

Interactive comment on “Understory vegetation relationships with soil element contents in a northern boreal forest ecosystem near a phosphate massif” by Laura Matkala et al.

Anonymous Referee #2

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General comments

Matkala et al propose a study of the relationships between vegetation community structure and leaf elemental composition, and environmental factors in a northern forest ecosystem of Finland. In line with the recent literature raising the fact that P availability can also be a strong driver of vegetation growth in northern ecosystems, the authors put a stress on total N and P contents in humus and soil layers. They justify this study by the need to establish a baseline status of the ecosystem before potential disturbance that may arise due to possible P mining in the region. It seems the authors want to assess if understory vegetation community composition can predict the ecosystem

C1

nutrient status to help developing a rather low cost monitoring but this is not developed further in the discussion.

The authors collected a substantial amount of data that should contribute to address their objectives. However, I have several concerns about the formulation of objectives, result analysis and discussion. In particular, both the text and the presentation of the results could be shortened and simplified, notably by focusing on clear objectives. This would help the reader to faster understand what the authors did exactly, and the reasoning leading to their conclusions.

To my opinion, this study has the potential to address important questions that falls well within the scope of *Biogeosciences*; however, the present manuscript requires a thorough revision before publication.

Specific comments

Title: rephrase; “understory vegetation” is not precise, that are the species composition and abundance that were studied. Why to focus on the understory since the tree cover was also studied? You could also focus on what you consider as your main result, for example “Soil total P explains vegetation community composition in a northern boreal forest ecosystem”.

Abstract: needs a sentence on sampling design (the way the relationship were addressed)... In the present case, the reader have no idea what the “plots” refer to and what to conclude from that information. Here and in the materials and methods section, you need to state clearly that you described vegetation, and sampled tree leaves and soil, at different distances from the P ore. Revise this abstract after clarifying the objectives and re-analyzing/discussing the results.

Introduction: could be simplified and shortened. Also needs to better formulate the objective(s) and hypotheses, and/or to provide all the information that lead to such hypotheses. In particular, it is not very clear why the hypotheses focus on the humus layer.

C2

By comparing the title, abstract and introduction, it is not clear if the objective is finally (1) to explain the understory species composition and abundance with environmental parameters, and particularly soil total P content, or (2) to predict soil/environment nutrient status by surveying understory vegetation. One option should be chosen and the whole article built around.

Material and methods: The site selection process is not clear; in particular, what is the basis for selecting those transects? I did not get if there is any gradient, for example. Are all the study sites located at a similar elevation with similar climate conditions? As the study sites were located on different geological units (Fig. 1), did the authors try to include such factor in their analysis? Do we know anything about the P contents of those rocks? Are these rocks essential parent material for the soils developed at the sites? Any idea of the age/development stage of the soils? Are all the soils studied haplic podzols? As for the statistical analyses, it seems the forest stand composition could be better taken into account by accounting for the species % of volume or by grouping sites according to their dominant species. As raised by reviewer 1, stand age could also be a confounding factor. I think the authors could try to better explain the variations they observe in soil values. Also, why did the authors focus on the elemental contents of the O horizon (humus) in their analysis? Do we have an idea of the distribution of fine roots (and vegetation uptake zone) in the soil profile? The use of understory species is interesting, would it be possible to go further by narrowing down the number of species, by detecting indicator species (of the P status for example), and building a “simple” prediction model?

Results: I feel some results are not presented in the way that best help to address the questions of interest. I think in particular about the Fig. 3 and 4 or Table A2–A4, where we don’t have any clue about what could lead the variability and differences (forest stand composition? rock parent material? other?).

Discussion: The authors have put honorable efforts in comparing the data they obtained with known ranges of values for similar areas published in the literature. How-

C3

ever, this part of the discussion could be better synthesized and written in a simpler and shorter style. The discussion lacks development on the results obtained in regard to the objectives of the study. What is the functional significance of these results? When focusing on key results, the Fig. and/or Tables where they are presented should be reminded to help the reader.

