Seagrass Parameter Affect the Fish Assemblages in Karimunjawa Archipelago

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Abstract. Seagrass beds promote high species diversity, abundance and biomass, and become important habitats for some economically important fishes. Plants of seagrasses result in structurally highly complex habitats and offering feeding grounds, shelter from predation as well as nursery areas for diverse fish assemblages. However, research on fish communities in Southeast Asian seagrass bed is rarely conducted. In the present study fish assemblages in seagrass beds with different parameters (cover, diversity and similarity indices, domination) was investigated in the Karimunjawa Islands, Indonesia. The purpose of this study were to assess whether fish assemblages differ concerning on the abundance and the species number. This study was conducted on the seagrass bed on Karimunjawa Islands in Java Sea, particularly in the water of Menjangan Besar and Menjangan Kecil Island. Line-quadrant transect was used to assess seagrass data, while the occurrence and individual number of fish harboured in the selected seagrass bed was counted by using underwater visual census in the stationary point count transects. Seagrass cover in Menjangan Kecil Island (41%) with various canopy included both upper and lower canopy was considerably higher than those in Menjangan Besar Island (5%). Fish diversity, species composition and abundance are considerably different between the two study sites. This study revealed that seagrass density or cover and canopy structure affected the fish abundance and species number harboured.

1. Introduction

Seagrass beds promote high species diversity, abundance and biomass, and become important habitats for some economically important fishes [1], [2]. Plants of seagrasses result in structurally highly complex habitats and offering feeding grounds, shelter from predation as well as nursery areas for diverse fish assemblages [3].

Located in Southeast Asian seas, Indonesia is the heart of the coral triangle regions, contain the highest numbers of fish species in the world [4]. In Indonesia, seagrass beds cover shallow water part of coastlines and offshore islands, and can be vegetated by up to ten seagrass species [5] and 80 or more fish species [6], [5] within a single meadow. As their importance for fish species, they become of interest for people.
Most studies of fish assemblages in seagrasses have been performed in the Caribbean. Moreover, diversity of the fauna in Seagrass beds in Southeast Asia is distinctly higher [2], and may therefore generate a differ mechanisms in influencing fish assemblages. However, research on fish communities in Southeast Asian seagrass bed is rarely conducted [7], [8], [9], [10].

In the present study fish assemblages in seagrass beds with different parameters (cover, diversity and similarity indices, domination) was investigated in the Karimunjawa Islands, Indonesia. The purpose of this study were to assess whether fish assemblages differ concerning on the abundance and the species number.

2. Methods

2.1. Study Area
The present study was conducted on the seagrass bed on Karimunjawa archipelago in Java Sea (Fig. 1). The archipelago is about 110 thousand hectare of wide, and consists of numerous islands and outspread reefs. It has a tropical climate, with an annual mean air and water temperature of 32 °C and 28 °C, respectively [11]. May to September is considered as dry, November to March as wet season. The tidal regime is predominantly semi-diurnal with a maximum tidal range at spring tide of 180 cm and an average tidal range of 80 cm (according to the tidal predictions for Semarang harbour). Seagrass bed close to Menjangan Kecil Island and Menjangan Besar Island were chosen as study area. Both islands are patch reefs crowned by corals and shallow subtidal seagrass beds. Both islands are not populated. Two different seagrass meadows of different canopy structure and species composition were chosen.

2.2. Seagrass parameters
Line-quadrant transect according to McKenzie [5] was used to assess seagrass data. A quadrat of 100 cm x 100 cm was randomly thrown along the transect line of 40m which stretched upright to the coast line the selected patches for the visual census. This transect line was then repeated 3 time with 25 m distance inter-transect in parallel with the coast line. The frame was then subdivided into 16 smaller sub-quadrats, each with a side length of 25 cm. The number of shoots of each seagrass species was counted.

2.3. Counting of fish harboured
The occurrence and individual number of fish harboured in the selected seagrass bed was counted by using underwater visual census in the stationary point count transects [3]. In each site, three replicates of 100 m, 60 m and 30 long marked transect lines, were deployed upright to the coast line. A single rope with a length of 5 m was used as a visual guidance for quadrat size. After placing the line, the observer waited 3 min before counting to minimise fish disturbance.

