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Opinion

# Environmental DNA (eDNA) as an Effective Monitoring Tool for Aquatic Biodiversity

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**Abstract**

Monitoring of species is fundamental to their management and conservation. Conventional survey methods require taxonomic expertise, extensive field surveys, invasive (species handling) and high finances. Field surveys for the detection, distribution, and abundance of species in freshwater and particularly in marine ecosystems are challenging. Environmental DNA (eDNA) has merged as an alternative survey tool for the monitoring of aquatic species. The steps in eDNA methods include water sample collection from the field, DNA extraction, design and validation of species-specific primer, sequencing, and taxonomic assignment. The analysis of eDNA provides a relatively fast and inexpensive tool for collecting presence, distribution, and abundance data. Single samples can be used for the estimation of biodiversity of a particular area. Early detection of invasive species beneficial to control their invasion. The environmental DNA method becomes more advantageous when species are elusive, cryptic, and rare or in small or low numbers and are difficult to be detected with traditional survey techniques. If eDNA protocol standardize for freshwater and marine biodiversity, it has a great potential in future to be an effective survey tool at large scale biomonitoring of freshwater and marine ecosystems.

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## Opinion

Aquatic ecosystems support a large number of species and genetic diversity. These ecosystems and species have a greater extinction risk than that of terrestrial species [1]. These threats include extensive harvesting of species, habitat degradation and loss, pollution, invasive species, and climate change. According to IUCN red list, a total 28% of all assessed species that consist of 41% amphibians, 37% sharks & rays, 33% reef coral and 28% selected crustaceans are facing threats to extinction at global level [2]. Monitoring of species is fundamental to their management and conservation. The accurate bioassessment of species is required to address issues and make policies for their future management. Multiple conventional survey methods are available that include identification of collected samples (by using net, traps, or other means) and observation (direct or camera). These methods require taxonomic expertise, extensive field surveys, invasive (species handling) and high finances. Alternatively, novel method may require less labor, time and cost, which increase efficiency of large-scale monitoring programme. Besides traditional survey methods, environmental DNA (eDNA) is an alternative survey tool for monitoring of freshwater and marine biodiversity. After the first successful detection of American Bull Frog (Lithobates catesbeianus) by using eDNA [3]. It has been applied for monitoring of different aquatic taxa including Fishes, Atlantic Salmon (Salmo salar) [4], Macquarie Perch (*Macquaria australasica*) [5], Amphibians, rare and protected the great crested newt (*Triturus cristatus*) [6] endemic Hazara Torrent Frog (*Allopaa hazarensis*) and Murree Hills Frog (*Nanorana vicina*) [7] Yellow-Legged Frog (*Rana sierrae*) [8] Trinidad Golden Treefrog (*Phytotriades auratus*) [9], Invertebrates, crayfish species [10] sessile bryozoan (Fredericella sultana) [11]. The DNA from skin, eggs and sperms, hair, mucus, and feces of organisms is released in the environment [12] and can be extracted from the water or soil without directly observing the organism [13]. The steps in eDNA methods include sample collection from the field, DNA extraction, design and

validation of species-specific primer, sequencing, and taxonomic assignment. Sometime there is an issue of false positive or negative detection of species that can be reduced by following the protocol from sample collection to analysis and standardization of method for species monitoring. Conventional field surveys are sometimes tedious, expensive, time taking and less efficient for large scale monitoring of aquatic species. The eDNA method is more cost and time effective than these traditional sampling techniques. For the detection and distribution of any species, multiple field visits are required (sites are visited monthly/seasonal basis) that increase the budget of monitoring programme. The eDNA method takes few minutes for samples collection, DNA extraction and qPCR/PCR can be performed within a few hours at a cost of a few hundred Dollars. The analysis of eDNA provides a relatively fast and inexpensive tool for collecting presence, distribution, and abundance data. Single samples can be used for the estimation of biodiversity of a particular area. Early detection of invasive species beneficial to control their invasion. The environmental DNA method becomes more advantageous when species are elusive, cryptic, and rare or in small or low numbers and are difficult to be detected with traditional survey techniques. The suitable time for eDNA survey is breeding season when detection probability increases due to high concentration of DNA in water, compared to non-breeding season. The eDNA has advantages over conventional methods in conservation point of view as well i.e., non-invasive survey method and target species is not disturbed.

