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Biogeosciences Discussions

Interactive comment on "Algal diversity of temperate biological soil crusts depends on land use intensity and affects phosphorus biogeochemical cycling" *by* Karin Glaser et al.

Anonymous Referee #2

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The goal of the presented study was to describe and characterize a biological soil crust that occurs in a temperate forest in Germany (p3. L 3). This was done by assessing the species composition and evaluating the effects of the crust on the soil chemistry (C;N;P). In a second step effects of land use on the number of algal species of this crust was examined. The study is well written and might represent a new and interesting contribution. Nevertheless, there are some major drawbacks, which should be considered before publication.

1.) Definition of BSC in forests

This is a critical topic in this manuscript because the authors do not provide enough

explanations here. In the classic BSC literature, a BSC is found in " regions where water availability limits vascular plant cover" (Belnap, Weber, Büdel 2016) or "in arid and semiarid lands throughout the world, where the cover of vegetation is sparse or absent" (Belnap and Lange 2003). Both definitions are taken from the exactly cited works as given in the introduction. In the present study, the authors examine a crust from a temperate forest which contradicts this definition. A temperate forest is a habitat with a dense vegetation cover and a biome characterized by a mean precipitation between 750 and 1500 mm. This sets the presented study into a critical position for two reasons. First, because the authors do not indicate this strong discrepancy between the classical BSC definition and their own approach and explain why they still aim to refer to a BSC in this context. Secondly, because there is a vast number of publications handling effects of land use on forest understory vegetation as well as microflora and –fauna that is not considered in the discussion. It is a recent trend in BSC literature that more and more BSC are found and described in humid and forest ecosystems and I would, therefore, like to encourage to authors to critically discuss this point here, especially because this publication is part of a special issue about BSC. This study provides a chance to introduce BSC in this ecosystem if the authors try to catch up on this point and explain carefully. Statements, like given in P2l7 or P2l17 about the lack of information regarding temperate forest BSC, might just be a result from a limited literature search that focused only on BSC and not on studies regarding understory community assemblies in temperate forests. Nevertheless, as it stands now I cannot see the difference between the studies on understory forest vegetation and the presented study. In this context, the study would clearly benefit from pictures showing this crust type and how it is assembled.

2.) Diversity

According to the title, algal diversity was evaluated in this study but I wonder why this terminology was used here. Species diversity consists of three components: species richness, taxonomic or phylogenetic diversity and species evenness. With these pa-

rameters, diversity or diversity indices can be calculated. In the given study the authors provide species richness and frequency data and I think it would be more precise to refer to these (or species composition) throughout the text, rather than to diversity or even biodiversity, which wasn't studied here. The terminology should be consistent throughout the text.

(examples of the used terminology in the manuscript: diversity, biodiversity, alga richness, algal richness, community composition of alga, richness of alga, algal species richness, algal biodiversity, biodiversity of microalgae and cyanobacteria)

3.) Phosphrous biogeochemical cycling

The title promises information about phosphorus biogeochemical cycling and in the introduction, the authors state that "the effect of BSC algal biodiversity on C, N, and P content, in particular on the different fractions of P was assessed". Nonetheless, different P proportions are not shown but taken from a previous study from the authors, that is cited very often throughout the article. The only data given here are C, N, and P contents for n=19 samples which seems to be a little database for the conclusions drawn. I also wonder about the statistical test that was chosen to interpret the results, because correlation does not imply causation and the authors should be careful with interpreting their results in such a broad way.

4.) Land use intensity

Land use intensity was approximated by applying the silvicultural management index. This was determined for each study site. In table 3 it is given that SMI affects algal richness with 30,5% and the proportion of filamentous algae with 37.7%. It is stated in p 6 L 13 that higher SMI resulted in higher species richness given in Figure 2. Figure 2 represents a pie chart with mean phylum numbers of all plots. So I assume Figure 4 should show this. This graph is difficult to understand. The caption needs to be improved and explain what the symbols show. I assume these are the different forest stands and the correlation was pooled stand independently? (So why include

this information?). What was the correlation index? Where is the information about coccal algae that is given in the text? What does "richness of algae" mean? From the discussion it becomes clear that SMI basically effects the BSC composition via tree density, thus shading and light availability. Therefore, it is critical to refer to land use in this context. The authors need to define how they expect SMI to affect the BSC directly or explain the SMI was used as a proxy for tree stand density.

Additional comments: - P1l10: What do you mean with disturbed areas - P1l20: This study only examined samples from one specific area, though it's tough to generalise this finding to all temperate forests - P1l24: Please explain what mechanisms you expect to drive this relationship. Why would a higher algal species richness lead to a more closed P cycle? - P2l2: Please give exact citations on the distributions/occurrences of BSC in temperate habitats - P2l11: richness of BSC organisms? - P2l22: Elbert et al. 2012 does not distinguish between different crust components and instead pools information from all photoautotrophs in cryptogamic covers. Please find an adequate citation for your statement. - P2l24: please provide a precise citation for this statement. - P3l6: this information is irrelevant here - P3l13: which plots were these? - P3l16: what is a microecosystem? - P4l2-8: I wonder whether this cultivation technique does not influence the species assembly because some species might be excluded and others overestimated. - P4l16-18: how were the frequency data gained? How were the 'proportion' data generated? - P4l25: is richness here the total species number? - P5l3: alga richness? Did you exclude the Cyanobacteria? - P4l7: specify community composition of algae - P10l4: This statement about the moss protonema is surprising because this was not studied here and just occurred as a side note in the discussion. Why is this included in the conclusion? - P10l8: A citation of a different study in the conclusion seems misplaced. Consider summarising the data presented here. - -Table 1: this can be provided in the supplement.

Examples of literature on the effects of land use on understory forest vegetation: Marshall, V. G. (2000). Impacts of forest harvesting on biological processes in northern

forest soils. Forest Ecology and Management, 133(1), 43-60. Staddon, W. J., Duchesne, L. C., & Trevors, J. T. (1996). Conservation of forest soil microbial diversity: the impact of fire and research needs. Environmental Reviews, 4(4), 267-275. Thomas, S. C., Halpern, C. B., Falk, D. A., Liguori, D. A., & Austin, K. A. (1999). Plant diversity in managed forests: understory responses to thinning and fertilization. Ecological applications, 9(3), 864-879. Decocq, G., Aubert, M., Dupont, F., Alard, D., Saguez, R., WATTEZâĂŘFRANGER, A. N. N. I. E., ... & Bardat, J. (2004). Plant diversity in a managed temperate deciduous forest: understorey response to two silvicultural systems. Journal of Applied Ecology, 41(6), 1065-1079. Barbier, S., Gosselin, F., & Balandier, P. (2008). Influence of tree species on understory vegetation diversity and mechanisms involvedâĂŤa critical review for temperate and boreal forests. Forest ecology and management, 254(1), 1-15.

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