# Benefits of Prairie Strips for Beneficial Insects - Pollinators, Honey bees, and Natural Predators

STRIPS project team

**Matt O'Neal,**

Caroline Murray, Drs. Amy Toth, Lisa Schulte Moore and Ge Zhang

Iowa State University

parasitoids

predators

# Natural enemies of insect pests


pathogens


Adam Varenhorst

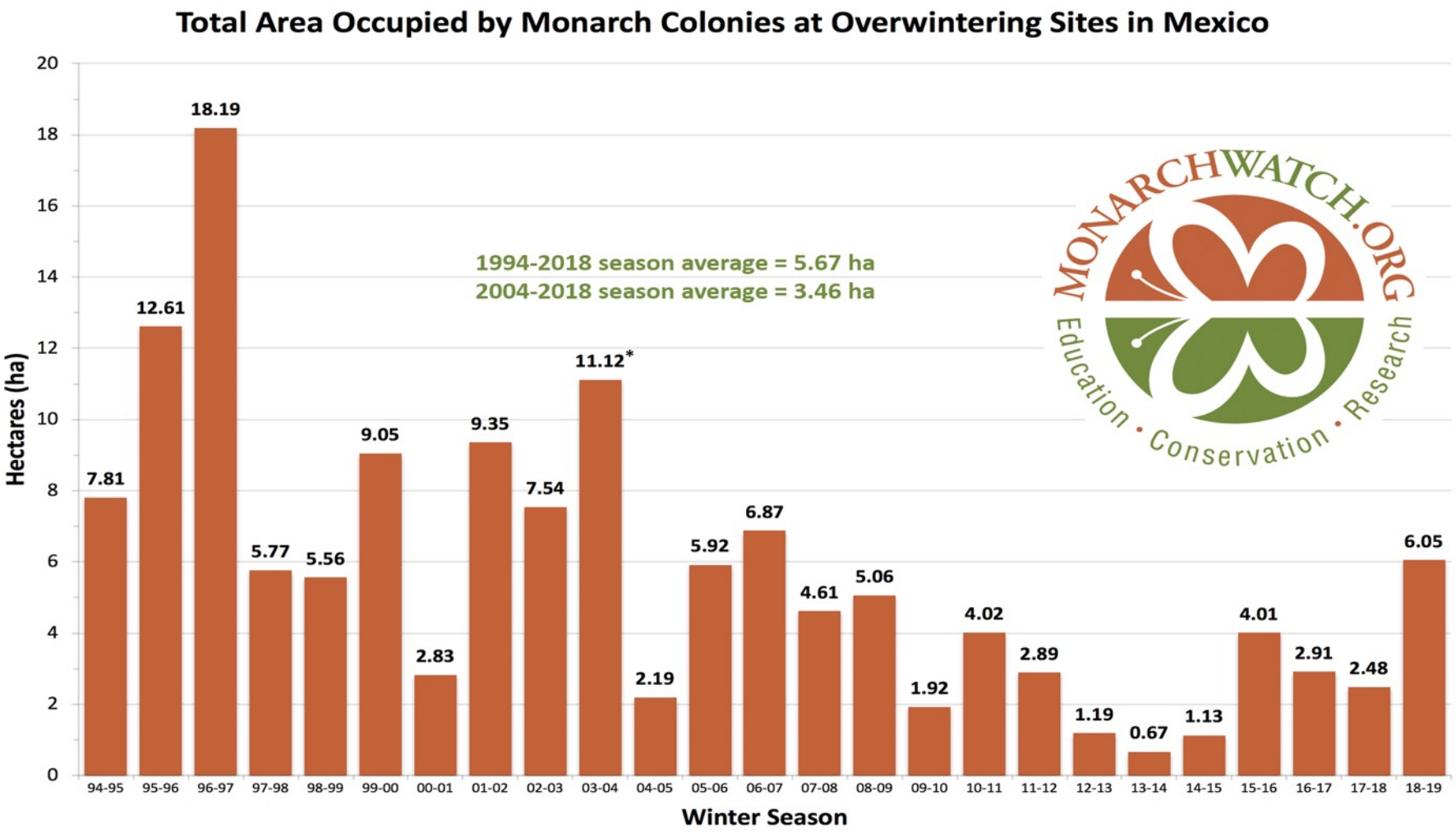
# What's the problem?

# Grassland Birds in decline

- 31 species in North America
- 74% of species in decline
- Habitat loss and pesticide exposure

Image: Jasper County; Anna MacDonald

# Monarch population in decline

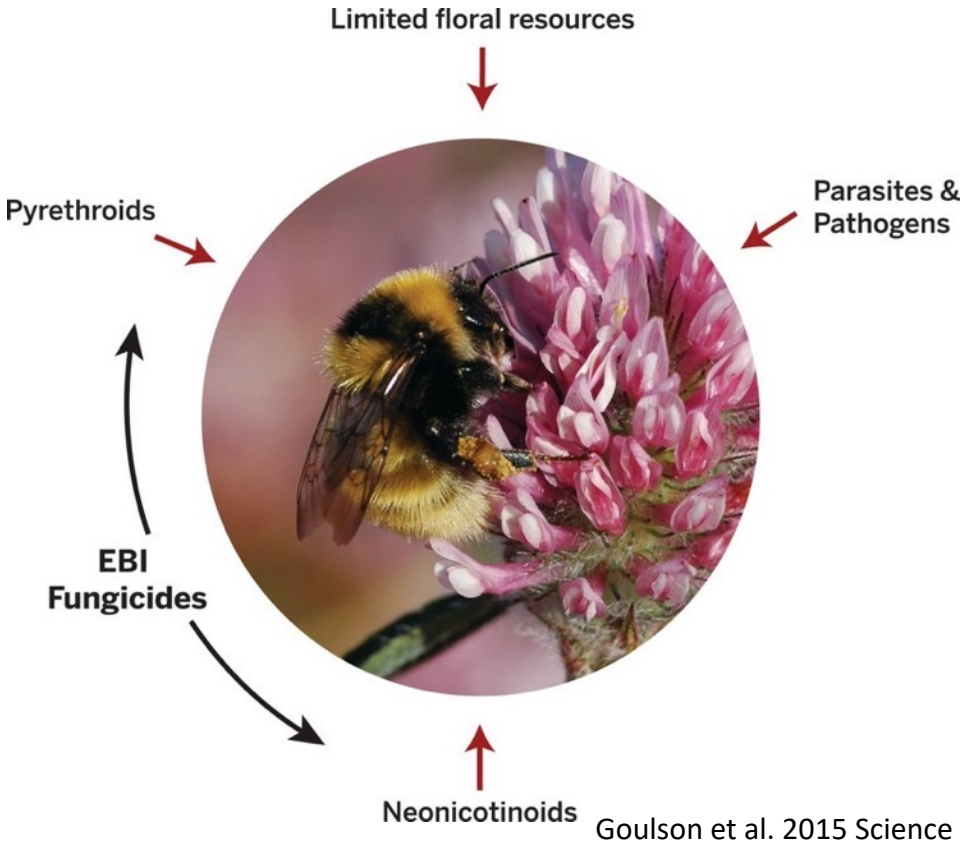



Data for 1994-2003 collected by personnel of the Monarch Butterfly Biosphere Reserve (MBBR) of the National Commission of Natural Protected Areas (CONANP) in Mexico. Data for 2004-2018 collected by World Wildlife Fund Mexico in coordination with the Directorate of the MBBR.

* Represents colony sizes measured in November of 2003 before the colonies consolidated. Measures obtained in January 2004 indicated the population was much smaller, possibly 8-9 hectares. CT

# North America Bees in decline

- 4000 species in North America
- 8 species listed as endangered
- Annual honey bee losses ≥ 30%


Goulson et al. 2015 Science

# Agriculturally dominated landscape

Green = land used for agriculture

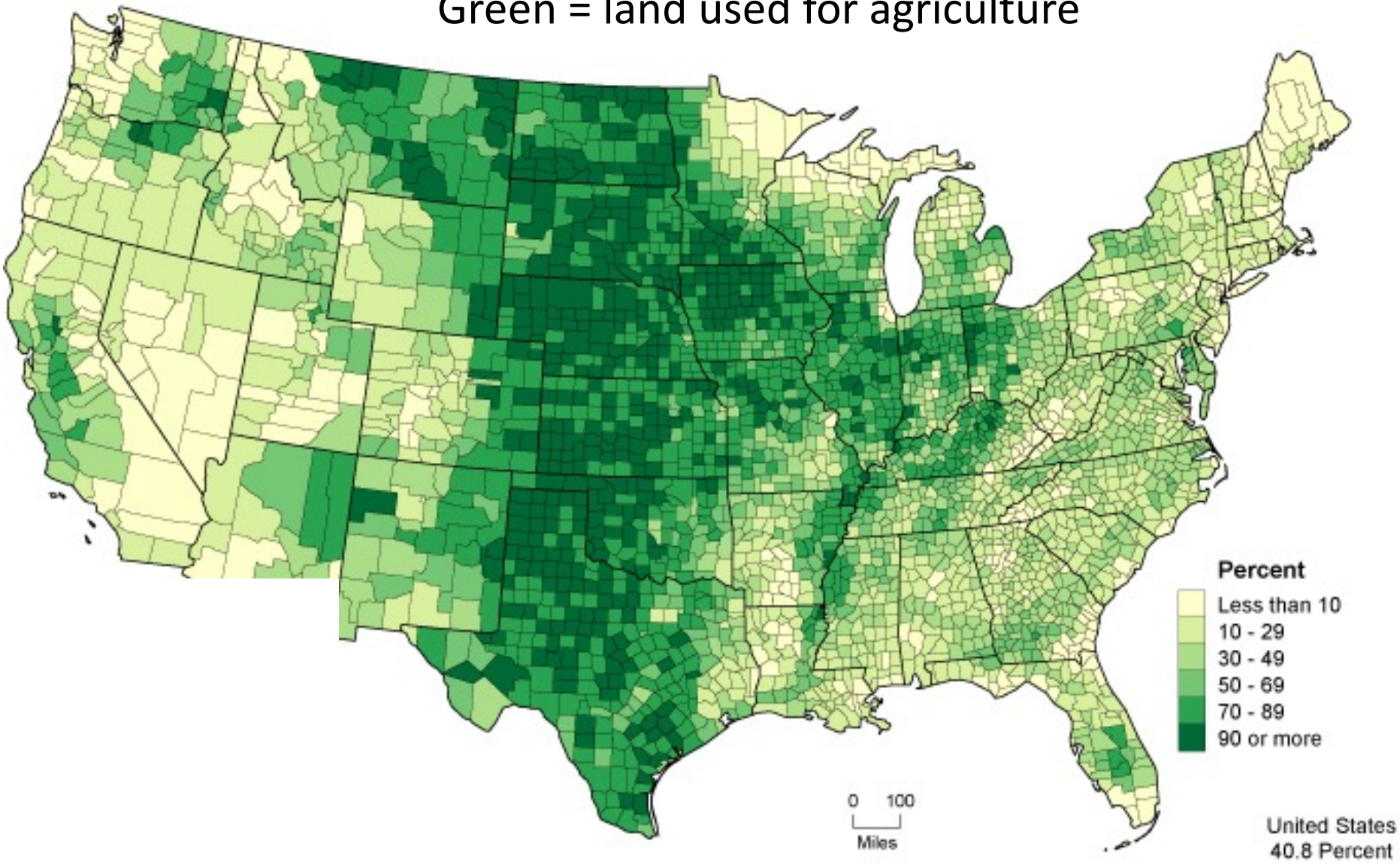


Image: Sac Co., Tim Youngquist


Image: Boone Co.; Todd Ontl

# FIELDS OF GREEN A DESERT FOR BEES

Story by Josephine Marcotty
Photos and videos by Renée Jones Schneider

Farmers such as Gary Schrad (above) have few alternatives to the high-tech seeds that produce big crops — but also create an unhealthy landscape for bees.

