Graduate Student Symposium at the LTER All Scientists Meeting
Estes Park, CO, September 9, 2012

The Graduate Student Symposium (GSS) occurred the day before ASM officially began. Approximately 150 graduate students from across the LTER network participated, about ¾ of whom were attending their first ASM. The day provided excellent networking and a fun, comfortable learning environment for the graduate students. Our theme for the day was "Thinking outside the ecological box: Incorporating additional disciplines in ecological research." To address this, Dr. Nancy Grimm from the CAP LTER gave an outstanding plenary speaking to us from the two "perches" of her unique perspective: lead PI of the CAP LTER and NSF program officer. Nancy discussed with us the why, what, where, who, and how of working across disciplines, including advice such as:

- Ecology tends to inherently draw on other disciplines for their tools, mechanisms, etc; but be aware that not all questions need to be cross-discipline in nature.
- Get investigators from other disciplines involved early (at the question development stage) and keep them involved throughout the project.
- Ask questions that are at the cutting edge in both/all of the disciplines you are working in.
- Find commonalities in discussion with investigators from other fields, but don't get hung up on differences in terminology.
- Many NSF programs encourage research than spans disciplinary boundaries, so be on the lookout for many funding opportunities for such work. Graduate students and post-docs may particularly be interested in IGERT and the SEES Fellows Program. Additionally, NCEAS and SESYNC offer great ways to get involved in interdisciplinary research.

In addition, three graduate students presented their work that incorporates other disciplines into their ecological research. Sakura Evans (CWT) discussed using social science techniques to examine why land-owners utilize land practices that degrade riparian zones in the southern Appalachian Mountains. Next, Sarah Frey Hadley (AND & HBR) explained what and how she has formed collaborations with computer scientists to examine single- and multi-species distributions of birds and identify bird songs from field recordings using machine learning. Finally, Rebecca Hale (CAP) spoke to us about working within engineered systems in Phoenix to examine water flow in the city. The student speakers provided excellent examples of how graduate students can each incorporate other disciplines into our ecological research within a time scale relevant to our dissertations.

The last activity of the morning was a panel of PIs chosen for their work across disciplines, including Drs. Nancy Grimm, Nik Heynan (CWT; social science), Mary Spivey (CDR; citizen science), and Dave Gutzler (SEV; climatology). They had some great advice for how to incorporate additional disciplines into ecological research during our dissertation work and beyond, including:

- "Get a life" – meeting new people will facilitate an exchange of ideas that might shift your perspective.
- "We don't work with assholes" – collaboration is fun
- "Push back on your advisor" – make them give you what you need to make collaboration possible

- "I work with citizen scientists, so ask me if you need free labor" – check with your education reps at each site for details.

The afternoon consisted of a series of concurrent working groups, organized and led by graduate students. GSS participants had the option to attend groups ranging in topic from patchiness in plant communities to identifying best practices to cross-disciplinary research. The working groups were all well attended and many will result in ongoing collaborations, including data synthesis and starting up new cross-site experiments. In summary, 9 working groups were lead by 28 students from 11 different LTERs. Over 150 students attend the 9 working groups, and 6 publications are planned to result from the working groups with 4 groups each submitting a proposal for further funding from the LTER. Specific details on each working group are below.

1. **Land Use: Unifying Social and Natural Sciences in Southern Appalachia and Beyond**

Organizers: Robert Northington, Peter Baas, Paige Barlow, Matt Craig, Sakura Evans, Jake McDonald, and Jeremy Sullivan

Faculty Facilitators: Drs. Nik Heynen and Brian Burke

Number Attending: ~20

Working Group Description: We began our working group with a brief introduction by Dr. Nik Heynen, followed by an overview of the working group objectives by Jeremy Sullivan. We did individual introductions of all the participants, and then we began discussing experiences with cross-disciplinary collaboration at our respective sites. We discussed the different methodologies used by natural and social scientists and brainstormed on ways grad students could learn more about other disciplines and think about ways to work together. We then split up into two groups and each group attempted to develop a framework for encouraging and supporting graduate student cross-disciplinary collaboration within the LTER. The groups came back together, each group presented an overview of their models, and we finished by discussing ways to merge the salient points from both models and possibilities for continuing the discussion.

Products from Working Group: Notes, outlines, and plans for drafting a framework for cross-disciplinary collaboration to present back to our site PI's was developed. We are also discussing the possibility of writing a research project for the upcoming summer to test out the framework we have been developing. Ideally, we hope for the efforts of this working group to result in a publication.

Future Plans: We met once more while at the ASM, once since, and have another meeting planned for two weeks from now. No plans to submit a proposal to the LNO for further funding, but we will revisit this prospect later in the future (probably this summer).

