Original article

Kondisi ekosistem mangrove di Pulau Sebongkok Kecamatan Selat Nasik Kabupaten Belitung Timur

Mangrove ecosystems in Sebongkok Island, District of Selat Nasik, Belitung Timur Regency

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Abstract

Sebongkok Island is one of a small island with a high potential mangrove resource with an equitable distribution. Communities around the Sebongkok Island used it inefficiently. The problems might because of lacking information (database) regarding the assessment of inventory, identification and mangrove structure vegetation, both derived from the research of academics, NGOs, government agencies and other institutions that engaged in the field of sustainability environment. Therefore, this research is important for mangrove sustainability. This study aims to: 1) determine the diversity and density of the mangrove species at the SebongkokIsland and its relation with abiotic components, 2) determine the status and condition of mangrove ecosystem on the Sebongkok Island. Our study revealed that the mangrove vegetation found in Sebongkok Island consists of 7 mangrove species, 5 families. The mangrove species that the most dominate and play an important role was R. apiculata, R. stylosa, and R. mucronata.

Keywords : *Sebongkok, mangrove, diversity, density, sustainability, species*

Introduction

Sebongkok Island is one area that is thought to have the potential mangrove resources with abundant and high density. Administratively, the Sebongkok Island is part of the territory of Petaling village, Selat Nasik District of East Belitung. Selat Nasik district is one of the five districts in Belitung regency of Bangka Belitung Province. The mangrove area in the Selat Nasik about ± 7664.47 ha. The coastal of Selat Nasik Districthas a vary distribution of mangrove vegetation. Usually, its can be found on the Bakau, Pilling, BatuDinding, China, Kalangbau, , Island Mendanau, Naduk, Sekutai and Sebongkok Island (Bappeda Kab Belitung 2006 in Sjafrie et al., 2007). On the West, the island is bordered by the TanjungNyato, the north by Tanjung Kulitisland, the east by Badau district or Belitung islandand the south by Nadok island (DKP, 2015).

Mangrove is an important in supporting of major ecosystem in coastal and marine areas (Dahuri et al., 2008). Mangrove ecologically has several functions as a protection from coastal erosion, sediment traps, nursery ground, feeding ground, spawning ground and the supplier of shrimp larvae, fish, and timber for materials construction, firewood, as well as raw material for paper (Saparinto, 2007).

In general, mangrove is quite resistant to various disorders and extreme environmental stresses, however, the human activities were become a main problem for mangrove habitat i.e. residential area, agriculture and fishpond zone. Besides, other factors that cause degradation of mangrove, both of quality, quantity and ecological function of mangroves is caused by human greed, attention, concern and lack of public knowledge of the importance of preserving coastal resources, especially mangrove ecosystem.It manifested in the presence of illegal logging of mangrove from various stages of growth and making charcoal from mangrove wood, as has happened on the island Sebongkok, even though in small quantities.

Sjafrie (2007), mentions that the mangrove vegetation on the Sebongkok island grow well with a dense canopy density. Unfortunately, in particular spots have been damaged by the construction, which is used by local fishermen as the traffic flow to fetch clean water. The pattern of mangrove regeneration of this area looks quite stable, both located in the area of the coastline as well as those located in the area of mangrove forests. Therefore, it is necessary to study the structure of mangrove communities associated with the abiotic component status, around the coastal areas of Sebongkok Island. This research expected that the management and utilization of mangrove ecosystem can be wise, effective and sustainable for the future so that the people life around is increase.

Materials and methods

Time and Location

The research was conducted in September-November 2015. The location of research focused on coastal areas in Sebongkok (Figure 1).

Figure 1. Location of Sebongkok Island

Research Method

a. Determination of Station

Observation stations is determined by purposive sampling method, which is determining the location of sampling with some specific considerations by researchers and recorded a part of population data for being representative of research object in the island Sebongkok. Station 1 is located in the North, Station 2 in the East, and station 3 in the South of SebongkokIsland.

b. Collecting Data and Status determination of Mangrove condition

Data collected including the number of species, the mangrove forest structure, density, frequency, dominance, importance value, diameter and height of trees and belta. Observations on the structure and composition of plant species is done by the line transect method and Line Transect Plot (LTP) (Figure 2). TLP method used by the consideration of:

1. LTP is a method with simple equipment but can provide accurate and representative data on some aspects and structural characteristics of the mangrove forest.

2. Permanent Plots have the LTP that can be used to measure changes that occur with the dimensions of time and space.
3. At each of these quadrants, all stands of the species identified, and counted the number of each species. Free collection also conducted to complement the species that are not included in the transects squared.

