The Evolution of a Network: Productivity-Diversity-Traits and More

Kay Gross

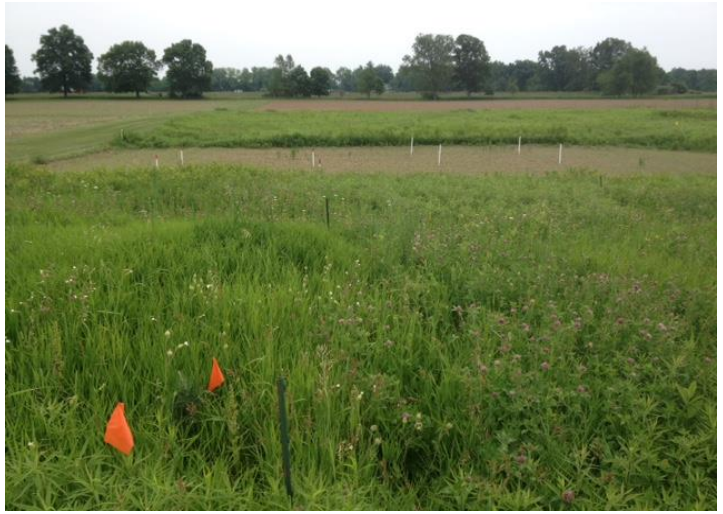
(former KBS LTER co-PI and Network ‘instigator’

