Plant Dynamics - Update

Tim Dickson
(for Kay Gross and Jen Lau)
KBS LTER All Scientist Meeting
5 April 2013

Central Questions:

1) What controls the diversity and composition of plant communities associated with agricultural systems?
2) How do diversity and composition of these communities change in response to “externalities” (e.g. increased Nitrogen input, variation in precipitation)?
3) What are the consequences of changes for ecosystem services provided by these systems?

Focus today:

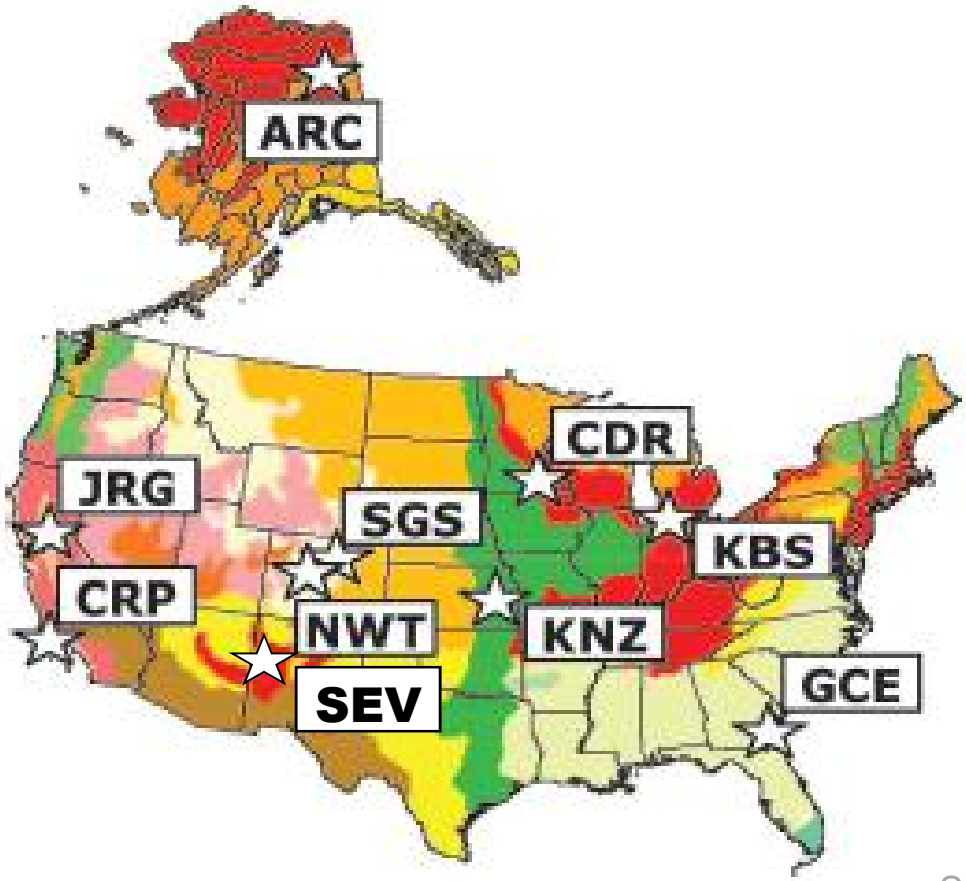
1) What controls the diversity and composition of the plant communities associated with agricultural systems?
2) **How do diversity and composition of these communities change in response to "externalities" (e.g. increased Nitrogen input, variation in precipitation)?**
3) What are the consequences of changes for ecosystem services provided by these systems?

Effects of Long-Term Fertilization on "grassland" communities

- *Ecological Responses (Gross lab and PDTNet):*
  - Ongoing LTER cross-site and within site analysis
  - Effects on diversity and composition of plant community

- *Evolutionary responses (Lau Lab):*
  - An emerging area.. new collaboration
  - Effects on legume-rhizobium interactions