ALBERT LEA, MINN. / *Third in an occasional series*

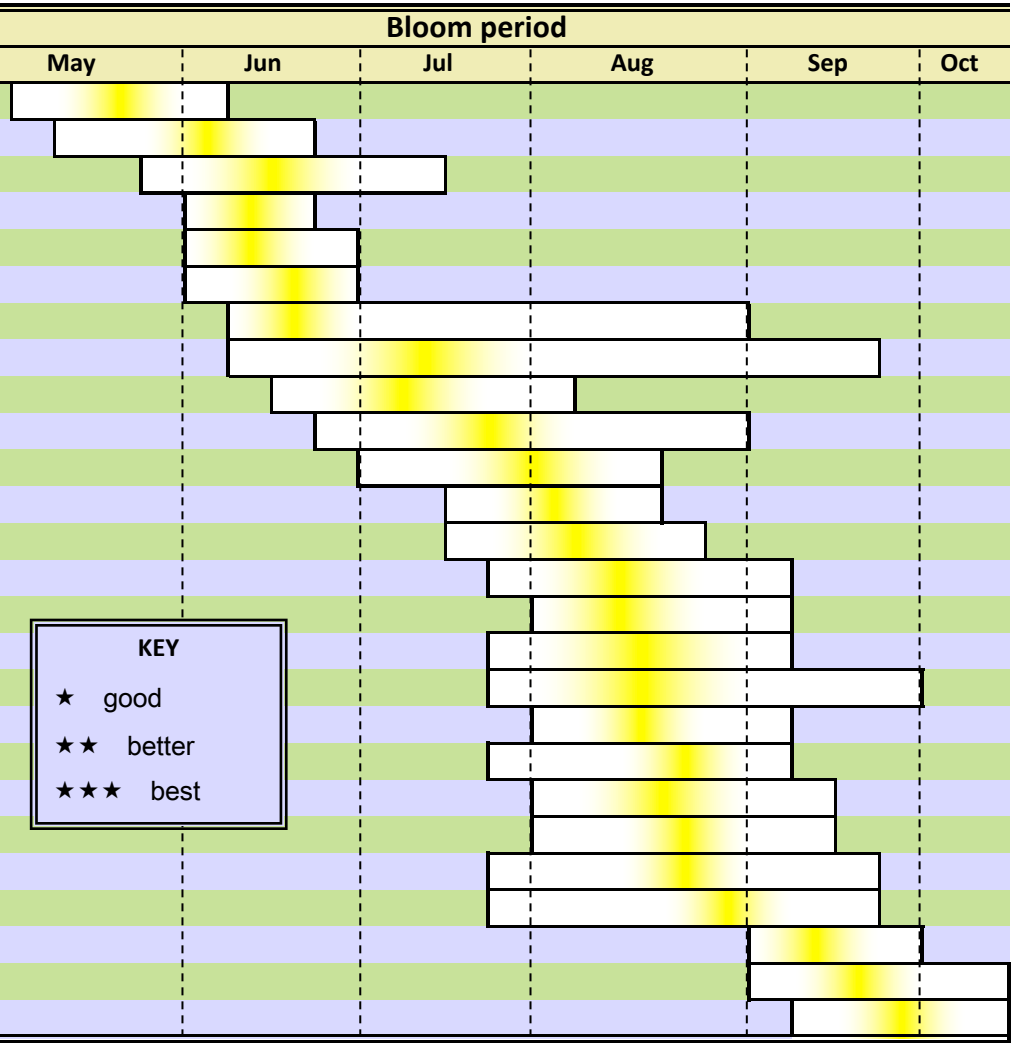
Is there a solution?

# Prairie covered the midwest before European settlers

**Visitation by wild and managed bees (Hymenoptera: Apoidea) to eastern US native plants for use in conservation programs**.
Tuell et al. 2008. Environmental Entomology 37: 707-718.

# Native plants attract bees

| Native plant | Natural enemies | Bees |
|---|---|---|
| wild strawberry | ★★ | ★ |
| golden alexanders | ★★★ | ★★ |
| Canada anemone | ★★★ | ★ |
| penstemon | ★★ | ★★ |
| angelica | ★★★ | ★ |
| cow parsnip | ★★★ | ★ |
| sand coreopsis | ★★★ | ★ |
| shrubby cinquefoil | ★★★ | ★ |
| Indian hemp | ★★★ | ★ |
| late figwort | ★★ | ★★ |
| swamp milkweed | ★★ | ★★ |
| Culver's root | ★★ | ★★★ |
| yellow coneflower | ★★★ | ★★ |
| nodding wild onion | ★ | ★★ |
| meadowsweet | ★★★ | ★★ |
| yellow giant hyssop | ★★ | ★★★ |
| horsemint | ★★★ | ★★ |
| Missouri ironweed | ★★ | ★★ |
| cup plant | ★★★ | ★★★ |
| pale Indian plantain | ★★ | ★★ |
| boneset | ★★★ | ★★ |
| blue lobelia | ★★★ | ★★★ |
| pale-leaved sunflower | ★★★ | ★★ |
| Riddell's goldenrod | ★★★ | ★★★ |
| New England aster | ★★★ | ★★ |
| smooth aster | ★★ | ★★ |

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www.nativeplants.msu.edu


*Where* can we practice
**PRODUCTION** & **CONSERVATION**
at the same time?

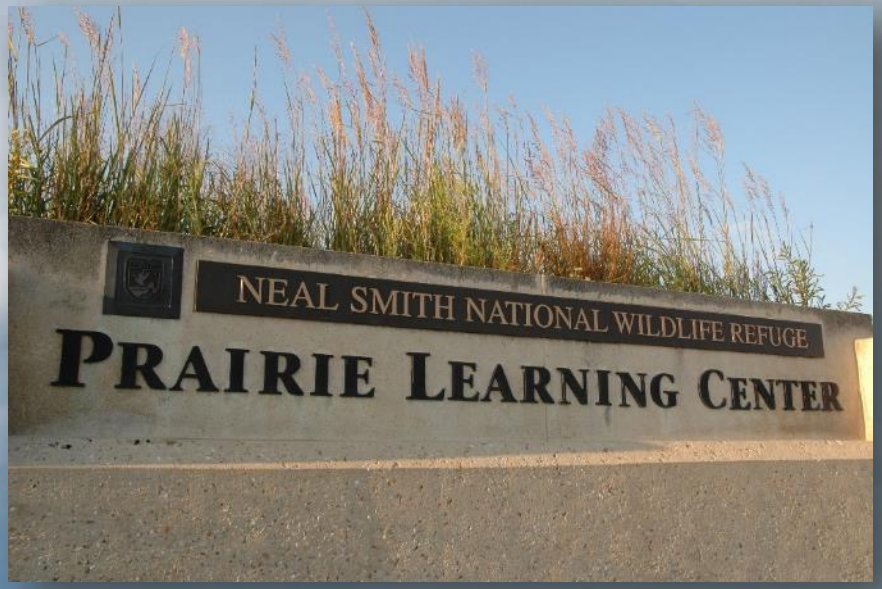

Lisa Schulte Moore, Matt Helmers, Matt Liebman, Jim Adelman, J. Arbuckle, Heidi Asbjornsen, Steve Bradbury, Cindy Cambardella, Mike Castellano, Rick Cruse, Pauline Drobney, Nancy Grudens-Schuck, Mary Harris, Michelle Hladik, Adina Howe, David James, Bob Klaver, Randy Kolka, Dana Kolpin, Laura Jackson, Mark Johnson, Bradley Miller, Tom Moorman, Jeri Neal, Jarad Niemi, Matt O'Neal, Mike Rentz, Kevin Roe, Michelle Soupir, Mark Tomer, Amy Toth, John Tyndall, John Westra, Brian Gelder, Maged Noshi, Karina Schoengold, Tim Youngquist, Dave Williams, Chris Witte, Xiaobo Zhou, Bethany Brittenham, Rachael Cox, Julia Dale, Lydia English, Jarad Flater, Jordan Giese, Jose Gutierrez-Lopez, Virginia Hernandez-Santana, Rene Hessel, Sarah Hirsh, Javed Iqbal, Farnaz Kordbacheh, Drake Larsen, Daniel Linton, Delise Lockett, Anna MacDonald, Mogan Mackert, Ryan Maher, Vilma Mateos-Remigio, David Mitchell, Amy Moorhouse, Julie Mueller, Matt Stephenson, Marlín Pérez-Suárez, Tomorra Smith, >75 undergraduate research assistants, >47 cooperating farmers & farmland owners







Image: Story Co., Drake Larsen




# STRIPS Phase 1:

## Research & demo on small experimental watersheds

Image: Jasper Co., Anna MacDonald

# Why prairie?

1. Perennial
2. Deep roots
3. Stiff stems that stay erect in a pounding rain
4. Diverse
5. Native

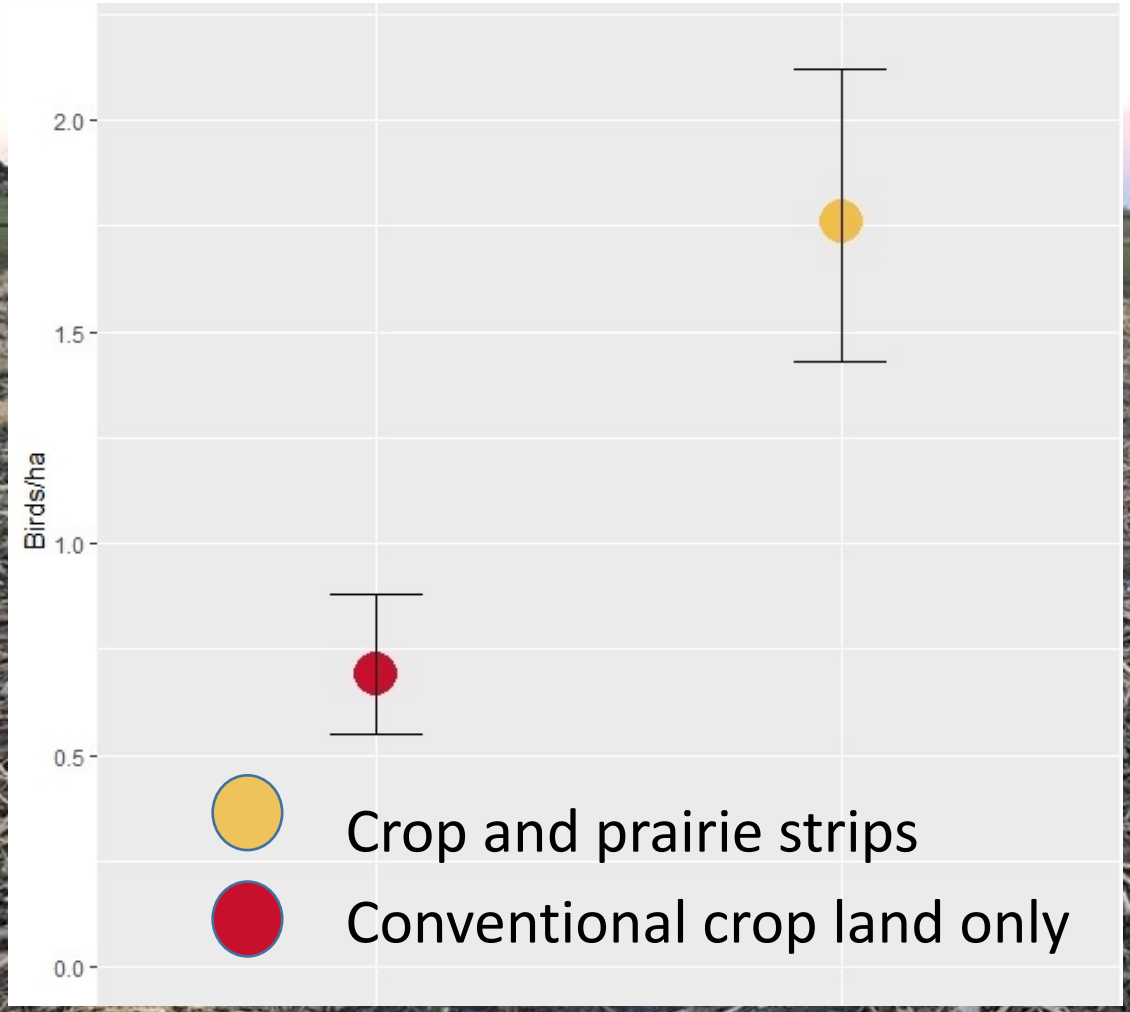
# How good is the solution*?

