WATERBIRDS BIODIVERSITY AND ATTENDANCE IN *Rhizophora* Sp. MANGROVE STANDS OF VARYING PLANTING AGES

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ABSTRACT

Many species of waterbirds depend on wetland sites and related with variated habitats based on the maturity of ecosystems. The objective of this study was to determine the attendance and biodiversity of waterbirds in *Rhizophora* sp. mangrove stands of varying planting ages in Subang, West Java. Comparisons were made among five stands of different ages in 4 years, 12 years, 21 years, 29 years, and 38 years. Parameters compared were mangrove structure and waterbirds biodiversity. Structure of mangrove was observed in three plots measuring 10 m x 10 m, while waterbirds abundance was doing by bird watching in the three times of test. Results show that mangrove structure differed among stand ages, except in plant cover physiognomy. Average tree height at the youngest stand (4 years) was 1.56±0.33 meters, DBH 2.92±0.23 cm,, and biomass 1.45 kg m-2 ; whereas at the oldest stand (38 years), average height 8.13±5.65 meters, DBH 16.29±7.23 cm, and biomass 108.62 kg m-2. Sixteen species waterbirdss were recorded found in *Rhizophora* sp. mangrove stands. Six recorded species are listed as endangered in the IUCN Red List. Occurence of waterbirds shows a variety ranged from eight to thirteen species, with the lowest occurrence at the 4 years stand (9.5%) and highest at 29 years (46.2%). The general conclusion is that age (time) affected certain parameters of mangrove structure, but have no effect to waterbirds attendance. Presence of waterbirds also did not show a clear trend or pattern among stands.

Keywords: biodiversity, mangrove, *Rhizophora*, waterbirds.

INTRODUCTION

Generally, there is only about 100 species of plants can be found on mangrove forestecosystems. It`s very small than the thousands plants on other terrestrial ecosystems, such as tropical rain forests and peat forests (Bengen, 2001). Mangrove plants have many different features about simple physical structure and often make a marked zonation because effects from geomorphological change, or physiological responses to clinal physical variables. Apart from thedirect collection of mangrove products, many commercially harvested species of fish, shrimp, and crab are sustained by mangroves. Unfortunately, the importance of mangroves is not always appreciated by massive degradation and destruction all components that sometimes deliberate, and in other cases is inadvertent (Hogart, 2007).

Mangrove forest ecosystems also have a very important value for the various species of birds, both as the stopover place, as well as a nesting place to find food supplies (van Balen, 1989 in Sodhi et al, 1997). Survival and breeding for birds often associated with the condition or ideal completeness of the forest structural. Forest with high vegetation cover is tightly and trunked width, as well as the uneven distribution of stands will be favored as a refuge by birds because they can safe from predators. The availability of many locations for nesting, and also the abundance of food (Hagenbuch et al, 2011). It is assumed that the addition of the age of the dominant vegetation in the mangrove ecosystem will increase the complexity of the structure of the vegetation. This condition is expected to affect the presence of many diverse species of birds that use it.

However the mechanisms and relationship between the use of vertical space by the age ofthe bird with the addition of the ecosystem is not yet fully understood so that this information is indispensable in order to enhance the ability of ecosystem services and the mangrove forests cancontinue to be used in a sustainable manner. Under these conditions, the purpose of this study todetermine how birds take

advantage of the vertical space availability in the mangrove forest by planting different ages.

MATERIALS AND METHODS

Study area

This research was conducted in *Rhizophora* sp. mangrove of varying planting ages. As a case study, the place for sampling is the mangrove forest that managed by RPH (Resort Stakeholder of Forest) Poponcol in Subang District, West Java Province (Figure 1). It can be found five types of vegetation based on its ages (4, 12, 21, 29, and 38 years old). Our study compared about mangrove structure parameters, waterbirds biodiversity, and also abiotic factors.

Figure 1. The study was conducted on the northern coast of West Java (a). The region is included in the protected forest area belongs BKPH Ciasem Pamanukan (b). While forests are managed by RPH Poponcol, Subang (c).

Procedures

1. Mangrove Structure Identification

Rhizophora sp. mangrove structure was observed by the number of individuals, total height, diameter at breast height (DBH), and biomass. Measurements were taken at three random plots and the sample take systematically (10 mx 10 m). The circumference of tree is count in order to obtain diameter of the trunk (expressed as diameter at breast height or dbh). For tall trees a clinometer should be used. For saplings and trees up to 6m a graduated telescoping rod is practicable. Where tree density is high then measuring height may be very difficult. Estimate as closely as possible, where it may be difficult to obtain actual measurement. Biomass of themangrove forest trees greater than 2.5 cm dbh is estimated by using trunk diameter and treedensity (number of trees per unit area). Individual tree biomass will be calculated using the dbh to weight conversion factor of Cintron and Novelli (1984): Biomass (g) = $b[(dbh)^2 (height)]^m$ where b and m are constants of 125.9576 and 0.8557, respectively (see paper for details) (CARICOMP, 2001).