PDTNet: Meta-analysis of N fertilization experiments across North America



-Total of 37 experiments

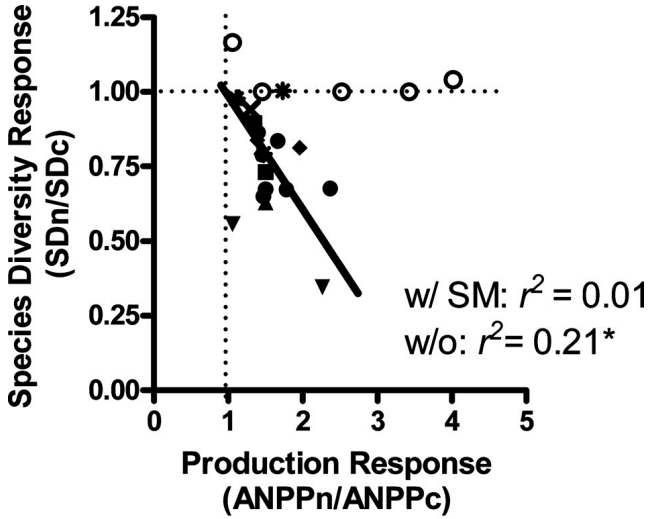
- Responses of 1000+ species records

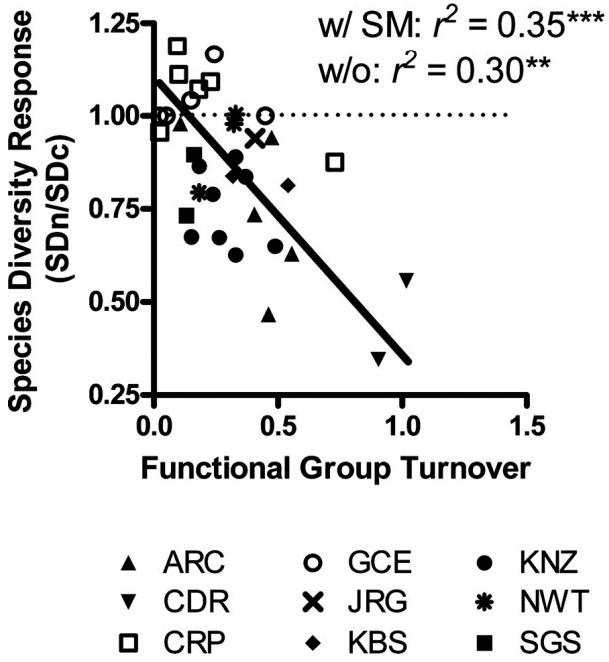
- Responses evaluated in relation to species traits

- Data compiled Cleland et al 2005 (and updated)

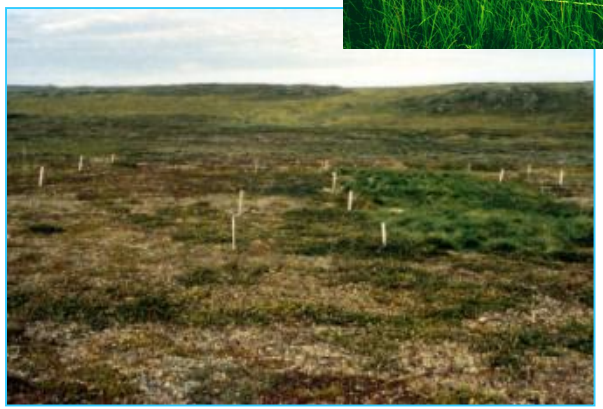
Suding et al. 2005 PNAS; Clark et al. 2008 Ecol Letters; Cleland et al 2011J Ecology; 2013 Ecology Gough et al 2012 Oecologia

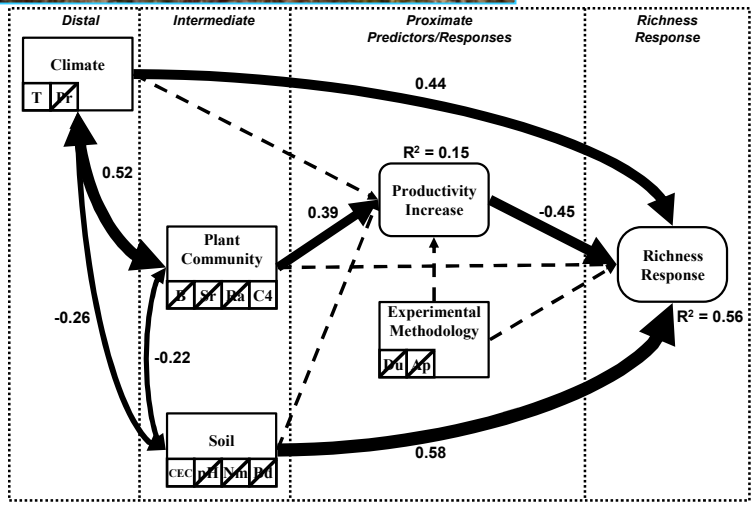
Cross-site Analyses (PDTNet)





