PROJECT FINDINGS

1. Population Status of *Hippocampus kuda:*

Across the seven-year study from 2007 to 2014, a total of 702 *H. kuda* individuals were recorded, with 651 individual measurements (Table 1). Deformed individuals were present throughout the study period, accounting for 9.7% (n = 63) of the total sample. The observed deformities varied widely and included clipped tails, deformed coronets, elongated trunks, emaciation, broken veins, lesions, bloated skin or pouches, as well as the presence of blotches, tendrils, scars, skin patches, and color spots.

There were significant differences in the total length of seahorse across the years of monitoring. The pattern of changes in total length were consistent between males and females (Figure 1). The total lengths of H. kuda also showed significant differences between sex, reproductive status, and deformity status (Figure 2 and Figure 3 a-b).

The total count of individuals encountered annually ranged from 27 to 301 (Figure 4a), with highest number of individuals (n = 301) encountered in 2007. However, the annual count dropped dramatically in the year 2008 (n = 98) and continued to decrease until the year 2012 (n = 27) with a slight increase in the year 2013 (n = 44). Mark-recapture histories from 519 tagged individuals were used to determine the quarterly relative abundance (n) and estimated abundance (N) of *H. kuda* (Figure 4b). The estimated survival rate was 0.35 ± 0.04 (S.E.), and the capture probability was 0.30 ± 0.05 (S.E.).

TABLE 1 Descriptive data of total length in cm (n = 651) for *Hippocampus kuda* based on sex and deformity

Sex	Deformity	Count	Mean	Standard Deviation
Male	No	326	15.4	1.2
Female	No	260	14.9	1.2
Juvenile	No	2	14.6	2.8
Male	Yes	40	14.7	1.5
Female	Yes	21	14.7	1.5
Juvenile	Yes	2	10.5	2.5

