



DISENTANGLING THE NEGATIVE RELATIONSHIP BETWEEN BIOLOGICAL SINGULARITY AND SPECIES RICHNESS IN FRESHWATER ECOSYSTEMS

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Understanding how species richness relates to ecological uniqueness is a central challenge in biodiversity science, particularly given its relevance for conservation prioritization. The Local Contribution to Beta Diversity (LCBD) has emerged as a key metric to quantify the contribution of sites to overall beta diversity in freshwater ecosystems, offering valuable insights for guiding both conservation and restoration strategies. However, its relationship with species richness remains unresolved. Here, we conducted a global meta-analysis focusing on freshwater ecosystems to evaluate this relationship. A systematic search in the Web of Science identified 471 studies, of which 100 were considered eligible after three screening stages, and 73 were retained for quantitative synthesis. We extracted effect sizes as correlation coefficients and transformed using Fisher's z . We applied a random-effects model to account for heterogeneity among studies. We found a significant negative relationship between LCBD and species richness ($r = -0.247$; 95% CI: -0.373 to -0.112 ; $p < 0.001$), indicating



that freshwater sites with higher richness tend to contribute less to beta diversity. Subgroup analyses revealed that this pattern was stronger and significant for fishes, invertebrates, and mixed assemblages, whereas non-significant relationships were observed for plants, algae, and microorganisms. No temporal trend was detected, and publication bias tests were not significant. The high heterogeneity observed among studies suggests strong context dependency, likely driven by differences in dispersal processes, environmental filtering, and spatial structure. These findings indicate that ecological uniqueness is not associated with high species richness in freshwater ecosystems, highlighting important implications for biodiversity conservation and prioritization in freshwater ecosystems.

Key-words: *beta diversity; community uniqueness; biodiversity patterns; aquatic systems*