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Submission date: 26-Jul-2022 10:14PM (UTC+0700)
Submission ID: 1875462587
File name: C26_-_Diversity_Based_Sustainable_Management_for.pdf (2.82M)
Word count: 2456
Character count: 12881

RESEARCH ARTICLE

Advanced Science Letters
Vol. 23, 2413–2415, 2017

Diversity Based Sustainable Management for Seagrass Ecosystem: Assessing Distribution and Diversity of Seagrass in Marine Protected Area

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Sustainable management of the natural resources is influenced by understanding of basic ecological condition. This study aims to investigate distribution and diversity of seagrass ecosystem at Karimunjawa National Park using satellite imagery GEO-EYE and ecological surveys as the basis of its management. Seagrass mappings were done at 10 locations. While ecological surveys were conducted using line and square transect. Satellite image interpretation results showed that seagrass were found scattered at several islands. The highest and the lowest percent cover of seagrass ecosystems were found at Krakal Kecil (38.64%/6.55 ha) and Cilik (0.20%/0.06 Ha). Diversity of seagrass was identified from two family, namely *Hydrocharitacea* and Cymodocea. The percentage cover of seagrass species including the highest and lowest were *Thalassia hemprichii* (11.31%) and *Thalassodendron ciliatum* (0.01%), respectively. The highest and lowest individual density were Menjangan (280 ind/m^2) and Mrican (26 ind/m^2), with an average of 148 ind/m^2. The value of diversity index ranged from low to moderate, while the evenness index values ranged from medium to high. There is no dominance of particular species at the study site. The results suggest that there is a need to develop diversity based sustainable management for this marine resource.

Keywords: Seagrass, Diversity, Sustainable Management, Karimunjawa Islands.

1. INTRODUCTION

Seagrass ecosystem is one of the most productive and dynamic ecosystems. Many studies have investigated the importance of seagrass beds as an ecosystem.[1–4] They do not only provides habitats, nursery as well as protection, but also the basic energy source for many marine species.[5] This ecosystem has important ecological functions and provide services such as a role in the dynamics of the food chain and the potential for ecological resilience.[6,7] Several reports indicate the occurrence of global loss of seagrass ecosystems.[8–10] The loss is due to natural causes and anthropogenic pressures.[11] Global seagrass loss between 1879 and 2006 was 27 km^2 yr^{-1}.[9] More than 50% seagrass meadows of worlds are currently decreasing, including Indonesia.

Seagrass in many areas in Indonesia were damaged and about 30–40% of seagrass has been lost, with as much as 60% being destroyed around Java.[12] The percentage of seagrass damage in Banten bay is 116 ha or about 26% of the total area of seagrass, which caused mainly by turbulent water induced by fishing boat movement and uprooting of seagrass by seines;[12] Grenyeng Bay and Bojonegara, by land reclamation for harbours[12] and Derawan.[13] Poor coastal management has been commonly claimed as the cause of seagrass decline and loss.[14,15] The management of seagrass ecosystems is believed to be very important.[16] Understanding basic ecological condition, diversity and distribution of seagrass is among the most important aspects to be considered in its management. Present study investigates the condition of seagrass ecosystem at Karimunjawa National Marine Park, Indonesia and discusses the relation to management need.

2. EXPERIMENTAL DETAILS

This study mapped the percent cover and distribution of seagrass using satellite imagery Geo-Eye and followed by ecological surveys. Satellite image interpretations were done at several islands i.e., Cemara Kecil, Cemara Besar, Krakal Besar, Krakal Kecil, Cilik, Sintok, Menjangan Besar, Menjangan Kecil, Tengah dan Karimunjawa (total 3.752 Ha). Ecological surveys of seagrass were conducted at Kemujan and Menjangan Besar Island.

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Table I. Average of seagrass cover.

	Seagrass cover (%)					
	Kemujan			Menjangan besar		
Species	1	2	3	1	2	3
E. acoroides	7,17	6,36	5,48	–	6,09	–
T. hemprichii	6,95	18,02	7,67	9,05	21,97	4,23
H. ovalis	–	4,58	0,05	2,04	0,62	13,22
C. serrulata	–	0,53	0,94	–	–	–
C. rotundata	0,21	0,46	0,09	12,96	2,67	0,85
H. pinifolia	–	19,27	1,36	0,336	0,09	–
T. ciliatum	–	–	–	–	–	0,02

Table II. Value of diversity (H′), similarity (E′) and dominancy (C) indices.

Island	Site	H′	Cat	E′	Cat	C	Cat
Kemujan	1	0,76	low	0,69	high	0,49	low
	2	1,31	med	0,73	high	0,31	low
	3	1,15	med	0,64	high	0,38	low
Menjangan besar	1	0,97	low	0,7	high	0,43	low
	2	0,87	low	0,54	med	0,53	med
	3	0,72	low	0,52	med	0,58	med

2.1. Procedures

Two different transects were done to observe seagrass which include number of stands/individuals, and percent cover.[17] First, line transects (100 m) were done parallel to the beach. While square transects (1 × 1 m) were done along the line transect seaward, with the distance between transects were 5 m or 20 m depending on seagrass species composition. For square with homogeneous species composition then the distance between transects taken was 20 m, whereas if the species composition of seagrass heterogeneous, the distance was 5 m. Seagrass mapping was done through several processing stages i.e., image restoration, image enhancement and image classification. Image corrections consist of geometric and radiometric.[18]

2.2. Data Analysis

The species composition was determined based on the species of seagrass found in the study site. Species identification was done based on Mckenzie and Yoshida.[19] Estimated percent cover was done using the method of Saito and Atobe. The value of relative cover, seagrass density, relative density, species frequency, relative frequency and importance value index were calculated based on Brower and Zar.[20] While diversity, similarity, and dominancy indices were calculated using the formula of Shannon-Wiener, Pielou, and Simpson, respectively.[21]

