

**POPULATION ASPECTS OF SEA CUCUMBERS (ECHINODERMATA:
HOLOTHUROIDEA) IN PROTECTED AND UNPROTECTED REEFS
ALONG THE SOUTHERN KENYA COAST**

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ABSTRACT

The holothurian fauna in Kenyan reefs was investigated in order to assess the status of the resource and evaluate the role of Marine Protected Areas (MPAs) in biodiversity conservation. The effects of management, habitat, topographic complexity and substrate cover were studied in four shallow (≤ 2 m) reefs (Malindi, Watamu, Mombasa and Shimoni), covering a total of seventeen sites within protected and unprotected reefs along a 180 km stretch of the southern Kenya coast. Visual surveys were done by use of belt transects (100 m by 4 m) and search-sampling (1-h time counts), and 10-m line intercept transects for substrate cover and rugosity. Data was Log_{10} -transformed to achieve normality and homogeneity of variances. Various statistical tests were used for data analysis to test the hypotheses based on a pre-determined probability value of 0.05 as level of significance.

Kenya's shallow reef-associated holothurian fauna, like other tropical Indo-Pacific regions, is typified by low density and high variability and diversity. A total of 12 different species belonging to 2 orders (Aspidochirotida and Apodida) and 3 families (Holothuriidae, Stichopodidae and Synaptidae) were recorded. The 4 most abundant species were *Holothuria atra* (27.88 %), *H. leucospilota* (26.92 %), *Stichopus chloronotus* (24.04 %) and *Synapta maculata* (12.26 %). The least abundant species was *Stichopus variegatus* (0.24 %). Highest number of species was recorded in Shimoni and Mombasa (10 species each) reefs. Watamu had the lowest number of species (2 species) and diversity. Except in Watamu, species richness indicated a positive logarithmic relationship between the number of species and the number of individuals encountered and the duration spent on sampling.

The overall average density of sea cucumbers in the entire study area was $4.47 \pm 0.68/400 \text{ m}^2$ ($\bar{x} \pm \text{SEM}$). Densities and/or mean abundances were highest in Mombasa ($6.33 \pm$

1.16/400 m²) and lowest in Malindi (0.83 ± 0.25/400 m²) reefs, respectively, but Mombasa had the highest diversity index (D = 0.77). Lagoons of both management categories had higher mean abundances than their corresponding reef flats. *S. chloronotus* had highest densities (3.95 ± 1.85/400 m²) in protected lagoons while *S. maculata* (1.43 ± 0.54/400 m²) in unprotected lagoons. Reef flats were dominated by *H. atra*; 1.72 ± 0.67/400 m² (protected) and *H. leucospilota*; 1.04 ± 0.35/400 m² (unprotected). Distribution was found to be clumped (CD = 1.42 ± 0.55) in protected and repulsed (CD = 0.32 ± 0.18) unprotected sites. Additionally, distribution in reef lagoons was clumped but repulsed in reef flats of both protected and unprotected areas.

The overall average abundance of commercial value holothurians was 3.92 ± 0.67/400 m². The most abundant species was the low value lollyfish, *H. atra* (1.25 ± 0.22/400 m²; $\bar{x} \pm \text{SEM}$), constituting 31.78 % of commercial species. Unprotected reefs had more species (12) than protected reefs (9 species) but there was higher abundance in protected reef lagoons (8.52 ± 2.32/400 m²) than protected reef flats (4.17 ± 1.52/400 m²). In unprotected habitats, reef lagoons had higher mean abundance (2.07 ± 0.38/400 m²) than the reef flats (2.04 ± 0.47/400 m²). Combined habitats (protected and unprotected) showed reef lagoons (4.73 ± 1.06/400 m²) as greater than reef flats (2.95 ± 0.71/400 m²) in abundance and also had higher number of species (12 species) than reef flats (8 species).

Holothurian abundance, diversity, density and distribution showed significant correlations with both substrate cover categories and rugosity. Hard coral was the most important variable and had significant ($p \leq 0.05$) effects on all holothurian population parameters except diversity ($p > 0.05$). Only seagrass significantly affected diversity negatively.

Management was found to be more important than habitat in controlling holothurian population densities and/or abundance. The higher densities in protected lagoons indicate that protection of whole reefs from exploitation may be an effective management option for conservation of holothurian stocks in Kenya. The information collected in this study will be key in developing effective management interventions for this potentially valuable fishery resource.

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