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# Distribution and Zonation of Seagrasses in the Palk Bay, Southeastern India

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## ABSTRACT

The distribution and zonation pattern of seagrass was assessed by SCUBA diving assisted with Global Positioning System (GPS) and 100 M transects at every 0.5 km, in the area between Mandapam and Thondi in the Palk Bay during March-July 2009. The study area has been divided into 3 regions, viz., Mandapam, Panaikulam and Thondi. Seagrass were distributed in about 175.2 $km^{-2}$ coastlines in the study area. The percentage of seagrass distribution and species composition in Mandapam it was 63.87% in nearshore with 10 species, 43.56% in middle zone with 7 species and 26.27% in offshore with 4 species. Likewise in Panaikulam it was 24.17% in nearshore with 7 species, 53.31% in middle zone with 6 species and 20.14% in the offshore 5 species. Where as, in Thondi it was 75.41% in nearshore with 9 species, 54.28% in middle with 8 species and 31.42% in offshore with 7 species. Overall all the 14 species were observed among the *Cymodocea serrulata* was the most abundant species and the least was *Enhalus acoroides* in these study region. Shoot density and biomass of 14 species of seagrass and epiphytic biomass in different zonation were analyzed. This study gives clear cut idea about distribution and zonation of seagrass in Palk Bay region.

**Key words:** Palk bay, seagrass, biomass, zonation of seagrass, offshore, *Cymodocea serrulata*

## INTRODUCTION

Seagrasses have been described as coastal canaries, global biological sentinels of increasing anthropogenic influences in coastal ecosystems (Orth *et al.*, 2006). Fundamental monitoring programme should provide a powerful tool for coastal resource managers through improved tracking of seagrass populations over time. Catastrophic losses of seagrass meadows continue worldwide along rapidly urbanizing coastal zones (Walker *et al.*, 2006), despite recognition of the enormous ecological and economic value of seagrass meadows (Orth *et al.*, 2006). A global conservation effort to protect seagrass habitat is critically needed (Orth *et al.*, 2006). Globally about 20% of documented seagrass area had disappeared because of direct and indirect human impacts and many remaining beds are increasingly stressed and fragmented (Green and Short, 2003).

Seagrasses are specialized marine flowering plants adapted to the near shore environment. These form extensive meadows supporting high biodiversity (Connolly *et al.*, 1999; Thayer *et al.*, 1975) in shallow coastal waters with sandy or muddy bottoms. It serves as feeding and nursery habitat for endangered species like dugong and turtles and also many commercial and recreationally important fishes. Seagrass regulate dissolved oxygen, reduce suspended sediments and nutrients in the water column (Stevenson, 1988; Short and Short, 1984) and there by modify physical and chemical environments. Seagrass are important in the production of organic carbon in the oceans (Duarte *et al.,* 2002). Its root and rhizome systems bind and stabilize bottom sediments and its leaves baffle currents and improve water quality by filtering suspended matter (Ward *et al.*, 1984). Seagrass beds also prevent coastal erosion thereby offering natural shoreline protection.

The Palk Bay covering an area of about 275 km from Point Calimere to Pamban in the Southern India. This area has luxuriant seagarss growth because of the topography and sediment texture. According to Jagtap *et al.* (2003), the major seagrass meadows in India exist along the Southeast coast (Gulf of Mannar and Palk Bay) and in the lagoons of Islands from Lakshadweep (Arabian Sea) and Andaman and Nicobar in Bay of Bengal. The seagrass species diversity is high in the Gulf of Mannar and Palk Bay, while, it is low in the Bay of Bengal (Parthasarathy *et al.,* 1991). Most of the earlier seagrass studies in the Palk Bay have focused only on their quantitative, taxonomic and structural components, but no comprehensive study was done on the distribution and zonation of seagrasses. Hence, the present study was carried out to collect detailed information on the current status, distribution and zonation of seagrasses in the area between Mandapam and Thondi in the Pak Bay.

