

## ***Interactive comment on “Testing functional trait-based mechanisms underpinning plant responses to grazing and linkages to ecosystem functioning in grasslands” by S. X. Zheng et al.***

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Point-to-Point Response

Reply to Reviewer #1

1. General comments: In this paper, the authors evaluate plant traits in grazed and ungrazed grassland sites in Inner Mongolia. This is the fourth paper using what seems to be the same data set to evaluate differences between grazed and ungrazed sites. In addition to analyzing the same data for this paper as was used in three previous papers, they borrow text from their previous papers for some of the sections of this paper. I had so many questions about the data and the presentation that I was not

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able to focus on the results. Much of the writing is very difficult to understand and requires substantial editing. The data from 6 sites were collected during an 18-day period in late July and early August 2007. According to data presented in Chen et al. (2011), 2007 was a relatively wet year. I raise this point because many of the plant traits Zheng et al. measured are sensitive to growing season conditions including SLA (Dwyer et al 2014). This means that data from a single growing season may not be representative of a general response especially since grasslands are characterized by a strong relationship between aboveground net primary production and annual and growing season precipitation (Huxman et al. 2004). While this does not negate the value of the data presented by Zheng et al., it is cause for a little circumspection in the interpretation of the results.

Reply: We appreciate these valuable comments and suggestions made by this reviewer. Actually, this is the third paper using the same data set to study plant responses to grazing. In the first paper (Zheng et al., 2010), we examined the effects of grazing on leaf traits (i.e. leaf area, leaf dry mass and specific leaf area) using a multi-organization-level approach. In the second paper (Zheng et al., 2012), we tested the effects of grazing on plant C: N: P stoichiometry. We also published a paper (Zheng et al., 2011) based on a long-term grazing experiment, which focused differential responses of two dominant species, *Leymus chinensis* (C3 perennial rhizome grass) and *Cleistogenes squarrosa* (C4 perennial bunchgrass) to grazing. In the revised manuscript, we have revised the sections that are similar to our previously published papers, in particular the Methods section, as suggested by the reviewer.

According to the data presented in Chen et al. (2011), 2007 was considered as a relatively wet year based on non-growing season precipitation from September 2006 to April 2007. However, if the growing season precipitation (from May to August) was also considered, the total precipitation from September 2006 to August 2007 was 295.8 mm. This means that 2007 was nearly a normal year compared with the long-term mean annual precipitation (330 mm) in the study area.

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We agree with the reviewer that data from a single growing season may not be representative of a general response in grasslands, which are primarily limited by water. In this study, nine functional traits of 276 plant species with 10-20 individuals for each species at each site were measured across six paired ungrazed and grazed sites during the peak growing season in 2007. It is really a labor cost work and difficult to conduct two or three years for temporally replicated measurements. To improve the generalization of the results, we reanalyzed the data along a continuous soil moisture gradient instead of discussing plant communities individually as suggested by the second and third reviewers, which may provide more general insights and implications on grassland ecosystems. We also revised Figures 2, 3, 4 and 5 and reorganized the Results section accordingly.

We agree that the original manuscript was not well organized and in some extent difficult to follow and unclear. Thus, we revised the entire manuscript by eliminating the redundant parts and improving the clarity of seemingly confusing places as suggested by the reviewer.

1. Zheng, S. X., Ren, H. Y., Lan, Z. C., Li, W. H., Wang, K. B., and Bai, Y. F.: Effects of grazing on leaf traits and ecosystem functioning in Inner Mongolia grasslands: scaling from species to community, *Biogeosciences*, 7, 1117-1132, 2010.

2. Zheng, S. X., Ren, H. Y., Li, W. H., and Lan, Z. C.: Scale-dependent effects of grazing on plant C: N: P stoichiometry and linkages to ecosystem functioning in the Inner Mongolia grassland, *PLoS One*, 7, e51750, 2012.

3. Zheng, S. X., Lan, Z. C., Li, W. H., Shao, R. X., Shan, Y. M., Wan, H. W., Taube, F., and Bai, Y. F.: Differential responses of plant functional trait to grazing between two contrasting dominant C3 and C4 species in a typical steppe of Inner Mongolia, China, *Plant Soil*, 340, 141-155, 2011.

4. Chen, Q., Hooper, D. U., and Lin, S.: Shifts in species composition constrain restoration of overgrazed grassland using nitrogen fertilization in Inner Mongolian steppe,

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China, *PLoS One*, 6, e16909, 2011.

2. Comments: I also have concerns about their interpretation of what they refer to as field hold capacity because water availability is such an important driver of ecosystem responses in grasslands. It would be clearer if they used "water holding capacity" or "field capacity" to refer to this variable, but that is not the issue I am concerned about. They claim, on page 13167, line 6, that " : :field hold capacity (F, an indicator of soil moisture): : :". It is only an indicator of potential of a soil to hold water against the pull of gravity. It only represents soil moisture in environments that are wet enough to fill the soil to capacity and the Inner Mongolian grasslands with annual precipitation between 300 and 400 mm do not qualify. Although I suspect that their meadow, with the highest water holding capacity, receives water inputs in addition to precipitation, such as run-on or from a shallow water table. Besides the high water holding capacity, the high soil carbon value (12%) in Table 1 suggests subsidized net primary production. This brings up a correction that must be made to Table 1 and throughout the text - the Walkley-Black dichromate oxidation method provides an estimate of total soil carbon not soil organic matter as it is referred to in the text.