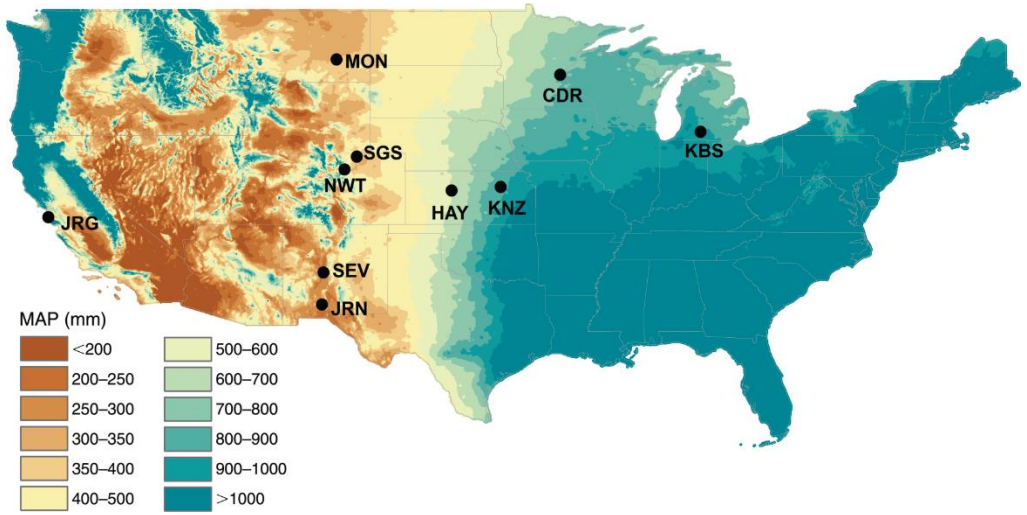
KBS LTER All-Scientist Meeting

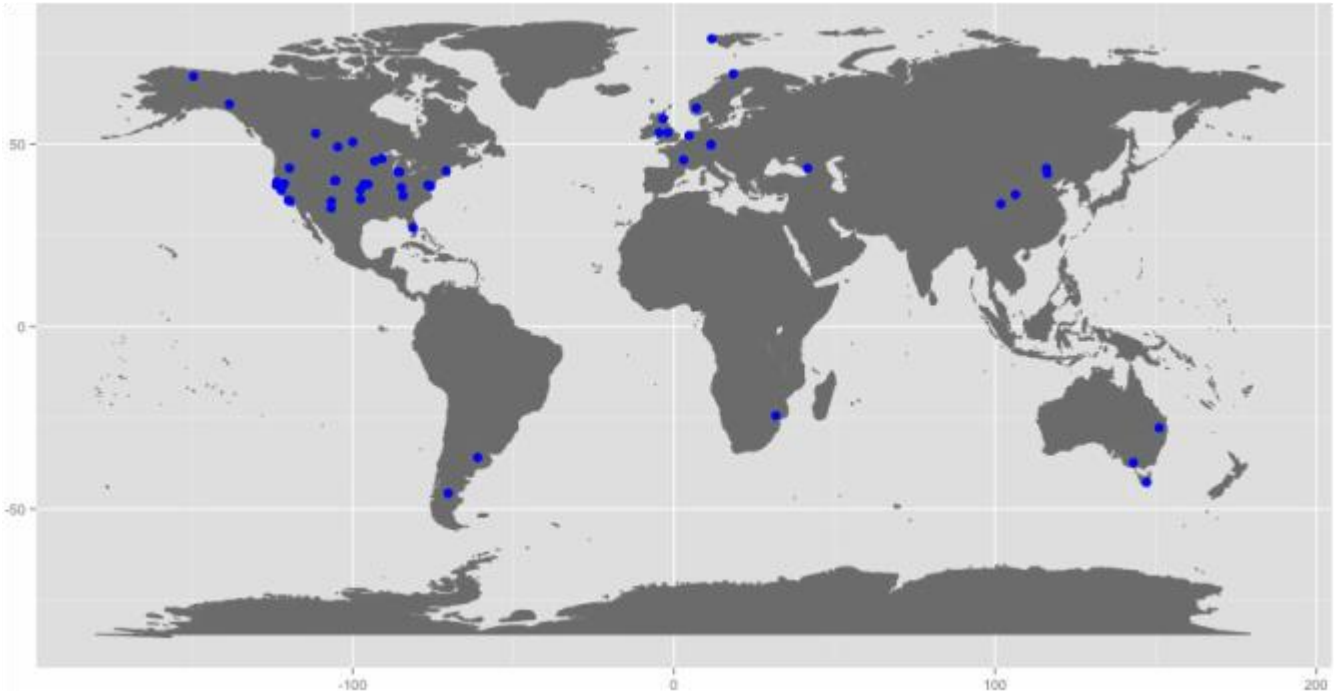
20 September 2019

Talk today…

1) How the PD(T) Network began
2) Outcomes and Lessons Learned
3) How it grew
4) What next?





