#### Role of landscape Design in Mitigating Agricultural Intensification



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# Intensification of agriculture has been linked to declines in...

#### **Biodiversity**

- Plants (Geiger et al. 2010)
- Arthropods (Hendrickx et al. 2007)
- Birds (Donald et al. 2001)
- Mammals (Sotherton 1998)



• Ecologists can play a key role in addressing this problem

#### **Functional Diversity**

• Birds, mammals (Flynn et al. 2009)

#### **Ecosystem Services**

- Pollination (Kremen et al. 2002, Garibaldi et al. 2011, Deguines et al. 2014)
- Biocontrol (Biabchi et al. 2006, Chaplin-Kramer et al. 2011)



#### **Biodiversity Function/Service Relationships** (BEF) (BES) Ecosystem — Resilience Ecosystem **Biodiversity** Function Services Basic Ecology Trait and Functional Diversity e.g. Crops & $\rightarrow$ e.g. Primary $\rightarrow$ e.g. Yield, $\rightarrow$ Sustainability Applied associated production, soil fertility, Agrocompetition, plants, pest ecology insects, N-fixation, suppression, microbes & pollination, recreation & vertebrates predation cultural

values



### **Additional Trends**

- Both local and landscape scales are important
- Common scale of response for natural enemies 700-2000 m
- Implies that in most landscapes, some level of cooperative action by stakeholders will be necessary to effect change



## **Engaging with stakeholders**

 Ecologists will need to engage with farmers and other stakeholders and socioeconomic experts to develop context-specific solutions
 & promote implementation—be transparent & make uncertainty explicit

 Successful models exist and can be extended to address the needs of varying landscapes

#### Hoeksche Waard, The Netherlands

Steingröver et al. 2010

- Agriculture and tourism
- Reduction in soil and water quality, bird habitat
- Threatened by urban development







## Hoeksche Waard cont.

- Engaged multi-stakeholder group
- "Robust and fine elements"
- "Green-blue veining network"



Steingröver et al. 2010, Landscape Ecology



Natural pest control makes use

of natural enemies: insects that

supress pest insects in crops by

redation or parasitism. In the

Hoeksche Waard are the main...

. crops, potatoes, sugar beets

. pests: aphids, cabbage moth

ladybugs, parasitic wasps

natural enemies: hover flies,

wheat, cabbage

Typical of the Hoeksche Waards

andscape is the network of

robust elements consisting

of dikes and creeks. The ele

ments are a potential source o

natural enemies. The insects

are passively dispersed over distances up to 1 km.

Field margins, beetle banks, road verges and ditch banks make up a network of fine elements. The fine elements provide potential habitat at short distances and help natural enemies to reach the crops. reen-blue veining only can support

natural pest control under following

spatial arrangement enables

ter provides nectar and pollen

etation structure and co

vegetation composition provides shell

vegetation structure provides shelter

vegetation management supports

enemies to reach the crops

conditions:

The foundation the Rietgors is a group of farmers that coöperate in the management of green-blue veining

## Examples cont.

- Midwest US (Iowa, Minnesota and Wisconsin)
  - Water quality and biodiversity
  - Landscape-Scale Learning Laboratories "Landlabs" Jordan et al. 2013
- Research on sustainability of bioenergy crop choices
- Develop decision support tools
   -Smartscape <u>http://dss.wei.wisc.edu</u>
- Pilot stakeholder engagement









#### Conclusions

- Re-design of agricultural landscapes is needed to mitigate negative impacts of intensification on arthropod-mediated ecosystems
- Collectively, we already know a lot

   But need additional studies at longer temporal and greater spatial scales
- While research gaps remain, the time is right for ecologists to engage with other disciplines, stakeholders and policymakers to foster agricultural landscape design for sustainable and resilient biodiversity services