*in an on-farm, commercial setting.

Audio feature of bird call when activated.

Audio feature of bird call when activated.

# More grassland birds with strips




# Most Common Grassland Birds in Prairie Strips

Common Yellowthroat

Eastern Meadowlark*

Dickcissel*

Red-winged Blackbird

*Iowa species of greatest conservation need

# How good is the solution* for insects?

*in an on-farm, commercial setting.

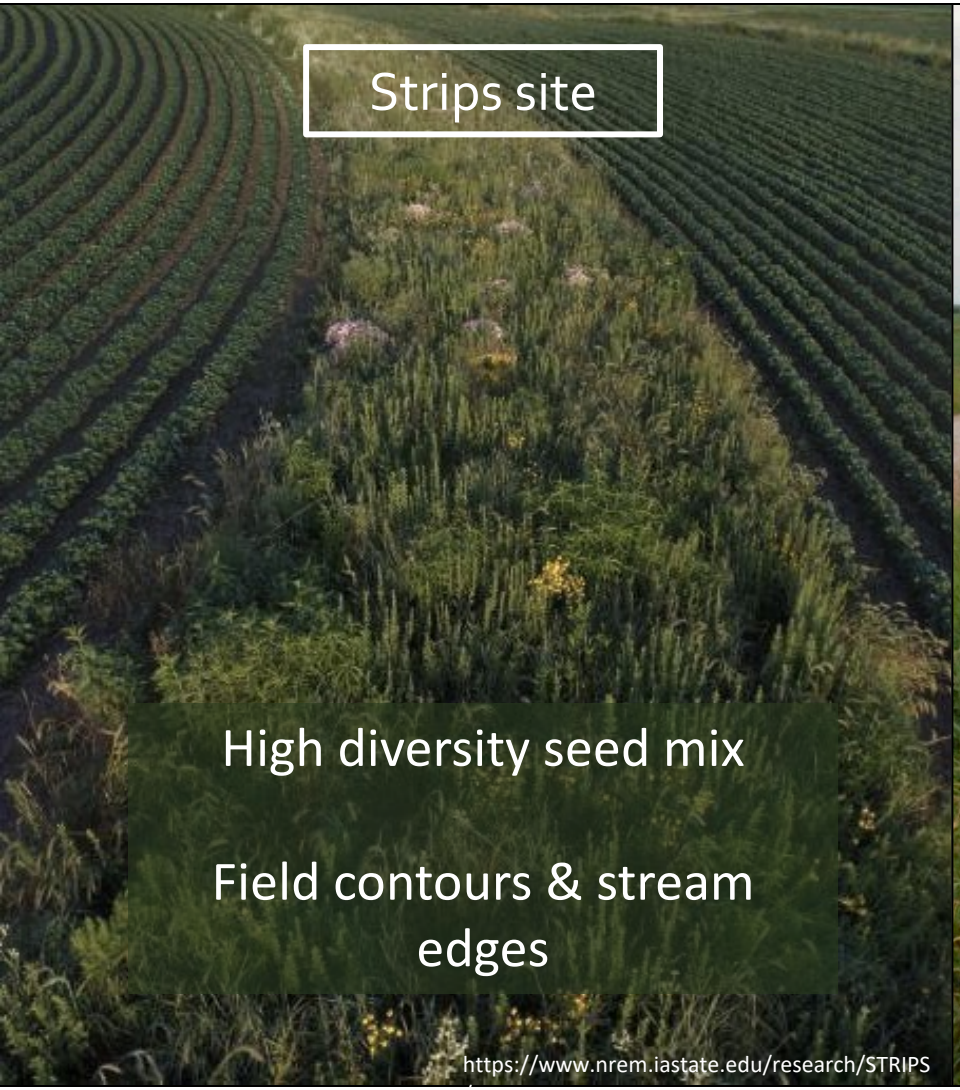
# Insect Response Field Team

Caroline Murray, M.S.
State of Oregon Dept. of Agriculture

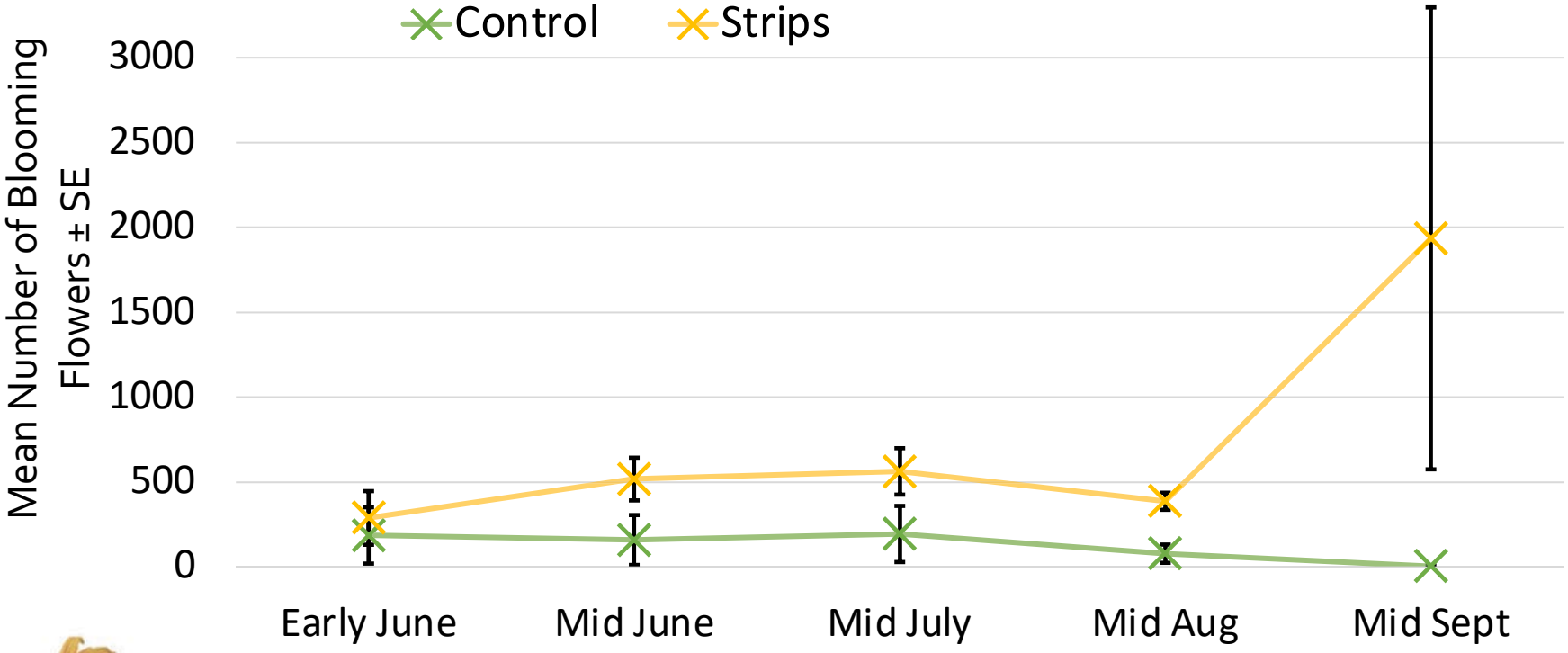
Maura Hall, Ph.D.
Proctor & Gamble

Ge Zhang, Ph.D.
Now a post-doctoral scientists
at Washington State University

# How good is it for pollinators?

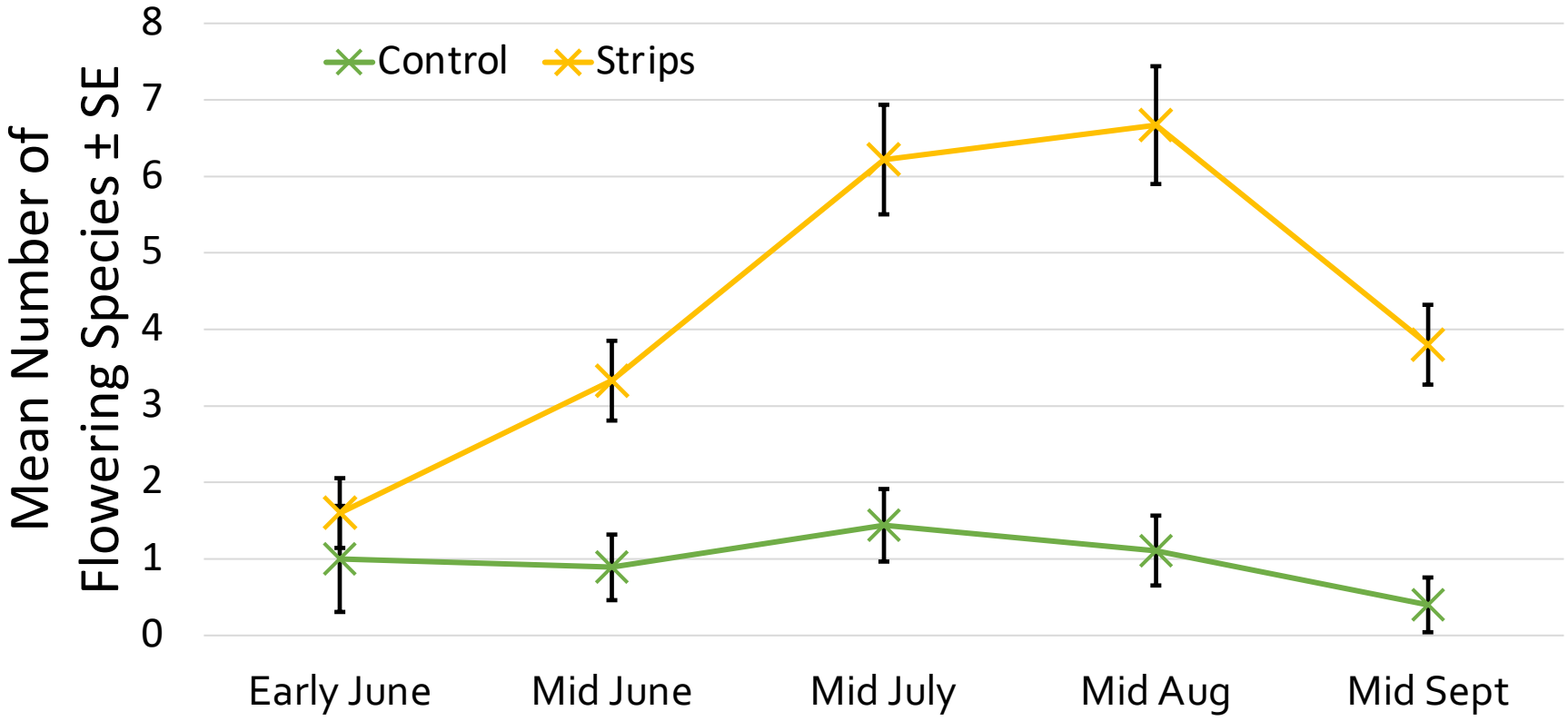



# More blooming flowers
## at farms with strips



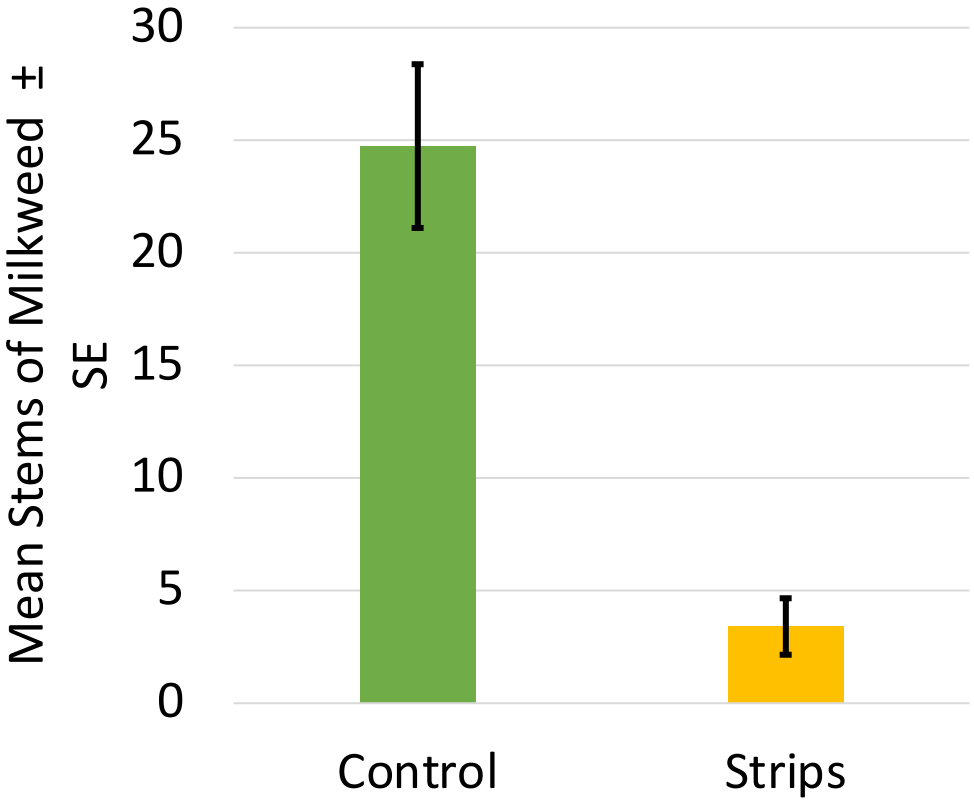

**ANOVA**
Site Type: 0.017*
Survey Period: 0.322
Site Type*Survey Period: 0.160

# Greater flower diversity at farms with strips




**ANOVA**
Site Type: <0.001***
Survey Period: <0.001***
Site Type*Survey Period: 0.003**

