<u>Responses to the referee's concluding notes at the bottom of the final page:</u>

"I enjoyed reading this immensely, as I think it's a really cool experimental setup. My comments refer mostly to the framing of the write-up as I think the strength of the experimental design is not currently shining through as well as it could given how cool I personally took it to be! I would suggest that the authors re-frame the paper to exploring the LEGACY effects of heavy lemming herbivory, by quantifying what 'normal' herbivory is in the site and how much more herbivory the experimental enclosures experienced over 16 days (perhaps using the existing NDVI data) to demonstrate the difference. The interpretation and discussion could then probe the circumstances in which such heavy herbivory could occur (e.g. climate-change-induced lengthening of snow-free time; loss of predation; an eruption in lemming population size; etc.) and the resilience of the ecosystem in terms of its recovery after such an event."

Since lemming populations are very cyclic in nature and vary with multiple environmental factors, their densities oscillate (Fauteux et al., 2015; Soininen et al., 2017) and make predicting a sort of 'normal' level of herbivory very challenging. Reports on estimated brown lemming density have found their local density to range from 5 to 65 lemmings per hectare (Ott and Currier, 2012; Alaskan Arctic) and about 0 to 9 lemmings per hectare (Fauteux et al., 2015; Canadian Arctic). However, as mentioned in our manuscript, the use of live-trapping as a technique to estimate density for this species may underestimate the actual density size, as brown lemmings are not readily captured using baited traps; we found manual capture techniques to be much more effective than baited traps. Moreover, in addition to space, it is important to consider time: we only kept lemmings inside the plots for 16 hours and there was no effect of lemming herbivory for any of the remaining time. The best comparison we could find to define the degree of herbivory was the observed effect on vegetation near their burrows and runways in published studies from similar ecosystems (Erlinge et al., 2011). Given this, it is extremely difficult to define the difference between 'normal' and 'heavy' herbivory. We agree that separating the effect of normal and heavy legacy effects is very important, but would be extremely difficult with current available data from these understudied Arctic ecosystems. In the revised manuscript, we will include a more careful discussion of this important point, and discuss the issues related to defining the population size and the degrees of herbivory.

"important to define the variables you measured/refer, as well as the timeline of your experiment, to very specifically in a table or list (see in-line comments)"

We will specify in more details the types of measurements collected during each summer in the revised manuscript. A summary of these measurements is included below:

	Data Collected	**Frequency of Measurement**
Summer 2018	CO_2 (NEE) and CH_4 fluxes, NDVI, air temperature, soil temperature, soil moisture, thaw depth, motion camera footage	Before and after lemming treatment
Summer 2019	CO_2 (NEE, ER, GPP) and CH_4 fluxes, NDVI, air temperature, soil temperature, soil moisture, thaw depth	Pre-, early, peak growing season

"what are you referring to when you refer to carbon uptake? I suspect it will be important to define it for reader. and, when you conclude in discussion that lemming herbivory negatively impacted the sites' ability to sequester carbon, do you mean as aboveground biomass/belowground biomass/belowground deposition of sugars/increased soil microbial respiration/decomposition of root biomass after tops are eaten? Which of these factors is that that is increasing carbon flux, and why do you posit so?"

Carbon ‘uptake’, or ‘sequestration’, in this context is the removal of CO_2 from the atmosphere and its storage in the above- and belowground biomass through photosynthesis. Therefore, when the lemming consumes the photosynthetic tissues of the vegetation (aboveground biomass), the CO_2 fluxes increase since the vegetation is no longer able to uptake CO_2 from the atmosphere. We will clarify this in the revised manuscript.

“REALLY need to say how soon after lemming removal you measured all your fluxes. that will change your proposed explanation for the change in flux. (see above) (maybe in the table describing sampling timeline that you proposed in the doc itself?)”

Lemmings were only placed in our experimental plots during the first summer of measurements (2018); the second summer of measurements (2019) was for measuring the recovery of the vegetation that had been affected by the lemmings during the first summer. In 2018 (the first season of measurements, when we included lemmings inside the manipulation plots) CO_2 and CH_4 concentrations were measured one day after lemming removal from the plots (exact time varied based on weather conditions and when plots were measured in temporal relation to other plots). We will include these details in the revised manuscript.

“important that you refer to what they’re measuring carefully; as a first-time reader of this work, my impression was that they were measuring the short and longer-term legacy effects of heavy herbivory (bc lemmings are still present here, so they were not removing herbivory; they were imposing then removing heavier herbivory).”

We will clarify this in the revised manuscript, and include a more careful discussion of the challenges in defining the degree of herbivory.

“It is worth identifying the predators of lemmings since they end up coming up a few times in discussion/conclusion.”

We specified this on line 7 of the submitted supplemental materials to this manuscript: predators include the snowy owl, parasitic jaeger (arctic skua), arctic fox, and ermine. We will further clarify this in the revised manuscript.

“lastly: it is worth circling back to the intro/drive in discussion. It’s likely going to feel more closed-loop if the intro brings up why knowing the near-term AND legacy impacts of heavy herbivory on carbon cycling in this system. (Changes to populations of predators? Climate change? etc.) E.g. the conclusions do it, but the intro does not hook the reader with ‘why should I be excited that you did this experiment with heavy herbivory’.”

We will mention this in the introduction, and make sure the larger implications of our experiment are clear.

“in closing: really cool experimental design! While I am suggesting some fairly large revisions here (e.g. in framing of the paper and some synthesis/interpretation), given the design and the very clear results, I am excited to see how it turns out and would gladly read another version.”

We thank the referee again for the very helpful comments and suggestions, which will majorly improve the manuscript.