Conclusions: potentially revise according to modifications in the introduction and discussion.

Technical corrections

Whole text: refer to Fig., Tables, and Appendix when appropriated, and order and number them following their first apparition in the text.

p. 1, l. 8: “We studied the relationship of forest understory vegetation with nutrient contents of soil and tree leaves...”: write something which fits with your objectives and title. Again, “understory vegetation” is not precise, add “species composition and abundance”, which appears only at l. 12–13.

p. 1, l. 9–10: add a comma: “At most study plots, boreal...”

p. 1, l. 11–12: here and elsewhere, change “abundance and species composition of the vegetation” to “species composition and abundance of the understory vegetation”.

p. 1, l. 13–14: what is the information you want to raise?

p. 1, l. 19: some fixes: “... controlling the **species** compositions of tree **stand** and understory...”

p. 1, l. 21: what do you mean by “modified”? I would rather say that those ecosystems are “characteristically cold, have a short growing season, and are nutrient-poor”.

p. 1, l. 21–22: “affects” is not precise, and the sentence could be shorter and simpler. Suggestion: “Organic matter decomposition and nutrient release are usually slow in cold climates”.

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- p. 1, l. 22–24: not very informative.
- p. 1, l. 25: change “tree species affect” by “tree cover affects”, unless you want to precise “different tree species affect differently understory...” (if this fits to the references cited).
- p. 1, l. 26: again, “understory vegetation” is not precise, which parameters? Focus on what you study here (i.e. species composition and abundance).
- p. 1, l. 27: “litterfall” is sufficient since it also includes branches, etc.
- p. 1, l. 29: N and P “are generally the **main** growth-limiting nutrients...”
- p. 1, l. 29–p. 2, l. 16: this whole paragraph convey interesting information but is not enough focused for the present study. It can be shortened and simplified by synthesizing the main ideas.
- p. 2, l. 3–4: useless information. In the context of vegetation growth, available N mostly derives from organic matter decomposition (unless the plant is a N-fixer), and available P both from weathering and organic matter decomposition.
- p. 2, l. 4–6: not necessary in the context of this article.
- p. 2, l. 8–9: N–P interaction is a bit cryptic (is that a statistical term?), can you say something more functional? I think the idea is that the coupling between the N and P cycles drives nutrient limitation.
- p. 2, l. 11: move the comma: “In boreal N-limited forests, ...”
- p. 2, l. 18: replace “soil nutrients” by “soil nutrient content” or “soil total N and P”.
- p. 2, l. 27–31: this is not related to your study and could be considered as a confounding factor hindering potential interesting relations. Move the information to the material and methods, and state clearly that you assume reindeer pressure (grazing, trampling, but also nutrient exports or inputs) is not such a confounding factor for this study. Of course,

C5

it has to be the case! Did you evaluate somehow the reindeer pressure at your study sites? How? Was it important? Was it typical for the region? Was it constant across sites?

p. 2, l. 32: what do you mean by “undisturbed”? The current (steady) state? A baseline status?

End of the introduction: rephrase and clarify objective(s).

p. 3, l. 1: move this (= method) after the effects of mining.

p. 3, l. 3–4: too much! Focus on mining and keep reindeer and/or climate change for an opening in the discussion. Other option: start the last paragraph of the intro saying that several disturbances such as mining, grazing (is there a change in grazing in the region? why?), and climate change could affect nutrient status of the ecosystem and you aim at establishing a baseline to monitor the effects of those disturbances. In that case, keep something on reindeer and/or add something on climate change, but keep it short and focused (effects on nutrient status of ecosystem).

p. 3, l. 4–5: simplify and shorten! It is not very clear why you did this... Did you want to establish a relatively simple and cheap protocol of monitoring? For example, surveys of key understory species abundance that would be indicative of the ecosystem nutrient status?

p. 3, l. 6–7: this sentence does not justify these hypotheses. Delete and replace by something like “We hypothesized: a)... b)...”, and move that at the end of the preceding paragraph.

p. 3, l. 9–11: are these hypotheses justified with the preceding text of the introduction? Do they really relate to the objective? Why to focus suddenly on “humus”? I feel some pieces of the reasoning are missing.

p. 3, l. 11: wouldn't it be rather the humus layer that reflects the nutrient content of the leaves? Unless you assume most of the tree uptake occurs in this layer.

