Arthropod biomass response to nutrient addition [Lind, Borer, LaPierre, Kay et al]
Ethabuka Main Camp, Spinifex Desert, Queensland Australia [G. Wardle, PI]
A global test of biodiversity loss through niche destruction
An opt-in manuscript
Stan Harpole & coauthors

*Status*: Comments received on first draft.
Second draft in progress.

*Figure 2*. Proportional loss of diversity (eH) scales with proportional increase in biomass. Sites showing independent responses or synergistic interactions to
Non-linear responses to gradients of nitrogen in grasslands
Site-level: CDCR, CBGB N-gradients
Stan Harpole & coauthors

**Status:** comments received on 1st draft
split manuscript into two?
  - CDCR co-limitation, NutNet vs. E001
  - CBGB multiple responses
Do demographic attributes of plant species predict response to nutrients?
Rob Salguero-Gomez, et al.
Species turnover in response to nutrient addition and herbivory

Wright, Wragg, Borer, Hillebrand, Gruner, Lind, Seabloom, Yang et al.

Spatial heterogeneity (homogenization)

$log(\text{mean distance between treated plots/mean distance between control plots})$

Jaccard distance

Fencing
Nutrients $\downarrow$ $P = 0.013$
Interaction $\uparrow P = 0.016$

Spatial turnover

$log(\text{mean distance between treated and control plots/mean distance between control plots})$

Fencing
Nutrients $\downarrow$
Interaction $\uparrow P = 0.006$

Temporal Turnover

$log(\text{mean distance between treated plots in years 1 and 3/mean distance between control plots in years 1 and 3})$

Fencing
Nutrients $\uparrow P = 0.012$
Interaction .
There has been great (and continuing!) debate over the notion that there is a “general” bivariate relationship between primary productivity and species richness that reflects the dominant processes operating in communities.

In this study, we are revisiting the Adler et al. (2011) *Science* data to determine what can be learned when one transitions from viewing a system through a multivariate lens rather than a bivariate one.
Climate: Temperature & Rainfall

Disturbance History

Structural equation model of productivity – richness interrelations. (arrow thickness proportional to effect).

Site Productivity $R^2 = 0.36$

Site Biomass $R^2 = 0.69$

Site Richness $R^2 = 0.62$

Plot Productivity $R^2 = 0.72$

Plot Biomass $R^2 = 0.79$

Shading $R^2 = 0.43$

Plot Richness $R^2 = 0.65$

Spatial Heterogeneity within Site

Edaphic Conditions

Note very good variance explanation in this multivariate model.
Allocation to roots increases with elevation, & declines N or P addition

- Plants allocate to gain limiting resources, don’t allocate to roots if N or P are plentiful (no effect of K, fencing, and no interactions)
- High elevation sites tend to have lower above-ground biomass and a higher proportion of PAR reaching the soil surface, so they may be less light limited (note, mean annual precip was not a significant covariate)
- 27 of 29 sites completed... manuscript coming soon!
Australian grasslands – biomass constrained by nutrients, or water?

Morgan, Dwyer, Price, Prober, Power, Wardle, Firn, Moore, Seabloom & Borer
As the World Churns
betrayal, angst, heartache, and redemption in the world’s grasslands

[MacDougall, Borer, Seabloom, Hautier et al.]

Responses (Controls versus N, fencing)

Stable:
Popln’s fluctuate but function does not [complimentarity]

Stable:
No variation in diversity but function remains stable [plasticity]

Unstable:
Popl’ns fluctuate but associated with species loss [not complimentarity], with resultant high variability in function

Unstable:
Diversity irrelevant: function regulated by external factors such as climate

Population Variation in plot diversity (time, space)

Variation in Ecosystem Function (time, space)
Belowground Microbial Responses to Elevated Nutrient Inputs
(Noah Fierer, Jon Leff, Suzanne Prober)

25,000 16S rRNA sequences per sample (bacteria)
8,300 ITS sequences per sample (fungi)
19 sites, 285 soil samples in total

<table>
<thead>
<tr>
<th>Bacteria OTU richness</th>
<th>Fungi OTU richness</th>
<th>Plant richness</th>
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<tbody>
<tr>
<td>% change from control</td>
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- Ascomycota: P = 0.07
- Basidiomycota: P > 0.1
- Glomeromycota: P < 0.001

Actinobacteria: P = 0.012
Bacteroidetes: P > 0.1
Firmicutes: P > 0.1
Proteobacteria: P = 0.017
Verrucomicrobia: P = 0.045
**Is Productivity or Spatial Heterogeneity Determining Small-Scale Plant Species Richness? Contrasts between Temperate and Tropical Regions**