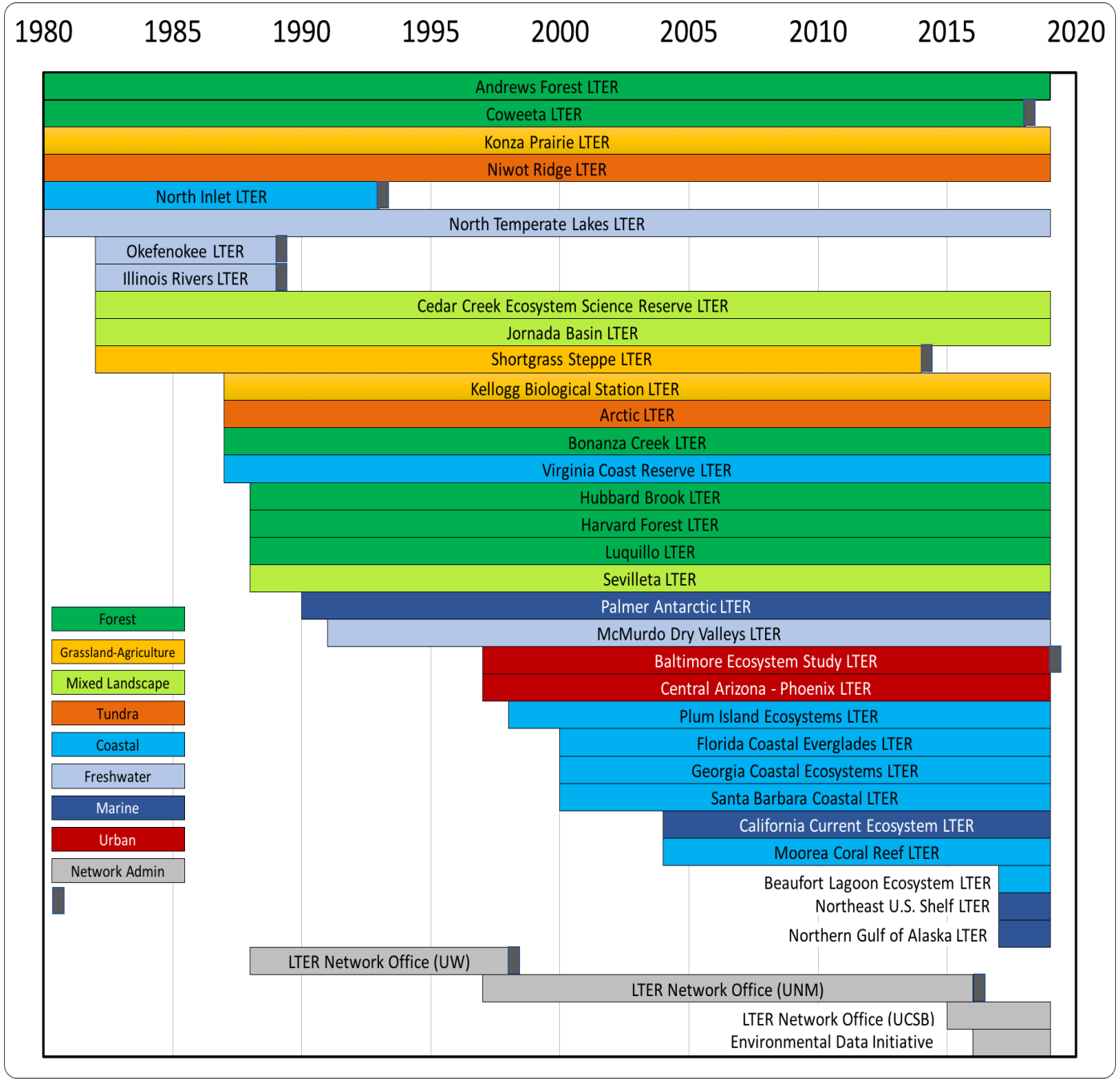


How it began…

LTER in the 1990's

The number of LTER sites was growing (18 in 1995) and while sites all collected data in cores areas, no overarching themes or hypotheses across sites to promote collaboration.

As a result, most sites developed individual, not coordinated, hypotheses and/or frameworks for collecting these data and there was little evidence of being a 'network.. And this was becoming an expectation.



How it began… Within the LTER a 'need'

1989 – NSF sponsored 'program review' of LTER

1990 – 2nd All Scientist Meeting (Estes Park, CO)

- Challenges of 'operating like a Network' included compiling and sharing data
- *Core Data Catalog* established (Network office managed)
- Climate data was agreed to be the start (easy and comparable)… But it wasn't a question driven decision.

1994 – Publications and Synthesis Committee established to and promote synthesis (site volumes) and collaborations

1994, 1995 – NSF held special competitions to promote 'cross-site comparisons and synthesis' between LTER and non-LTER sites

But something was missing – Motivation!

LTER Five "Core Areas"

1) Disturbance patterns
2) Movement of *inorganic nutrients*
3) Movement of *organic matter*
4) Population studies
5) Controls on primary production

(from the Jornada Website)

Other: Climate/hydrology; Landuse and Cover Change; Human-Environment Interactions

An opportunity: NCEAS

1995, NSF funded NCEAS to address "…*a need to combine disparate existing data to seek new, bigger picture insights from them - to synthesize them - there was also a need for a place where the collaboration necessary for such research could occur*."

- RFP went out for the first round of working groups in late 1995
- LTER Science Council meeting (U Minnesota)… discussions of how to take advantage of this opportunity and show how LTER data could be used to address 'important and unresolved (or at least interesting) questions in ecology
- Productivity- Diversity relationships starting to get attention….and LTER sites all had Productivity data

1996 - Proposal to NCEAS (led by Bob Waide and Mike Willig) for a Working Group: "Analysis of the Relationship between Productivity and Diversity using Experimental Results from the Long-Term Ecological Research Network"

- Funded in Spring 1996 .. 3 sessions; 22 scientists (not all LTER), including:
  - representatives from 'most' LTER sites (data managers, postdocs, faculty)
  - people who could bring a 'conceptual focus' to the discussion

The Productivity-Diversity working group focused on two questions:

1) What are patterns of productivity and diversity among/across biomes (LTER sites)?
expected to use data on ANPP and species richness across sites
2) Can we test the hypothesis that Productivity controls/drives this relationship?
Fertilization experiments at many of the sites

The challenges (among them)

1) Sites measured ANPP in different ways – and scales
especially challenging to compare aquatic and terrestrial systems
Solution *– split of the aquatic systems (Dodson et al 2000 Ecology)*

2a) Not all terrestrial sites had data on 'species richness' ..
Solution - Dropped the forests and focused on 'grasslands" *(low-stature plant communities)*
(Gross et al. 2000 Oikos; Gough et al. 2000 Oikos)

2b) Not very interesting to just look at one habitat type…
Solutions *- Expand the scope of analysis beyond LTER sites (Willig et al 1999 ARES; Mittelbach et al 2001 Ecology)*

3) Species richness is not estimated at the same scale (plot size matters)
Solution *- Develop statistical tools for 'scaling' (Scheiner et al 2000 Evolutionary Ecology Research)*