2.4. Data Analysis
Fish were recorded as juveniles when they were smaller than one third of the maximum species’ length [12] [5]. Data of both the seagrass and the fish were analysed descriptively and presented in graphs.
3. Result

3.1. Study Area
Seagrass cover in Menjangan Kecil Island (41%) was considerable higher than those in Menjangan Besar Island (5%). They were composed of Enhalus acoroides, Thalassia hemprichii, Cymodocea rotundata, C. serrulata, Halodule uninervis, Halophila ovalis and H. minor in different composition between the two sites (Fig. 2.). Menjangan Besar Island was comprised only two species of seagrass, while seven seagrass species without any species domination (C=0.21) were found in Menjangan Kecil Island. Diversity of seagrass species as showed from the indices in here was moderate with high similarity (Fig. 3.) It result in various canopy included both upper and lower canopy. The upper canopy was mostly generated from E. acoroides shoots. T. hemprichii comprised the second upper canopy. The rest other species together formed a lower canopy. H. ovalis found in higher stand with bigger leave among the genus. The leave shape was ovate, obovate or oblong. The two other species, H. uninervis and H. minor scarcely occurred.

Different types of canopy were performed in the Menjangan Besar Island. As there were only two species, they formed only high canopy in the seagrass path. E. acoroides and T. hemprichii stand in the relatively same composition and resulted in the low diversity of seagrass meadow.
Figure 2. Species composition of seagrass meadow in Menjangan Kecil and Menjangan Besar Islands.

Figure 3. Diversity indices, similarity indices and domination of seagrass meadow in Menjangan Kecil and Menjangan Besar Islands.
3.2. Fish harboured in the seagrass meadow.
It seemed that there was a considerable different in the family, fish and species number between those in Menjangan Kecil Island and Menjangan Besar Island (Table 1.). There were eight species of mangrove/seagrass-associated reef fish found in Menjangan Kecil island. Among the reef fish, *Abudefduf sexfasciatus* and *Sphyraena flavicauda* were the most abundance. In contrast, only 2 species of mangrove/seagrass-associated reef fish belong to Pomacentridae family were in Menjangan Besar Island. Seagrass species from family Engraulidae looked dominated among the fish in both waters.

Table 1. Harboured fish in the seagrass beds

| Family/Species   | Menjangan Kecil Island | Menjangan Besar Island | Note |
|------------------|------------------------|------------------------|------|
| Apogonidae       |                        |                        |      |
| *Apogon margaritophorus* | 10                     |                        | Rf   |
| *Cheilodipterus isostigmus* | 5                      |                        | Rf   |
| Blenniidae       |                        |                        |      |
| *Petroscirtes variabilis* | 14                     | 3                      | Sg   |
| Caesionidae      |                        |                        |      |
| *Caesio teres*   | 8                      |                        | Rf   |
| Chaetodontidae   |                        |                        |      |
| *Chaetodon octofasciatus* | 5                     |                        | Rf   |
| Engraulidae      |                        |                        |      |
| *Encrasicholina heteroloba* | 384                   | 51                     | Sg   |
| *Stolephorus waitei* | 136                   | 8                      | Sg   |
| Monacantidae     |                        |                        |      |
| *Acreichthys tomentosus* | 4                     |                        | Sg   |
| Nemipteridae     |                        |                        |      |
| *Pentapodus trivittatus* | 7                     |                        | Rf   |
| Pomacentridae    |                        |                        |      |
| *Abudefduf sexfasciatus* | 23                    | 5                      | Rf   |
| *Dischistodus prosopotaenia* | 6                     | 3                      | Rf   |
| Sphyraenidae     |                        |                        |      |
| *Sphyraena flavicauda* | 23                    |                        | Rf   |
| Syngnathidae     |                        |                        |      |
| *Syngnathoides biauculeatus* | 5                     |                        | Sg   |

| Number of individu | 630 | 70 |
|--------------------|-----|----|
| Number of Species  | 13  | 5  |
| Number of reef fish species | 8 | 2 |

4. Discussion
In the present study fish assemblages in seagrass beds with significantly different seagrass parameters were investigated. Fish diversity, species composition and abundance are considerably different between the two study sites, i.e between Menjangan Kecil Island and Menjangan Besar Island, even both are subtidal seagrass bed and close to reefs. This study revealed that seagrass density or cover and
canopy structure affected the fish abundance and species number harboured. Moreover, higher diversity and less domination seemed promoted higher fish number as well as species number. Pogoreutz et al. [4] found that fish assemblages in seagrass beds at different water depths and with differing canopy structure defined by significantly different shoot density, biomass and leaf area index (LAI), differed significantly in terms of species number, total abundance, and abundance of most common species. They revealed an effect of water depth and seagrass shoot density on total fish abundance and LAI, seagrass biomass and water depth affected the abundance of most common fish species.