Figure 2 Sampling plot, mangrove measurement (English *et al*. 1997).

Identification of plant species is done in-situ in the field with reference to Kitamura et al. (1997), Noor et al. (1999) and Tomlinson (1986). Criteria weighting is based on the density of the mangrove. The determination of these criteria is based on Decree of the Minister of Environment No. 201 of 2004.

Table 1 Mangrove status determination

Criteria		Closure (%)	Density (trees/ha)
Good	High	≥ 75	≥ 1500
	Medium	≥ 50 - < 75	≥ 1000 - < 1500
Damaged	Low	< 50	< 1000

c. Research Procedure

Mangrove observation procedure is referring to the modification of English et al. Bengen 1997 and 2000, with the following stages:

1. Determining the location of the observation of mangrove vegetation that represent the study area.
2. At each specified location is conceptually based on the representation of the location of the study.
3. At each observation station, the line transect will set of seaward to landward and perpendicular to the shoreline along the mangrove zone
4. Installation of sample plots (plot) 10 x 10 m by 3 plots at point 0 m, 10 m and 30 m. Plot number is flexible, depending on the thickness of mangroves at each location. If the thickness of the mangrove tend to be high, transect line stretched along 100 mtowards the ground (LH Decree No 201 of 2004). At each plot that have been determined, count of each mangroves species, the number of individuals, and measure the circumference of each mangrove trunk at breast height (1.3 m).
5. On each plot measuring 10 m x 10 m, made data retrieval tree (dbh, diameter at breast height of 1.3 m ≥ 5 cm). sampling (1 cm ≤ dbh <5 cm) were taken in the sub-plots measuring 5 m x 5 m and seedling ≤ 1 cm (dbh) taken in the sub-plots of 1 m x 1 m.
6. Plot observations carried crosses mangrove starting from the left, right and left back.
7. If you have not known the name of mangrove species, cut on the complete section of leaves and twigs, and flowers and fruit if possible.
8. Observe and record at each type of substrate (mud, clay, sand, etc.).
9. Measure of environmental parameters that affecting the survival of mangrove vegetation, both in situ and laboratory scale.
10. All coordinate points of each station observation and environmental conditions were recorded using GPS.

Measuring the diameter of mangrove vegetation carried out at chest height (diameter at breast height / dbh; 1.3 m). Measurement of the tree is not always done at breast height (1.3 m), due in part tree of the mangrove vegetation sometimes have unique shapes and sometimes makes it difficult to determine the position of the diameter measurement, then with slight modifications Cintron recommendations and Novelli (1984) in Kusmana (1997) used in this study :

a. If the stems branching below chest waders (dbh; 1.3 m) and each branch has a diameter ≥ 4cm then measured as two separate trees.
b. If branching stems are above chest height or slightly above the diameter measured at breast height or size under its branches.
c. If the stem has hard/air roots, then the diameter measured 3 cm above the highest bulge.
d. If the rods have straight stems, branches or there are abnormalities in the measurement points taken diameter 30 cm above or below chest height.

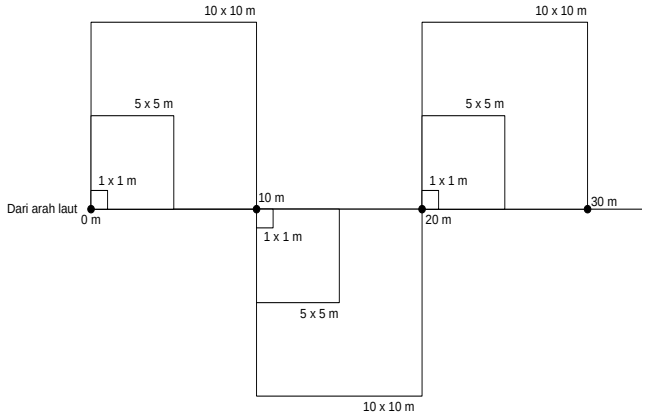

Figure 3 Installation procedure and observation

Data Analysis

SpeciesDensity (Di)

The density is the number of species stands i per unit area (Bengen, 2000):

$$D_i = ni/A$$

where *Di* is species density i, *ni* is total species stand i, and *A* is total area (plot).

