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Dr. Paul C. Stoy
Associate Editor
Biogeosciences
European Geosciences Union

Dear Editor,

Please find attached our revised manuscript entitled **"Response of vegetation and carbon fluxes to brown lemming herbivory in Northern Alaska"** *for publication in your journal.*

We would like to thank you and the referees again for the great feedback. We include below point-by-point responses to the referees' technical corrections (with line numbers for the manuscript with track-changes off). We hope that with these corrections you will find our manuscript appropriate for publication in your journal.

Best Regards,
Jessica Plein

Department of Biology
San Diego State University

Referee Technical Corrections:

47: Few rodent species persist throughout the Arctic. Lemmings are by far the most abundant and widespread and are consequently identified as a keystone species in tundra environments (Krebs 2011). ***Current wording contains confusing negatives*****.**

We changed this wording to: "Throughout the Arctic, lemmings are by far the most abundant and widespread rodent species, and are identified as keystone species in tundra environments (Krebs, 2011)" (lines 43-44).

65: Somewhat awkward phrasing that makes the reader search for what the 'gap' in question is (carbon cycling). Could consider rephrasing this sentence to be more clear, e.g. "The current body of literature does not explore lemming impacts on carbon cycling, leaving a crucial gap in our understanding of how one of the main herbivores influences this rapidly changing ecosystem especially in light of Arctic warming."

We changed the phrasing to: "The current body of literature does not explore the direct impact of lemming presence on carbon cycling and vegetation recovery, leaving a crucial gap in our understanding of how one of the main herbivores influences this rapidly changing ecosystem, especially in light of Arctic warming" (lines 59-61).

70: would suggest changing "the disturbance" to "herbivory" or "targeted herbivory" because the authors suggest in their response to reviewers that the level of herbivory experienced in the enclosures is normal. "Disturbance" suggests a treatment effect that is above normal or what the enclosed areas would experience without the experiment.

We changed this wording, as suggested (lines 65, 67).

76: remove "their" – currently it implies the lemmings are recovering, not the vegetation

We removed "their" (line 71).

79: we measured what in the plots? Suggest: "…, we measured vegetation in the plots again to evaluate vegetation recovery from grazing"

We specified that vegetation was measured (line 74).

88-92: some issues with tense here, as previously the authors used exclusively past tense. Suggest changing here or committing to present tense elsewhere, and double-checking for consistency throughout. Additionally, line 88 seems to be leftover from a previous draft? I think this part is meant to include only line 89 on.

The tense was changed to past tense for consistency with the rest of the manuscript (lines 81-84). The line 88 referenced by the referee was a line we removed but was not showing as removed in the PDF version including the track-changes.

104: I still really love this figure. Too few of these kinds of papers include some vivid photographs of the experimental setup, and it's so helpful!

Thank you for your feedback on this! We want readers to be able to easily visualize the experimental setup.

132: this seems like an example of the previous sentence, so "additionally" feels like an awkward word choice. Perhaps, "to wit,", or "for example,", etc.?

We changed "additionally" to "to wit" (line 113).

149-152: repeated paragraph? Delete

This paragraph does not repeat in the version with track-changes off, but was not showing as such in the PDF version including the track-changes.

168: suggest "for inclusion in the experiment". Current phrasing is a bit confusing, implies the lemmings were immediately placed in the enclosures.

We changed this phrasing, as suggested (line 144).

172-173: confusing phrasing. Suggest: "Each plot contained different vegetation types (mosses, lichens, graminoids, and wet sedges) and each pair was ensured to be as similar in composition as possible…"

We modified the phrasing to improve clarity, as suggested (lines 148-150).

175-176: order of phrasing here is confusing. Suggest merging these two sentences. "We placed control plots within 1m of their paired lemming plot to keep environmental factors as similar as possible within pairs; we located each pair of plots approximately 3m away from each other."

We merged the two sentences to improve clarity, as suggested (lines 151-153).

206: this table is great! Really makes the sampling timeline clear, and what the authors measured. Very much appreciate this addition and think it adds a lot.

