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Species surrogacy in environmental impact assessment and monitoring: extending the BestAgg approach to asymmetrical designs

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ABSTRACT: The mainstream approach to define effective surrogates for species in routine biomonitoring focuses on the use of coarse levels of taxonomic resolution. A new approach to species surrogacy, the Best Practicable Aggregation of Species (BestAgg), which uses pilot data to generate null models of decreasing information at increasing levels of aggregation of variables, has been recently proposed. The approach has been tested in different environmental contexts, providing several advantages compared to the analysis at taxonomic levels higher than species. However, BestAgg still lacks a framework for its application to asymmetrical designs, thus limiting its general use in environmental impact assessment. Here, we implemented a new procedure to fill this gap and provided a specific R code for BestAgg in asymmetrical analysis. We presented an example of the application of this procedure to a real case study assessing the potential impact of harbour activities on subtidal sessile assemblages. Results from taxonomically fine-resolved data showed a significant effect of harbour activity on assemblage structure, although variable in time. Such patterns were consistent up to order level. Results based on surrogates from BestAgg were also aligned with those obtained at fine taxonomic resolution, but led to retention of much more information on original patterns and increased timesaving in sample processing compared to a classic approach based on the use of higher taxonomic levels. BestAgg represents a more formal procedure to species surrogacy than the empirical determination of the sufficient taxonomic resolution. The approach increases cost-efficiency while maximizing ecological information, and can be used under a wide range of experimental settings, now including asymmetrical designs.

KEY WORDS: Asymmetrical designs · Harbour impact · Null models · Sessile assemblages · Species surrogacy · Taxonomic surrogates

INTRODUCTION

Environmental monitoring has long been considered to be of minor scientific value compared to manipulative experiments and theoretical work in ecology and is often seen as an expensive and unrewarding practice (Legg & Nagy 2006, Lovett et al. 2007). Mounting evidence that the systematic collection of reliable environmental and/or biological data may provide important insights into natural and human-driven changes to ecosystems (Lovett et al. 2007) has increased awareness that adequate programs for continued data collection are necessary to achieve effective environmental management (e.g. Babcock et al. 2010, Fraschetti et al. 2012, 2013, Bates et al. 2014), leading to integration of routine assessment and monitoring procedures in regulatory frameworks at international level (e.g. Borja et al. 2010).

Indeed, environmental monitoring plays a key role in ecology, providing crucial information for hypo-

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