Relative Density Spesies (RDi)

Relative density is the ratio between the number of stands of species (ni) and the total number of stands across species (∑n).

$$RDi = (ni / \sum n) \times 100$$

Where :

Rdi = Relative density spcies i
ni = Total plot species found i
∑n = Total species stand

Species Frequency (F_i)

Species Frequencyis a potential found of species in observed plot.

$$F_i = P_i / \sum n$$

if :

Fi = Species frequency i
Pi = total species found i
∑n = Total species stand

Relative Frequency Spesies (RFi)

Relative frequency of species is the ratio between the frequency of species and the number of frequencies for all species.

$$RFi = (F_i / \sum F) \times 100$$

if :

Rfi = Relative frequency species i
Fi = Frequency species i
∑ F = Total frequency species

Spesies Closure(C_i)

The species closure is widely closure of i-th species per unit area

$$C_i = \sum BA / A$$

Where :

Ci = Closure of species- i
BA = π DBH^2 / 4 (cm^2)
DBH = Diameter of the tree species-i,
DBH = CBH / π (cm)
A = Total area of sampling.
CBH = Circle at breast height (cm).
π = 3,1416

Relative ClosureSpesies (RCi)

Relatively species closure is a comparison between the area of the closure of the species i (Ci) and a total area closure for all species (∑C):

$$RCi = (Ci / \sum C) \times 100$$

dimana :

∑ C = Total area of closure for all species
RCi = Relatif closure of species -i
Ci = Closure for all species

Importance Value Index (IVI)

IVI is a sum of species Relative Density Index (RDI), Relative Frequency Index (RFI) and Relative Closure Index (RCI) are then calculated as :

$$INP = RDi + RFi + RCi$$

IVI able to provide an overview of the influence or role of a mangrove plant species in the mangrove community (Brower *et al.*, 1977 in Bengen, 2000).

According to Curtis in Marinda (2006), INP can be interpreted also as summation relative density and the relative dominance . This formula can be used to determine the IVI seedling, is as follows:

$$\frac{KR}{RFi} = \frac{Jumlah\ Individu\ Tiap\ Jenis}{Total\ Jumlah\ Semai}\ x\ 100\%$$

$$\frac{FR}{RFi} = \frac{Persentase\ Individu\ Tiap\ Jenis}{Total\ Persentase\ Semai}\ x\ 100\%$$

$$INP\ Semai = RDi + RFi$$

Diversity Index

Diversity index is a characteristic of a community that describes the level of species diversity of organisms that are present in the community (Odum, 1993). The formula is as follows:

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

Where :
H' = Shannon-Wienner index
N = Total amount of species
ni = Amount of individue per species -i

According Wilham and Dorris (1986) in Odum (1993), classification-Wienner Shannon diversity index is as follows:
$H' < 1$ = low diversity
$1 \leq H' \leq 3$ = medium diversity
$H' > 3$ = high diversity

Uniformity Index

Uniformity index is the ratio between the value of species diversity by the natural logarithm of the number of species (Odum, 1993),

$$E = \frac{H'}{Log\ (S)} = \frac{H'}{H\ maks}$$

Where:
H' = Shannon Winner Index
S = Amount of species

According to Krebs (1989) in Odum, ranges of uniformity index is 0 - 1, where :
E' > 0,6 = High uniformity
0,4 < E' < 0,6 = medium uniformity
E' < 0,4 = low uniformity

Indeks Dominansi

Dominance index is the degree of the dominance of one, several or many species (Odum, 1993). The calculation method used is the formula Simpson dominance index (Simpson, 1949 in Odum, 1993), namely;

$$D = \Sigma\ (ni/N)^2$$

Where :
D = index of dominance
ni = Amount of individue species-i
N = Total amount of individue

Criteria of index of dominance according to Simpson (1949) *in* Odum (1993):
0 < C < 0,5 = tidak ada spesies mendominasi
0,5 < C < 1 = ada spesies yang mendominasi

Physical-chemical parameters

Physical-chemical parameters of aquatic environment aremeasured to determine the environmental conditions in mangrove ecosystems.

RESULT AND DISCUSSION

Physical-chemical parameters

The results of measurements of chemical physics parameters of waters during research on the Ketawaiisland can be seen in Table 2.

