

Biodiversity as a buffer against *E. coli* contamination of fresh produce

Bill Snyder, Washington State University



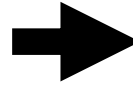
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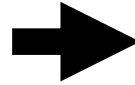
United States Department of Agriculture
National Institute of Food and Agriculture





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”



Biodiversity is good.

Biodiversity-friendly #1: organic farming



- Natural controls rather than pesticides
- Manure rather than chemical fertilizer
- **Species richness might increase** (Bengtsson et al. 2005, Hole et al. 2005, Crowder et al. 2010)



Biodiversity-friendly #2: mixed-vegetable production



- Many crops inter-planted
- Often smaller-scale
- Farms (often) include natural habitat
- **Direct market to consumers, collapse supply chain**

Biodiversity-friendly #3: livestock integration

- Direct delivery of free manure
- Grower can sell both meat and produce
- Weed/pest suppression
- **Restores a very traditional style of farming**



What could go wrong?



Really bad biodiversity: *E. coli* O157:H7



265,000 sick/year, 30 deaths annually

Symptoms:

- abdominal cramping
 - nausea/vomiting
 - bloody diarrhea
 - renal failure
-
- **Infective dose= ~5-10 cells!!!**

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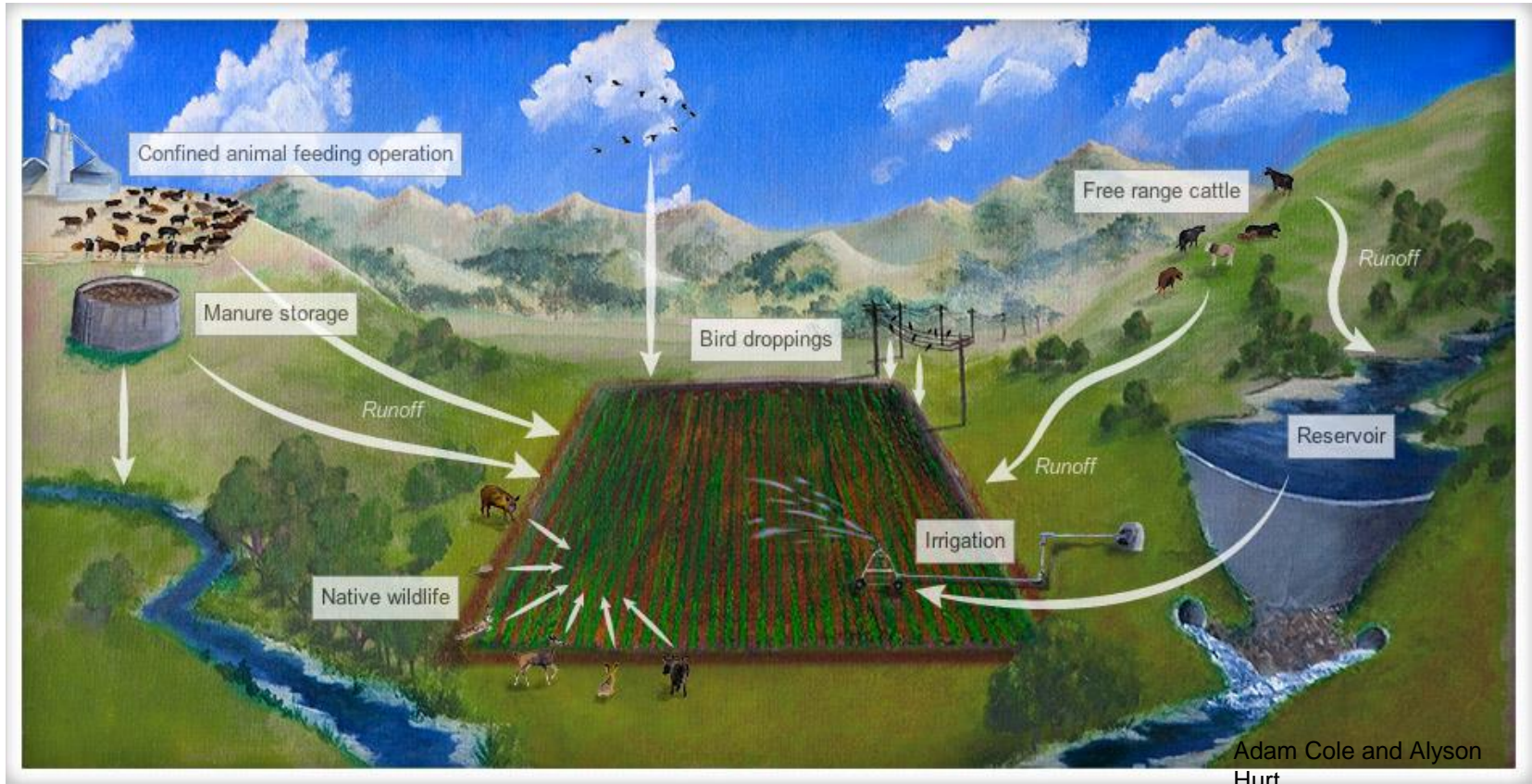


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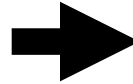
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 - renal failure
-
- **Infective dose= ~5-10 cells!!!**

How might crops get contaminated?



“Good Agricultural Practices” (GAPs): do they reduce food safety risks?



Farm under GAP regulations

e.g., Karp et al. 2015 PNAS

Natural suppression of human pathogens?



