Quantifying Biodiversity Patterns and Extinction Risk in Seasonal Wetland Plant Communities

by

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Abstract

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Wetlands are among the most threatened habitats on Earth. They are essential components of functional landscapes, providing habitat for native flora and fauna as well as supporting critical ecosystem services. Loss of wetland biodiversity threatens these values. There is an urgent need to understand patterns of wetland biodiversity, the processes creating these and the risk of species loss to plan effective intervention. Species-area relationships have a successful, although controversial, history of quantifying the risk of extinction in terrestrial biomes, and can provide rapid estimates of extinction risk at a range of scales without the need for extensive datasets. Prior to my research, applications of species-area relationships in extinction risk were limited to island archipelagos and formerly continuous terrestrial habitats that had become fragmented. Naturally occurring, discrete habitat types—such as wetlands—have been ignored. I address this gap, demonstrating that area-based methods can, with some modification, be successfully applied to predict extinction risk in wetland communities. Before considering extinction risk I analysed patterns of wetland plant diversity and occupancy and how competing community-assembly processes produce more or less unique combinations of species among wetlands. I showed that much of the plant community diversity in seasonal wetlands in South Australia is driven by rare terrestrial species of wetland fringes, which assemble from a much larger available species pool. The distribution of these rare species was not correlated with total species richness or wetland size, suggesting that changes in the number or total area of wetlands could result in different extinction dynamics, depending on how they affected endemic species. I therefore compared risks associated with loss of complete wetlands (patch loss), with loss of the equivalent wetland area while maintaining the total number of wetlands. To implement the latter scenario, I developed a novel approach consisting of three steps: (*i*) a generalized empirical endemics-area relationship to predict the number of species lost within each wetland as a function of a reduction in wetland area; (*ii*) I selected the identities of the predicted number of species lost at each wetland probabilistically; (*iii*) I compred the number of wetlands from which each species was lost with its regional occupancy, and I considered any species predicted to be lost from all known sites as extinct. I then repeated steps (*ii*) and (*iii*) many times to obtain a distribution of regional-scale species loss for a given loss of area in each wetland. Step (*ii*) allowed for different scenarios to be tested by adjusting the sampling probability for each species. I found that a higher extinction risk was associated with the loss of complete wetlands than the equivalent area loss shared among all wetlands. Moreover, for a given area loss, small wetlands had a much higher risk of species loss due to the distribution of endemic species. The approach I developed could be readily applied to any discrete habitat type, providing predictions of risk for a range of ecosystems that have received little attention.

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