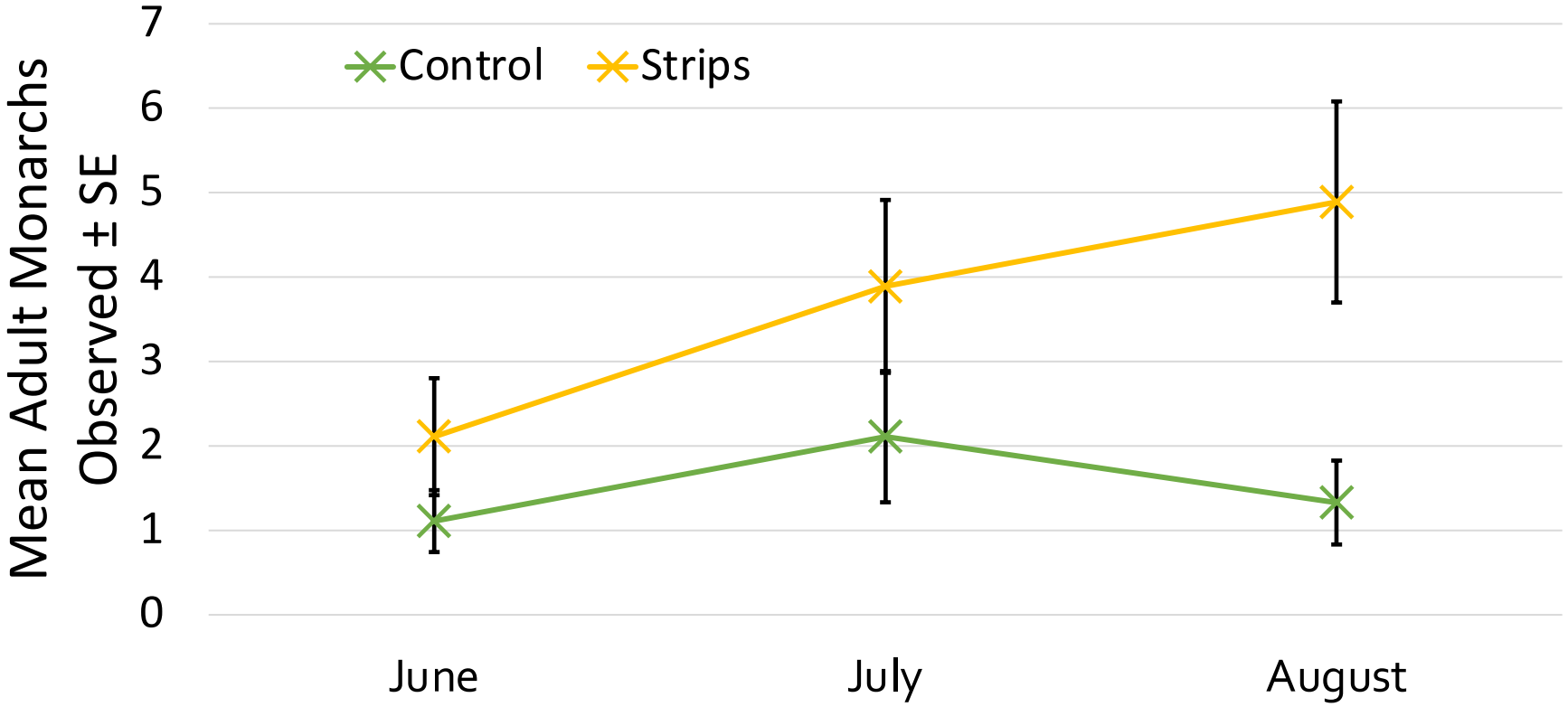
# More common milkweed at control sites




*p*-value: <0.001***; df: 34; t-stat: 5.44

Photo of a control site, July 16, 2019

# More adult monarchs
## at farms with strips




**ANOVA:**
Site Type: 0.004**
Survey period: 0.016*
Site Type*Survey Period: 0.321

# **Several native pollinators** in prairie strips


*Mellisodes bimaculata*

Family: Apidae


*Lasioglossum dialictus*

Family: Halictidae


*Agapostemon virescens*

Family: Halictidae

*Toxomerus marginatus*
Order: Diptera
Family: Syrphid

**Strips of prairie vegetation placed within row crops can sustain native bee communities**
https://journals.plos.org/plosone/article/authors?id=10.1371/journal.pone.0240354

Are these exposed to neonicotinoids?

Agriculture, Ecosystems & Environment
Volume 325, 28 February 2022, 107723


# Quantifying neonicotinoid insecticide residues in milkweed and other forbs sampled from prairie strips established in maize and soybean fields

Maura J. Hall [a, b], Ge Zhang [a, 1], Matthew E. O'Neal [a], Steven P. Bradbury [a, b, c], Joel R. Coats [a, b]

