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Report for the James Rennie Bequest

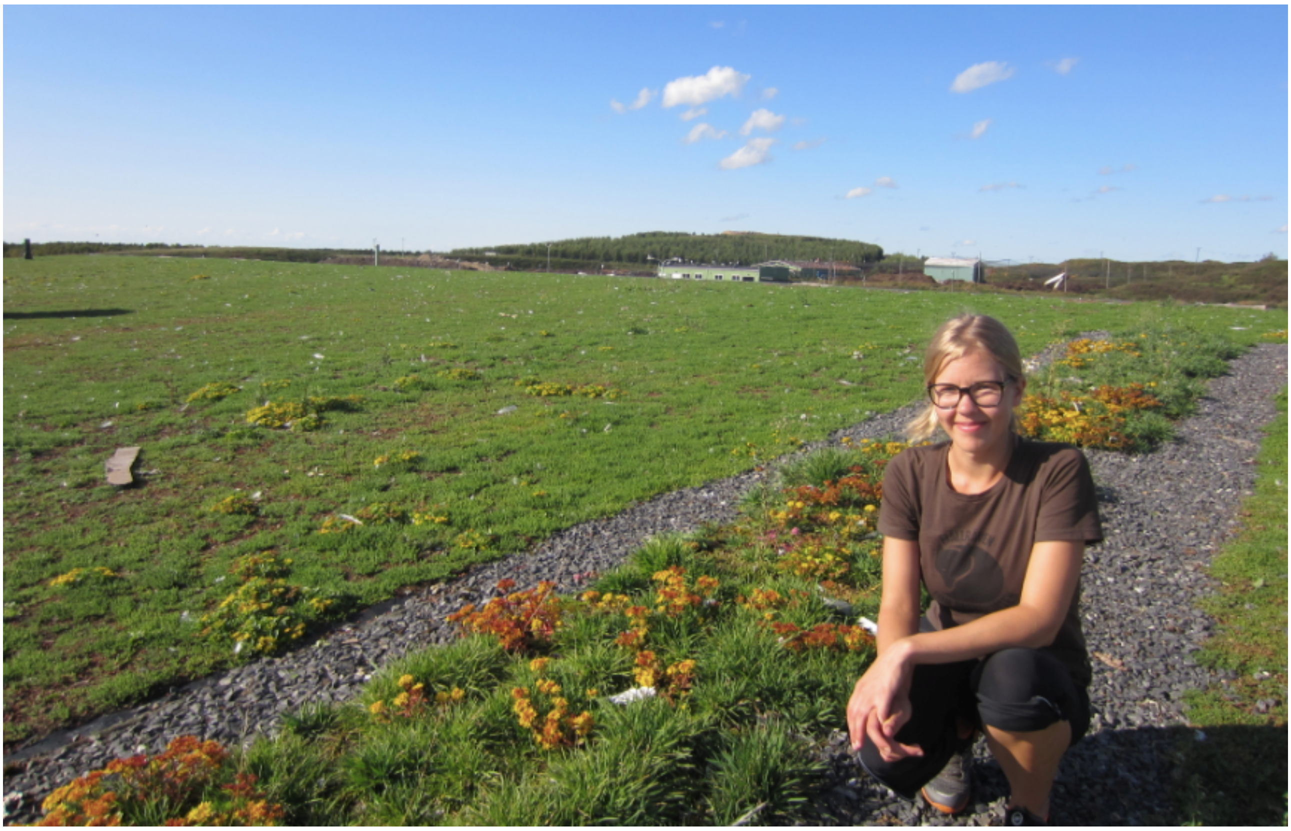
Dear Committee of the James Rennie Bequest,

I am writing to you to provide you with a report of the research project I carried out in June-August 2013. Without the support from James Rennie Bequest I would have not been able to develop my research skills to the extent I did, and I am extremely thankful for your support.

All the best

Anja Helena Liski

BSc Ecological Science (Ecology)
3rd year of study



Expedition/Project Name	**Survival and diversity of urban rooftop plant communities**
Contact name & e-mail address	**Anja Helena Liski & A.H.Liski@sms.ed.ac.uk**
Location	**Helsinki, Finland**

Introduction and aims

Integration of nature into urban architecture in the form of green roofs can be used to provide ecosystem services for urban citizens and compensate for habitat losses due to urban development. There have been a several studies on the performance of meadow species in United Kingdom (Nagase and Dunnet 2013), Germany (Köhler 2006) and United States (Dewey *et al* 2004) but the optimising conditions for meadow species in the Finnish climate region has not been studied before.

