RESCON 2025 EES 10

ENVIRONMENTAL GRADIENTS AND FUNCTIONAL RESILIENCE: A COMPARATIVE STUDY OF REEF FISH COMMUNITIES IN PASIKUDA AND POLHENA BACK-REEFS

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Coral back-reef ecosystems are biodiversity hotspots that are critical to sustain key ecological processes; yet they are increasingly vulnerable to climatic and anthropogenic stressors. This study examined reef fish communities in two shallow back-reef ecosystems in Sri Lanka: Pasikuda (East Coast, sheltered, northeast monsoon influenced) and Polhena (South Coast, wave exposed, southwest monsoon influenced), to assess how environmental gradients influence community composition, functional traits, and ecological resilience. Underwater visual census data was collected from 20 stratified plots in each site. Species abundance and environmental parameters were analysed using multivariate ordinations (NMDS, CCA), functional diversity metrics (FRic, FDis, FR; based on feeding behavior across 12 dietary guilds), and Boosted Regression Trees (BRTs). Indicator species analysis was employed to identify habitat-specific assemblages. Despite higher taxonomic richness and abundance in Pasikuda, both sites exhibited similar evenness and low dominance. Community composition diverged along distinct environmental axes: pH and depth were key structuring factors in Pasikuda, whereas salinity and depth were key in Polhena. Functional richness peaked in isolated plots but showed contrasting spatial patterns. Pasikuda showed variable FRic linked to environmental fluctuations, while Polhena maintained stable but lower FRic. FDis revealed broad trait use in Pasikuda verses more clustered train use in Polhena. Functional redundancy, a proxy for ecological insurance, was greater in deeper Polhena plots, whereas Pasikuda's resilience stemmed from broad trait dispersion. BRT models confirmed site-specific ecological thresholds: pH (~37%) was most important in Pasikuda, while salinity (~49%) and depth (~37%) were key drivers in Polhena. Indicator species further supported these contrasting resilience strategies, showing trait overlap in Polhena vs. niche differentiation in Pasikuda. These findings demonstrate that even under similar monsoonal regimes, back-reef ecosystems may adopt distinct resilience mechanisms. Integrating environmental data with machine learning offers a powerful diagnostic framework for adaptive reef conservation. However, limited sampling warrants caution and further study to capture dynamic reef responses under climate pressure.

Financial assistance from Maalu Maalu Resort & Spa (Thema Collection) is acknowledged.

Keywords: Computational ecology, Environmental gradients, Functional diversity, Reef fish assemblages, Resilience mechanisms