

Balancing biological control and other ecosystem services in bioenergy landscapes



USDA

Claudio Gratton

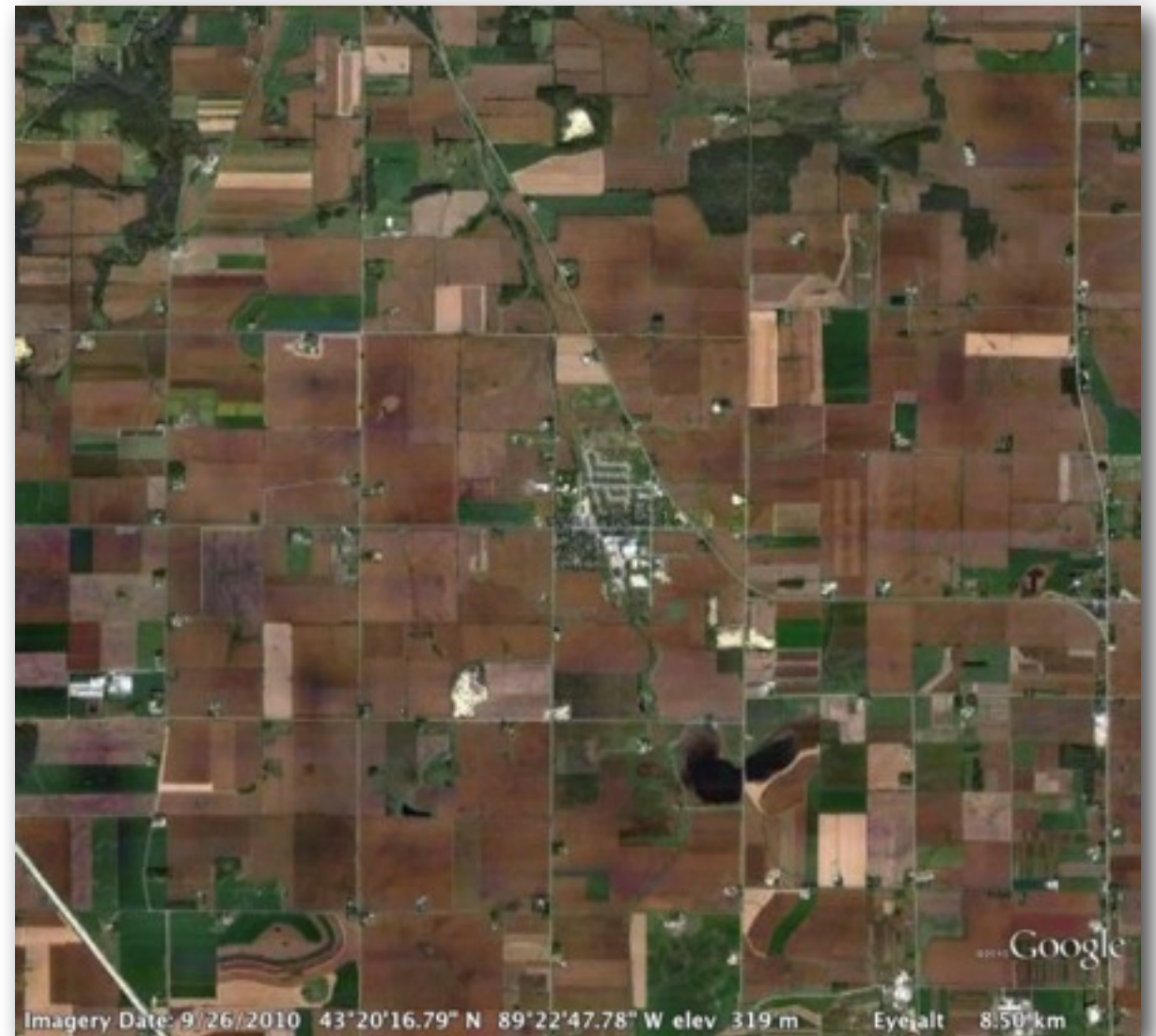
Randy Jackson and Tim Meehan

Department of Entomology

University of Wisconsin - Madison



Humans change landscapes



Wildlife is habitat and landscape dependent



Natural Pest
suppression



Pollination



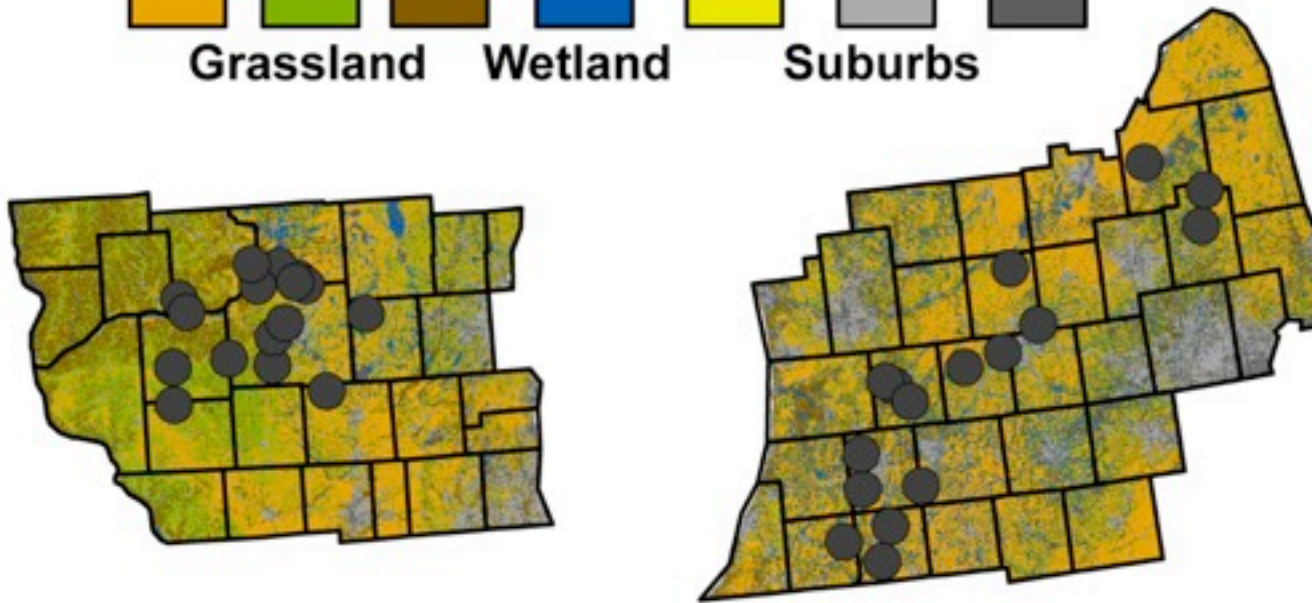
Bird richness

Measuring who is there, and how many there are, is relatively easy
Relating them to how they benefit humans is more difficult