2. **Student perspectives on urban ecological theory**

Organizers: Anna L. Johnson, BES; Eric Chapman, CAP; Julie Ripplinger, CAP

Number Attending: 25 (13 students from BES/CAP directly affiliated with workshop via short presentations or as organizers, and 12 additional participants, including representatives from Coweeta, Andrews Forest, Cedar Creek, Kellog Biologial Station and Konza Prairie, in addition to BES and CAP)

Working Group Description: We organized this session to have an hour of short presentations from BES and CAP students, consisting of a short intro of each site and then talks from students working on social science, biogeochemistry/hydrology and biodiversity topics. This was followed by an hour of open discussion. Our talks went about twenty minutes longer than planned, cutting into discussion time, but the discussion though short was pretty lively and led us to follow up with two more ad-hoc meetings of interested participants.

Products from Working Group: We created the outline for two potential manuscripts. One, which came directly from the workshop, is meant to be a case studies approach to students studying urban ecologies, and discuss how the "next generation" urban ecologists create a toolbox from diverse and multi-disciplinary data sets and methods. The second is a larger project, and would be a textual analysis of titles/abstracts of publications across LTER's that have a range of "human impacts" on their study sites, looking at the extent to which the treatment of these impacts and attention to urbanization issues in publications has changed with time.

Future Plans: We have a core group of five-six students who are committed to meeting regularly via Skype and putting together these manuscripts. We will be submitting a proposal to fund meetings to work on analysis and writing for our larger textual analysis project.

3. **Sharing Stories from Outside the Box: Preferences in Research that Crosses Disciplines**

Organizers: Elise Benveniste (PhD student, Dept of Sociology, MSU); Leah Harris (PhD student, Dept of Agricultural, Food, and Resource Economics, MSU); Leila Desotelle (PhD student in Zoology, MSU)

Number Attending: 16

Working Group Description: Elise, Leah and Leila began with a 15 minute power-point presentation where we discussed the following:

- General motivations for interdisciplinary research (IDR), particularly the need to address "wicked problems", as well as accessing grant opportunities with IDR proposals
- Truths and challenges: that IDR tends to be unique and that there's not formula for collaboration; interdisciplinary teams are scary; and working outside the box is more "real world".
- Characterizing the type of actors/nodes in graduate networks, including: graduate specializations, interdisciplinary grants (funding structures/assistantships), connections with other graduate students, networking at conferences

- Discuss workshop goals, which are to share preference for interdisciplinary research – talk about what works and why – and for grads to talk about how IDR benefits them professionally, and the science.

Then each of the working group organizer lead the small group discussion that on experiences and preferences to interdisciplinary research. A set of questions (see attached) were used to facilitate discussion. After an hour of small group discussion, the working group returned to the group of the whole to discuss common or significant experiences working in IDR, and preferences for fostering an interdisciplinary collaborative culture.

Products from Working Group: We anticipated and observed graduate students engaging in candid discussions of their own experiences, and regard this as a benefit/product in and of itself. Following the guided discussion questions provided by workgroup organizers, students compared their IDR experiences with each other. Several students commented that as IDR student practitioners they felt isolated in their departments, unless those departments had already established a collaborative culture through programs like IGERT. This suggests that students working in/with multiple disciplines have to do much of the disciplinary bridging work on his, or her own with few guides for support. We find that the community and identity of students engaged in innovative bridge work is not likely to be a priority for University departments, yet it is that kind of support that is critical to fostering the cultural practices of collaboration demanded of IDR.

Participant-observation data was collected during this focus group that will used to develop a commentary piece on collaborative cultures in network science. Drawing from student experiences and preferences discussed during the workshop, this piece identifies how University departments, LTERs and LTER networks foster both barriers and opportunities to interdisciplinary research practices. This commentary piece will also be influenced by the outcomes of the proposed working group "Best Practices for Graduate Student Socio-Ecological Research," of which both Leah Harris and Elise Benveniste anticipate participating in.

Future Plans: In the future, this working group should collaborate with the ASM working group on Graduate Student Socio-Ecological Research practices. The major difference is the ASM working group was prescriptive, whereas this working group was more exploratory; for people to share their experiences, and talk about their preferences in terms of interdisciplinary practices. We are collaborating with Synde Record and Paige Barlow on the working proposal for "Best Practices for Graduate Student Socio-Ecological Research".

4. **Influence of climate change on dormant season ecology**

Organizers: Laura Ladwig (SEV), Zak Ratajczak (KNZ), Katya Hafich (NWT)

Number Attending: 18

Working Group Description: Katya and Laura started the first session introducing the research idea and giving site specific examples of how winter climate change alters biota. The majority of the session was spent introducing the crowd and discussion possible directions for the research.

The second session Zak introduced a data analysis method we decided to utilize cross-site, we narrowed down our objectives, and brainstormed what data sets were available.