Suding et al. 2005 PNAS

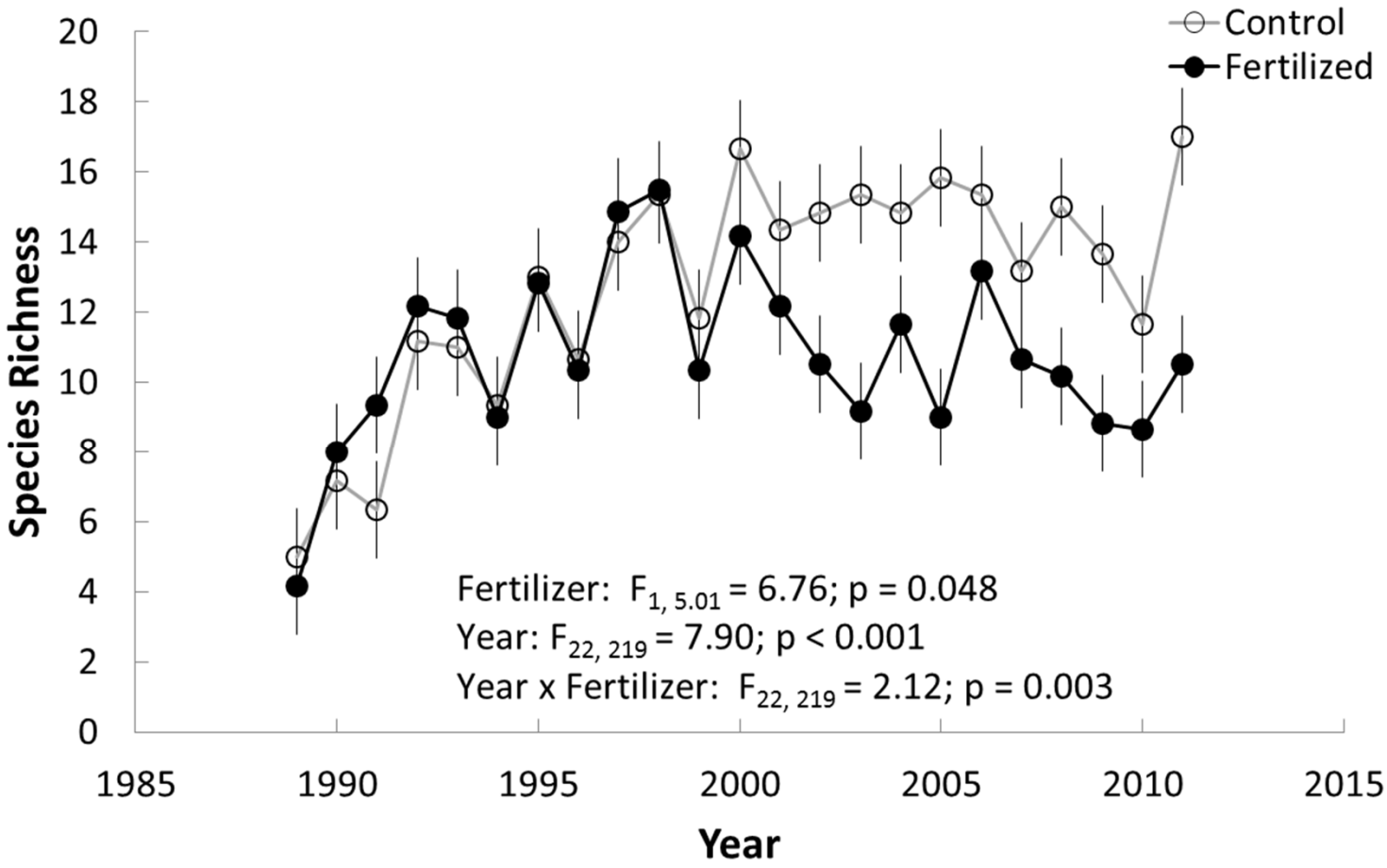




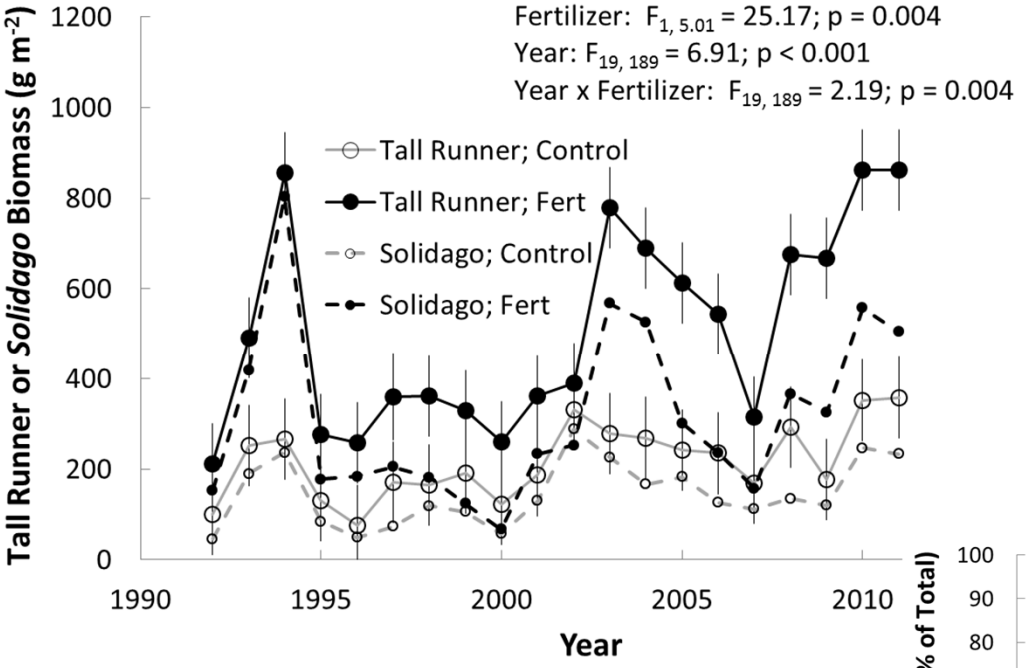
Clark et al. 2008 Ecol Letters

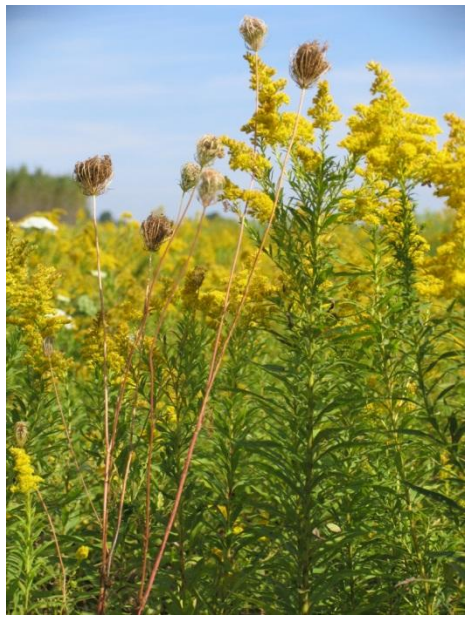
The "KBS Story" … did not fit follow the "pattern"

