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Biodiversity and Site Quality as Indicators of Mangrove Forest Health Pasir Sakti, Indonesia

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Abstract

Forest health is an effort to control the level of forest damage that can support and guarantee the function and benefits of the forest. The purpose of this study was to determine the health status value of the Pasir Sakti Mangrove Forest with indicators of biodiversity and site quality. Data obtained using the Forest Health Monitoring (FHM) method. The results showed that the health status value of Pasir Sakti Mangrove Forest was 50% were in the good category, 17% were in the moderate category and 33% were in the bad forest health category. This is influenced by the level of biodiversity and the quality of the site at the research location. The results of the data that have been obtained can be used by managers as a basis for making the right management decisions for mangrove forest management in supporting forest sustainability.

Keywords: avifauna, epifauna, mangrove forest, forest health.

Introduction

The mangrove forest is a major ecosystems support important life in coastal and marine areas (Pradana et al., 2013). Mangrove habitat is the source of productivity that can be utilized both in terms of the productivity of fisheries and forestry as well as the ecosystems bermukimnya variety of flora and fauna (Adiwijaya, 2009). In addition, mangrove forests also play a role in mitigating caused by global warming because of the mangrove has the ability to store carbon (Bismark, et al. 2008; Sondak, 2015; Bachmid et al., 2018). Forest health can be used as one of the indicators of sustainable forest management (Safe'i et al. 2019).Forest health has several indicators to assess the health condition of the forest, such as biodiversity and the quality of the site. Biodiversity and the quality of the site used as indicators of forest health

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assessment as to describe the condition of forest ecosystems in a region. In this study biodiversity parameters used are birds and epifauna, while the tread quality parameters used are cation exchange capacity (CEC). Birds and epifauna are animals that live in the mangrove forest habitat. The existence of birds serve as biological indicators of a region (Qiptiyah et al., 2013) and epifauna is a species that is very sensitive to changes in water quality point of his life that will affect the composition and abundance (Hamidy, 2010).

Methods

Implementation

This study was conducted in December 2018 in the area of Mangrove Forest Pasir Sakti. The method used in this study is the Forest Health Monitoring (FHM) (Figure 1), with sampling using stratified sampling. According to Mangold (1997) FHM is a method to monitor, assess and report on the current status, changes and trends in the long-term health of the forest by using ecological indicators are measurable. Stratified sampling technique is used when there are different traits, or characteristics between existing strata (Arieska and Herdiani, 2018). At the study site has a different characteristic that has the effect of tide levels are different, so the population is divided into levels or strata,

The sampling intensity of 0.009%, so with an area of 296 ha based image analysis of Google Earth in 2018 and an area of 0.4 ha plot clusters thus obtained 6 clusters plot FHM (Forest Health Monitoring). It is based on the P.67 / Menhut-II / 2006 on Criteria and Standards of Forest Inventory that is in the form of plots using circles, rectangles, dots, and lines sampling intensity of at least 0.0025%. So that sampling of 0.009% was able to represent the mangrove forest area studied. The formula for determining the amount of cluster plot as follows.

$$n = \frac{A \times IS}{Cl}$$

Information:

N = Number of clusters plotsamples

A = Acreage would be*sampling*

IS = sampling intensity (0.009%)

Cl = Broad observation plots (plot clusters)

