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Disconnectivity matters: The outsized role of small ephemeral wetlands in landscape-scale nutrient retention

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Wetlands protect downstream waters by filtering excess nitrogen (N) generated from agricultural and urban activities. Small ephemeral wetlands, also known as geographically isolated wetlands (GIWs), are hotspots of N retention but have received fewer legal protections due to their apparent isolation from jurisdictional waters and are typically left out of restoration efforts. Here, we hypothesize that the isolation of the GIWs make them more efficient N filters, especially when considering transient hydrologic dynamics. We use a reduced complexity model with thirty years of remotely sensed monthly wetland inundation levels in 3,700 GIWs across eight wetlandscapes in the United States to show how consideration of transient hydrologic conditions that capture disconnectivity dynamics can increase N retention estimates by up to 130%, with greater retention magnification for the smaller wetlands. This effect is more pronounced in semi-arid systems, where transient assumptions lead to 1.8 times more retention, compared to humid landscapes where transient assumptions only lead to 1.4 times more retention. Our results highlight how GIWs have an outsized role in retaining nutrients, and this service is enhanced due to their hydrologic disconnectivity. Under the context of the new EU Nature Restoration Law and other global conservation efforts, these unique ecosystems must be protected and considered in restoration plans to maintain the integrity of downstream waters.