



Macro-Litter Pollution in the Anawilundawa Mangrove Restoration Site and Periphery Using a Modified OSPAR Protocol: Composition, Spatiotemporal Patterns

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Despite recent scientific focus on microplastics and litter removal campaigns, many countries lack data to quantify marine litter beyond beaches. This study assessed macro-litter using a modified OSPAR protocol across 27 locations within the Anawilundawa Mangrove Restoration Site (ANRM) and its connected lagoonal-coastal ecosystems in Puttalam district, Sri Lanka. Strata included the Accelerated Natural Regeneration of Mangroves (ANRM) site (09) and periphery [Dutch Canal (05), Mundal Lagoon (04), shrimp farm (03), paddy field outlets (03), freshwater tanks (02) and Udappuwa urban coast (01)]. Three seasonal surveys (wet post-flooding, intermediate, and dry; October 2024-October 2025) yielded 81 sampling events. In total, 6811 items (57.67 kg) were recorded across 11 OSPAR categories, with plastics dominating by count (90.8%) and weight (73.9%). Kruskal-Wallis tests revealed significant spatial differences among individual locations (count: $\chi^2 = 169.2$, $p < 0.001$; weight: $\chi^2 = 137.41$, $p < 0.001$) while Friedman tests confirmed significant temporal variation (count: $\chi^2 = 9.10$, $p = 0.011$; weight: $\chi^2 = 11.63$, $p = 0.003$). Litter abundance was significantly higher during the wet post-flooding season (3173 items) than in the intermediate (1657 items; $p=0.028$) and dry seasons (1981 items; $p = 0.009$), suggesting flood-driven transport of land-based litter. Single-use plastics comprised 57% of plastics, and fisheries-related items 18%. Udappuwa recorded the highest number (2700 items; Clean Coast Index = 180.0, "Extremely Dirty"), with a pronounced spike in June 2025, following the sinking of the container vessel MSC Elsa-3 off Kerala, where lids, nurdles, and plastic fragments were recorded as the dominant items. Sixteen sites (59.3%) were classified as clean, while Udappuwa, Dutch Canal, and shrimp farm outlets were found to be pollution hotspots. Urban runoff, agricultural inputs, fisheries activities, and maritime incidents were identified as key contributors. These findings offer baseline evidence for targeted coastal waste management and pollution mitigation planning, coastal waste management and targeted pollution mitigation in Sri Lanka.

Keywords: *Anawilundawa mangrove restoration site, Clean Coast Index, Coastal waste management, OSPAR marine litter protocol, Plastic pollution*