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Conference Abstract

The use of environmental DNA in monitoring aquatic biodiversity for conservation: a review of challenges and opportunities

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Abstract

Evidence-based decision-making in conservation and natural resource management is often constrained by lack of robust biodiversity data. Technology offers opportunities for enhanced data collection, with satellite-based remote sensing increasingly complemented by Earth-based sensors such as camera traps, acoustic recording devices and drones. In aquatic as well as terrestrial systems, environmental DNA is increasingly promoted as a tool to monitor species diversity and community composition. But if conservationists and natural resource managers are to know when to use eDNA, they need to understand its relative advantages and disadvantages, and when it can be used with or instead of other tools. In this paper, I expand on two recent publications (Stephenson 2020; Stephenson et al. 2020) to review lessons learned from the application of eDNA, especially metabarcoding, to the monitoring of aquatic biodiversity for conservation and to identify factors affecting its relevance and applicability.

Over the past decade there have been many advances in technological solutions for biodiversity monitoring. eDNA and various remote sensing tools offer opportunities to create the enabling conditions for enhanced biodiversity monitoring, and are becoming cheaper and easier to use for scientists, public and private sector resource managers, and citizen scientists. Nonetheless, a number of challenges need to be addressed to, for

example, improve the standardisation of tool use and to enhance capacity for the use, storage, sharing and analysis of huge volumes of data, especially in high-biodiversity countries. More studies comparing the relative efficiency and cost-effectiveness of different tools with different species in different habitats would help managers choose the right tools for their needs and capacity and better integrate them into monitoring schemes.

eDNA is becoming the go-to option for the monitoring of aquatic species diversity and community composition and has also proven successful in some terrestrial settings. eDNA is especially useful for monitoring species that are in low densities or difficult to observe with traditional observer-based methods; indeed, several studies show eDNA metabarcoding techniques have a much better detection probability overall for taxa such as amphibians and fish. In some cases, eDNA has been shown to complement other tools when used together, by either increasing animal detection probabilities or increasing the number of indicators that can be measured at one site. This suggests that, in future, more effort should be made to test the effectiveness of integrating eDNA with one or more other tools to enhance the efficiency and effectiveness of measuring indicators and to increase the diversity of species detected. For example, eDNA could be combined with camera traps for monitoring vertebrates visiting waterholes. Testing multiple tools would also provide better opportunity to quantify when and how traditional observer-based methods can complement the technological solutions and when they are more cost-effective. However, it is noteworthy that, in general, the taxa for which data are most lacking, such as invertebrates, plants and fungi, are still those less easily monitored by eDNA and other new technologies. This suggests a focus only on technological solutions for biodiversity monitoring may perpetuate existing taxonomic data biases.

I conclude by discussing the international policy context and the relevance of eDNA for monitoring global biodiversity indicators. Several opportunities exist to integrate eDNA into monitoring programmes to measure government, business and civil society contributions towards delivery of the post-2020 global biodiversity framework and the Sustainable Development Goals.

Keywords

biodiversity, conservation, indicators, monitoring

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