Measuring biocontrol potential

Land cover

Annual crops Forest Other crops Urban
Grassland Wetland Suburbs

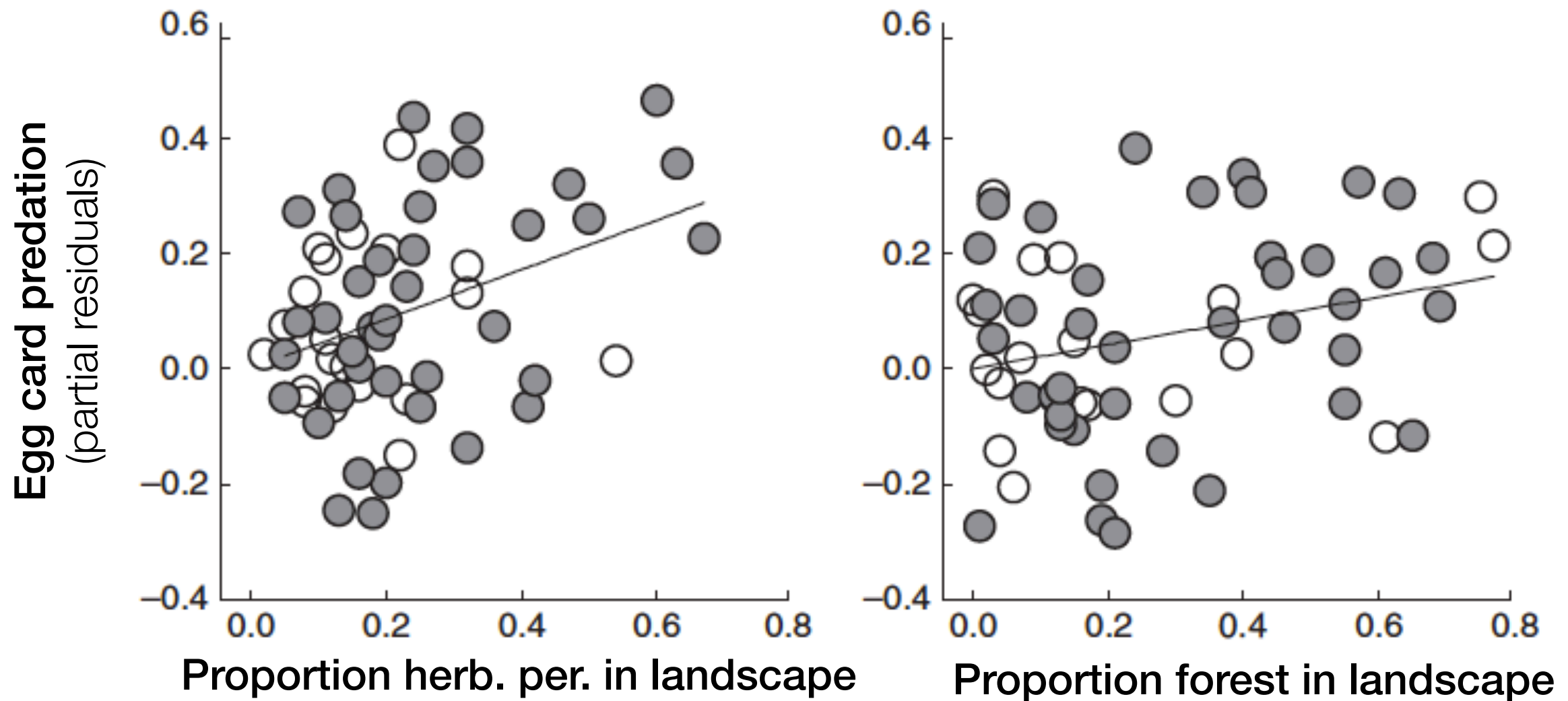


Relating to landscape features

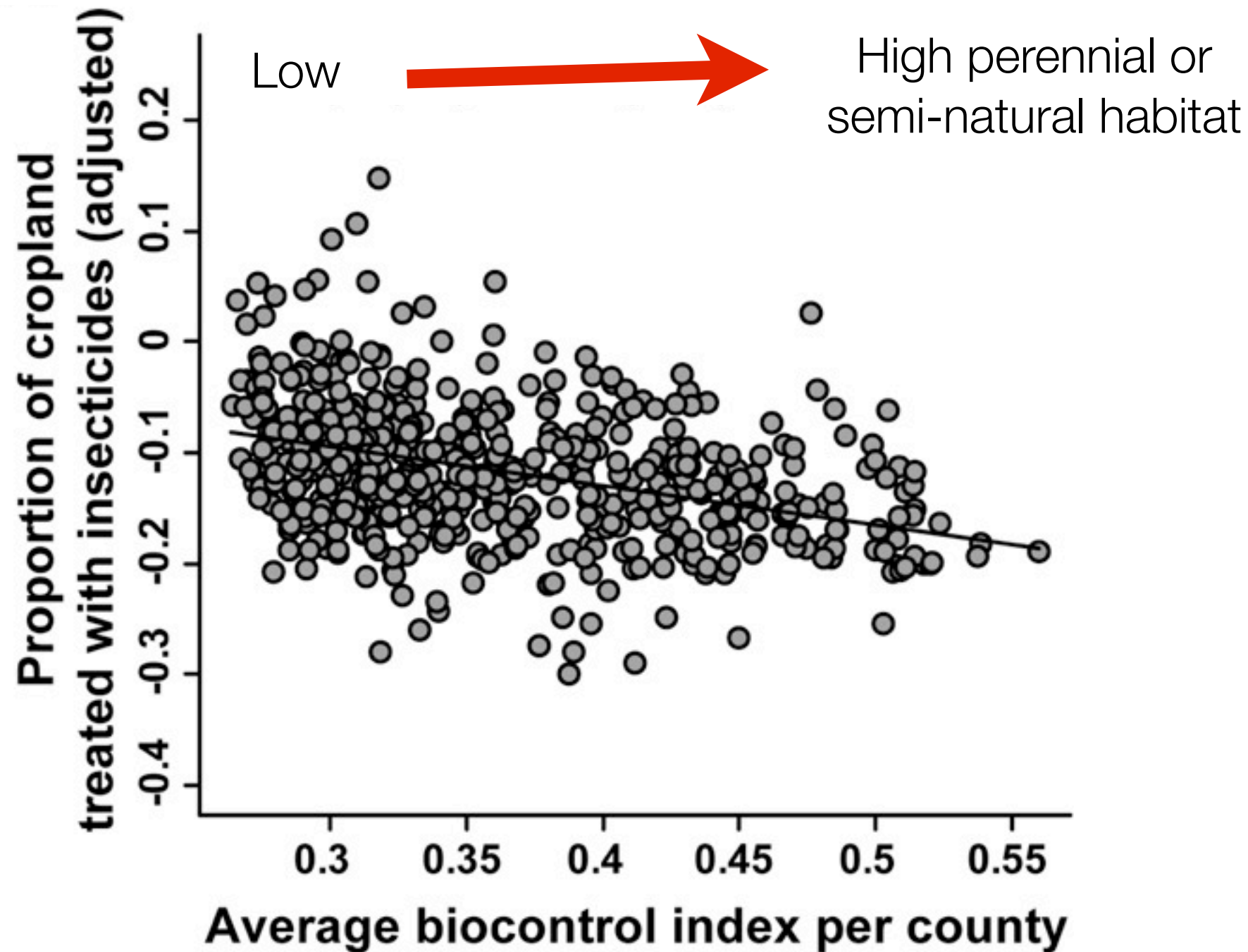
Biocontrol Assay



Landscape context affects biological control potential

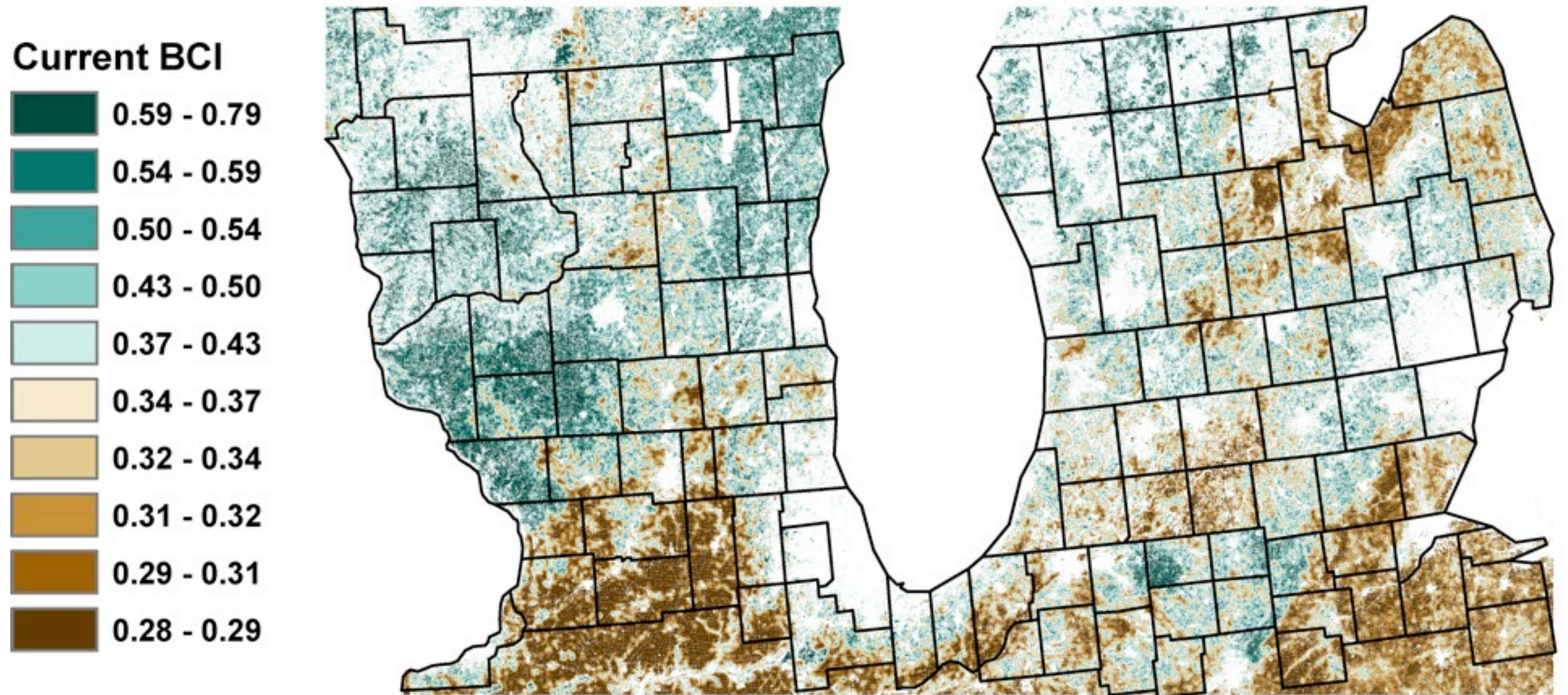


Biological control potential and landscape perenniality decrease pesticide applications



Farmers behavior appears to be linked to landscape composition (which drives biocontrol index).