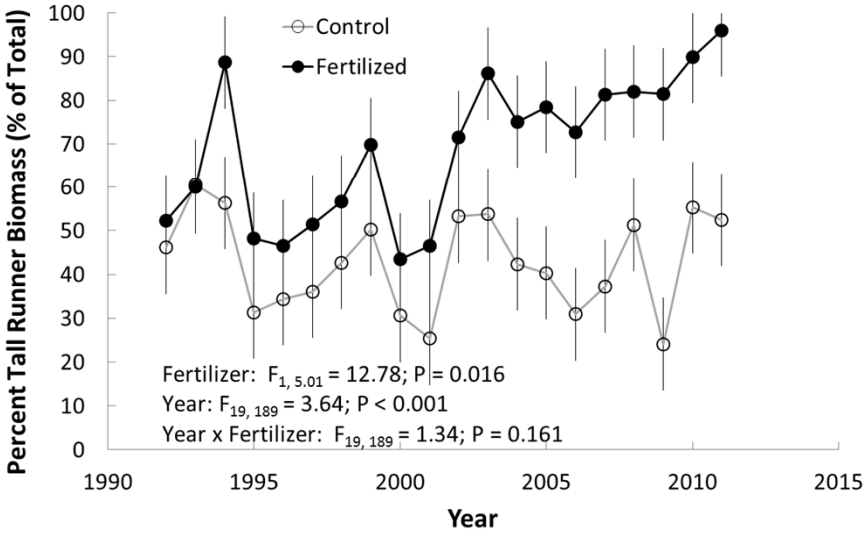
Species richness decline was 'delayed'… 14 years!



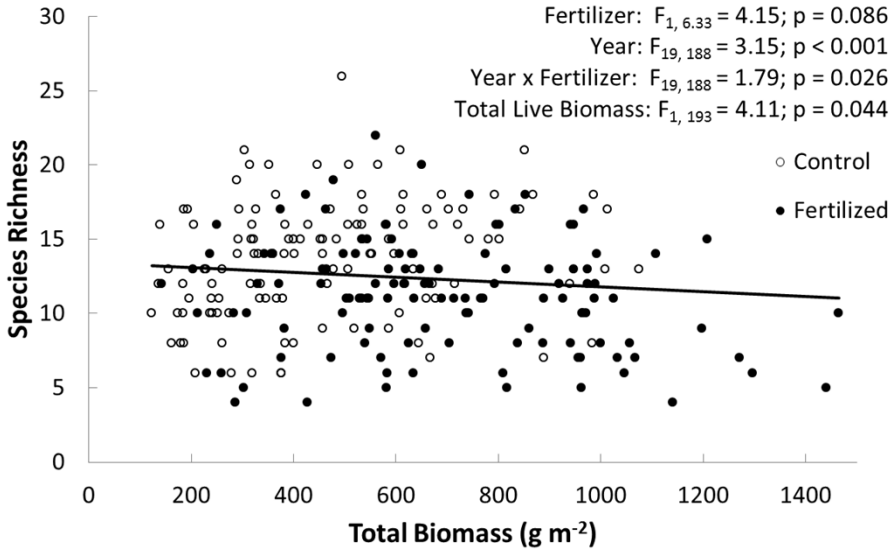
Changes in the abundance of ‘tall-runner’ species (goldenrod species) seems to drive this pattern