Outcomes and Lessons

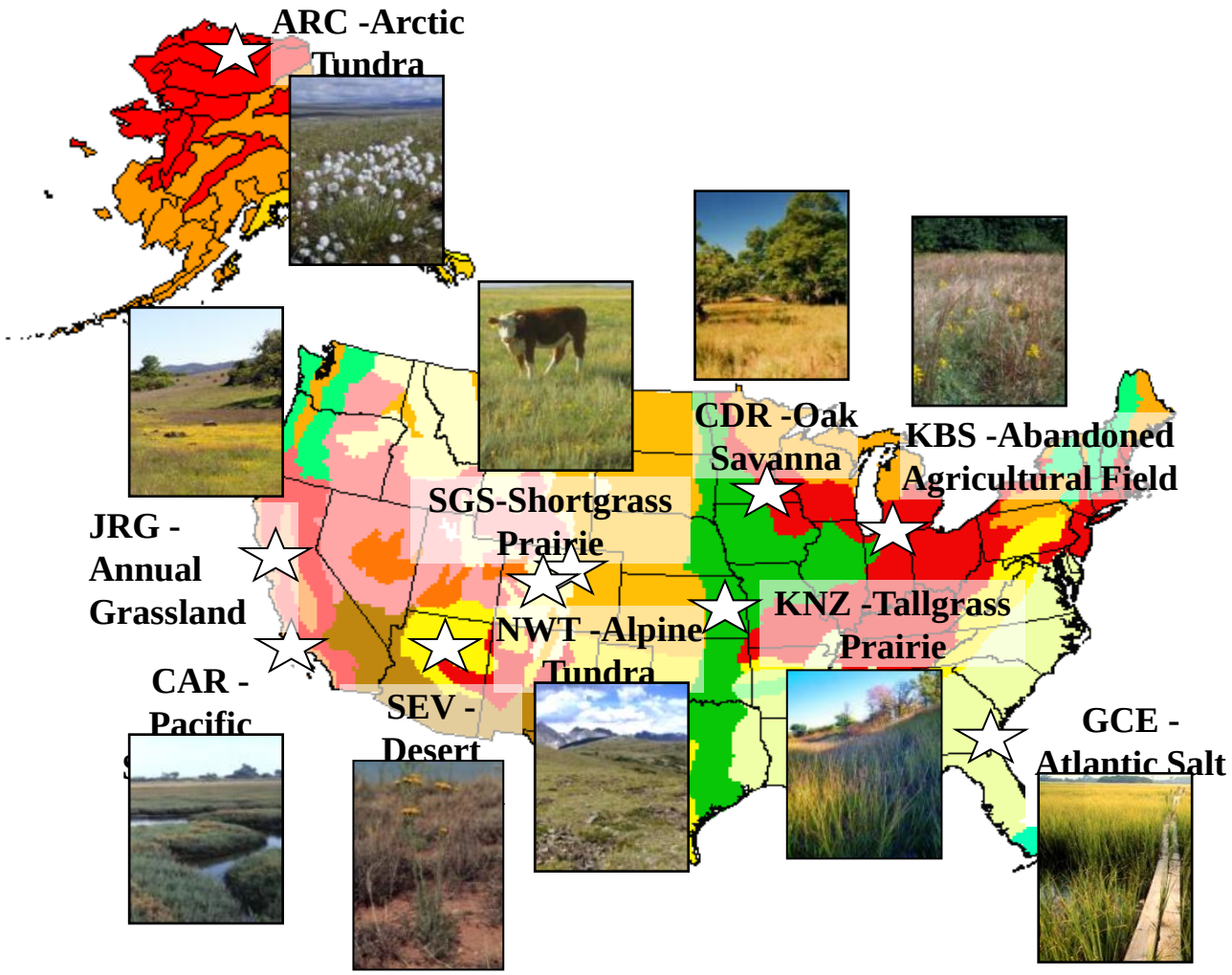
Successful synthesis working group:

- Over 8 papers in peer-reviewed journals. Among them 2 of the 'top 100' for NCEAS
- Created opportunities – and motivation – for the development of meta-data standards, and tools and training in data analysis (cross-site graduate seminars)
- Created opportunities to 'broaden the portfolio' of researchers involved in LTER science and synthesis, including explicitly including graduate students and postdocs!
- Demonstrated the potential of LTER science – and scientists – to contribute to the developing culture of synthesis
- Motivated lots of additional research and synthesis!

But….

