Soil carbon and nitrogen as influenced by nitrogen deposition and invasive species in the novel ecosystem of Mount St. Helens

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1. Introduction

- Soils of volcanic origin can store large amounts of carbon (C) from the reburial of organic matter (OM).
- OM complexation into soil C occurs though microbial processing of plant litter and root C exudates.
- Anthropogenic influences of nitrogen (N) deposition and the presence of invasive species may alter rates of soil C storage via changes in litter quality and quantity and shifts in plant-microbial relationships.
- We address the effects of N-deposition and the invasive stem-boring weevil (*Cryptorhynchus lapathi*) on Willows (*Salix sitchensis*), the dominant woody plant species, in the disturbed system of Mount St. Helens (MSH) via our long-term NxWeevil exclusion experiment.
- Our ***objective*** was to determine how soil C and N are influenced by the developing plant community and global change pressures: Invasive species and N-deposition on soil C and N in the earliest stages of ecosystem development.

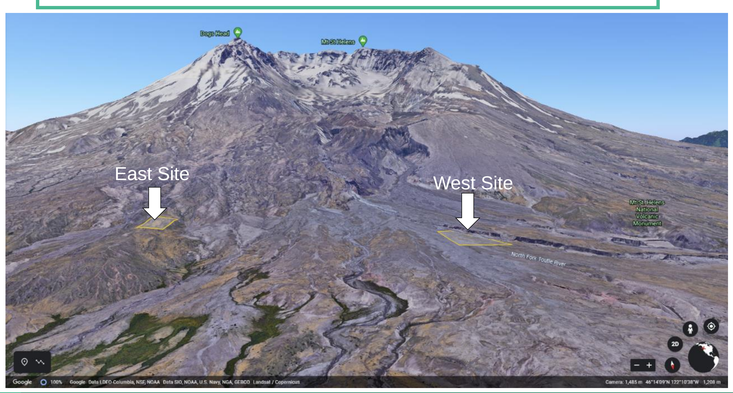
Hypotheses:

—Soil C will be highest in plots with N-addition and weevil exclusion

Rationale: Higher plant growth from N-addition and weevil exclusion increases litter and OM. Increases in N addition could relieve microbes from resource limitation allowing them to increase activity and decomposition of OM which will increase soil C

— Soil C will be greater where weevils are present compared to plots where weevils are excluded.

Rationale: Weevils may add small woody debris as partially broken-down litter and frass increasing soil C compared to weevil exclusion treatments.

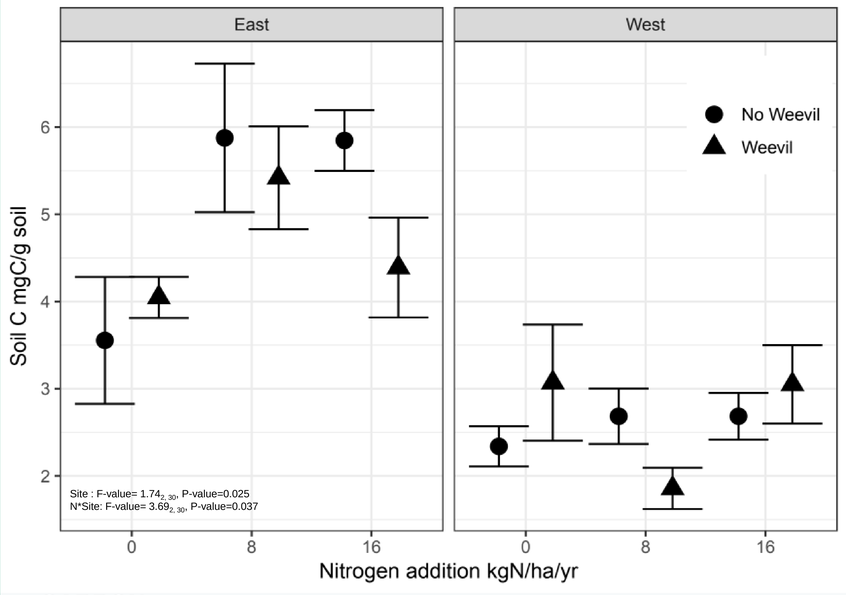


2. Methods

N addition x Weevil Exclusion Experiment established 2013
-36 plots (18 “West” 18 “East”) measuring 64m^2 and containing 5-22 willow trees.
-Factorial design: 3 levels of N addition representative of 2-4x ambient levels (0, 8, and 16 kg N/ha/yr) with a weevil exclusion treatment, replicated in 6 blocks.
-N added twice yearly using a ratio of NH_4NO_3 and $NaNO_3$
-Weevils excluded by spraying the basal portion of willows yearly with insecticide
Soils collected 2018
- O/A soil horizon (0-10cm) from 20x20cm pits at 10 random points in each plot, after removing and collecting herbaceous vegetation, moss and litter.
-A subsample of each pit was combined by plot and 3 samples from each bulked sample were measured for C and N at the stable isotope core at WSU Pullman