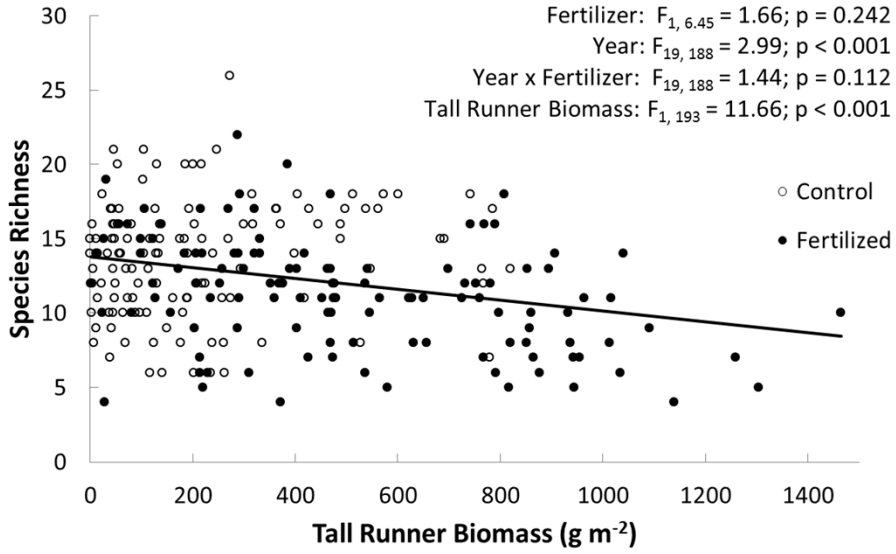


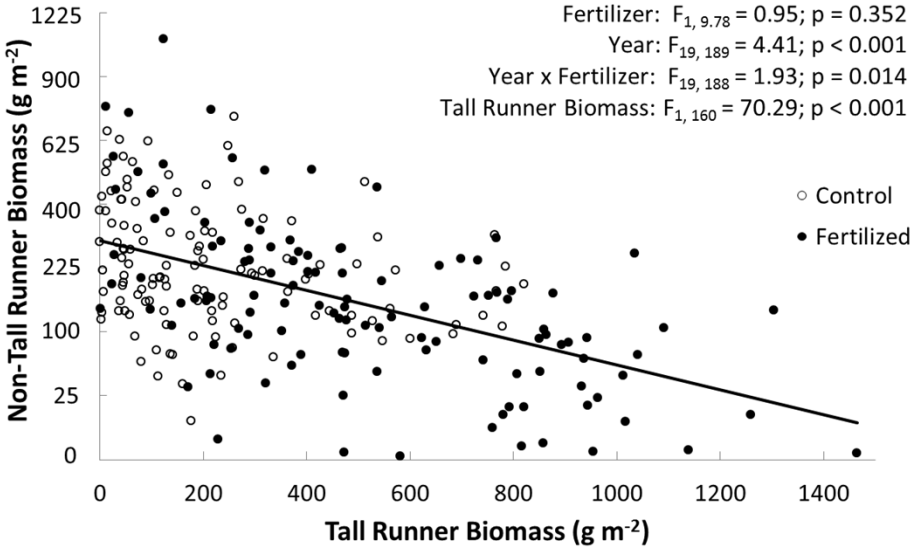




Dickson & Gross (in review)







When “tall-runner species” increase, “non-tall runners” decrease in abundance…
and species richness declines

Dickson & Gross (in review)

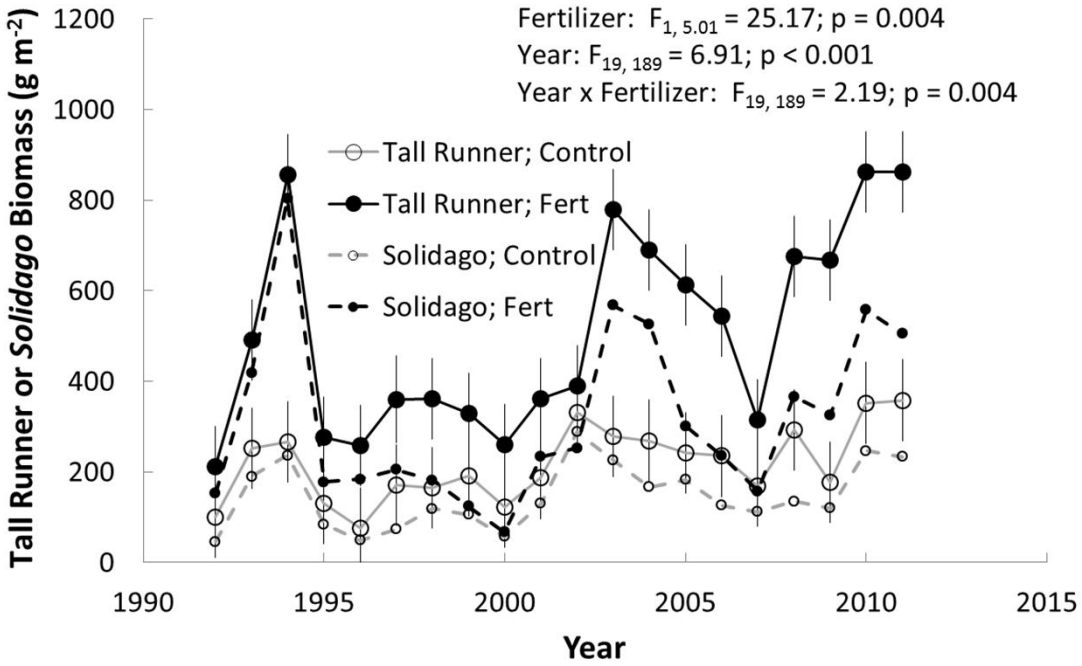
What caused the delay?

