

2015 KBS LTER Symposium

Farming for Ecosystem Services:

New Directions for Long-term Ecological Research in Agriculture

Insect Dynamics

A Long-term Perspective on Insect Biodiversity & Ecosystem Services in Agricultural Landscapes

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Department of Entomology

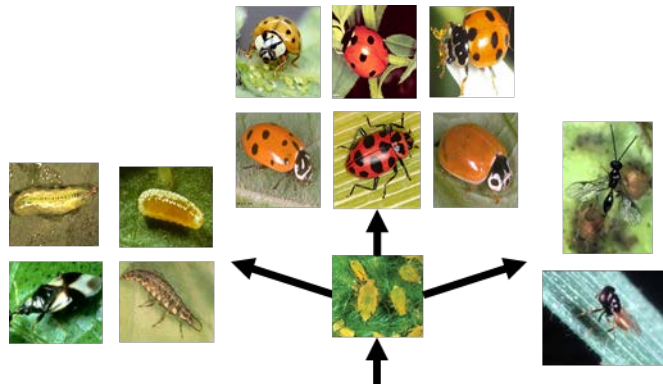


KBS LTER
Kellogg Biological Station
Long-term Ecological Research

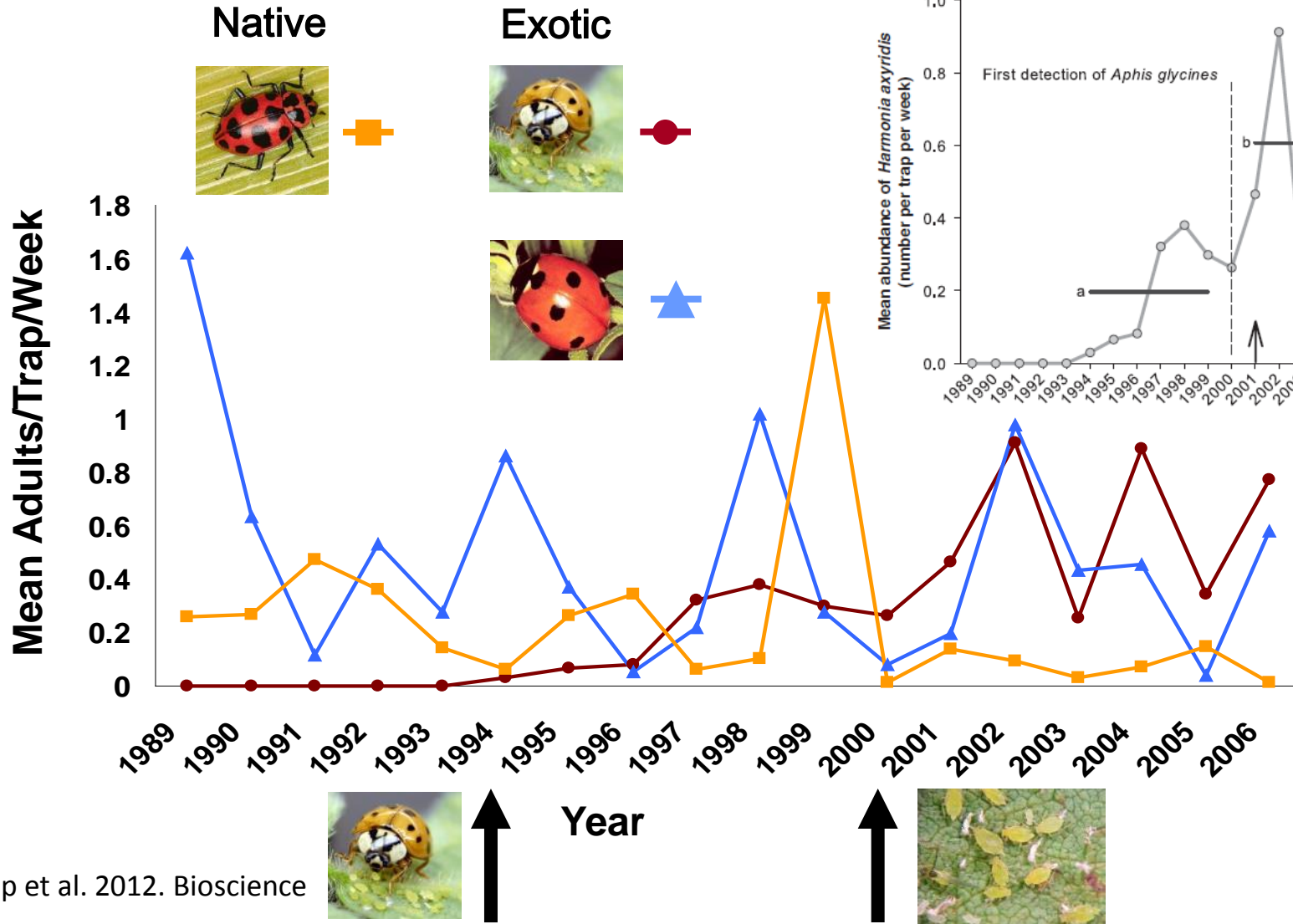
Agricultural Landscapes



Central question: How does predator identity, diversity, and landscape structure interact to mediate pest suppression?