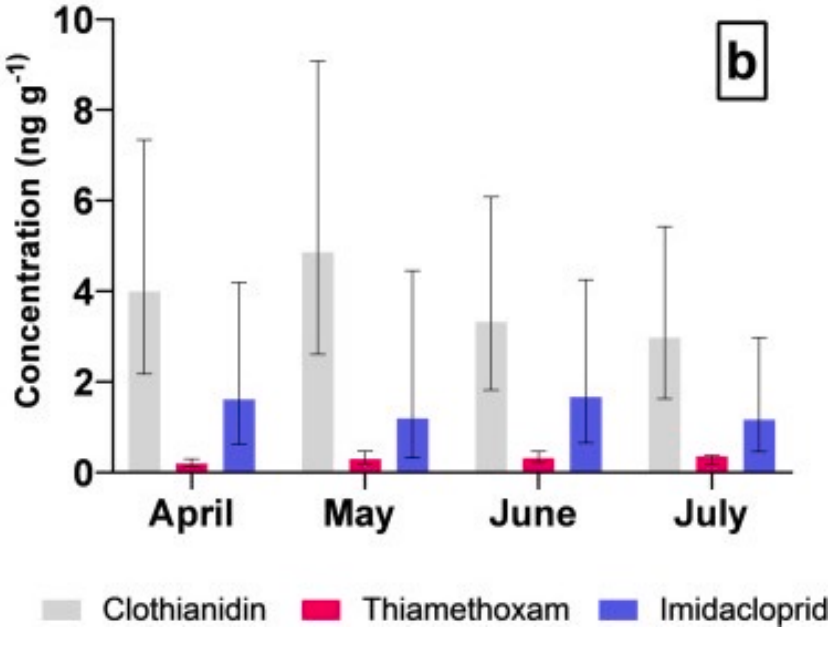
# Sample Collection

Soil

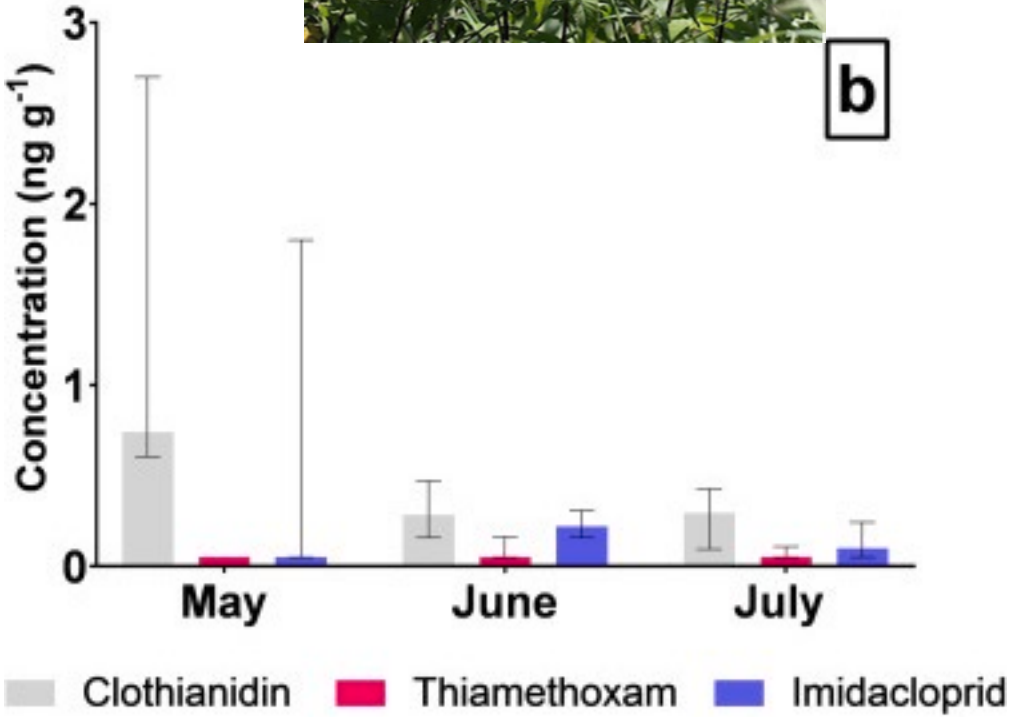
Plants

Images: Lynn Betts, Ge Zhang, Maura Hall

## Soil



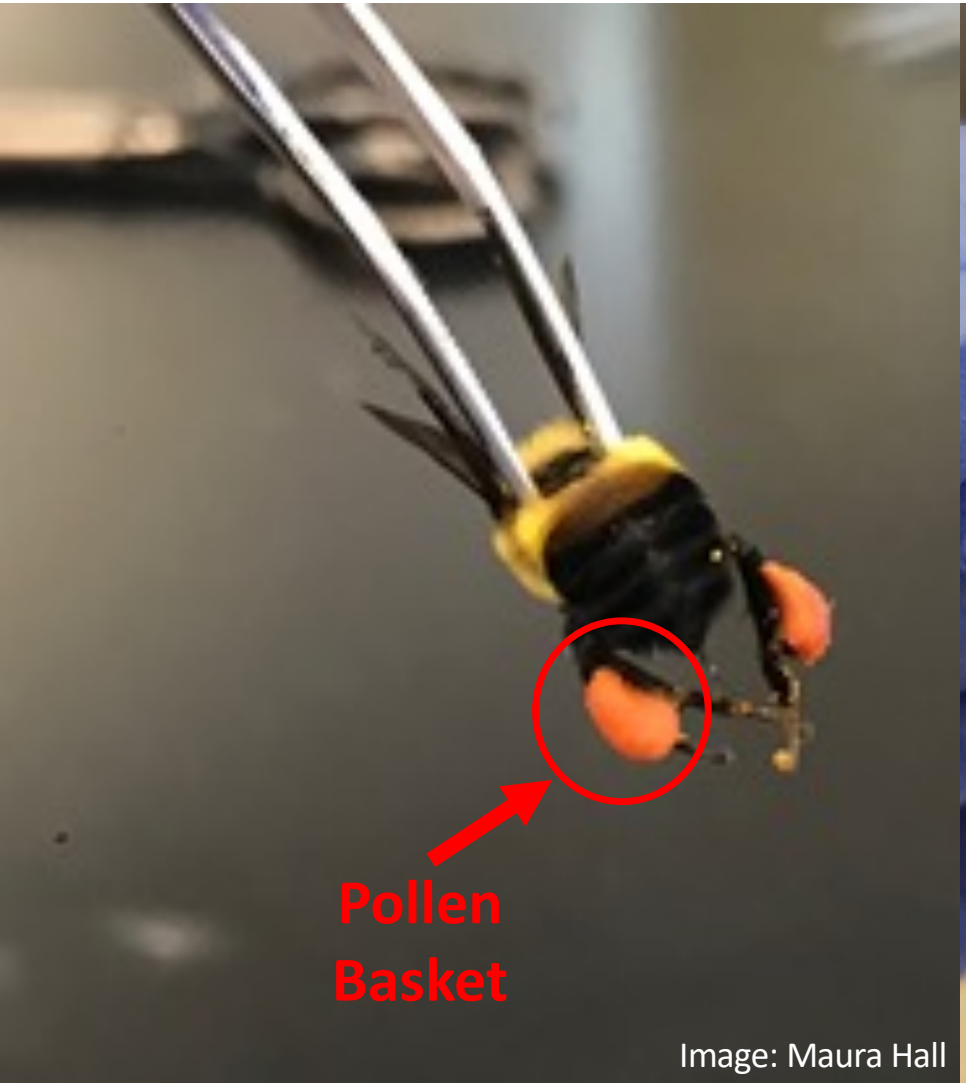

## Plants

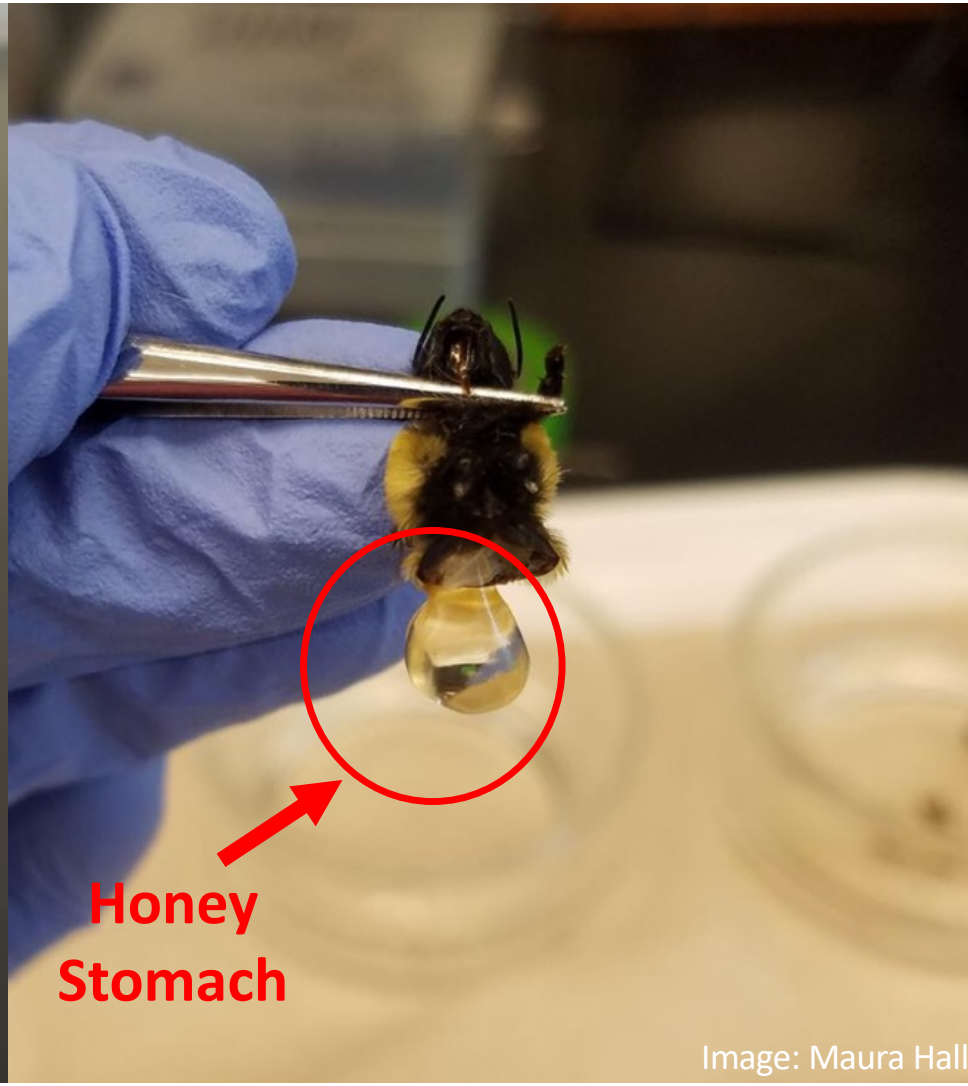



**Neonicotinoids found in the soil and leaf tissue of flowering plants in prairie strips**

Figures from Hall et al. 2022

# But are bees exposed to neonics in prairie strips?




Hall et al. Unpublished data

| Location | % detects of neonicotinoids |
| --- | --- |
| soil | 100% |
| plant tissue | 80% |
| nectar | 15.5% |
| pollen | 2.45% |
| | |

Hall et al. Unpublished data

| Location | % detects of neonicotinoids |
| --- | --- |
| soil | 100% |
| plant tissue | 80% |
| nectar | 15.5% |
| pollen | 2.45% |
| What about in the colony? | |

Hall et al. Unpublished data

| Location | % detects of neonicotinoids | Level of detection | Median concentration (max) |
|---|---|---|---|
| soil | 100% | | |
| plant tissue | 80% | | |
| nectar | 15.5% | | |
| pollen | 2.45% | | |
| Nurse worker bees | 0.12% | | |

Hall et al. Unpublished data

# Conclusions from Hall et al.

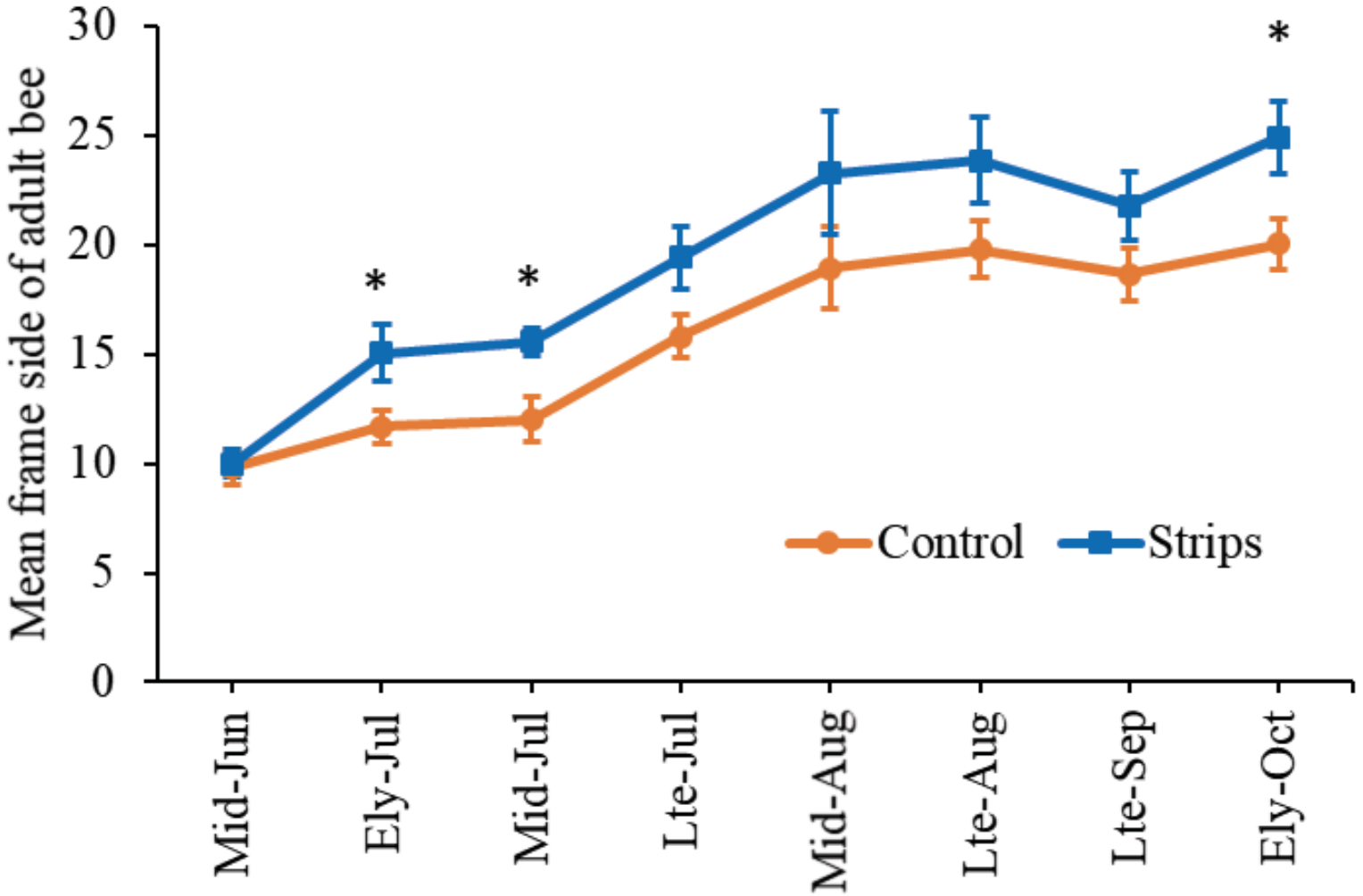
- Neonics are found in prairie strips, soil, flowering plants and pollen and nectar. (Hall et al. 2022)
- Frequency of detections declines from soil to nectar to bees. (Hall et al. 2022 and in prep)
- Concentrations are orders of magnitude below the $LC_{50}$ for monarchs. (Hall et al. 2022 and in prep)
- We observed no honey bee colony deaths in the 3 years of this study. (Zhang 2020)