Disappearance of 'tall runners' such as Solidago species 3-4 years into the study

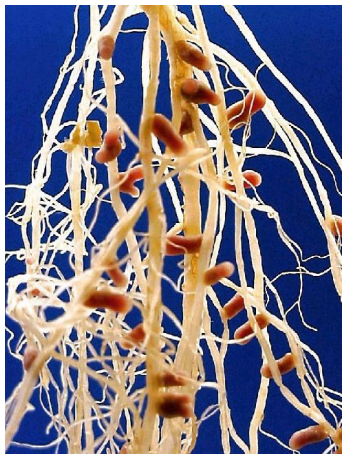
What caused the Solidago 'tall runners' to decline?

Hypothesis:
Emergence of species specific herbivore (e.g. *Trirhabda* spp) which controlled *Solidago* abundance and prevented losses of species due to fertilization

A hypothesis to be explored in summer 2013!



Evolutionary Responses: *Legume-Rhizobium interactions* (Lau Lab)



Rhizobia are bacteria that form a symbiotic relationship with legumes

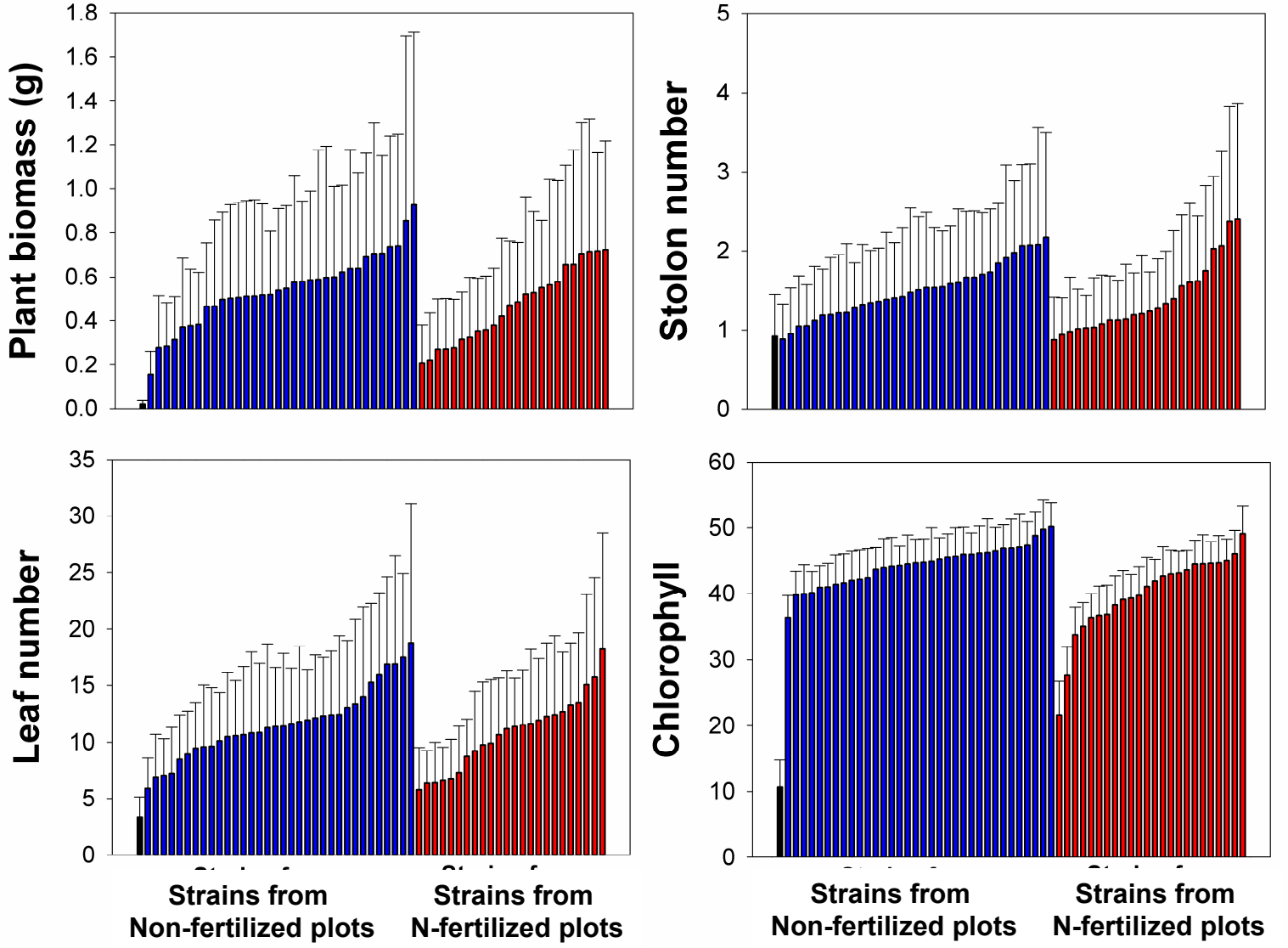
The interaction is 'typically' mutualistic, but can vary and become parasitic

