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Critical considerations for ecological inference from quantitative eDNA

By Dr. Matthew Yates

Environmental DNA (eDNA) has undoubtedly revolutionized the science of species detection, but the concentration of eDNA in an aquatic ecosystem can also provide potential ecological information. Substantial research, for example, has demonstrated consistent positive correlations with eDNA concentration and organism abundance in aquatic ecosystems. However, 'eDNA dynamics' in aquatic ecosystems are complex because a variety of abiotic and biotic variables can influence pseudo steady-state eDNA concentrations in natural environments. Accounting for 'eDNA dynamics' and the ecology of eDNA production in study design and data analysis is thus crucial to interpreting quantitative eDNA data and relating it to metrics of organism abundance in natural ecosystems. We discuss a number of important factors to consider when designing an effective study to correlate quantitative eDNA data with organism abundance, as well as how to interpret and analyse eDNA data in this context. This includes key survey design considerations for lentic and lotic systems, as well as important biotic variables that can affect the distribution of eDNA in aquatic ecosystems. We also present a novel framework that unifies the relationship between numerical abundance, biomass, and quantitative eDNA data by 'correcting' for allometric scaling in eDNA production. Although relating eDNA data to metrics of abundance (N, biomass) in natural ecosystems is complicated, we are optimistic about the potential application of eDNA as a broad means for 'rough', but cost-effective, assessments of abundance in aquatic ecosystems.