

## Effects of Climate Change on Insect Communities in Organic Farming Systems

David Crowder, Washington State University

February 4, 2013

[http://www.extension.org/organic\\_production](http://www.extension.org/organic_production)




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Dave Crowder, Washington State University

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## Effects of Climate Change on Insect Communities in Organic Farming Systems



Dave Crowder  
Washington State University

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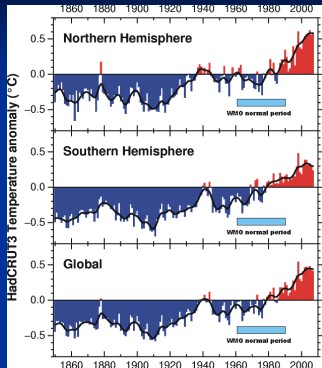
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Climate Change



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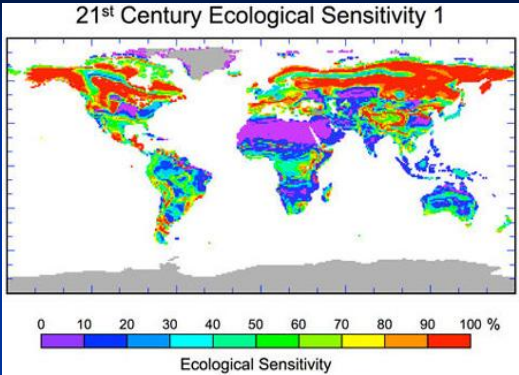
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Climate Change and Ecosystems



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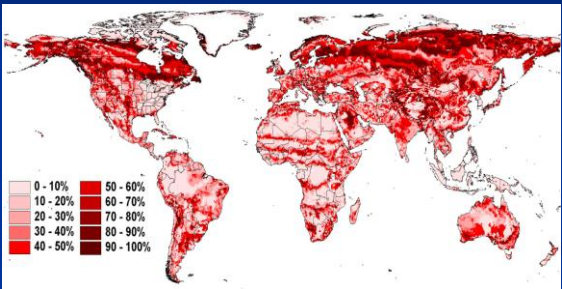
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Climate Change and Habitat Loss



Malcolm and Markam 2000

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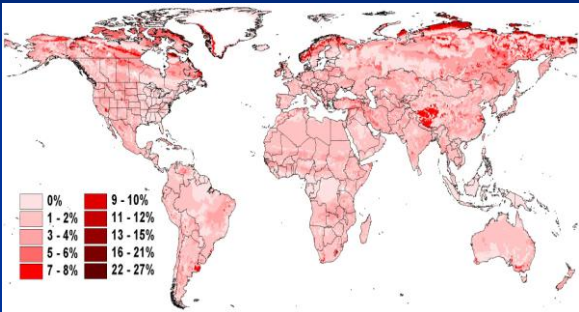
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### Climate Change and Species Loss



Malcolm and Markam 2000

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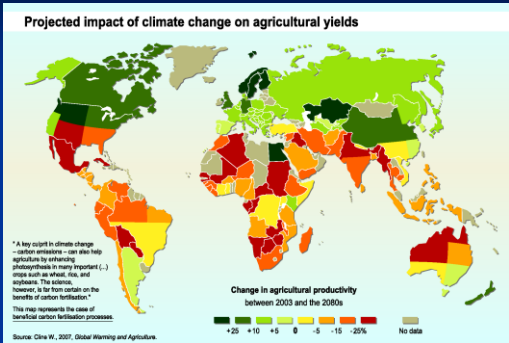
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### Climate Change and Crops



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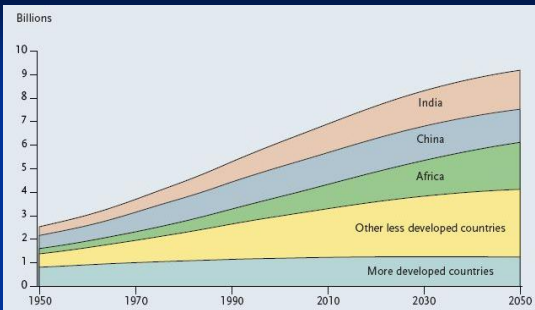
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### Human Population Growth



SOURCE: UN Population Division, World Population Prospects: The 2006 Revision, Medium Variant (2007).