Not all *Rhizobia* are equally effective in promoting the growth of their hosts …

and

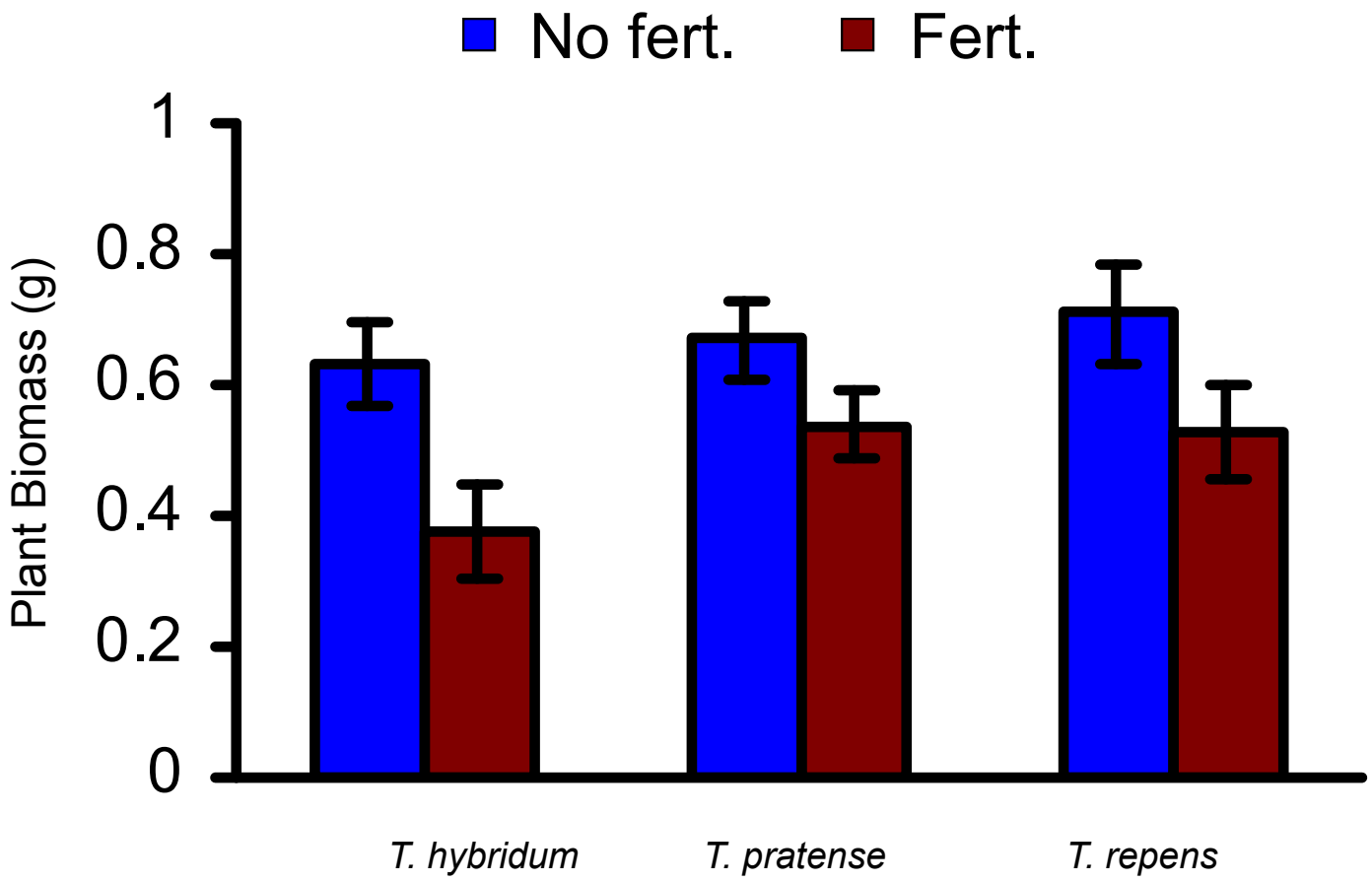
The abundance of beneficial strains can change under 'chronic fertilization'