Table 2. Physico-chemical characteristic of waters

No	Parameter	Research station		
		I	II	III
1	Temperature (^oC)	28	29	30
2	Salinity(‰)	29	30	31
3	pH of waters	7,5	7,5	8,0
4	pH of sediment	4,0	4,5	5,5
5	Type of Substrate	Muddy-sands	Muddy-sands	Sandy

The temperature of the waters around the Sebongkok island ranged between 28-30°C. Effendi (2003) states that the optimal temperature range for the growth and development of mangrove species is 28 °C - 30 °C. Supriharyono (2000) adds that, the good temperature for the life of mangroves is less than 20°C, while the range of seasonal temperature does not exceed 5 °C, the high temperature (> 40 ° C) was not affect mangrove growth and fertility. Setyawan (2008) suggested that sunlight, temperature and humidity are very influential on species diversity in its habitat.The difference of water temperature depending on the time limit of warming water by solar radiation, in addition it can also be influence by the position of the sun, geography, season, as well as weather conditions and cloud at the time of measurement.

Salinity is a major factor that most determined of growth, zoning and mangroves spread (Dahuri et al., 2008). The salinity of the waters on the Sebongkok island ranged between 29 - $31^o/_{oo}$. According Dahuri (2003) optimum salinity for the mangroves is $35^o/_{oo}$, which means that the range of values based on observations in the normal range for the survival of the mangrove ecosystem. Bengen (1999)also supportedthat mangroves can live in brackish waters

(20-22 ‰) to salt (38 ‰). According Dahuri et al. (2008) the difference of salinity due to the change of land use which may result in modifications to the fresh water, nutrient and sediment inputs.

The pH value at any observation station is not much different, ranging antara7,5 - 8.0. This range is in accordance with the standards of water quality for aquatic biota and aquatic plants (vegetation pesisisir) based on the Minister of Environment KEP 51 / MNLH / I / 2004, that the normal pH range of waters for aquatic organisms is 6.50- 8.50 (MNLH 2004).

The pH value of the wet sediment ranged from 4.0 to 5.5. The lowest pH was from the third station 4.0. According to Arief (2003), the soil pH was not much different on mangrove ecosystem, about 4.6 to 6.5 under the *Rhizophara sp*, where the wet mangrove areas will occur the oxidation reaction that produces sulfate ions in large quantities. It dissolved in the soil so that turned into a very sour soil that contained of acidic such as iron sulfide, acetic acid, propionic acid, lactic acid, formic acid, butyric acid and alcohol and CO2, H2 and CH4 in the form of granules and black. Setyawan (2002) and Supriharyono (2000) mentions that the mangrove lands are generally neutral to slightly acidic due to the activity of sulfur reducing bacteria and their sedimentation. Sulfur reducing bacteria activity is indicated by the dark soil, acidic and malodorous.

Fraction substrate of Sebongkok Island is dominated by a high sand content. At the I and IIstation, found muddy sand substrate with the dominant type species that recorded was *R. apiculata*. According to Noor et al. (1999), *R. apiculata* can thrive on their muddy substrate which is rich in organic substrate. While the substrate type that found at station III, was sand. Mangrove species that found were tolerant to sand substrate; this was in accordance by Noor et al., (1999) that *Rhizophorastylosa* grow in habitats that vary in tidal areas, mud, sand and rocks. It was preffered the tidal river embankment, also as a pioneer species in the coastal environment or on the mainland part of the mangrove. One typical type of niches that can occupy is the edge of mangroves on the island/rock substrate.

MangroveSpeciesComposition

Based on identification, we were found 7 mangrove species of 5 families that identified in the research station. Mangrove species found in the study site was*Acanthus ilicifoliusL, Rhizophora apiculata, Blume, Rhizophora mucronataLamk, Rhizophora stylosa Griff, Sonneratia alba (J) Sim, Xylocarpus granatum Koendan, Hibiscus tiliaceusL*. Diversity of mangrove species at each observation stations tends to be different but *Rhizophora apiculata* dan*Rhizophora stylosa* can be found in every observation station. Mangrove species composition of each station are presented in Table 3.

Table 3 Mangrove species found

No	Species	Family	Local name	Station		
				I	II	III
1	*Acanthus ilicifolius L*	Acanthacea	Semak Duri	-	+	-
2	*Rhizophora apiculata* Blume	Rhizophoraceae	Bakau Merah	+	+	+
3	*Rhizophora mucronata* Lamk	Rhizophoraceae	Bakau Gede	+	+	-
4	*Rhizophoras tylosa* Griff	Rhizophoraceae	BakauPutih	+	+	+
5	*Sonneratiaa lba* (J). Sim	Sonneratiaceae	Prepat	-	+	-
6	*Xylocarpus granatum* Koen	Meliaceae	Nyirih	-	+	-
7	*Hibiscus tiliaceus*L	Malvaceae	Warulaut	-	+	-

Keterangan:
(+) : Mangrove i found
(-): No mangrove i found

Mangrove Density

Based on the research results obtained value of density / density Mangrove species, which are presented in the following Tabel4.