2. Waterbirds Biodiversity and Function

Observations were made three times at different times as replication based on the methods from MacKinnon et al, (2010). The parameters observed among other bird species, the average attendance at each age

and the type of bird food crops. The necessary number of observers as many as six people including four observer standing on the embankment on the outside of the forest were observed to record the number of birds that come out and go into the woods, while the two people who were in the woods crawl the content and take down the birds seen perched or perch. Observation time for each age is at 06.00 up to 08.00 pm for 10 minutes and repeated at three times (Figure 2).

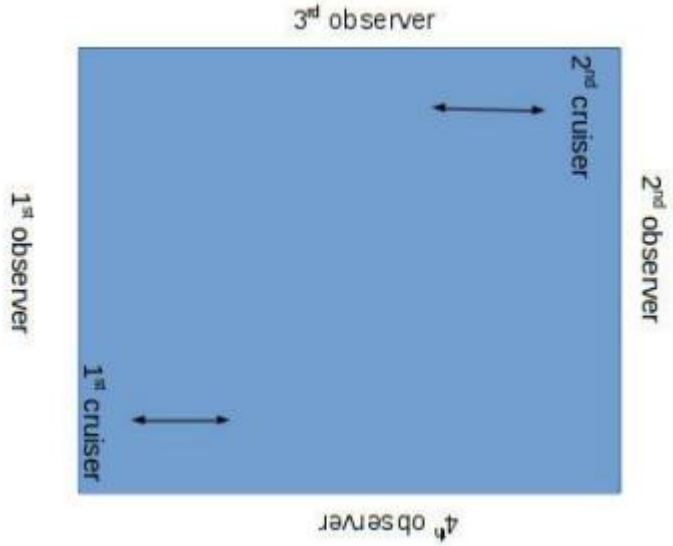

Figure 2. Birds watching sampling methods in *Rhizophora* Sp. Mangrove varying planting ages.

3. Abiotic Factors Monitoring

The measurement of environmental conditions (light intensity, humidity, and air temperature) is done in the morning in every time where the samples were taken. Repetition for sampling is performed about three times for each study site and the average is calculated.

RESULTS AND DISCUSSIONS

1. *Rhizophora* Sp. Mangrove Structure.

Rhizophora Sp. mangrove structure measurement results (height, DBH, biomass, and abundance) and its average value are shown in Table 1. While the importance value index in *Rhizophora* Sp. mangrove of varying planting ages is shown in Table 1 and Table 2.

Table 1. The average value of vegetation structure in *Rhizophora* Sp. mangrove stands

	Mangrove Rhizophora sp				
	Ages (years)	Height (m)	DBH (cm)	Total of Biomass (kg m^{-2})	Abundance (individu ha-1)
Tree	4	1,56 ± 0,33	2,92 ± 0,23	1,45	800
	12	5,17 ± 1,25	5,15 ± 0,93	7,96	600
	21	5,32 ± 1,59	10,14 ± 2,83	11,03	333
	29	5,23 ± 2,51	12,39 ± 5,44	49,14	633
	38	8,13 ± 5,63	16,29 ± 7,23	108,62	567
Seed	21	1,053 ± 0,02	1,047 ± 0,09	0,5	2267
	29	0,98 ± 0,06	1,08 ± 0,07	0,36	1600
	38	1,03 ± 0,02	1,32 ± 0,09	1,22	3767

Table 2. The Importance Value Index (IVI) in *Rhizophora* Sp. mangrove stands of varying planting ages.

Ages of planting		Tree type	KR (%)	FR (%)	DR (%)	IVI (%)
Years	4	*Rhizophora* Sp.	100	100	100	300
	12	*Rhizophora* Sp.	100	100	100	300
	21	*Rhizophora* Sp.	100	100	100	300
	29	*Rhizophora* Sp.	93,2	75,0	73,7	241,9
		Acanthus sp.	6,8	24,9	26,3	58,1

	Rhizophora Sp.	95,5	80,0	94,9	270,5
38	*Acanthus* sp.	4,5	19,9	5,0	29,5

2. Biodiversity and Function of Waterbirds

Monitoring in *Rhizophora* Sp. mangrove stands of five varying planting ages can be found about 19 species of waterbirds (Table 3).

Table 3. Presence and status of birds in *Rhizophora* sp. mangrove stands.