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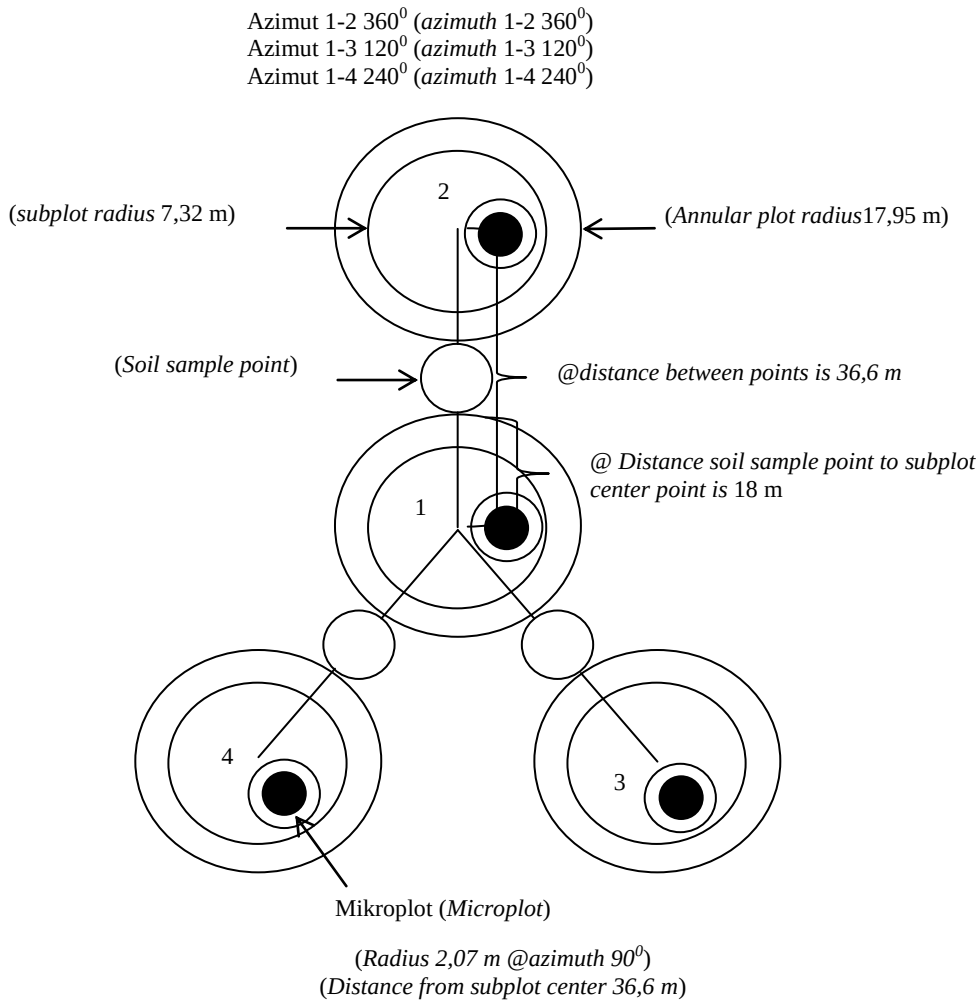

Figure 3. Plot Cluster Design FHM (Mangold, 1997).

Data collection techniques including data collection biodiversity of fauna and footprint.

a. Data fauna biodiversity (diversity of fauna)

Data taken biodiversity fauna and avifauna includes epifauna. Data epifauna and avifauna taken on each cluster plots. Data fauna biodiversity (fauna species diversity) is taken by observing avifauna in each annular plot for 30 minutes in the morning at 06:00 to 9:00 pm and the afternoon from 3:00 p.m. to 17:00 pm. This time is used as in the morning because it is a bird out of the nest to find food and later the birds to return kesarang wktu. Epifauna observations made on each annular plot at a time.

b. Quality Site

Site quality data retrieval is done by taking a soil sample done 3 points. Soil sampling on each cluster plot located between plots 1 and plot 2, plot 1 and plot 3, and plots 1 and 4 at a distance of 18 meters using tires and spades then the soil sample is inserted into a plastic that

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has been labeled the identity of the location , Soil samples have been obtained selajutnya tested at the Laboratory of Soil Science, University of Lampung.

Data Processing

Data processing is done by the tabulation and counting biodiversity (species diversity) fauna contained in each cluster plot by using the formula of Shannon-Wiener Index by Odum (1996)as follows.

$$H' = -\sum_{n=1}^{n} (Pi \ln Pi)$$

Information:
H′ = Index of diversity of fauna
Pi = Ni / N
Ni = The number of individual species to 1
N = Number of individuals of all kinds

Criteria diversity index values as follows.