Honey bees kept at control and prairie strips sites in 2017, 2018, & 2019.

Boxes added to allow colonies to grow, while measuring honey bee health.

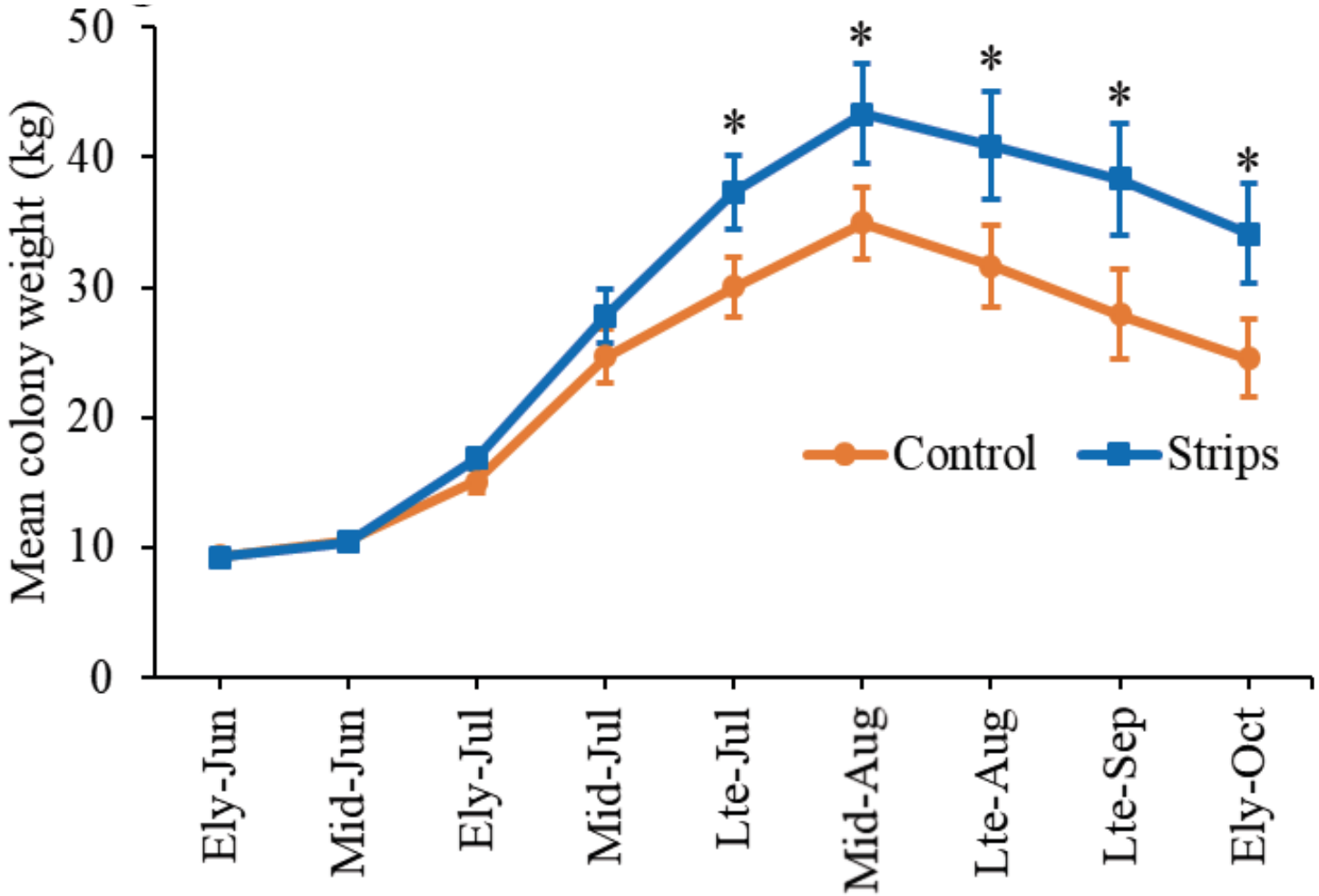
# Larger honey bee populations with prairie strips

Est. of adult honey bees



# Honey bees colonies gained more weight with strips

Est. of honey production



# More honey with prairie strips

**Bee hives at a control site, August 2019.**

**Bee hives in a prairie strip, August 2019.**

*Note extra box on each colony.*

# Prairie's conserve more than bees

https://bugguide.net/node/view/825817

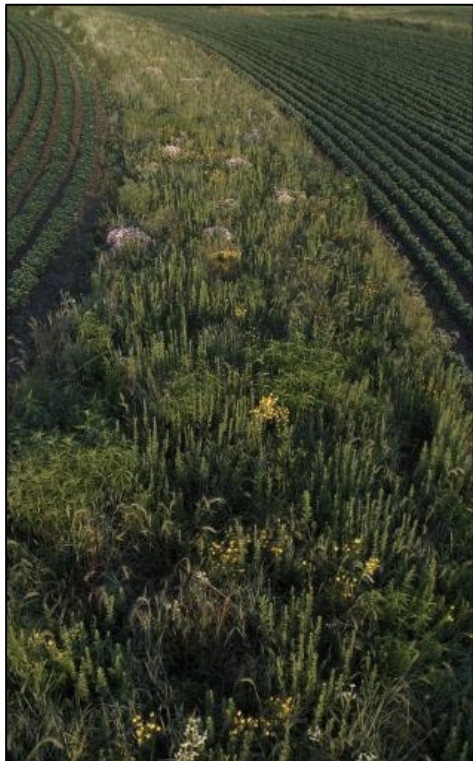
# What do we get from prairie strips*?

*in an on-farm, commercial setting.

# Prairie strips…

- increased **bird abundance**,
- increased number of **flowers**,
- increased **flowering plant diversity**,
- increased abundance of **pollinators**,
- increased **honey bee productivity**,
- increased abundance of **key natural enemies**.

***All occurred on commercial farms using herbicides and insecticides (including neonicotinoid seed treatments)***.

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RESEARCH STATION, AMES, IOWA
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# Resources

- Prairie Strips. Iowa State University https://www.nrem.iastate.edu/research/STRIPS/
- Email prairiestrips@iastate.edu
- Follow us on Twitter @prairiestrips

**Undergraduates + Techs**

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Madison McQueen
Morgan Lichtenstein

**Amy Toth Lab + Adam Dolezal Lab**

Ashley St. Clair
Ge Zhang
Amy Geffre
Harmen Hendriksma

**STRIPS Project**

Lisa Schutle Moore
Tim Youngquist
Omar de Kok-Mercado

**Soybean Entomology Lab**

Erin Hodgson
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Greg VanNostrand

**www.prairiestrips.org**

**prairiestrips@iastate.edu**

**@prairiestrips**

Agricultural Research Service

McIntire-Stennis Program

Committee on Agricultural Development

Iowa Natural Heritage Foundation

# How can I make this work on my farm?

**Natural Resources**

- Agriculture
- Buffer Law
  - Does this apply to my land?
  - What can I plant?
  - Where can I get support?
  - I need more time
  - Alternative Practices
  - Buffer Maps
- Climatology
- Energy
- Environmental Education
- Environmental Management
- Forests & Forestry
- Geographic Information
- Minerals
- Pollution
- Renewable Energy
- Sustainability
- Waste Disposal
- Water
- Wildlife

# Minnesota Buffer Law

Minnesota's buffer law establishes new perennial vegetation buffers of up to 50 feet along lakes, rivers, and streams and buffers of 16.5 feet along ditches. These buffers will help filter out phosphorus, nitrogen and sediment. The deadline for implementation for buffers on public waters is November 1, 2017. The deadline for public ditches is November 1, 2018. The law provides flexibility for landowners to install alternative practices with equivalent water quality benefits that are based on the Natural Resources Conservation Service Field Office Technical Guide.

