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THE DIVERSITY AND REGENERATION OF MANGROVE ON PANJANG ISLAND JEPARA CENTRAL JAVA

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Abstract

Panjang Island is a small island under the administrative territory Jepara Regency, Central Java Indonesia. Small islands, such as Panjang, have been vulnerable to changes and environmental pressures. Because of their natural resources and fragile nature, the existence of small islands is necessary to be protected and ensured. Mangrove is a vegetation with a function to protect the coastal ecosystem. Its regeneration status will determine the sustainability of the ecosystem. This study aimed to assess mangrove species diversity and mangrove regeneration on Panjang Island. The site research was determined by purposive sampling. Research sites were four stations located in the southern, eastern, northern, and western part of the island. Each station occupied with three plots measuring 20 × 20 meters for tree stage, 5 × 5 m for sapling and 1 × 1 m for the seedling stage. Data was calculated according to important value index (IVI), diversity index (H') and the evenness index E . In Panjang Island, 7 true mangrove and 7 mangrove associated species have been found. The dominant true mangrove was Pemphis acidula, whereas the dominant mangrove associate was Thespesia populnea. The diversity index mangrove species (H') is between 1.28 – 1.82. The mangrove regeneration in Panjang Island did not take place appropriately, as indicated by the number of individual saplings (57 individuals/Ha) < number of individual seedlings (191 individual/Ha) < number of individual trees (274 individuals/Ha). There were two important tree species in Panjang island, Pemphis acidula (Stigi) with Least Concern status according IUCN, and Excoecaria agallocha. Both species require protection. The study recommended a mangrove reforestation with local species in order to obtain the sustainability of coastal ecosystem in Panjang Island.

Keywords: *Small island; Diversity; Sustainability; Regeneration; Important Value Index (IVI).*

Introduction

Panjang Island is a small island under the administrative territory Jepara Regency, Central Java Indonesia. Panjang Island has natural resources, such as white sand beaches and clear waters where various organisms become a distinct attraction for tourists. In addition, the island is also home to protected forests with various species of plants and wildlife.

Panjang Island is an island without river. The only freshwater supply available is a well, which is located nearby cemetery. The need for freshwater, for plants was dominantly fulfilled by rain water. The rainfall of the Panjang Island was considered low (< 100mm) for the past six

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years. Only few vegetations that survived during the dry season, such as *Bombax ceiba* and *Ceiba pentandra* [1].

Small islands generally have properties that are particularly vulnerable to changes and environmental pressures. Based on its natural resources and fragile nature of the island, the existence of Panjang Islands is really need to be maintained and protected. Panjang Island environmental conditions already suffered damage threatens the sustainability of the island if not be done protect immediately. Abrasion sea waves have caused 1/3 Panjang Island area have been damaged [2]. In addition, there has been a heavy metal pollution in coral reef tissues [3] and damage of coral reefs in Pulau Panjang [4].

Mangrove species were also found in coastal area of Panjang Island. Their growth is affected by tide. They adapt well to unpromising habitat and are capable of coping with periodic immersion as well as exposure by the tide, fluctuating salinity, low oxygen concentration in the water, and frequently high temperature in the tropical area [5]. Mangroves play an important role in protecting the coast from the ocean waves. Accordingly, mangrove species and regeneration status have become critical information about the determination of policies concerning the protection of the coastal ecosystem [6].

Panjang Island ecosystem sustainability is determined by the regeneration process of the mangrove species. Regeneration process in natural forests occurs naturally by the death of old trees, disease, wind, lightning, among others. The process also deals with the growth of seeds in the soil in the form of seed bank [7]. This mechanism occurs naturally to be able to maintain the balance of forest ecosystems. The status of the plant regeneration can be determined by comparing tree species richness and its generation, at the phase of saplings and seedlings [8]. Factors that inhibit the occurrence of natural regeneration mostly come from human activities pressures such as fires, presence and invasion of the dominant species, the presence of exotic species, micro-climatic conditions are not suitable, poor soil and the absence of seed bank adequate [8, 9].

Quantitative information of mangrove vegetation became crucial for the conservation and management coastal ecosystem. The research aimed to assess mangrove species diversity and mangrove regeneration as base of conservation on Panjang Island.