Products from Working Group: We are writing up a grant proposal for the LNO to propose a working group to meet and solidify a manuscript.

5. **Habitat Heterogeneity and trophic interactions in small streams**
Organizers: Erika C Martin and Danelle M Larson

Number Attending: 5

Working Group Description: We discussed working hypotheses regarding the title topic and what kinds of pre-existing data occur at the LTER sites to answer these questions.

Products from Working Group: Just a brainstorming activity.

Future Plans: No future plans at this time as little data currently exists to address our questions.

6. **Belowground research across LTER sites**

Organizers: Charlotte Riggs (CDR), Clare Kazanski (CDR)

Number Attending: 23

Working Group Description:

-activity to visualize soil and climate gradients represented by participants
-small group discussions of research themes and challenges within and across major research domains (i.e. biological, physical, chemical soil processes/mechanisms)
-large group discussion of common challenges as well as compilation of themes discussed by small groups

Products from Working Group:

-email list
-brainstorming of common research themes and challenges
-follow-up email including the previous two items, plus an invitation to keep the conversation going into the future

Future Plans: We (the organizers) will follow-up with interested parties on an idea to initiate a cross-site soil analysis to evaluate soil heterogeneity. However, an explicit timeline has not been determined as of yet.

7. **Plant Community Patchiness: Does it explain the divergent responses in biodiversity-ecosystem function relationships seen across multiple sites?**

Organizers: Kevin Wilcox (KNZ), Sally Koerner (KNZ)

Number Attending: 19

Working Group Description: The session was initiated by a 15 minute introduction into current topics of community ecology (e.g. the richness-productivity relationship), the potential importance of beta diversity (or patchiness) on ecosystem processes, and possible metrics for quantifying beta diversity. We then opened the floor for discussion of these topics. One of the main themes that came up repeatedly throughout the discussion was that of scale and how to deal with the different scales used among sites. One suggestion was to use consistent scales within biomes but let the scale vary among biomes. Another suggestion was that we stick with one biome to start.

Another major discussion thread was how functional responses of ecosystems to patchiness of these systems may vary depending on the level of richness present within these patches or the functional redundancy within the whole system. Finally, we focused on getting information about which sites have appropriate data for a meta-analysis and which sites we may want to add. Overall, it was a very successful working group.

Products from Working Group: At least one publication will come from this working group.

Future Plans: The organizers plan to submit an LTER proposal for this year's working group funding cycle.

8. **Comparing Hydrogeological Drivers Among LTER Ecosystems and Their Effects on Productivity, Sedimentation, and Social Constructs**

Organizers: David Lagomasino (FCE), Mernoosh Mahmoudi (FCE), Adam Wlostowski (ARC)

Number Attending: 25

Working Group Description: Our working group consisted of a number of hydroecologically themed presentations followed by an in-depth discussion comparing and contrasting the various LTER sites represented during the presentations. A list of presenters is included at the end of this report. There were about 20-25 student participants that attended the working group session. Additionally, we also webcasted and recorded the student presentations, allowing the opportunity for others to watch and learn from their provocative research.

Although participants of the workshop spanned a wide range of sites and scientific objectives, a clear unifying theme was identified: *hydro-ecological processes and human society are bi-directionally and intimately linked*. It was agreed that in order to develop a full understanding of ecological processes at any site, we must work in the context of local, regional, and global human impact. Human activity impacts hydrology at LTER sites in many ways. For example, upstream flood-control infrastructures (e.g. dams, canals) regulate flow through downstream ecosystems. Also, hydro-ecological dynamics at HBR are anticipated to change in the face of anthroprogenic changes in temperature, precipitation, and solar radiation inputs. We also recognized hydroecologic phenomena which influence human decision making. For example, natural groundwater dynamics in central Wisconsin cornfields threatens the productivity of

harvest yields. Better understanding of hydrogeologic dynamics and associated ecological responses allows farmers to make better decisions in a more informed and symbiotic planning framework.

Our working group displayed an understanding of hydro-ecological change and the bi-directional link between human societies. However, it was unclear how human societies (non-scientists) conceptualize and understand the linkages between ecology and society. How do populations and decision-makers perceive ecological change as a problem? So, given a long-term or short-term measured change in a system (e.g. algal blooms in local lake), what are the primary driving mechanisms causing the change, perceived by the community (nutrient loading?) and how does this perception change amongst stake-holders within the community? This dialogue then transitioned into a discussion of the importance of spatial and temporal scales of a study, and what scales are most relevant to society.

