Invasive deer alter soil microbial biomass, community structure, and nutrient availability in old growth forests

Catriona Catomeris & Sue J. Grayston
Belowground Ecosystem Group, Faculty of Forestry, University of British Columbia, Vancouver, BC
c.catomeris@alumni.ubc.ca & sue.grayston@ubc.ca

INTRODUCTION

Sitka black-tailed deer (*Odocoileus hemionus sitchensis*) were introduced to Haida Gwaii, BC in 1878 where they lack natural predators. They have invaded most of the archipelago, reached densities of 13 to 30+ deer/km^2, and have dramatically altered the vegetation community. However, the belowground effects of these aboveground herbivores have been largely overlooked. We quantified soil microbial biomass and community structure and assessed soil nutrient availability on deer and deer-free islands on Haida Gwaii.

METHODS

Figure 1: Islands in the archipelago of Haida Gwaii, BC that were sampled for this study. White text and circles indicate deer-free islands. Pink circles and/or font indicate deer-inhabited islands. Red markers indicate plot locations.

- Organic soil F horizon was collected from deer-free and deer-inhabited islands in Haida Gwaii, BC in August 2016 (Figure 1 & Table 1)
- Phospholipid fatty acids (PLFAs) were extracted from freeze-dried soil and analyzed on a GC-MS
- Microbial functional community structure was assessed using known PLFAs
- Signature PLFAs were selected to assess fungal and bacterial biomass
- Plant Root Simulator® (PRS) probes were buried in the forest floor for ~1 year to measure available soil nutrients

Table 1: Island name, browse history, and size

Island	Deer Colonization (years)	Island Size (ha)
Agglomerate	0	22.9
Low	0	9.6
Lyell	60+	>17,300
Ramsay	60+	1,622.8
Reef	60+, culled and re-populated	249
South Skedans	<30	5.6
Tar	0	6

RESULTS

MICROBIAL COMMUNITY STRUCTURE

- Deer presence, island, and plant diversity significantly contributed to the model of microbial community structure (Figure 2)
- Available nutrients could not explain differences in microbial community structure
- Total bacterial and fungal biomass were roughly 20% higher on deer-free than deer inhabited islands (NS)

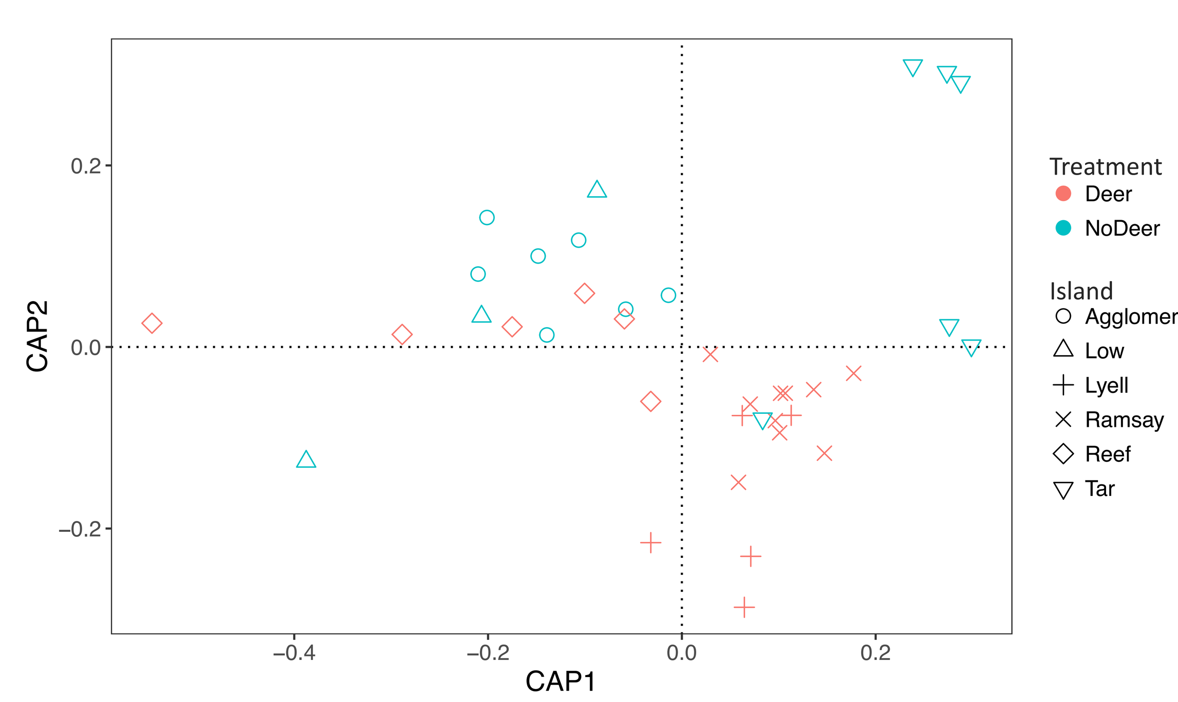

Figure 2: Partial-CAP of microbial community structure (PLFAs) on deer-free (blue) and deer-inhabited islands (pink).

