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Detecting a change in diversity of vascular plants in the natural forest reserve 'Gaisberg' – a comparison of a systematic and representative sample approach

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Abstract

In the natural forest reserve 'Gaisberg' (Vienna Woods) a vegetation survey was carried out including the Representative Vegetation Survey (RVS) and the Systematic sample Plot Cluster method (SPC). Focusing on the herbal layer, both methods are compared. Thus, it is possible to estimate the information value regarding changes in species composition and vegetation dynamics.

Both methods detect a significant loss in species. However, it is more pronounced in the systematic sampling. According to the large plots of the representative sampling more rare and high dispersed species were assessed compared to the small systematic plot clusters. Thus, quite a number of species had higher frequencies in the representative plots which favour statistical analysis. However, a generalization of the representative approach is not possible, because the results are not area-related. Moreover, the selection process probably discriminates sites characterized by inhomogeneous vegetation structure with high dynamics.

Keywords

natural forest reserve, biosphere park Vienna woods, vegetation survey, monitoring, sample design, decreasing diversity.

Introduction

The Austrian Natural Forest Reserve Programme was initiated in 1995. Today it consists of 195 reserves with a total area of 8400 ha. One of these protected areas is the natural forest reserve 'Gaisberg', which is also part of the 'biosphere park Vienna Woods' (Biosphärenpark Wienerwald). It is 29 ha in size and is located 20 km southwest of Vienna. In the course of the establishment a vegetation survey based on representative sample plots was carried out in order to document and characterize the occurring forest communities (Steiner & Karrer, 2003). To detect vegetation dynamics additionally a systematic survey was conducted. Both, representative and systematic method were repeated after a certain time span, assessing changes in the occurring vascular plant diversity of the herbal layer. Comparing the results of these methods, strengths and weaknesses in detecting diversity and vegetation dynamics are outlined.

Methods

The study area is dominated by a beech forest community (*Cyclamini-Fagetum*). Another occurring community is an oak-hornbeam forest (*Galio sylvatici-Carpinetum*). Both associations are rich in species and can be differentiated into two sub-associations (Tab. 1) due to their species composition.

Two different methods of vegetation survey are compared (Fig. 1, Tab. 1).

A **Systematic sample Plot Cluster method (SPC)** with 27 cluster plots was carried out on a 100 x 100 m grid. On each intersection 8 sub-plots of 1 m² were placed in 5 m distance according to the 8 cardinal points. For each sub-plot the presence of each vascular plant species was assessed and thus a scale of frequency classes from 1 to 8 could be defined. The observing interval is 15 years. For statistics, surveys from 1998 and 2013 were analyzed.

The **Representative Vegetation Survey (RVS)** was applied including 27 plots á 100 to 500 m² (on average 296 m²). The observing interval is 20 years using data from the 1997 to 2017 survey period. The selection process of them is based on expert considerations regarding soil type, vegetation structure and species composition (Braun Blanquet, 1964). The estimation of the plant species cover distinguishes 8 different categories, following Willmans method (1989). These are:

1. 1 to 5 individuals ;
2. 6 to 50 individuals ;
3. > 50 individuals in which categories 1, 2 and 3 respectively have less than 5 % of plant surface cover;
4. 5-15% plant surface cover;
5. 16-25%;
6. 26-50%;
7. 51-75%; and
8. 76-100% plant surface cover disregarding frequencies.

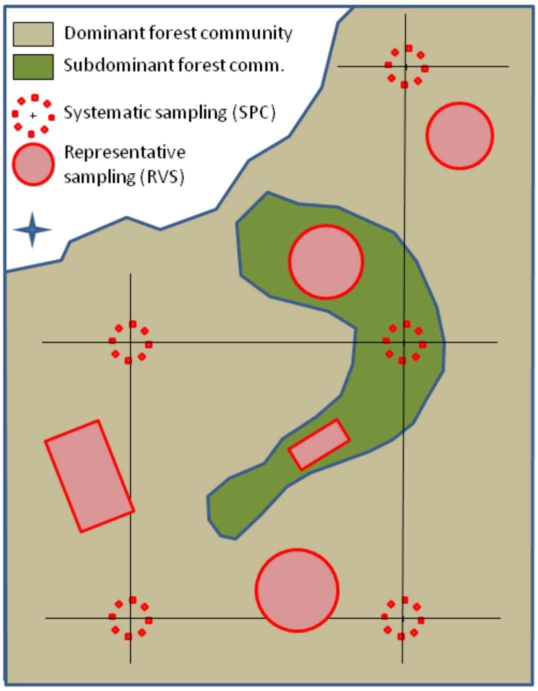

Figure 1: Schematic diagram of the representative (RVS) and systematic (SPC) sampling design.

