Patterns and Consequences of Shrub Encroachment across North America
Report from ASM 2006
(John M. Briggs and Alan K. Knapp)

The general goal of the workshop was to complete and extend our cross-site synthetic research begun in previous meetings supported by this x-site program. At the end of the workshop we decided to plan to host two additional workshops in order to (1) finish a manuscript based on our previous analysis of the ecological consequences of shrub expansion in grasslands and (2) to strategize regarding additional data collection needs to strengthen our synthetic database focused on LTER and non-LTER sites across North America. In our earlier proposal, we proposed to examine the impact of the expansion of shrubs and short-statured woody plants in grasslands and to determine if there are some general "rules" that are driving this catastrophic shift in ecosystems (e.g. linked to changes in disturbance regimes). As part of this synthetic work, we focused on the impacts of the shift in dominant growth form on the C budget of these ecosystems. We worked extensively with seven scientists this past year and plan to continue was has developed into a collegial and productive collaboration. Included in this group are Steve Archer (University of Arizona) who has a long history of working in shrublands of Texas and is now involved with the Santa Rita Experimental Range with its extensive history and data base associated with shrub expansion into grasslands, Scott Collins (SEV), Brent Ewers from the University of Wyoming, who is investigating the impact of fire on sagebrush steppe chronosequences in Wyoming, Debra Peters (JRD), Gus Shaver and Syndonia Bret-Harte, (ARC) and Donald Young (VCR).

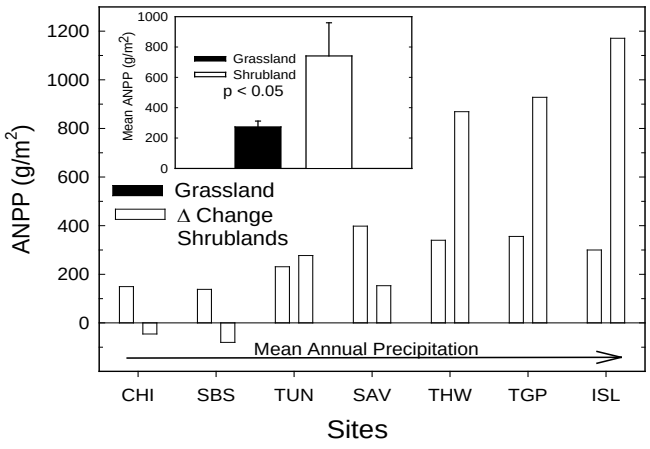

Fig.1. Patterns of ANPP in grasslands for each of the study sites and the response in ANPP (increase of decrease) to conversion to shrub dominance. Note that sites along the x-axis are ordered by increasing mean annual precipitation (MAP) and that the largest responses in ANPP occur in the most mesic sites. **Inset**: mean increase in aboveground net primary production (ANPP) over all sites with shrub encroachment into grasslands ($t = -2.42$, $d.f = 6$, $P = 0.05$). (CHI = SEV&JRN; SBS = Sage brush steppe; Wyoming; TUN= ARC; SAV = Savanna; Western OK, THW= Thorn woodland; Southern TX; TGP = KNZ; ISL = VCR)

Results from prior meetings. This working group has been productive in a number of ways. We were responsible for planning the science theme portion of the Fall 2005 CC meeting at VCR. In addition, based upon that meeting, this group was also responsible for organizing the 6th Annual LTER Symposium, *Building on the Legacy of LTER Research: Ecology for the Future* at the National Science Foundation, Washington, DC, on March 9, 2006. Both of those symposia were very successful.

We met at the SEV in February 2006 where we began building a database on the ecological consequences of shrub expansion into grasslands. Based upon those data, we have continued our work in smaller meetings this past year and held another face to face meeting at the ASM meeting. One tangible product is a manuscript that we will soon submit. This

manuscript examines the ecological consequences of shrub encroachment into grasslands at a continental scale (Alaska to Southern Texas; New Mexico to Virginia). We combined data from eight North America sites, each with intensively studied paired grass vs. shrub-dominated plots, and quantified responses in soil, plant community and ecosystem structure. Subsequently, we focused on the relationship between the 4-fold gradient in mean annual precipitation (MAP) and shrub-induced alterations in aboveground net primary production (ANPP), a key ecosystem process regulating C inputs (Fig. 1). Across this gradient, relatively small responses to shrub encroachment were evident in soil C and N, and these were unrelated to MAP. However, increased leaf area index (LAI) and leaf N content accompanied shrub encroachment across much of the US, with large reductions in herbaceous plant species richness noted in more mesic sites. We conclude that the conversion of grassland to shrubland globally will impact ecosystem C uptake unequally, and most strongly where resources are abundant.