Reply: We agree with the reviewer that, as also pointed out by the second and third reviewers, field holding capacity may not be an appropriate proxy of soil moisture in the Inner Mongolian grasslands. Thus, we directly used the soil moisture instead of field holding capacity as a continuous variable, and the results in Figures 2, 3, 4, 5 were presented along the soil moisture gradient in the revised manuscript.

In this study, the six plant communities are subjected to similar climatic conditions (i.e. temperature and precipitation), but they differ in soil moisture and other soil properties (e.g. soil organic carbon and nitrogen contents). This is mainly caused by topography-controlled wind and water erosion and deposition processes (Hoffmann et al. 2008; Kölbl et al. 2011). We have revised the text accordingly.

We agree that the Walkley-Black dichromate oxidation method provides an estimate of

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total soil organic carbon (SOC), and soil organic matter (SOM) was calculated as soil carbon multiplied by 1.724 (a constant) in this study. We have corrected the Table 1 and throughout the text as suggested by the reviewer.

Hoffmann, C., Funk, R., Wieland, R., Li, Y., and Sommer, M.: Effects of grazing and topography on dust flux and deposition in the Xilingele grassland, Inner Mongolia, *J. Arid Environ.*, 72, 792-807, 2008.

Kölbl, A., Steffens, M., Wiesmeier, M., Hoffmann, C., Funk, R., Krümmelbein, J., Reszkowska, A., Zhao, Y., Peth, S., Horn, R., Giese, M., and Kögel-Knabner, I.: Grazing changes topography-controlled topsoil properties and their interaction on different spatial scales in a semi-arid grassland of Inner Mongolia, P.R. China, *Plant Soil*, 340, 35-58, doi: 10.1007/s11104-010-0473-4, 2011.

3. Comments: A statement in the text that needs to be clarified to facilitate evaluation of the results is the sentence "In contrast, the grazed sites, located outside the fence of ungrazed sites, have been managed as free grazing pasture (mainly by sheep) since 1950s, thus they have about 60 years of grazing history (Zheng et al., 2010)." I found the Zheng et al. (2010) paper and it provided no additional information. In fact, here is what it says on the issue "The grazed sites, located outside the fence of the ungrazed sites, have been managed as free grazing pasture (mainly by sheep) since 1950s, thus they have about 60 years of grazing history." I also found a PLoS One paper entitled "Scale-Dependent Effects of Grazing on Plant C: N: P Stoichiometry and Linkages to Ecosystem Functioning in the Inner Mongolia Grassland." Here is the sentence it used to describe the grazed sites "In contrast, the grazed sites, located outside the fence of ungrazed sites, have been managed as free grazing pasture (mainly by sheep) since 1950s, thus they have about 60 years of grazing history." The issue of whether all sites were grazed by sheep or if cattle or another large herbivore grazed some of them is unresolved. The effects of different species of grazers can be large and account for some of the differences observed among sites.

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Reply: Great point. We agree that the effects of different species of grazers on plant community structure and composition differ substantially. In our study area, sheep grazing has been the dominant form of land use practices since 1950s. Seventy-eight to ninety-one percent of the total livestock numbers was composed of sheep, with numbers of cattle accounting for 5-9% and horses accounting for 2-13% of the total livestock numbers (The Economics Department of Inner Mongolia University and Baiyinxile Pasture, 1993). We have added this information in the revised manuscript.

The Economics Department of Inner Mongolia University and Baiyinxile Pasture: The strategy and planning for the social and economic development of Baiyinxile pasture, Inner Mongolia University Press, Huhhot, 1993.

4. Comments: Now I want to return to the issue of the generality of these results. We know that grasslands are characterized by year-to-year fluctuations mostly in response to variability in precipitation (Noy-Meir 1975). A single year's data is a sample from a distribution of responses each associated with an amount and seasonal distribution of precipitation. While we often learn interesting things from individual year's responses, they do not provide a sound basis for making generalizations. In my opinion, Zheng et al. make too many unwarranted generalizations in this manuscript. For instance, the first sentence of section 4.5 "Our findings have important implications for understanding ecosystem structure and functioning and managing arid and semiarid grasslands." They go on to generalize about responses of arid and semiarid grasslands to global change much if not all of which seems unwarranted.

Reply: We appreciate the critical comments made by the reviewer. We agree that it is difficult to provide a sound basis for making generalizations based on a single year's data. To improve the generality of the results, we used the soil moisture gradient as a continuous variable instead of discussing communities individually in Figures 2, 3, 4 and 5 as suggested by the second and third reviewers, which may provide more general insights and implications on grassland ecosystems. We also revised the implications as per suggested by the reviewer.

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For the detailed changes we have made, please see the supplement files that includes (1) reply to Reviewer #1, (2) revised manuscript, and (3) revised supplementary material.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/11/C8586/2015/bgd-11-C8586-2015-supplement.zip>

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Interactive comment on Biogeosciences Discuss., 11, 13157, 2014.

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