4th International Congress on Biodiversity
"Man, Natural Habitats and Euro-Mediterranean
Biodiversity", Malta, 17-19th November 2017

Random sampling overestimates species richness of shrubland vegetation

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Vegetation surveys are usually carried out at a single spatial scale, using randomly positioned sample plots. A random design would be very suitable for a species inventory, but may misrepresent local diversity as it would detect species populations that, despite sharing the same habitat, would be distant from one another and probably not interact significantly. As such, it may be less useful for understanding ecosystem processes, since most such processes work most intensely at a short range.

This study aimed to determine whether the diversity of plants at different spatial scales varied according to the sampling design used. Two quadrat sampling designs, one using random quadrats and the other using nested quadrats were compared in six shrubland communities in the Maltese Islands. A grid measuring 125m x 125m was identified as the sampling area for both investigations. For the 'random sampling' design, a 20cm x 20cm frame quadrat (the basic 'unit quadrat') was randomly positioned 125 times within each site. A list of species present enclosed by the frame was noted after each 'throw' of the quadrat.

The nested quadrat design was intended to look for vegetation patterns at different and contiguous spatial scales within the 125m x 125m grid in each site. For each study site, the basic unit quadrat sample was initially replicated symmetrically five times in an area measuring 1m x 1m. This $1m^2$ block was, in turn, nested within an area measuring 5m x 5m. Each 5m x 5m block was similarly nested within a 25m x 25m area, and five 25m x 25m areas nested within a 125m x 125m area. This ensured that each scale of sampling would contain one sampling unit from the next smaller scale nested within it. Presence/absence data was collected from each unit quadrat and was subsequently used to derive abundance data at higher spatial scales. The presence/absence and abundance data were used to calculate the estimated species richness S(est) and the Chao-1 estimator of diversity.

The data collected from all 125 random quadrats was compared directly to the data derived from the nested design. The results indicated that the random quadrat design

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consistently gave higher values for both S(est) and Chao-1 relative to the nested design, independently of spatial scale, with the trend being more pronounced for the Chao-1 estimator. These differences were statistically significant for both S(est) ($t= -3.931$; $P=0.002$) and Chao-1 ($t= -4.734$; $P< 0.001$). In general, the random quadrat design detected more species, independently of the index used to measure species richness and this effect was more pronounced in species-rich sites.

The implications of these results are that vegetation surveys intended to assess the diversity of a site should correct for this factor when results are reported.