STATISTICS FOR BIODIVERSITY MONITORING

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Abstract

Key ecosystem services ultimately depend on biodiversity (Cardinale *et al.*, 2012). There is comprehensive qualitative evidence of a global biodiversity change (e.g., Cardinale *et al.* 2012; Chase *et al.* 2020), which has catalysed a general demand for biodiversity preserving policies and management (MEA, 2005, UN, 2021). Yet, without reliable quantitative information on biodiversity patterns and trends, rational biodiversity management is logically impossible. What we do not know and do not measure, we cannot effectively manage, either. To be directly applicable, such information should be generated at a high spatiotemporal resolution, thus matching that of other national assets, such as infrastructure, land use, and industry (Dasgupta, 2021).

Despite the obvious information need, for most taxonomic groups, and for biodiversity as a whole, we still lack critically validated methods for producing such information, and for validating the uncertainties associated with it. In most countries, long-term biodiversity monitoring programs have been initiated for different reasons, are currently implemented by multiple actors, and remain focused on a few selected taxonomic groups (for example, birds, butterflies and game species, each monitored using a separate design). Individual programs lack coordination both within and between countries, and taxon-specific assessments are rarely combined into holistic analyses of the general state of biodiversity (Roslin & Laine, 2022). The current situation is a major obstacle to achieving sustainable development.

In this talk, we will present an overview of the state of Finnish nature monitoring programs and analyse their usefulness for biodiversity monitoring. Our results highlight that most of the monitoring programs do not provide statistically representative data on Finnish biodiversity – implying that classical design-based estimates are inadequate for analysing these data. As an alternative, we will consider modern model-based approaches and show how they can alleviate the challenge, and what are their current limits (e.g., Foster *et al.*, 2021). Furthermore, we will show, how ecological processes themselves might cause bias to population and biodiversity estimates even when statistically perfect sampling design is applied. Changes in habitat availability often change species behavior so that design-based methods give biased estimates for population change (Numminen *et al.*, 2023).

To tackle the modern challenges posed by the biodiversity change, we need holistic planning for future biodiversity monitoring programs. We will present preliminary results from our on-going work, where we analyze, how future monitoring programs should be arranged in Finland to achieve good cost-efficiency. Our approach is based on Bayesian approach where we calculate the expected utility of alternative monitoring design (Liu & Vanhatalo, 2020).

Keywords: biodiversity monitoring, ecology, species distribution modeling, monitoring design.

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