Modeling Biological control in current landscapes





Bell's Vireo



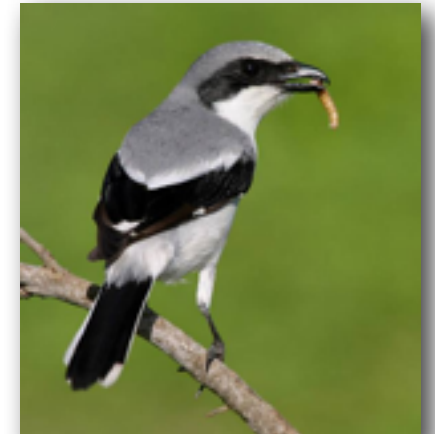
Dickcissel



Field sparrow

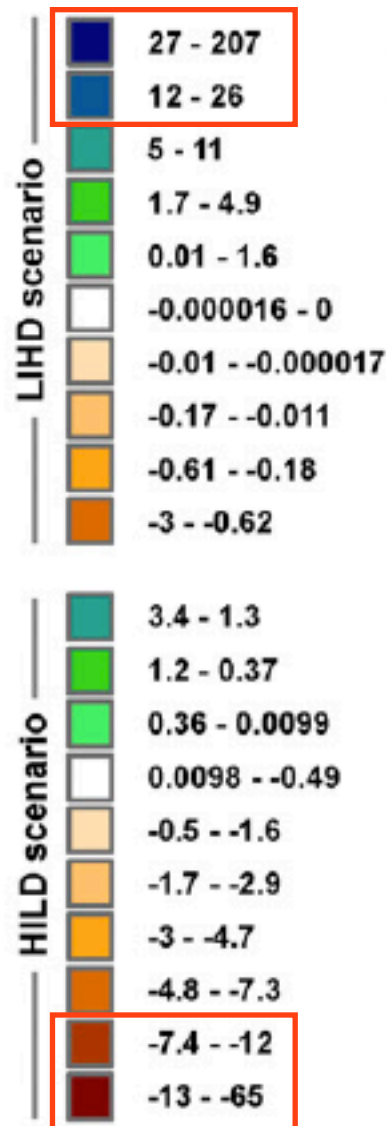
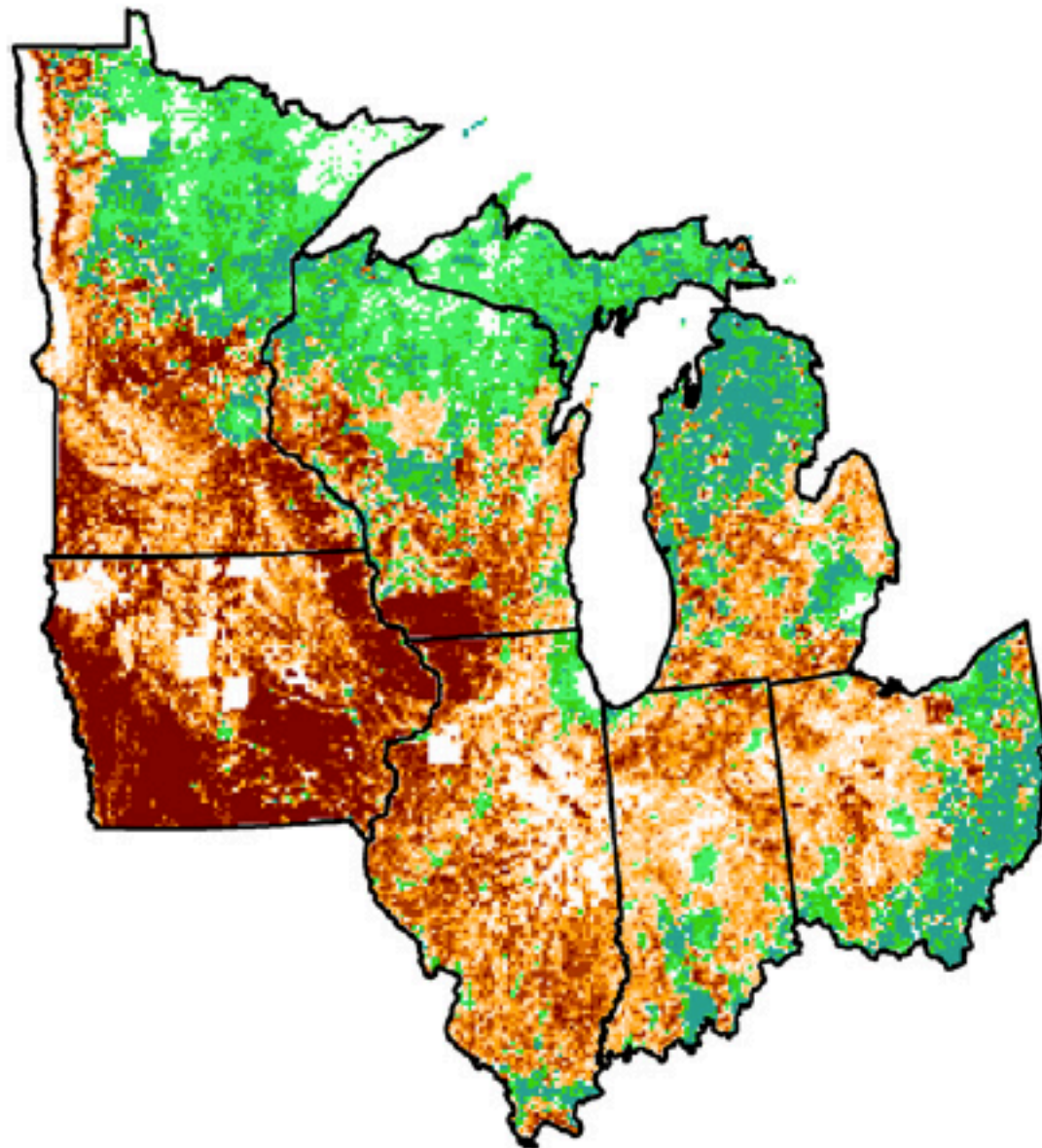


Boblink

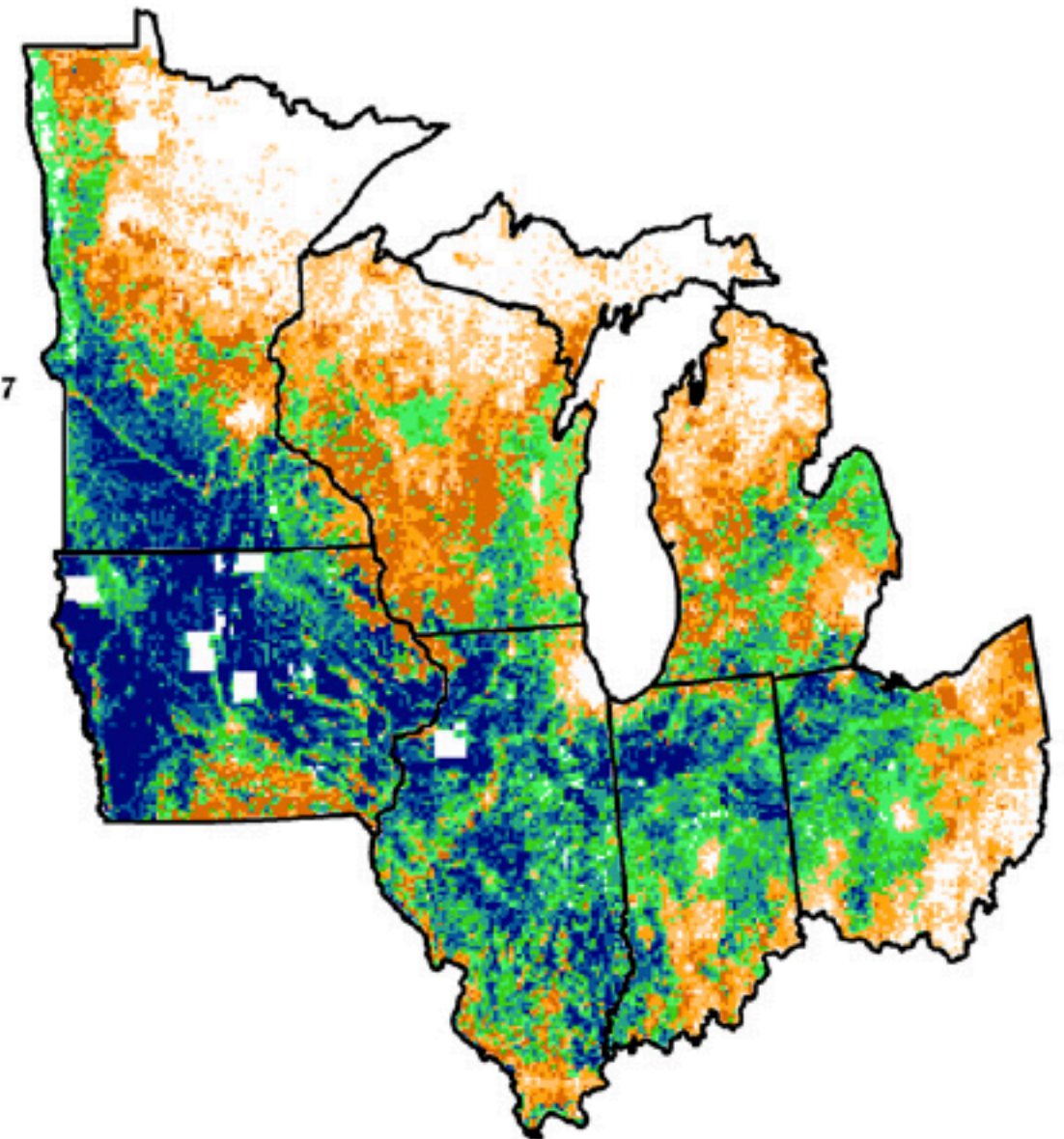


Loggerhead shrike

Change in total richness (%) under HILD scenario



Change in total richness (%) under LHD scenario





news.wisc.edu




blooms.uwcfl.org

Convert annual **crop** (corn) near streams or highly erodible land to **perennial grassland**