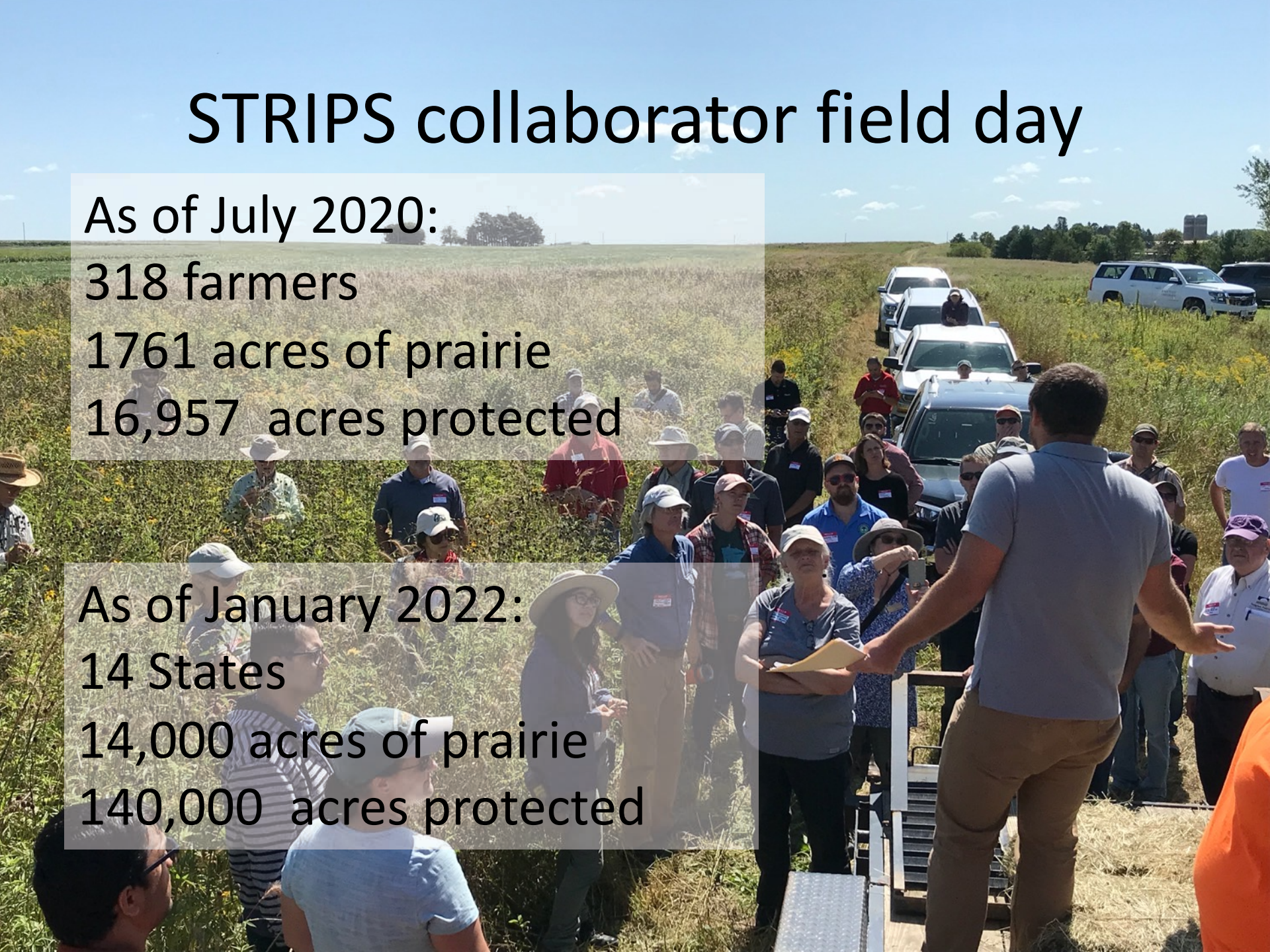
The Board of Water and Soil Resources (BWSR) reports that statewide 89% of parcels adjacent to Minnesota waters meet preliminary compliance with the law. Soil Water Conservation Districts (SWCDs) are reporting encouraging progress in their work with landowners around the state. View the buffer maps for a visual representation of the Minnesota Buffer Law.

# STRIPS Phase 2:

## Research & Demonstration on Commercial Farms


Image: Tama Co., Tim Youngquist

# STRIPS collaborator field day

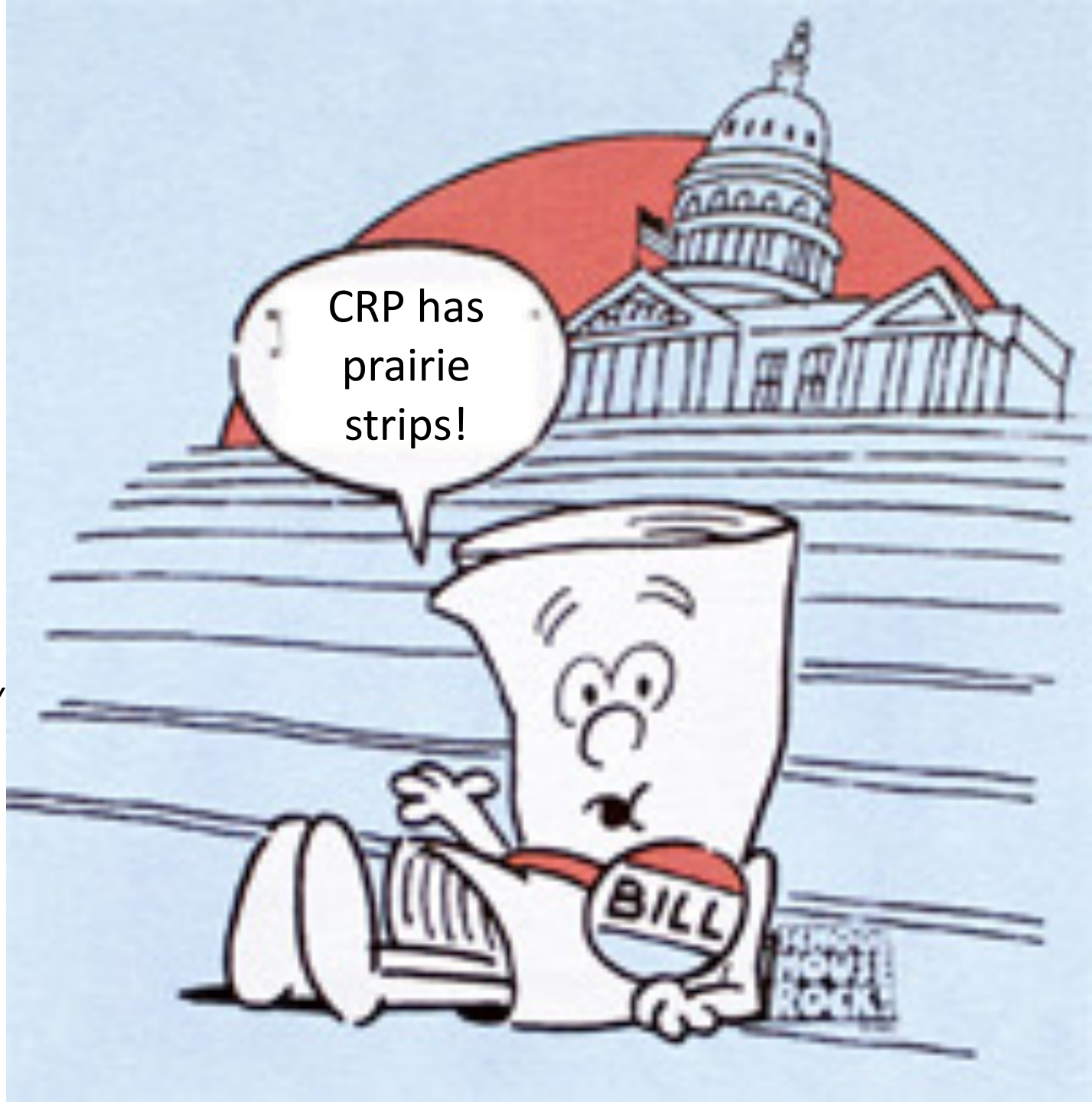


As of July 2020:
318 farmers
1761 acres of prairie
16,957 acres protected

As of January 2022:
14 States
14,000 acres of prairie
140,000 acres protected

*Prairie strips are eligible for CRP cost-share*

*Details at: https://www.nrem.iastate.edu/research/STRIPS/content/faq-what-do-prairie-strips-cost*



# Conservation Programs & Prairie strips

(Note - programs can vary by state, county & year)

1. Conservation Reserve Program:
   CP 15A – Contour Grass Strips*
   CP 21 – Filter Strip
   CP 42 – Pollinator Habitat
   CP 33 – Upland Bird Habitat*
   CP 43 – Prairie strip
1. Environmental Quality Incentive Program (EQIP, NRCS):
   Practice 332 - Contour Buffers Strips
   Practice 393 – Filter Strips
2. US Fish and Wildlife Service Partners Program
3. Non-gov conservation programs may apply:
   Pheasants Forever
   Trees Forever

# Resources

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Agricultural Research Service

McIntire-Stennis Program

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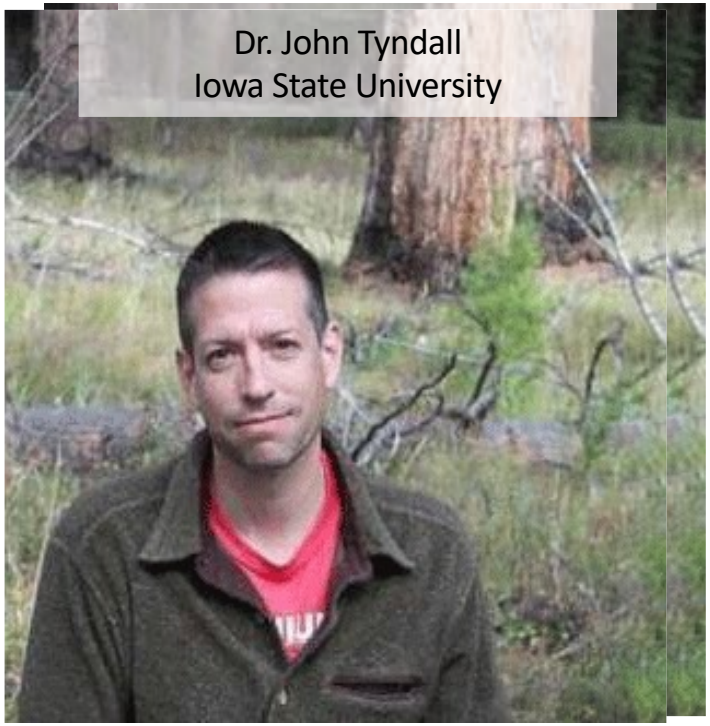
# Key references


- Kulhanek et al. 2017. A national survey of managed honey bee 2015–2016 annual colony losses in the USA, Journal of Apicultural Research. 56:328-340, DOI: 10.1080/00218839.2017.1344496To link to this article: http://dx.doi.org/10.1080/00218839.2017.1344496
- Koh et al. 2016. Modeling the status, trends, and impacts of wild bee abundance in the United States. Proceedings of the National Academy of Sciences 113 (1) 140-145; https://doi.org/10.1073/pnas.1517685113
- Schulte et. al. 2017. Proceedings of the National Academy of Sciences. 114 (42) 11247-11252; https://*doi*.org/*10.1073/pnas.1620229114*.
- M. J. Wheelock, K. P. Rey, M. E. O'Neal. 2016. Defining the Insect Pollinator Community Found in Iowa Corn and Soybean Fields: Implications for Pollinator Conservation, Environmental Entomology, Volume 45: 1099–1106, https://doi.org/10.1093/ee/nvw087
- https://www.nrem.iastate.edu/research/STRIPS/

# ***Cost of prairie strips***!

www.extension.iastate.edu/alternativeag/info/Cost of Prairie Conservation Strips.pdf




## The Cost of Prairie Strips

### What are prairie strips?

Prairie strips are a tool for improving the health and function of row crop farm fields. Researchers at Science-based Trials of Row crops Integrated with Prairie Strips (STRIPS) have found that strategically planting native prairie in farmland provides benefits to the land, water, and wildlife well beyond the area of land converted.

### How much does prairie planting cost?

Table 1 represents typical costs for a prairie strip planting after soybean. The range of costs is calculated based on average land rent across cropland quality, as measured by its Corn Suitability Rating (CSR). The water runoff from every nine acres of row crops can be treated with just one acre of perennial prairie. So, for every ten acres of farmland, the average total annual cost of converting one acre of cropland to prairie ranges from $280 to $390. In other words, converting a tenth of every acre from annual crop to prairie costs between $28 to $39 per year.

Some farms may experience higher "opportunity costs" than the average farm (e.g. in terms of foregone rent or revenue), thus annual costs can scale higher in these cases. However, the USDA Farm Service Agency also offers Conservation Reserve Program (CRP) contracts. Under a 15-year CRP contract, farmers could receive a total cost reduction of approximately 75 percent, thus costing about $8 per year per crop acre treated with prairie. Other sources of financial support are also available (see reverse side).

