Invasive plant restoration: soil nutrient pools and enzyme activity among stands dominated by exotic, invasive plants.

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Experiment 1 – comparison of soil properties from invasive dominated and native sites.

We measured soil nutrient cycling and soil microarthropod density among sites dominated by *Rhamnus frangula* (glossy buckthorn), *Ligustrum sinese* (Chinese privet) and *Celastrus orbiculatus* (Asian bittersweet), three common invasive plants in eastern deciduous forests. Glossy buckthorn and Chinese privet are woody shrub species while oriental bittersweet is a vine that can also form a thick ground cover.

The goal of this study is to establish baseline information regarding the effects of invasive plants in a hardwood forest ecosystem. This baseline data will be used to monitor the effectiveness of ongoing restoration treatments.

Methods

We randomly selected 6 sampling plots dominated by each individual exotic species (18 sites total) and 6 corresponding control sites dominated by native vegetation. At each sampling plot, the density of the exotic plant was measured and 3 soil cores and surface samples were collected. Separate soil cores were also collected for bulk density measurement. The surface soils were composited, dried and sieved for nutrient analysis.

Because of the spatial distribution of each exotic species, control samples were pooled for comparison among native control, Asian bittersweet and Chinese privet samples. These species co-occurred throughout the sampling area. Glossy buckthorn had a more localized distribution and was compared to control samples collected within close proximity.

Species Descriptions

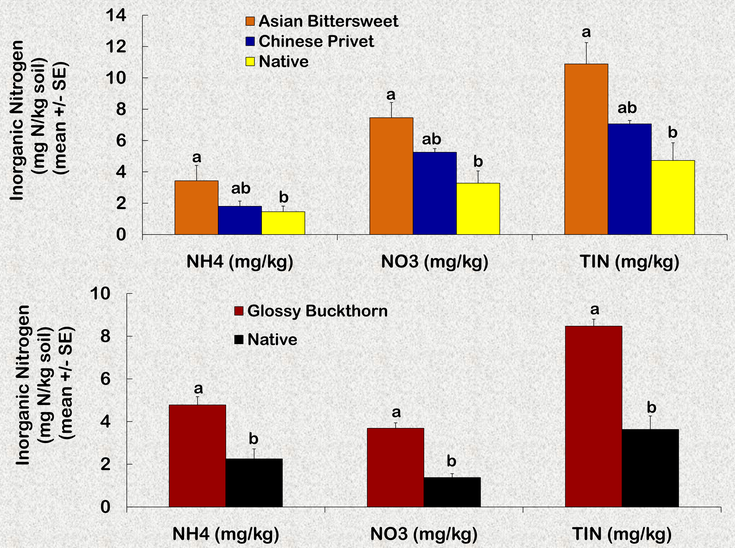
Chinese Privet (*Ligustrum sinese*)
- Small shrub/tree; typically 1-3 m tall
- Widespread exotic, especially in SE US.
- Shallow extensive root systems
- Produces prolific seed bank
- Sample plots averaged 6-14 stems/m^2

Glossy Buckthorn (*Rhamnus frangula*)
- Small, understorey tree (4-6 m tall)
- Produces extensive seedbank
- Common in wet, acidic soils
- Sample plots averaged 11-25 stems/m^2

Asian Bittersweet (*Celastrus orbiculatus*)
- Woody, deciduous vine
- Climbs up to 20 m and can overtop mature canopy trees
- Forms extensive ground cover in disturbed areas.
- Sample plots averaged 30-90 % cover

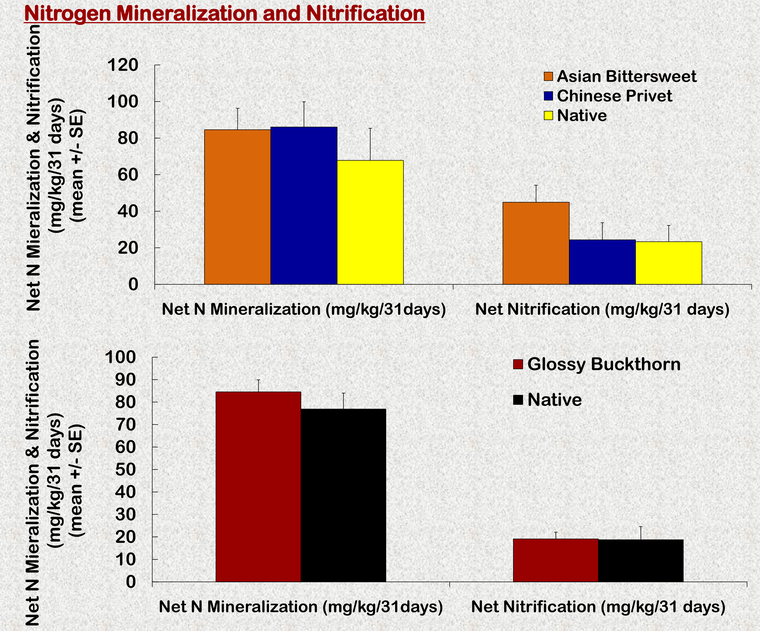
Acknowledgments
The authors thank Kara Blakeley, Kelly Conley, Katlin Leo and Laura Zawleskey for their help with fieldwork and lab analyses.

Inorganic Nitrogen



Soils from both Asian bittersweet and glossy buckthorn had significantly greater inorganic N (NH_4, NO_3 and total inorganic N) compared to soils from native vegetation sites. There was no difference between Chinese privet and native vegetation sites for any measure of inorganic N availability.