Unattacked Willow Attacked Willow

3. Results



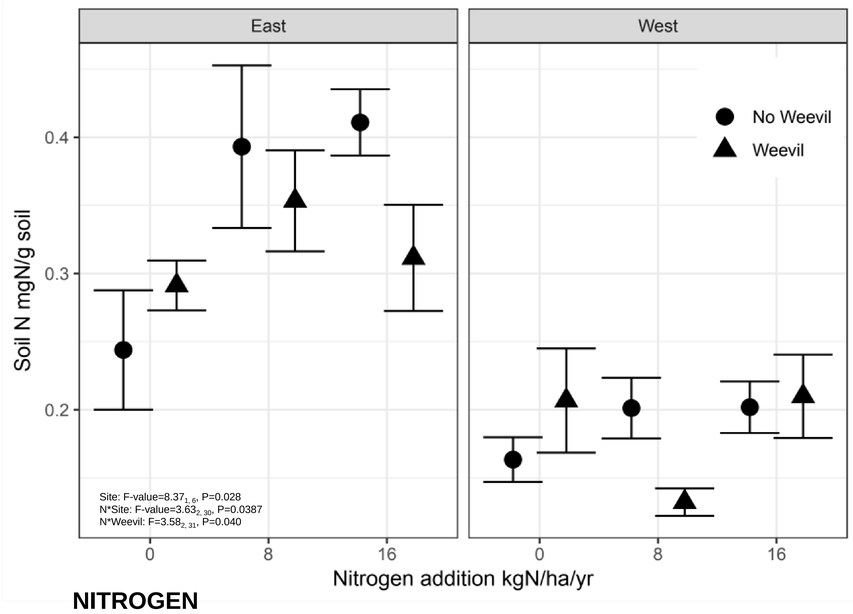
CARBON

EAST

- +8N and +16NxNW greater than all other treatment combinations
- Weevils decrease soil C but only at +16N

WEST

- C significantly lower than in east plots
- No effect of +N on soil C
- Weevils only reduce soil C at +8N



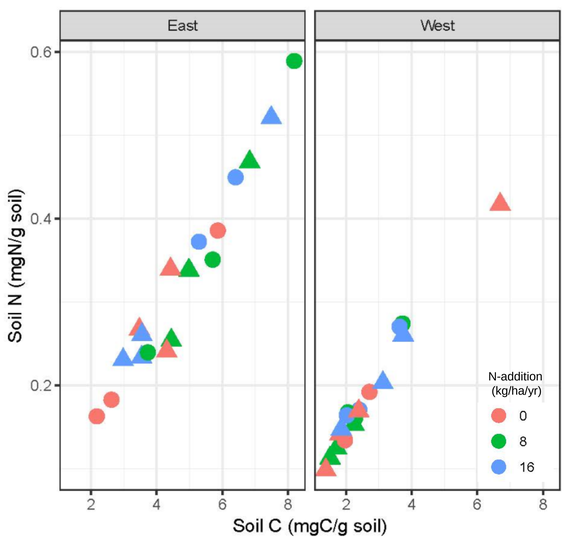
NITROGEN

EAST

- +8N and +16NxNW greater than all other treatment combinations

WEST

- Weevils decrease N at +8N compared to all other treatment combinations



Soil C and N are highly correlated. Over 7 years we have added a total of 56kgN/ha (+8) and 112kgN/ha (+16) in each plot yet it appears that remains in the soil.

4. Discussion

- C and N higher in East than West
  - Different substrates
  - More conifers and cottonwoods in the east than west which may serve as an additional C and N source when weevils consume willows
  - In the west willows may be more sensitive due to a lack of plant community development
- N addition increased C and N in the east plots
  - Potentially from increases in litter and SOM which support microbes and microbial turnover of litter
- Similar response of soil C and N under +8N and +16N
- Willows and soil could have a N critical load around 8 kg/N/ha, microbial soil OM processing may decrease with additional N (no added benefit of +16N)
- The highly correlated relationship between C and N suggests that N is being utilized by plants and microbes or is lost/leached and is not accumulating in the soil.

  +N→ increased plant biomass→ increased soil C

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