C6

- p. 3, l. 14: what are these transects? Are they organized along a gradient? Which one? It seems on the map that it would be the distance to the carbonatite massif.
- p. 3, l. 15: "No plots were located inside the mining district", why?
- p. 3, l. 19: needs reference, but isn't that what you want to study? Consider moving this info to the discussion.
- p. 3, l. 22: start the sentence with "Thus,"
- p. 3, l. 23–24: delete ", but they were not on any Natura area".
- p. 3, l. 26: what is the gradient?
- p. 3, l. 32: add a comma after "5°C".
- p. 4, l. 1: change subsection title to "Plot setup and vegetation characterization".
- p. 4, l. 5: change subsection title to "Sampling of soil".
- p. 4, l. 6–10: move this to the preceding section.
- p. 4, l. 6: cite Table 3 and add to the table tree height and diameter info.
- p. 4, l. 7: precise "cover (% **surface area**)".
- p. 4, l. 8: cite appendix C.
- p. 4, l. 10: add comma after "Altogether".
- p. 4, l. 11: provide diameter of the soil corer.
- p. 4, l. 11: change to "The soil was sampled within one meter from the subplots".
- p. 4, l. 12: change "The samples" to "The soil cores".
- p. 4, l. 14–15: simplify and shorten.
- p. 4, l. 16: remove "already".

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- p. 4, l. 18: remove "samples from".
- p. 4, l. 20–21: two first sentences useless, delete and add "2015" after "September" in the third sentence.
- p. 4, l. 30: remove ", totalling of 100 leaves per plot".
- p. 5, l. 2: replace "in a similar way than needles" by "at 65°C for 48 h".
- p. 5, l. 2: concretely, how did you clean the leaves? With a brush? Deionized water? Other?
- p. 5, l. 11: fix: "two to three mg of sample **were**..."
- p. 5, l. 11: "VarioMax analyser" is a machine, what is the method behind?
- p. 5, l. 12: idem, replace "MilliQ water" by "ultrapure water".
- p. 5, l. 21: "Ordination pattern of the study plots and weighted averages of plant species", not clear, I thought you ordinated the weighted averages.
- p. 5, l. 23: state why you did not present results for dim 2 vs dim 3.
- p. 5, l. 24: "some other environmental variables", list them.
- p. 6, l. 5: "... imply rather high variation between and within plots", isn't that what you want to study? Maybe a deeper analysis, including tree species, forest stand age, and/or geology could help explaining a bit the variability observed.
- p. 6, l. 5–6: "Other soil elements...", precise which ones or delete the sentence.
- p. 6, l. 11–12: the higher P content in young needles may indicate reallocation processes, which could be discussed shortly in regard to P availability for example.
- p. 6, l. 12: replace "Unlike the expectations" by "Unlike **our** expectations".
- p. 6, l. 15–23: refer to the Table or Fig. these informations are presented (if you go back to Table 2 after referring to Table B2, for example).

