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Three years exclusion of large herbivores in a high arctic mire in NE Greenland resulted in changed vegetation density and greenhouse gas emission and uptake

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Herbivory is an important part of many ecosystems and their presence effects the ecosystems carbon balance with both direct and indirect effects. Little is known about what will happen to an arctic ecosystem that is influenced by herbivory, if the animals disappear. We hypothesized that trampling and grazing by large herbivores influence the vegetation density and composition and hereby the carbon balance.

Method: In 2010 an in-situ field experiment in Zackenberg, NE Greenland, were initiated to study the effects of herbivory on the vegetation and carbon balance. Exclosures were established to exclude the muskoxen *(Ovibos moschatus*), which are a natural part of these ecosystems. The experiment consists of five block replicates with three treatments within each block, i.e., control, exclosure and a snow fence (the treatment area is 10x10 m and the fences are 1 m high). During the growing season we have since 2011 performed weekly measurements of CO_2 and CH_4fluxes, the concentration of labile substrate for CH_4 formation (organic acid concentration) in pore-water and additional ecosystem properties, i.e., water table depth, active layer depth and soil temperature. In 2013 a detailed analysis of the vascular plant species composition and density within each measurement plot were performed. Furthermore biomass (including mosses) samples 20x20 cm were harvested within all treatments.

Results: The third year after the initiation of the experiment we observed a clear effect of excluding muskoxen grazing from the ecosystem. The exclosures had lower uptake of CO_2 and lower CH_4 emission. The vegetation analysis inside the plots showed a decrease in total number of vascular tillers and of *Eriophorum scheuchzeri* (ES) tillers. Correspondingly, the biomass samples from the exclosures had lower number of total plant tillers, ES tillers, total green leaves and green ES leaves and the height of all vascular plants and of ES plants were higher. Finally, the dry weight of the biomass showed that there were more mosses and old biomass inside exclosures.

Conclusions: Removing muskoxen grazing and physical presence has dramatic effects on the ecosystem. As there is no trampling inside the exclosures the mosses become more dominating and starts to grow upwards, due to less compaction. As there is no consumption of the vascular plants, all the old biomass remains on the ground surface, most likely leading to light limitation of the vascular plants and they therefore decrease in number of tillers and in green leaves. The thicker moss layer forces the vascular plants to grow taller, as seen inside the exclosures. The decrease of CO_2 uptake can partly by explained by the lower number of vascular plants, while the decrease in CH_4 emission most likely is connected to lower CO_2 uptake, less vascular plants and lower overall carbon allocation below ground and hereby less root exudation.

The future of the muskoxen in a changing arctic environment are uncertain, this experiment is pointing towards the potentially large effect that herbivory has on the carbon balance of natural ecosystems in the Arctic.