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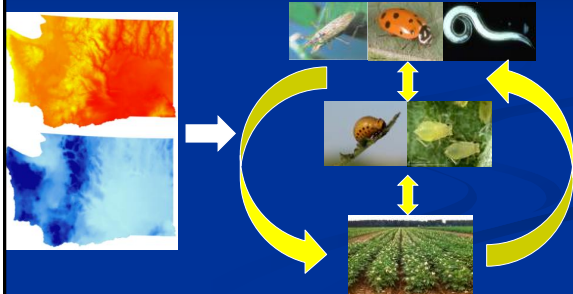
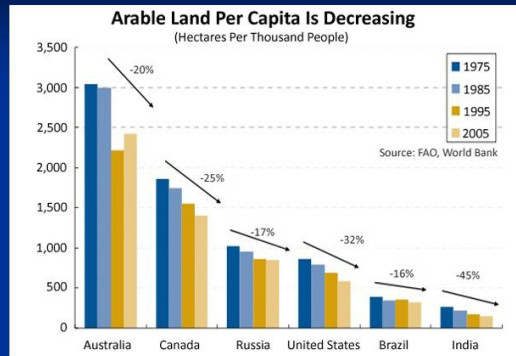
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1. Loss of biodiversity
2. Habitat loss and change
3. Variable effects on crop yields

[illegible]

## The Big Questions

1. How do farming systems and climate change impact biodiversity?
2. What might be effects of loss of biodiversity?
3. How might organic farming, or other sustainable practices, mediate harmful effects of climate change?

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## Diversity in Agriculture

Pimentel 1961, *Annals of the Entomol. Soc. Am.*:  
*"Considerable evidence in the literature suggests that the lack of species diversity [in] communities modified by cultivation...may be responsible for the outbreaks which are so typical of these simplified communities"*



If correct, fostering predator biodiversity will improve pest control.

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Altieri 1999:  
*"The key is to identify the type of biodiversity that is desirable to maintain and/or enhance...ecological services, and to determine the best practices to encourage the desired biodiversity components."*

- This requires quite a detailed understanding of biodiversity effects

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### Study System: Potatoes in East-Central Washington

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### Growing Adoption of Organic Production

Conventional	Organic / Sustainable
1) Calendar based sprays of broad-spectrum pesticides	1) Natural or "environmentally-friendly" pesticides
2) Soil fumigation	2) Bio-fumigation
3) Harmful to pests and natural enemies	3) Promotes natural enemies but may have more pests

