Ecosystem Services and Agricultural Ecosystems

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Ecosystem Services in a Changing World

KBS LTER
Kellogg Biological Station
Long-term Ecological Research

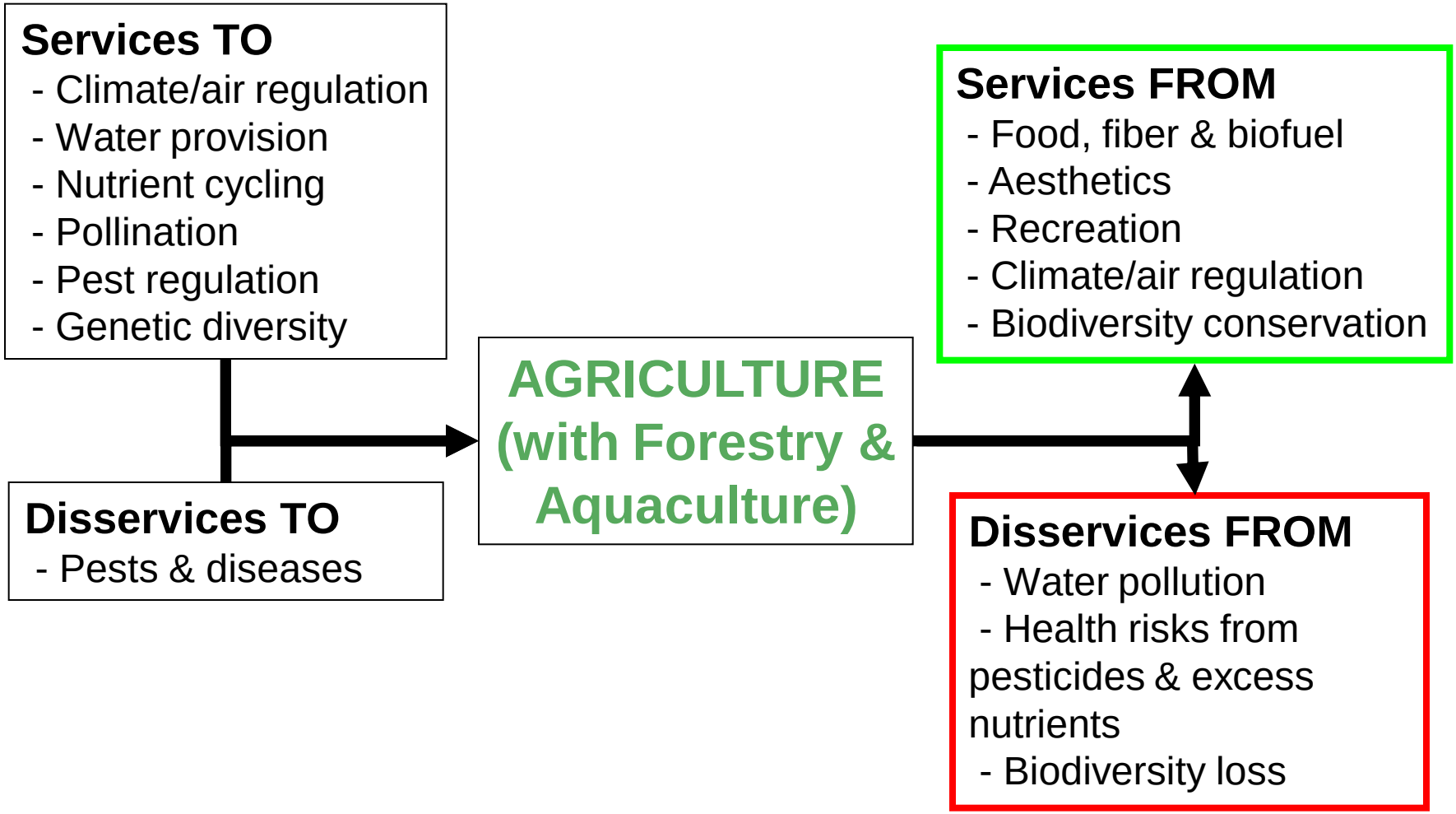
LTER

MICHIGAN STATE UNIVERSITY

Agriculture as a managed ecosystem

- "Ecosystem services" (ES) imply humans as recipients
- Agriculture = working ecosystem
  - How does ecosystem function → ES?
  - What motivates human management?
- Science with impact
- Illustrations from the KBS-LTER

An ecosystem both receives and generates ecosystem services



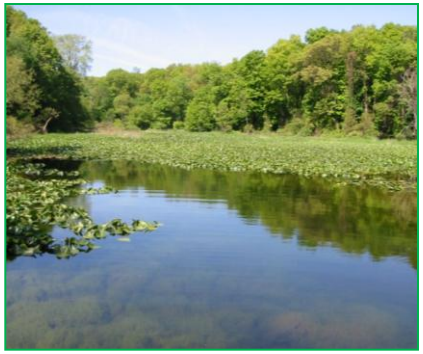
Swinton et al., *Ecol Econ, 2007*

Three ecosystem services at three scales

Insect predator-prey relationships that control pest populations

Climate regulation by greenhouse gas fluxes from crop management

Cycling of nitrogen and other nutrients to ground & surface waters and to the atmosphere



Experiments at plot scale

Land Management Type

Management intensity

Annual Grain Crops (Corn - Soybean - Wheat)

