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Amphibian metapopulation persistance in dynamic dispersal networks in wetlandscapes under stochastic hydroclimatic forcing

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Wetlands are dispersed fractal heterogeneous aquatic habitats that play a key role in watershed eco-hydrology. Loss of wetlands leads to habitat loss/fragmentation and decrease in landscape connectivity, which in turn hampers the dispersal and survival of wetland-dependent species. Here, we analyzed how the temporal hydrological variability, resulting from stochastic hydro-climatic forcing, in wetlands is of fundamental importance for the persistence of amphibian metapopulation. Temporal variations in wetland habitats and the dispersal networks in response to stochastic precipitation inputs is also dependent on the dispersal ability of the considered species. Species characterized by a large dispersal kernel are can travel longer distances and populate larger portion of the landscape. The linkage between the hydrological variability in wetlands attributes (e.g., stage, surface area, storage volume, separation distances, habitat carrying capacity) and the dispersal ability of certain species is defined by the dynamic wetlandscape dispersal network. We simulated metapopulation dynamics in six wetlandscapes across the United States, characterized by diverse hydroclimatic conditions and geologic legacy. The novelty of this approach mainly consists in the creation of stochastic dispersal networks that can be used to analyze landscape amphibian persistence in wetlandscapes. Indeed, based on few network metrics (e.g., node-degree distribution, betweenness, minimum spanning tree) we were able to identify "keystone" wetland habitats that are most important (e.g., "stepping stones") for amphibian dispersal. Extended dry periods lead to a contraction in wetlands area, and, consequently, in the habitat that can support amphibian metapopulations. When rainfall events occur, the mean separation distance among wetlands decreases, allowing these species to move among wetlands. The proposed framework can be applied in diverse landscapes and hydro-climates, and could thus be used at large scales. The proposed approach could also inform conservation and restoration efforts that target landscape functions linked to transport in wet ecological corridors.