## MATERIALS AND METHODS

The study was conducted in Mandapam, Panaikulam and Thondi regions of the Palk Bay during March-July 2009 in the area between latitudes 09° 17-45' N and longitudes -079° 15-079° 02' E. Each region was divided into three zones based on the depth namely Nearshore (0-2.0 m depth), Middle zone (2.1-4.0 m depth) and Offshore (4.1-7.0 m depth). The area of seagrasses and distribution was assessed by SCUBA diving assisted with Global Positioning System (GPS) as well as 10 m inter well three parallel 100 M transects were laid on the seagrass meadows at every 0.5 km and the transects were parallel to each other and perpendicular to the shore using English *et al.* (1997) method. In each transects a Quadrat (50×50 cm) was laid at 5 m regular intervals. Each quadrat were divided into 25 squares (10×10 cm) in order to calculate the percentage cover of seagrass species through visual estimation method (Saito and Atobe, 1970). The seagrass biomass was estimated using Mellors (1991). Epiphytic biomass was estimated by using Penhale (1977) method. The most commonly used way of expressing biomass or standing crop is g dry weight per $m^{-2}$.

## RESULTS AND DISCUSSION

The total seagrass distribution in the study area was 175.2 $km^{-2}$. Out of this 22, 49.5 and 103.8 $km^{-2}$ were distributed, respectively in Mandapam, Panaikulam and Thondi region. Seagrass percentage cover was 63.87, 43.56 and 26.27%, respectively in nearshore, middle and offshore of Mandapam. Likewise it was 24.17, 53.31 and 20.14% in Panaikulam region; and75.41, 54.28 and 31.42% in Thondi region (Fig. 1).

Shoot density of seagrass occur in different zonation at Mandapam region was 382.66, 285.96 and 88.07 shoot $m^{-2}$ at nearshore, middle zone and offshore, respectively. Highest shoot density (102.57 shoot $m^{-2}$) was observed in *Cymodocea serrulata* in the nearshore and lowest (13.19 shoot $m^{-2}$) was in *Thalassia hemprichii* in the offshore (Fig. 2). Seagrass biomass was 260.18, 179.80 and 45.90 g dwt $m^{-2}$ at nearshore, middle and offshore, respectively. In the