Table 4 Mangrove Density

Station	Species	Species density (ind/ha)		
		Trees	Saplings	Seeds
I	*R. mucronata*	100	-	-
	R. stylosa	1400	-	-
	R. apiculata	9800	-	-
	Total	**11300**	**0**	**0**
II	*S.alba*	100	-	-
	R. stylosa	1100	75	2
	R. apiculata	2300	225	-
	H. tiliaceus	400	-	-
	X. granatum	900	-	-
	A. ilicifolius	-	-	15
	Total	**5600**	**300**	**17**
III	*S. alba*	300	50	-
	R. mucronata	400	125	3
	R.stylosa	800	200	5
	R. apiculata	1000	250	3
	Total	**2500**	**625**	**11**

Keterangan: The densities of saplings and seeds in Sebongkok Islands been ignored. (refers to Kepmen LH No. 201 , 2004).

The total density value of tree stands on the station I, II and III (see Table 4) were 11,300 trees/ ha, 5600 trees / ha, and 2500 trees/harespectively, based on LH No 201 of 2004, the criteria of the Standard Quality and Guidelines for Damage Determining in

mangroves, the condition of mangrove ecosystem around the Sebongkok island categorized as good with very dense mangrove density in excess of 1500 trees /ha with the closing average percent exceeds 75%. According to Setiawan (2002), trees that have been established are generally able to regenerate with a big number. In some spots, especially on the station I, the type of growth stage of samplings and seedlingswas not find, this is due to human activities around mangroves areain Petaling and Mendanau village used for the fishing /flow of vessel traffic to get the water, even there is also a group of species mangrove that was death as *S. alba*. According Bengen (2000), in general,*S. alba*was live in the front area of mangrove zone, especially on the island.The presence of this species was able to reduce coastal erosion and protect other mangrove species from the big wave. It will support the distribution and mangrove seeds live in some regions.

Recently, variety activities on the Sebongkok Islandwere not affect the existence of mangroves, due to the village had understood about the important role of mangroves as coastal protection. The remain problemwas local government rule to determination of mangrove management for further life.

Mangrove community at station I and III can be categorized as the older generation, due to the total density of tree stands was higher than the total population of density saplings and seedlings. This indicates that the regeneration of tree growth stage was not good enough.

On the other hand, Station III showed that, mangrove community was belonging to theyounger generation.It could be seenbased on the tree density values was higher than the density of saplings and seedlings, but the spread of mangrove vegetation for each stage seem uniformly. This condition means that the mangrove regeneration was going wellas expected. Therefore, Sebongkok Island would be very appropriate for mangrove conservation/rehabilitation management, since there are some areas that do not have a supply of seedlings.

Mangrove Closure(%)

Based on the research results obtained the closing value of Mangrove species were varied. The closure percentage of species can be seen in Table 5 at below.

Table 5 Closure percentage of Mangrove species (%)

Stat.	Species	Closure (%)		
		Trees	Saplings	Seeds
I	*R. mucronata*	2,84	-	-
	R. stylosa	29,12	-	-
	R. apiculata	68,04	-	-
	Total	**100**	-	-
II	*S.alba*	11,90	-	-
	R. stylosa	11,20	18,38	11,77
	R. apiculata	42,27	81,62	-
	H. tiliaceus	2,92	-	-
	X. granatum	31,71	-	-
	A. ilicifolius	-	-	88,23
	Total	**100**	**100**	**100**
III	*S. alba*	34,35	9,25	-
	R. mucronata	19,22	12,98	27,27
	R.stylosa	28,25	32,17	45,45
	R. apiculata	18,17	45,58	27,27
	Total	**100**	**100**	**100**

The result appears that the species with the highest percentage were *R. apiculata* (ST.I = 68.4%, ST.II = 42.27%, ST.III = 18.17%) and *R, stylosa* (ST.I = 29.1, ST.II = 11.20, S.iii = 28.12%). According Supriharyono (2000), roots of mangrove were able to bind the sediment around the island and make it more dense,especially *R. apiculata* and *R. mucronata*. It was potential to build a new land nearby the sea.

Importance Value Index of Mangrove

Importance Value Index provides an overview of the influence or role of a mangrove species in the mangrove community (Brower and Zar, 1977 at the Marinda, 2006). The result in each station observations are presented in Table 6.