H '<1 (Low diversity)
1 <H '= 3 (Diversity medium)
H '> 3 (High diversity)

Based on data from the Land Research Center (1993), site quality analysis obtained from laboratory test results regarding the criteria CEC CEC (me / 100g) as follows.

<5 (very low)
5-16 (low)
17-24 (Medium)
25-40 (high)
> 40 (very high)

Appraisal

Assessment of the health status of mangrove forests using the FHM (Forest Health Monitoring) technique is obtained from the final value of the health condition of the mangrove forest. According to Safe'i and Tsani (2016), the final value of forest health conditions is the result of the multiplication of the sum derived from the weighted value of the indicator and the score parameter for each indicator of mangrove forest health. The weighted value is eigenvalues obtained using ANP (Analytical Network Process). ANP is a decision making method with qualitative methods that can capture the influence between components (Saaty, 2003).

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Formulation formula final value of mangrove forest health is as follows.

NKHm = $\sum_{n=1}^{n}(NTXNS)$
NKHm = $(NT_{Biodiv} \times) + NS_{Biodiv}\,(NT_{kualitas\ \ tapak} \times) NS_{kualitas\ \ tapak}$

Information:
NKHm = Final value of mangrove forest health condition.
NT = Weighted parameter value of each indicator mangrove forest health.
NS = Score of each parameter of health indicators mangrove forest.

Results and Discussion

The mangrove forest in the district of Pasir Sakti, East Lampung regency, Lampung is located in the area of Protected Forest Management Unit (KPHL) Gunung Balak is geographically located on 10530'0"BT -1060'0"BT and 50'0"LS - 530'0"LS. This research was conducted in Register 15 Estuary Way Sekampung form of protected mangrove forest and swamp forest selapan. Resort Muara Sekampung has an elongated shape that is dominated byplants flame (Avicennia sp.) and mangrove (Rhizophora sp.). Based onrock formation from the sediment surface, mostlyare peppered throughout the East. This region consists of plains and tidal marshreceding formed from Holocene sediments containing marine clay, sludgerivers and swamps, as well as beach sand deposits (Malau, 2015).

Biodiversity

Fauna species found in the study site as much as 5 different types of epifauna and 9 species of avifauna as presented in Table 1 and Table 2.

Table 1. Type epifauna found in mangrove forests Subdistrict Pasir Sakti, East Lampung District, Lampung Province

Family	fauna	Scientific name	amount	clusters plot FHM	Conservation Status	
					Regulation No. 106 2018	IUCN
Gobiidae	fish glodok	*Periothalamus sp.*	19	4.6	T	-
Limulidae	Mimi / crab	*Limulidae*	22	4,5,6	D	EN
Potamididae	mangrove clams	*Telescopium Telescopium*	5,364	3,4,5,6	T	-
Ellobiidae	mangrove snails	*Cassidula aurisfelis*	12 672	3,4,5,6	T	-
Portunidae	Wideng	*Sesarma* spp	15 495	1,2,3,4,5,6	T	-

Description: EN (Endangered) / endangered, T (Not protected), D (Reserved)
Source: Primary Data, 2018.

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Epifauna can be used as an indicator of pollution due to poorly adapted to the environmental conditions. In addition epifauna pendekomposisi acts as an organic material (Purba et al., 2015). Epifauna type encountered at all locations are wideng (Sesarma spp), because This kind is able to survive in the forest soil condition dry or waterlogged (Hidayat et al., 2012).