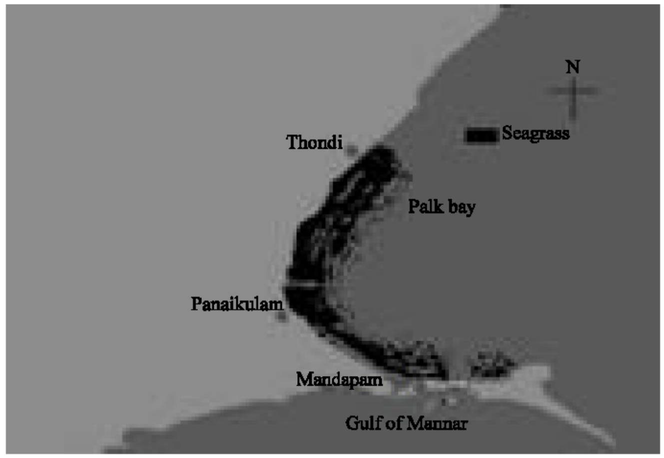


Fig. 1: Distribution of seagrass along the palk bay

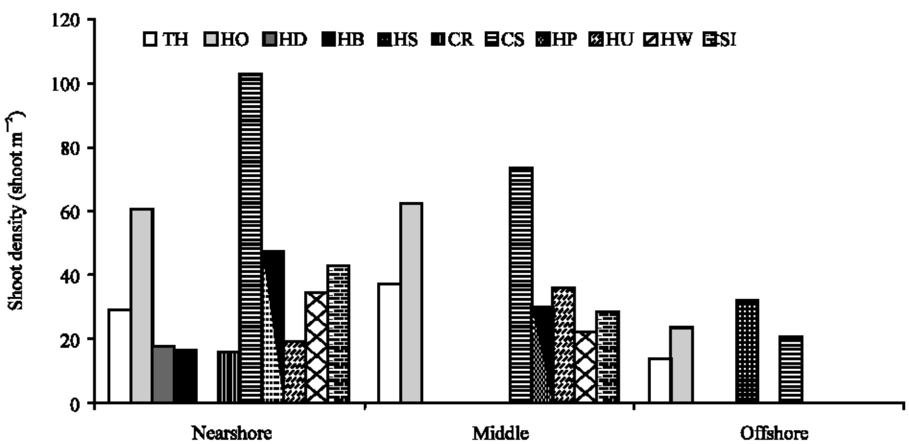


Fig. 2: Shoot density in different zonation of Mandapam. TC: *Thalassodendron ciliatum*, HO: *Halophila ovalis*, TH: *Thalassia hemprichii*, HM: *Halophila minor*, CR: *Cymodocea rotundata*, HD: *Halophila decipiens*, CS: *Cymodocea serrulata*, HP: *Halodule pinifolia*, HS: *Halophila stipulacea*, HU: *Halodule uninervis*, SI: *Syringodium isoetifolium*, HW: *Halodule wrightii*, EA: *Enhalus acoroides*

nearshore high biomass was noticed in *Cymodocea serrulata* with 86.15 g dwt $m^{-2}$ and lowest biomass was in *Halophila ovalis* with 7.54 g dwt $m^{-2}$ in offshore (Fig. 3).

Likewise the shoot density of seagrass in Panaikulam region was 206.89, 244.38 and 146.63 shoot $m^{-2}$ at nearshore, middle and offshore, respectively. In middle zone high shoot density was observed in *Cymodocea serrulata* with 75.78 shoot $m^{-2}$ where as in the offshore lowest density in *Thalassia hemprichii* with 12.10 shoot $m^{-2}$ was noticed (Fig. 4). Biomass noticed was 129.16, 163.75 and 70.77 g dwt $m^{-2}$ at nearshore, middle and offshore, respectively. In the nearshore highest biomass was noticed in *Syringodium isoetifolium* with 31.56 g dwt $m^{-2}$ where as in the offshore lowest biomass was noticed in *Halophila minor* with 9.22 g dwt $m^{-2}$, *Halodule uninervis* with 8.45 g dwt $m^{-2}$ and in *Thalassia hemprichii* with 8.40 g dwt $m^{-2}$ (Fig. 5).

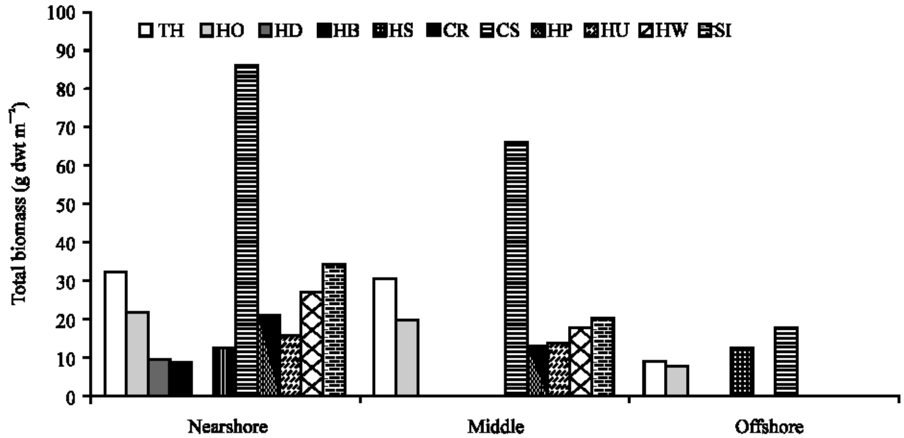


Fig. 3: Total biomass in different zonation of Mandapam. TC: *Thalassodendron ciliatum,* HO: *Halophila ovalis,* TH: *Thalassia hemprichii,* HM: *Halophila minor,* CR: *Cymodocea rotundata,* HD: *Halophila decipiens,* CS: *Cymodocea serrulata,* HP: *Halodule pinifolia,* HS: *Halophila stipulacea,* HU: *Halodule uninervis,* SI: *Syringodium isoetifolium,* HW: *Halodule wrightii,* EA: *Enhalus acoroides*