**METHODS**
- linear models (7 models, separately for temperate and tropical regions)
- results from model averaging (elevation n.s. in temperate and tropical regions)

**DATA**
- 38 temperate + 12 tropical sites
- total species richness per block
- average biomass per 1 m²
- coefficient of variation (CV) of biomass within a block
- elevation
MS 1: Strong abiotic controls over seed removal in a continent-wide study

Authors: Orrock, Brudvig, Firn, MacDougall, Yang, Melbourne, Baker, Bar-Massada, Borer, Crawley, Damschen, Davies, Gruner, Kay, Lind, McCulley, Seabloom.

Status: In review at Ecology

MS 2: Contingency in consumer-mediated invasion

Authors: Orrock, Firn, Bakker, Blumenthal, Borer, Brown, Brudvig, Buckley, Chu, Cleland, Cottingham, Crawley, Damschen, Davies, Firn, Frater, Gruner, Kay, Kirkman, Klein, Knops, LaPierre, Leakey, Li, Lind, MacDougall, McCulley, Melbourne, Moore, Morgan, Nelson, Prober, Seabloom, Stevens, Wolkovich, Wright, Yang

Status: Introduction drafted, analyses underway, draft of ms by December

MS 3: Biofuel potential of three grasslands

Authors: Orrock, Watling, Brudvig, Damschen, Borer, Seabloom, Baker

Status: Finalizing analyses and drafting final ms, full draft ms by December
Dispersal Trait Study
Lauren Sullivan (@cbgb.us), with cdcr.us and tmpl.us

**Question:** How do nutrient inputs influence dispersal traits of plant communities across the tallgrass prairie region? How do individual species respond? How does the community respond?

**Methods:** Measured 1) height at seed release, 2) number of seeds produced, 3) seed mass from 5 individuals of all species within plots in MN, IA and TX

**Results:** All from MN only
The Silwood Sites 2013

[M Crawley, reporting]

- The latest spring and the driest summer
- Unfenced, plus-N plots are heavily-grazed and highly scorched, their smaller root systems unable to cope with the drought
- Fenced plots, with N&P have changed floristic composition over the years and the new dominants (Holcus mollis and Arrhenatherum) are less drought adapted, so the unfertilized fenced plots out-yield the fenced fertilized plots
Arbuscular mycorrhizal colonization and extracellular enzyme assays on NutNet soils

We have been working on arbuscular mycorrhizal colonization in conjunction with Charlotte Rigg’s research where we have found site differences that may be related to soil texture. Additionally, we are gearing up to perform extracellular enzyme assays on NutNet soils where we have already observed N-treatment effects in our preliminary analyses.

Participants: Elizabeth Bach, Sarah Hobbie, Kirsten Hofmockel, Charlotte Riggs, Ryan Williams
Nutrients and herbivores control plant diversity via light in a global grassland experiment

Borer et al. [opt-out]
Cages to remove insects increases plant production in higher productivity prairie [LaPierre]

- Removing invertebrate herbivores increases aboveground biomass both with and without N added in mixed- and tallgrass prairie, due to compensatory feeding in the no N plots and selective feeding in the N addition plots by inverts at each site.
- No effect of removing invertebrate herbivores was observed at shortgrass steppe, perhaps due to compensatory plant growth or less leaf tissue removed by invert herbivores at this site.
NUTNET – PORTUGAL
Companhia das Lezírias

Figure 1. a) Average species richness (number species m^{-2}), and b) aboveground biomass (g.m^{-2}) in spring 2013

- NPK plots were the most productive and less rich in species. Poaceae made up 83% of biomass (Avena barbata and Gaudinia fragilis were dominant species);

- At beginning of vegetation growth, Rs was highest in NPK plots, followed by NK and NP, probably reflecting leaf area index values;

- Rs responded to soil temperature and soil moisture patterns and by June was very low in all treatments due to low soil moisture and high soil temperatures.

Figure 2. Soil respiration (Rs)

Figure 3. Site location

Figure 4. Chamber for measurement of vegetation CO₂ and H₂O exchange. An extra-measurement being performed.
The Aquatic Side of Nut Net
Seth Thompson (with undergrad team) and Jim Cotner
thom2587@umn.edu

Here we show water extractable organic carbon as a function of water extractable total nitrogen. We find that despite a strong coupling of carbon and nitrogen export on a large scale, by separating out by soil types we begin to see differences in C:N export ratios. This suggests potential differences in organic matter quality being exported to aquatic ecosystems. This may help explain why terrestrial organic matter exported into aquatic ecosystems can be more labile than previous believed.