Table 2. Types of avifauna found in mangrove forests Subdistrict Pasir Sakti, East Lampung District, Lampung Province

Family	fauna	Scientific name	amount	clusters plot FHM	Conservation Status	
					Regulation No. 106 2018	IUCN
Ardeidae	great egret	*Egretta alba*	41	1,2,3,4,5,6	T	LC
	little egrets	*Egretta garzetta*	16	2,3,4,5	T	LC
	striated heron	*Butorides striatus*	6	3	T	-
	Heron ash	*Ardea cinerea*	2	4.6	T	LC
Phalacrocoracidae	Cormorant black rice	*Phalacrocorax sulcirostris*	9	1,2,4	T	LC
Alcedinidae	cekakak river	*Todiramphus chloris*	1	5	T	LC
	King prawns blue	*Alcedo coerulescens*	12	3,4,5,6	T	LC
Anatidae	wandering whistling duck	*Dendrocygna arcuata*	2	4.6	T	LC
Ciconiidae	Stork casks	*Leptoptilos javanicus*	1	6	D	VU

Description: LC (Least Concern) / low risk, VU (Vulnerable) / vulnerable
D(dilindungi), T (unprotected)
Source: Primary Data (2018)

Avifauna species diversity that is found in a cluster plot is great egret (Egretta alba) included in the cluster plots 1 and 6. Egret bird species is a species of bird most commonly found, because the condition of mangrove forests are mostly watery and muddy shallow so it is favored by the bird species to perform daily activities (Iswandaru et al., 2018), So the birds can be used as indicators of ecosystem change. Another type is found in the cluster plots 1 and 6 are black rice Cormorant (Phalacrocorax sulcirostris), the king of blue shrimp (Alcedo coerulescens), sea kokokaan (Butorides stariatus). Based Kartijono et al. (2010) that the bird species are species of birds which use mangrove forests as a place to build a nest and is habitat for foraging.

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The highest diversity of fauna found in clusters of plots 6 and the lowest for the cluster plots 1 and in detail described in Table 3.

Table 3. Value diversity of fauna in each cluster plot FHM

Cluster Plot FHM	H ' (Diversity index Type Fauna)
1	0.45
2	1.00
3	2.30
4	2.43
5	2.58
6	2.75

Source: Processed primary data (2018)

The highest diversity of fauna on cluster plot 6 due to the condition of the forest floor were flooded by water, so some kind of epifauna can survive as a slug mangrove (*Cassidula aurisfelis*), Mangrove clams (Telescopium Telescopium), fish glodok (*Periophthalmus sp.*), Crab (Limulidae), and wideng (Sesarma spp). This is supported by Hamidy (2010) which states that somespecies of molluscs such as mussels mangrove group (Telescopium Telescopium), mangrove snails (Cassidula aurisfelis) prefer a watery area or waterlogged and very sensitive to the condition of a body of water.

The data quality value footprint (CEC) in this study showed that the highest CEC values contained in cluster 1 and the lowest plots on a plot cluster 3 (Table 4).

Table 4. Value CEC (cation exchange capacity) on each cluster plot FHM

Cluster plot FHM	CEC value (me / 100g)
1	19.92
2	19.74
3	16.53
4	17.51
5	17.74
6	17.82

Source: Data analysis Soil Science Laboratory (2018)

The results showed that the cluster plot with a high CEC value would have a lower value species diversity. High CEC caused by the content of organic material contained therein are derived from mangrove litter decomposition process that falls to the forest floor naturally. On this plot cluster level low diversity fauna, because the condition of the forest floor is not flooded by water and other things that can cause low diversity fauna, namely the content contained in the CEC.

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The content of the high CEC has two possible contents therein which may affect the fauna. According Sufardi et al. (2017) land with high CEC content can be dominated by alkali cations are Ca, Mg, K and Na, which can increase fertility. However, if a high CEC content dominated acid cation such as Al, H, it can reduce soil fertility. Things to allow the plot clusters is caused by the content of acid cation such as Al, H more likely to lead to some kind of fauna not be able to survive, so in this plot clusters have low diversity fauna. Additionally aeration can be run properly to support the process of decomposition. A final assessment of mangrove forest health condition based on the data obtained in Table 5.

Table 5. The final value of mangrove forest health condition

Cluster plot FHM	NT_{Biodiv}	NS_{Biodiv}	$NT_{site\ quality}$	$NS_{site\ quality}$	The final value of mangrove forest health condition
1	0.10	1	0.90	1	1.00
2	0.10	2	0.90	1	1.10
3	0.10	5	0.90	1	1.40
4	0.10	5	0.90	1	1.40
5	0.10	3	0.90	1	1.20
6	0.10	4	0.90	1	1.30

Source: Processed primary data (2018).