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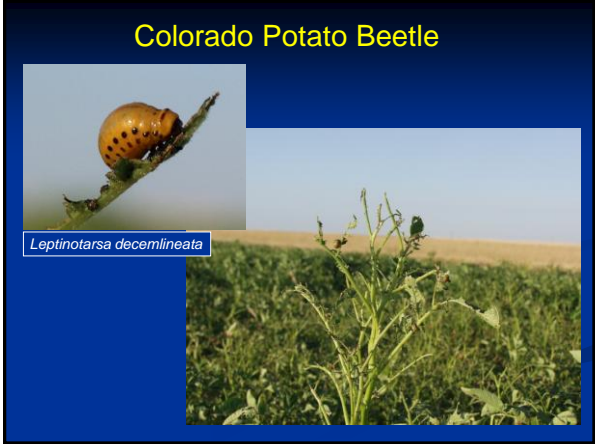
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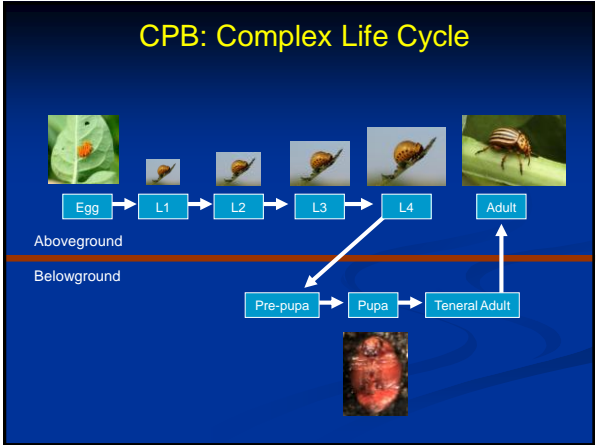
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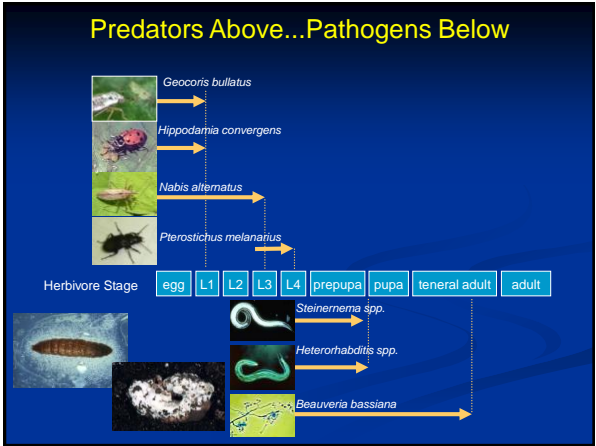
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## Surveys in Potato

- Predator and pathogen field surveys in potato




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## Sampling




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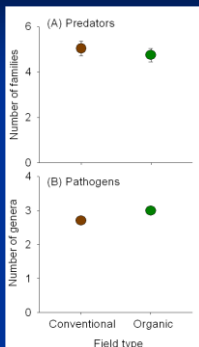
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## Natural Enemies in Potato



Among WA potato fields there is little variation in taxa present...

...and no effect of management.

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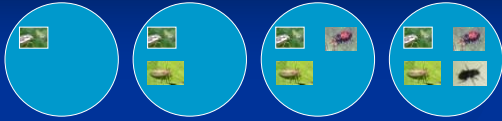
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## Natural Enemy Communities

- Number of species



- Evenness




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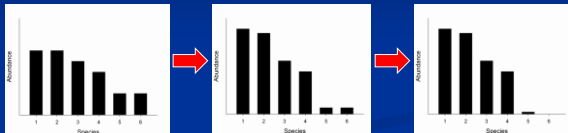
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## Why Consider Evenness?

- Evenness variation common in real landscapes?



- Effects on function of ecosystems?

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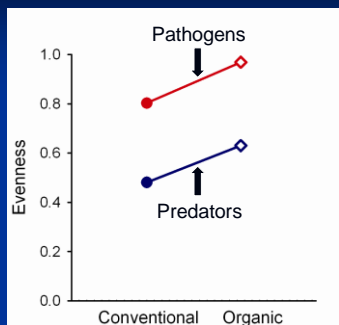
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## Organic Ag Increases Evenness in Potato



Crowder et al., *Nature* (2010)

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## Does Organic Ag Generally Impact Natural Enemy Evenness?

- Meta-analysis of 48 studies across 23 crops in 16 countries (40 predators, 8 pathogens)
- Calculated evenness in each field

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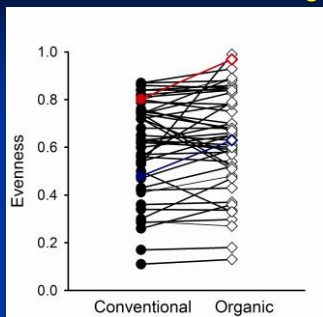
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## Evenness Increases in Organic



Crowder et al., *Nature* (2010)

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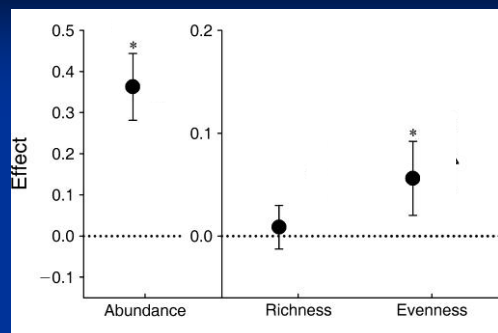
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## Do Trends Hold for all Organisms?