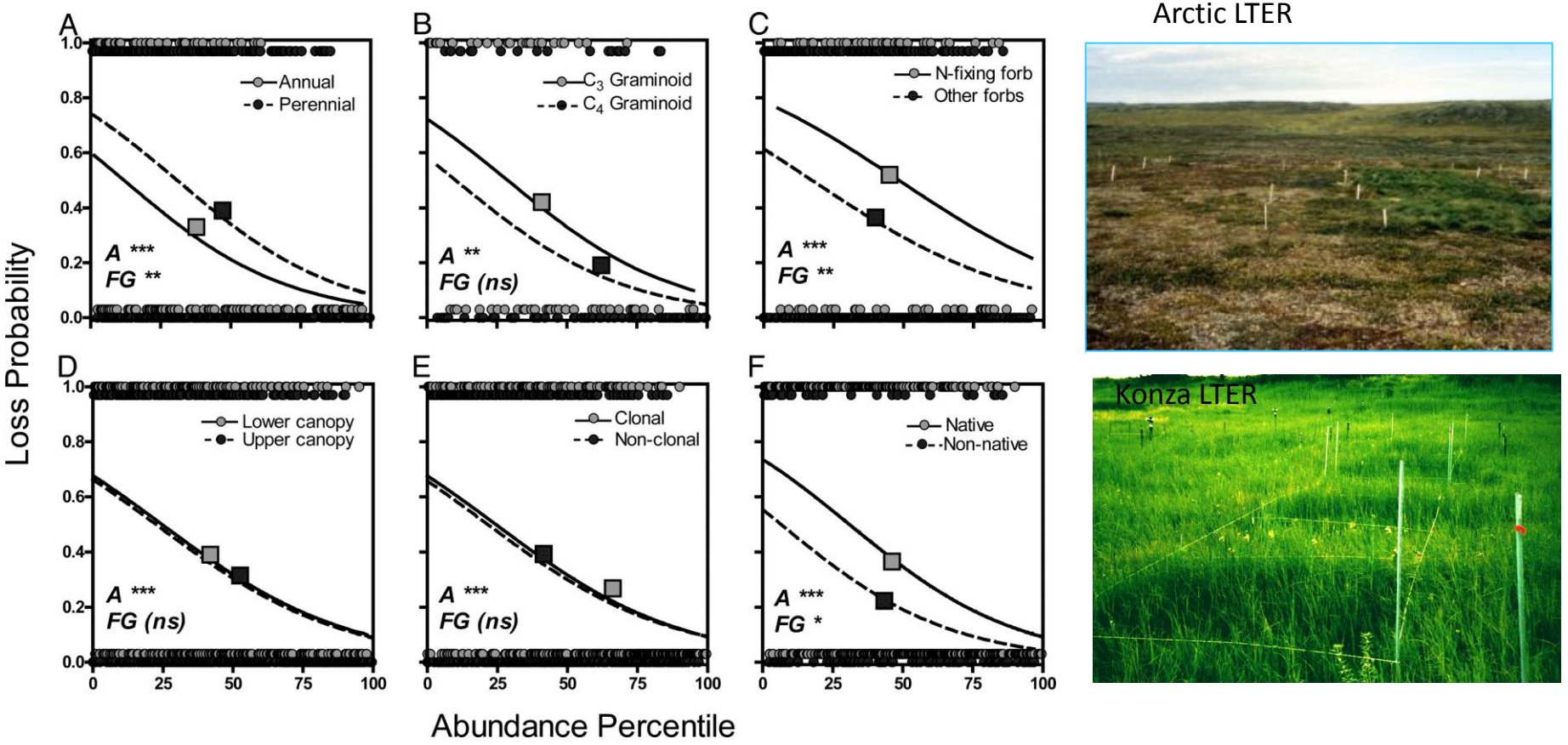
- LTER site data was not sufficient to address these 'big questions' – needed to broaden the sites (and experiments) included in these syntheses
- Challenge to draw conclusions based on 'species' when there was little overlap in species composition across sites (need to focus on traits)..PDTNet
- Differences in experimental (and sampling) protocals limited the ability to make clear conclusions about effects of 'nutrient additions', and ignored other factors (NutNet – Research Collaboration Network and 'grassroots approach')

Productivity-Diversity- Traits Network: PDTNet



PDTNet sites: All sites all have Nitrogen fertilization experiments in “low stature” plant communities; trait data were compiled (by researchers or the literature) ..