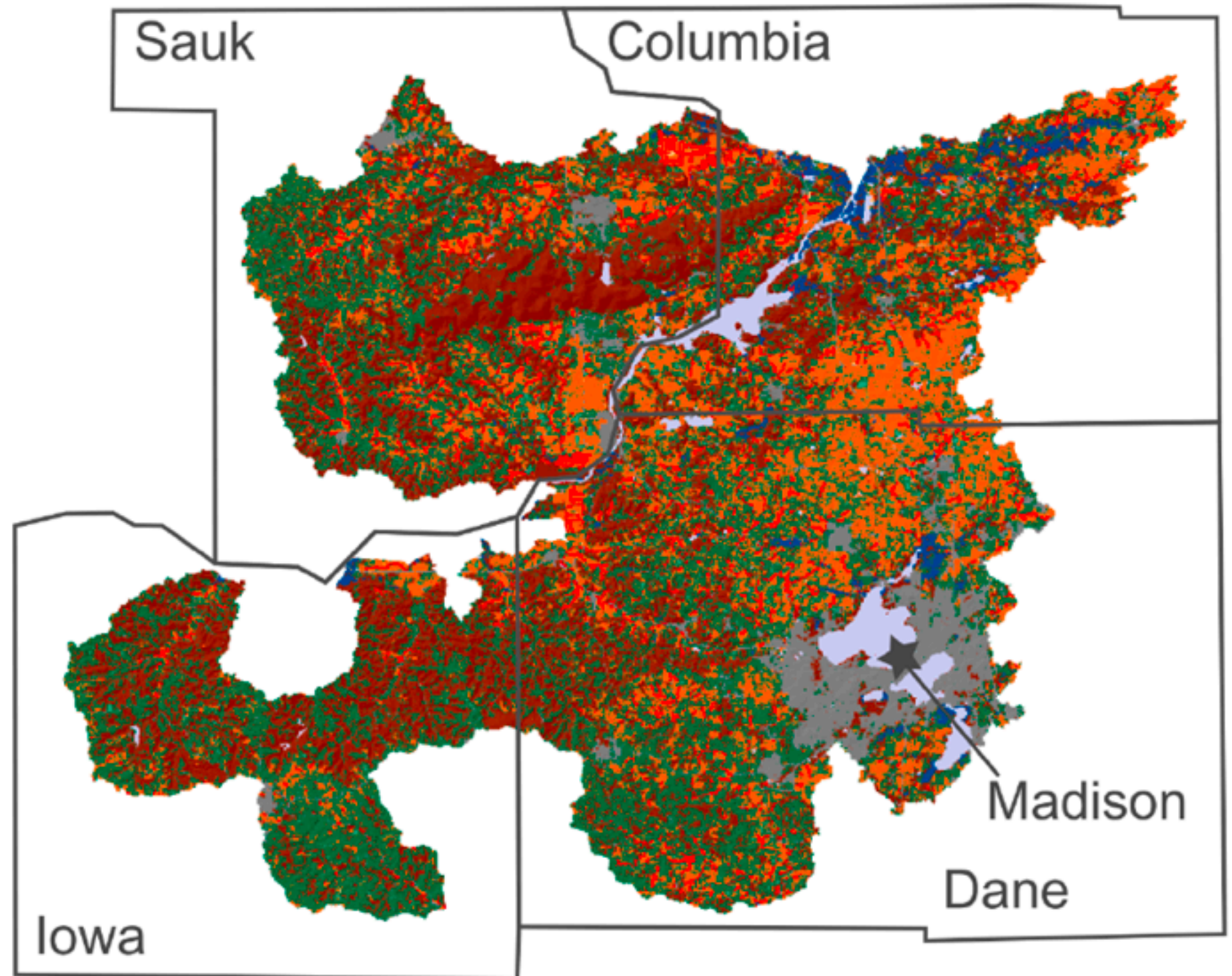
Land cover

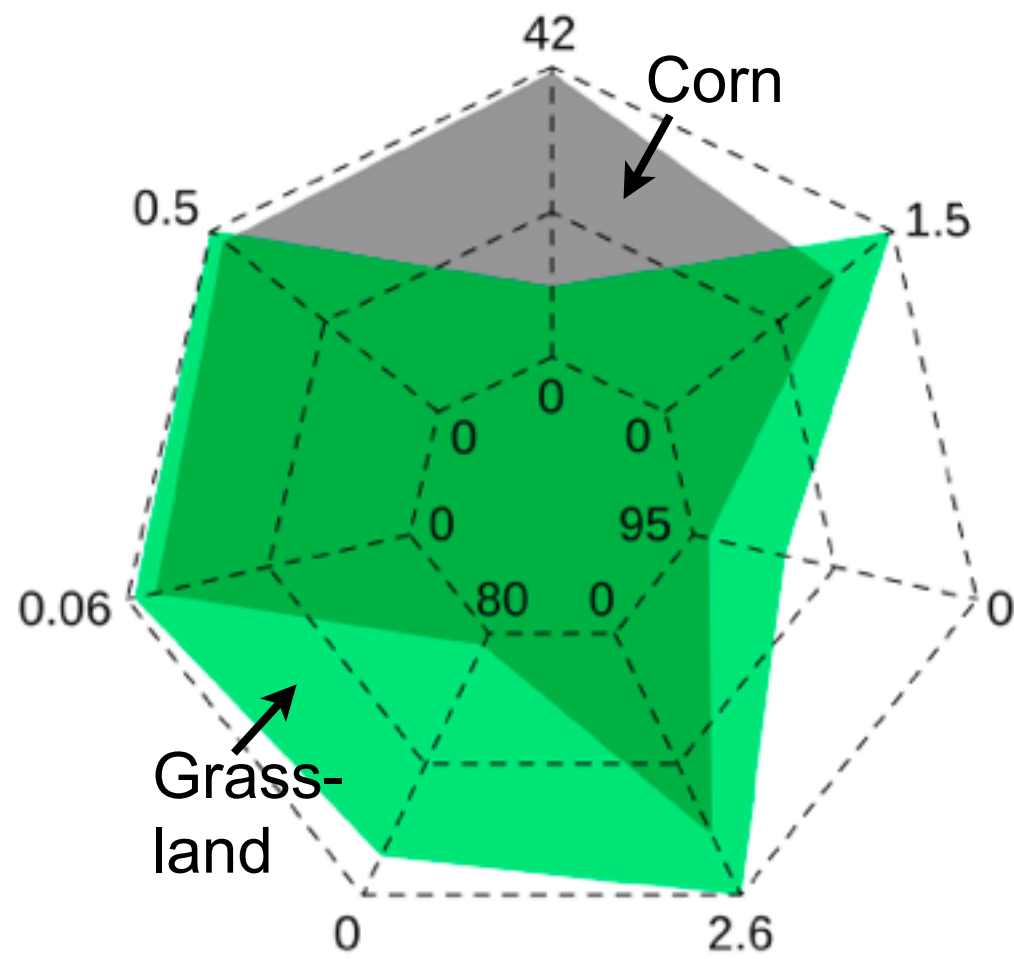
-  Corn and soy
-  Open water
-  Urban
-  Forest
-  Grassland
-  Wetland

Focal land

-  Corn and soy located within 100 meters of stream

17% land in corn,
corn-soy rotations

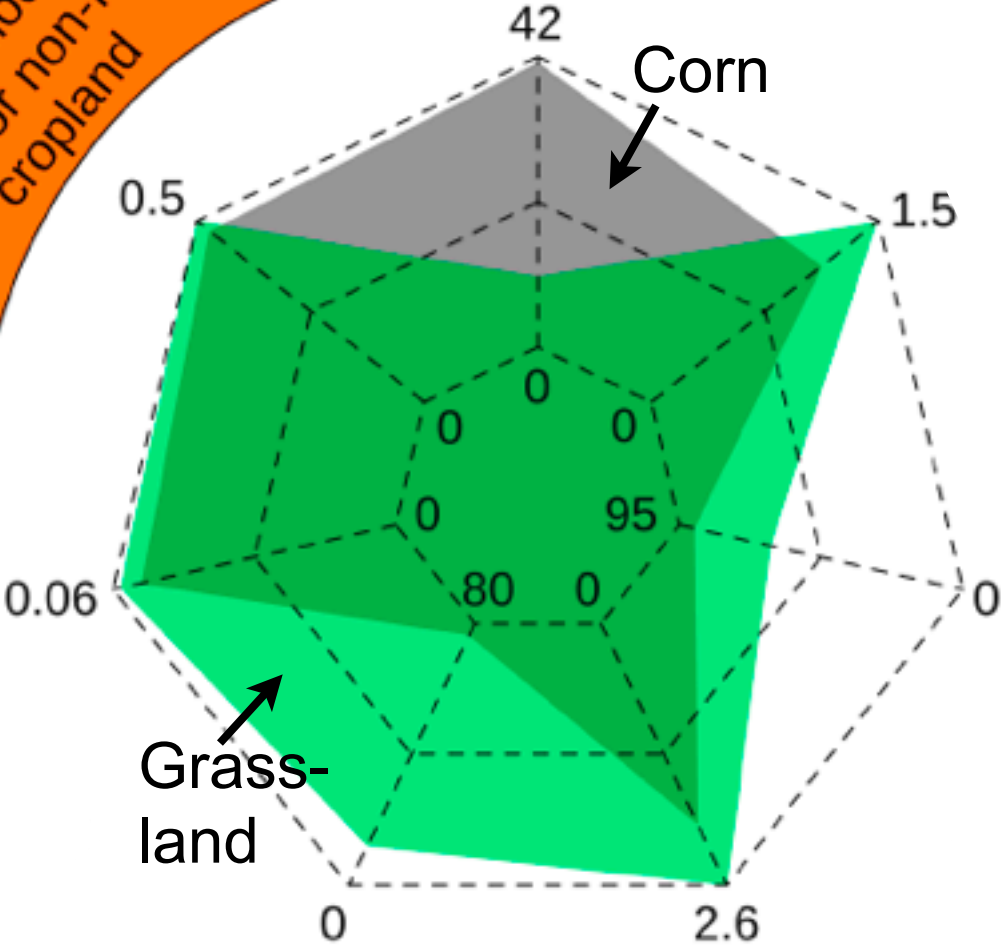




6% increase
pest
suppression
index



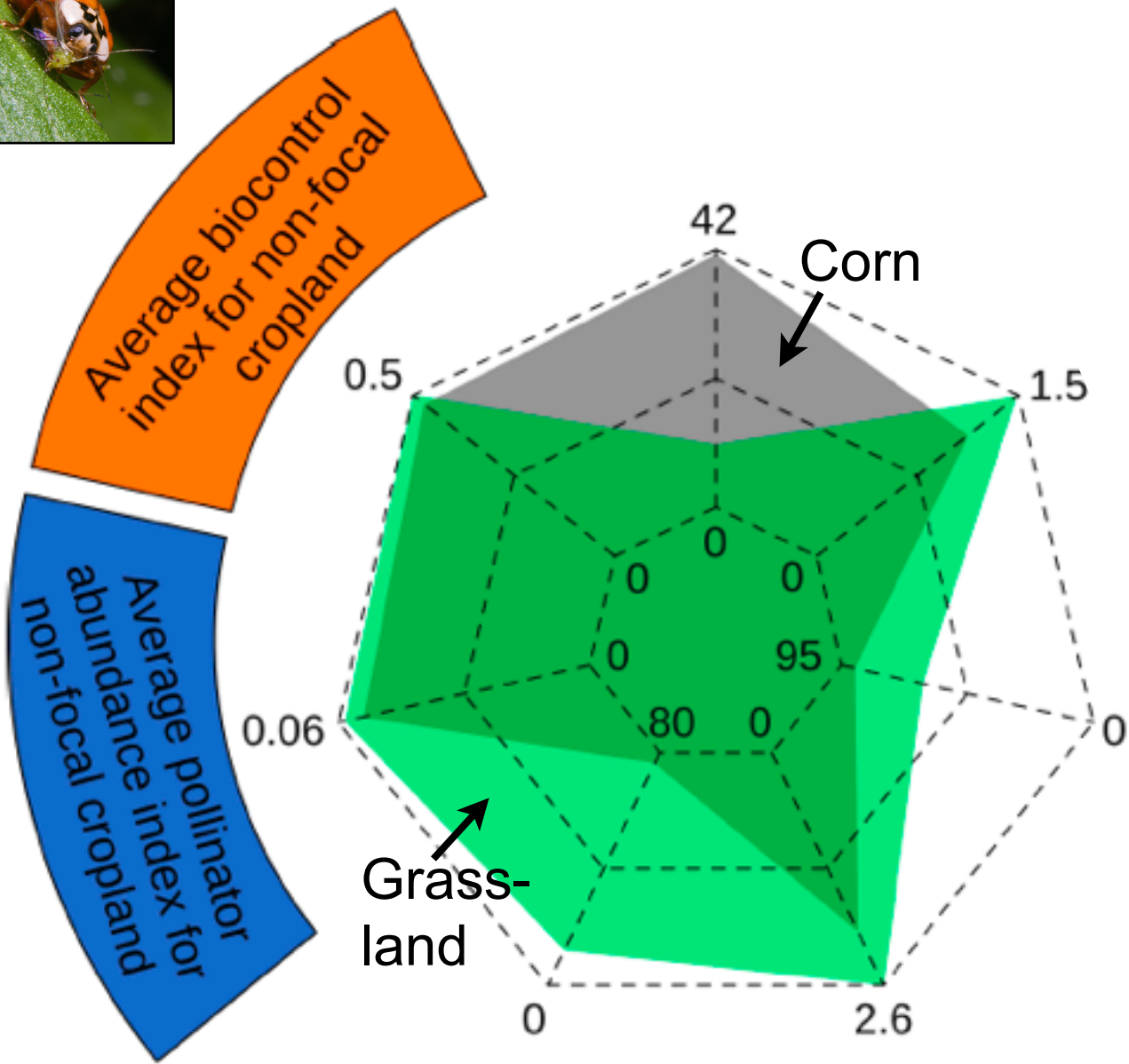
Average biocontrol
index for non-focal
cropland



