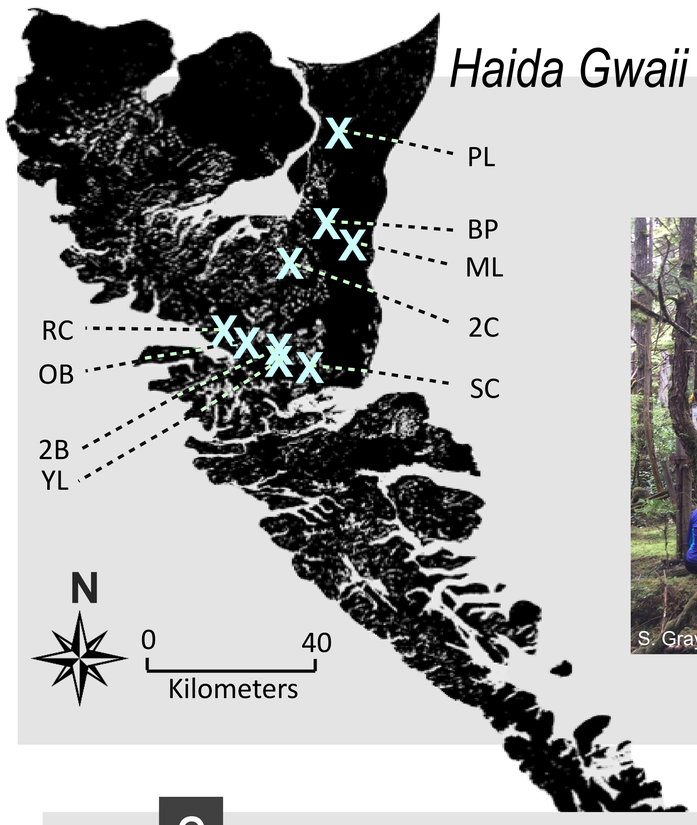
Impact of introduced deer on soil properties in Haida Gwaii's forests

Maillard Morgane[1,2], Martin Jean-Louis[1], Chollet Simon[3], Grayston Sue[2]

1. Centre of Functional and Evolutionary Ecology, CEFE-CNRS (UMR 5175), Montpellier France. **2.** Department of Forest and Conservation Sciences, University of British Columbia, Vancouver Canada. **3.** ECOBIO (UMR 6553) Rennes 1 University, Rennes France..

Contact:
morgane.maillard@cefe.cnrs.fr

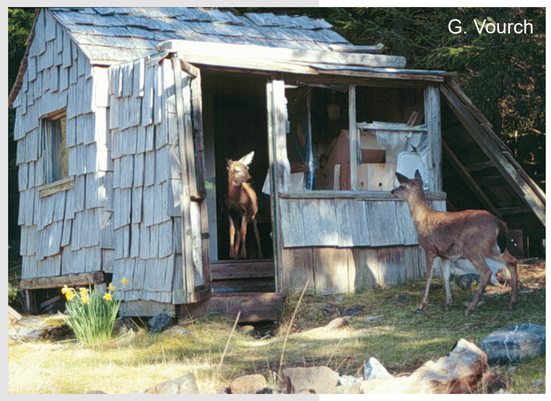
The **proliferation** of **introduced** Sitka black-tailed **deer** on the archipelago of Haida Gwaii (BC, Canada) has **cascading effects** on native aboveground plant and animal communities[1]. Understanding their effects on **belowground** processes is lacking and needed, given their vital role in ecosystem functioning. Deer can affect soil nutrient cycles both positively and negatively through the modification of the plant community by selective browsing, and the modification of soil physical properties by trampling and plant removal[2,3]. We compared vegetation, soil physical properties and soil nutrient stoichiometry inside and outside deer exclosures to better understand how deer affect belowground ecosystem in temperate rainforest.



1 Deer exclosures for ecosystem restoration

The exclosure system

18 exclosures of 25m² were installed in 1997. Deer cannot enter these areas, allowing us to study ecosystem restoration after **deer exclusion**. We sampled the soil organic layer and surveyed vegetation inside and outside each exclosure.

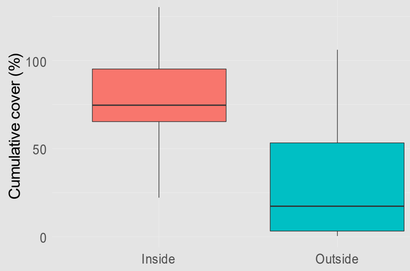


Sitka black tailed deer have colonized about 99% of the archipelago, with high density between 13 and 30 deer/km²

