Impact of Invasive Buckthorn on the Soil Mycobiome Surrounding Wetlands

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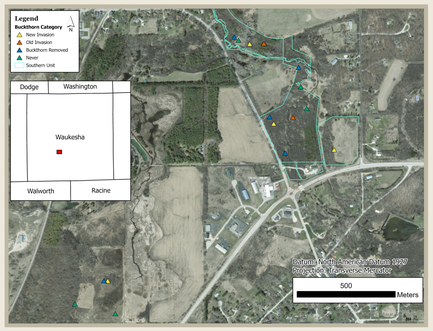
Introduction

- Human activity disperses species beyond their historical natural geographic range. Invasive species establish in new ecosystems and thrive in ways that displace native and endemic species, altering community and ecosystem function.
- Plants manipulate their environment and disadvantage their competitors by releasing chemicals into the environment (allelopathy).
- Buckthorn (*Rhamnus cathartica*) has long been reputed to release allopathic chemicals. Evidence from our field station suggests that the presence of buckthorn in the environment has wide-ranging effects including reduction of understory and other ground-level plants.
- Fungi are an important, but understudied, component of ecosystems. Because of their complex relationships, changes to fungal communities can have significant effects on their ecosystems.
- This research seeks to determine if the presence of buckthorn affects the soil mycobiome and physical properties of soil.

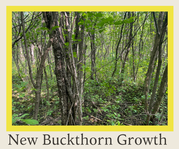
Methods



- Twenty-nine soil samples were collected from Prairie Springs Environmental Education Center (PSEEC) and Genesee Oak Openings (GOO) in southeastern Wisconsin.
- Sample sites were paired based on proximity and/or ecosystem similarities.
- Each site was categorized into one of four groups:

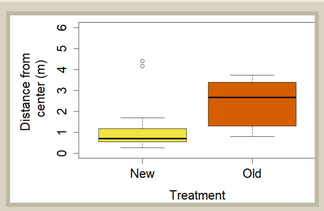

Never Invaded


Buckthorn Removed


New Buckthorn Growth


Old Buckthorn Growth

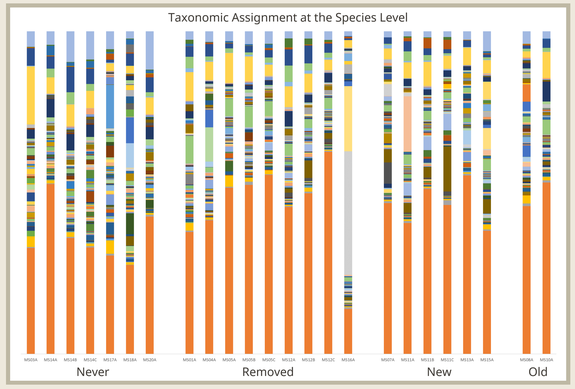
- Where buckthorn was present, four buckthorn trees determined by point-quarter method were measured for their distance from the center tree and their diameter at breast height (DBH) as a proxy for the relative age of buckthorn stands.
- DNA extraction was conducted using a DNEasy PowerSoil Pro Kit.
- DNA was sent to Psomagen, Inc. for shotgun metagenome sequencing.



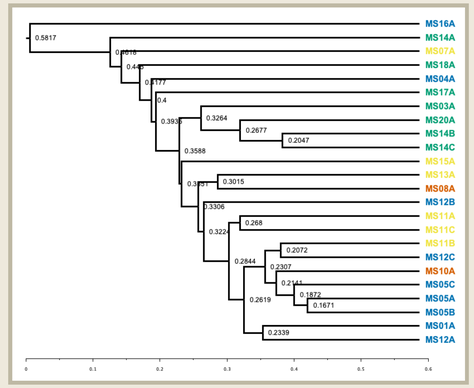
The higher distance between trees in the old growth buckthorn plots insinuates lower tree density, which may be related to successional growth and the results of competition limiting the quantity of trees the land can support.

Results

- Overall, we recovered 12 phyla, 31 classes, 79 orders, 152 families, 215 genera, and 244 species in all samples combined
- Although we used fungal primers, many results were either associated with other eukaryotes or could not be assigned (about 54% of sequences averaged across all samples).
- Some additional samples were assigned to fungi, but could not be identified to smaller taxa.
- Ascomycota is the most commonly identified fungus in these samples.



- The most common taxa present at MS16A differed from other sites; these taxa were *Cuphophyllus virgineus* and the *Hygrocybe* genus, which are both waxcap mushrooms.
- The notable bar of MS17A is from the genus *Stropharia.* This was also looked into more due to its unique presence in comparison to the other sites.



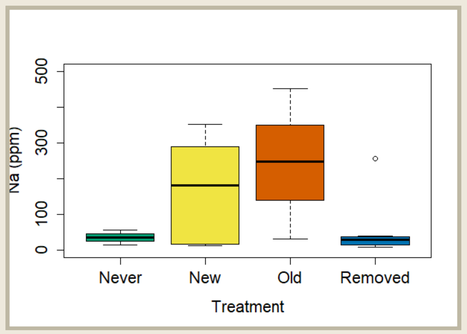
The clustering of most of the buckthorn-affected sites on the dendrogram indicates that they have similar fungal communities and never-invaded sites often have less similar communities.

The most common fungus identified was *Phoma herbarum*, a plant pathogen (7% on average across all samples).

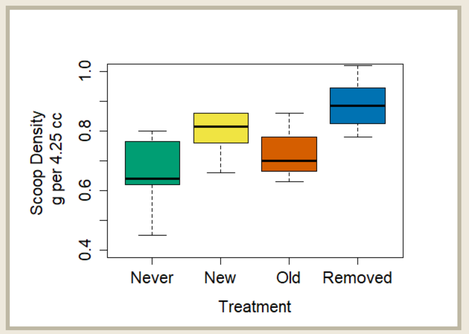
The second most common fungus identified was *Neonectria* sp, a widely-distributed saprophyte (6% across all samples).

The third most common fungus identified was *Metarhizium anisopliae*, a member of a widely distributed group that parasitizes insects (1.7% across all samples).

Soil Characteristics



There is a significant difference (p=0.027) of Na concentrations between treatments, with presently invaded sites having significantly higher levels of Na compared to those with no active buckthorn stands.



There is a significant difference (p=0.017) in the density of soil between treatments. Removed has the highest density, likely due to higher levels of human activity and disturbance.

Discussion

- Although the differences were subtle, soil fungus communities differed between sites with different buckthorn invasion histories.
- The two prevalent species of mushroom in MS16A are waxcaps. These species are indicative of a grassland environment which could signify success in the overall restoration of this site following buckthorn removal.
- The difference in Na concentration between treatments correlates with buckthorn presence. These effects do not seem to have a lasting impact, as areas that have undergone buckthorn removal have similar levels to those with no history of invasion.
- The dendrogram indicates that there may be a relationship between buckthorn history and fungal species present at a given site.

Moving Forward

- Increased sampling might increase our ability to detect subtle differences among fungal soil communities.
- Future research into how the soil composition and fungal communities of each treatment group impacts the surrounding flora and fauna may help determine the role of fungus in buckthorn invasions.
- Restoration methods may be altered to account for the impact that buckthorn may have on the soil mycobiome. Rather than only doing buckthorn removal and herbicide application, soil transplants could be used to achieve whole-ecosystem restorations.

Acknowledgments

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