- Conventional
- No-till
- Low-input with cover crops
- Organic with cover crops

Perennial Biomass Crops

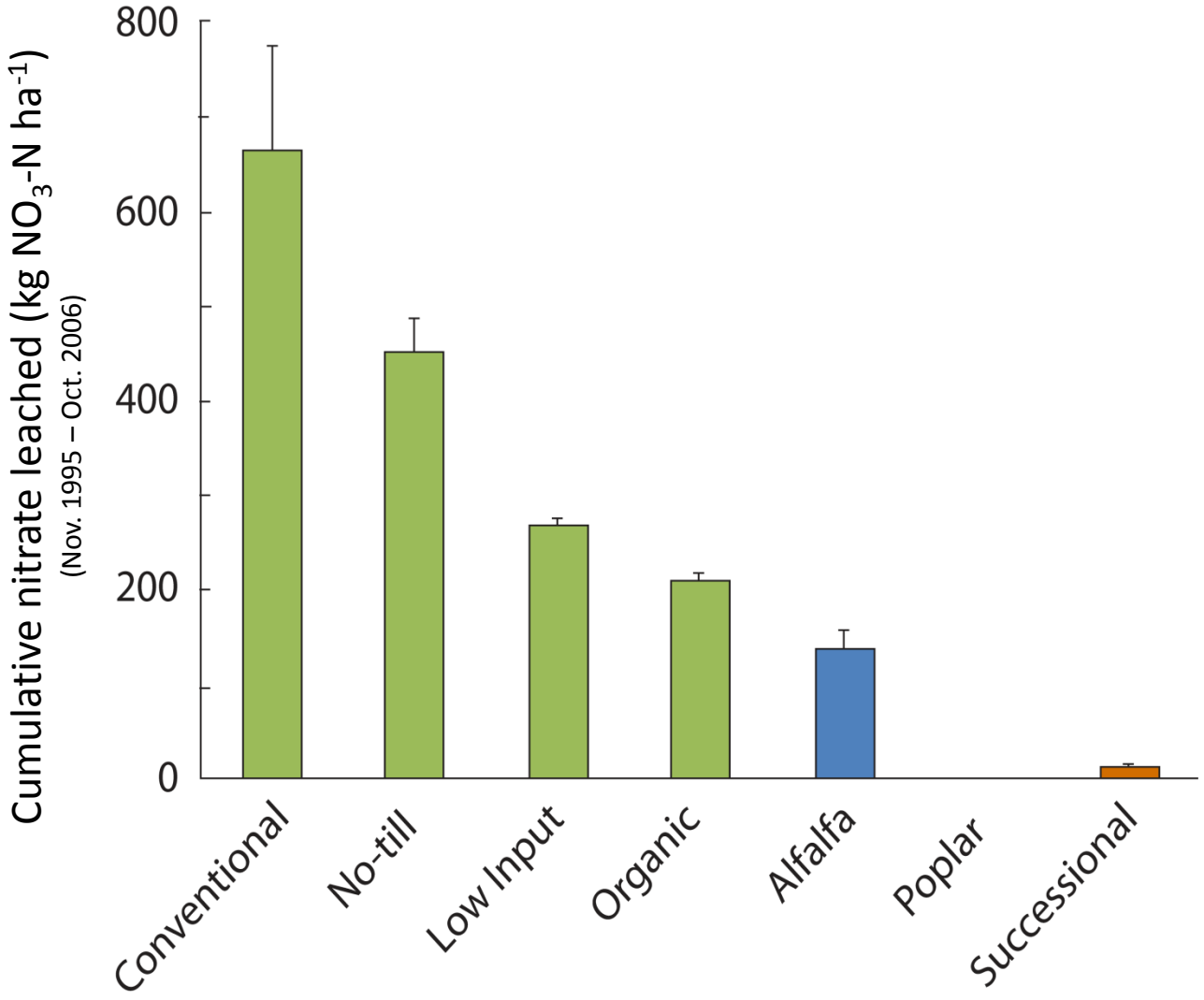
- Alfalfa
- Poplar trees

- Early successional old fields

HIGH

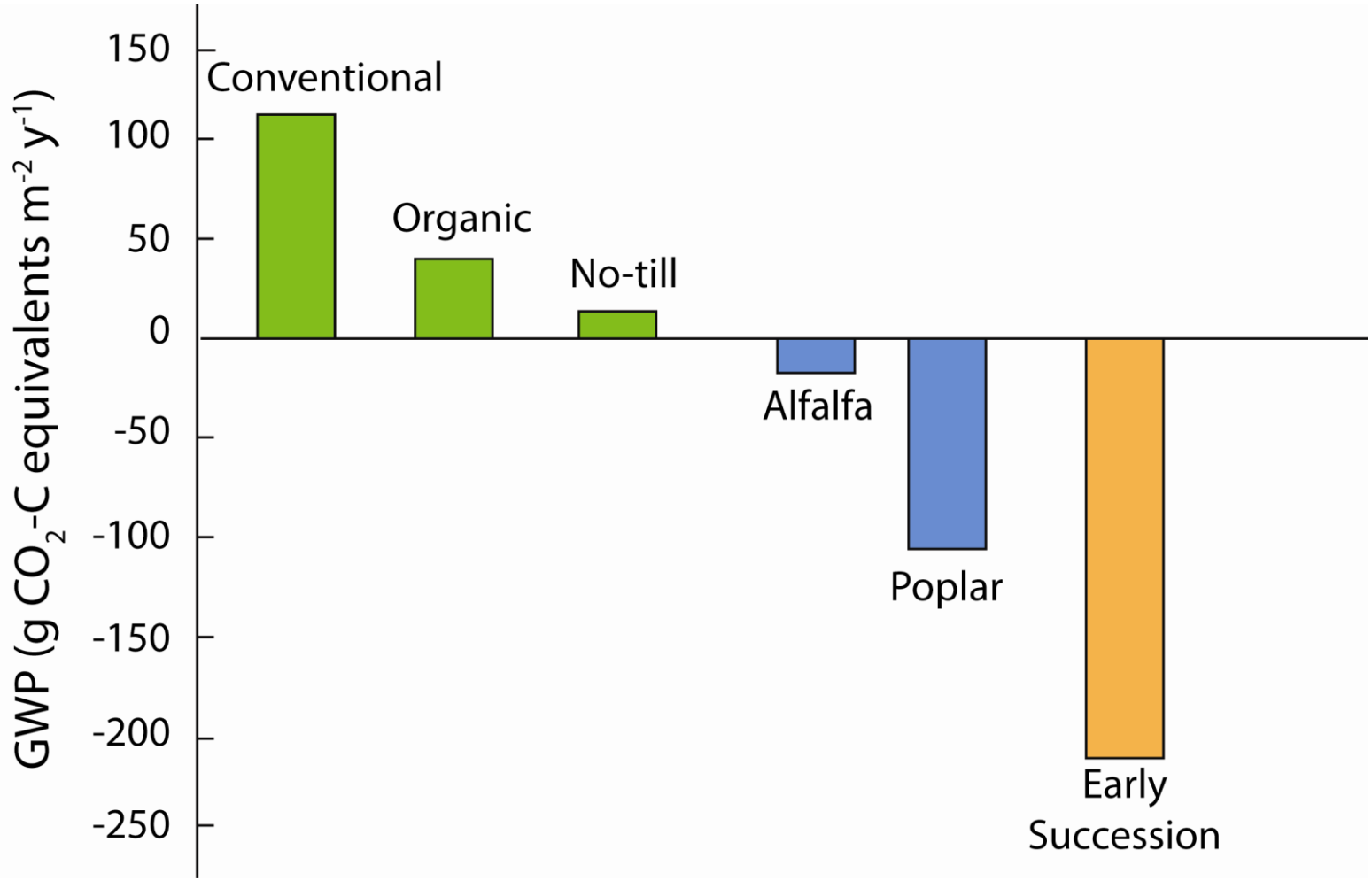
LOW

Water quality regulation: Nitrate leaching declines with management intensity



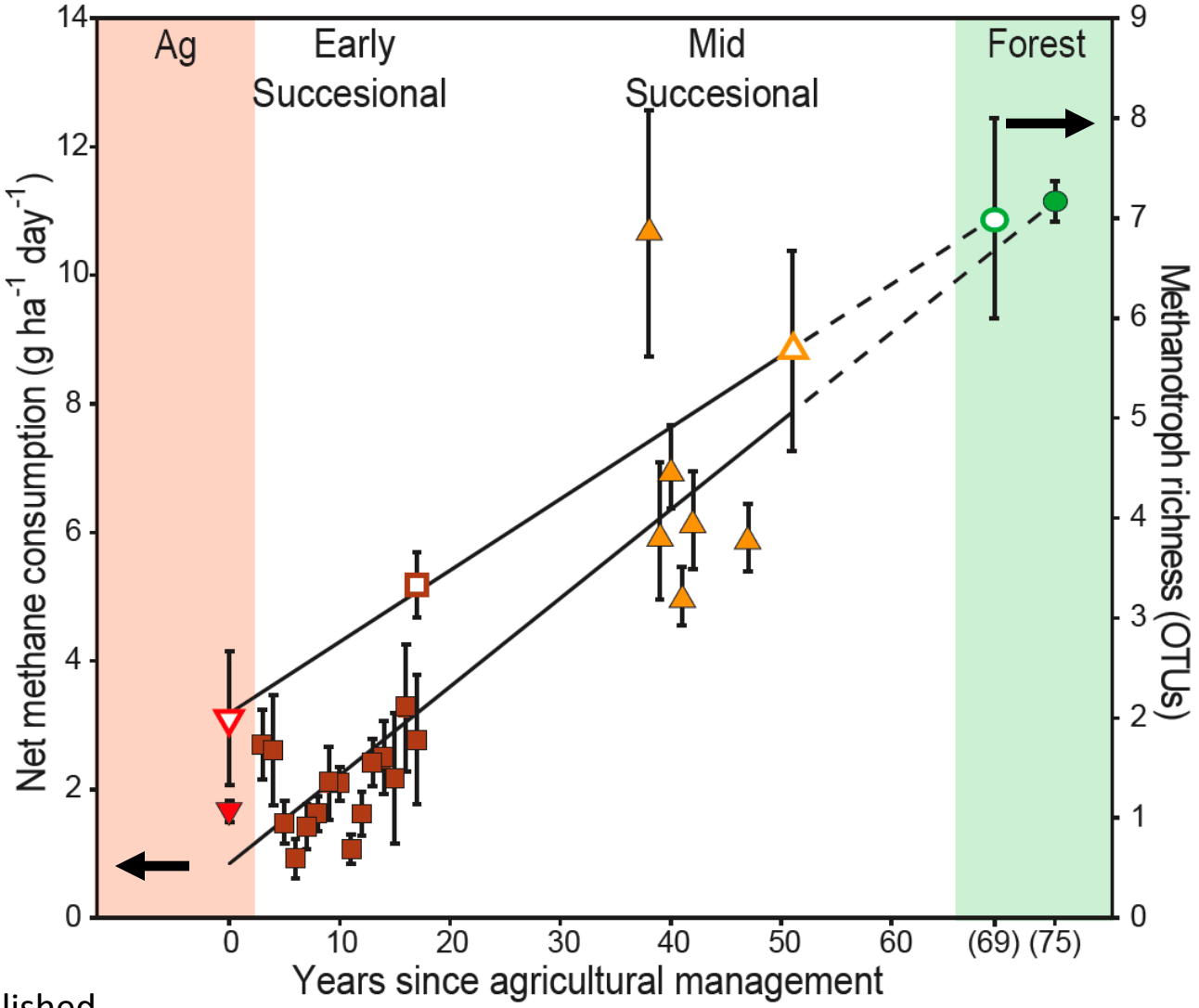