It is generally approved that structurally rich seagrass beds, i.e. beds with high shoot density and/or biomass, provide good conditions, such as advance habitat complexity and food availability, and decreased predation pressure [13], [10]. High fish abundances in relation to high seagrass shoot densities were deal with previous studies [10], [14]. Hovel et al. [13] found that significant relationships between seagrass biomass and animal densities were only detected at high seagrass biomasses, which is in contradiction with the finding of Pogoreutz et al. [4] that showed overall faunal abundance was found to be higher in beds with higher shoot densities and biomasses compared to beds with lower shoot densities, although certain taxa apparently preferred the less structured habitat [10]. The most abundance fish families in the present study were Engraulidae for seagrass species and Pomacentridae and Sphyraenidae for mangrove/seagrass-associated reef fish. Similarly, Pomacentridae comprised the most abundant families in seagrass bed of the Spermonde Archipelago, Indonesia [4]. Conversely, the most abundant family in a seagrass bed at Wakatobi found by Unsworth et al. [2] was Apogonidae. These different results might be due to the sampling methods used or site-specific.

5. Conclusion
Fish diversity, species composition and abundance are considerably different between the two seagrass beds with different species parameters. Higher seagrass density or cover and canopy structure combination with lower domination resulted in the higher fish abundance and species number harboured. Different result in the most abundant family compared to those at Wakatobi might be due to the sampling methods used or site-specific.

References
[1] Parrish J D 1989 Fish communities of interacting shallow-water habitats in tropical oceanic regions vol 58 pp 143–160
[2] Unsworth R K F et al 2007 Diel trophic structuring of seagrass bed fish assemblages in the Wakatobi Marine National Park, Indonesia 72
[3] Dorenbosch M et al 2005 Seagrass beds and mangroves as potential nurseries for the threatened Indo-Pacific humphead wrasse, Cheilinus undulatus and Caribbean rainbow parrotfish Scarus guacamaia 9
[4] Pogoreutz C et al 2012 Estuarine, Coastal and Shelf Science The in fl uence of canopy structure and tidal level on fish assemblages in tropical Southeast Asian seagrass meadows Estuar. Coast. Shelf Sci. 107 pp 58–68
[5] McKenzie L et al 2007 Seagrass ecosystems of Papua. In: Marshall A J and Beehler B M (Eds.) The Ecology of Papua Part 2 Periplus editions (Hk) Ltd pp 800-823
[6] Hutomo M and Martosewojo S 1977 The fishes of seagrass community on the west side of Burung Island (Pari Islands, Seribu Islands) and their variations in abundances Marine Research in Indonesia 17 147-172.
[7] Nienhuis P H et al 1989 Community structure and biomass distribution of seagrasses and macrofauna in the Flores Sea Netherlands Journal of Sea Research 23 197-214
[8] Erftemeijer P L A and Allen G R 1993 Fish fauna of seagrass beds in south Sulawesi, Indonesia Records of the West Australian Museum 16 269-277
[9] Vonk JA et al 2008 Redefining the trophic importance of seagrasses for fauna in tropical Indo-Pacific meadows *Estuarine, Coastal and Shelf Science* 79 653-660
[10] Vonk J A et al 2010 Abundance, edge effect, and seasonality of fauna in mixed-species seagrass meadows in southwest Sulawesi, Indonesia *Marine Biology Research* 6 282-291
[11] Erftemeijer P L A and Herman P M J 1994 Seasonal changes in environmental variables, biomass, production and nutrient contents in two contrasting tropical intertidal seagrass beds in South Sulawesi, Indonesia. *Oecologia* 99 45-59
[12] Nagelkerken I and Van der Velde G 2002 Do non-estuarine mangroves harbour higher densities of juvenile fish than adjacent shallow-water and coral reef habitats in Curacao (Netherlands Antilles)? *Mar. Ecol. Prog. Ser.* 245 pp 191–204
[13] Gullström, M et al 2002 Seagrass ecosystems in the western Indian Ocean *Ambio* 31 588-596
[14] Hovel K A 2002. Effects of seagrass landscape structure, structural complexity and hydrodynamic regime on macrofaunal densities in North Carolina seagrass beds *Mar. Ecol. Prog. Ser.* 243 11-24