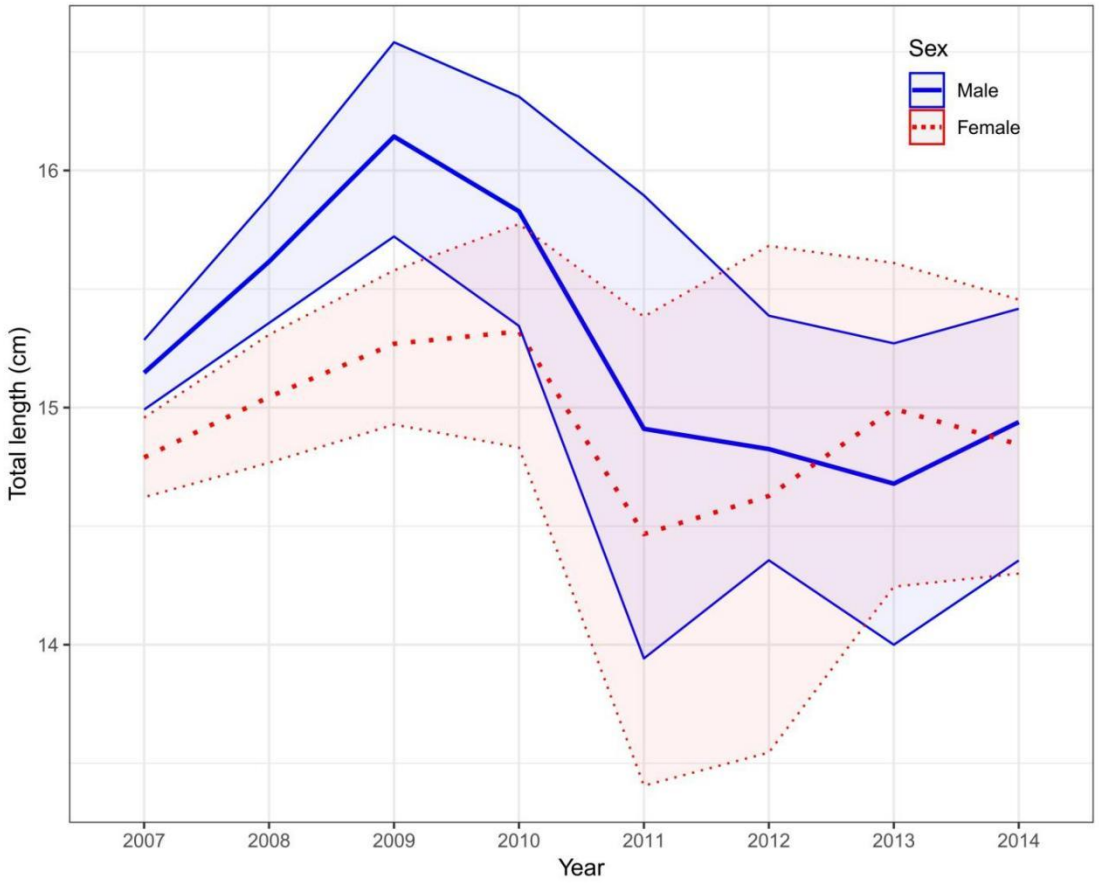


FIGURE 1 Total length measurements of *Hippocampus kuda* between male and female throughout the study period (2007-2014). The dotted lines and shaded