Syswerda 2009

Climate regulation: Global warming potential declines with mgmt. intensity



Robertson et al., 2000, Science

Soil microbe populations recover diversity, digesting more methane after agriculture



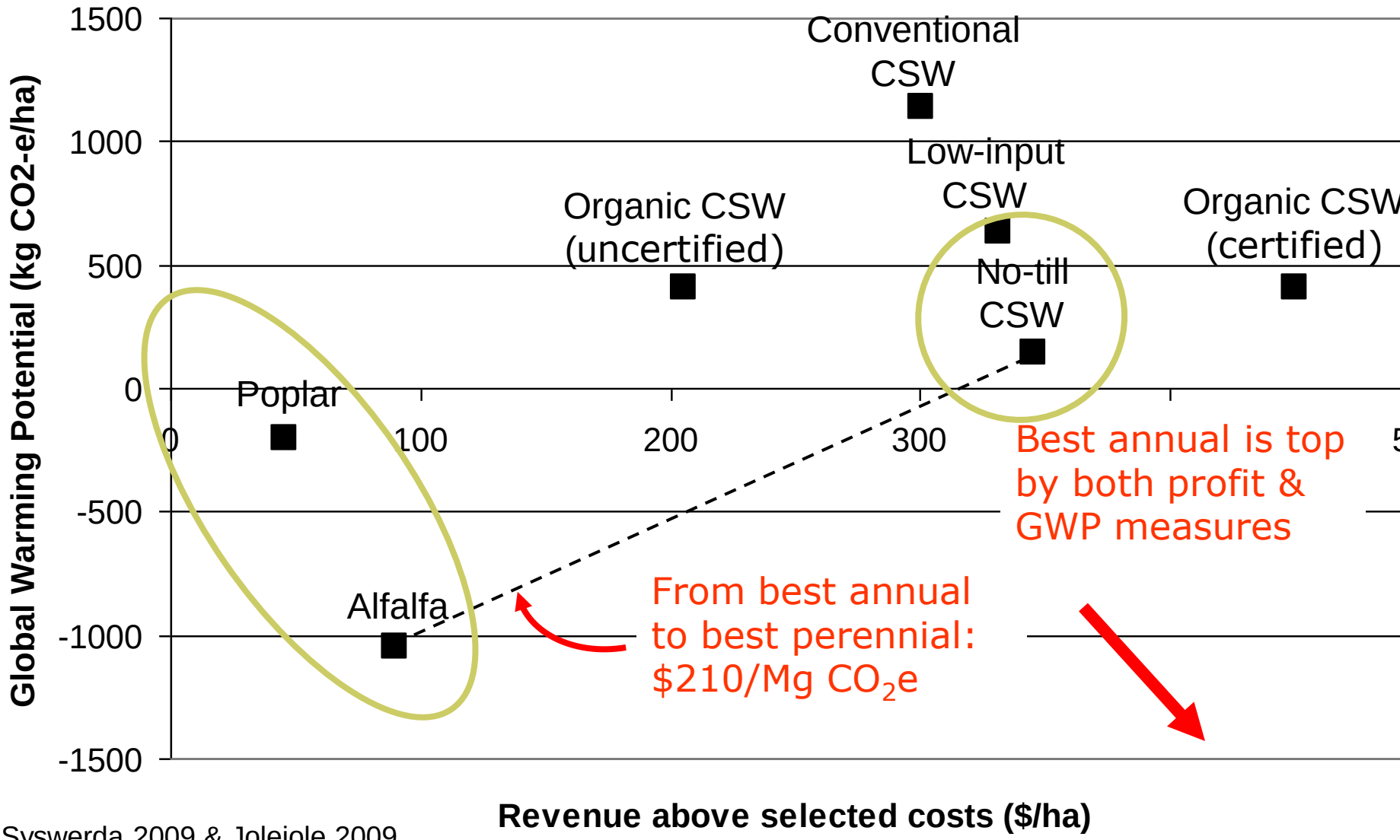
Schmidt, unpublished

What does it take for people to manage for more ecosystem services?

- Able and willing?
  - Awareness, attitudes, barriers, incentives
- For farmer suppliers to provide more ES:
  - Direct cost (including equipment)
  - Opportunity cost (foregone earnings)
- For consumer demanders of more ES:
  - Willingness to pay

Cost of providing reduced Global Warming Potential

→ Implied cost of efficient GWP reduction @ KBS



Syswerda 2009 & Jolejole 2009.