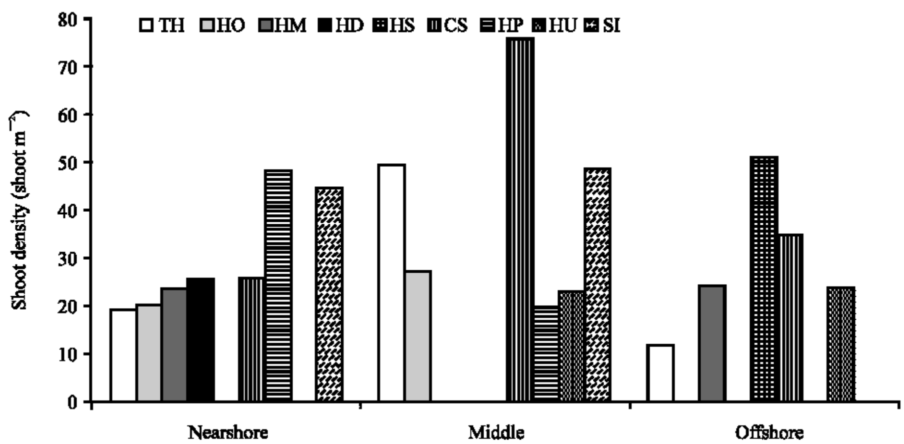


Fig. 4: Shoot density in different zonation of Panaikulam. TC: *Thalassodendron ciliatum,* HO: *Halophila ovalis,* TH: *Thalassia hemprichii,* HM: *Halophila minor,* CR: *Cymodocea rotundata,* HD: *Halophila decipiens,* CS: *Cymodocea serrulata,* HP: *Halodule pinifolia,* HS: *Halophila stipulacea,* HU: *Halodule uninervis,* SI: *Syringodium isoetifolium,* HW: *Halodule wrightii,* EA: *Enhalus acoroides*

In Thondi region 419.52, 335.74 and 292.79 shoot m$^{-2}$ shoot densities of seagrass were noticed at nearshore, middle and offshore, respectively. In the nearshore highest shoot density was noticed in Thalassodendron ciliatum with 105.84 shoot m$^{-2}$ and the lowest shoot density was noticed in *Cymodocea rotundata* with 18.92 shoot m$^{-2}$ (Fig. 6). Seagrass biomass was 421.50, 207.99 and 127.35 g dwt m$^{-2}$ at nearshore, middle and offshore, respectively. In the nearshore high biomass was noticed in *Thalassodendron ciliatum* with 151.34 g dwt m$^{-2}$ and offshore lowest biomass was observed in *Halophila minor* with 11.17 g dwt m$^{-2}$ (Fig 7). Epiphytic biomass of seagrass in

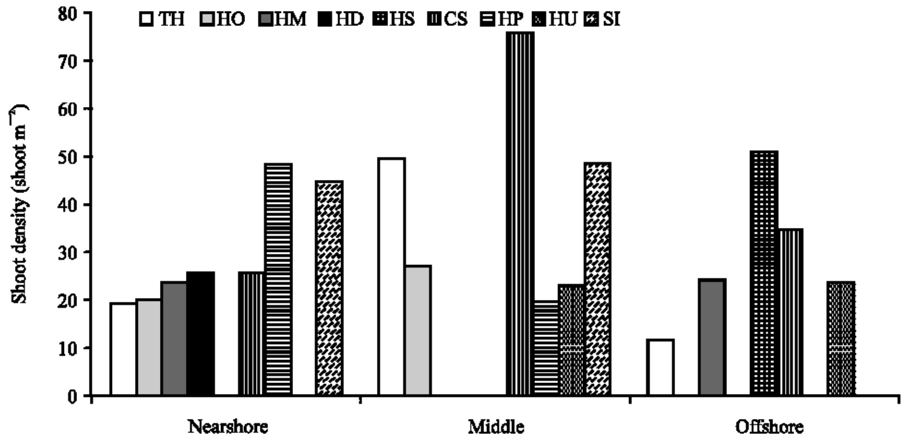


Fig. 5: Total biomass in different zonation of Panaikulam. TC: *Thalassodendron ciliatum*, HO: *Halophila ovalis*, TH: *Thalassia hemprichii*, HM: *Halophila minor*, CR: *Cymodocea rotundata*, HD: *Halophila decipiens*, CS: *Cymodocea serrulata*, HP: *Halodule pinifolia*, HS: *Halophila stipulacea*, HU: *Halodule uninervis*, SI: *Syringodium isoetifolium*, HW: *Halodule wrightii*, EA: *Enhalus acoroides*