6% increase
pest
suppression
index



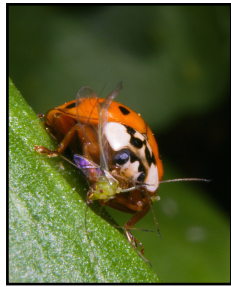
11% increase
pollinator index



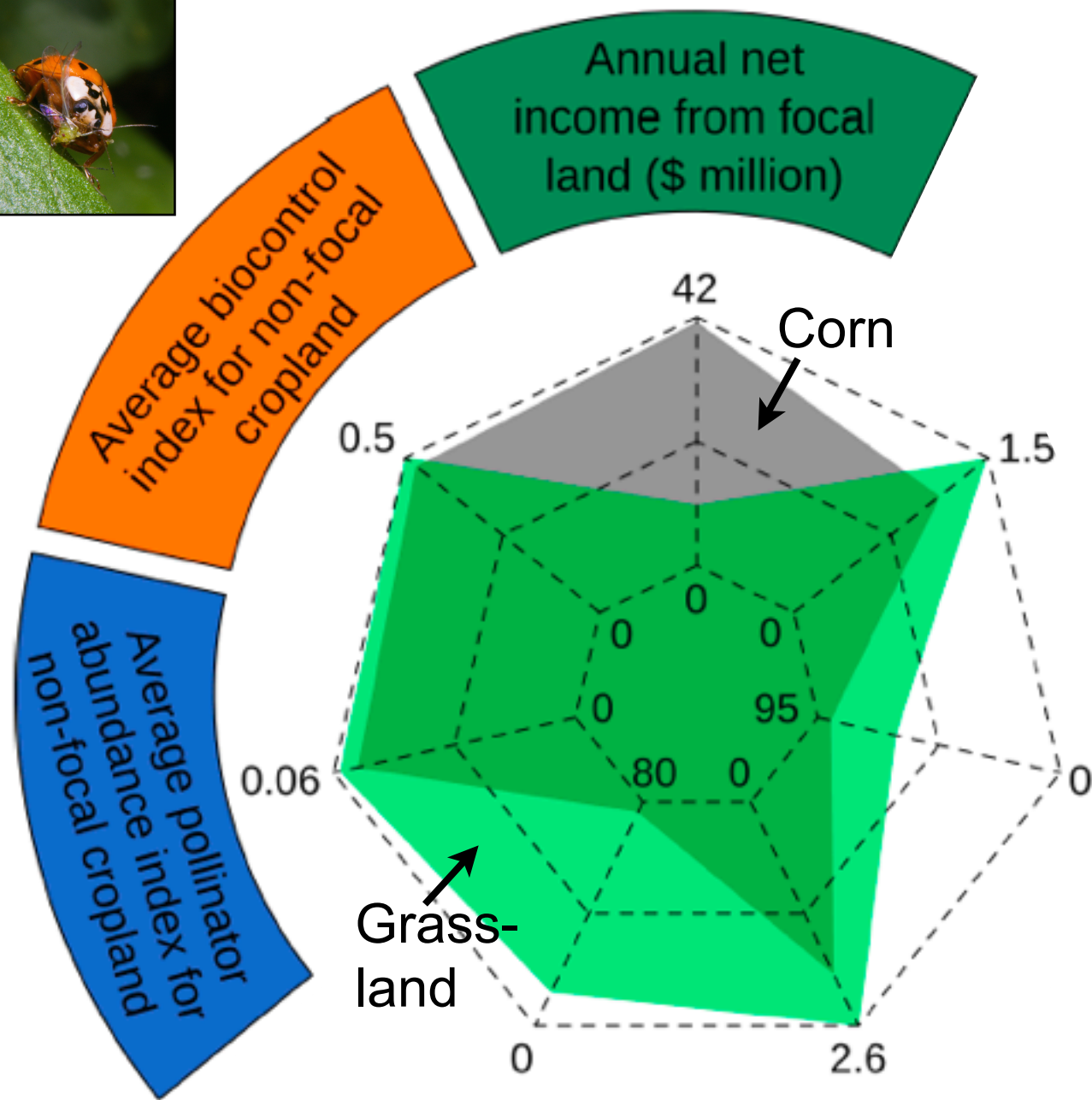


75% decline
in producer
income

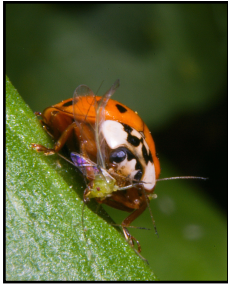
6% increase
pest
suppression
index



11% increase
pollinator index



6% increase
pest
suppression
index

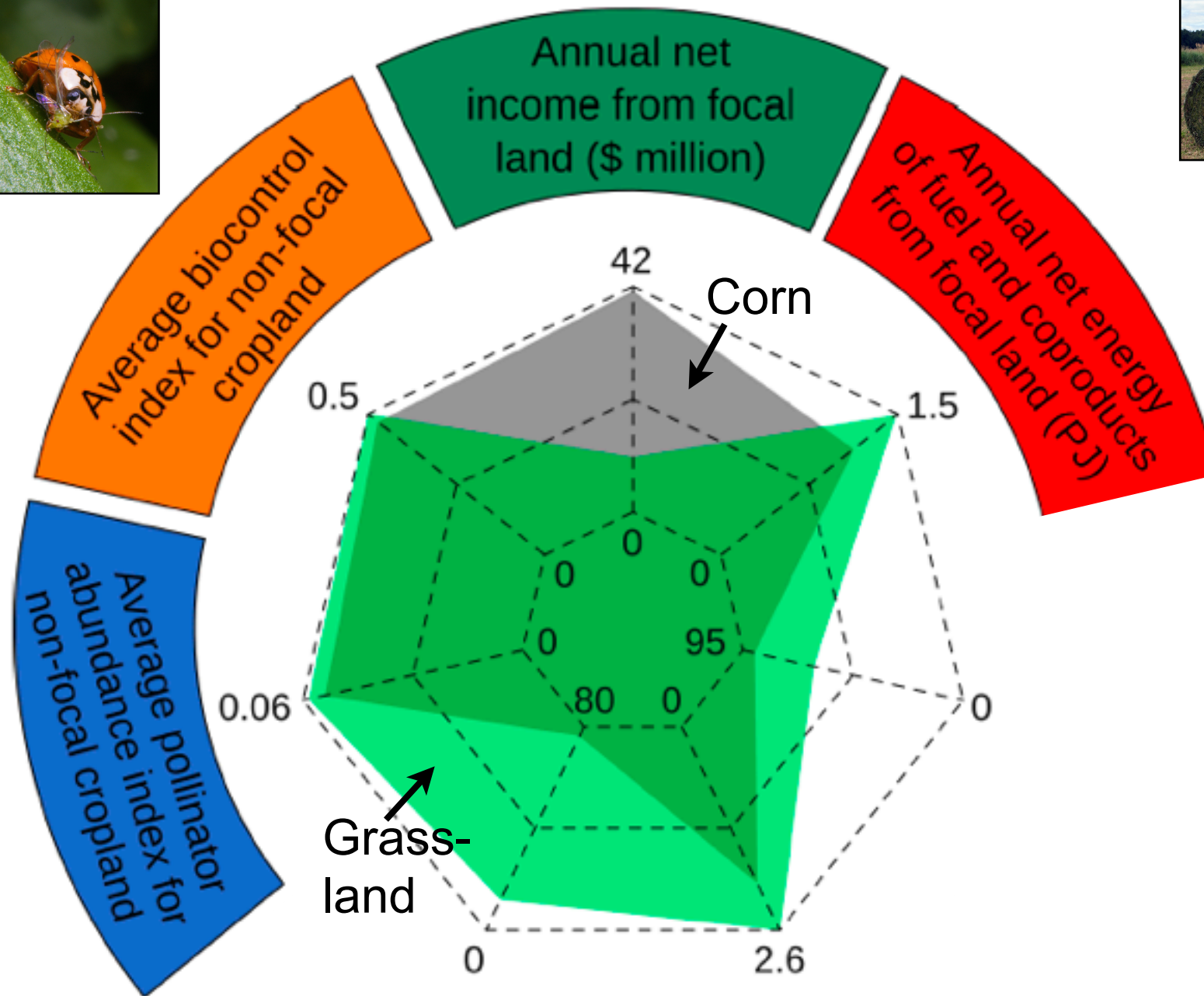


75% decline
in producer
income



33% increase in
Net Energy
production

11% increase
pollinator index



6% increase
pest
suppression
index



75% decline
in producer
income

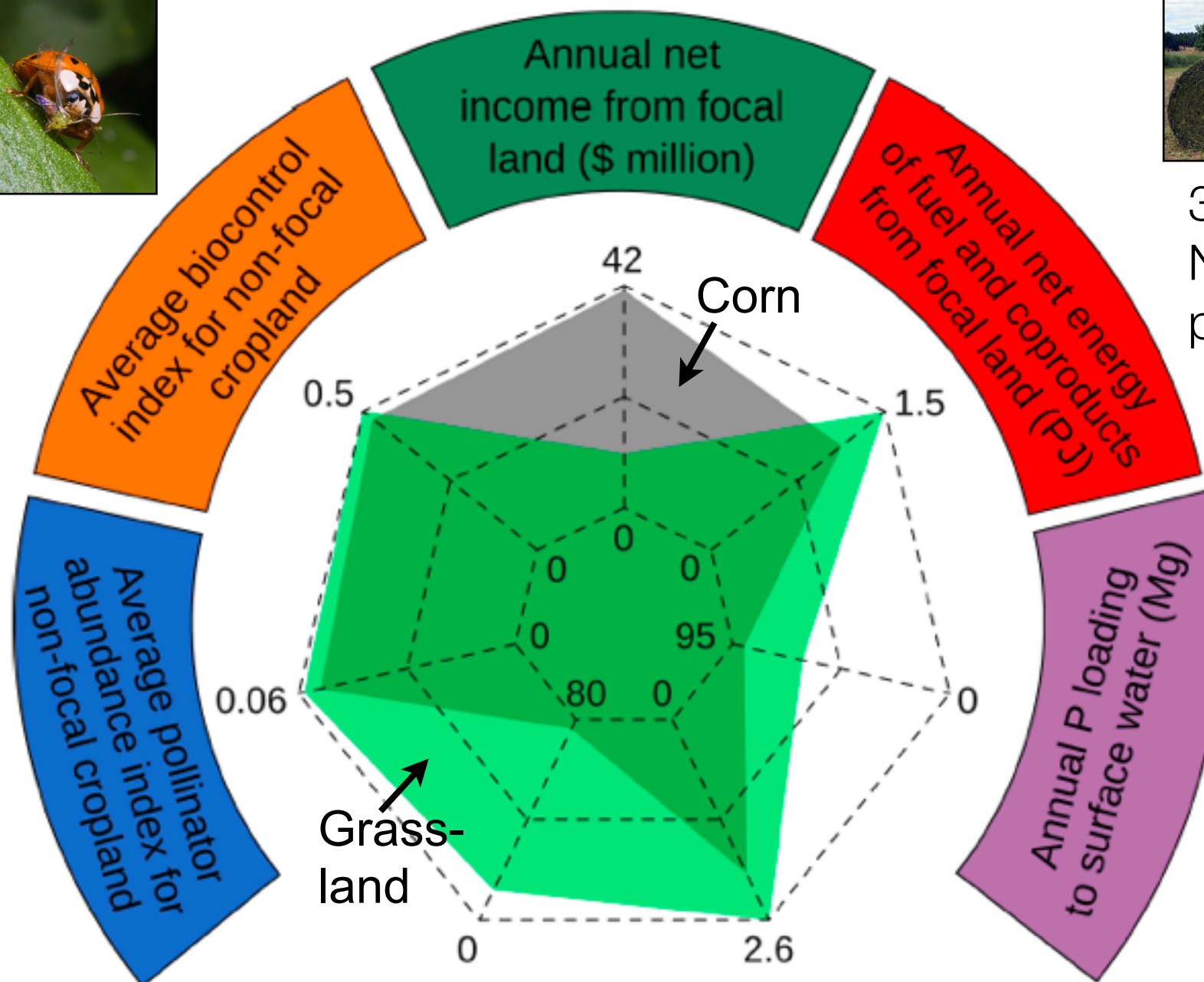