*See ESA posters by Undergraduates Emily Whitaker and Joseph Kelly*
Effects of nutrient enrichment on size and cycling of multiple soil organic matter pools
Charlotte Riggs, Elizabeth Bach, Sarah Hobbie, Kirsten Hofmockel

1) No effect of N on total soil C, but size and cycling of individual pools does change....

2) Fast cycling soil organic C decays more quickly with N addition, while slow cycling soil organic C decays slower.

3) N increases the proportion of macro-aggregates (>2 mm), but not other aggregate size fractions.

4) No effect on microbial biomass, but % mycorrhizal colonization does increase with N addition (contributing to increased aggregation, C inputs, enzymatic potential???)

Implications: Long- and short- term effects of nutrient addition on soil C cycling and storage may differ.

Check out our poster @ ESA Monday

5 NutNet sites sampled in 2012
NutNet Site at the Univ. of Florida

Maria L. Silveira

M. Silveira, Soil and Water Science, UF/IFAS Range Cattle REC
Dry matter (kg ha$^{-1}$)

Initial - April, 2013

- Litter
- Above-ground biomass
Mechanistic models of multiple resource use to explain biodiversity patterns in nutnet grasslands

Lauren Shoemaker, Brett Melbourne, Kendi Davies, ....

- Mechanistic approach to understand the link between productivity and local richness, beta diversity etc
- Spatial ("metacommunity") model
- Individual based simulator similar to SORTIE (forest community)

- Plant functional types
- Explicit resource use (water, sunlight, nutrients)
- Parameterized from site data
Figure 2. a) Effect size (natural log response ratio) of aboveground net primary productivity (mean ± 95% CI) averaged over all 43 sites and all available years for the eight nitrogen (N), phosphorus (P), and potassium (K) treatment combinations. b) N effect and P effect (natural log response ratio) for each site. The sites are ordered by the magnitude of the N-effect. Sites with a significant N-effect are shaded green; Sites with a significant P-effect are shaded in blue.
Atmospheric N deposition predicts grassland production better than climate variables

[Stevens, Lind et al.]
NutNet @ Doane College

Site basics

- 60 plots (6 blocks) established 2012
- Initial data by undergrad Ecology class early September 2012
- Initial fertilizer in April 2013
- 2nd harvest in early Sept 2013 by Ecology class

Impact on students

1) Was there anything interesting or surprising that you learned about prairies through sampling in NutNet?
   - "I was surprised that there was diversity in such a small area. Like one sampled area could be really diverse with many different types of things like grass, woody, forbs, etc. and the site right next to it could only have grass in the sample."
   - "I was surprised at how much litter was in the prairie. I never really have thought about it being part of an ecosystem. I was also surprised about how much plant diversity was in a 'strip'"

2) What do you think about being part of a global experiment?
   - "I believe that this sort of collaboration is lacking in many other of our studies and that more experiments and cooperation like this could be beneficial for all."
   - "I think it is very exciting to be a part of something like this. I enjoy “bragging” that I get to participate in this to people that don’t have these opportunities."
   - "Being a part of a global experiment is inspirational. I feel like I am doing something that will impact the world for the better."

[Ramesh Laungani, PI]
Global effects of biodiversity and eutrophication on the stability of grasslands

41 sites
Biodiversity and ecosystem multifunctionality in grasslands

Hautier, Isbell, Seabloom, Borer, Lind, McDougall, Stevens, Hector + any interested

Functions:
Aboveground live biomass
Proportion of light transmitted
Soil C
Soil N
Soil P
Soil K
Litter disappearance
Invasion resistance

58 sites
Consequences of fertilization on biodiversity and ecosystem productivity

Hautier, Isbell, Seabloom, Borer, Lind, McDougall, Stevens, Hector + any interested

Taken from Grace & Anderson
Mechanisms of plant diversity loss with fertilization

Hautier, Seabloom, Borer, Lind, Grace, Anderson, Hector + anyone interested

Over 4 years of chronic nutrient addition (NPK)
41 sites
Enhancing productivity increases the role of niches in the community assembly of global grasslands

**Question:** Does enhancing productivity (nutrient addition) across a productivity gradient alter the role of niches in community assembly (in face of stochasticity)?

- Approach beta diversity, null deviation relate to productivity in experimental (nutrient addition) data

- Analysis redo
  - PEI (Chase paper)
  - Add latest experimental data,
Kibber, Himachal Pradesh, India

- Full experimental study established in 2011
- Year 3 sampling currently underway