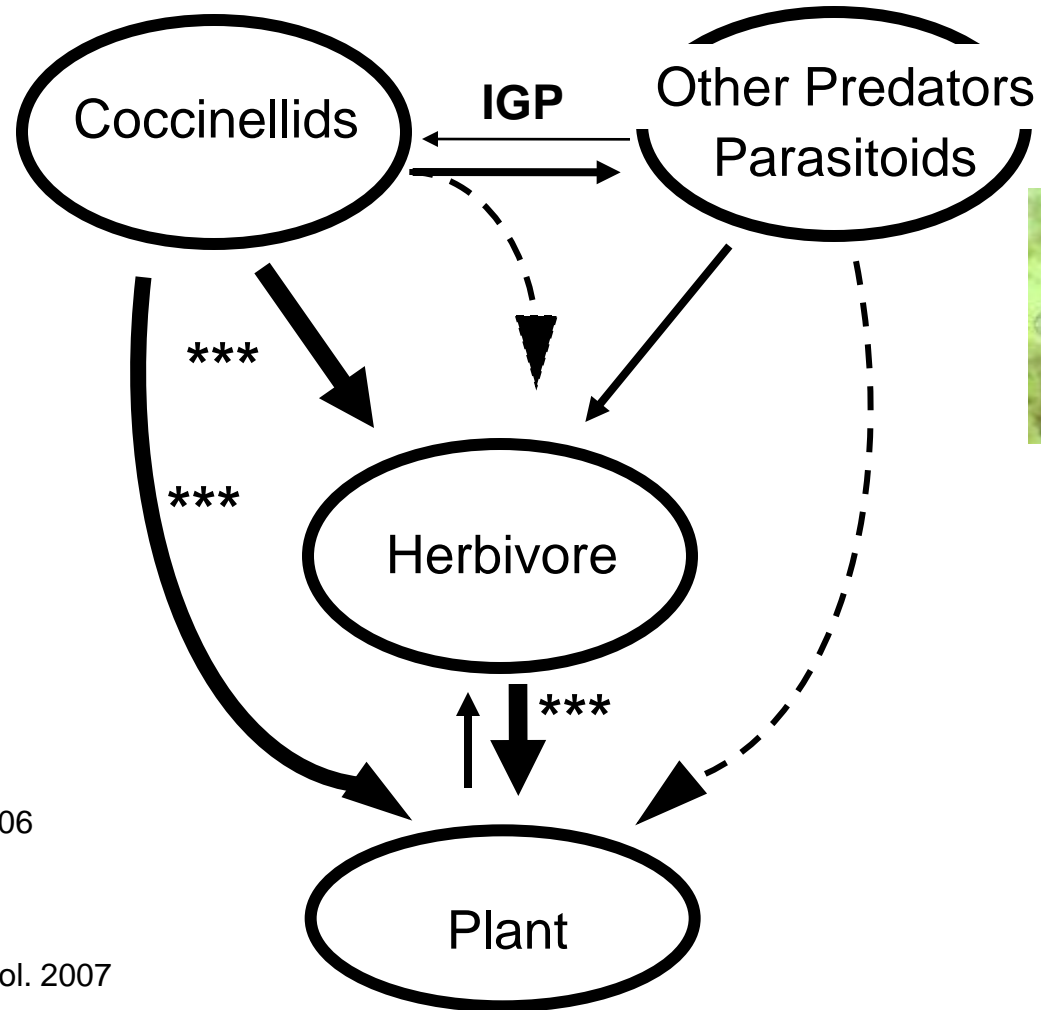
The Value of Long-term Studies



Knapp et al. 2012. Bioscience

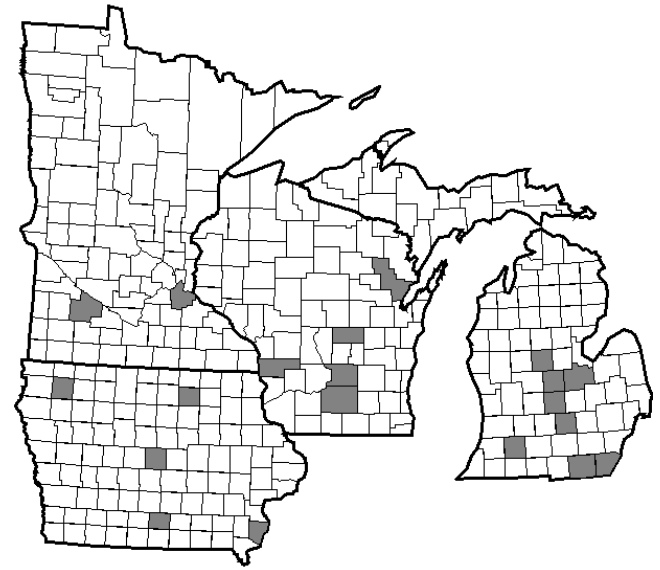
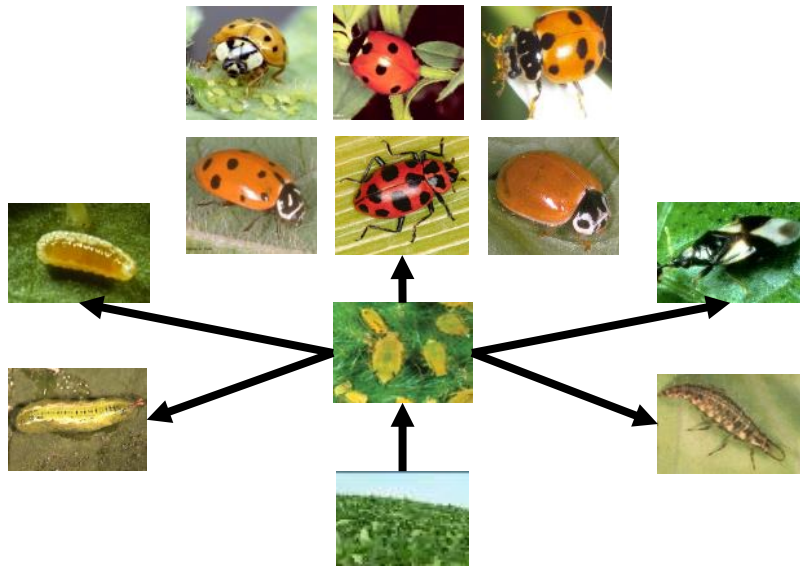


Tri-trophic Interactions



Costamagna & Landis. Ecol. Applic. 2006
Costamagna *et al.* Ecol. Applic. 2007
Gardiner & Landis. Biol. Cont. 2007
Costamagna *et al.* Biol. Cont. 2007
Costamagna *et al.* Agr. and For. Entomol. 2007
Costamagna *et al.* Biol. Cont. 2008
Costamagna and Landis Biol. Cont. 2011

Landscape Interactions

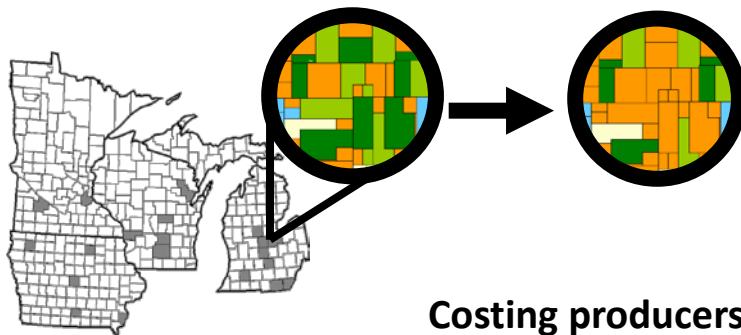


Valuing Aphid Biocontrol at Landscape-scales

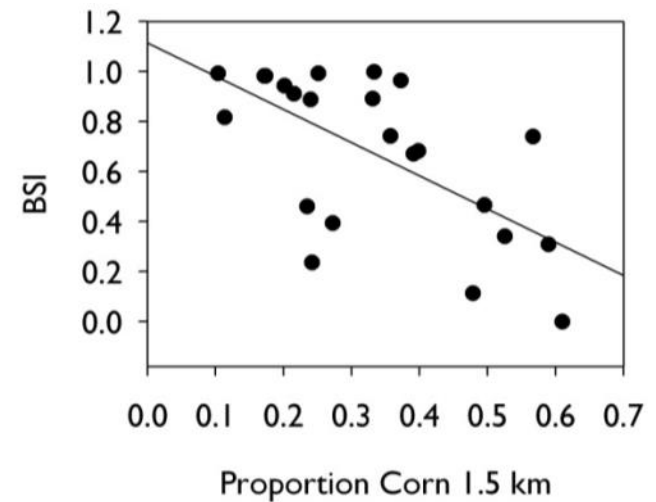


Predators save soybean farmers \$13-79 acre⁻¹ yr⁻¹ in reduced pesticide applications and yield loss

Increased corn in the landscape reduces key predators and biocontrol services in soybean



Costing producers \$58 – 671 M yr⁻¹ in forgone biocontrol services



(based on actual 2006-07 increase in corn in MI, MN, IA, WI)

Gardiner et al. Ecol. Applic. 2009

Landis, Gardiner, van der Werf, Swinton. PNAS 2008

Current Objectives

- Continue long-term study of the coccinellid community of the KBS LTER
- Investigate within-field dynamics of predator-prey interactions (predator flux)
- Study landscape controls on predator-prey interactions and pest suppression