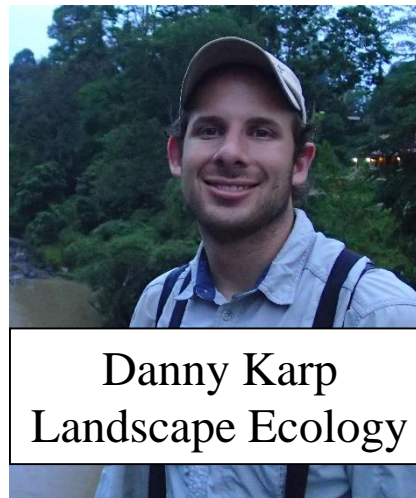
Matt Jones, PhD student



John Reganold
Soil Science



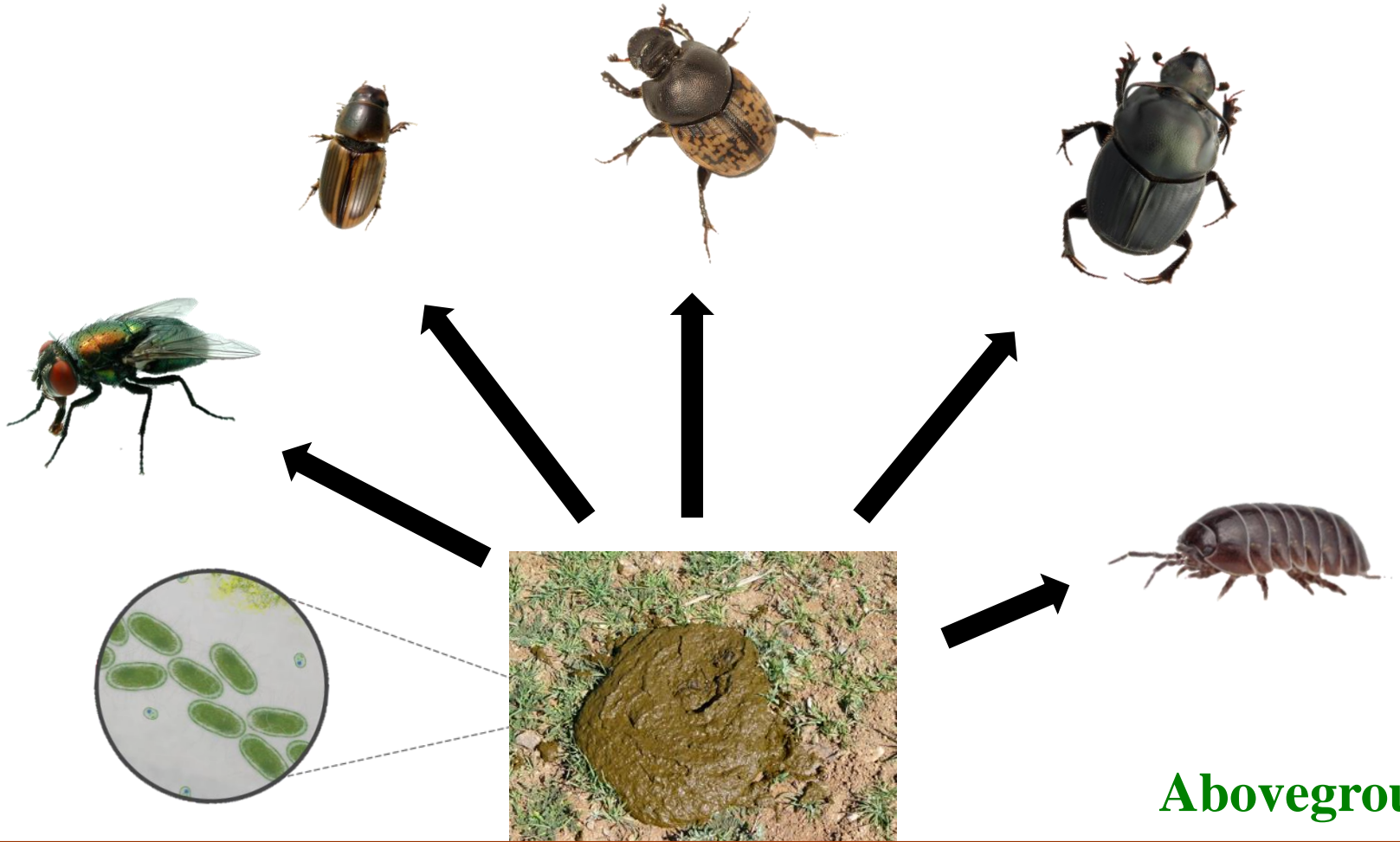
Tom Besser
Vet Med



Danny Karp
Landscape Ecology

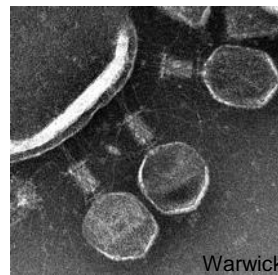
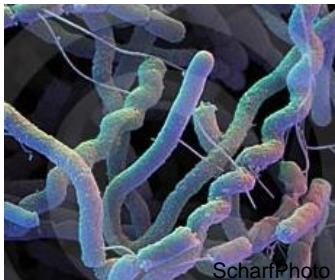