Real farms and farmers are more heterogeneous than any experiment

- Survey of 1800 farms
- Environmental stewardship based on KBS-LTER findings
  - Awareness
  - Attitudes
  - Barriers
  - Incentives

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Crop Management and Environmental Stewardship:

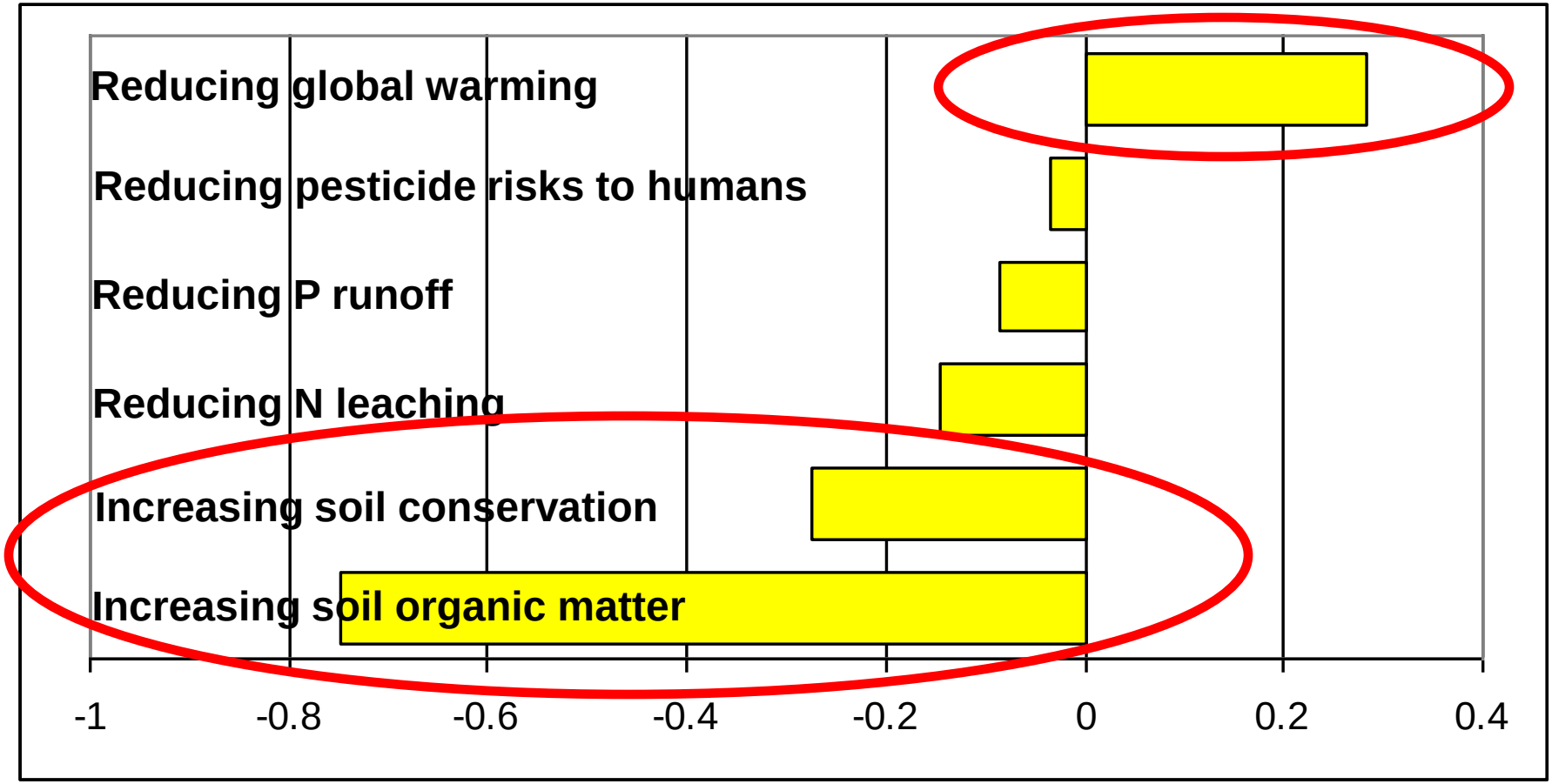
A SURVEY OF YOUR OPINIONS

This research aims to understand farmers' views on adopting various low-input cropping practices. There are no right or wrong answers because everyone farms different ground and has different management strategies and marketing plans.

Your opinions matter!

By completing this questionnaire you are helping to inform the design of future policies that better reflect the views and concerns of Michigan farmers.