The Changing LTER Coccinellid Community

Number of species

N=10 aphidophages

1 exotic

6 common natives

3 uncommon natives

N=13 aphidophages

4 exotics

5 common natives

4 uncommon natives



Coccinella septempunctata



Harmonia axyridis



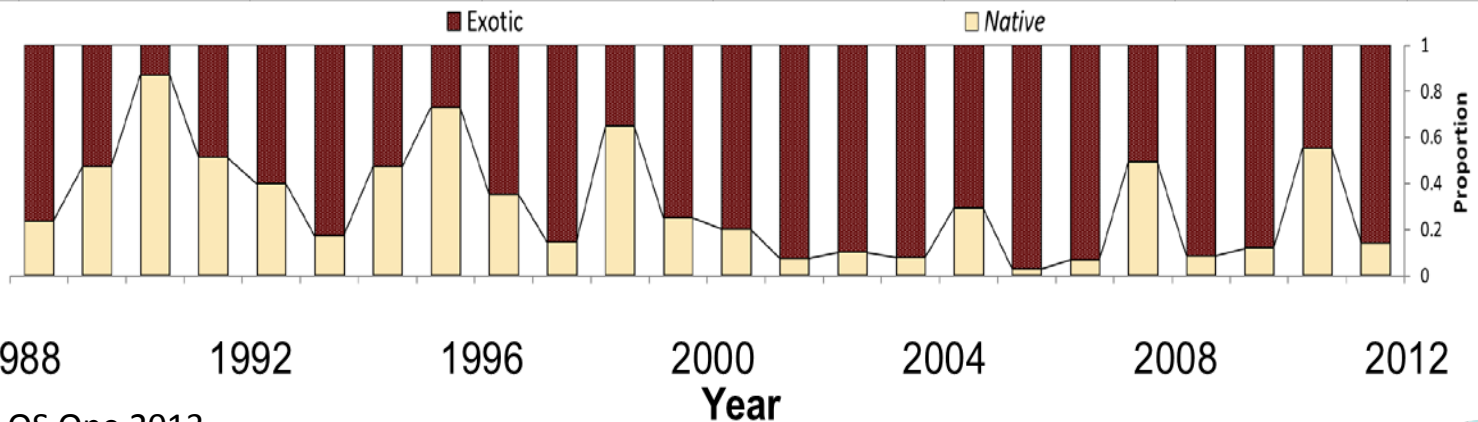
1998

Hippodamia variegata

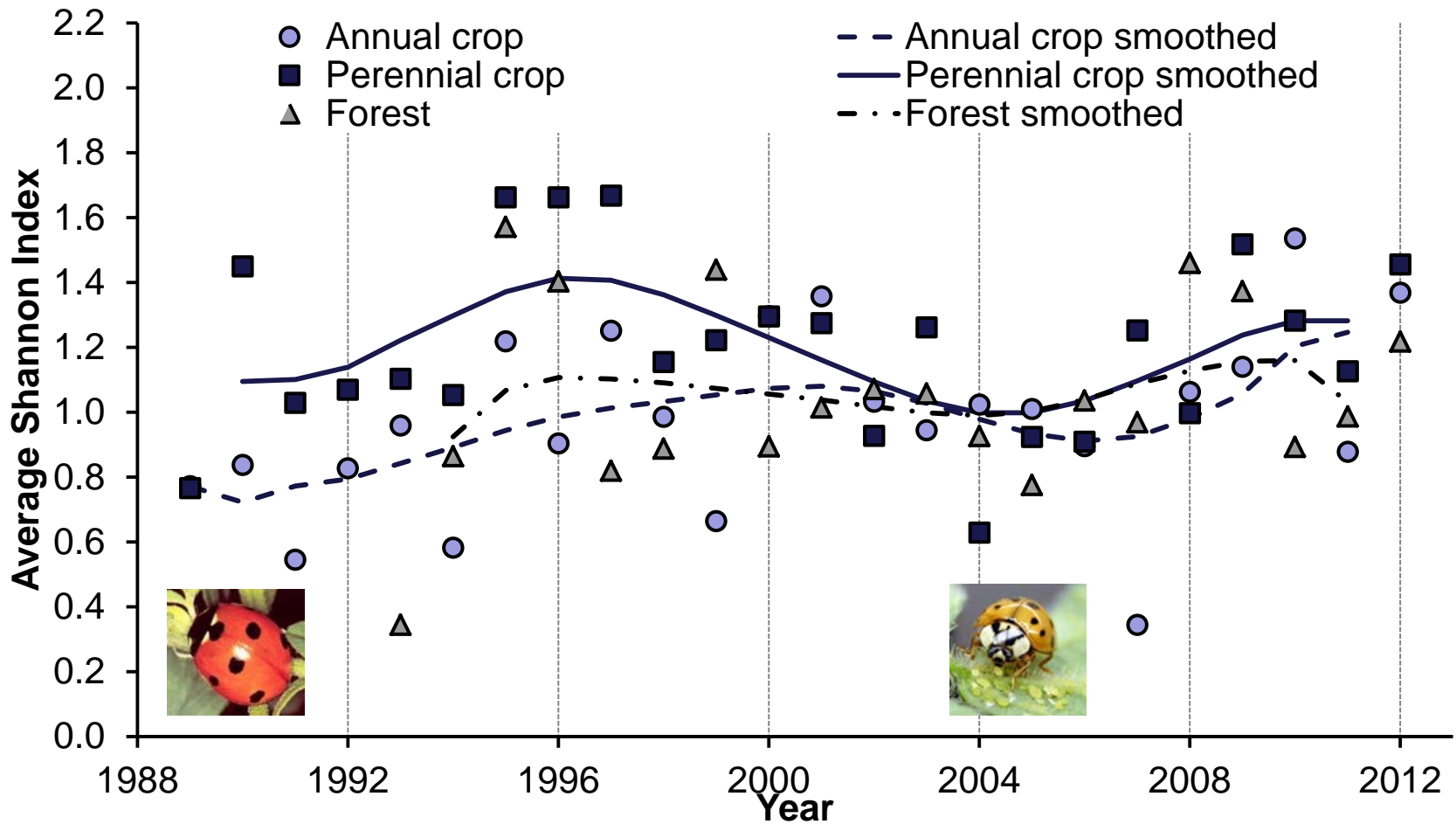


2007

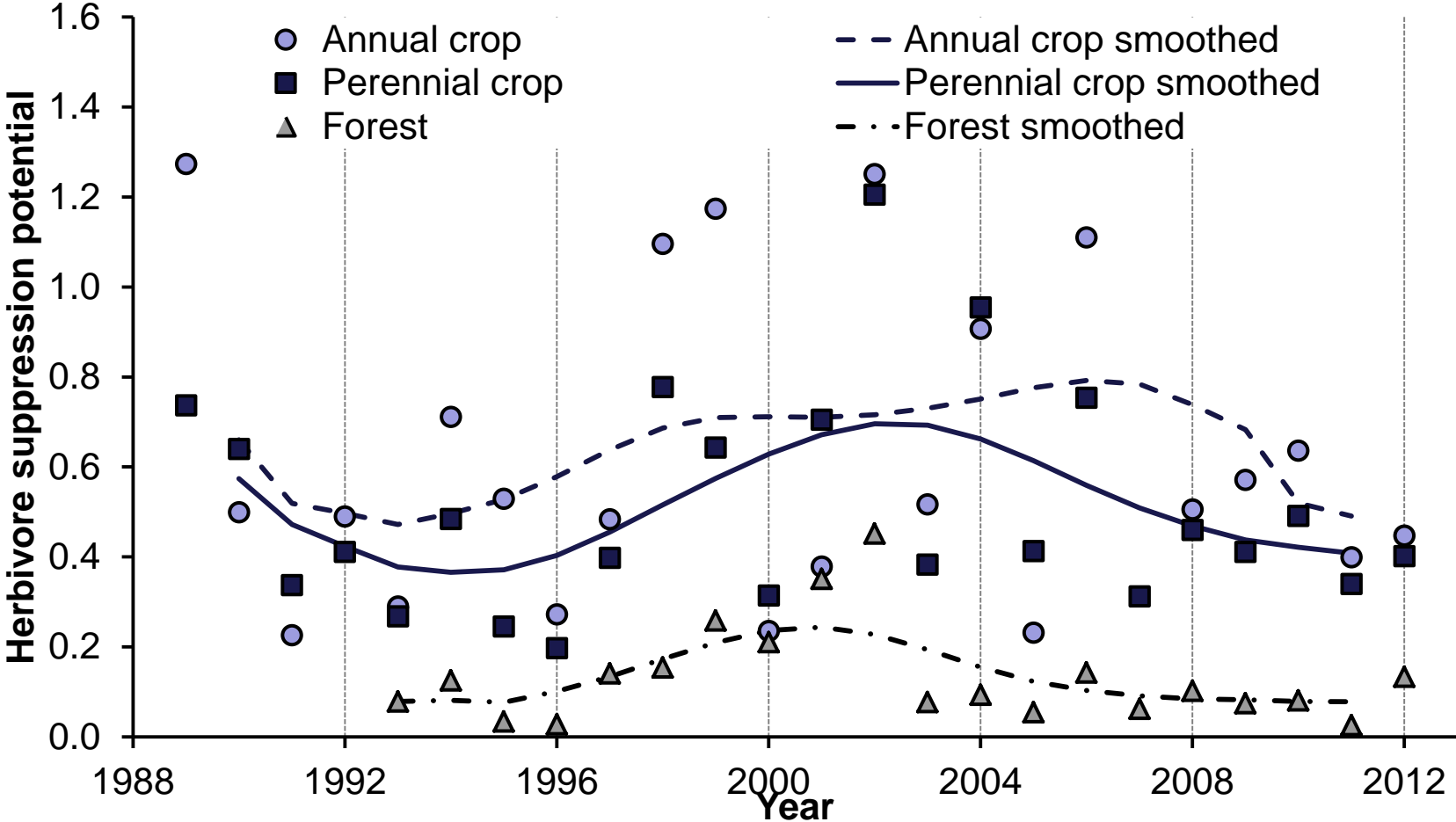
Propylea quatuordecimpunctata



Diversity