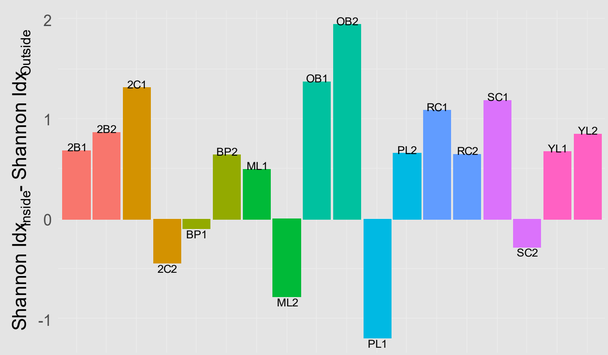
2 Deer affect plant community

Exclosure, site 'PL'

Cumulative plant species cover



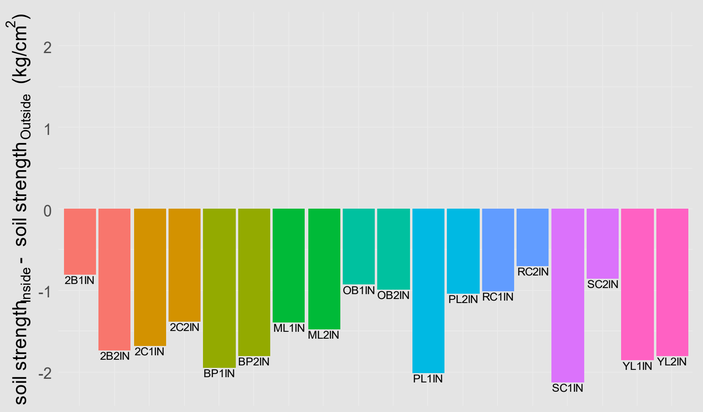
Difference in Shannon index between inside and outside of exclosures



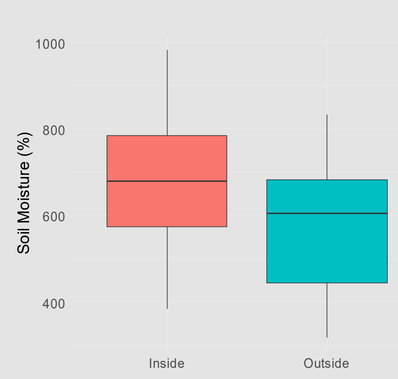
Deer exclusion had a **positive effect** on both **plant cover** (paired t-test, t = 6.73 , p-value = 3.51e-6) and **plant diversity** (t = 2.81, p-value = 0.012). Such modifications could change soil properties through decomposition processes.

3 Deer affect soil physical properties

Difference in soil compaction between inside and outside of exclosures



Soil moisture



Soil compaction was significantly **lower** inside all the exclosures (paired t-test, t = 12.72, p-value = 4.10e-10). Deer can indeed induce soil compaction through trampling. **Soil moisture** was significantly **higher** inside the exclosures (t = 2.13, p-value = 0.05). Reduction of plant cover due to browsing can increase soil exposure, promoting evaporation at the soil surface[3]. These physical properties could both impact nitrogen cycling through their control of microbial activity[3].

4 Soil stoichiometry remains constant

Difference in C/N between inside and outside of exclosures

Co-variables

We found that 20 years of deer exclusion **did not affect soil Carbon/Nitrogen ratio** (repeated measured ANOVA, F= 0.15, p-value = 0.71), despite the observed vegetation and soil physical properties changes.

5 Conclusion and perspectives

20 years of deer exclusion have led to an increase in plant abundance and diversity. This is due to the disappearance of the browsing pressure. It has also significantly reduced soil compaction by preventing soil trampling by deer. Although soil nutrients are linked to both vegetation and soil physical properties, we found no changes in soil nutrient stoichiometry. Changes in nitrogen dynamics could occur at a finer level in nitrogen cycling. To investigate this, we aim to study the microbial activity and nitrogen transformation rates inside and outside the exclosures using ^{15}N isotope dilution and qPCR methods.

Acknowledgment

We would like to thanks the FFCR and Mitacs Globalink for their financial support. Catriona Catomeris Maria Continentino, Yonadav Anbar and Dylan Mendenhall for their help on the field.

References: [1] JL Martin, SA. Stockton, S. Allombert, Anthony J. Gaston (2010). Top-down and bottom-up consequences of unchecked ungulate browsing on plant and animal diversity in temperate forests: lessons from a deer introduction, Biological Invasions 12:353–371 [2] R. D. Bardgett and D. A. Wardle (2003). Herbivore-mediated linkages between aboveground and belowground communities. 84(9), pp. 2258–2268 [3]Schrama, M., Veen, G. F. . C., Bakker, E. S. . L., Ruifrok, J. L., Bakker, J. P., & Olff, H. (2013). An integrated perspective to explain nitrogen mineralization in grazed ecosystems. Perspectives in plant ecology evolution and systematics, 15(1), 32-44. DOI: 10.1016/j.ppees.2012.12.001