Crowder et al., *Ecology* (2012)

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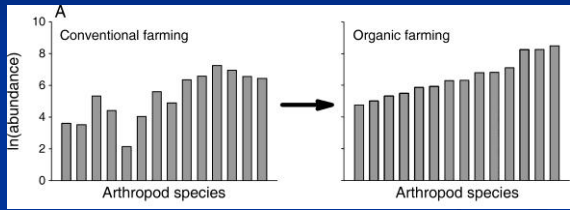
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Organic vs. Conventional



Crowder et al., *Ecology* (2012)

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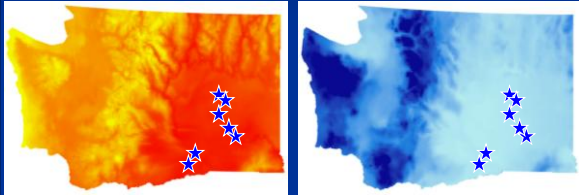
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Climate Change and Diversity



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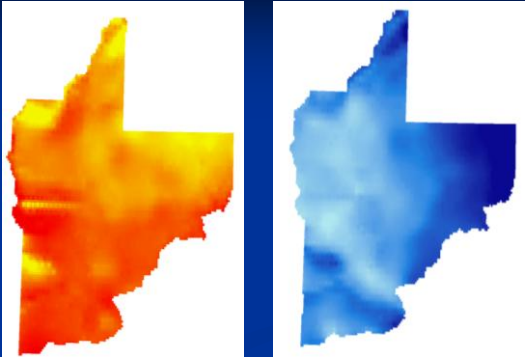
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Climate



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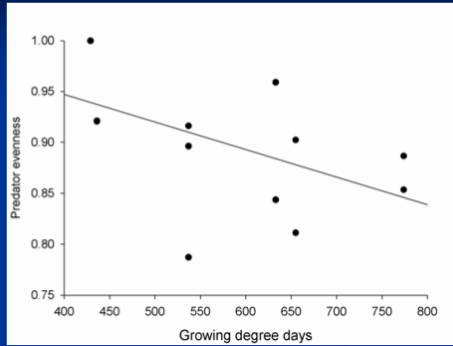
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## Climate and Evenness




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## The Big Questions

1. How do farming systems and climate change impact biodiversity?

Organic promotes evenness of organisms

Climate change degrades evenness

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## The Big Questions

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## Does Evenness Impact Beetle Control?

Searched potato survey data for fields that differed in:

1. Evenness
2. The numerically dominant species

-- reproduced these real-world communities in field cages, added beetles, eventually harvested plants.

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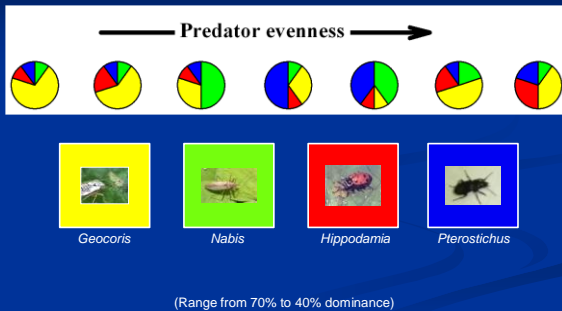
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## Predator Evenness Treatments




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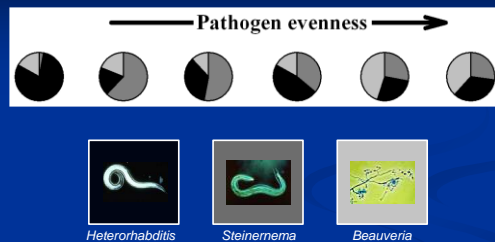
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## Pathogen Evenness Treatments