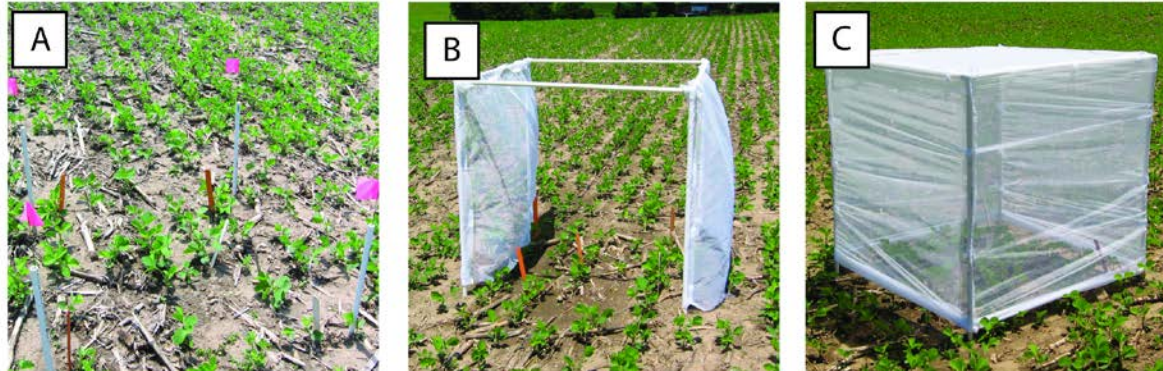


Predicted Biocontrol Service

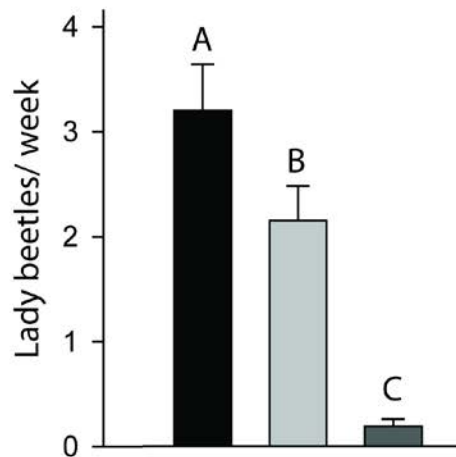


Coccinellid Flux

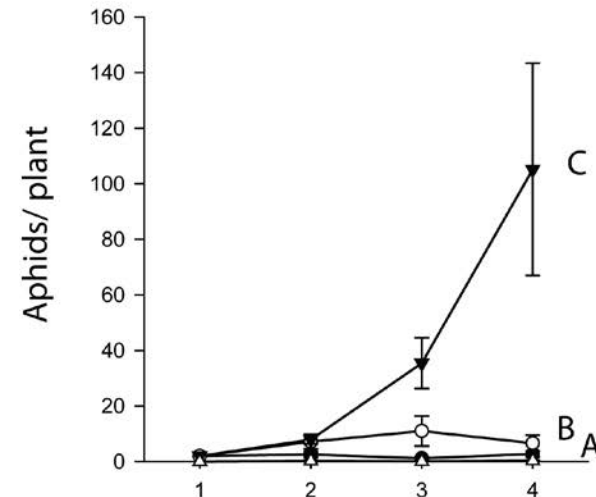
1) Barriers disrupted coccinellid dispersal ...



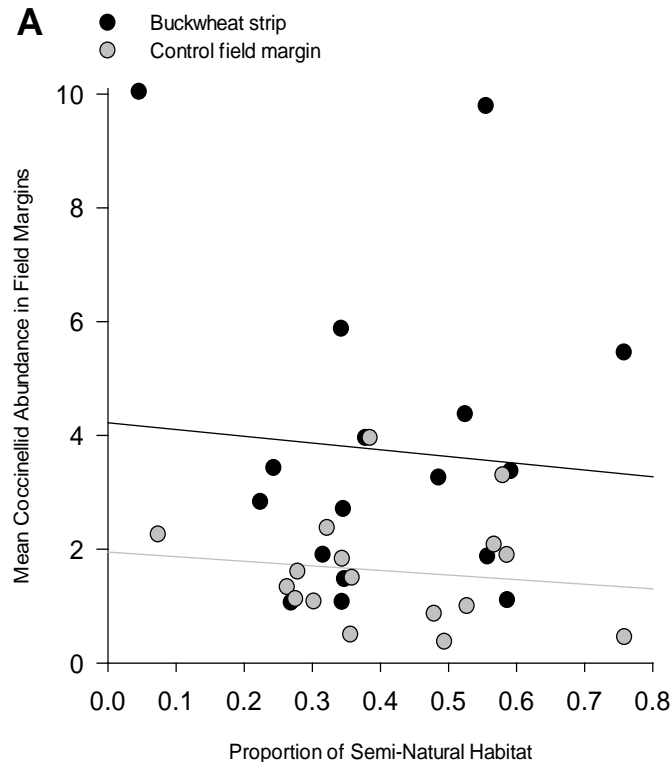
2) ...changing coccinellid immigration rates to plots ...



3) ... resulting in changes in aphid suppression.



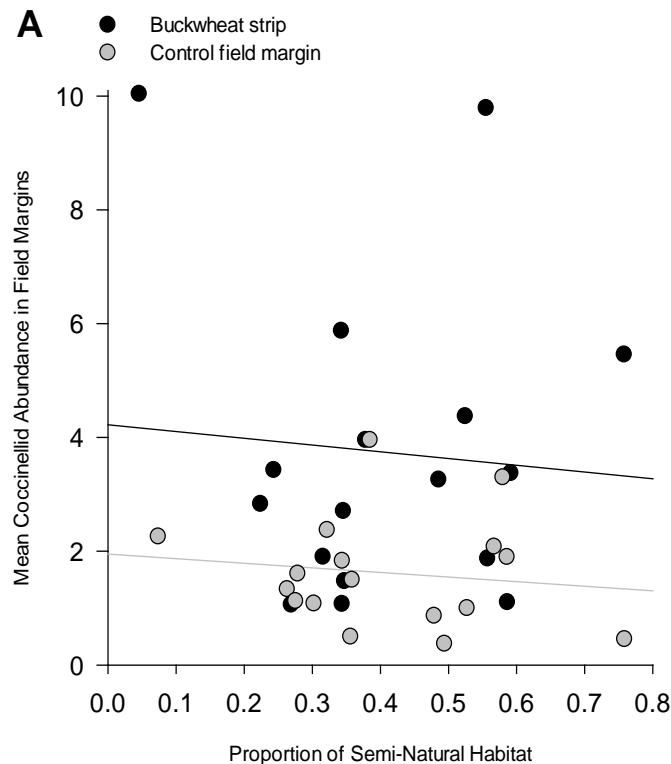
Buckwheat Successfully Attracts Coccinellids to Field Edges



