Effects of plot shape and arrangement on species richness counts in grasslands

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Background & Aims: Due to the universal distance decay in ecological similarity, the shape of the sampling unit should affect species richness counts, with more species being found in elongated vs. compact units. Similarly, where a sampling unit consists of several non-contiguous plots within a larger spatial extent (e.g. rarefaction curves), it should contain more species than a contiguous unit of the same area (Dengler & Oldeland 2010). Although the differences of elongated vs. compact (shape) and non-contiguous vs. contiguous (arrangement) are theoretically clear, ecologists rarely acknowledge them when comparing biodiversity data originating from different sampling schemes (Dengler 2008). Moreover, from the few existing studies the effect sizes are hard to assess. With this study we thus aimed to quantify the relative differences in species richness counts resulting from varying shapes and arrangements of sampling units at different, small spatial grain sizes.

Methods: We used monitoring plots of the BiodivERsA project SIGNAL in semi-natural grasslands of six Eurasian countries (France, Germany, Italy, Hungary, Bulgaria, and Turkey). In each study site we established six blocks of 2.80 m X 0.40 m, subdivided into 448 micro-quadrats of 25 cm^2. We recorded the vascular plant species composition in each of these micro-quadrats. Then we calculated species richness values for different sampling unit sizes (4, 16, and 64 micro-quadrats) for different shapes (1:1; 1:4, and 1:16) and arrangements (contiguous vs. three non-contiguous variants, drawn from different extents: sub-block, block, and site). We tested for differences by means of linear mixed-effect models.

Main Results & Interpretations: Both shape and arrangement had highly significant effects on richness values of sampling units. These responses were consistent across the six countries and the sampling unit sizes. Generally, the differences between squares and 1:4 rectangles were negligible while 1:16 plots showed a clear increase in species richness. This indicates that compact and slightly elongated plots of the same size can be combined without problems in the same study, while serious distortions are to be expected only for extremely long and thin plots. In contrast, the contiguous and the various non-contiguous arrangements showed significant differences in species richness, with richness increasing strongly with the spatial extent from which the subplots were drawn. This suggests that rarefaction curves are highly idiosyncratic and should not be compared between studies because their spatial extent is hardly ever the same (see also Chiarucci et al. 2009).

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