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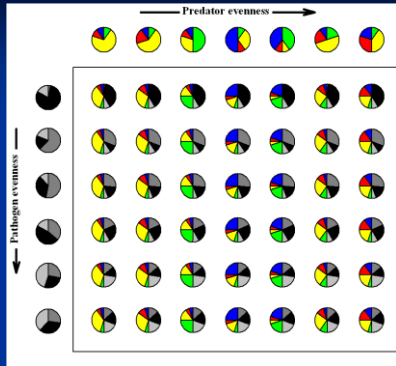
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## Fully Crossed Design




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## Details



- Field enclosures containing potato plants and all immature potato beetle life stages
- Varying levels of predator and pathogen evenness
- Experiment run for 31 days

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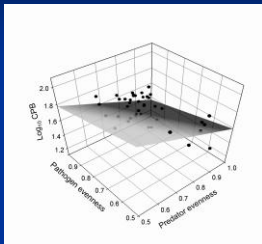
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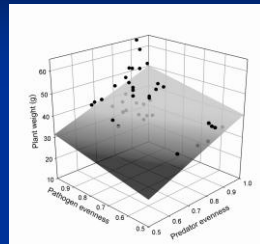
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## Enemy Evenness Increases Beetle Mortality and Plant Biomass



Predator evenness  $P = 0.023$   
 Pathogen evenness  $P = 0.036$   
 Pred x Path interaction n.s.



Predator evenness  $P = 0.005$   
 Pathogen evenness  $P = 0.003$   
 Pred x Path interaction n.s.

Crowder et al., Nature (2010)

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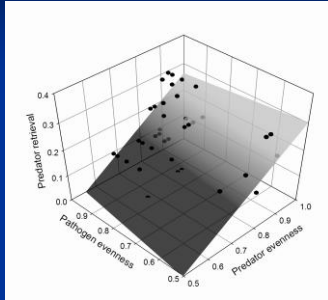
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## Predator Evenness Increases Predator Survivorship



Predator evenness only significant factor ( $P = 0.0002$ )

Crowder et al., *Nature* (2010)

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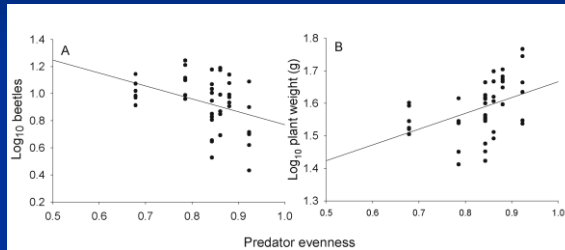
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## Does this occur in real fields?




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## Summary

- Organic farming promotes more balanced communities of natural enemies in many crops
- In potato, greater enemy evenness lead to fewer pests (-18%) & larger plants (+35%)
- **Organic farming may offer a solution to the difficult challenge of evenness restoration/conservation**

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Why might this occur?



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Can Natural Enemy Communities be Managed to Improve Natural Pest Control?

*(does any of this have any value to farmers?)*



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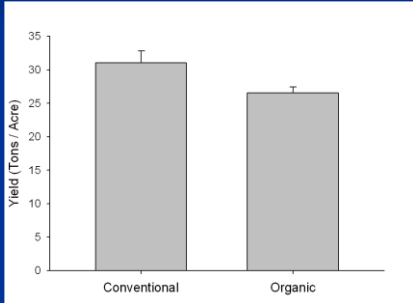
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Experiment Summary

- Increased predator evenness can help organic farmers produce yields close to conventional farms



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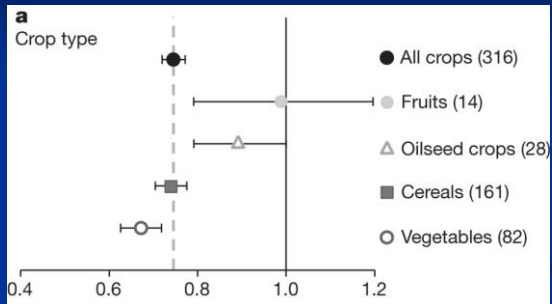
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### Crops that may benefit