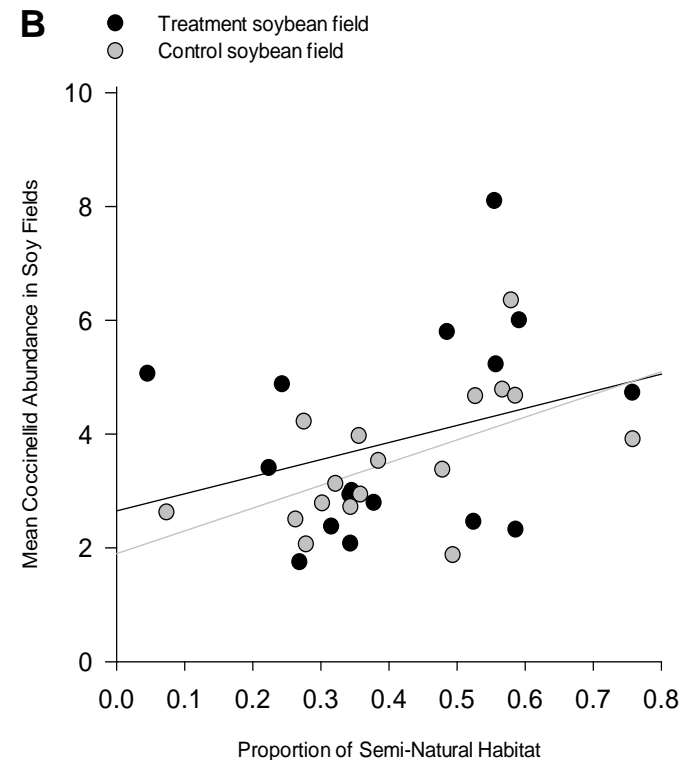
$F_{1,30}=10.78, p=0.003$



But Coccinellid Abundance in Fields is Determined by Landscape Structure



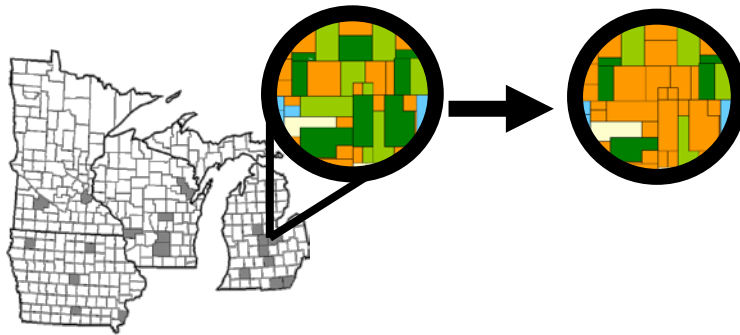
$F_{1,30}=10.78, p=0.003$



$F_{1,30}=6.11, p=0.02$

Landscape Change and Ecosystem Services

Rapid
("Pulse")



Long-term
("Press")

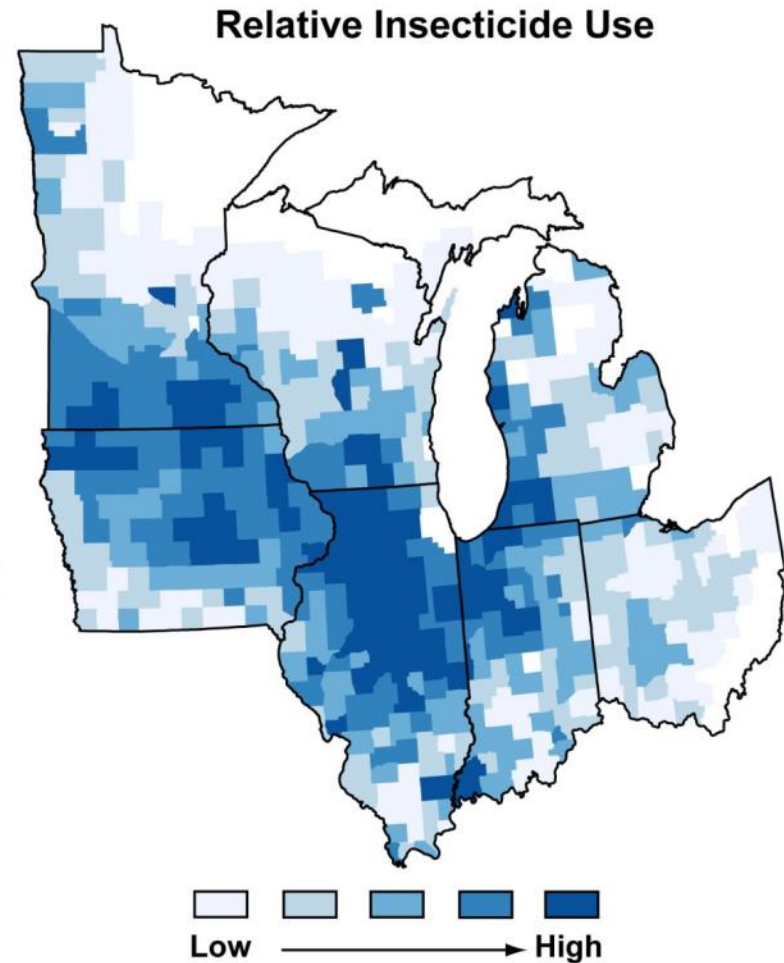
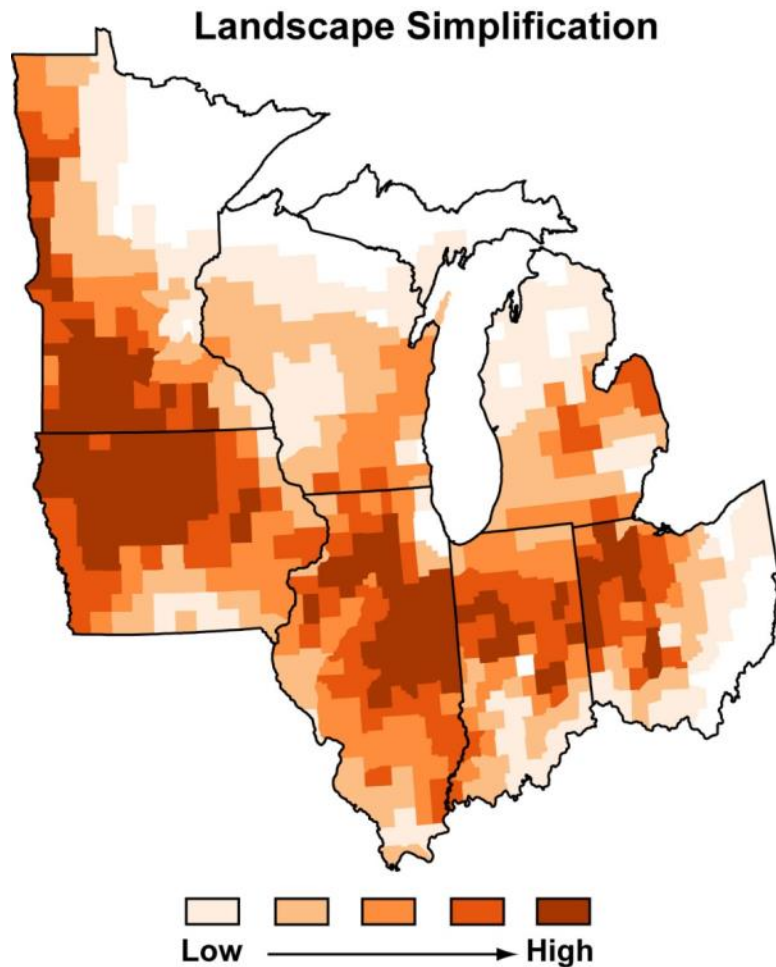