33% increase in
Net Energy
production



29% decrease
phosphorous
export to
streams

11% increase
pollinator index



6% increase
pest
suppression
index



75% decline
in producer
income



33% increase in
Net Energy
production



29% decrease
phosphorous
export to
streams



30% increase in
below ground
carbon storage

Below-ground carbon
sequestered on focal
land (20 yr, Tg)

Annual P loading
to surface water (Mg)

Annual net energy
of fuel and coproducts
from focal land (PJ)

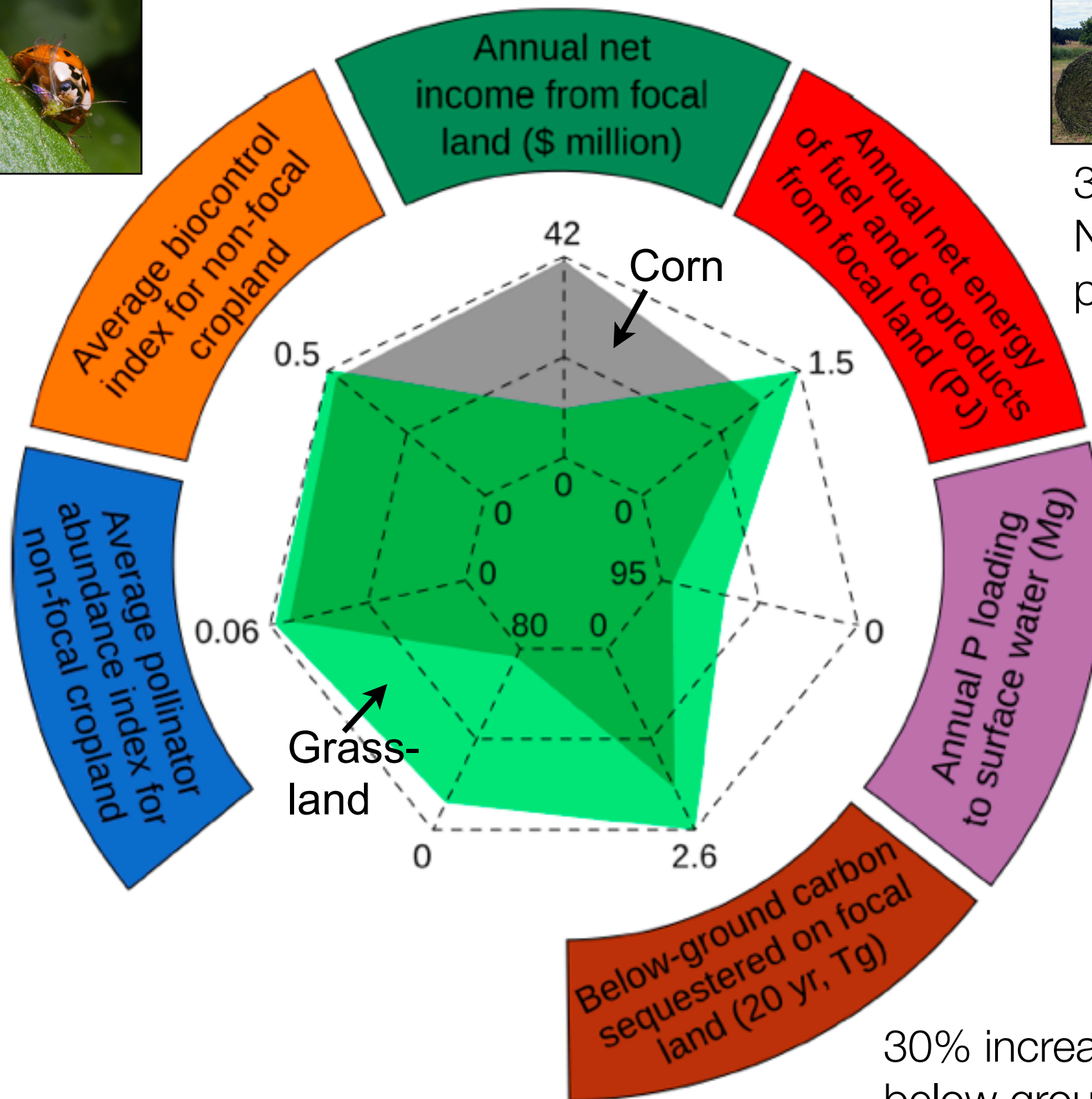
Annual net
income from focal
land (\$ million)