Attitudes: Some ES have more private value, others more public



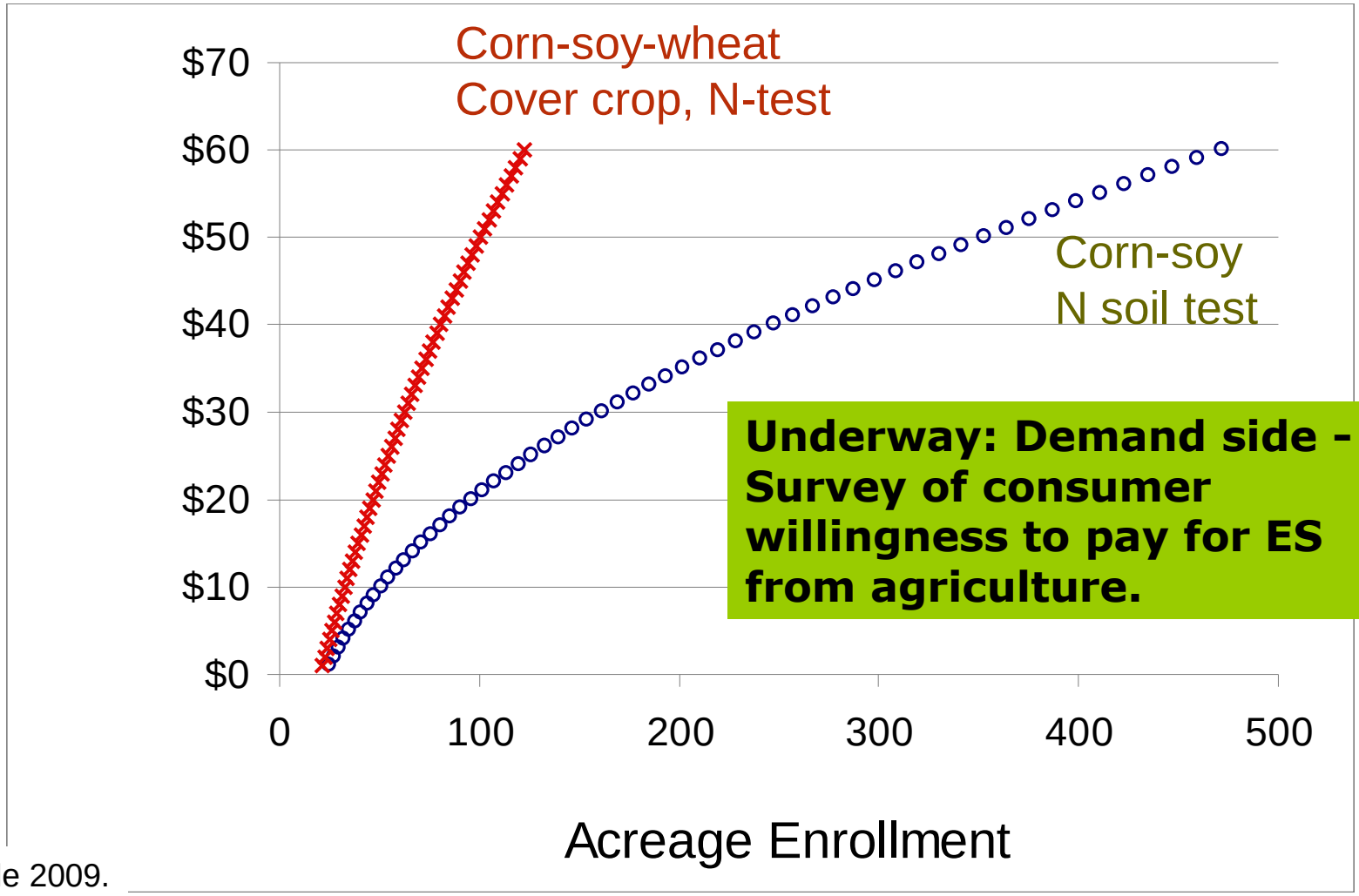
N=1800 Michigan corn-soy farms. Unpublished data 2008.

Incentives: How willing are farmers to supply ES from lower input systems?

- **A**: Corn-soybean
- Reduced tillage
- Nitrogen fertilizer just-in-time based on tests

- **D**: Corn-soybean-wheat
- Reduced tillage
- Nitrogen fertilizer just-in-time based on tests
- Winter cover crop
- 1/3 cut in fertilizers by applying only over row

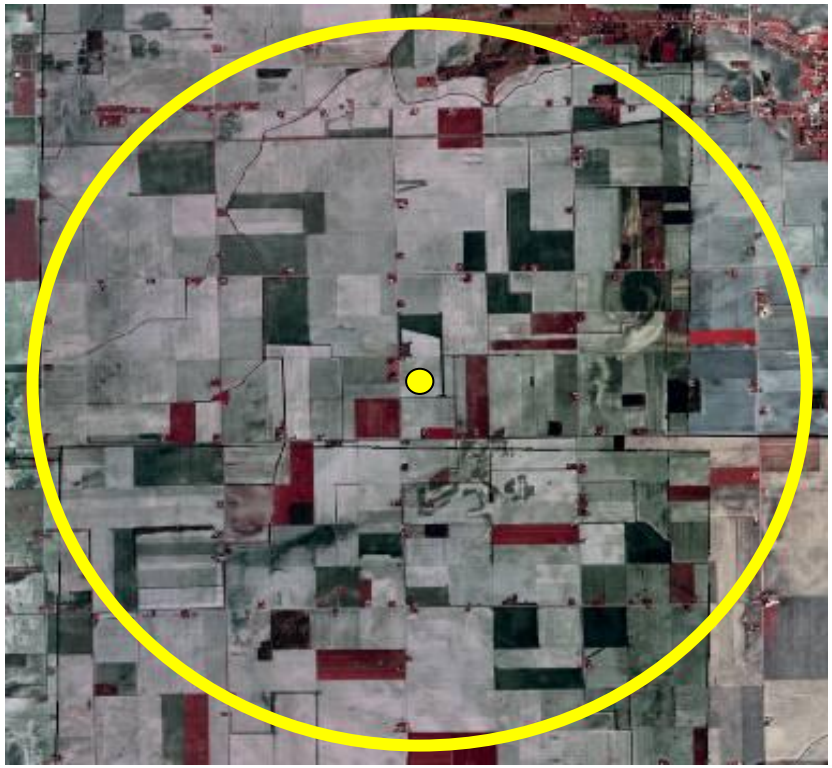
Small changes cost less to supply, so more land offered by average farm