Mix of crop and non-crop

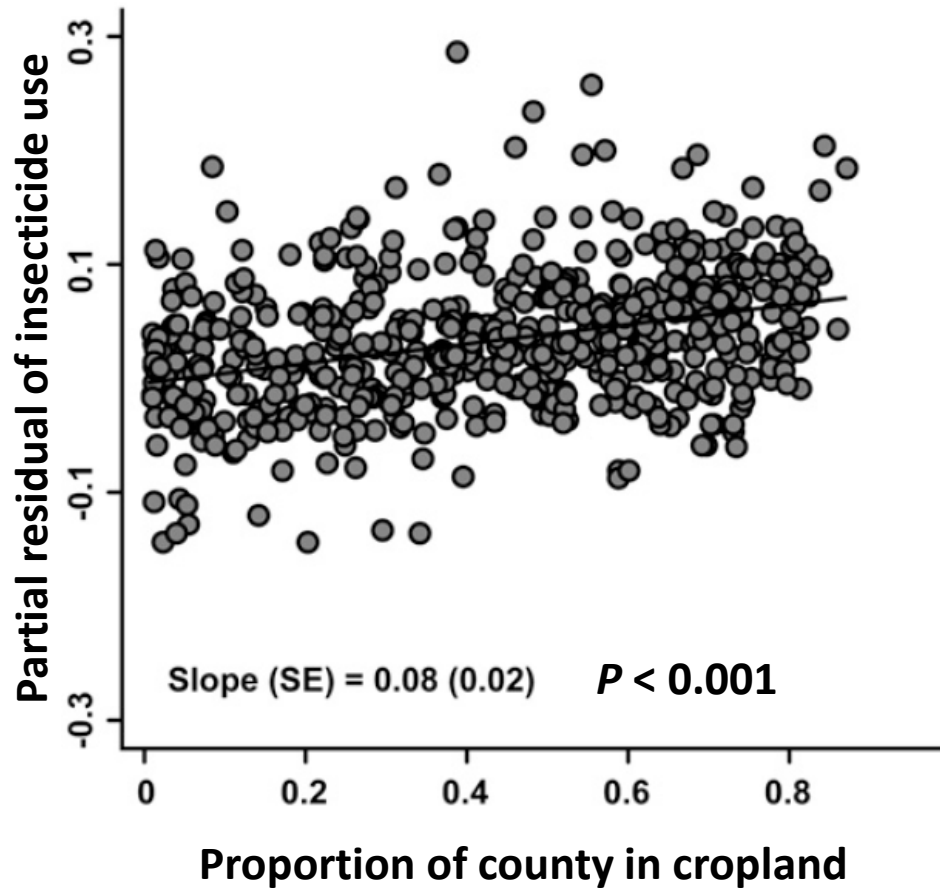
Extensive annual crops


Simplification

Landscape Simplification and Insecticide Use



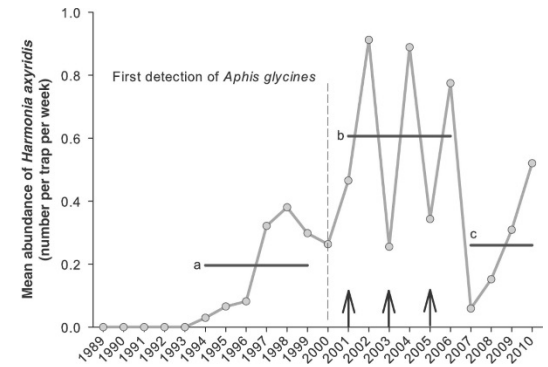
Landscape Simplification and Insecticide Use



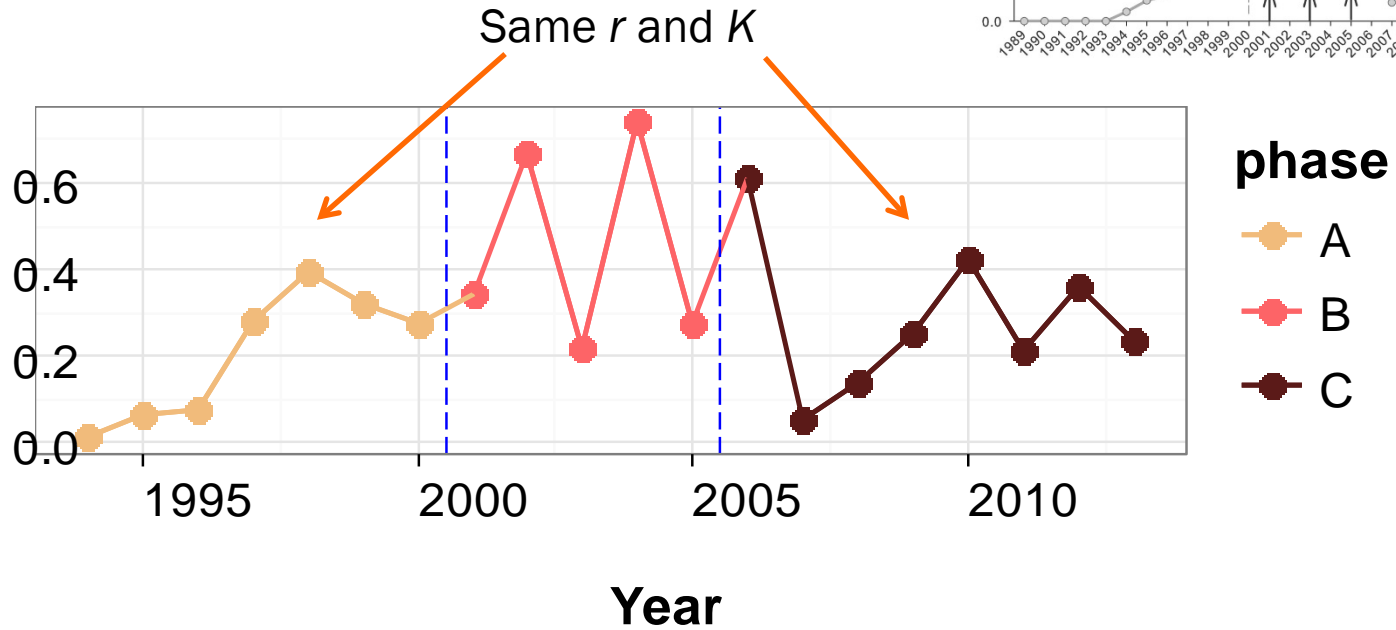
**Simplification cost farmers
\$69 million in extra
insecticide applications in
2007**