C8

- p. 6, l. 19: replace “discovered” by “detected”.
- p. 6, l. 22: “Çyumber of species”, is this a good variable for your objectives? Could the total % cover of different species groups (the ones of Fig. 5, for example) be more informative?
- p. 6, l. 27: how do you define the left and right sides of the plots? Is there a threshold or is this empirical?
- p. 6, l. 28: do you mean Fig. 6b? Or 6a–b?
- p. 6, l. 30: no need to cite Table 3 here.
- p. 7, l. 10: Start the paragraph by citing the Fig.: “In Fig. 7c–d, ...”
- p. 7, l. 18: did you analyze soil samples by plot or by cluster? Did you quantify both within- and between-plot variabilities?
- p. 7, l. 19: refer to Fig. 3 where the soil P contents are presented. Also, this is a huge variability: is mainly due to between- or within-plot variation? If this is between plots, you might be able to explain it somehow by additional exploration of environmental factors, but if it is within plot there is no hope tree species will help, for example...
- p. 7, l. 24: “implying that decaying plant parts were a major source of P”, for what? The soil organic layers or plants?
- p. 7, l. 24–27: would it be possible to find a pattern of P content in the deep soil layers according to the soil rock parent material/geology? Do you think that high P content in the humus layer is important for plant nutrition (recycling) or is that just high litter production coupled with slow decomposition rates?
- p. 7, l. 28: what is the context of the study by Köster et al (2014)?
- p. 8, l. 2: and so? Can you say something concrete for your study area?
- p. 8, l. 4: replace “similar than” by “similar to”.

C9

- p. 8, l. 18–19: Which analysis/which Fig. or Table? Table 4? But is it species richness or ordination pattern which was regressed? What do you mean exactly by “species richness”? The number of species?
- p. 8, l. 19–20 and l. 30: which soil layer(s) are you considering? The hypotheses were about humus.
- p. 8, l. 32–p. 9, l. 2: “needles were sampled at different time of year than soil...”, this should be mentioned in, and even might only be part of, the materials and method section. If you sampled the needle at a right moment, it should be quite integrative of nutrient availability across the growing season.
- p. 9, l. 4–8: why not such an opening but right now it is not well connected to what precedes. You could also talk about the coupling between N and P cycles and how this could be affected by climate change or disturbances and in turn affect ecosystem status and processes.
- p. 9, l. 6: “variation in the vegetation”, be more precise (which parameter, sense of variation).
- p. 9, l. 10 and 17: “vegetation dynamics”, this is not what you study here, change to “vegetation community composition” or something like that.
- p. 9, l. 12: change “has been discovered” to “was found”.
- Fig. 2: draw or remind in the title where tree cover was described.
- Fig. 3: would it be possible to also represent tree cover species (or different groups based on dominant species)? or age? or geology? Is this graph representing between-plot variability (i.e. you first calculated the mean for each plot and made the boxplots with those means) or a mix between within- and between-plot variability (i.e. you took all sub-plots values to make the boxplot)? It would be interesting to compare between- and within-plot variabilities.

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Fig. 4: same comments as for Fig. 3.

Fig. 5: What is the correlation coefficient calculated? (Pearson? Other?) Precise what is the “bottom layer”. Why not to call this layer “moss lichen”? It would be clearer.

Fig. 6: what is the criteria to define “the most abundant species”?

Fig. 6, l. 8: replace “generic” by “genera”. Start the last sentence of the figure legend by “In (a),”

Fig. 7: remind which soil layer was considered for this analysis (I am assuming it's O).

Table 1: “degree days”, shouldn't that be called “sum of degree days”? What is the unit?

Table 2: the classical ordering would be C, N, P, K, C:N, N:P. For numbers (mean and sd), provide the same number of digits after the dot for each column (one is enough) and align the numbers to the right to ease comparison of lines. Why not to put K in the same unit as the others?

Table 3: did you estimate the whole aerial volume of trees or just the trunk volume? Make three sub-columns for each species abundance. Add in this table tree height, diameter,...

Table 4: remind the first seven lines are soil values.

Tables A2–A4: From which statistical test are these table issued? These tables hardly help to address your objectives.

Table B1: title: change to “Statistically significant differences between needle age group by species”. From which test?

Appendix C: precise “(% of surface area)”.

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