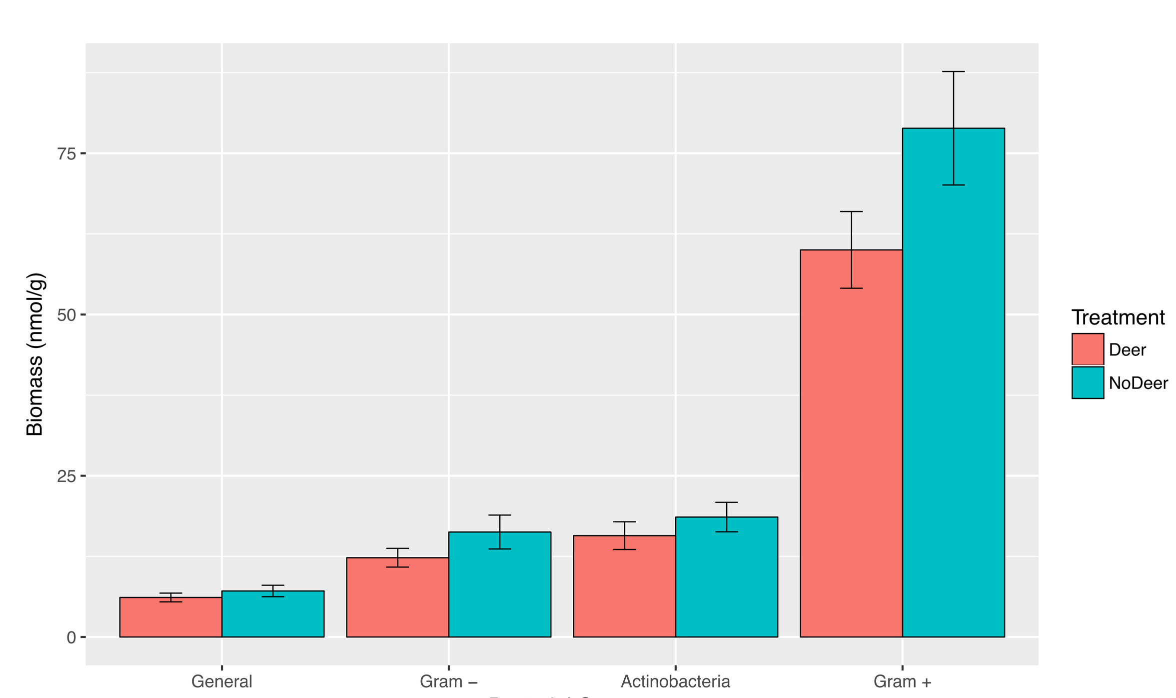

Figure 3: Mean bacterial biomass, separated by bacterial groups, on deer-inhabited (n = 21) and deer-free (n = 16) islands ± SE.