Harmonia dynamics



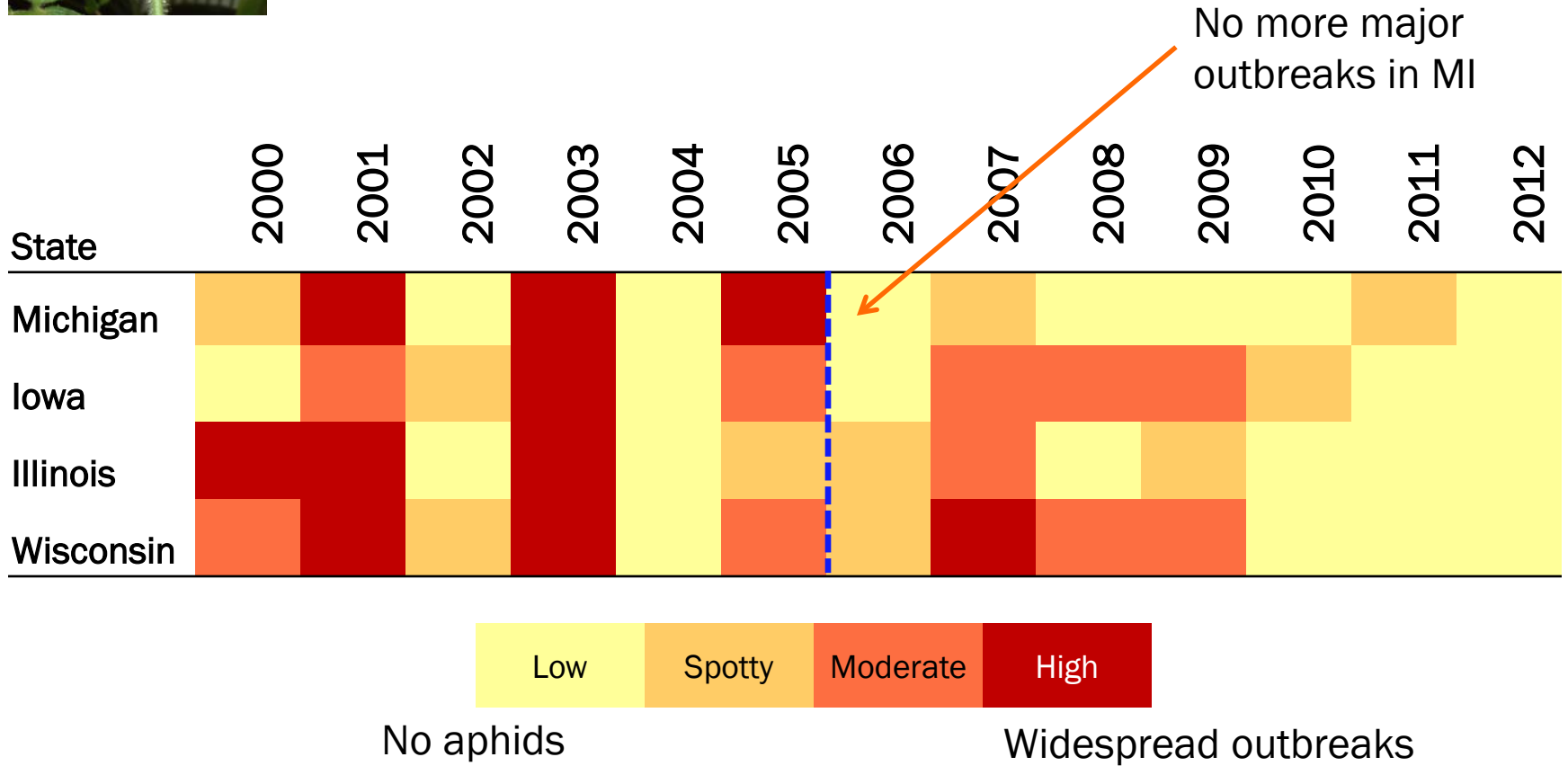
Average capti



- Arrival of soybean aphid (2000) induced shift in *Harmonia*'s dynamic regime
 - $r + 20\%$, $K + 40\%$
- What caused return to previous regime after 2005?



Soybean aphid

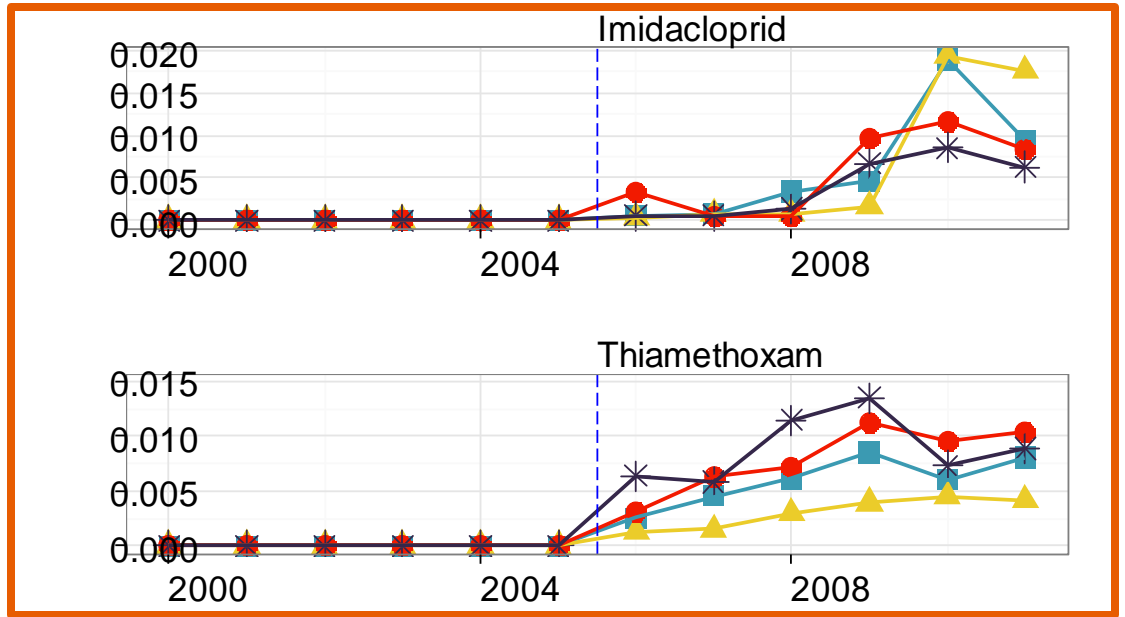
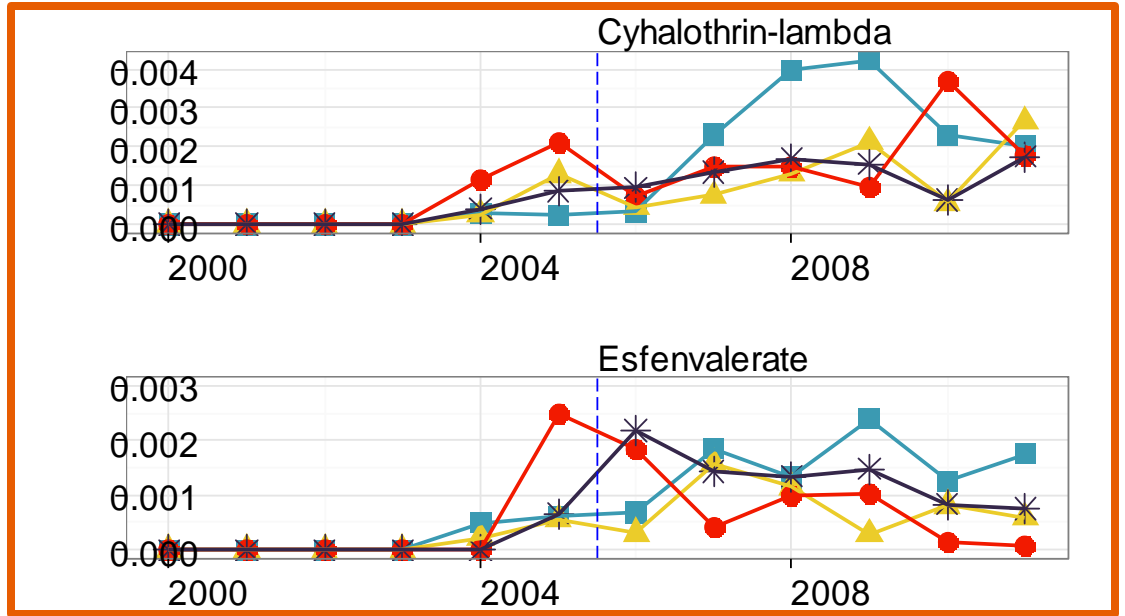