Claire Kremen
Agroecologist

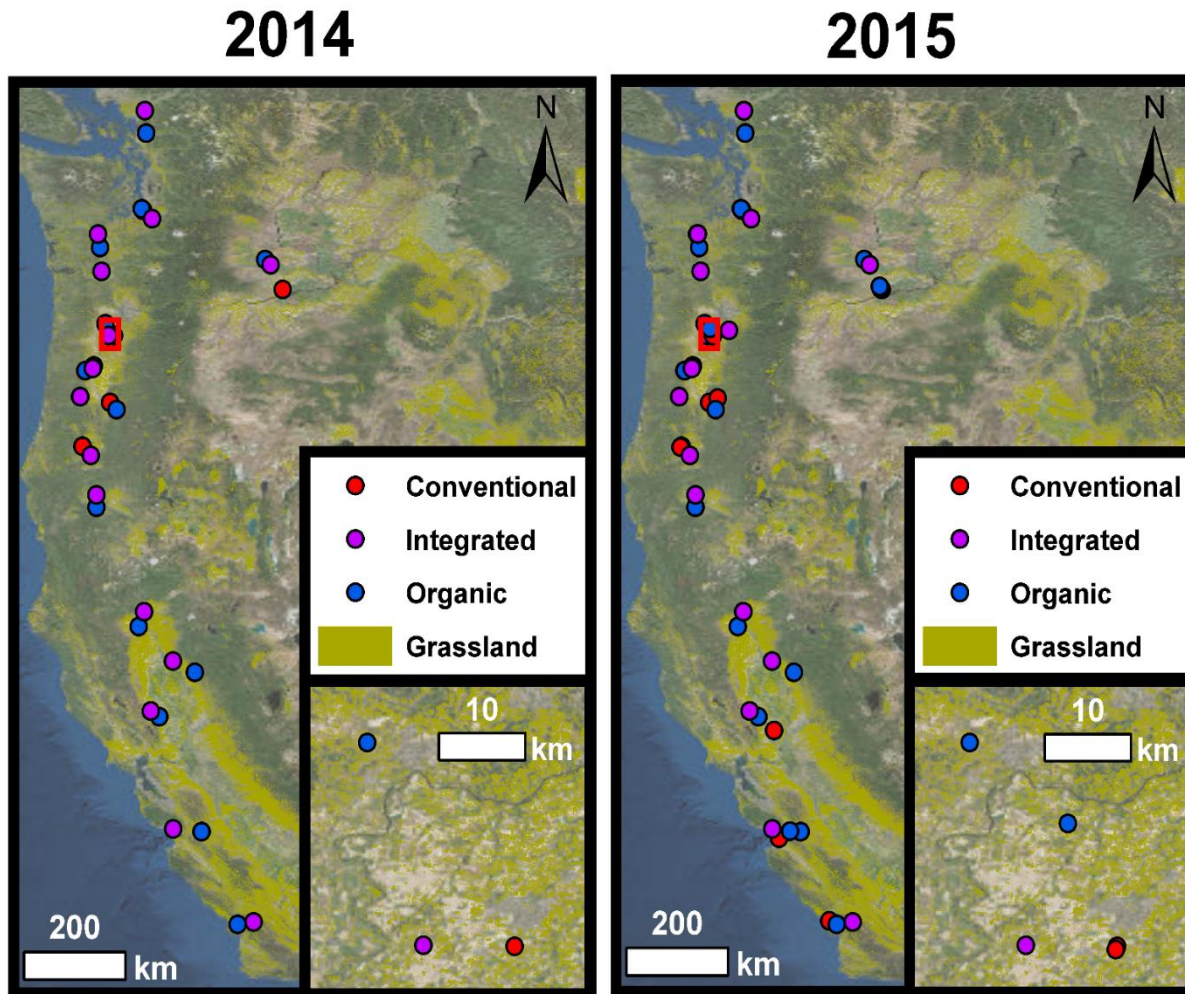


Aboveground

Belowground



Landscape-scale, on-farm:



Conventional



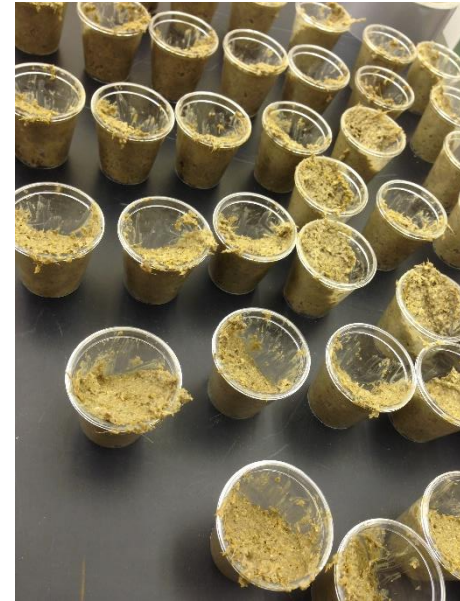
Organic



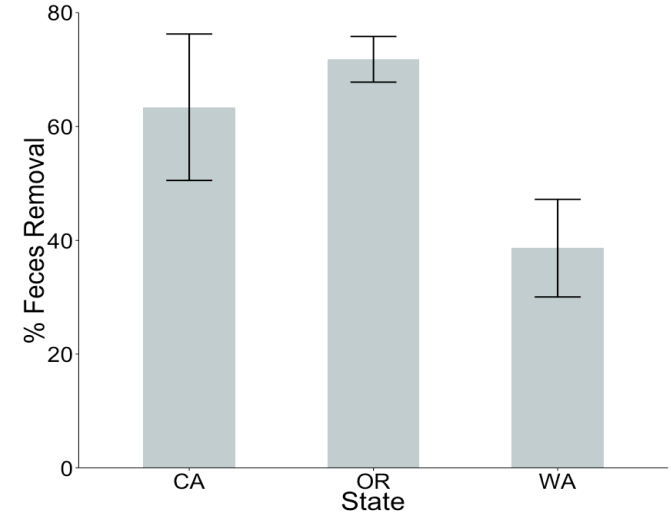
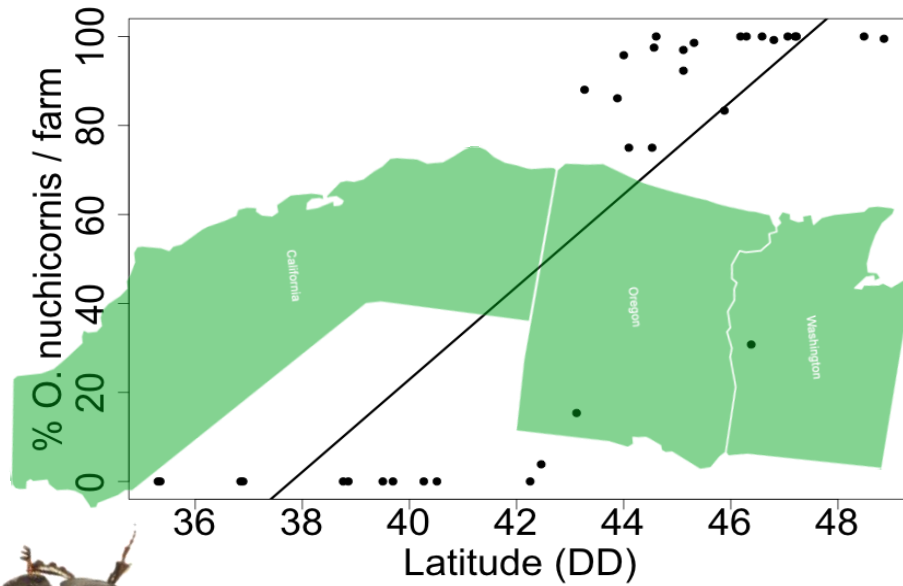
Organic+Livestock

Methods overview:

1. Fill a van with pig feces
2. drive to s. CA
3. Follow spring broccoli north
4. Collect soil, coprophages
5. Measure feces consumption



Invasion by *Onthophagus nuchicornis*:

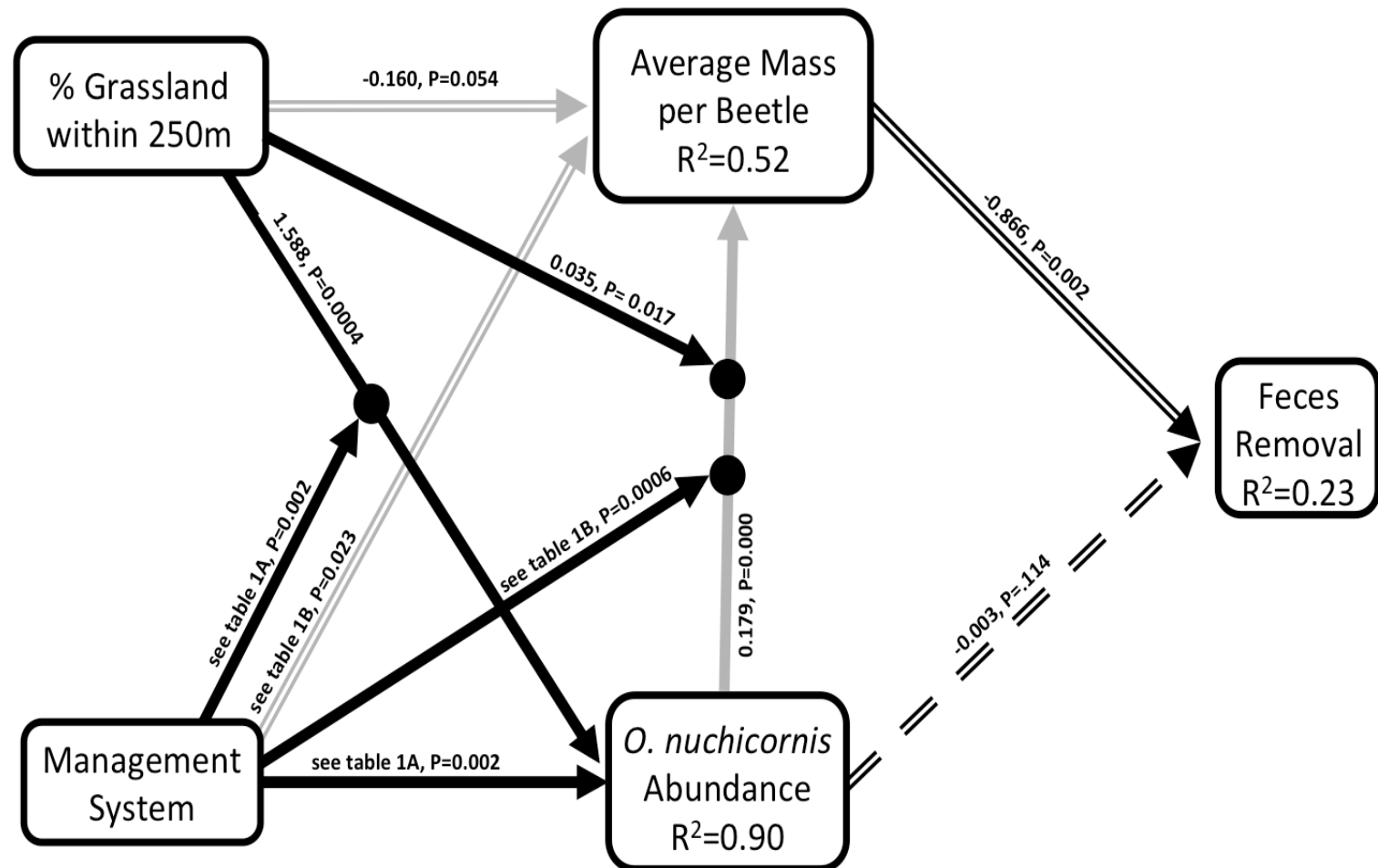


Structural Equation Modeling:

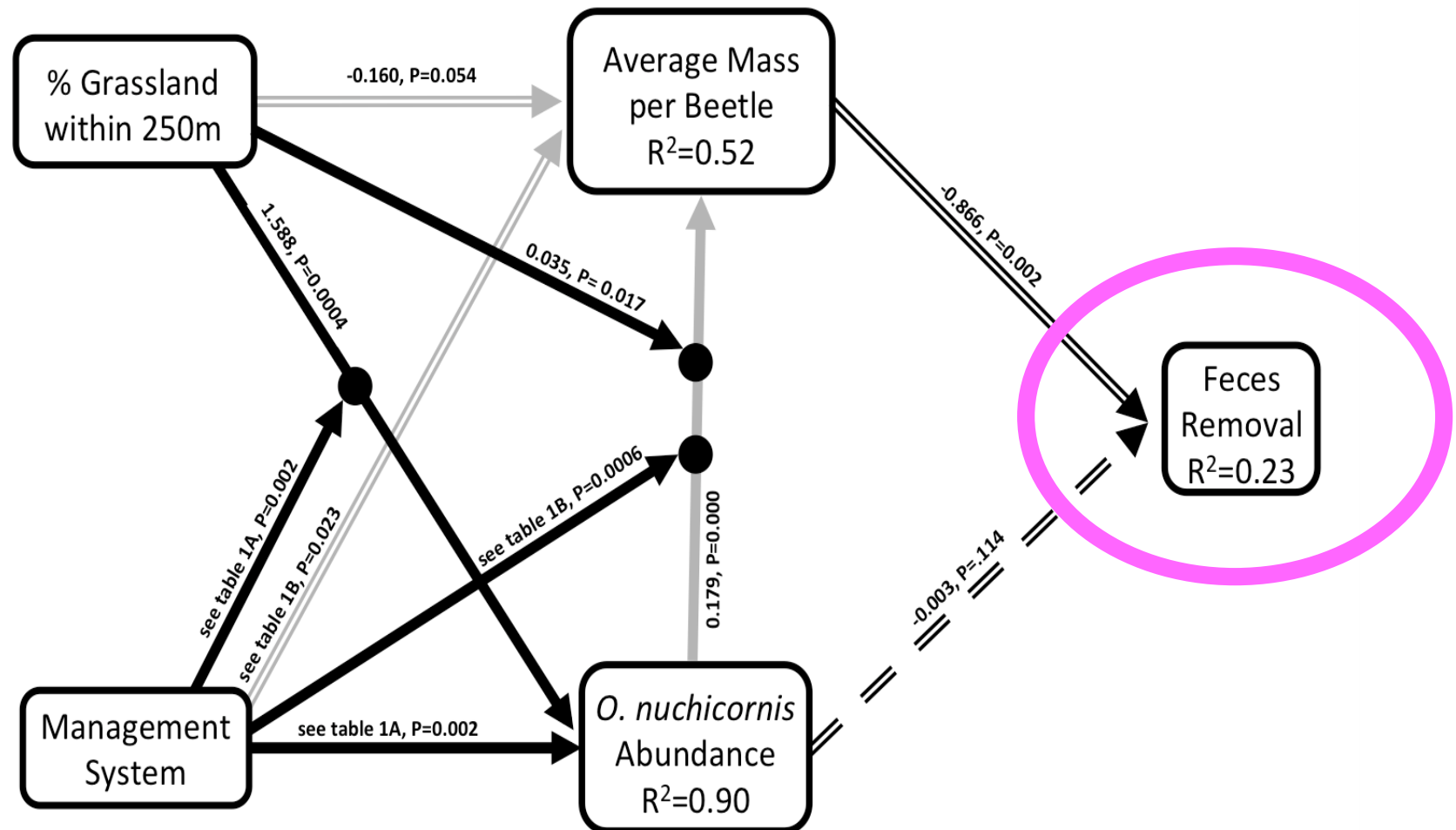
Statistically fits network of relationships among complex sets of variables (e.g., path analysis). Here, what appears to be the net effect of *Pterostichus melanarius*?



