How geese shape arctic ecosystems

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Geese are highly selective herbivores. After the young have hatched, the geese congregate on grazing lawns. During this period in which the goslings grow by almost doubling their weight every week, the adults lose their flight feathers and are flightless for a month. This limits the home range of the geese on arctic tundra to areas of high vegetation quality and safety against predators. As a consequence the geese exert a strong impact on the vegetation.

Goose numbers have increased enormous since 1970. The main reasons for this increase originates from the wintering and spring staging areas. An increase in the use of fertilizer by farmers, the amount of nitrogen deposition and conservation management, together with a reduction in effective hunting pressure has led to historic high goose numbers. How does the Arctic ecosystem cope with this increase in goose numbers?

Studies on the lesser snow goose *Chen caerulescens* in La Pérouse Bay, Canada first described an interesting interaction between the geese and the vegetation, where vegetation productivity was increased due to an acceleration of the nitrogen cycle by goose faeces. However when goose numbers increased further, large areas of coastal tundra lost all vegetation due to goose grubbing, followed by an increase in salinity.

On the European tundra of Spitsbergen/Svalbard, both processes were assessed in an experimental combination of grazing pressure and climate change. Grazing proved to change the vegetation to a much larger extent than warming and made the moss tundra into a source of CO_2 to the atmosphere. Studies on exclosures, areas where the herbivores are excluded, showed the consequences of selective grazing on vegetation composition, productivity, seed bank, nutrient cycling and moss-grass interaction.

To understand the consequences of climate change on plant herbivore interaction, the whole food web needs to be included. The increased goose populations have the potential of removing extra productivity due to warming. They also provides predators with an abundant new food source. Predator populations have responded with shifts in diet and an increase in numbers, but are also facing direct effects of changing winter, snow and ice conditions on their population numbers. And it is still unclear whether shifts in behavior or timing are possible and fast enough to facilitate climate adaptation and survival.

Finally, species specific behavior might play an important role in structuring the food web. Barnacle geese *Branta leucopsis* and pink-footed geese *Anser brachyrhynchus* have been found to change food webs in a different way. As an example, we will discuss the effect of geese on lake ecosystems, where the food web structure is highly dependent on the specific goose species being present.

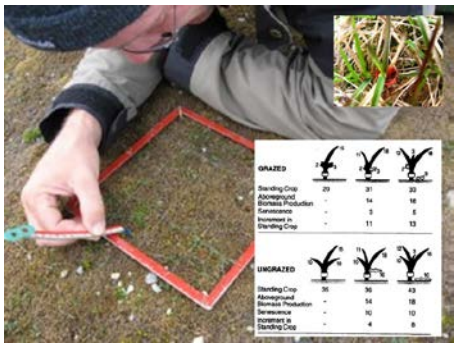

Figure 1. Measuring goose relevant plant production and consumption by measuring leaf length over time intervals from grazed and exclosed grass shoots.

References

Hik D. S., and Jefferies R. L. Increases in the net above-ground primary production of a salt-marsh forage grass: a test of the predictions of the herbivore-optimization model. Journal of Ecology, 78, 180-195, 1990.

Pezzanite B., Rockwell R.F., Davies J.C. and Loonen M.J.J.E. & Seguin, R.J. Has habitat degradation affected foraging behaviour and reproductive success of lesser snow geese (Chen caerulescens caerulescens)? Ecoscience 12, 439-446, 2005.

Kuijper D.P.J., Ubels R. and Loonen M.J.J.E. Density-dependent switches in diet: a likely mechanism for negative feedbacks on goose population increase? Polar Biology 32, 1789-1803, 2009.

Sjögersten S., Kuijper D.P.J., van der Wal R., Loonen M.J.J.E., Huiskes A.H.L. and Woodin, S.J. Nitrogen transfer between herbivores and their forage species. Polar Biology 33, 1195-1203, 2010.

Sjögersten S., van der Wal R., Loonen M.J.J.E. and Woodin S.J. Recovery of ecosystem carbon fluxes and storage from herbivory. Biochemistry 106(3), 357-370, 2011.