At the ASM, we organized a workshop to more broadly examine the consequences of shrub expansion into grasslands. Over 30 participants from eight different LTER sites (and three non-LTER sites, including one international site) were in attendance and based upon a series of additional meetings at the ASM, it was decided to continue this working group. One part of the workshop involved the “core group” (mentioned above) to discuss the manuscript while the rest of the group broke out in a discussion group. The following is a report of the break out group from ASM 2006.

Working Group: Shrub expansion and dynamics across the L TER network: a cross-site synthesis of patterns, mechanisms and consequences convened 9/23/06

We had a lively discussion centered issues related to the current project (as presented by John Briggs in the introduction to the session) and the identification of possible future directions for the working group. The following represent the maior themes of our discussion.

1. All were interested in the **expansion of the current studies into other systems** that are also experiencing increases in shrubs. Notable systems mentioned included: other savanna systems, forested systems, high elevation treelines. This would allow the evaluation of whether there are common mechanisms across systems.
2. We suggest that future work examine the **drivers of change** in a more experimental framework with the particular goal of looking for common drivers of shrub response across the L TER. Why is shrub encroachment an issue across such disparate sites? Are there multiple drivers? What is the relative importance of different drivers? One driver that was repeatedly mentioned was climate change (temperature & C02). However, other drivers may include H20, N or disturbance (fire or grazing). A related question was what are the consequences for storage and fluxes of energy (heat flux/energy balance) and mass (carbon storage, carbon & water fluxes)? We also wondered about the role of past land use history, system age, and generally the contribution of longer term perspectives (e.g. any paleoecological records)?

3. We felt that there was a large gap in the current analysis and understanding because **belowground measurements** were not included. However, we also recognize that nothing is easy in the belowground realm. Suggestions here included: examining the soil microbial & fungal communities or using a LIDET approach for relatively simple cross-site comparisons (e.g. decomposition in shrub and no shrub, root cores, soil samples). Moving into the belowground realm may also involve the initial identification of what data exist on belowground processes in the study sites.
4. Several participants were interested in **species compositional shifts and changes in diversity** due to shrub encroachment. We noted that scale issues would make such comparisons difficult especially with an expanded set of systems.
5. There was a suggestion that shrub encroachment questions be posed in a **state change framework.**

Future products:

1. We all agreed that advancements of understanding would benefit from **new studies using standard methods** across sites. We were interested in the development of crosssite projects using common measures that may provide insight into common mechanisms, processes and effects of shrub encroachment. Suggestions included: root cores, microbial biomass, an other belowground measurements using Standard Soil Methods for Long- term Ecological Research published as part of the LTER/OUP series. There was also enthusiasm for a **cross-site manipulative experiment** although we recognized that such studies require substantial investments in time and money.

2. Related to the planning grant, we wondered about creating **network wide standards** for certain types of data that would facilitate future cross-site synthesis.

3. We were interested in the development of a **future workshop** to expand the scope of cross-site synthesis related to shrub encroachment and to discuss issues related above. We suggest the compilation of a list of everyone doing work on shrublands or shrubs and the kinds of research pursued. This would guide the exploration of an expansion of the group and the identification of other sites/investigators to invite to participate.

Rebecca Montgomery Frank Day Jackie Vick Jennie DeMarco Julie Naumann Brett McMillan Noemi Baquera Rod Simpson Selene Baez Laura Calabrese Isabel Ashton

Based upon our preliminary discussion at the ASM, it is believed that the next logical step will be to seek funding from an external funding source to conduct cross-site research at key sites. Funds are also requested for a follow-up meeting (Fall 2007) to write this proposal.

2006 – LTER ASM Workshop Participants

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