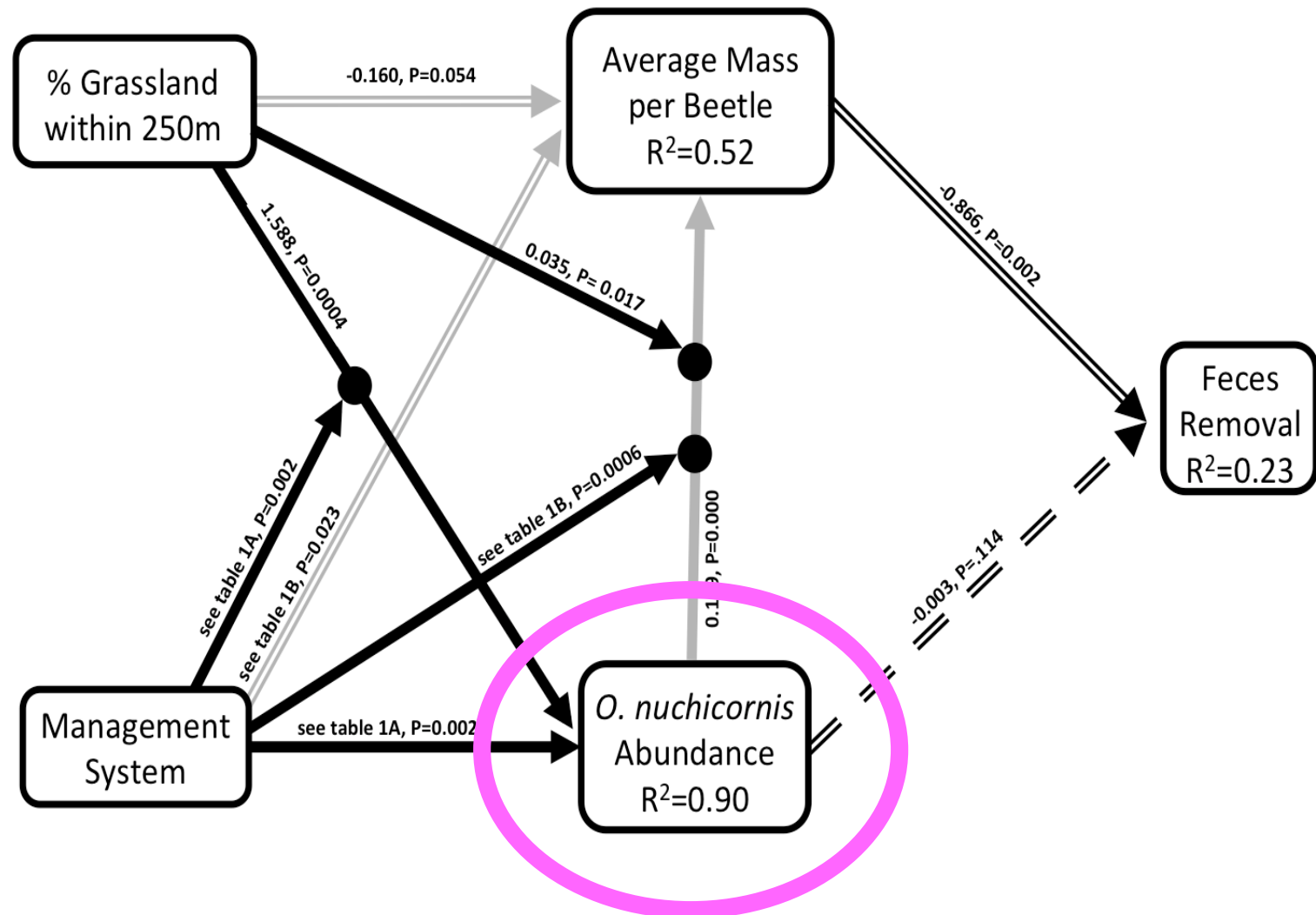
Structural Equation Modeling



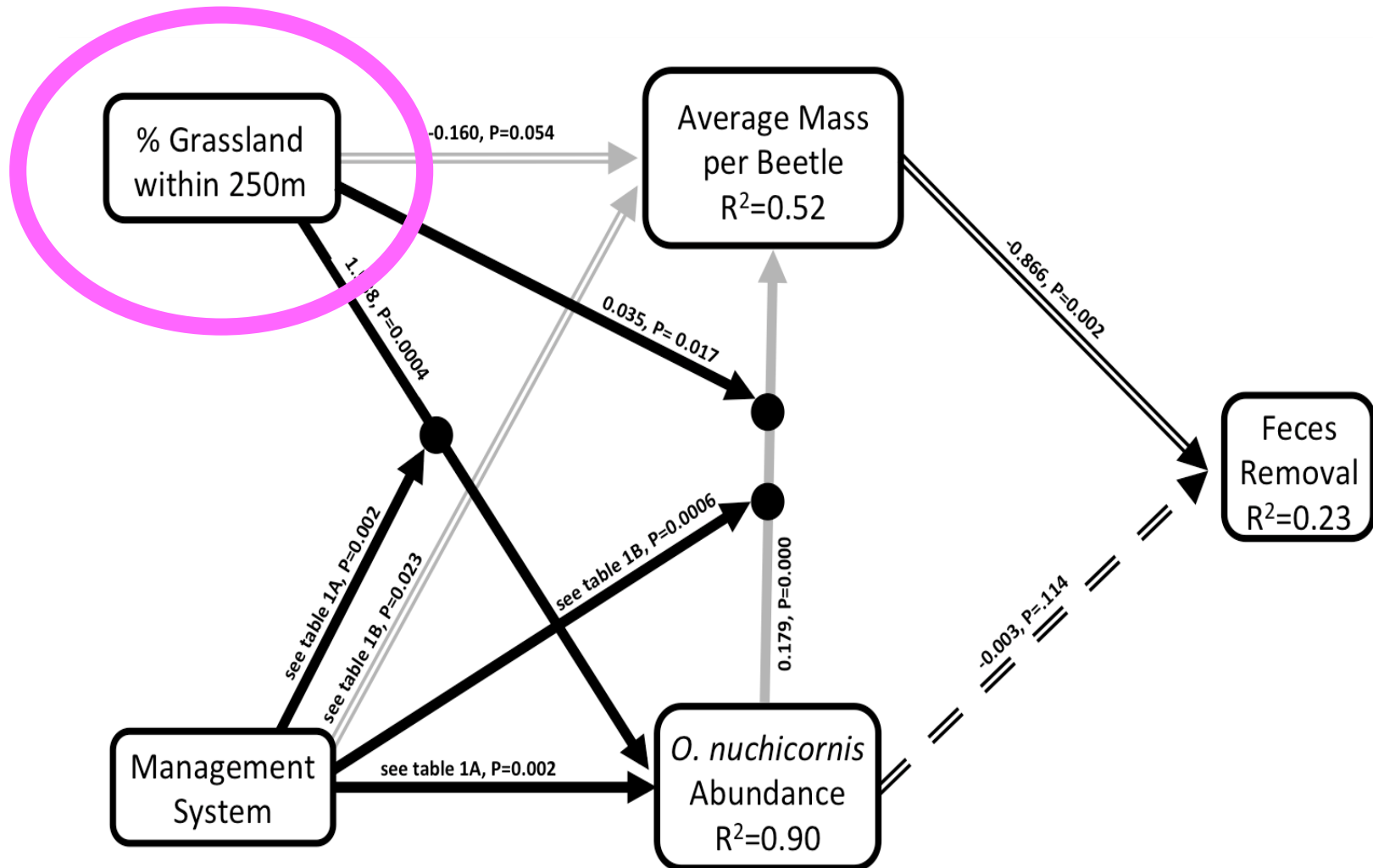
Structural Equation Modeling