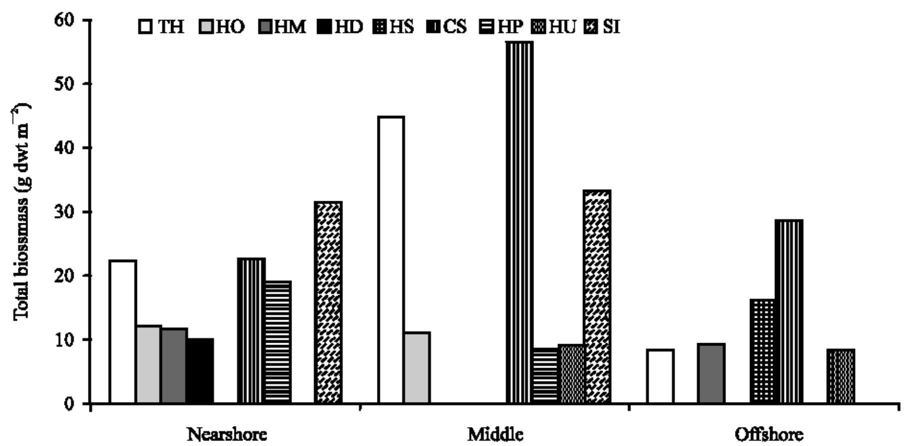


Fig. 6: Shoot density in different zonation of Thondi. TC: *Thalassodendron ciliatum*, HO: *Halophila ovalis*, TH: *Thalassia hemprichii*, HM: *Halophila minor*, CR: *Cymodocea rotundata*, HD: *Halophila decipiens*, CS: *Cymodocea serrulata*, HP: *Halodule pinifolia*, HS: *Halophila stipulacea*, HU: *Halodule uninervis*, SI: *Syringodium isoetifolium*, HW: *Halodule wrightii*, EA: *Enhalus acoroides*

Mandapam region were 21.48, 11.47 and 3.49 g dwt m$^{-2}$ in Panaikulam region were 7.15, 10.46 and 4.15 g dwt m$^{-2}$; in Thondi region were 25.16, 12.84 and 8.41 g dwt m$^{-2}$ respectively in the nearshore, middle zone and offshore of the study regions.

Present study has recorded 175.2 km$^{-2}$ of seagrass beds in this study area of Palk Bay during the year 2009, which is high when compared to entire Palk Bay and Gulf of Mannar could be estimated to have a seagrass cover of ca 30 km$^{-2}$ reported earlier study (Jagtap, 1996). This study

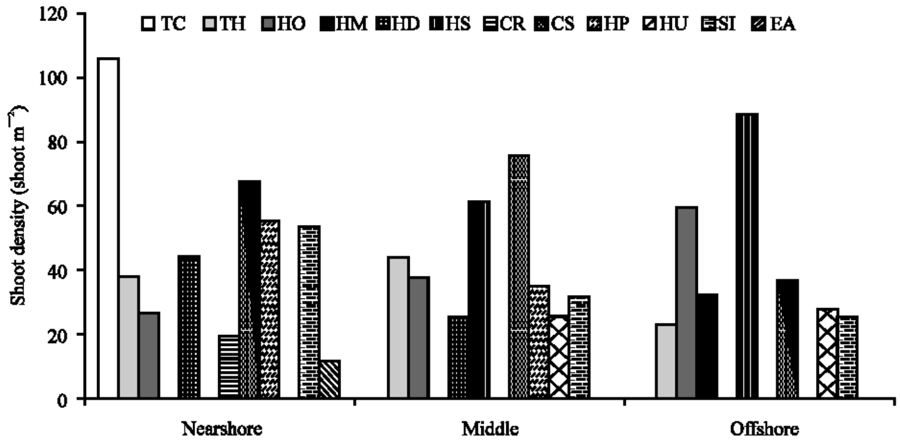


Fig. 7: Total biomass in different zonation of Thondi. TC: *Thalassodendron ciliatum*, HO: *Halophila ovalis*, TH: *Thalassia hemprichii*, HM: *Halophila minor*, CR: *Cymodocea rotundata*, HD: *Halophila decipiens*, CS: *Cymodocea serrulata*, HP: *Halodule pinifolia*, HS: *Halophila stipulacea*, HU: *Halodule uninervis*, SI: *Syringodium isoetifolium*, HW: *Halodule wrightii*, EA: *Enhalus acoroides*