The final value of the health condition of mangrove forests have been obtained will determine the health status of mangrove forests as shown in Table 6.

Table 6. Limits of mangrove forest health status

Health status of mangrove forests	The threshold values of mangrove forest health status
Ugly	1.00 to 1.12
moderate	1.13 to 1.25
Well	1.26 to 1.38

Source: Processed primary data (2018).

Based on these results, the condition of the health status of mangrove forests can be seen in Figure 4.

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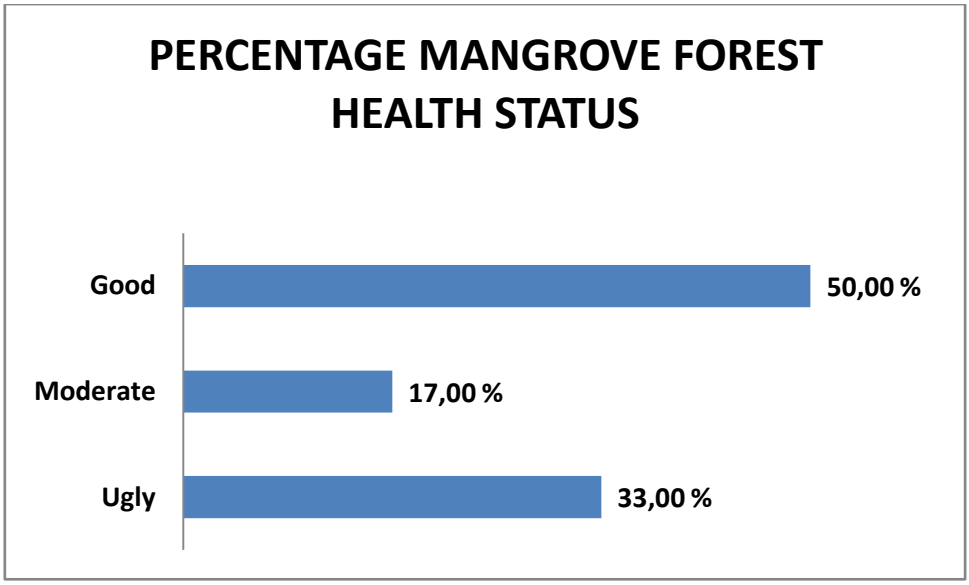

Figure 4. Percentage of health status of mangrove forests.

The percentage of the value of the highest health status of mangrove forests have good forest health condition as influenced by site quality value (CEC) belonging to the category of being at 5 clusters FHM plot. In addition a weighted basis of quality indicators footprint is higher than the value of biodiversity indicators. Another thing that supports the health status of being is the value of biodiversity that has been obtained, where the value of diversity based on Shannon index-Wienner has media diversity was contained in cluster 5 plots of 6 clusters existing plot.

The percentage of the value of the lowest health status of mangrove forests have a health condition forest being. This is because the value of the quality of the site (CEC), which are low in one cluster plot. At these locations mangrove forest floor flooded by water so that aeration can not run properly when the decomposition process conducted by the type of epifauna. This indicates that the quality of the site greatly affect the existence epifauna nor vice versa. This is in line with Tamsar et al. (2013) that the survival epifauna (makrobentos) will mendekomposit litter of mangrove vegetation, so the existence of epifauna also determine the level of soil fertility. Besides the presence of avifauna can also be influenced by the quality of the site, because avifauna foraging forest floor. Based Jamili et al.

Conclusion

The final value of the health condition of the mangrove forests in Pasir Sakti, East Lampung Regency, Lampung is at 50% in the good forest health category, 17% in the moderate category and 33% in the bad forest health category.

Suggestion

Suggestions in this research that is needed to do the development of mangrove forest health assessment indicators and other parameters to reproduce the data and information related to the health of the mangrove forest.

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