**Table 1.** Annualized total costs of prairie strips calculated over a 15-year management period at a 2% discount rate (in 2017 dollars)

| | High quality (CSR 83) | Medium quality (CSR 73) | Low quality (CSR 60) |
|---|---|---|---|
| Per acre of prairie | $353 | $319 | $279 |
| Per protected crop acre | $35 | $32 | $28 |
| Per protected crop acre with CRP | ~ $8 | ~ $8 | ~ $8 |

*See following page for detailed cost breakdown.*

### Why plant prairie strips on farmland?

Prairie strips are of primary importance because they prevent soil erosion and nutrient runoff from farmland. Specifically, converting 10 percent of farmland to prairie can reduce sediment and nutrient transport off the field into waterways by more than 90 percent. Strips also increase plant, pollinator and wildlife diversity and create opportunities for economic diversification on farms.

### What else to consider

Before farmers choose one or several best management practices (BMPs) to implement, three factors should be considered: effectiveness of the BMP in performing its intended field-level task (e.g., reducing run-off, increasing biodiversity, retaining nutrients, improving soil health); compatibility of the practice relative to the current operation in terms of equipment and time/labor availability, etc.; and financial feasibility of the practice relative to alternative management options. Prairie strip plantings require minimal land conversion and maintenance, and are among the cheapest BMPs, especially when combined with a CRP contract.

For their size, prairie strips result in dramatic, disproportionally large benefits to the landscape. In other words, a little goes a long way toward soil conservation, nutrient retention, wildlife habitat and the long-term economic productivity and sustainability of farmed landscapes.

IOWA STATE UNIVERSITY
Extension and Outreach

AE 3611 June 2017

# ***Average*** Prairie Strip Cost

*Cost calculation assumptions:*

- *Planting after soybeans 15-yr management period*
- *Ave 2017 Iowa land rents to represent opportunity cost*
- *One acre of prairie "treats" the run-off from about 9 acres of row crops*

| **Annualized Total Costs** | Higher Quality Land (CSR 83) | Medium Quality Land (CSR 73) | Lower Quality Land (CSR 60) |
|---|---|---|---|
| Per acre of prairie | $353 | $319 | $279 |
| Cost per treated acre | $35 | $32 | $28 |

For reference, cover crops in Iowa cost ~ $40 to $60 per acre/ year

≤ 10% of total cost


+

~ 10% - 15% of total cost


+

> 75% total cost

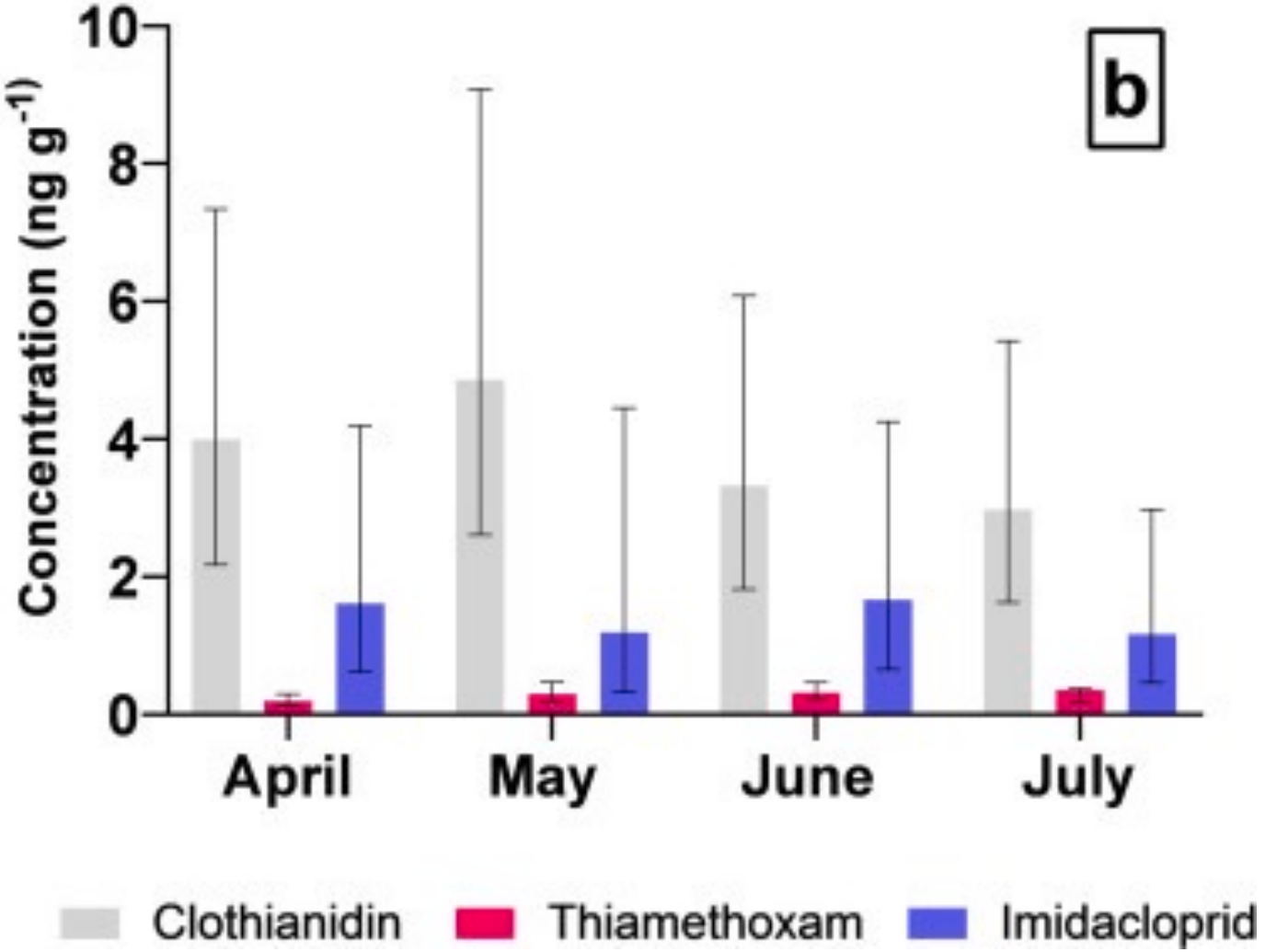



**Fig. 3**. Median soil concentration ( ± 95% confidence interval) of neonicotinoids per prairie strip for months sampled in 2017 (a) and 2018 (b).

From Hall et al. 2022

Image: Jasper Co., Anna MacDonald

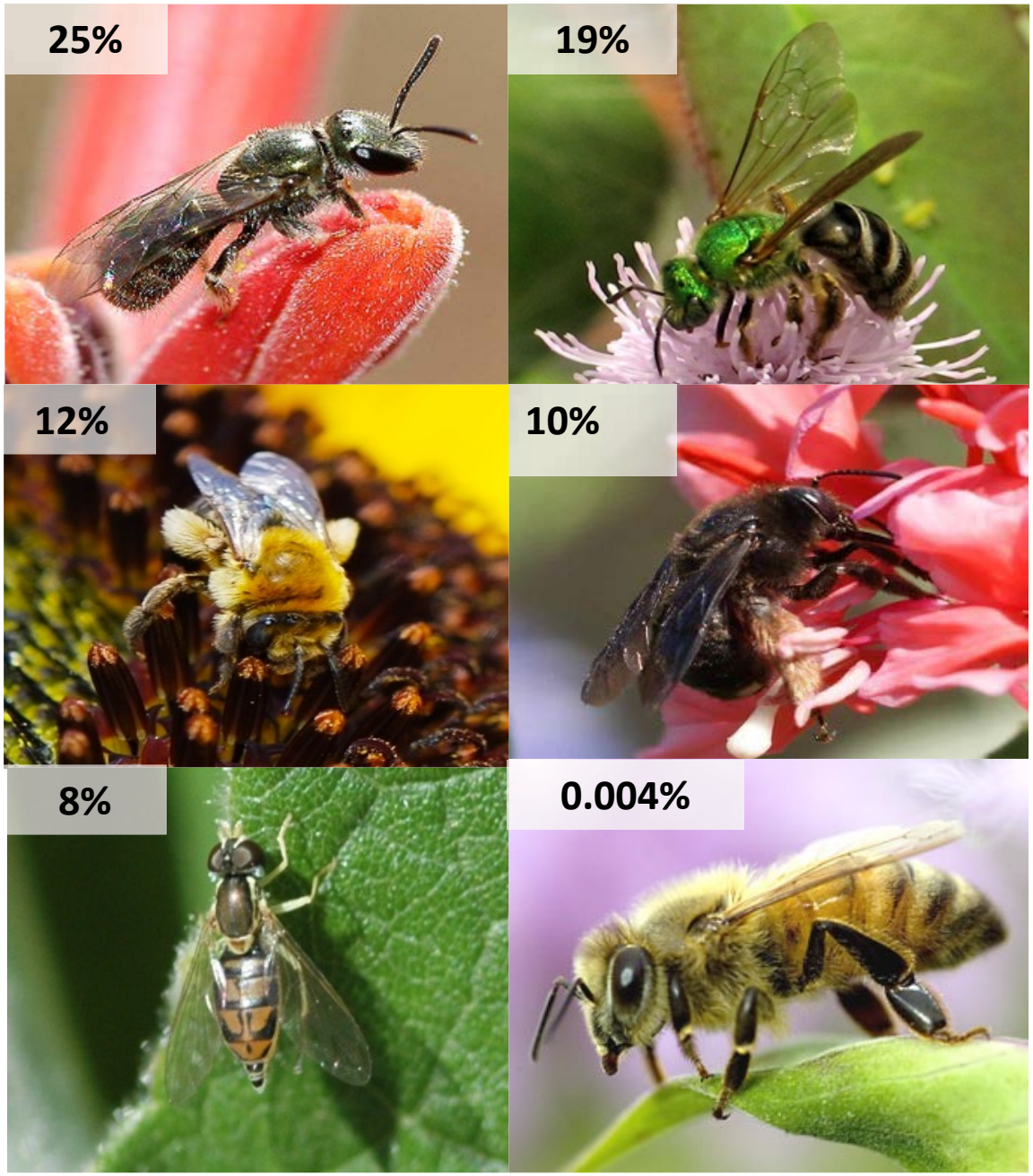
## 100% crops

## 100% prairie

## 90% crops : 10% prairie


Sources: Zhou et al. 2012, Helmers et al. 2012, Hernandez-Santana et al. 2013, Iqbal et al. 2014, Mitchell et al. 2014, Zhou et al. 2014

# Pollinators persist in Iowa corn & soybean fields*




*Wheelock et al. 2016

# Neonics in pollen and nectar but…

| Matrix | Year | | CLO | TMX | IMI |
|---|---|---|---|---|---|
| Pollen | 2017 | Detections (%) | 25 | 0 | 31.3 |
| | | Max (ng $g^{-1}$) | 2.41 | | 22.7 |
| | 2018 | Detections (%) | 22.2 | 11.1 | 33.3 |
| | | Max (ng $g^{-1}$) | 2.41 | 5.12 | 1.27 |
| | 2019 | Detections (%) | 4.2 | 0 | 8.3 |
| | | Max (ng $g^{-1}$) | 0.79 | | 11.0 |
| Nectar | 2017 | Detections (%) | 0 | 6.25 | 0 |
| | | Max (ng $g^{-1}$) | | 0.174 | |
| | 2018 | Detections (%) | 0 | 7.17 | 0 |
| | | Max (ng $g^{-1}$) | | 0.176 | |
| | 2019 | Detections (%) | 0 | 4.35 | 4.35 |
| | | Max (ng $g^{-1}$) | | 4.16 | 1.95 |

LOQ – ranged from 0.03 to 0.5 ng $g^{-1}$

Hall et al. Unpublished data