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A Four Year Study of the Effects of Substrate Depth on the Survival of Different Plant Species in Portland, OR

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Why green roofs?
Green roofs provide ecosystem services (contributions for humans by the ecosystem) like reducing urban heat-island effect, regulating a building’s temperature, improving storm water management, increasing urban habitat, and providing a space where people and nature can connect (Oberndorfer et al., 2007).

What is the difference between extensive and intensive green roofs?
Extensive green roofs have a depth of 3-6 inches. Intensive green roofs have depths greater than 6 inches. The different depths affect the performance of the roof, the types of plants to use, and its maintenance plan (Dunnett et al., 2008).

Why study CHERP?
CHERP has been not been maintained heavily after its installation. This provides a rare opportunity to study a neglected green roof and observe what originally planted species succeed in the Pacific Northwest climate.

A FOUR YEAR STUDY OF THE EFFECTS OF SUBSTRATE DEPTH ON THE SURVIVAL OF DIFFERENT PLANT SPECIES IN PORTLAND, OR
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University Honors College, Portland State University, Portland, OR

Abstract
The changes in green roof plant species composition was observed after a four year time period. Twelve plots were planted in either native or non-native species at two different substrate depths according to a 2 by 2 factorial design. The list of original species from installation was used to identify which species survived over time in their respective plots. After four years, 9 out of 12 native species and 13 out of 14 species survived. The high survival of 26 original species must be compared to the colonization of 68 new species. With minimal maintenance, new species colonized plots. Extensive plots were composed of 33% original planting and 67% colonizing species. Intensive plots were composed of 24% original plantings and 76% new species. The original species that had the highest survival were Sedum and Festuca.

Background & Significance

Materials & Methods

During spring of 2016, a class collected the following samples from the Cramer Hall green roof: substrate, insects, temperature, plant coverage, plant height, and plant diversity. For the purpose of this study, strictly plant diversity data was used.

The original plant list was referred to, to compare with the observed species that survived in the plots after 4 years.

Observations were made between extensive native, extensive nonnative, intensive native, and intensive nonnative plots.

Results

Table 1: Original species that have survived in the extensive and intensive plots after 4 years.

<table>
<thead>
<tr>
<th>Type</th>
<th>Extensive</th>
<th>Intensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedum oreganum</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Festuca rubra</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Festuca subulata</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sedum tectorum</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Sedum kamtschaticum</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sedum kamtschaticum var. oreganum</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sedum kamtschaticum var. rupestre</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sedum kamtschaticum var. oreganum</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sedum kamtschaticum var. spurium</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Non-Native</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Festuca subulata</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sedum oreganum</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sedum kamtschaticum</td>
<td>3</td>
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<tr>
<td>Sedum kamtschaticum var. oreganum</td>
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</tr>
<tr>
<td>Sedum kamtschaticum var. spurium</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

The species that had the greatest survival on the extensive plots were Festuca idahoensis, Festuca glauca, Sedum oreganum, and Sedum rupestre. On the intensive plots, the species with the greatest survival were Sedum rupestre and Sedum album.

Knowing the long term survival of these species indicate they are adaptable and resilient to the Portland climate and should be considered for other local green roofs.

The colonization by outside species indicate how important maintenance is to ensure the desired plant composition remains intact. The high percentage of new species across all plots suggest that research should be conducted to review the fit of colonizing species on green roofs. If these species colonized CHERP and prove to be resilient to the Portland climate, they should be added to the list of suggested plants for green roofs.

The overall, the plants chosen for CHERP did well on the Cramer Hall rooftop. After four years, 9 out of 12 native species and 13 out of 14 nonnative species survived.

A future study can be to repeat the study to see if the same observations can be made. In addition, compiling a more thorough study to incorporate substrate, insects, temperature, plant coverage, plant height, and plant diversity would provide a greater understanding of the Cramer Hall green roof.

The colonization by outside species indicate how important maintenance is to ensure the desired plant composition remains intact. The high percentage of new species across all plots suggest that research should be conducted to review the fit of colonizing species on green roofs. If these species colonized CHERP and prove to be resilient to the Portland climate, they should be added to the list of suggested plants for green roofs.

Acknowledgements

I would like to thank my research advisor, Dr. Olyssa Starr and the BUILD EXITO research program for supporting me. I would also like to thank the PSU living lab program for including us in their program, and PKI facilities for letting us collect samples from the Cramer Hall rooftop.

References


Figure 1: Green roof at Portland State University (Bolkan, 2012).

Figure 2: Green roof layers (Details of green roof).

Figure 3: Photo of students collecting samples from CHERP.

Figure 4: Species that had the greatest survival on the green roofs. (Left to right) Sedum album, Festuca glauca, Sedum rupestre, Festuca idahoensis, and Sedum oreganum.

Figure 4: The charts of percent composition between original species and new species between plots.

Figure 5: Pie charts of percent composition between original species and new species between plots.