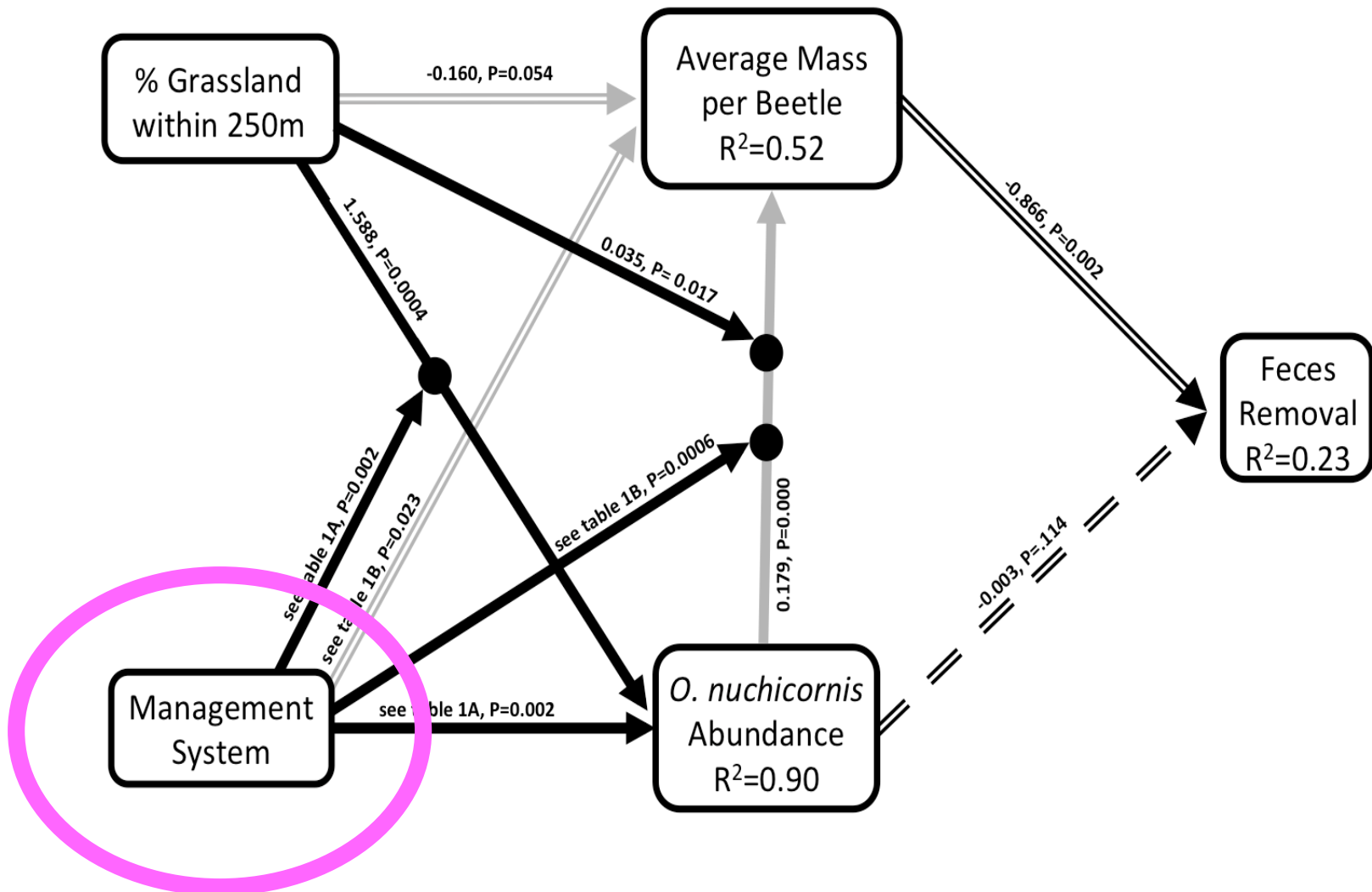
Structural Equation Modeling



Structural Equation Modeling

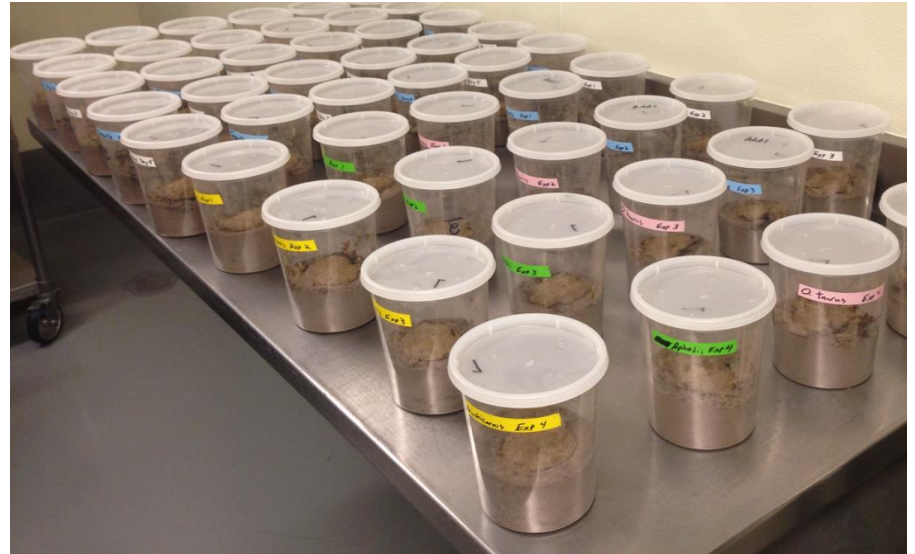