areas represent the total length standard deviation of each year by sex

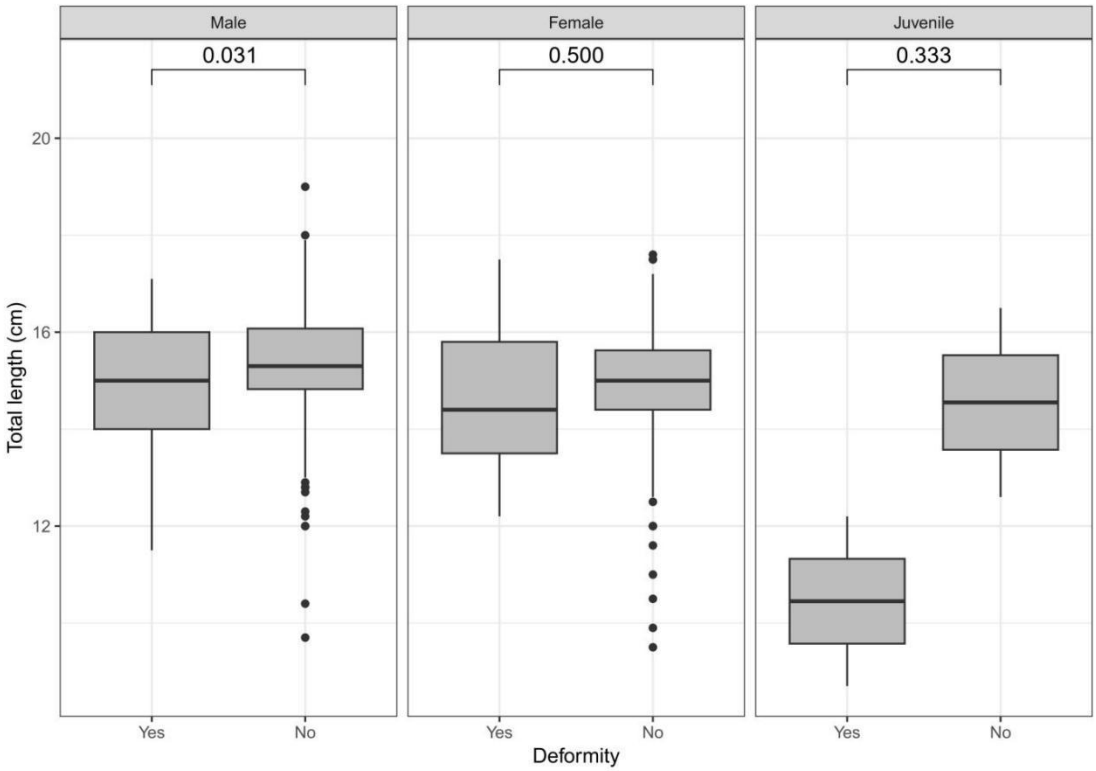
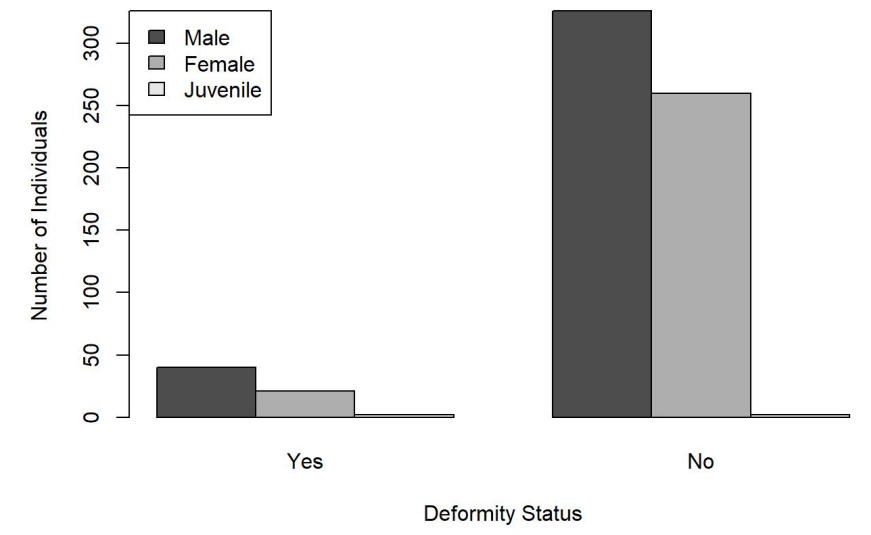
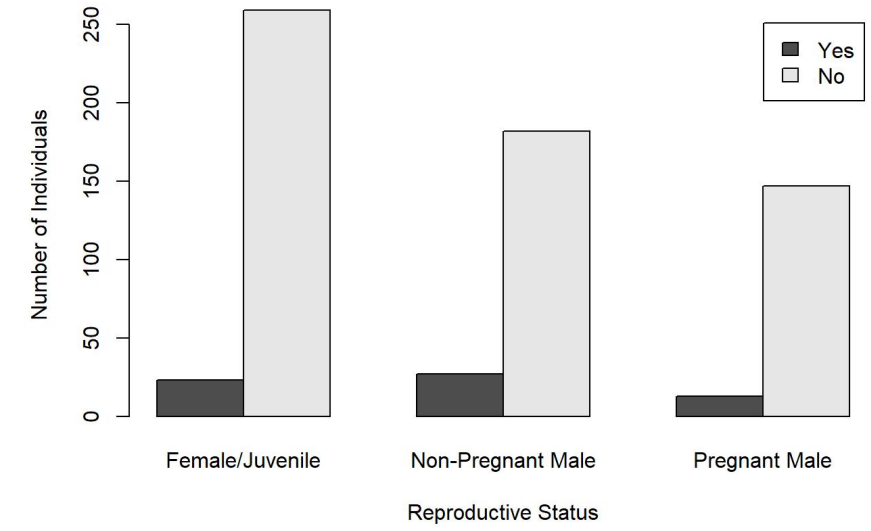


