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## **Do birds provide proxies for biodiversity in the assessment of ecosystem value?**

**CHRIS PANTER\*, PAUL DOLMAN & HANNAH MOSSMAN**

School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK

\*Email: [c.panter@uea.ac.uk](mailto:c.panter@uea.ac.uk)

Birds have major importance within the UK. They provide cultural services, contributing to social value of landscapes, regularly forming the highest profile component of biodiversity. Birds also have intrinsic value in their contribution to wild species diversity. Many bird species are highly visible and recognizable and data on abundance and distribution are extensive, particularly when compared with invertebrate groups. Not surprisingly, birds are widely used as indicators of environmental 'health', when assessing the relative value of landscapes to wildlife and as proxies for biodiversity in assessments of ecosystem value.

Many studies have quantified the effectiveness by which one group of species can act as proxy for other groups. Numerous studies have found that bird species richness correlates with the richness of other groups, but there is considerable variation in congruence between different taxa and many studies have found no correlations between species groups. Most studies have been conducted either at small (site-based) or very large (e.g. 1° squares) spatial scales, and few have been conducted at small spatial scales consistently over a whole region. While contrasts in richness between bioregions can be recognized by small local samples within each, understanding which localities should be prioritized within a particular landscape requires detailed data within the region. Furthermore, most studies focus on a small number of taxa, particularly vertebrate groups, butterflies and occasionally a group of beetles.

We systematically collated available species records for all taxa in two contrasting biogeographical regions of the UK, Breckland (2300 km<sup>2</sup>) and the Broads (2300 km<sup>2</sup>). The recording coverage of plants, vertebrates and major insect groups was good, while coverage of fungi, microscopic organisms and soil infauna was poor. We related richness of all species and those with conservation designations, for diverse groups of non-avian taxa, to the avian richness at varying spatial scales (1, 5 and 10 km), whilst controlling for differences in recording effort. The 20 non-avian groups included angiosperms, bryophytes, butterflies, beetles, hymenoptera, diptera, moths, spiders and mollusca.

We found that the richness of bird species and bird species with conservation designations were poor proxies for the richness of other taxonomic groups at all spatial scales, with a number of species groups being significantly negatively correlated with avian richness. Butterfly richness was significantly correlated with the richness of priority species, but only at a spatial scale of 1 km<sup>2</sup>. In contrast, the richness of priority beetle species was significantly correlated with priority richness of other groups, at all spatial scales.

This work suggests that birds are poor indicator species for wider biodiversity and for groups of species of conservation concern. Whilst the cultural and societal value provided by birds should not be diminished, we suggest caution in their use to assess or value other wild species diversity. Butterflies may provide good proxies for biodiversity at small spatial scales, but beetles were the best indicators overall. We acknowledge that beetles are not as readily recorded as birds or butterflies; however, we demonstrate that data currently available can be used.