Structural Equation Modeling



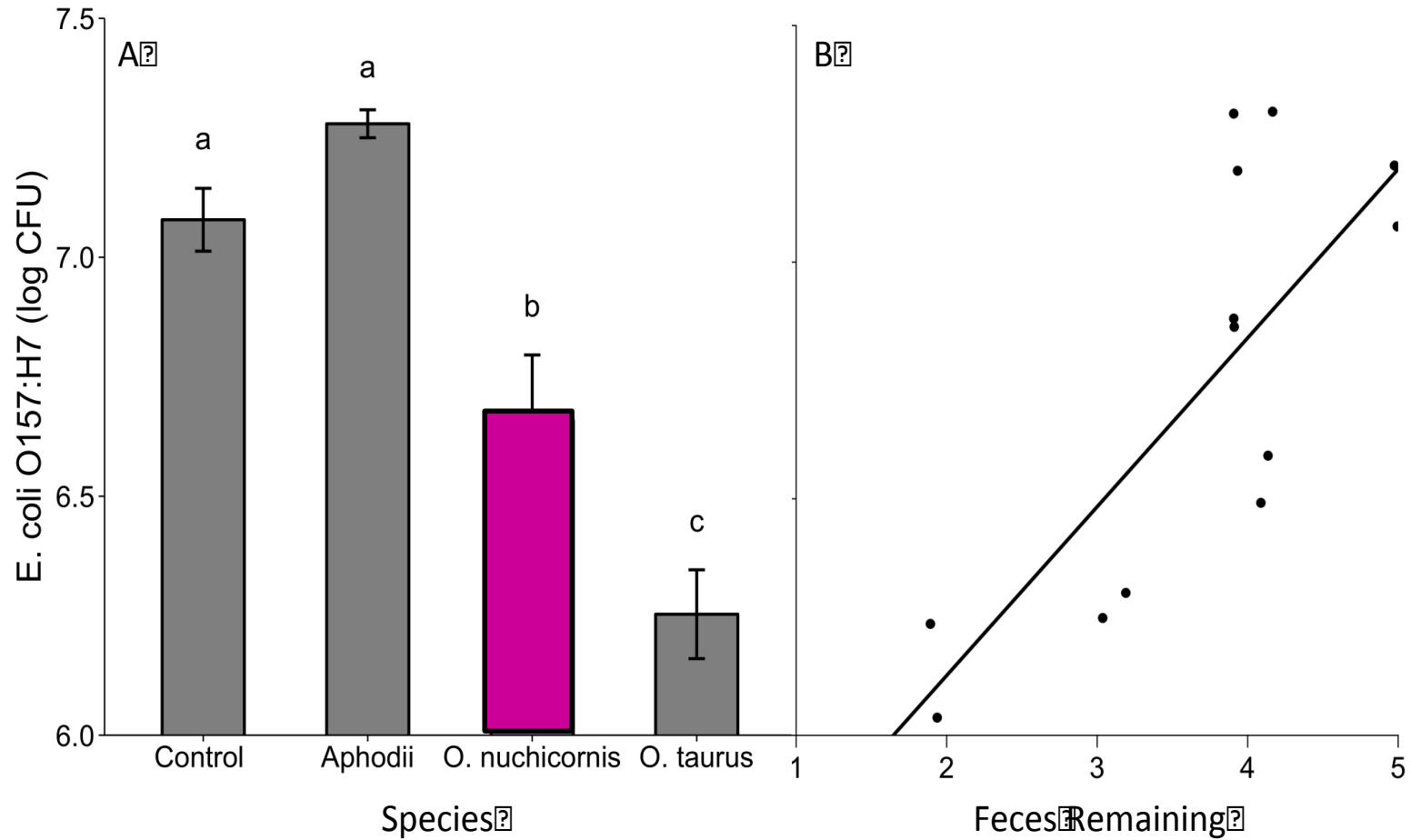
Implications for pathogen suppression?

