Cascading impacts of plant dispersal and environmental limitations on pollinator communities on a capped landfill in the New Jersey Meadowlands

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ABSTRACT

Large landfills in the New Jersey Meadowlands provide human-derived environmental conditions that are quite different from the surrounding marsh ecosystems. What types of communities of plants grow on these landfills? What are processes that create these communities? How does the resultant plant community impact the pollinator community? Many ecologists have found that plant communities are formed through a hierarchy of processes or filters including dispersal and soil suitability, followed by competition and interaction with other trophic groups including pollinators and birds. We determined the limiting ecological factors for plant communities on capped landfills by conducting a seed and soil addition experiment with a fully factorial design on Erie Landfill within the New Jersey Meadowlands. The added seed provided a way to test whether dispersal is a filter for the plant communities on Erie Landfill. The added soil allowed us to compare different soil environments to determine potential environmental restrictions on plant communities. The seed mix added was comprised of hardy, early successional species that are commonly used after a landfill has been capped. We found that landfill plant species are dispersal limited, but that environmental conditions further limit the species that are able to germinate and survive. Ecological limits on the plant community have cascading effects on pollinator communities where abundance of bees is related to plant community composition. In order to support diverse bee communities, capped landfill land managers may want to focus on overcoming these ecological limitations for pollinator friendly plants.

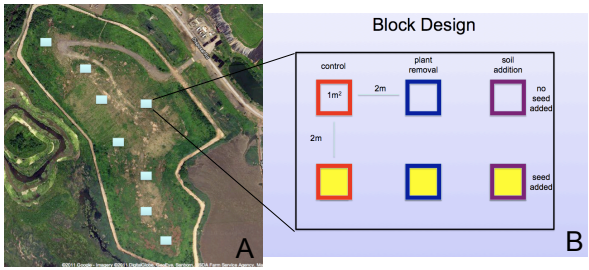

FIGURE 1. A) Erie Landfill, New Jersey Meadowlands, each rectangle is one experimental block. B) Each block contained 6 plots, each with a different treatment combination (see Figure 2A).

INTRODUCTION

Ecological communities are made up of living organisms that interact with one another. Multiple biological filters working in concert are thought to control for community composition. These filters include environmental conditions such as climate and soil, as well as dispersal ability of organisms and interactions between species. Urban communities have been severely impacted by anthropogenic forces including pollution, introduction of non-native species and fragmentation of native habitat. These anthropogenic filters often create novel communities.

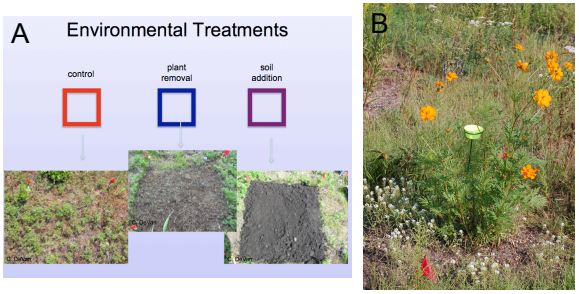

FIGURE 2. A) Three environmental treatments were used within each block to test for environmental filters of soil quality. Using a block design, each environmental treatment was combined with a seed addition treatment, which tested for dispersal filters (see Figure 1B). B) End of season example of a seed addition + soil addition plot. The yellow bowl in the center of the plot is a trap that samples for bees.

APPROACH OF WORK

We used an experimental approach to test for the existence of specific filters (dispersal and soil environment) for an urban plant community. Our experiment was performed on an unrestored capped landfill where the extant community had developed "spontaneously." Using a block design (Figure 1), we created 8 blocks each with one replicate treatment combination (Figure 2). Controls were plots of un-manipulated existing vegetation. Soil moisture was used as an indication of soil quality. Bees were sampled within each plot to determine how plant community composition impacts other trophic groups.

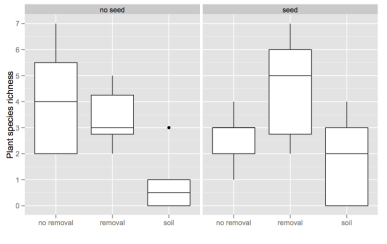

FIGURE 3. Plant species richness (number of plant species per plot) averaged across each treatment. There is a statistically significant interaction between environmental and seed addition treatments on plant species richness.

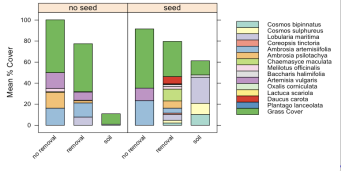

FIGURE 4. Mean % cover of plant species per treatment. The first 4 species listed were seed additions, the rest were extant species. Grass cover includes all grass species combined. Community composition varies greatly between treatment. Existing vegetation may act as a biotic filter preventing new individuals from establishing.

RESULTS & CONCLUSIONS

- Urban plant communities are impacted by:
  - Dispersal limitations (Figure 3)
  - Environmental conditions (Figure 3) such as soil moisture (Figure 5)
  - Competition from existing species (Figure 4)
- Soil moisture is highly correlated with plant species richness (Figure 5)
- There is a trend for bee abundance to be related to plant species richness (Figure 6) but more research is needed.

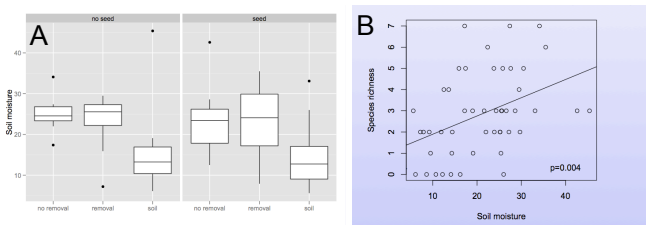

FIGURE 5. A) Mean soil moisture (% volumetric water content) per treatment. Soil moisture is generally lower for the soil addition treatment. B) Correlation between species richness and soil moisture. Correlation is statistically significant indicating that soil moisture may act as an environmental filter for plant communities.

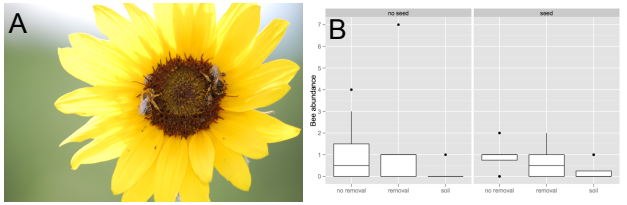

FIGURE 6. A) *Helianthus annuus* (common sunflower) with two bee visitors. Bees are dependent on flowers for food and in exchange provide pollination services. Therefore plant community composition can have important impacts on bee communities. B) Mean bee abundance per treatment. Treatment differences are not statistically significant however there is a trend for bee abundance to increase with plant species richness.

INNOVATION & RELEVANCE

By using an experimental approach to test for ecological filters, we are able to provide a mechanistic understanding of plant community development in urban areas. Our results can be used by land managers who want to restore ecological function to degraded urban areas.

ACKNOWLEDGMENTS

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