The fieldwork to be carried out is an essential part of a long-term experiment looking into the plant community dynamics on extensive roof systems that are characterised by having a shallow substrate depth (<0.2 m) and low maintenance requirements (Dunnett and Kingsbury 2008). This project is a preliminary investigation of the treatment effects (substrate depth and quality) on plant species abundance on experimental extensive green roof plots established in summer 2012.

Methods

Four substrate types are investigated: substrate with limestone; substrate with biochar; substrate with limestone and biochar; substrate without limestone and biochar. Two types of meadow vegetation are investigated: vegetation a) has a sedum-grass-meadow-herb mat provided from Vegtech and added seed mixture from Suomen Niittysiemen. Vegetation b) consists of plug plants from Vegtech and added seed mixture from Suomen Niittysiemen. The effect of total substrate depth is investigated at 1 cm intervals between from 5 to 10 cm.

All species found within the plot area were identified and relative abundance of species found within quadrats was estimated. All plots have four right angles, 1 m wide from one side, and the width of the second side varies from 2-15 m. The plot was divided into 2 m^2 squares along the longer edge, and the area that does not fill a 2 m^2 square was excluded from sampling (Figure 1). A 0.5 m^2 quadrat was placed in the middle of the 2m^2 square (Figure 1). The relative abundance of each species in the 0.5 m^2 quadrat was estimated by two observers in percentages and the average of the two estimates was recorded.

2 m^2 square	0.5 m^2 quadrat	2 m^2 square	2 m^2 square	2 m^2 square

Figure 1. The layout of squares within a 10 m^2 plot and how the 0.5 m^2 quadrat is placed in the square.

A minimum of 1/8 of total plot area was sampled within each plot. Some of the roofs were on a shallow slope, and due to the drainage of water downwards the plants in the lower were less limited by water. To ensure both ends of the moisture gradient were sampled, plots were sampled systematically and the starting point for sampling was drawn randomly.

Statistical analyses were carried out using General Linear Model framework in Minitab 16 in which two models were built. The response variable in the first model was herb level cover (%) and in the second model moss cover (%). For both models roof (nine levels), presence of biochar (two levels), presence of limestone (two levels) and vegetation (two levels) were added as categorical explanatory variables; substrate depth and treatment area were added as covariates. Visual assessments of the residual distributions were carried out to see whether GLM was suitable for the data set.

Results

For the herb cover, a significant difference between roofs ($P<0.05$) and vegetation types ($P<0.05$) was found; no significant effects of area ($P>0.05$), biochar ($P>0.05$), limestone ($P>0.05$), and depth ($P>0.05$) were found. The residual distribution for herb cover appears normal with a mean close to zero in a cumulative plot and in a histogram. The residual distribution against their fitted values is not random for fitted values smaller than 0. The residual distribution against their observation order increases in variance for observations higher than 50.

For the moss cover, a significant difference between roofs ($P<0.05$) and vegetation types ($P<0.05$) was found; no significant effects of area ($P>0.05$), biochar ($P>0.05$), limestone ($P>0.05$), and depth ($P>0.05$) were found. In the cumulative plot, residual distribution appears fairly normal, but there are some outliers for higher and smaller values. In the histogram the distribution appears fairly normal with a mean close to zero. The residual distribution against their fitted values is not random for fitter values smaller than 30. The residual distribution against their observation order appears normal.

Discussion

Estimates of the percentage cover of different moss species were very inaccurate as species that were thought to be a single species turned out to be a mixture of many species that were impossible to distinguish without microscopic examination. Bryophyte species should be treated as a single group in further analyses.

The main limitation of the project is that patterns in species diversity were not analysed, because 15 collected samples are still unidentified in Helsinki. Some graminoid samples may turn out the same species, and most bryophyte samples are almost certainly a mixture of many species. The analyses were therefore limited to comparing treatment effects on functional groups.

Overall, residual distributions against their fitted values and observation orders were not considered to be random. Using general linear model is therefore not suitable for this data set and further analyses should be conducted using *generalised* linear model in R program. The analyses conducted found no significant treatment effects (substrate depth, biochar or limestone). Either there were no significant differences between treatments or the models were not sensitive enough. Constructing a mixed model with roof as a random effect would allow higher statistical power, as only 2 degrees of freedom would be lost instead of nine.

Conclusion

Better monitoring techniques should be developed for estimating species cover for bryophytes using microscopes. More sophisticated and better suitable models should be constructed for further analyses of the dataset.

Personal Statement

This project was a great academic and professional asset that gave me a chance to practice ecological science in practice.

Summary

I estimated the abundance of plant species growing on experimental rooftop plots to see whether substrate depth and quality effect the survival of plants. This knowledge can be applied to improve the value of green roofs in habitat provision for urban nature.

Acknowledgements

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