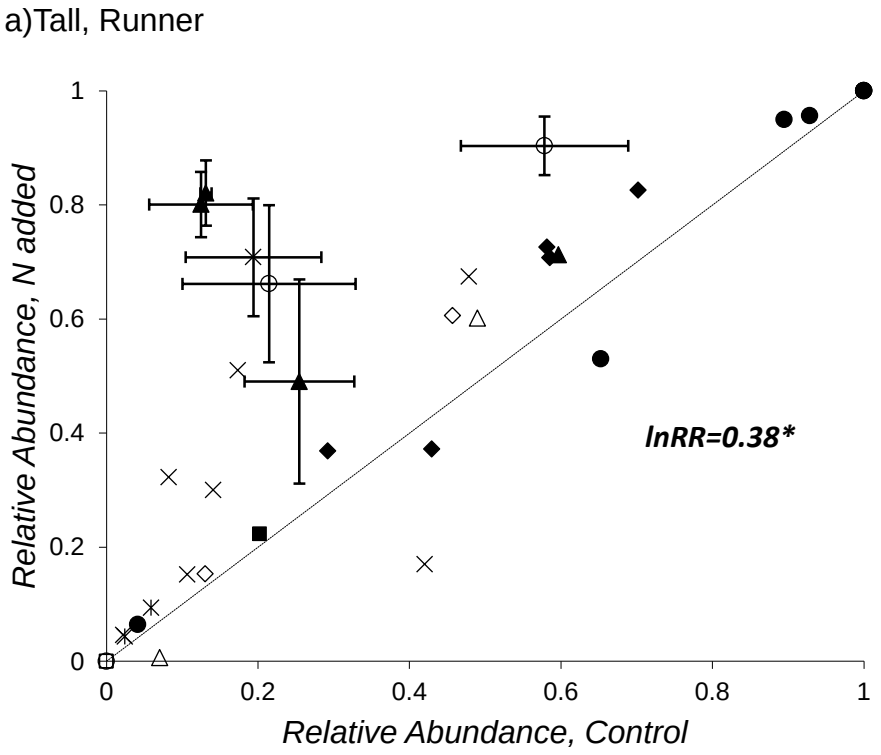
PDTNet: Species traits predict probability of being excluded (lost) in response to fertilization…..

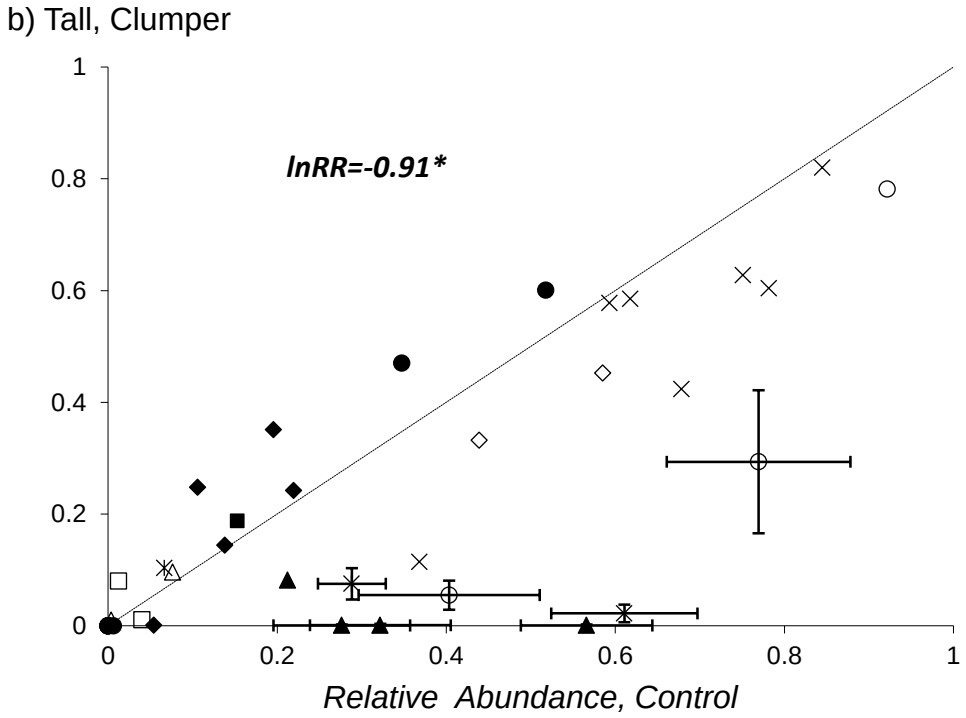


Arctic LTER

- Found Abundance (A) and other traits predicted probability a species would be lost from fertilized plots…
- *No effect of plant height or clonal growth form* (Suding et al. 2005)

Further analysis, focusing on abundance showed that combination of Clonality and Height predict responses to fertilization across sites….



