# Analysis of the Relationships Between Ichthyoplankton and Zooplankton Communities in Natural, Degraded and Restored Mangroves in Relation to Habitat Complexity

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Mangrove ecosystems serve as important feeding and breeding grounds for fishes; however, their role in supporting the early larval stages of fishes in tropical regions is understudied, particularly under different conditions of habitat complexity. This study aims to assess mangrove habitat condition using remote sensing and to analyse the relationship between habitat condition, zooplankton communities and ichthyoplankton in natural, degraded and restored mangroves. Four mangrove zones in the Northwestern Province of Sri Lanka, known as Gangewadiya (mature), Waikkala (degraded), Anawilundawa and Pubudugama (restored), were selected. Remote sensing analysis was conducted using Sentinel-2 satellite data acquired over a one-year period (31 October 2024 - 31 October 2025), applying 14 multispectral indices within Google Earth Engine. Field sampling of ichthyoplankton and zooplankton was conducted across 12 sub-sites during the southwest monsoon period using plankton nets with mesh sizes of 500 µm and 200 µm, respectively. Fish eggs and larvae were sorted and counted and zooplankton were counted. Remote sensing results indicated that Gangewadiya and Pubudugama contain 70.4% and 6% healthy mangroves, respectively. Waikkala exhibits a high level of degradation (62.9%), while 57.5% and 99.4% of the mangroves in Pubudugama and Anawilundawa, respectively, are identified as being in nursery condition. Five zooplankton groups (copepods, crustaceans, jellyfish, annelids, chaetognaths) were identified and copepods were the most abundant. A significantly higher zooplankton density (382.96 ind./m³) was recorded in Anawilundawa compared to the other zones ($p<0.05$). The highest ichthyoplankton density (83.95ind./100 m³) was also observed in Anawilundawa, whereas lower densities were recorded in Pubudugama (4.96ind./100m³), Gangewadiya (13.27ind./100 m³), and Waikkala (1.5 ind./100m³) ($p<0.05$). A significant relationship between mangrove condition and plankton communities was identified using a General Linear Model, with Spearman's rank correlation indicating a moderate positive relationship ($\rho=0.585$, $p < 0.05$). Results confirm the effectiveness of multi-index analysis and the dynamics of plankton communities in mangroves.

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