Method	SPC	RVS
Total number of Galio sylvatici-Carpinetum cluster plots	4	12
Galio sylvatici-Carpinetum typicum sub-association	2	4
Gal. sylv.-Carp. primuletosum veris sub-association	2	8
Total number of Cyclamini-Fagetum cluster plots	17	15
Cyclamini-Fagetum typicum sub-association	12	8
Cyclamini-Fagetum seslerietosum sub-association	5	7
Unclassified	6	0
Total number of plots	**27**	**27**

Table 1: Number of sample plots per method and forest community.

Results

During both periods, the total number of vascular plant species present in all plots and plot clusters was assessed. Using SPC method, 161 species were present in period 1 and decreased to 135 species in period 2. The RVS method also showed a decrease from 193 to 171 species (Tab. 2).

With regard to the single plot or plot cluster, the average species number decreased from 28,8 to 18,7 using SPC method and from 52,6 to 46,1 with RVS method respectively. Both results were significant according the paired t-Test (TRAXLER, 1997) and a significance level of 99%. Referring the forest communities the loss of diversity was highest in the beech forest sub-association *Cyclamini-Fagetum typicum* (Tab. 2).

Both methods show obvious differences in the frequency of the occurring species. Due to the larger plot size, the frequency of quite a number of species, like some orchids (*Cephalanthera* spp.), martagon lily (*Lilium martagon*), wild cherry (*Prunus avium*) and february daphne (*Daphne mezereum*), is significantly higher in the RVS method than in the SPC method.

Furthermore, the distribution of the sample plots within the forest communities influences presence and frequency of the species. Due to the higher number of RVS plots in the oak-hornbeam forest (*Galio sylvatici-Carpinetum*), the number of species related to this community are more abundant.

The Wilcoxon's median comparison test (significance level 95%) (KÖHLER et al., 1995) reveals a decrease for 16 species using SPC data. With RVS data such a decrease is significant even for 40 species.

A particularity is the frequency change of ash (*Fraxinus excelsior*). For this tree species an increase was significant for SPC data only.

Method	SPC		RVS	
Period	1	2	1	2
Average number of species				
Galio sylvatici-Carpinetum	31,3	24,0	55,4	48,6
Galio sylvatici-Carpinetum typicum	37,0	29,0	68,8	62,5
Galio sylvatici-Carpinetum primuletosum veris	25,5	19,0	48,8	41,6
Cyclamini-Fagetum	24,2	15,5	50,4	44,1
Cyclamini-Fagetum typicum	22,8	13,6	39,8	33,9
Cyclamini-Fagetum seslerietosum	27,6	20,2	62,6	55,9
Unclassified	40,3	24,2	-	-
Total number of species within the sample	161	135	193	171
Average number of species per plot	28,81	18,7	52,6	46,1
standard deviation	2,66	2,57	3,04	3,54

Table 2: Number of species assessed using the systematic (SPC) and representative (RVS) method in respect to the forest communities.

Discussion

In this natural forest reserve within the last 15 years a decrease of vascular plant species is obvious.

It is suggested that this loss is caused by a continuously denser canopy due to the lack of human intervention. For SPC data it seems more severe, because there are more plots located in young stands with high dynamics.

For statistical analysis a certain number of sample plots per species or community is essential. Thus it is more likely to find changes using RVS method than SPC method.

Although ash is one of the most abundant species, its increase could not be confirmed with RVS method. This may be traced by its rough scale. Only the small sub-plots of SPC made a change in frequency category visible.

Conclusion

The information value of the RVS data is limited, due to the not area-related plot selection process. Moreover, inhomogeneous sites with high succession rates might be discriminated. In this case vegetation dynamics are underestimated. Hence it is not possible to generalize the results of this method.

The smaller the plot, the lower is the number of species for which changes can be detected. This is also valid to assess rare species.

Small plots are more sensitive to detect changes in populations of high abundant species.

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