Materials and methods

Site Description

The study was carried out in the forest area of Panjang island Jepara, Central Java in January 2014. Panjang Island is geographically located at position 06°34'33.6" to 06°34'40.8'S and 110°37'37.2" to 110°37'51.59'E. The site located on facing slope with an inclination of 0-2% and the altitudinal range is between 0-5m a.s.l.

Experiment Design

The sites research applied purposive sampling technique by making paths across the island and determining sampling site in the South, West, North and East. At each site 20×20m tree plot, 5×5m sapling plot and 1×1m seedling plot were determined. The trees were divided into three classes: < 1,5m tall (seedings), ≥ 1,5 tall and < 10cm dbh (saplings) and ≥ 1,5 tall and > 10cm dbh [10, 11]. Soil samples were collected for analysis of soil organic matter, pH, concentration of N, P, K, soil salinity, soil texture, soil moisture and soil temperature.

Vegetation Analysis

Analyses of vegetation consist of Important Value Index (IVI), Diversity Index and Evenness Index.

Important Value Index (IVI)

The study applied analysis was to frequency, density and abundance [12], in which:

Density = total number of individual species/total samples area

Relative Density = (number of individual of a species/number of individual of all species) x 100%

Frequency = total number of quadrate in which the species/total number of quadrates studies

Relative Frequency = (frequency of a species/frequency of all species) x 100%

Dominance = total number of basal area species/total samples area

Relative Dominance = (basal area of a species/basal area of all species) x 100%

Important Value Index = Relative Density + Relative Frequency + Relative Dominance

Diversity Index
Shannon-Wiener's species diversity index:

$$H' = - \Sigma ni/N \times \log ni/N$$

H' = Shannon-Wiener diversity index
ni = Number of individuals of a species
N = Total number of all individual
Evenness Index

$$e = H'/\ln S$$

e = Evenness Index
H' = Shannon-Wiener diversity index
S = Number of species

Result and Discussion

Panjang Island has seven species of true mangroves and seven species of mangrove associates (Table 1). The dominant true mangrove in Panjang Island is *Pemphis acidula* (53.25%), whereas the mangrove associated was dominated by *Thespesia* populnea (115.75%). Both species was considered dominant because they had highest importance value index, indicating the dominance and ecological success, good power of regeneration and greater ecological amplitude [13]. The species which have high Importance Value Index is the dominant plant species and has a high ecological value of the area [13,14].

Pemphis a typical plant Panjang Island. The plant, however are largely found in tropical areas, spreading over the South Asia coastal area, including Indonesia, the Philippines, Singapore, Thailand, Vietnam and Sri Lanka [15]. *Thespesia populnea* a associate mangrove species are quite often found in coastal India [16]. Associated mangrove mostly take the form of terrestrial vegetation. Such phenomenon has implied that abrasion incidence in Panjang Island mostly occur in the terrestrial area. Therefore, on Panjang Island found only rarely found true mangrove and more dominated by mangrove associate. Abrasion habitat have resulted in damaged and loss of many species of mangrove [17].

There were only few mangroves that grow in Panjang Island, both the species and abundance. Mangrove species in the island are still out numbered by those in Maluku Island, where people may discover 17 species in Anambas Island and Liran Island in addition to found in Liran Island [18]. One of significant factors affecting the scarcity is due to the fact that there is not any river in Panjang Island as the source of freshwater and the home for organic matters derived from the mainland as well as substrate sands. River estuaries and delta of alluvial silt substrate types, in addition to freshwater or brackish water support the optimal growth of the mangrove species [19].