Average biocontrol
index for non-focal
cropland

Average pollinator
abundance index for
non-focal cropland

Grass-
land

Corn



6% increase
pest
suppression
index



75% decline
in producer
income



33% increase in
Net Energy
production

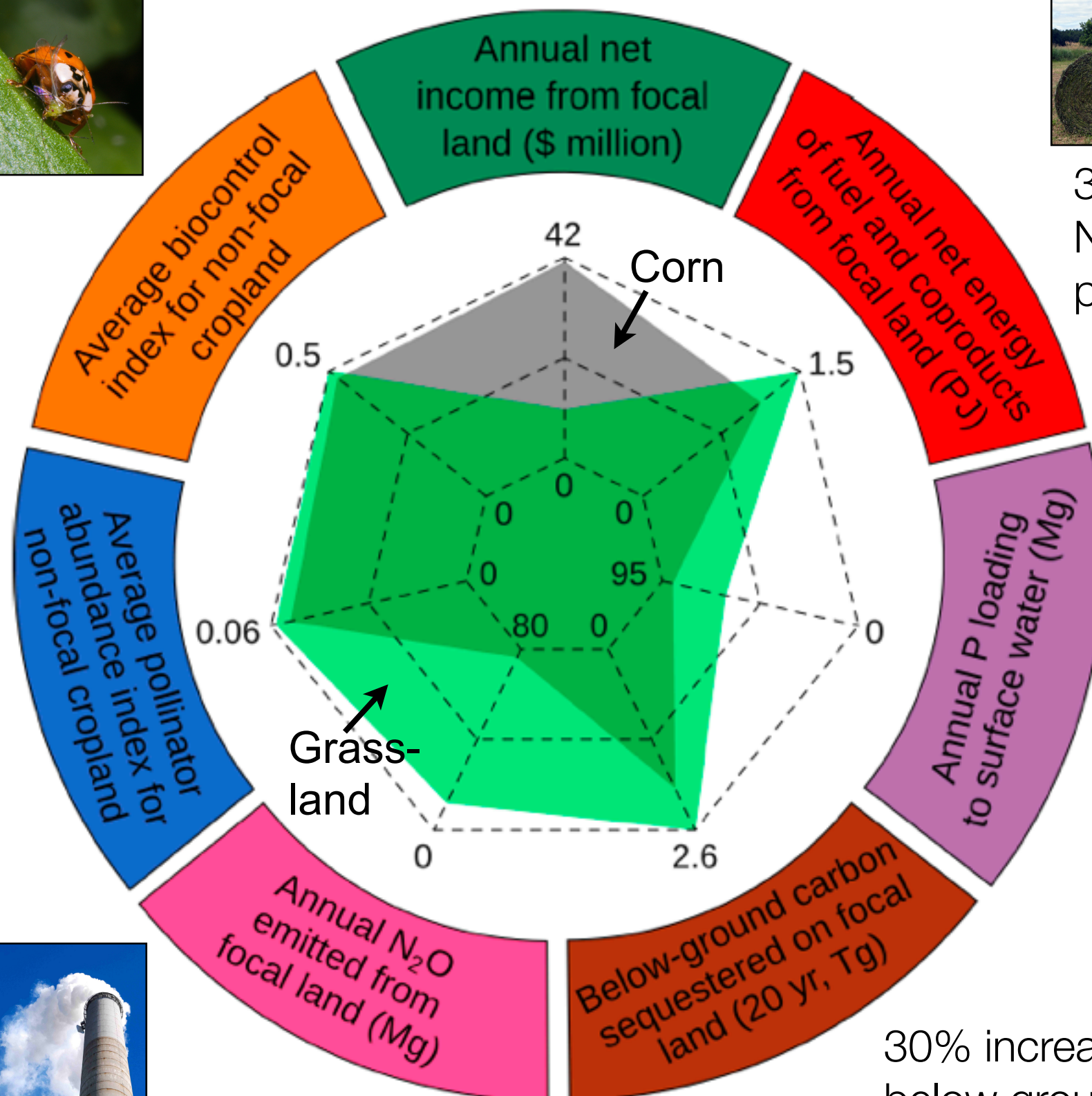


29% decrease
phosphorous
export to
streams

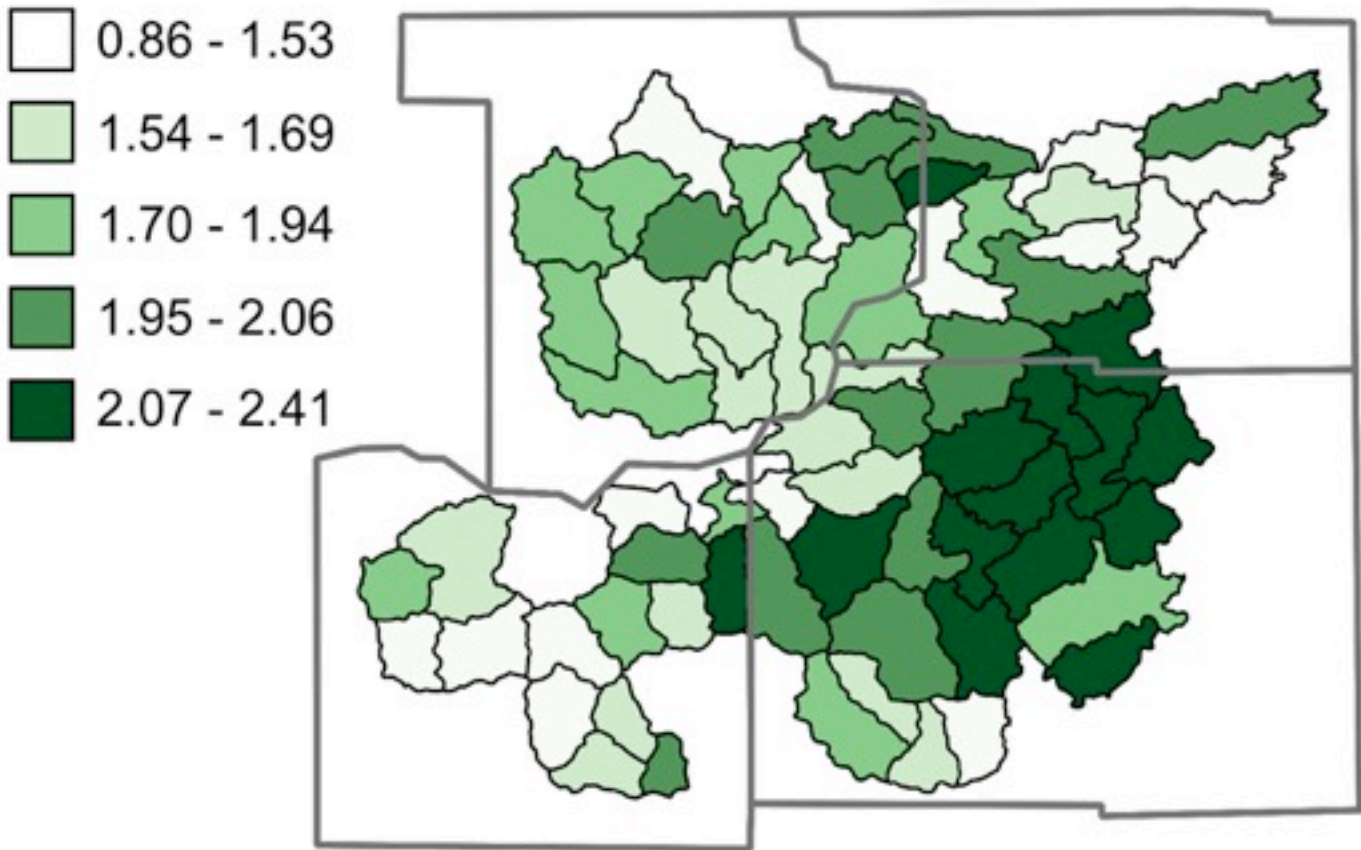


30% increase in
below ground
carbon storage

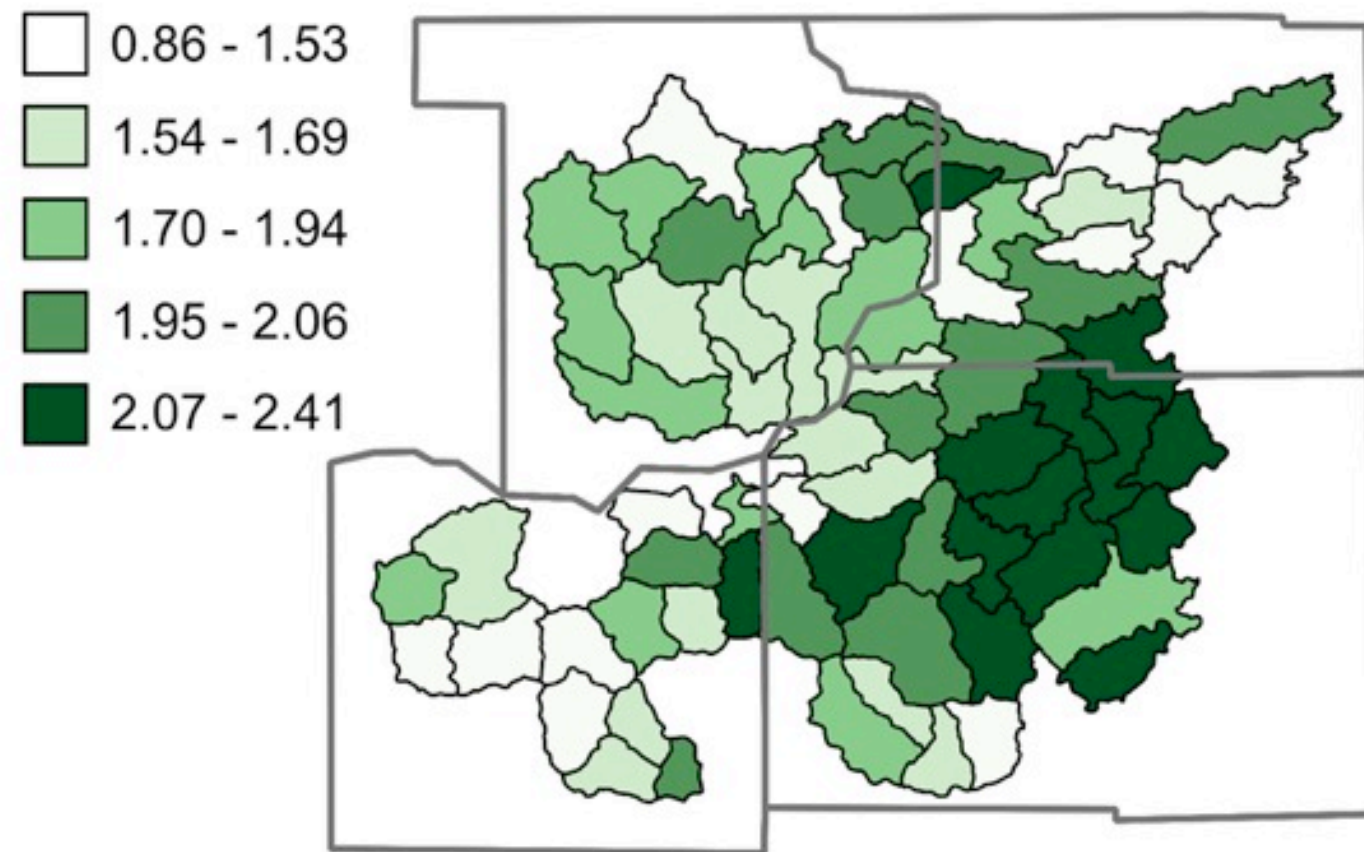
84%
decrease in
 N_2O
emissions



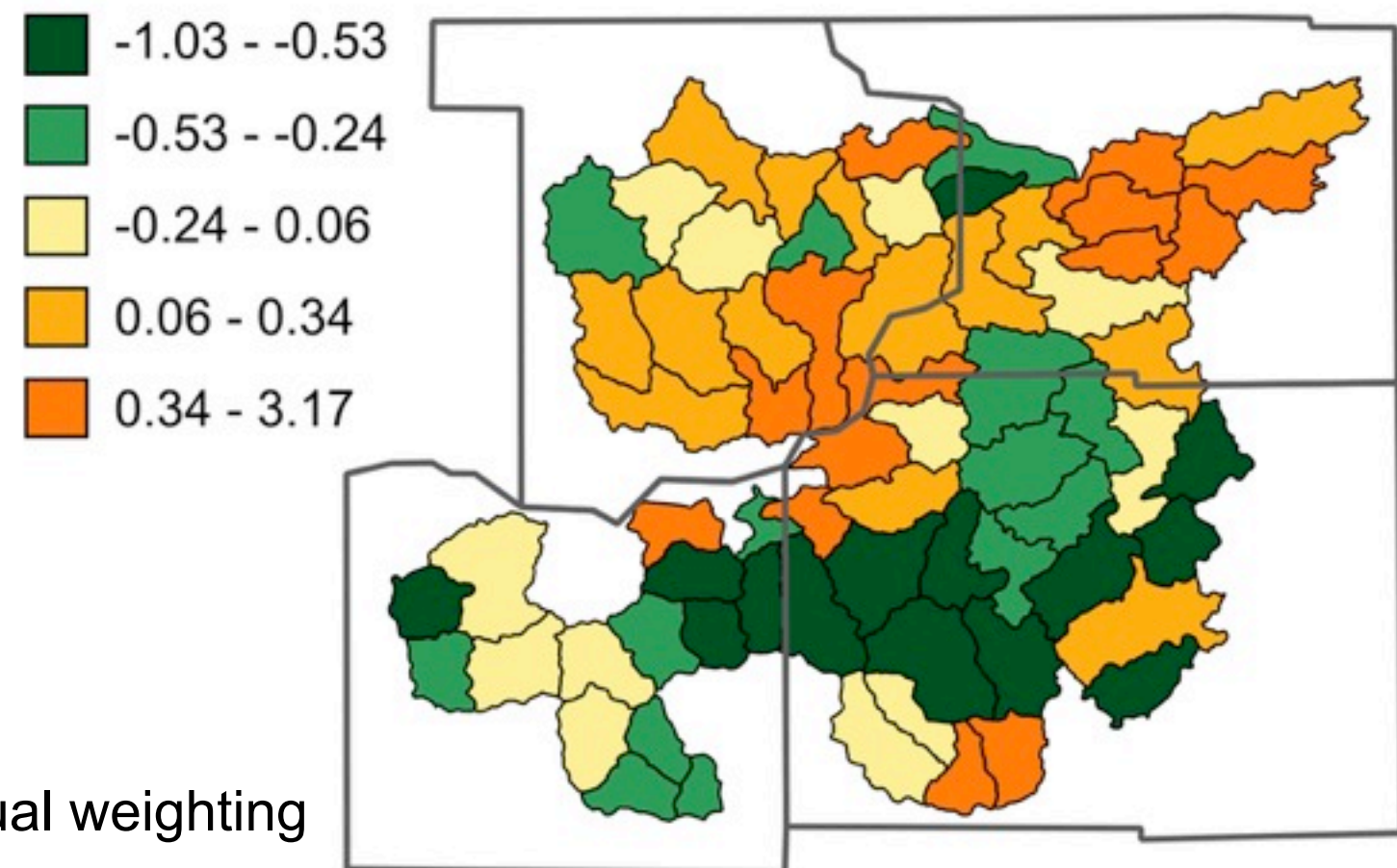
Reduction in net income (\$1,000 ha⁻¹)



Reduction in net income (\$1,000 ha⁻¹)



Mean normalized benefit-cost ratio

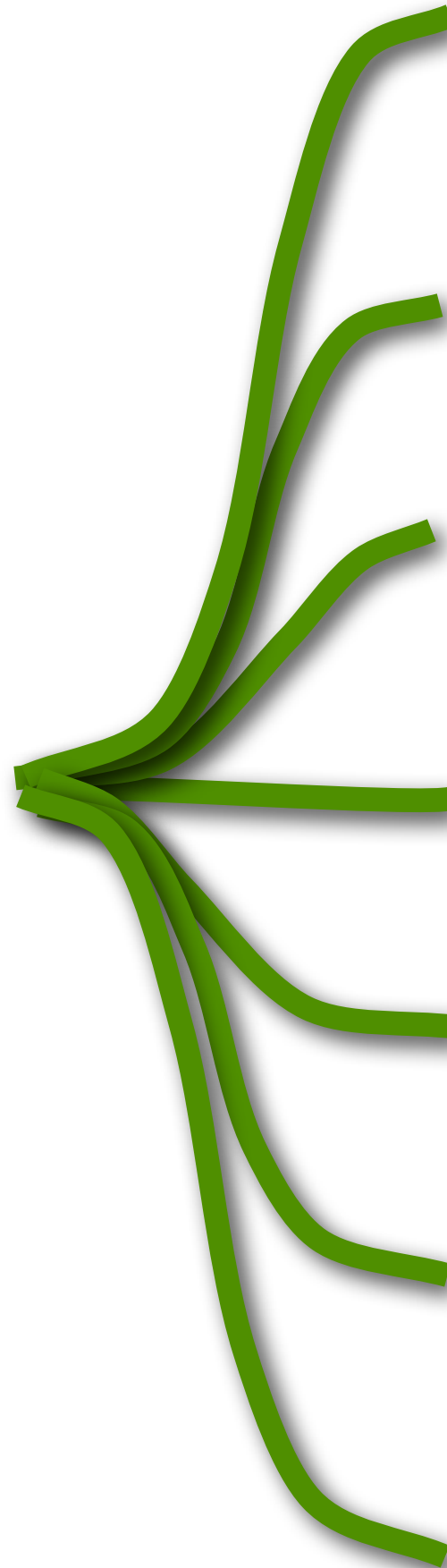