FIGURE 2 Boxplot depicting the total length differences of *Hippocampus kuda* based on deformity and sex, with significant differences indicated for each category (p-values)



a



b

FIGURE 3 Barplots representing the frequency of association between pairwise variables. **(a)** Deformity by sex. **(b)** Reproductive status by deformity, where females and juveniles are grouped together as a single reproductive category since neither are capable of reproduction, unlike non-pregnant and pregnant males

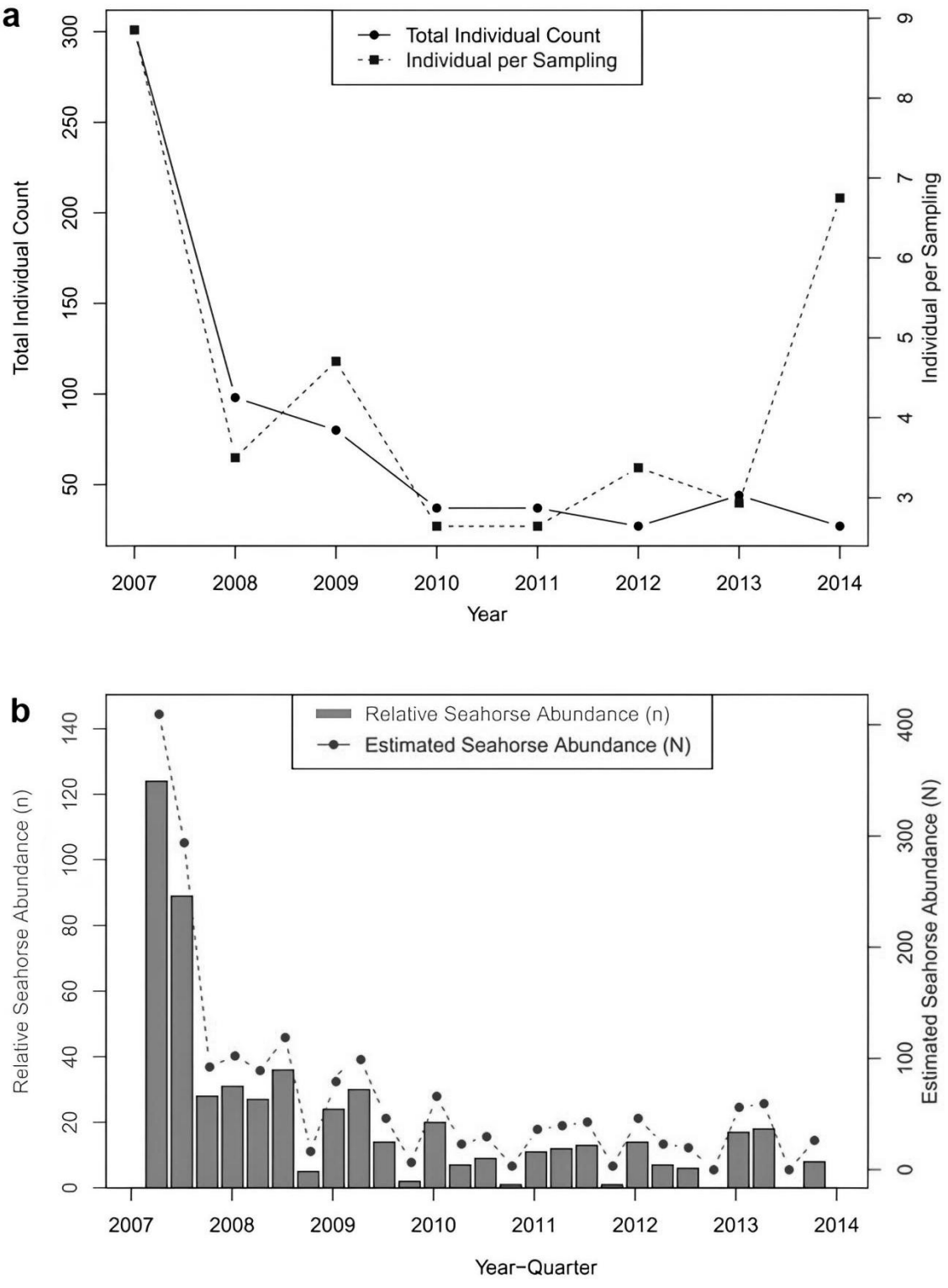


FIGURE 4 (a) Annual count of measured individual *Hippocampus kuda* and the average number of individuals recorded per sampling trip between 2007-2014. **(b)** Quarterly relative (n) and estimated (N) seahorse abundance over the same period based on the best Cormack-Jolly-Seber model

2. Baseline Study on the Seagrass Distribution and Species Diversity:

A total of six genera and three major functional groups (Table 1) of seagrasses, seaweeds, and marine invertebrates were recorded on the quadrat across all transects in the study area, along with abiotic components such as sand, silt, and water. The most dominant benthic groups identified were seagrasses (*Enhalus acoroides* and *Halophila* spp.), seaweed (*Caulerpa* sp.), and sediments (sand and silt). Other taxa, including *Amphiroa fragillisima*, *Ulva reticulata*, *Gracilaria* sp., gastropods, *Cercodemas anceps*, and sea anemones, were present in lower abundances (median< 5.00%).

Seven distinct benthic habitat clusters were identified across Merambong Shoal, each characterized by varying compositions of seagrass, seaweed, invertebrates, and sediments. *Enhalus acoroides* was dominant in Cluster C3, while *Halophila* spp. was most abundant in C2. Seaweed presence was limited and low in coverage, with *Ulva reticulata* being the most widespread, especially in C3 and C6. Invertebrates such as gastropods, sea anemones, and *Cercodemas anceps* were scarce, mostly appearing in C3 and C4. Sediments, mainly sand and silt, were present in all clusters except C2, with the highest coverage in C5 and C6. Each cluster had distinct dominant taxa or substrate types, reflecting habitat variability across the shoal.