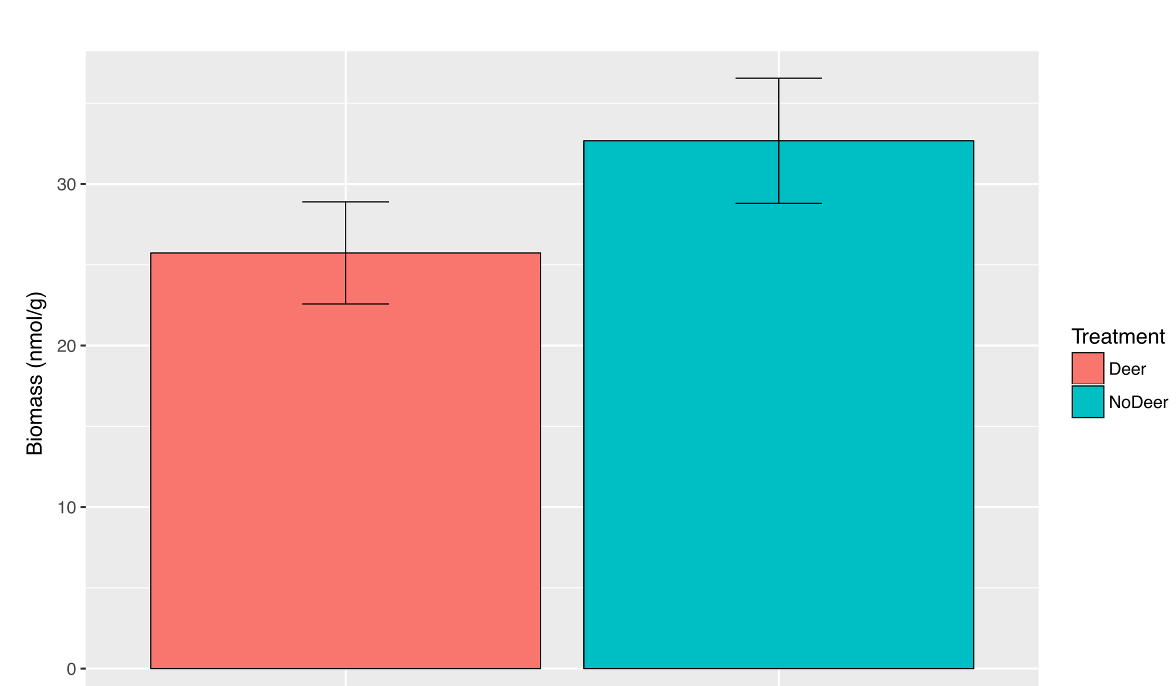

Figure 4: Mean fungal biomass on deer-inhabited (n = 21) and deer-free (n = 16) islands ± SE.

AVAILABLE SOIL NUTRIENTS

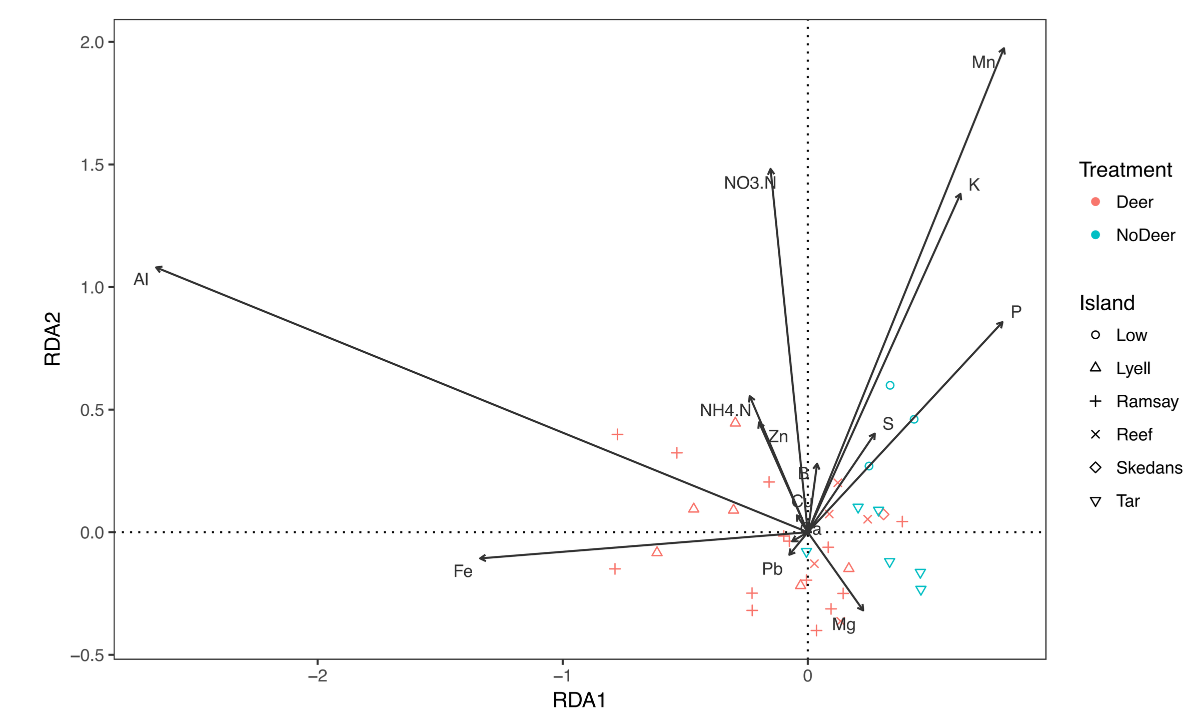

Figure 5: Partial-RDA of available soil nutrients on deer-free (blue) and deer-inhabited (pink) islands.

- Nutrient profiles differed between treatments
- Al and Fe tended to be higher on deer-inhabited islands; Mn, K, and PO_4 tended to be higher on deer-free islands

CONCLUSIONS

- Soil microbial community structure differed between deer-free and deer-inhabited islands
- Deer presence resulted in a large decrease in fungal and bacterial biomass; the largest absolute reduction being Gram-positive bacteria
- Deer presence altered available soil nutrients, including reducing PO_4
- Direct and indirect effects of deer may contribute to changes in soil microbes and nutrient availability
- Differences between islands on their effects on soil microbial community structure and soil nutrients may have been a result of island size, site conditions, or browse history

Acknowledgements

Gwaii Haanas and the Research Group on Introduced Species are thanked for the use of their facilities. This research was funded by NSERC, Parks Canada, and RGIS.

RGIS
Parks Canada Parcs Canada