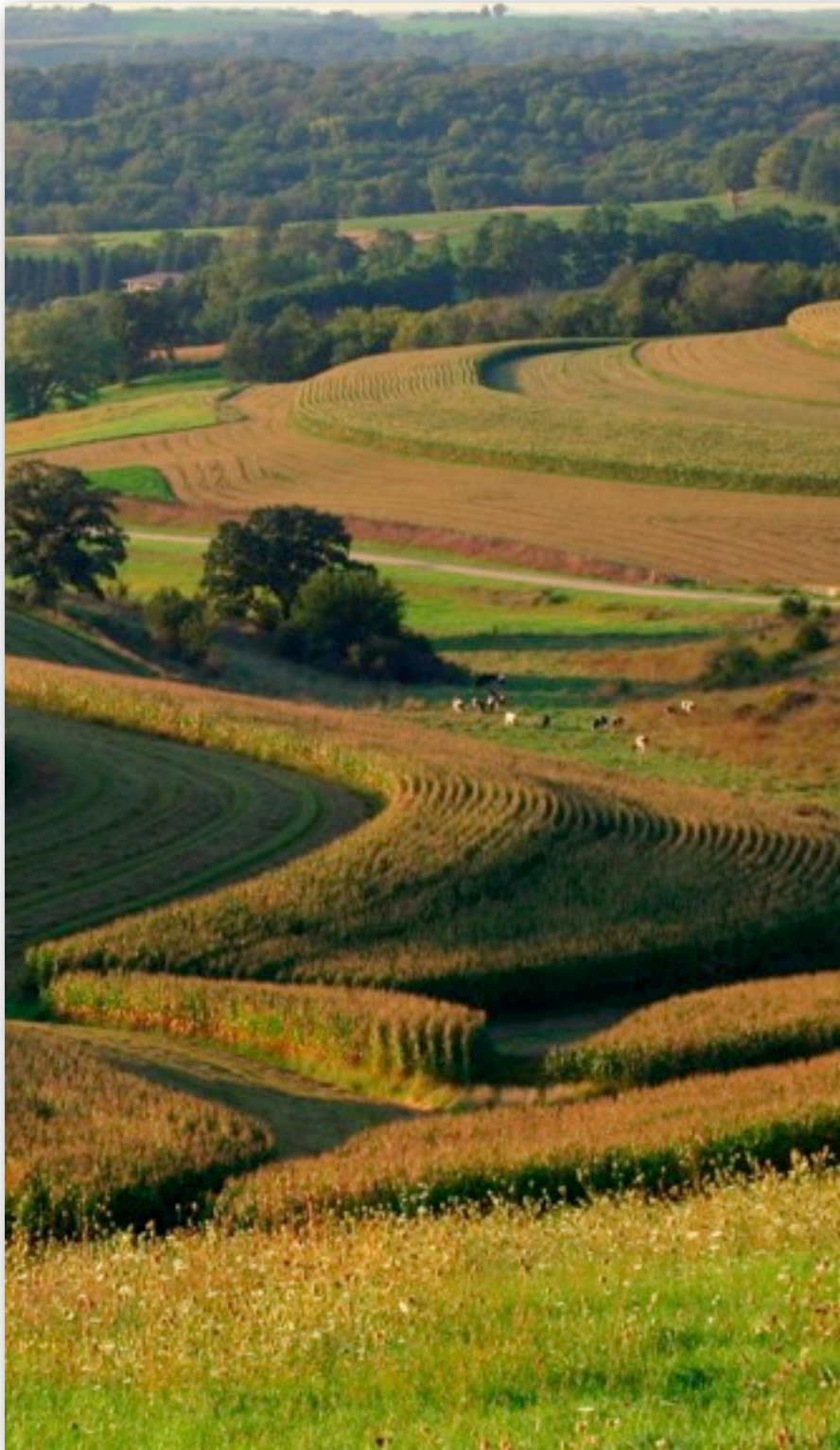


Equal weighting

Landscape services



Landscape services



Natural Pest suppression



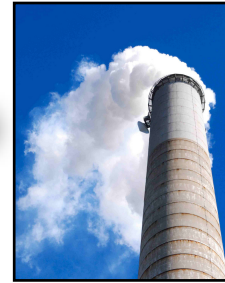
Pollination Services



Income (\$)



Biomass (Gg)



Energy (PJ)



Soil (Tg C storage)



Water Quality (Mg P export)

Take-away messages

- Linking biodiversity to ecosystem services is critical
- Agricultural landscape patterns are important to the provisioning of ecosystem services
- Understanding spatial tradeoffs in agriculture/bioenergy landscapes of ecosystem services that includes biodiversity
- “Keystone” hectares can be identified in the landscape where tradeoffs can be evaluated (but how to assign value is difficult)