The spatial distribution of benthic clusters varied notably across the North, Mid, and South areas of Merambong Shoal (Figure 1 and Figure 2). In the North, Cluster C7 was most dominant, while C1 was absent. The Mid area was mainly dominated by C6, with moderate coverage of C3 and C1. In the South, C3 was overwhelmingly dominant, covering 75% of the area, with minimal presence of other clusters and absence of C1, C2, and C4. These patterns highlight clear shifts in benthic community structure across the shoal, likely influenced by environmental gradients or habitat conditions.

Seagrass density varied across the study areas, with the South showing the highest overall cover, followed by the Middle, and the lowest in the North (Figure 3). *Enhalus acoroides* was most abundant in the South, with very low presence in the Middle. In contrast, *Halophila* spp. was densest in the Middle area and least abundant in the South. These patterns indicate distinct spatial differences in seagrass species distribution across Merambong Shoal.

TABLE 1. Median and [mean] percentage cover of benthic community and environmental variables at different clusters. Color represents the colors of clusters in Figure 2. **Bold** values represent the highest within each cluster. (ENH = *Enhalus acoroides*, HAL = *Halophila* spp., ULV = *Ulva reticulata*, CAU = *Caulerpa* sp., AMP = *Amphiroa fragilissima*, GRA = *Gracilaria* sp., GAS = Gastropods, CER = *Cercodemas anceps*, ANE = Sea anemone, SS = Sand and silt).

CLUSTER	COLOR	ENH	HAL	ULV	CAU	AMP	GRA	GAS	CER	ANE	SS
1		13.54 [19.27]	**60.42 [67.21]**	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0]	0.00 [0.00]	1.04 [13.52]
2		0.00 [0.00]	**100.00 [100.00]**	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0]	0.00 [0.00]	0.00 [0.00]
3		**72.50 [56.44]**	11.00 [18.74]	0 [0.23]	0 [0.08]	0 [1.85]	0 [0.15]	0 [0.12]	0 [0]	0.00 [0.12]	13.50 [22.28]
4		0.00 [0.00]	**75.79 [75.79]**	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0]	2.11 [2.11]	22.11 [22.11]
5		17.50 [23.12]	**59.50 [44.00]**	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0]	0.00 [0.00]	28.50 [32.88]
6		21.00 [29.18]	8.00 [29.17]	0 [2.29]	0 [0.29]	0 [0.00]	0 [0.00]	0 [0.00]	0 [0]	0.00 [0.00]	**40.00 [39.08]**
7		**46.39 [45.02]**	**37.81 [43.87]**	0 [0.00]	0 [1.42]	0 [0.00]	0 [0.33]	0 [0.00]	0 [0]	0.00 [0.17]	7.00 [9.20]