3. RESULTS AND DISCUSSION

3.1. Seagrass Diversity

Two families and seven species were found in Kemujan dan Menjangan Besar island, namely Hydrocharitacea (*Enhalus acoroides, Thalassia hemprichii, Halophila ovalis*) and Cymodocea (*Cymodocea serrulata, Cymodocea rotundata, Halodule pinifolia, Thalassodendron ciliatum*). While the highest and lowest percent cover of seagrass species found were *T. hemprichii* (11.31%) and *T. ciliatum* (0.01%), respectively (see Table I). Menjangan island has higher individual density (280 ind/m^2) compared with Kemujan island (26 ind/m^2), with an average individual density of 148 ind/m^2. The highest and lowest individual frequency of each site Kemujan (50%) and Menjangan Besar (8%).

Table II shows that diversity indices of Menjangan island were lower than Kemujan island. On the other hand, the similarity indices of Kemujan island were higher than those of Menjangan island. The most common species of seagrass found in every site was *T. hemprichii*, although there is no dominancy of certain species found.

3.2. Seagrass Distribution

Results of mapping study showed that seagrass were found scattered at several islands only i.e., Cemara Kecil, Cemara Besar, Krakal Besar, Krakal Kecil, Menjangan Besar, Cilik, Tengah and Karimunjawa. The highest and the lowest percent cover of seagrass ecosystems were found at island of Krakal Kecil (38.64%/6.55 Ha) and Cilik (0.20%/0.06 Ha) (See Fig. 1). Total research area was 3752 Ha while seagrass area was 216,27 Ha (5,76%). This study found that the the seagrass cover in Karimunjawa (5.76%) is also very low when compared with percent cover of coral reefs i.e., 1073.57 Ha (28.61%) and mangrove 475.09 Ha (12.66%). These data are relatively lower than those in other areas, such as coastal of Denpasar (28.25 to 42.74%).[22] and Talise island of North Sulawesi (40–80%).[23]

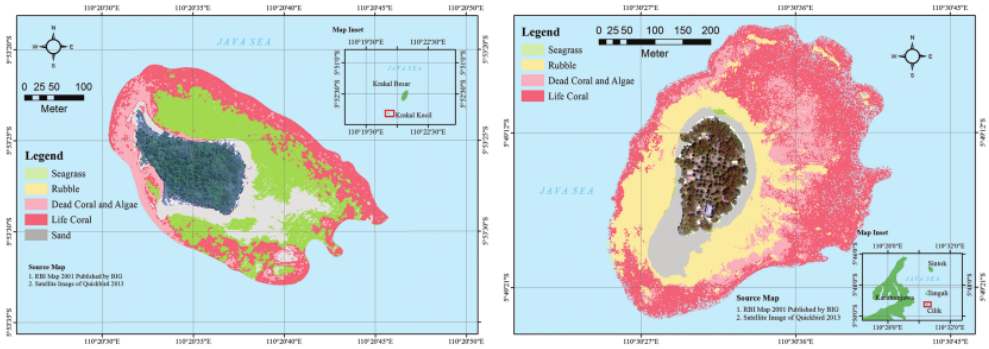

Fig. 1. The highest and lowest percent cover of seagrass at Krakal Kecil and Cilik island.

Decrease in the percentage of seagrass percent cover primarily caused by human activities,[11,24] which is also greatly influenced by existing management processes. This is further confirmed the opinion that the presence of seagrass has not been a serious concern. One suspected cause is a lack of public understanding on the importance of seagrass compared with other coastal ecosystems and the cause of the decline.[8,25] Seagrass ecosystem management in Karimunjawa can be categorized as general conservation management. At the global level, protection and conservation of seagrass not receive adequate attention which occur almost worldwide.[8] As also suspected by Duarte et al.,[26] that knowledge transfer, management and monitoring to the public have been more emphasis on coral reef and mangrove ecosystems. The development of marine conservation area only to protect the coral reefs, mangroves and the fish within the area. Moreover, monitoring of seagrass in the region has not been done regularly and seagrass biodiversity has not been included as an important factor in the development of management system.

Since every locations have specific characters in terms of seagrass diversity as well as ecological parameters and functions, biodiversity-based management become very important in maintaining the sustainability of seagrass. Further study of seagrass genetic diversity is very important[27,28] to have better understanding of this ecosystem. The management must be accompanied by monitoring the condition of the ecosystems are conducted periodically. Monitoring which includes diversity and ecological parameters that describe the condition of seagrass biodiversity should be the primary consideration in its management. Priority should be taken to implement diversity based conservation management in the area of the richest biological diversity,[24] such as Indonesia which is known as the center of mega-biodiversity.[28,29] It is known that the seagrass has a very significant role included being able to provide important ecosystem services,[9] fisheries[30,31] and important carbon stock.[32,33] Increased attention to the condition of this ecosystem needs to be improved[6] not only on the reef and mangrove ecosystems alone.[26] Particular attention need to be address to the development of proper management of seagrass ecosystem based on the biodiversity of the seagrass.

4. CONCLUSION

The results suggest that there is a need to develop diversity based sustainable management for this marine resource.

Acknowledgments: The authors would like to thank to Balai Taman Nasional Karimunjawa and M. Helmi of Coastal Disaster Rehabilitation and Mitigation Center, Diponegoro University for satellite imagery and maps analysis. Ecological survey team, M. H. P. Iqbal, E. R. Arifismail, S. Teo Andri, N. A. Siti and P. P. Rendy Mapping team R. K. P. Tegar and R. Rio.

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Received: 12 October 2016. Accepted: 2 November 2016.

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