Accounting for preferential sampling in longitudinal occupancy models

Preferential sampling (PS) is a form of nonrandom sampling where the "value" of a unit affects the probability with which it is surveyed. PS is a major challenge for the analysis of opportunistically collected biodiversity data including virtually all citizen-science data: ignoring PS can seriously bias all inferences. However, our understanding of PS is still in its infancy. We developed dynamic occupancy models that account for PS and analyzed population trends of Swiss Eagle owls (Bubo bubo) in a nationwide survey over 20 years (2002–2021). We used JAGS to fit a joint PS/multistate occupancy model with two presence states (single bird, pair), where the estimated presence in year t, for both presence states combined, was used as a predictor in the probability that a territory was surveyed in year t+1. We stratified all parameters by six regions, since anecdotal evidence suggested different population trends in different parts of the country. We estimated a strongly positive effect of previous presence on visitation probability, i.e., strongly positive PS. Our joint model that accounted for PS identified stable to strongly increasing population trends in all six regions, and for single bird- and territories occupied by pairs alike. In contrast, trends in the raw data, as well under a PS-naive occupancy model, suggested stable or even declining populations. Our study emphasizes the importance of accounting for non-random sampling in analyses of biodiversity data. In particular, it provides a powerful solution to the problem of PS in the important context of longitudinal occupancy models.