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Dissertation topic: The effectiveness of bird species detection in passive acoustic monitoring

Abstract

Passive acoustic monitoring (hereby PAM) is a technique that involves deploying sound recording devices, such as autonomous recording units, in natural environments to record soundscapes. This scientific tool is increasingly used as it allows for unattended and non-invasive recording of soundscapes incorporating animal vocalisations in fully programmable temporal schemes. PAM has been developing since the 1990s and has been applied in research of various animal groups, including birds. Despite technological advancements, many aspects of this method remain unclear, such as the effectiveness of detecting birds and their detection distances. The sound in natural environments, such as forests, is subject to many physical factors (such as temperature or humidity) that influence its degradation and impede the determination of the exact detection distance. In Chapter 1 of this dissertation, which is a published article in Scientific Reports journal, I conducted experiments in the Zielonka forest (Greater Poland region) to determine the natural distances of bird detection. The results provide data on detection distances for various bird species and identify environmental factors that influence sound propagation. Chapter 2 (manuscript under review in Ibis journal) is a further development of the experiment results, where I conducted research comparing the effectiveness of three detection methods: auditory, visual based on spectrogram analysis, and automatic using BirdNET software. In this work, I analysed factors influencing bird detectability, determined detection distances of birds for all methods, and assessed the effectiveness of the automatic method in acoustic research in terms of working time and results compared to manual detection. In Chapters 3 and 4 (work published in journals: Emu – Austral Ornithology and African Journal of Ecology), I used the automatic detection software Kaleidoscope Pro to compare the effectiveness of passive monitoring and automatic methods in estimating the vocal activity of four African bird species of various abundances. These publications show annual activity patterns of chosen species in the context of seasonal changes and weather and determine the effectiveness of the methods used for long-term research in remote places. In Chapter 5 (manuscript currently being reviewed in the Ecological Indicators journal), I compared manual surveys conducted within a short period with automatic species detection on several-hour recordings using BirdNET. I also tested whether acoustic indices, which are numeric representations of the acoustic energy present on the recording, reflect bird species richness. This work was done in the context of common cuckoo *Cuculus canorus* vocalisations, which, according to some previous works, is a good predictor of the areas of greater bird species richness. This work points to the imperfection of acoustic indices and

the underestimation of the number of species obtained with manual detection and shows the effectiveness of the common cuckoo as an indicator of the areas of greater bird species numbers.