Microbial Responses Associated with *Alliaria petiolata* (garlic mustard) Invasion in Northeastern Mixed Forests

Mark Anthony[1*], Serita D. Frey[1], Kristina Stinson[2]

1. Department of Natural Resources and the Environment, University of New Hampshire, MA;
2. Department Of Environmental Conservation, University of Massachusetts, Amherst, MA

**Presenting author (mat5955@wildcats.unh.edu)*

University of New Hampshire

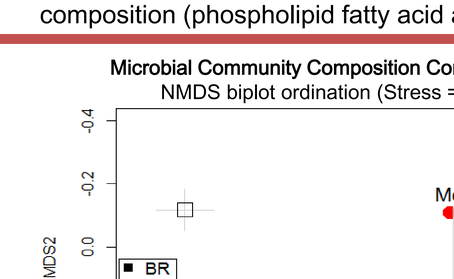
SERDP DOD • EPA • DOE | ESTCP

Meeting DoD's Environmental Challenges

Background

- Garlic mustard is invasive in most of North America
- The plant is a *Brassicaceae*, is non-mycorrhizal, requires high soil fertility, and is allelopathic--producing glucinolates and flavonoids
- Mycorrhizal fungi appear most sensitive to allelopathy; effects on other microbial groups is unclear
- The influence on edaphic factors on the microbial response to invasion is also not well understood.

Map of the Study Forests in a Regional Compartment of the Northeast USA



Objective

- Characterize edaphic soil properties in invaded and uninvaded forest.
- Assess impacts of invasion on microbial biomass and community composition
- Relate microbial responses to soil characteristics

Microbial Biomass

- Microbial biomass exhibited variable response to invasion
- Microbial biomass increased with rates of N-deposition.

Garlic mustard invasion in a western MA forest

Pittsfield, MA

Methods

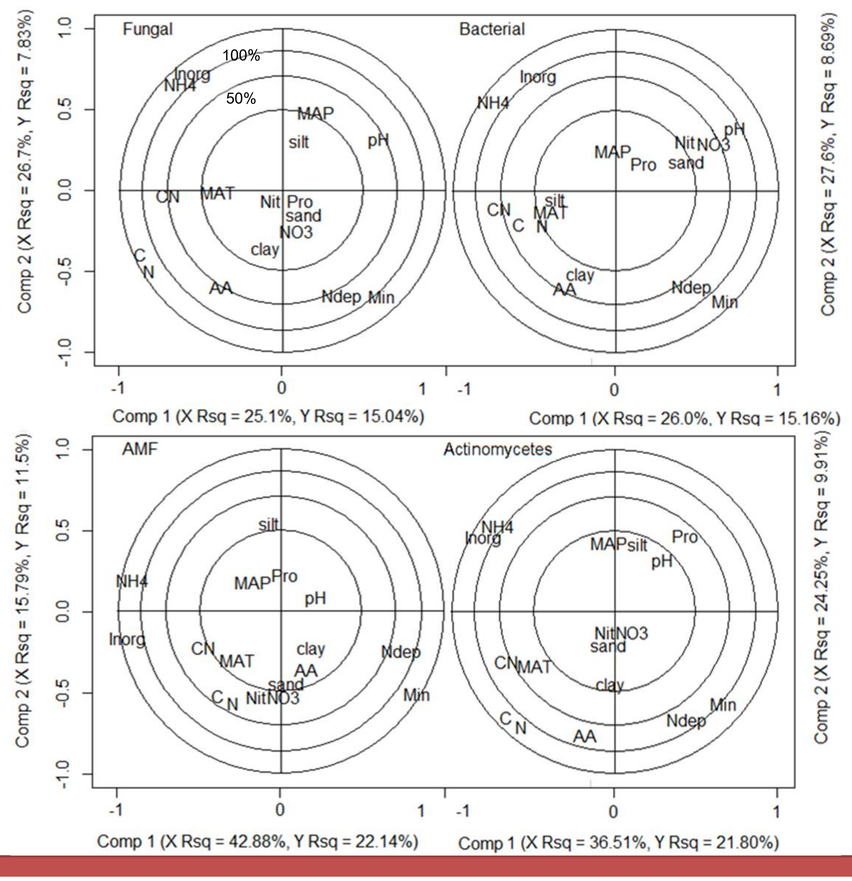
- Collected soil samples from uninvaded and invaded plots at eight temperate forest sites (see map).
- Measured soil properties and microbial biomass/community composition (phospholipid fatty acid analysis).

