Study of The Compositional Change of The CGC Green Roof
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Introduction

In many landscapes, ecological succession, the process by which a biological community changes in composition over time, occurs [1,2]. Green roofs (rooftops that house vegetation) act as ecological communities by hosting diverse assemblages of flora and fauna [3]. Green roofs enable scientists to closely study environmental changes that occur in ecological communities [4]. Recent research suggests that native plants, especially on unmanaged green roofs, are likely to be succeeded by hardier colonizers and invasive species due to the harsh conditions generally present on green roofs, including strong winds, high exposure to solar radiation, and acidic soil [5].

The Center for Global Conservation’s (CGC) green roof (figure 1), originally established in 2009, has been unmanaged for seven years (figure 2). Its plant community, originally consisting of native New England grasses, low-growing wildflowers, and small shrubs has been succeeded by common invasive weeds and trees, such as mugwort and tree of heaven.

Our study of the CGC’s green roof explores how both the biotic and abiotic conditions of an unmanaged, sloped intensive green roof have changed from 2009 to 2016. Specifically, we investigate how and to what extent the green roof’s community of native northeastern American grasses, shrubs, and forbs has been replaced by colonizers. In addition to how the green roof’s growing medium has been altered.

Methods

To determine the correlation among soil depth, soil moisture, species richness, and species abundance, we took six growing medium samples, each from every 6 meters along the midpoint of the roof.

To measure the average height of each species along areas of differing growing medium depths and levels of moisture, we used a random sampling technique. We laid out a 63 meter long transect that bisected the roof through its midpoint. Every three meters along this transect we recorded soil depth measurements two meters to the left and right. Along each of these three meter points we took soil-depth measurements two meters to the left and right. At each of these three meter points we laid out eight quadrats that spanned across the width of the roof. We performed a visual estimate of the grasses, trees, shrubs, and forbs rooted in each quadrat and assigned each species a Daubenmire cover class (table 1) and stem count. We took six growing medium samples, each from every 6 meters along the midpoint of the roof. We sent our samples to the University of Massachusetts, Amherst Soil and Plant Nutrient Testing Laboratory for routine soil analysis.

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Results

1. How has the composition of the CGC’s green roof changed, in regards to both biotic and abiotic factors, from 2009 to 2016?
2. Is there a correlation between growing medium depth and plant species richness or abundance?
3. Is there a correlation between growing medium moisture levels and plant species richness or abundance?

Hypotheses: We hypothesize that as the growing medium depth on the green roof increases, the abundance and richness of plants will increase because deeper soil is able to house a larger number of plants, while retaining more water [1]. For this reason, we also believe that there will be a positive correlation between growing medium moisture and plant species richness and abundance.

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Discussion

Our hypothesis regarding growing medium quality was incorrect. As shown by figure 3, the only plant available nutrient that reduced by more than 10% rpm was magnesium [1]. In 2009 the growing medium had a pH range of 5.5-7.5, while in 2016 the growing medium had a pH range of 6.1-6.8. This indicates that the pH across the green roof has become more uniform.

The range of the total percentage of organic matter in the growing medium has changed from 6-12% in 2009 to 4-8.5% in 2016.

Our hypothesis that deeper growing medium and moisture levels would positively correlate with the abundance of plants was supported. As shown by figures 5, 7, and 11, there is a strong correlation between growing medium depth and plant abundance-specifically average cover class, average plant height and average stem count; they have r² values of 0.622, 0.813, and 0.775, respectively.

There is a significant, but slightly weaker correlation between plant abundance and growing medium moisture levels, as shown by figures 4, 6, and 10, whose r² values are 0.673, 0.8, and 0.561, respectively.

Contrary to our hypothesis, we found a slightly negative correlation among average species richness, growing medium depth, and growing medium percent moisture, as can be seen in figures 8 and 9, whose r² values are 0.383 and 0.24, respectively.

Although there is no significant relationship among average species richness, growing medium depth, and growing medium percent moisture, the overall species richness of the green roof has increased slightly from 25 species in 2009 to 30 species in 2016.

Conclusion

After seven years, the CGC green roof’s growing medium has changed minimally; it now has a narrower range of pH levels, slightly less organic material, and similar levels of plant available nutrients.

There is a positive correlation among plant abundance, growing medium depth, and growing medium moisture levels; there is a negative correlation among species richness, growing medium depth, and growing medium moisture levels.

When the green roof was originally established there were a total of eight non-native species; currently there are 15 non-native species, including 11 forbs, one tree, and three shrubs. This demonstrates that the CGC green roof is undergoing succession by mostly non-native species and, as a result, the species richness of native species is gradually decreasing.

Only six of the original species remain on the green roof. Of these species, two are grasses, three are forbs, and one is a shrub.

Table 1: Daubenmire[1] Cover Class Ranges

<table>
<thead>
<tr>
<th>Cover Class</th>
<th>Range of Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-5%</td>
</tr>
<tr>
<td>2</td>
<td>5-25%</td>
</tr>
<tr>
<td>3</td>
<td>25-50%</td>
</tr>
<tr>
<td>4</td>
<td>50-75%</td>
</tr>
<tr>
<td>5</td>
<td>75-95%</td>
</tr>
</tbody>
</table>

Fig. 2: Concentration of Nutrients in Growing Medium

Fig. 8: As the growing medium moisture increases, the average stem count increases.

Fig. 9: As the growing medium depth increases, the average cover class decreases.

Fig. 10: As the growing medium moisture increases, the average species richness decreases.

Fig. 11: As the growing medium depth increases, the average stem count increases.

References


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