Moose Browsing Effects on Soil Nutrient Availability in the Boreal Forests of Isle Royale National Park

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Introduction & Significance Boreal forest ecosystems are globally important stores for soil organic carbon [1], because carbon inputs from vegetation production generally are greater than outputs from decomposition or disturbances in these cold climates. Disturbances such as wildfire [2], changes in climatic factors [1], and resulting changes in biological factors such as stand conversion or increased browse pressure by herbivores [3] likely change the carbon sink-strength of boreal soils [4].

Currently, the most extensive disturbance to boreal forest on Isle Royale National Park is derived from browse pressure by moose [5]. Examination of moose disturbances is particularly timely, as the moose population has grown 20% per year over the past 6 years, the wolf population is down to two individuals, and there is limited predation on the moose [6]. This will lead to an increase of moose browsing, which will affect the abundance of vegetation and inputs to the soil. This study will look at the long-term impact of moose browse on soil nutrients, organic matter, and soil physical properties. These comparisons can then inform land managers on consequences of increasing moose populations. Prior work has shown that moose browse significantly alters vegetation structure and elemental cycling [3, 4, 7], but to date there are no mechanistic studies of how this disturbance affects soil horizon development or changes in nutrient availability by genetic horizon, in relation to soil organic matter content.

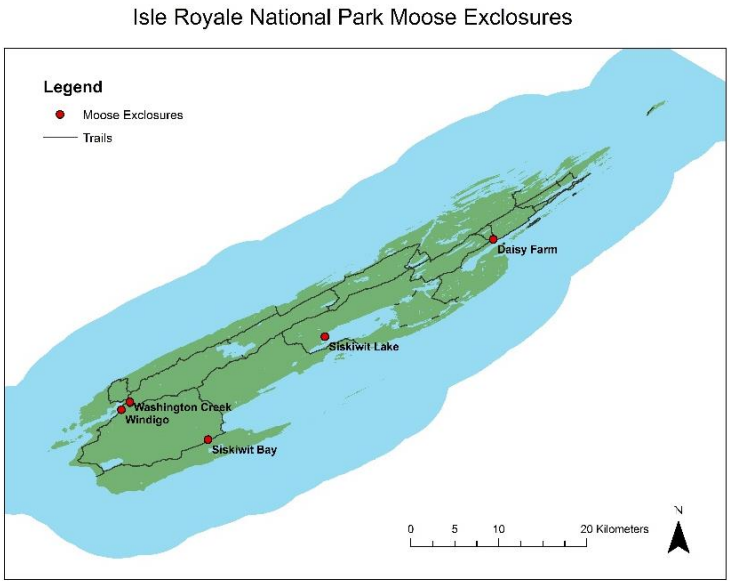

Figure 1. Locations of the existing five moose exclosures, maintained by NPS, on Isle Royale National Park

In an early attempt to examine moose browse pressure on vegetation dynamics, in 1948 and 1970, five 15 m by 15 m exclosures were built on Isle Royale in various locations with multiple soil and forest types (Figure 1; see also [7]). These exclosures were built to ensure there was area where moose could not affect the vegetation and soils. **While this early work demonstrated strong top-down controls on some seasonal estimates of surface soil carbon and nutrient dynamics, the study only measured soils to a fixed shallow depth (5 cm) and did not distinguish among different soil horizon types or taxonomic units**. For example, carbon-rich horizons (O and A) could have been lumped with carbon poor horizons (e.g., E), which likely obscured a mechanistic understanding of the true effects of moose disturbances on soil formation (see [8]). This study will leverage these exclosures and prior research to look at the long-term effects of moose browse on soil nutrient and carbon stocks. I will build on the work of Pastor et al. (1993) by analyzing soils by genetic horizon to a greater depth, 40 cm. This will give a more accurate view on what effects the moose have had on soil nutrients, while also providing mechanistic insight as to soil horizon development. Also new with this study, 5 plots

will be sampled from Passage Island, since moose have never been there to affect soil properties.

Hypothesis Long-term heavy moose browse pressure has decreased soil organic matter storage, soil horizon development, and as a result increased bulk density and decreased fertility.

Methods I will leverage the existing five exclosures on Isle Royale National Park (Figure 1). Prior to field work, GIS and GPS maps will be made for navigation to each sampling area. For each exclosure, there will be five plots within the exclosures and five control plots adjacent to the exclosures. On Passage Island five more plots will be randomly established within a similar forest type, as allows, to that of the exclosures. At each plot, a 60 cm by 60 cm descriptive soil pit will be dug to a depth of 40 cm (a total of 55 shallow pits). The depths of each genetic soil horizon will be recorded, a bulk density sample will be taken (using corers) in each horizon following standard methods from the MTU FW3330 Soil Science course. Other samples by horizon (more than 500 grams, wet) will be put into labelled bags to be used in physical and chemical analyses. Any soil that was not taken for sample will be placed back into pit, and the pit location will be monumented following National Park Service (NPS) guidance. For the lab portion, we will analyze soils for bulk density, organic matter content (loss on ignition), exchangeable ammonium and nitrate, and exchangeable calcium using standard lab procedures (FW3330, Soil Science Laboratory Workbook, 2016). Any samples that are not used will be frozen in support of future investigations. All data will be entered in Microsoft Excel, and treatment effects will be examined through multiple comparisons of means tests at a significance level of alpha = 0.05.

Timeline Soil pits from the five exclosure locations and Passage Island will be described and sampled from May-June, with laboratory analyses to follow in June-July at the Soils Lab at SFRES (MTU) (Table 1). Travel to site locations will be coordinated with NPS biotechnicians conducting synergistic vegetation surveys at the exclosure sites in early summer.

Table 1. Proposed timeline of project starting in May and ending in August with 40+ hours worked per week.

		May			June			July			August		
Activity	**Week**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Field Work Preperation		x											
Soil Sampling		x	x	x	x								
Soil Processing					x	x	x	x					
Data Analysis and Synthesis									x	x	x		
Project Write Up/Publication											x	x	x

Support and Ensuring Success Isle Royale National Park is committed to this project and will cover Ranger III travel to the island, boat accommodations around Isle Royale, and dormitory lodging on Mott Island in support of field work. Lynette Potvin, the NPS ecologist on Isle Royale, has been involved in planning this proposal and will facilitate sampling at each exclosure. Dr. Evan Kane will assist with field work and soil profile descriptions, laboratory analyses, and in statistical analyses and writing. Sampling and lab equipment will be supplied by both Michigan Tech's SFRES soils lab and the USDA Forest Service Northern Research Station. All fellowship money will be applied toward a stipend for Chelsey Bach.

References

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