

Towards the fully automated monitoring of ecological communities

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Abstract

High resolution monitoring is fundamental to understand and predict the dynamics of ecological communities in an era of global change and biodiversity declines. While real-time and fully automated monitoring of the abiotic components of ecosystems has been possible for some time, monitoring the biotic components at different organizational scales, e.g. from individual behaviours and traits to the abundance and distribution of species, is far more challenging. Recent technological advancements offer potential solutions to achieve this through: (i) increasingly affordable high throughput recording hardware, which can collect rich multidimensional data, and (ii) increasingly accessible artificial intelligence approaches, which are able to extract ecological knowledge from large datasets. However, automating the monitoring of facets of ecological populations and communities via such technologies is still in its infancy, being primarily achieved at low spatiotemporal resolutions within specific stages of the monitoring workflow. Here, we review existing technologies for data recording and processing that enable automated monitoring of ecological communities. We then present novel frameworks that combine such technologies, forming fully automated pipelines to detect, track, classify, and count multiple species, and even record behavioural and morphological traits, at resolutions which have previously been impossible to achieve. Based on these rapidly developing technologies, we illustrate a solution to one of the greatest challenges in ecology and conservation: the ability to rapidly generate high resolution, multidimensional, and critically, standardized data across complex ecologies.

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