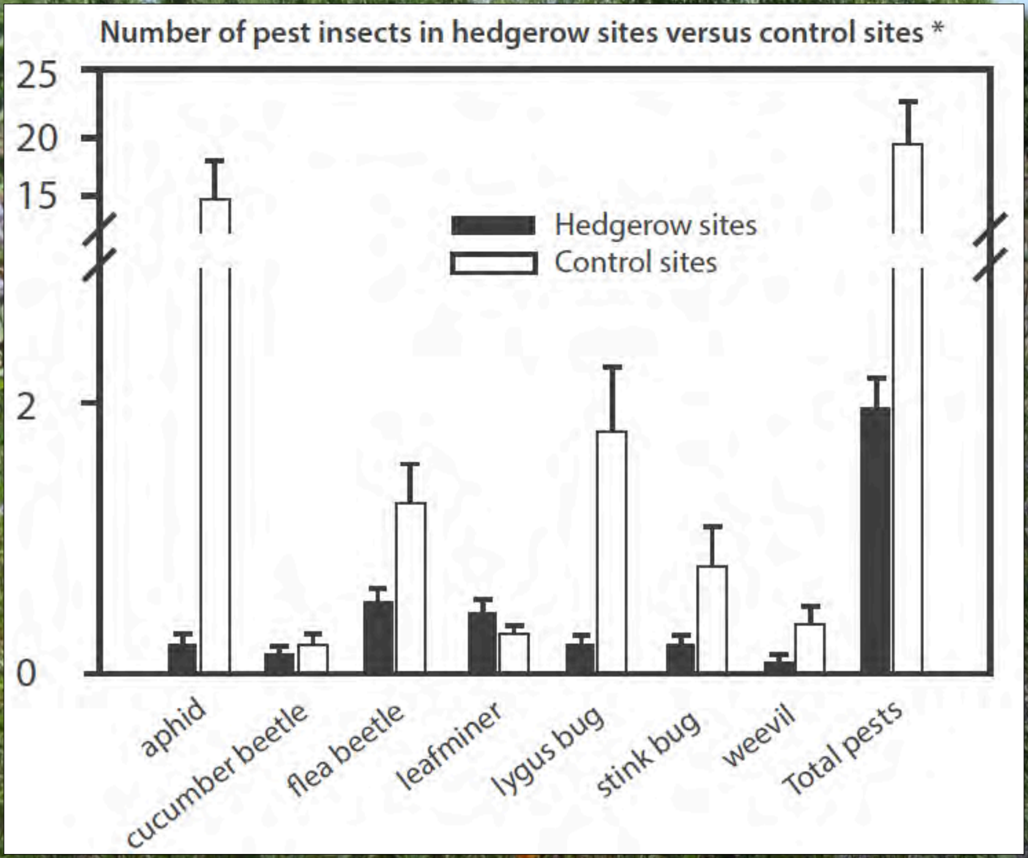
- 1.3 million acres of grassland/prairie converted to cropland in northern corn belt since 2008
- *Largest conversion of habitat to cropland since just before the Dust Bowl*

Wright and Wimberly 2013

Photo: Griggs Dakota

Benefits of Habitat

Hedgerows Do Not Increase Pest Populations



Graph: Fewer pests in and around hedgerows than in weedy / disturbed field edges

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

Photos: Michael Trolove

Habitat to support pollinators: Rights-of-Way

Utility corridors provide pollinators with food, shelter, and connectivity to other habitat

Source: Russell et al. 2005

Photo: Nancy Adamson

Protection from insecticides: Avoid using neonicotinoids

2013 The largest mass pesticide poisoning of bumble bees ever documented

Wilsonville Oregon, June 2013

Photos: Rich Hatfield

Managing Insecticides: Special Considerations

Assessing Toxicity: What is NOT on the Label

- Sub-lethal effects NOT on labels
  - lower fecundity, compromised larval development, or reduced foraging abilities in adults
- Affects on larvae not on label
  - testing done on adults
  - larva often affected differently
- Tank sprays – synergistic effects of mixing pesticides, not on labels
  - DMI fungicides w/ neonicotinoids or pyrethroids (triazoles)