- pig feces inoculated with 4 strains of *E. coli* O157:H7
- 9 days beetle feeding
- plated soil and feces (on SMAC)



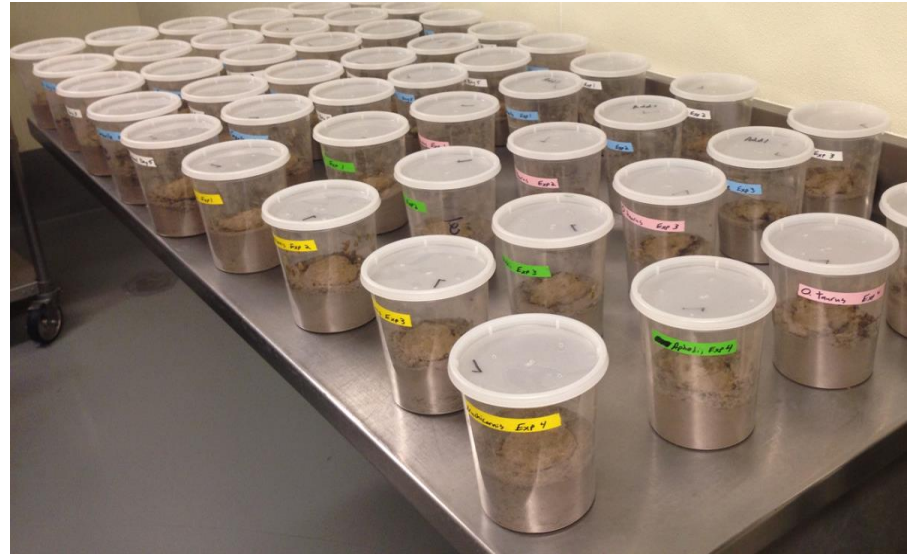
Russ McClanahan

O. nuchicornis seems a little crappy:



Belowground suppression of *E. coli*?

- pig feces inoculated with 4 strains of *E. coli* O157:H7
- Feces placed onto soils collected from 3 farming systems
- 7 days exposure to soils, whatever lives within them
- plated soil and feces (on SMAC)
- Characterize microbial communities using 16s sequencing



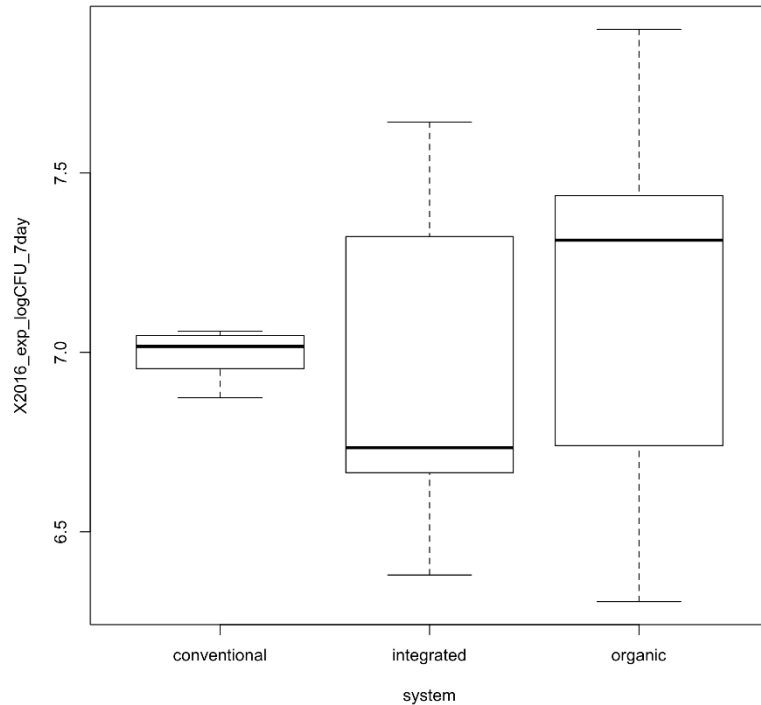
Daisy Fu



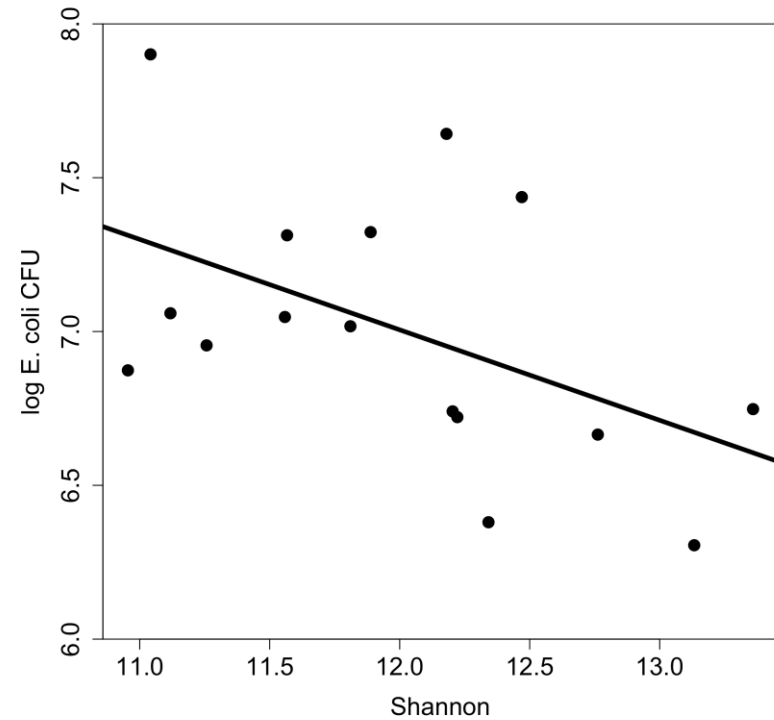
Russ McClanahan

Belowground microbial *E. coli* suppression?

A) Pathogenic *E. coli* after 7 d



B) Microbial diversity suppresses?



Conclusions

- Dung beetles and diverse soil microbes suppress pathogenic *E. coli*
- Organic farming and livestock integration encourage natural *E. coli* suppression
- **Biodiversity helps, not hinders, food safety**

Acknowledgements

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