Table 1. Importance Value Index (%) Species Mangroves on Panjang Island

No	Familia	Species	Important Value Index (%)			
			Station 1	Station 2	Station 3	Station4
A. True Mangrove						
1	Combretaceae	*Lumnitzera racemosa*	-	-	11.13	43.63
2	Euphorbiaceae	*Excoecaria agalloca*	-	-	11.13	-
3	Lythraceae	*Phemphis acidula*	-	18.19	53.25	-
4	Malvaceae	*Xyllocarpus granatum*	-	10.45	46.08	52.52
5	Rhizophoraceae	*Rhizophora mucronata*	-	-	18.18	-
6	Soneraceae	*Soneratia alba*	-	-	12.99	-
7	Verbenacea	*Avicennia officinalis*	-	8.19	12.42	-
B.MangoveAssociated						
8	Caesalpiniaceae	*Pongamia pinnata*	12.5	-	-	-
9	Combretaceae	*Terminalia catappa*	45.41	11.29	-	13.12
10	Convolvulaceae	*Ipomoea pes-caprae*	35.05	8.48	9.04	-
11	Malvaceae	*Hibiscus tiliaceous*	27.31	31.92	-	-
2	Malvaceae	*Thespesia populnea*	11.06	38.65	115.75	31.97
13	Pandanaceae	*Pandanus tectorius*	38.73	-	-	-
14	Passifloraceae	*Passiflora foetida*	59.42	28.60	20.80	-
	Σ species		7	8	10	4
	Diversity Index (H')		1.82	1.75	1.3	1.28
	Evenness index (e)		0.79	0.76	0.56	0.56

Panjang Island has diversity species index (H') between 1.28 to 1.82 with evenness species index between 0.50 to 0.79. According to the diversity index, the island has a moderate community diversity of trees. While the evenness index, Panjang Island possesses a high value. The species diversity denotes the conditions of biotic communities [20]. The high species diversity in the community explain complex and stable ecosystem with high level of interaction between species [12]. Communities with abundant species possess high diversity level [13]. The index value of diversity is not only determined by the species richness, but also determined by evenness or distribution of individual species [12].

Table 2 showed that number of individuals for mangrove tree phase (274 individuals/ha) were large than number of individual of sapling phase (57 individuals/ha) and the seedling phase (191 individuals/ha). It indicated that mangrove species in Panjang Island had a poorer regeneration than forest regeneration. A better regeneration status is denoted by the following condition, in term of density rate: seedling phase > saplings> tree [6, 13].

Table 2. Number of individuals mangrove/ha in protected forests Panjang Island, Jepara

No	Familia	Species	Phase		
			Tree	Sapling	Seedling
1	Combretaceae	*Lumnitzera racemosa*	33	8	17
2	Euphorbiaceae	*Excoecaria agalloca*	8	8	8
3	Lythraceae	*Phemphis acidula*	108	33	-
4	Malvaceae	*Xyllocarpus granatum*	100	-	33
5	Rhizophoraceae	*Rhizophora mucronata*	-	-	100
6	Soneraceae	*Soneratia alba*	8	8	-
7	Verbenacea	*Avicennia officinalis*	17	-	33
	Σ Species		**6**	**4**	**5**
	Σ Individual species		**274**	**57**	**191**

The density of the number of individuals at sapling phase is less than the number of individuals at both seedling and tree phases. This is because the sapling phase is a critical in the life cycle of plants. Besides, the sapling phase is also characterized by the highest mortality rate [21]. The large mangrove species during the seedling phase in Panjang Island was *Rhizophora*

mucronata. The species was generally grown by designed reforestation, not by nature. However, it was proven that Panjang Island had not been a good place for *Rhizophora mucronata* to grow abundantly due to the dominating sand substrate. The species tends to grow better in silt substrate [22].

In Panjang Island, it founds of the plants species that need to be protected its existence since already included in the category of Least Concern which means it has threatened with low risk [23] i.e., are *Pemphis acidula* and *Excoecaria agallocha*. *Pemphis acidula* wood was believed to be mystical and favorite bonsai lovers. This tree so much hunted and cause the population continues to decline and likely to become endangered if there is no conservation action. Species *of Excoecaria agallocha* also a protected species in Indonesia and species is endemic in Java.

Conclusions

In Panjang Island there were found 7 species of true mangrove, and 7 species of mangrove associated. The dominant true mangrove was *Pemphis acidula*, while the dominant mangrove associate was *Thespesia populnea*. The diversity index of mangrove species (H') is between 1.28 – 1.82. The mangrove regeneration in Panjang Island did not take place appropriately, as indicated by the number of individual saplings (57 individuals/ha) < number of individual seedlings (191 individuals/ha) < number of individual trees (274 individuals/ha).

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