(Moffet et al 2015, Brittain and Potts, 20111, Ramoutar et al 2010, Sandrock et al 2013, Rundlofet et al 2015), (Moffet et al 2015, Brittain and Potts, 20111, Ramoutar et al 2010, Sandrock et al 2013, Rundlofet et al 2015)

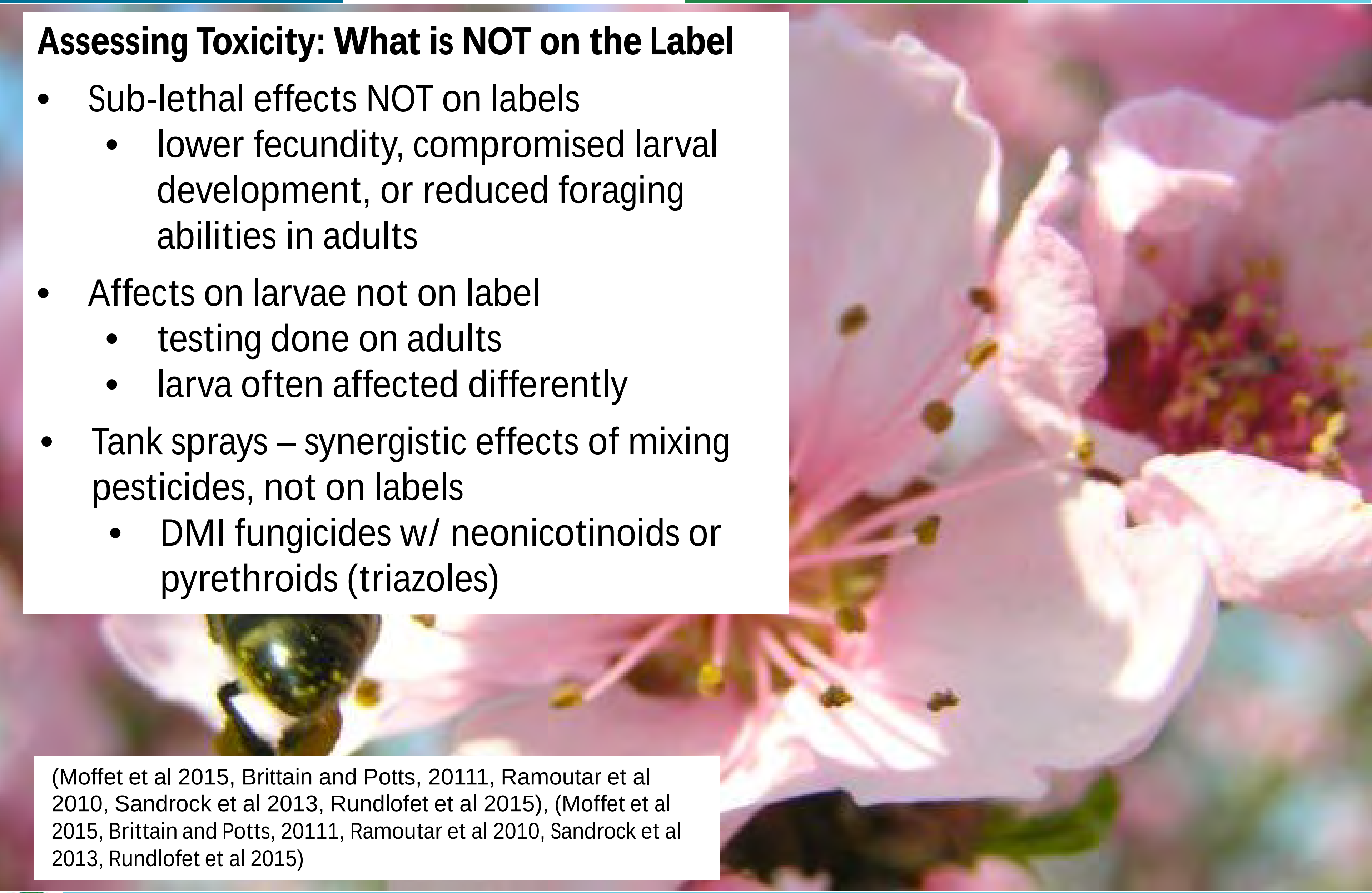


Photo: Nancy Adamson