Microbial Community Composition Correlated with Edaphic Factors

NMDS biplot ordination (Stress = 0.07, Distance = Bray)

Microbial Responses to Invasion In Relation to Soil and Climatic Variables:

Partial least squares regression correlation loading plots



Statistical Results

Invasion as fixed effect and site as random effect

Response variable	SE	DF	*t*-value	*P*-value
Nutrient properties				
Nitrate ug NO_3^- gds^{-1}	0.210	39	-3.85	**>0.001**
Ammonium ug NH_4^+ gds^{-1}	0.000	39	0.070	0.945
Inorganic N ug (NH_4^+ + NO_3^-) gds^{-1}	0.154	39	-2.898	**0.006**
Amino acids mg TFPA gds^{-1}	0.005	39	0.197	0.844
Edaphic properties				
pH	0.019	39	-2.157	**0.037**
% Nitrogen	0.018	39	0.766	0.448
% Carbon	0.061	39	1.978	**0.055**
C:N	0.032	39	3.02	**0.005**
Microbial biomass				
Total biomass nmol PLFA gds^{-1}	0.093	39	-1.066	0.293
Bacteria nmol PLFA gds^{-1}	0.088	39	-0.714	0.500
Fungi nmol PLFA gds^{-1}	0.123	39	-1.583	0.122
F:B ratio	0.009	39	-1.711	**0.095**
Arbuscular mycorrhizal fungi nmol 16:1ω5c gds^{-1}	0.246	39	-0.375	0.710
Actinomycetes nmol 10Me16:0 gds^{-1}	0.249	39	-2.499	**0.017**

All variables log transformed (log + 1)

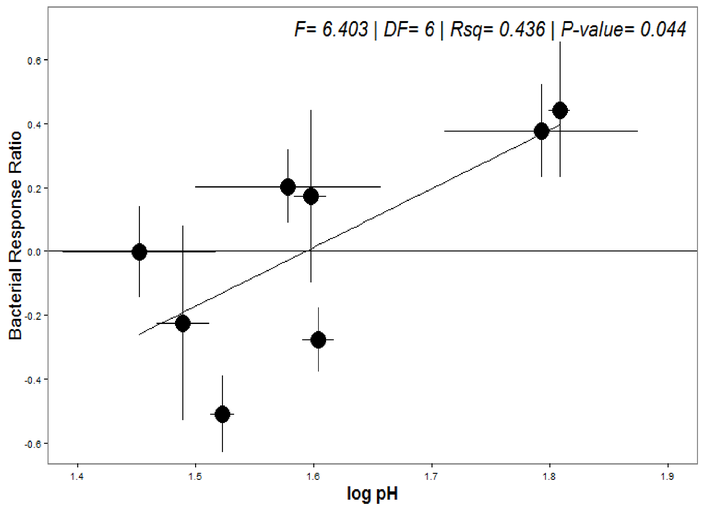
Summary

- Inorganic N pools elevated
- Soil pH increases
- Reduced soil C and C:N ratios.
- Higher F:B ratios and actinomycete biomass.

Significant correlation between microbial community composition and soil N fertility in invaded plots.

Mantel *r* = 0.26, *P*-value = 0.03

Bacterial Response to Invasion In Relation to Soil pH



Mycorrhizal (AMF) Response In Relation to Soil Inorganic N

Conclusions

- Significant reductions in total soil C associated with invasion and increased soil inorganic N.
- Invasion was associated with differential microbial community composition responses.
- Invasion was associated with significant correlations between microbial community composition and N fertility.
- Soil pH is a potential driver of bacterial responses to invasion.
- Inorganic N concentrations are potential indicators of AMF responses to invasion.

Acknowledgments

- Thanks to Jason Aylward, Johnathon Morse and the Frey Lab for field and analytical assistance.
- Funding support from the Department of Defense SERDP Program.