revealed that *Cymodocea serrulata* was dominant species and *Enhalus acoroides* was the least dominant species in the Palk bay. In the nearshore *Cymodocea serrulata* was dominant species; in the middle zone *Thalassia hemprichii* was dominant species, where as in the offshore *Halophila stipulacea* was dominant species. In the nearshore due to the presence of soil erosion, prevalent wave action and water current during monsoon wind most of the seagrass species (non-runners) are unable to withstand where as *Cymodocea serrulata* is a runner it can tolerate because of these species possess more root density and also drop-off all its leaves during seasonal changes (especially during monsoon wind wave action). Distribution of seagrass species in these study zones indicated that various physicochemical and geomorphological characteristics have role in the distribution of seagrass as noted by Coles *et al.* (1987) that dense stands of *Cymodocea serrulata* are common in shallow coastal estuaries. *Enhalus acoroides* and Thalassodendron ciliatum are endemic to the region which posed rich amount of clay toasted silt soil (Thangaradjou and Kannan, 2005). *Enhalus acoroides* and Thalassodendron ciliatum were observed in Thondi region in only because of this region only posed rich amount of clay toasted silt soil. *Halodule stipulacea* was only distributed in the offshore zone of this study sites because these are alive under low light circumstance as suggested by Longstaff and Dennison (1999).

*Thalassia hemprichii, Cymodocea serrulata* and *Enhalus acoroides* contribute more biomass in Palk Bay regions. Similar trend has been noticed in Gulf of Mannar (Kannan, 2005). According to Short *et al.* (1993) the overall reduction in the total seagrass weight could be due to insufficient light and the effects of decreased light have reduction in shoot density, number of leaves per shoot and growth rate. The shoot density, biomass and Epiphytic biomass of seagrass were gradually decrease from nearshore to offshore in this study it indicated the raise of depth and reduced light penetration affect shoot density and biomass. Epiphytic biomass too decreased with increasing depth due to insufficient ambient light (Mazzela and Alberte, 1986).

The offshore zone of Palk bay is highly loaded with sediment contain nutrient from river disposals, waves and tidal currents; due to increased loading of sediments, less light penetration, more predator and clay soil the seagrass population were very less. The suspended fine sediments can exacerbate anoxia and depress gas exchange (Ralph *et al.,* 2006) by increasing the diffusion boundary layer for gas exchange across the leaf surface, thus decreasing photosynthetic rates (Ralph *et al.,* 2006). High turbidity and nutrients associated with sediment resuspension over denuded areas, in combination with erosion from waves and tidal currents, accelerate and maintain further seagrass loss (Clarke and Kirkman, 1989; Walker *et al.,* 2006). During the present study, multiple threats have been identified as causes for seagrass losses. These include localized impacts due to increased loading of sediments from ship channel that has lead to physical disturbance and fragmentation, aquaculture practices that can potentially cause physical disturbance and increased deposition of organic matter and nutrients.

A number of general parameters are critical to whether seagrass will grow and persist. These include physical factors that regulate the physiological activity of seagrasses (temperature, salinity, waves, currents, depth, substrate and day length), natural phenomena that limit the photosynthetic activity of the plants (light, nutrients, epiphytes and diseases) and anthropogenic inputs that inhibit the access to available plant resources (nutrient and sediment loading). Various combinations of these parameters will permit, encourage or eliminate seagrass from a specific location. The present study reveal that comparing to nearshore, middle and offshore the nearshore have more seagrass percentage, shoot density, biomass and epiphytes because in the nearshore of Palk pay region which possess more salinity and more temperature, waves, currents, less depth, sandy-clay substrate and more day length, light, nutrient and less sedimentation which favor the growth of seagrass. This study of seagrass in Palk Bay would be the base line data to know the changes in seagrass population in future.

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