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Systematic Map  
CEE 18-005

## Herbivory research does not cover a sufficient range of environmental variation in the Arctic to estimate herbivore impacts on vegetation

Soininen, E.M., Barrio, I.C., Bjørkås, R., Björnsdóttir, K., Ehrich, D., Hopping, K.A., Kaarlejärvi, E., Kolstad, A.L., Abdulmanova, S., Björk, R.G., Bueno, C.G., Eischeid, I., Finger-Higgins, R., Forbey, J.S., Gignac, C., Gilg, O., den Herder, M., Holm, H.S., Hwang, B.C., Jepsen, J.U., Kamenova, S., Kater, I., Koltz, A.M., Kristensen, J.A., Little, C.J., Macek, P., Mathisen, K.M., Metcalfe, D.B., Mosbacher, J.B., Mörsdorf, M., Park, T., Propster, J.R., Roberts, A.J., Serrano, E., Spiegel, M.P., Tamayo, M., Tuomi, M.W., Verma, M., Vuorinen, K.E.M., Väisänen, M., van der Wal, R., Wilcots, M.E., Yoccoz, N.G., Speed, J. D.

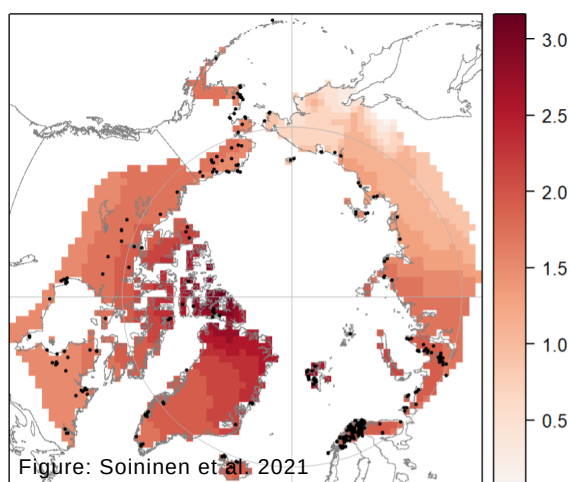


Figure: Soininen et al. 2021  
Distribution of studies of herbivore impacts on arctic vegetation. Background color shows change of mean temperature (°C) from period 1951-1980 to period 2000-2020.

**The effects of herbivores on vegetation may depend on climatic and ecological context. Research on the impacts of herbivores on arctic vegetation is concentrated in those parts of the Arctic that are warmer, wetter, near the coast, and that have experienced a moderate increase in temperature. The current evidence base might therefore provide an incomplete picture of the effects of herbivores on arctic vegetation throughout the region.**

### Why is this Evidence Synthesis Needed?

A warming Arctic leads to changes of vegetation, the increase of trees and shrubs in the open tundra landscapes being the most evident of such changes. Herbivores that inhabit the Arctic encompass mammals (e.g., reindeer, musk ox, lemmings), birds (e.g., ptarmigan, geese), and invertebrates (e.g., birch moth). They modify arctic vegetation through feeding, fertilizing and disturbance. The effects of herbivores can counteract some of the climate-change induced changes of vegetation. However, the effects of herbivores on plants and ecosystem structure and function vary across the Arctic and seem to depend on the environmental conditions under which herbivory takes place. For example, the herbivore impacts on vegetation can differ in areas with different temperature or vegetation productivity. Therefore, studies in different locations can generate different outcomes, and generalizing the impacts of herbivores on plants becomes difficult. This systematic map assessed how well the existing literature of herbivore impacts on vegetation covers the environmental variation in the Arctic, to understand how robust are the conclusions that we can currently make about the effects of herbivores across the tundra biome.

This Collaboration for Environmental Evidence Systematic Map examines how well existing studies on herbivory cover the environmental conditions in the Arctic to assess how robust conclusions about the effects of herbivores on tundra vegetation might be. The map summarizes evidence from 662 studies on herbivore effects on arctic vegetation.

## Main Findings

### *What studies are included?*

The map identified 309 articles including 662 studies of herbivore impacts on plants or vegetation spanning the circumpolar Arctic. Studies included observational and experimental approaches, mainly from field studies but also remote sensing, modelling, and greenhouse studies. Most studies were published after 1980, with a marked increase in studies conducted around 2000 and peaking around 2010. Vertebrate herbivory, mainly by reindeer, small rodents, and geese, was studied seven times more often than invertebrate herbivory. Geographically, the largest cluster of studies was in Northern Fennoscandia.

### *How well do studies of herbivory cover environmental conditions in the Arctic?*

Most studies on Arctic herbivory have been conducted in warm and moderately wet parts of the Arctic. Coastal areas and areas where the increase in temperature has been moderate have been studied more than more remote areas with extreme arctic conditions. However, the existing studies covered the range of observed warming and changes in vegetation greenness and growing season length in the last decades. The studies spanned the full range of Arctic vertebrate herbivore diversity and human population density and footprint.

### *A database of herbivory studies across the Arctic*

The database of studies of herbivore effects on arctic vegetation is available through an interactive visualization tool: <https://shiny.vm.ntnu.no/users/speed/ArcticHerbivorySystematicMap/>. This tool allows exploration of individual environmental variables and the coded data for exploration and to generate further hypotheses.

## What are the Implications of the Review Findings?

The current evidence base might not be sufficient to understand the effects of herbivores on Arctic vegetation throughout the region. The bias in the geographical distribution of herbivore studies in the Arctic, the uneven coverage of some environmental gradients and the limited evidence base on invertebrate herbivory compromise generalized conclusions on herbivore impacts on Arctic vegetation. In particular, the overrepresentation of studies in areas with moderate increases in temperature prevents robust generalizations about the effects of herbivores under different climatic scenarios. The systematic map calls for future studies to prioritize the areas experiencing the most pronounced climate changes but also in those that are changing the least to increase our broader understanding and management of the effects of herbivores. Understanding how herbivory influences the responses of Arctic ecosystems to environmental change can help guide appropriate adaptive strategies to sustain ecosystem functioning and the provision of ecosystem services.



Photo: Eeva Soininen

## Synthesis Time Frame

The authors of this systematic map conducted their searches between March 2018 and March 2020, with no time-restriction applied. This CEE Systematic Map was published in October 2021.

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