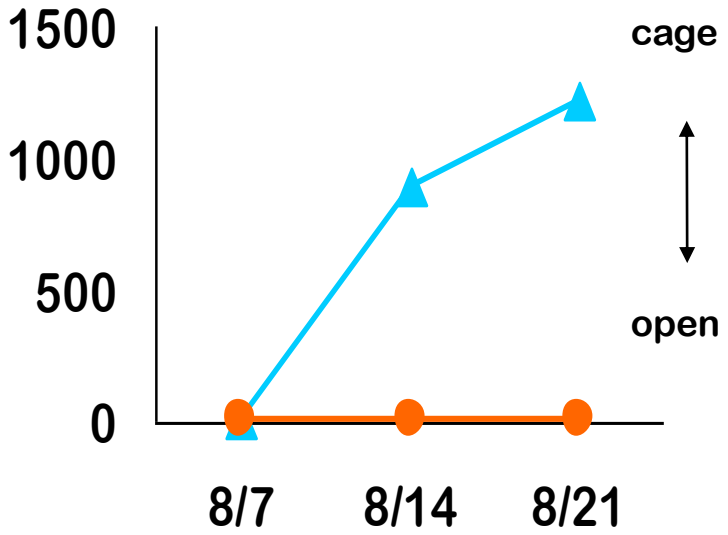
Underway: Demand side – Survey of consumer willingness to pay for ES from agriculture.

Jolejole 2009.