Seufert et al. 2012

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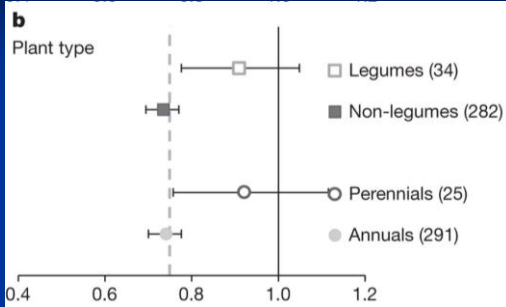
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### Crops that may benefit



Seufert et al. 2012

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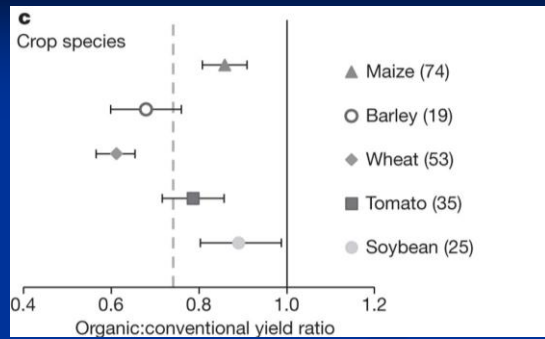
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### Crops that may benefit



Seufert et al. 2012

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## The Big Questions

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## Promoting Biodiversity




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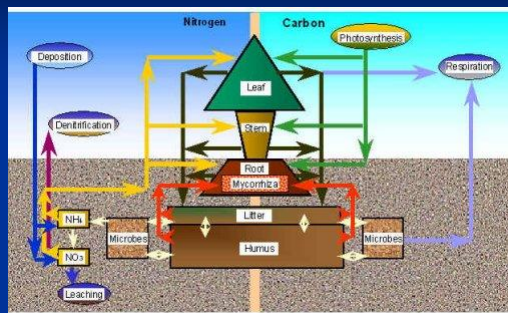
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## Ecosystem Services




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### Pollination



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### Biological Control



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### Mechanisms

1. Complementary species interactions
2. Insurance effect

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## Summary

1. Climate change is expected to reduce biodiversity and potentially degrade ecosystem services
2. Organic agriculture mediates these effects by promoting biodiversity and ecosystem services
3. Increased adoption of organic agriculture, or other sustainable practices, may help alleviate harmful effect of climate change in agricultural ecosystems

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## Acknowledgements

- Bill Snyder, Tobin Northfield, Joyce Parker, Christine Lynch, Randa Jabbour, Carrie Wohleb, Elliott Moon, Jacob Gable, Liz Aultman, John Reganold
- Growers throughout Columbia Basin
- Funding: USDA – AFRI, USDA RAMP, WSU BioAg

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## Links

- <http://entomology.wsu.edu/david-crowder/>
- <http://newsletters.cahnrs.wsu.edu/green-times/2011/11/01/welcome-insect-biodiversity-people-events/>
- [http://www.nytimes.com/2010/11/30/science/30farm.html?\\_r=2&pagewanted=all&](http://www.nytimes.com/2010/11/30/science/30farm.html?_r=2&pagewanted=all&)
- <http://www.nature.com/news/2010/100630/full/news.2010.324.html>
- [http://seattletimes.com/html/localnews/2012250093\\_taters01m.html](http://seattletimes.com/html/localnews/2012250093_taters01m.html)

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Questions?




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Find all upcoming webinars and archived eOrganic webinars at <http://www.extension.org/pages/25242>

Find the slides as a pdf handout and the recording at <http://www.extension.org/pages/66899>

Additional questions about organic farming?  
<https://ask.extension.org/groups/1668>

We value your feedback! Please fill out our follow-up email survey!




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