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Acoustic detection and occupancy models: A systematic review with insights for future monitoring programs

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Wildlife management requires monitoring to infer spatiotemporal changes in the distribution or abundance of species and communities of organisms. Technological advancements have increasingly facilitated monitoring species through new data collection methods. Such technological advancements include small-sized acoustic recording devices that can record a wide range of sound frequencies, making them especially suitable for analysis by recently developed statistical tools such as occupancy models. We reviewed 108 publications that used acoustic methods and occupancy modelling to synthesise and discuss the potential of combining these two methodologies in future research studies in ecology and conservation. We found that 50% of these studies limited their analysis to the simplest modelling solution, single-season and single-species models, even though many recorded multiple species and sampled across several seasons. This limited analysis hinders the retrieval of complete information from available datasets because more complex models, such as the multi-species occupancy models, provide more robust occupancy parameters for both commonly and rarely detected species. We also argue that multiple-season or dynamic models are easy to implement and essential for monitoring species' temporal fluctuations. Recent developments in occupancy include modelling false-positive detections, which have been applied in only 11 revised publications. This modelling approach seems particularly under-used as many species cannot be accurately distinguished solely based on acoustic data. Finally, we noted a geographical imbalance in implementing acoustic methods with occupancy models; research was performed primarily on study sites in North America. Coupling low-cost passive acoustic monitoring with a diversified set of occupancy models is a scalable methodology that can help to implement standardised protocols for regional and larger-scale monitoring programs. Long-term monitoring programs will significantly benefit from such protocols by informing habitat and wildlife management more effectively, which are thus critical for animal conservation in an increasingly anthropogenic landscape.

ORAL COMMUNICATION

Vegetation canopy height shapes bats' occupancy: a remote sensing approach

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Anthropogenic activities have significantly altered land cover on a global scale. These changes often have a negative effect on biodiversity, limiting the distribution of species. The extent of the effect on species' distribution depends on the landscape composition and configuration at a local and landscape level. To better understand this effect on a large scale, we evaluated how land cover and vegetation structure shape bat species' occurrence while considering species' imperfect detection. We hypothesise that intensification of anthropogenic activities, agriculture for example, reduces the heterogeneity of land cover and vegetation structure, and thereby, limits bat occurrence. To investigate this, we conducted acoustic bat sampling across 59 locations in southern Portugal, each with three spatial replicates. We derived fine-scale vegetation structural metrics by combining spaceborne LiDAR (GEDI) and synthetic aperture radar data (Sentinel-1 and ALOS/PALSAR-2). Additionally, we included land cover metrics and high-resolution climate data from CHELSA. Our findings revealed an important relationship between bat species' occupancy and vegetation structure, particularly with vegetation canopy height. Moreover,