Rhizobia strains isolated from Control and Fertilized plots (T7) differ in their effects on plant growth and production



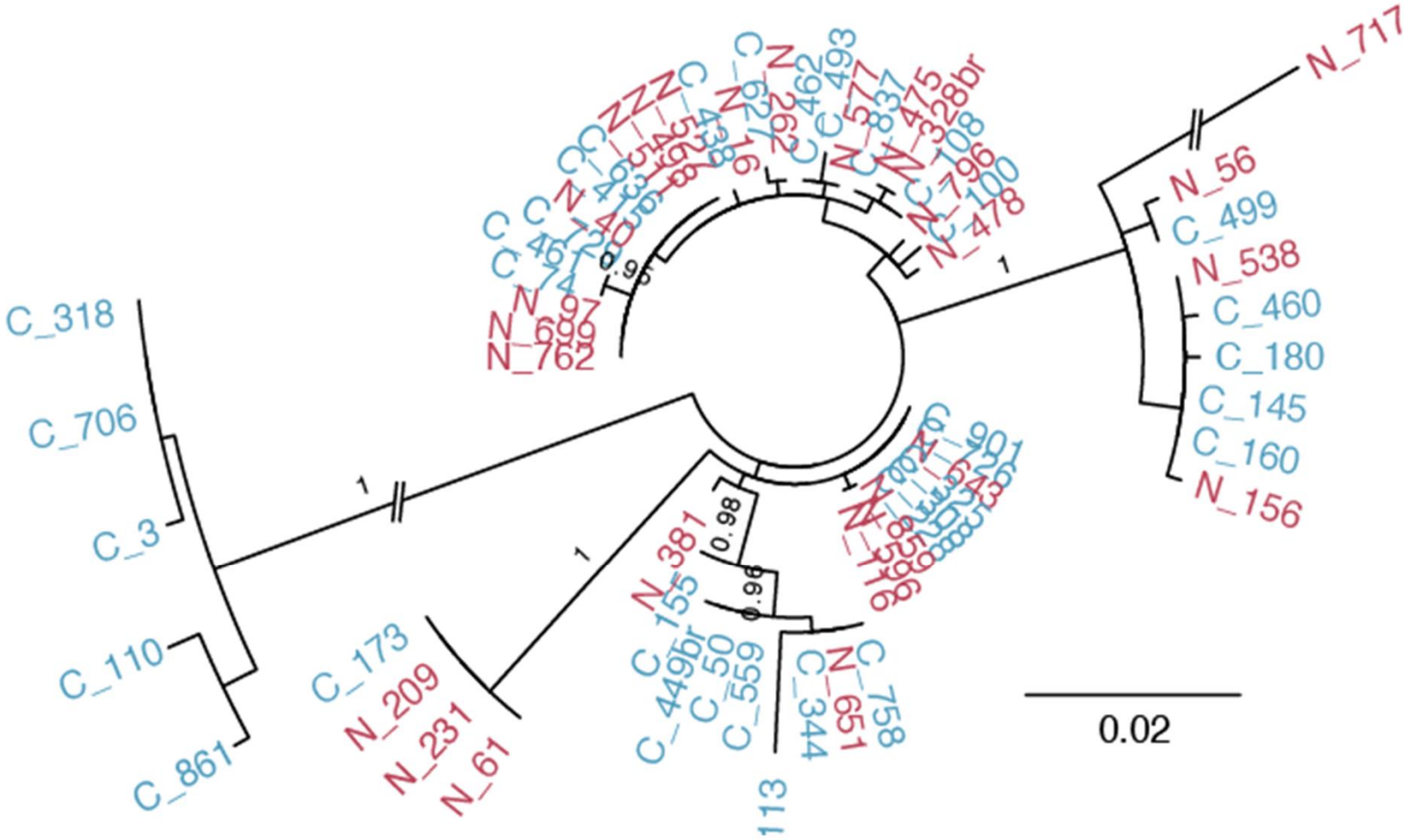
Lau and Weese in review

Fertilization causes the evolution of less cooperative mutualists in several *Trifolium* species



Weese et al., *in review*

Strains from N-fertilized and control plots are interspersed across the phylogeny…



. . . suggesting these changes are an evolutionary response to N-fertilization rather than due to changes in community composition

What's ahead?

"Gross Lab" - Experimental studies to determine if interactions between 'tall-runners' and herbivores accounts for the 'delayed response' in fertilization effects at KBS….

"Lau Lab" - Further explorations into the evolutionary dynamics of legume-rhizobium interactions .. and how these change under chronic fertilization

"Both Labs" – Expanding interactions with other LTER scientists to understand how changes in plant communities impact ecosystem properties and processes.