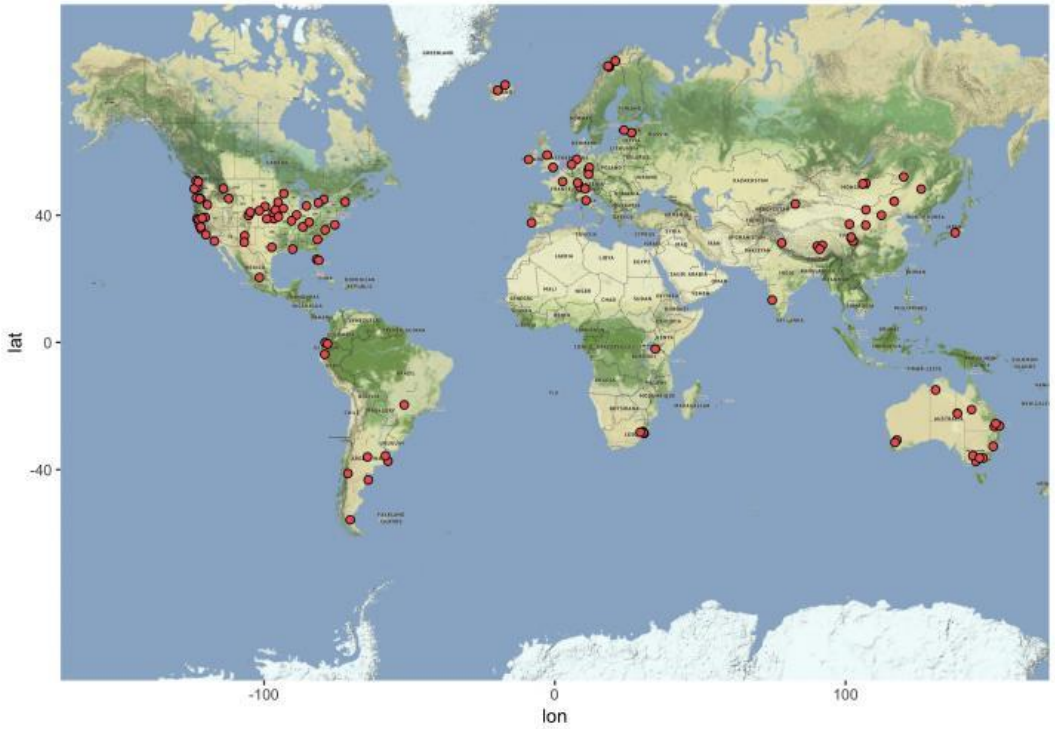


Gough et al, 2012

Next Steps…*NutNet…*. a collaboration borne out of frustration with the challenges of using ‘existing data sets’ to address questions about the effects of human activities (specifically nutrient addition and manipulation of consumers) on plant communities

- Standardized experimental protocals …. and an explicit focus on data-sharing and collaboration
- Truly global… over 130 sites.. Broad range of climatic zones
- Still primarily ‘grasslands’
- “Cost to collaboration”.. Funding? Maintaining the experiments and data synthesis