Table 6 Importance index of Mangroves

Station	Species	Importance Value Index (%)		
		Trees	Saplings	Seeds
I	*R. mucronata*	20,39	-	-
	R. stylosa	74,85	-	-
	R. apiculata	204,76	-	-
II	*S. alba*	33,86	-	-
	R. stylosa	57,63	93,38	61,8
	R. apiculata	101,97	206,62	-
	H. tiliaceus	26,91	-	-
	X. granatum	79,63	-	-
	A. ilicifolius	-	-	13,8
III	*S. alba*	71,35	42,25	-
	R.mucronata	60,22	57,98	67,3
	R. stylosa	85,25	89,17	85,5
	R. apiculata	83,18	110,58	47,3

The dominant mangrove species that grow and have an important role in Sebongkok Island for growth trees stage, saplings and seedlings were *R. apiculata* and *R. stylosa*. Previous study conducted by LIPI Team (Sjafi'e et al, 2007) demonstrated that *R. apiculata* and *R. Mucronata* from *Rhizophoraceae* found as dominant species belta and trees strata in the mangrove area, surrounding Mendanau Island. These species commonly found at the coastal of Indo-Malesia (Indonesia and Malaysia) which is the biogeograpy center for certain species such as

Rhizophora, Bruguiera, Sonneratia, Avicennia, Ceriops, Lumnitzera and other species (Tomlinson, 1986).

Based on the results, *Rhizophora apiculata* hasan important role in structuring the mangrove vegetation at the station I, II, and III. Importance value index at the station I, II, and III in were 204.7; 101.97; and 83.18respectively. Moreover,*Rhizophora stylosa* has St. I = 74.85, St. II = 57.63, and St. III = 85,25.*Sonneratia alba* with important value index 33,86 (St. I), and 71.35 (St. II), while *R.mucronata* with 20,39 (St. I), and 60 , 22 (St. III) respectively.

On the other hand, *Xylocarpus granatum Hibiscus tiliaceus, Acanthus ilicifolius* were 79.63; 26.91; and 13.8 importance value index, respectively.

Diversity (H'), Homology (E) & Dominance (C)Indeks

Diversity Index is one of the ecological index commonly used in evaluating the condition of an ecosystem based on biological indicators. Calculation Result diversity index, index and dominance index uniformity on the stage of growth of mangrove species of trees, saplings, and seedlings are presented in Table 7 below:

Table 7 Indeks of Diversity (H'), Uniformityy (E) and Dominance (C)

Stat.	Species	Index of Ecology		
		H'	E	C
I	Trees	1,77	0,98	0,77
	Saplings	-	-	-
	Seeds	-	-	-
II	Trees	0,75	0,42	0,32
	Saplings	1,44	0,80	0,63
	Seeds	1,82	1,01	0,79
III	Trees	0,69	0,39	0,30
	Saplings	0,71	0,39	0,31
	Seeds	0,82	0,46	0,36

Mangrove diversity index at observation station in Sebongkok Island for tree growth stage ranged from 0.69 to 1.77 (medium category), sapling stage ranged from 0.71 to 1.44 (medium category), and seedling stage ranged from 0.82 to 1.82 (medium category). According to Odum (1993), it stability of mangrove vegetation was slightly disturbed which shown by significant ecological pressures that affect the survival of mangroves.

Value of uniformity index (E) of all observation stations ranged from 0.39 to 1.0 were low to high. It means that many species were uniform in their observation station due to species not spread evenly.

Dominance Index value on each observationsstation ranged from 0.30 to 0.79, where the value of dominance index was lowest for the third station particularly fortreecategory.Whereas,the highest dominance index for the treecategory was on the first station.

Mangrove vegetation found in Sebongkok Island, Selat Nasik District consists of seven mangrove speciesin five families, the most dominate species and play an important rolewere *R. apiculata, R. stylosa,* and *R. mucronata*. In generally, the ecosystems condition of Mangrove in Sebongkok Island categorized as relatively good.

Further studies for monitoring changes in extent and density of mangrove cover using remote sensing data is important, so the prediction of multi-year rate degradation of mangroves in Sebongkok Island can be recorded

Acknowledgment

The author acknowledge for Department of Water Resources Management of Universiity of Bangka Belitung, who have sponsored this research. This article was thanks to the cooperation research between LPPM UBB with DKP Kabupaten Belitung in Marine Resource Inventory activities in 2015. Author was involved as expert team of surveyors' mangrove. Thank for the Indonesian Institute of Science that already contribute for the mangroves data processin the study area. The author also would like to thank for Mr. Indra Ambalika Syari, M.Si as chairman of the study team.

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