Pesticide use



- State**
- IA
 - ▲ IL
 - MI
 - * WI

kg active ingredient per hectare



Year

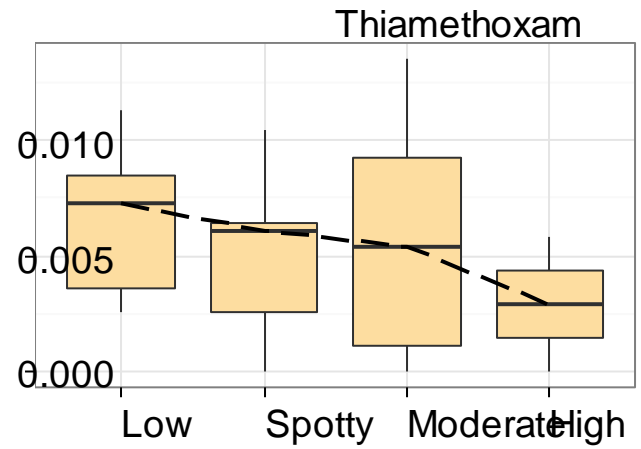
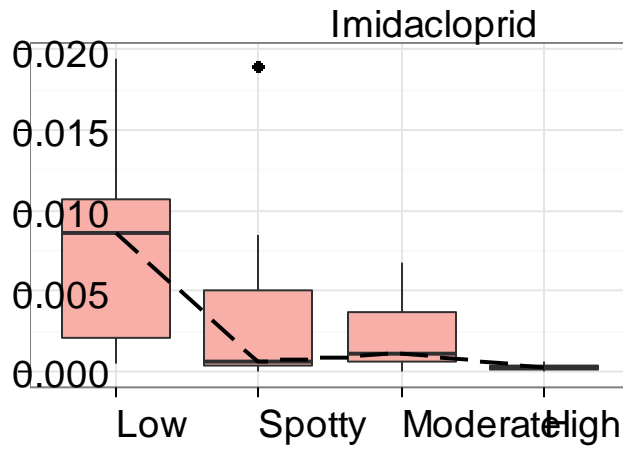
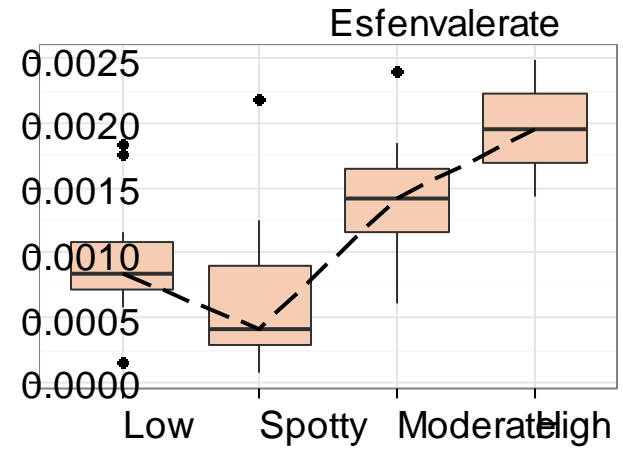
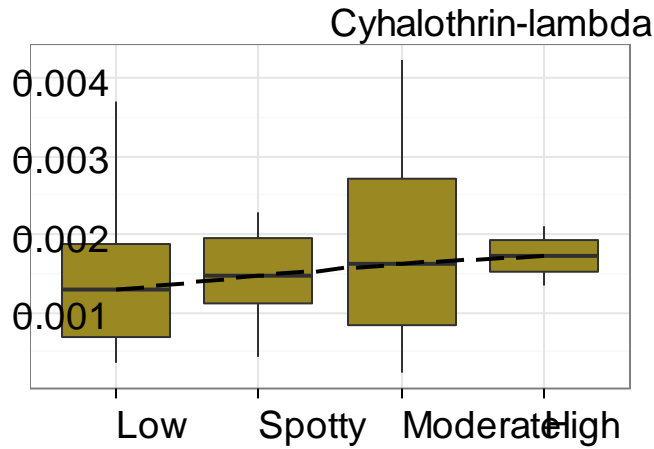
Foliar

Seed applied



Aphid infestation vs pesticide use

kg active ingredient per

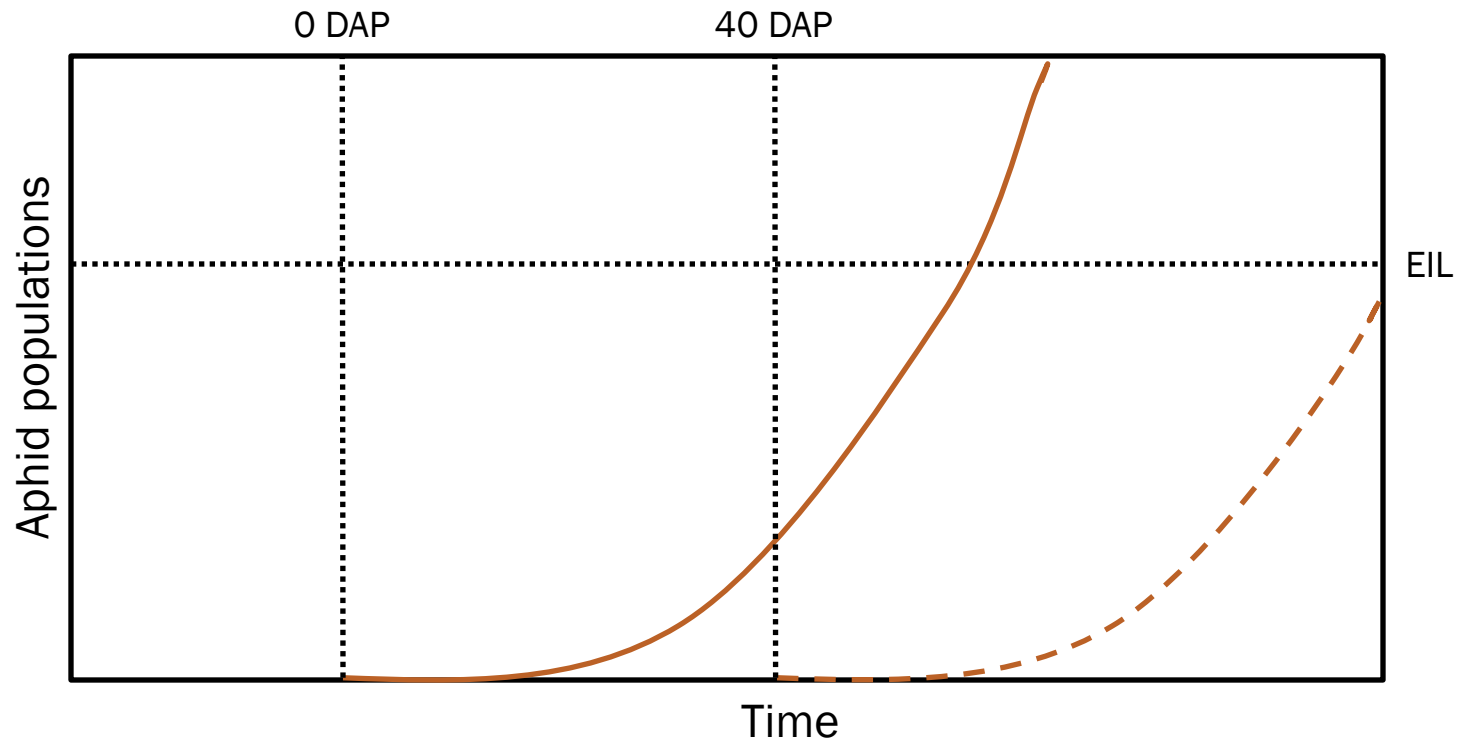


Aphid infestation



Seed treatments and soybean aphid

- Seed treatments: limited window of efficacy (~40DAP)
- Early season suppression leads to regional control?



Conclusions

- Predator communities provide valuable pest suppression services in agricultural landscapes
- Pest suppression is controlled by species identity and landscape configuration
 - With implications **ON** insecticide use
 - Also influenced **BY** regional patterns of insecticide use
- Long-term studies reveal ecological phenomena that would be overlooked or obscured by shorter-term studies



Acknowledgements

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