## Conclusion

Most of the marine species are data deficient as efficient survey method that can report marine diversity are currently lacking. Metabarcoding helps for the biomonitoring of ocean diversity at large scale in limited resources. A single sample holds the information of all biodiversity of an area that can be used for the detection of all species. Protocol for eDNA sampling should be standardized for metabarcoding for freshwater and marine biodiversity. Most of the efforts are made for the early detection of species; and few studies are available for the estimation of abundance of species by using eDNA concentration in the water. If eDNA protocol standardize for freshwater and marine biodiversity, it has a great potential in future to be an effective survey tool at large scale biomonitoring of freshwater and marine ecosystems.

## References


1. Andrea JR, Andrew KC, Irena FC, Erika JE, Peter AG, et al. (2019) Emerging threats and persistent conservation challenges for freshwater biodiversity. Biol Rev Camb Philos Soc 94(3): 849-873.
2. IUCN (2021) The IUCN Red List of Threatened Species. Switzerland.
3. Ficetola GF, Miaud C, Pompanon F, Taberlet P (2008) Species detection using environmental DNA from water samples. Biol Lett 4(4): 423-425.
4. Siobhán A, Jeanette ELC, Bernard B, Damian E, Mary KQ, et al. (2018) A quantitative PCR-based environmental DNA assay for detecting Atlantic salmon (Salmo salar L.). Aquat Conserv Mar Freshw Ecosyst 28(5): 1238-1243.
5. Bylemans J, Furlan EM, Hardy CM, McGuffie P, Lintermans M, et al. (2017) An environmental DNA-based method for monitoring spawning activity: a case study, using the endangered Macquarie perch (Macquaria australasica). Methods Ecol Evol 8(5): 646-655.
6. Rees HC, Bishop K, Middleditch DJ, Patmore JRM, Maddison BC, et al. (2014) The application of eDNA for monitoring of the Great Crested Newt in the UK. Ecol Evol 4(21): 4023-4032.
7. Muhammad S, Muhammad R, Ayesha A, Maggie RW, Kenneth FK, et al. (2022) Development and validation of an eDNA protocol for monitoring endemic Asian spiny frogs in the Himalayan region of Pakistan. Sci Rep 12: 5624.
8. Mallory EB, Kristina VSH, Colin D, Caren SG (2021) Evaluating Sierra Nevada yellow-legged frog distribution using environmental DNA. J Wildl Mangaement 85(5): 945-952.
9. Sarah B, Chloe M, Eleanor G, Thomas JB, Mark SG, et al. (2017) Development and application of an eDNA method to detect the critically endangered trinidad golden tree frog (Phytotriades auratus) in bromeliad phytotelmata. PLoS One 12(2): e0170619.
10. Sune A, William BL, Steen WK, David S, Philip FT, et al. (2017) Monitoring of noble, signal, and narrow-clawed crayfish using environmental DNA from freshwater samples. PLoS One 12(6): e0179261.
11. Carraro L, Hartikainen H, Jokela J, Bertuzzo E, Rinaldo A (2018) Estimating species distribution and abundance in river networks using environmental DNA. Proc Natl Acad Sci USA 115(46): 11724-11729.
12. Taylor MW, Kevin SM, Michael KY, Stephen FJ, Winsor HL, et al. (2013) Robust detection of rare species using environmental DNA: The importance of primer specificity. PLoS One 8(3): e59520.
13. Pierre T, Eric C, Mehrdad H, Loren HR (2012) Environmental DNA. Mo Ecol 21(8): 1789-1793.