From plot to landscape scale: Pest regulation of soy aphid by natural enemies

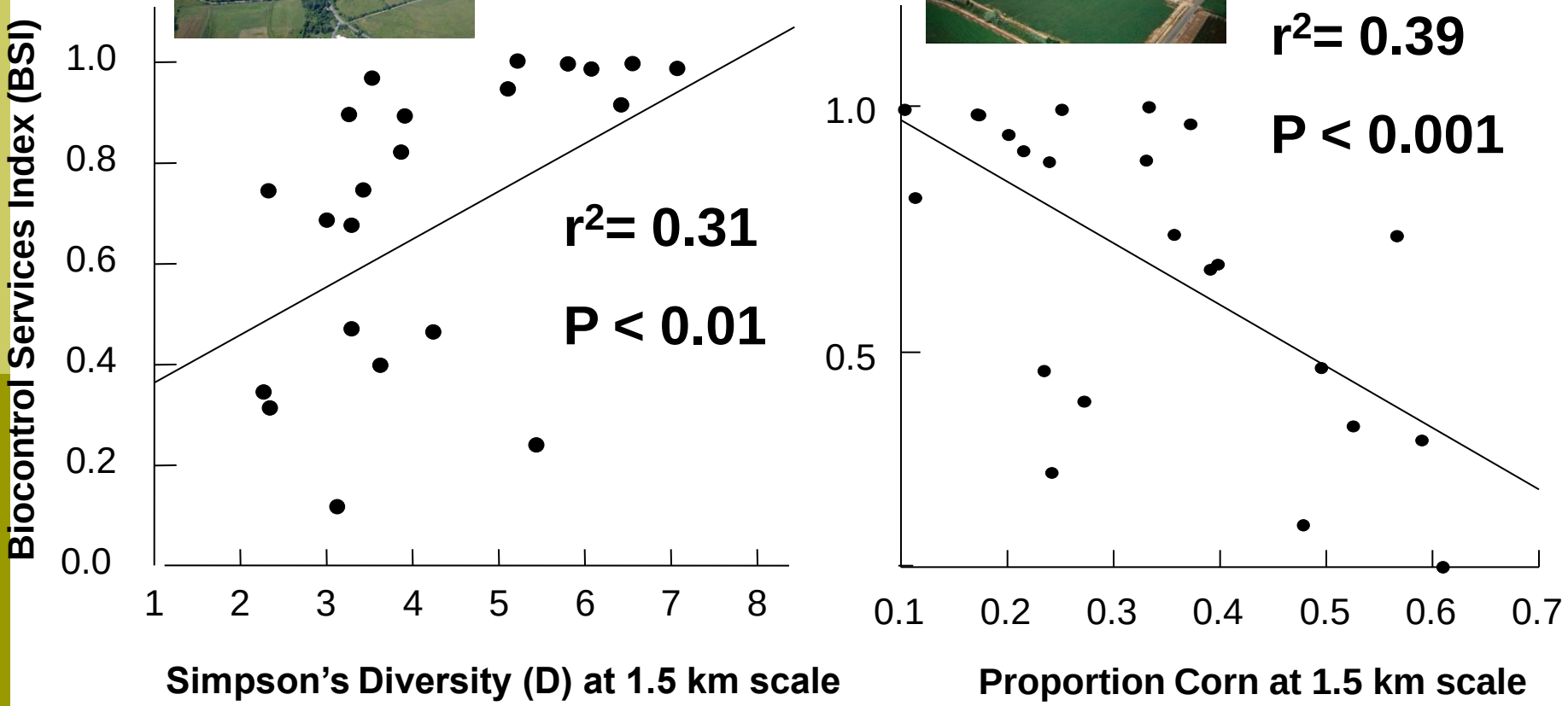


Surrounding landscape affects predation of soybean aphid



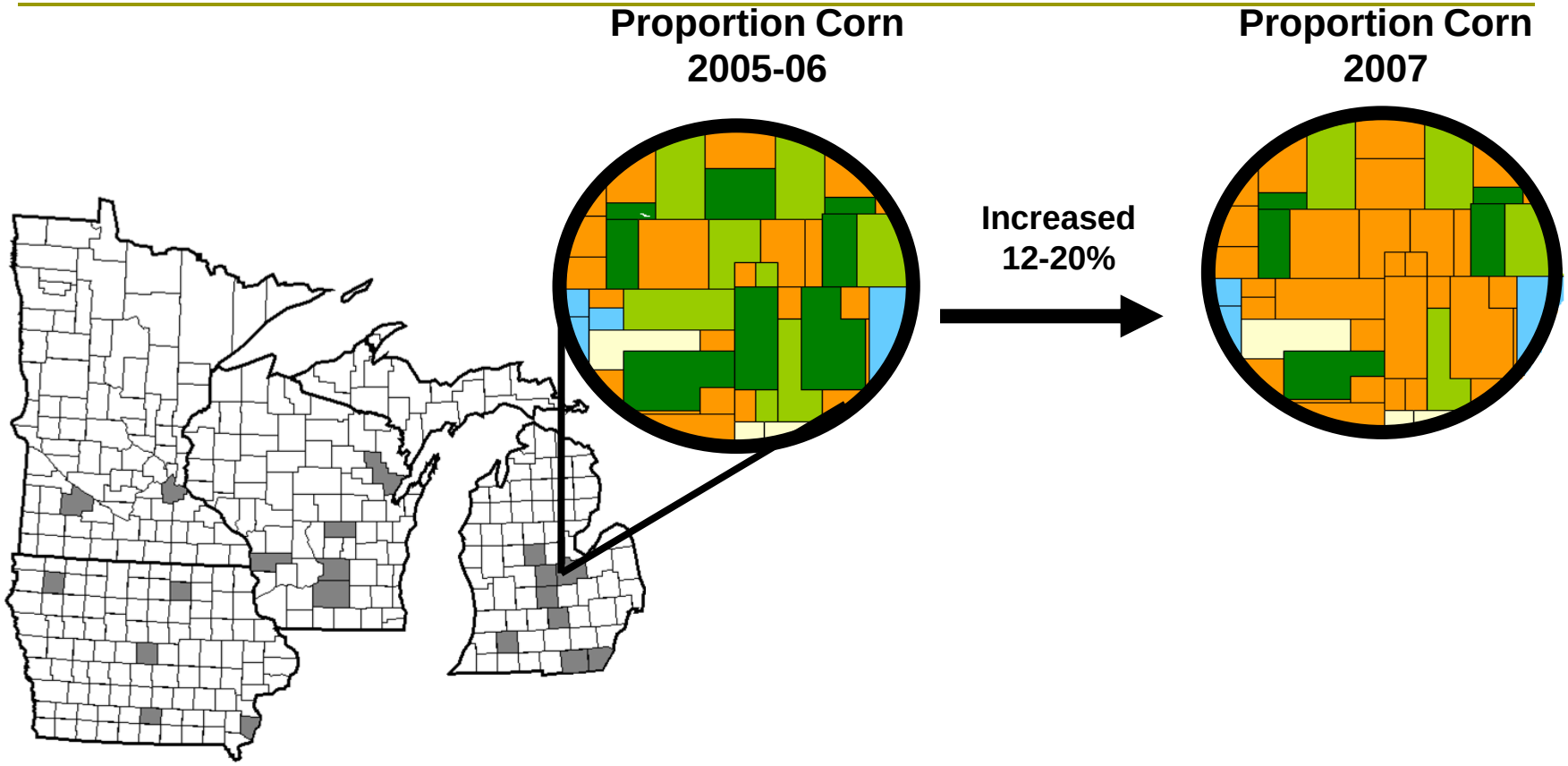
Soybean aphids per plant rise in cages that exclude predators

Biocontrol rises with diverse land cover; falls with corn area



Gardiner *et al*. Ecol. Appl. 2009

Implications for expanded U.S. corn acreage



Due to increased demand for ethanol, corn acreage increased 19% nationally from 2006-2007.

Value of biocontrol services

- **$23 $ha^{-1}y^{-1}$ in 2005-06**
  - **- Averted yield loss**
  - **- Insecticide savings**
  - **= $239 M y^{-1} Michigan, Wisconsin, Minnesota and Iowa alone**

- **Loss of $58 M y^{-1} ($9 ha^{-1}) in biocontrol services due to 2007 increase in corn acreage**

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

Agricultural ecosystems: Tightly linked human-natural systems

- Expanding understanding of ecosystem function & services
  - Microbes to landscapes
  - Single to multiple ES
  - Farmers & consumers to markets & policy
- Frontiers ahead
  - Landscape-scale ecosystem function
  - Valuation of "stacked" ES from crop system changes
  - Adaptation to changing climate/environment

Thanks to

- KBS-LTER colleagues of all sorts
- LTER site collaborators in Working Ecosystems workshop
- Funding partners who have magnified impacts