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Invisible biodiversity: widespread extinction debts and colonization credits in US bird communities

Landscape modifications are a major source of biodiversity change, but species responses to land cover change are not instantaneous. Extinctions and colonisations may take a long time to occur, leading to extinction debts and colonisation credits. If unaccounted for, debts and credits can lead to erroneous predictions of future biodiversity that may misinform conservation actions. Current attempts to measure debts and credits are limited in their spatial/temporal scale and do not consider multiple facets of landscape composition and history. Here, we develop a Bayesian model in order to quantify the relative contribution of past and current landscapes on the current effective number of species in 2880 US bird communities. Furthermore, we explicitly measure the biodiversity magnitude of these delayed responses to increases and decreases of five land cover types. We find that the current effective number of species is still largely explained by the past landscape composition, and thus that there are widespread extinction debts and colonisation credits. The extent of these legacy effects depends on the type, directionality and magnitude of recent land cover change. Specifically, we reveal debts across 52% of the US, particularly in recently urbanised areas, and colonisation credits in the remaining 48%, which were primarily associated with grassland decrease. We conclude that biodiversity policy targets risk being obsolete unless past landscapes are considered and debts and credits accounted for.