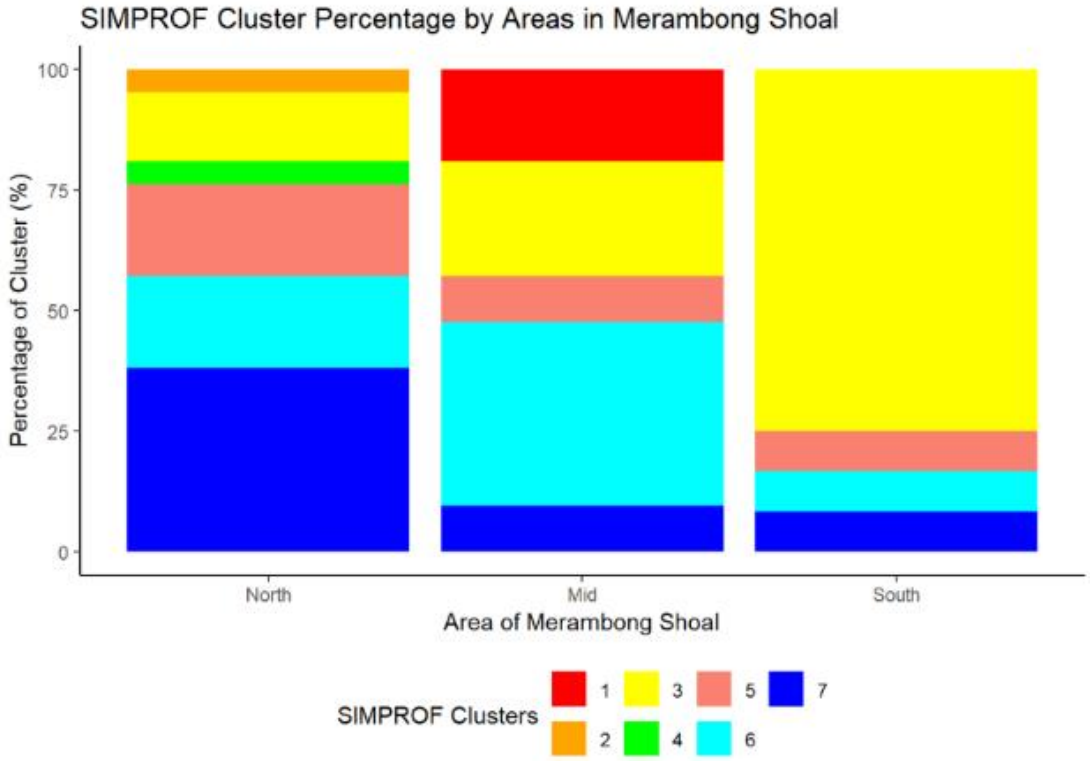


FIGURE 1 Bar graph of SIMPROF cluster percentage cover of benthic community and environmental variables across North, Middle and South of Merambong Shoal.