We, as a group, were commonly intrigued by the spatial and temporal scale of results, and which scales are most important to stakeholders and decision makers. The research presented in our working group ranged from plot-scale ($10m^2$) rain and vegetation studies to catchment scale ($10km^2$) and regional scale forest nutrient dynamic studies. For example, students at JRN are doing plot-scale research manipulating precipitation measurements for the purposes of measuring NPP of desert scrubs, while others are determining relationships between fishing data and regional-scale marsh inundation at the FCE site. The question of importance then sprouts; *how can we better link studies across spatial and temporal scales to provide the best scientific products to society?*

The working group discussion can be summarized into three major points:

- ***Hydro-ecological processes and changes are bi-directionally and intimately linked to human societies and climatic uncertainty***
- ***It is unclear how populations and decision-makers perceive ecological change as a problem.***
- ***We can better work to connect vastly different spatial and temporal scales of study to provide the best research products to human societies.***

Future Plans: There was a general consensus from a handful of students to pursue the above points further by submitting a proposal to the LNO for potential workshop funding. This workshop would seek to culminate and synthesize data from various LTER sites spanning a variety of climatic environments and urban gradients, with the over-arching question of *how is the hydroecology linked to ecosystem services and processes across LTER sites?* Particular emphasis will be placed on determining water budgets, land-use changes and identifying important ecosystems services for each represented LTER site. Ultimately, the group would like to produce an article or white paper detailing the findings from the LNO- funded workshop.

9. **Carbon Storage and Flow across Ecosystem Boundaries**

Organizers: Jill Greiner (VCR), Dirk Koopmans (VCR), Jennie Rheuban (VCR), Talia Dibbell (VCR), Emily Adams (VCR)

Number Attending: 26

Working Group Description: First we held detailed introductions for all the attendees to state who they were, which LTER they worked at, and their research focus. We had a large variety of attendees across many LTER sites looking at ocean acidification, climate change, and land use conversion for biofuel production, among other environmental stressors. After the introductions, we described research at the VCR LTER site and our specific interests in carbon flow and storage across stream, marsh, lagoon, and barrier island systems.

We then opened up the discussion to the group in terms of any examples they might have at their sites, or even looking at one component of carbon storage or transport. As an example, one individual who was at Hubbard Brook was interested in above and belowground carbon storage to develop a carbon budget for the system. However, the contributor to this was not directly working on this project and was not able to elaborate much more on details.

At this point we decided to break up into 2 groups, one focusing on terrestrial carbon flow (about 8 people) and storage and another on marine carbon flow and storage (about 18 people). From the marine group, we discussed a lot of methods for measuring carbon or identifying the sources. Here people went around and discussed who their project related to the working group topic and brought up potential challenges in looking at carbon. We discussed a lot about looking at pH and oxygen in these systems (both water column and sediment) and the different methods to do this specifically at high resolution. One of the identified issues in creating carbon budgets, is measuring export of carbon from a system. The marine group discussed potential ways of measuring this by measuring seagrass wrack getting pushed off the lagoons, modeling, or even measuring small particulate organic carbon coming off kelp using mesh bags and filters. Lastly, the marine group discussed potentially issues relating to climate and land use change in our systems and how it could influence carbon transport and storage.

The terrestrial group focused our discussion on cross-site drivers of carbon respiration and photosynthetic production. We started discussing the effect of increased summertime high temperature on respiration rates in soils. While there are clear effects of higher temperature alone, we concluded that water availability would be critical in accounting for cross-site responses. Much of the annual respiration in arid ecosystems can be associated with storm events that bring the water needed by soil microbes to respire organic carbon. We continued our discussion on pulses and presses of organic or inorganic carbon between terrestrial and aquatic ecosystems, and the limited recognition of the importance of freshwater ecosystems in the degradation of terrestrially-derived organic matter. We finished up by picking an individual process that may be affected by climate change to discuss in more detail; the importance of extracellular enzymes in terrestrial systems and if they could contribute to carbon degradation in surface waters.

Lastly, both groups came together and gave a short presentation on topics discussed and problems that arose. Large scale climate and land use change was discussed as a global issue. Lastly, the idea of creating carbon budgets was brought up and what would we need to create these for an LTER site or even LTER region. The expertise of the individuals represented at the workshop, however, was limited with respect to components of carbon transfer or storage. This, along with the challenges of determining specific rates of carbon storage and transfer at individual sites due to site-specific conditions, limited our capacity for cross-site collaboration on the impact of climate change, for example, on carbon storage and flux.

Products from Working Group: The group was able to discuss different methods for measuring carbon and ways they might be able to improve their measurements with different instruments or methods. There was also a lot of interesting discussion on all the different projects that involve looking at carbon in some type of way. However, because of the large variety of what people were looking at and why, cross site collaboration was challenging to establish for this group. While no paper or proposal will come directly from this workshop, the attendees learned about site-specific challenges and methods for determining carbon storage and flux.