We agree that this table was a great suggestion and addition to the manuscript!

232: would be helpful to use consistent phrasing to describe each summer. "following" and "subsequent" seem like two different summers despite both being 2019. I suggest using "…before and after the the first summer's manipulations (2018) as previously described and to track the seasonal development of NEE during the second summer (2019). In the second summer, we used a …"

We modified the phrasing, as suggested by the referee (lines 204-206).

406, 407: remove these lines (repeats the following line)

These lines do not repeat in the version with track-changes off, but was not showing as such in the PDF version including the track-changes.

423-427: this paragraph seems like it should be placed in the same paragraph as the one above, preceding that text (e.g. placed at line 415 before the text that is currently there). In its current placement the information feels redundant even though the authors are discussing different data.

We moved the paragraph to the location recommended by the referee (lines 361-366).

452-456: these repeated lines seem like a formatting error but highlighting in any case

Yes, it appears the referee is correct about this being an error. These lines do not repeat in the version with track-changes off, but was not showing as such in the PDF version including the track-changes.

457-461: are the authors referring to changes to spatial effects on vegetation given the risk of predation and its impacts on lemming foraging behavior? I think this final paragraph could be fleshed out a tiny bit more; what kinds of changes to foraging behavior are they referring to and how would that change carbon storage/cycling? My first instinct is spatial changes in carbon cycling given changes to lemming foraging, but risk of predation could also cause more physiological changes to lemming populations that would indirectly affect carbon (see Hawlena and Schmitz work on fear effects on grasshopper behavior and physiology). But the long and short of it is that this final paragraph could use 1-2 specific examples of the kinds of proposed predator effects on carbon cycling re: effects on lemmings that the authors are discussing here (especially as they bring up predators in their conclusions, which otherwise don't occur in the body of the ms).

In the revised manuscript, we discussed in more details how we expect predators to affect the tundra carbon cycling (lines 394-403). Lemming populations may vary in response to regulation by predators (Fauteux et al., 2018b), and predation risk may change lemming physiological response and foraging behavior (Hawlena and Schmitz, 2010). In many terrestrial systems, indirect effects of predator presence on herbivores have been shown to have dramatic effects on vegetation consumption (Apfelbach et al., 2005; Borowski, 1998), with resulting behavioral changes rippling through the ecosystem (Ripple and Beschta, 2003). Given the substantial impact of lemming herbivory on the tundra carbon balance, indirect cues indicating predator presence may alter lemming behavior and thus vegetation. If predator cues elicit a fear response in the lemmings, therefore decreasing the time spent consuming vegetation, this change in behavior may decrease the severity of lemmings' impact on vegetation and carbon cycling, specifically their negative affect on CO_2 sequestration.
In addition to the experiment outlined in our manuscript, we also incorporated predator cues from major predators of lemmings in order to examine the potential for indirect effects of predators on herbivory rates (see supplementary materials). However, the sample size of our predator manipulation was too small given some logistical issues related to the data collection for this aspect of the experiment, so we suggest future studies to better quantify the influence of predator-prey interactions on herbivory, and how they further impact vegetation and carbon fluxes in the Arctic tundra.

475: replace "the" with "carbon"

We replaced the word choice, as recommended (line 417).

<u>TAKEAWAY:</u>
The reading of the manuscript has improved greatly with the inclusion of the reviewers' comments. I appreciate the efforts the authors have made and the changes asked for, and think that the final product is clearer, more "punchy", and that the substantial research summarized therein is highlighted much more effectively. The above line edits are, for the most part, minor, with the exception of my one comment on adding a few sentences to the discussion (lines 457-461, highlighted in green for ease). I commend the

authors on the work they have done, and am happy to recommend the paper to be accepted with technical corrections and handed over to the journal's editors for that work with the authors.

We thank the referee for their very helpful comments and detailed suggestions. We agree the manuscript is much stronger with the inclusion of the referee feedback, and appreciate the recommendation of the paper.