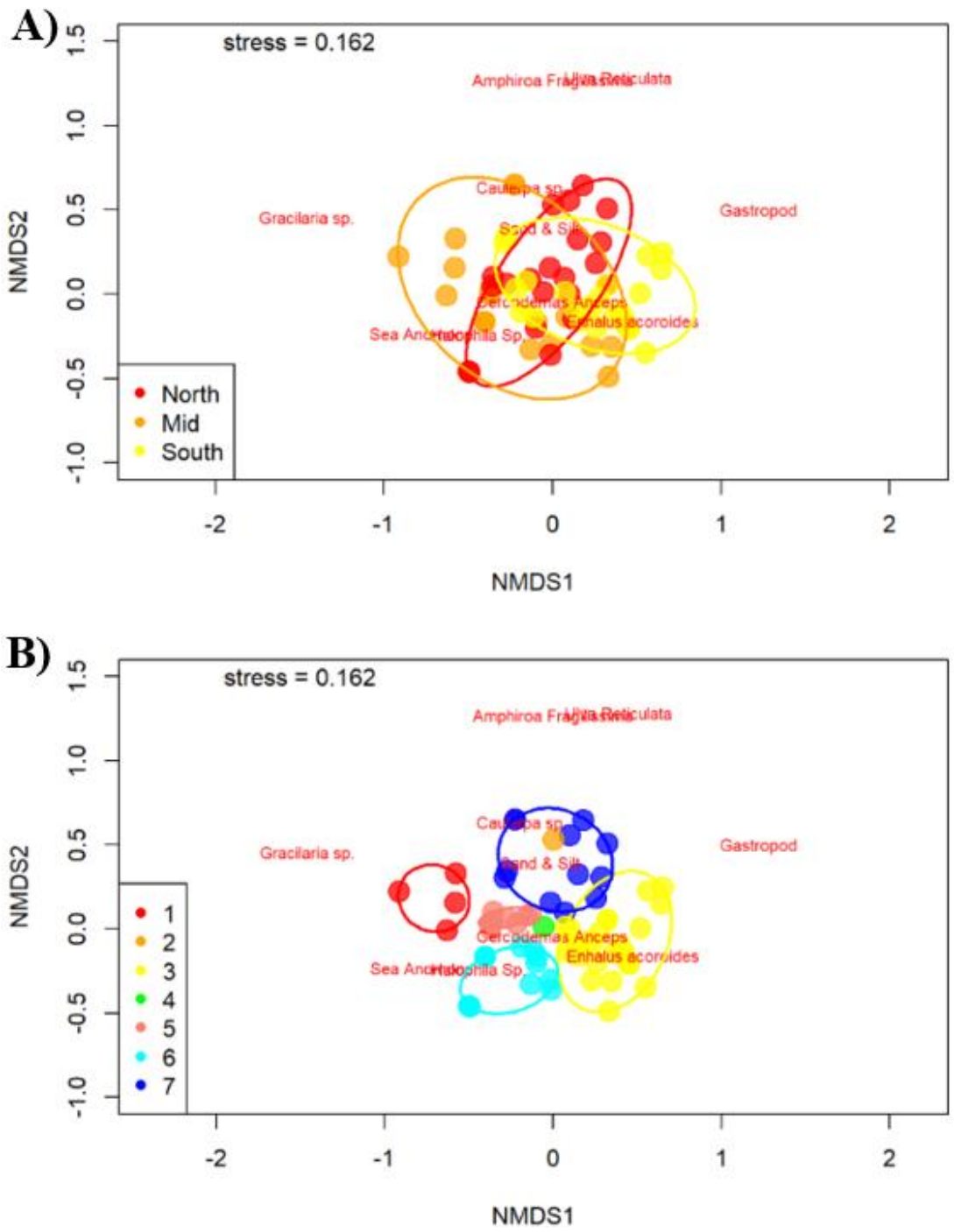


FIGURE 2 NMDS plot illustrates the distribution of benthic community and variables based on: (A) Areas, and (B) Clusters across Merambong Shoal. Each point represents a site, differentiated by colors based on their areas and clusters. Groupings show distinct clusters corresponding to different areas and clusters.

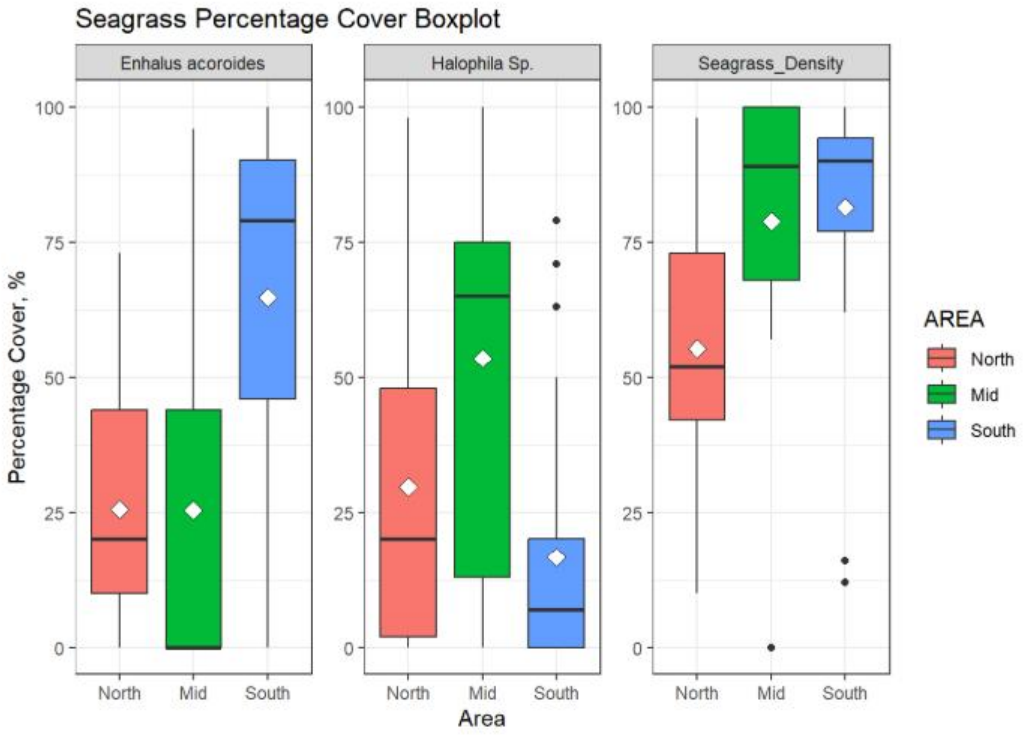


FIGURE 3 Seagrass density boxplot for: (A) *Enhalus acoroides*, (B) *Halophila* spp., (C) Overall seagrass density across the three areas of North, Middle, and South of Merambong Shoal.