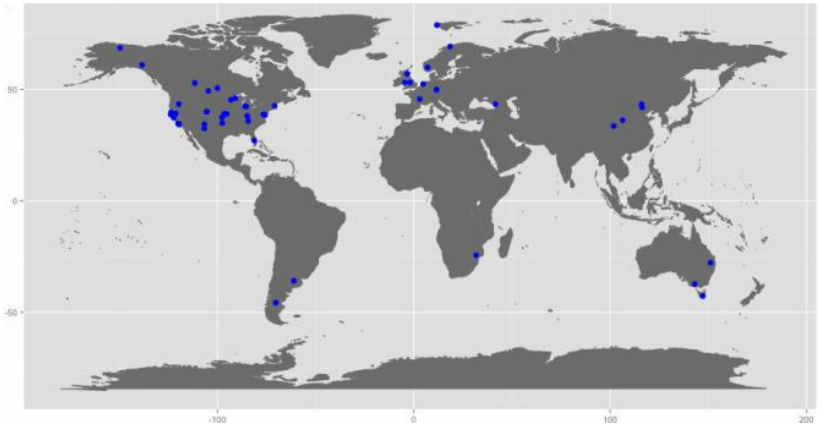
nutrient network



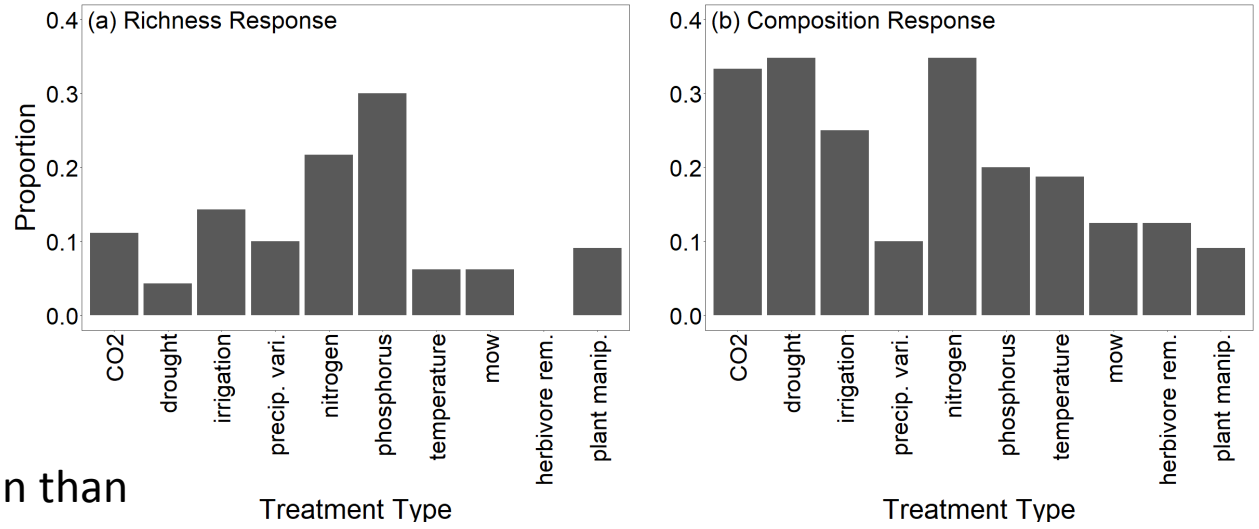
Still room for comparative cross-site analysis using existing data sets:

CoRRE:

Community Responses to Resource Experiments



- Established in 2012…led by ‘core’ group of young researchers whose advisors had been involved in various LTER synthesis activities
- Motivated by desire to examine community responses to multiple global change drivers
- Funded by LTER Network Synthesis ... SYSENC, NCEAS, faculty startup
- 101 data sets (to date) with global scope



Komatso et al 2019 PNAS

Most recent paper Komatsu et al 2019, PNAS

- More likely to see change in species composition than diversity
- Longer term (>10 yrs) studies more likely to detect change

Challenge: Authorship and attribution

Author	CoRRE Leader	CoRRE Member	CoRRE Database	Provided Raw Data	Developed Research Questions	Analyzed Data	Contributed to Data Analyses	Wrote Paper	Contributed to Paper Writing
Kimberly J. Komatsu	***x***	***x***	***x***	***x***	***x***	***x***	***x***	***x***	***x***
Meghan L. Avolio	x	x	x	x	x	x	x		x
Nathan P. Lemoine		x			x	x	x		x
Forest Isbell		x		x	x	x	x		x
Emily Grman		x			x	x	x		x
Gregory R. Houseman		x		x	x		x		x
Sally E. Koerner		x		x	x		x		x
David S. Johnson		x		x	x		x		x
Kevin R. Wilcox		x		x	x		x		x
Juha M. Alatalo				x			x		
John P. Anderson				x					
Rien Aerts				x					x
Sara G. Baer				x					x
Andrew H. Baldwin				x					x
Jonathan Bates				x					x
Carl Beierkuhnlein				x					x
R. Travis Belote				x					x
John Blair				x					
Juliette M. G. Bloor				x			x		x
Patrick J. Bohlen				x					
Edward W. Bork				x					x
Elizabeth H. Boughton				x					x
William D. Bowman				x					
Andrea J. Britton				x			x		x
James F. Cahill, Jr.				x			x		
Enrique Chaneton				x			x		x
Nona Chiariello				x			x		
Jimin Cheng				x					

What's Next?

1) Continuing opportunities to participate in/join existing Networks
   - NutNet
   - CoRRE
   - Drought Net….
2) NEON… LTAR… can/are providing opportunities for new research collaborations (linking to LTER!)
3) Not just North American networks… growing number of research networks in Europe (EU promotes), South America, Asia
4) Not just research network.. Education and Outreach groups are also forming Networks
   - UFERN (Undergraduate Field Experiences in Research)
   - NC Climate Collaboration
   - LTER Outreach Network