Nitrogen Mineralization and Nitrification



There were no significant differences among exotic or control plots for net N mineralization and nitrification..

Soil pH, Organic Matter and Exchangeable Cations

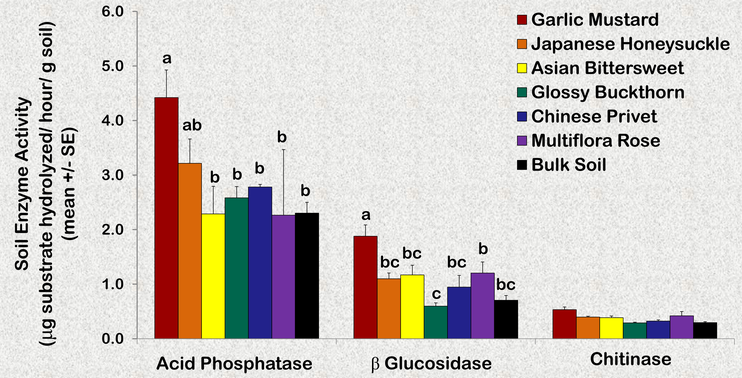
Site	pH (+SE)	Organic Matter (%)	Ca^{2+} ($cmol_c$/kg soil)	Mg^{+} ($cmol_c$/kg soil)	CEC ($cmol_c$/kg soil)	Base Saturation (%)
Asian Bittersweet	5.1 (0.25)^{a}	3.73 (0.32)^{ab}	6.44 (1.71)^{a}	0.92 (0.16)^{a}	8.11 (1.90)^{a}	80.2 (8.6)^{a}
Chinese Privet	5.2 (0.44)^{a}	3.39 (0.22)^{b}	3.71 (1.14)^{ab}	0.78 (0.18)^{ab}	5.18 (1.33)^{ab}	61.5(7.4)^{a}
Native	4.0 (0.11)^{b}	4.50 (0.23)^{a}	1.33 (0.52)^{b}	0.39 (0.10)^{b}	2.39 (0.69)^{b}	29.1 (8.1)^{b}
Glossy Buckthorn	4.3 (0.07)	3.63 (0.27)	0.81 (0.14)	0.25 (0.02)	1.59 (0.18)	23.1 (2.6)
Native	4.2 (0.06)	4.08 (0.30)	0.75 (0.12)	0.21 (0.01)	1.45 (0.13)	20.0 (2.0)

Soil pH and cation exchange capacity differed among invasive dominated and native dominated sites. Soils from Asian bittersweet sites had significantly greater pH, exchangeable cations, and % base saturation compared to soils from native vegetation sites. Chinese privet sites had significantly greater pH, and % base saturation. Chinese privet soils also had significantly lower soil organic matter compared to native vegetation soils. There was no difference between glossy buckthorn sites and native vegetation sites.

Experiment 2 – comparison of rhizosphere and bulk soils

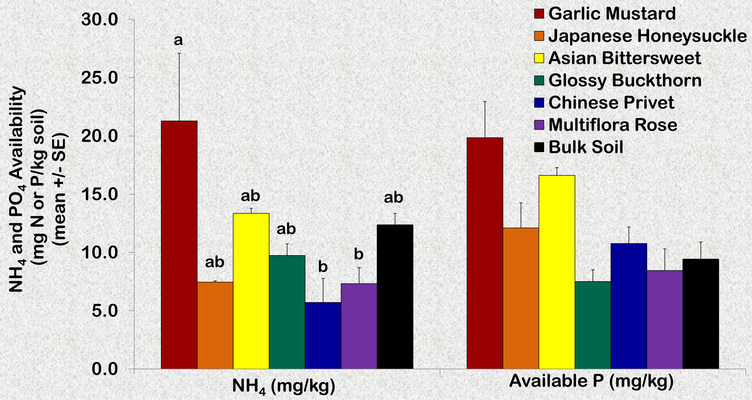
We collected rhizospere and bulk soils from experimental plots where invasive plants were being mechanically removed. Invasive plants present at the sites included Japanese honeysuckle (*Lonicera japonica*), mulitiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata),* glossy buckthorn (*Rhamnus frangula*), Chinese privet (*Ligustrum sinese*)and Asian bittersweet (*Celastrus orbiculatus*). We compared soil enzyme activity, and nutrient pools between rhizosphere soils collected from the roots of each invasive plant and bulk soils within the restoration plots

Soil Enzyme Activity



The actvitiy of acid phosphatase and β glucosidase was significantly greater from soils collected from the rhizosphere of garlic mustard compared to the rhizoshpere of other invasive plants and the bulk soil. There was no difference in the activity of chitinase among the rhizosphere or bulk soil.

Nitrogen and Phosphorus Availability



Soil NH4 was significantly greater in the rhizosphere of garlic mustard compared to Chinese privet and multiflora rose. There was no difference in soil available P among rhizosphere and bulk soil.

Conclusions

- Invasion of natural ecosystems by non-native species can alter community composition and ecosystem properties.
- In our hardwood forest ecosystem, we observed the largest differences among invasive dominated and native dominated sites in the availability of inorganic nutrients (including NH_4, NO_3, PO_4 and exchangeable ions).
- However, there were few differences in the rates of nutrient processing (N mineralization and nitrification) or faunal biomass (microbial biomass P or microarthropod abundance).
- In our second experiment, rhizosphere soils from garlic mustard showed the largest differences from other invasive plant rhizosphere soils and bulk soil. Garlic mustard has been shown to have a large impact on both soil properties and nutrient availability and the microbial community.