No	Name of birds		% abudance of *Rhizopora* sp. Mangrove stands (years)					Status
	Familia	Species	4	12	21	29	38	
1.	Alcedinidae	*Alcedo cerulescens*	2.94	1.79	24.4	1.21	1.64	Protected
		Halcyan chloris	0	5.36	14.6	0	1.64	Protected
2.	Anatidae	*Anas gibberifrans*	0	19.6	19.5	0	3.28	No Protected
3.	Apodidae	*Collacalia esculenta*	5.88	3.57	2.44	6.67	18	No Protected
		Collacalia fuciphaga	0	0	0	0	4.92	No Protected
4.	Ardeidae	*Ardea purpurea*	0	0	4.88	0.61	0	Protected
		Ardeola speciosa	14.7	0	0	14.5	0	Protected
		Butorides striatus	2.94	1.79	12.2	0.61	4.92	No Protected
		Egretta sacra	0	10.7	9.76	1.82	13.1	Protected
		Nycticorax nycticorax	0	5.36	4.88	0	0	No Protected
		Bubuculcus ibis	47.1	16.1	2.44	73.2	23	Protected
5.	Artamidae	*Artamus leucorhynchus*	11.8	0	0	0	23	Protected
6.	Cisticolidae	*Cisticola juncidis*	0	5.36	4.88	0	0	No Protected
7.	Columbidae	*Streptopelia chinensis*	2.94	0	0	1.21	0	No Protected
8.	Nectarinidae	*Nectarina jugularis*	0	21.4	0	0	0	Protected
9.	Pardalotidae	*Gerygone sulphuria*	11.8	0	0	0	0	No Protected
10.	Sulidae	*Sula-sula*	0	3.57	0	0	0	Protected
11.	syviidae	*Orthotamus ruficeps*	0	1.79	0	0	6.56	No Protected
		Orthotamus sutarius	0	3.57	0	0	0	No Protected

Diversity index and evenness index of birds in *Rhizophora* Sp. mangrove stands of varying planting ages can be found on Table 4.

Table 4. Diversity index and evenness index of birds in *Rhizophora* Sp. mangrove stands

Index	Ages of Rhizophora Sp. mangrove stands (years)				
	4	12	21	29	38
Diversity H`	1,6	2,2	2,05	0,9	1,97
Evenness E	0,5	0,6	0,55	0,2	0,48

3. Abiotic Factors

Measurement of abiotic environmental conditions (light intensity, humidity, air temperature) in *Rhizophora* sp. mangrove stands of varying planting ages (Table 5).

Table 5. Measurement of abiotic environmental conditions

No.	Parameter	Ages of *Rhizophora* Sp. Mangrove (years)				
		4	12	21	29	38
1.	Light intensity (Lux)	± 5840	± 5594,6	± 5970,8	± 5581,8	± 4819,3
2.	Air temperature (^{0}C)	± 28,9	± 28,3	± 28,6	± 28,1	± 27,9
3.	Air humidity (%)	± 87,5	± 85,5	± 84,3	± 85,4	± 86

DISCUSSION

1. *Rhizophora* Sp. Mangrove Structure

Life Stage. *Rhizophora* sp. mangrove of life stage criteria is turn on the height, DBH (diameter breast of height) and biomass. Found two levels of living (trees and seedlings) in stands of *Rhizophora* Sp. mangrove that observed. Level tree (height> 1 m and DBH> 2.5 cm) found in all age categories, while seedlings (germination up to a height of 1 m), is found only in 21 years old up to 38 years old.

Density. The density of the mangrove *Rhizophora* sp. showed a tendency to wane with increasing age of the planting. The highest density of trees found in the age of 4 years (800 trees ha-1) and the lowest at age 21 years (333 trees ha-1). High density of trees back to the age of 29 years (633 trees ha-1), and lower the age of 38 years (567

trees ha-1) (Table1). In contrast, the density of seedlings (Table1) showed no particular pattern when it is connected with the growing age. 21 years old seedling density is 2,267 individuals ha-1, lower at age 29 years (1,600 individuals ha-1), and the highest at the age of 38 years ie 3767 individuals ha-1.

Height, DBH, and Biomassa. The height, DBH, and biomass on mangrove tree *Rhizophora* sp. stands of varying planting ages showed an increase in harmony with the addition of plant age (Table1). The average height of the youngest trees (4 years) is 1.56 ± 0.33 meters; DBH of 2.92 ± 0.23 cm; and biomass of 1.45 kg m-2. Then the value is increasing in 12 years old with an average tree height about 5.17 ± 1.25 meters; DBH 5.15 ± 0.93 cm; and biomass of 7.96 kg m-2. Age of planting 21-year high reached on average 5.32 ± 1.59 meters; DBH 10.14 ± 2.83 cm; and biomass 11.03 kg m-2. Age 29 years increased so that the average height of 5.23 ± 2.51 meters; DBH 12.39 ± 5.44 cm; and the total biomass of 49.14 kg m-2. Increasing the value of high parameters, DBH, and biomass continue until reaching the age of 38 years with a mean of 8.13 ± 5.63 meters high; DBH 16.29 ± 7.23 cm; and biomass 108.62 kg m-2.

Important Value Index. The highest IVI index (300) in Table 2, can be found on three first groups of *Rhizophora* sp. mangrove (4, 12, and 21 years old). Association of plants (Acanthus sp.) with *Rhizophora* Sp. start find on 29 years old (*Rhizophora* sp. = 241,95 dan = 58,05) and 38 years old (*Rhizophora* sp. = 270,52 dan Acanthus sp. = 29,48).

The effects of varying planting ages on *Rhizophora* sp. mangrove vegetation structure is known through the Tests of Between-Subjects Effects and acquired the significant value at 0.015 (P<0,05). The conclusion is that the planting ages of *Rhizophora* sp. mangrove affects many vegetation structure of parameters especially in height, Diameter of Breast Height (DBH) and also biomass.

2. Biodiversity and Function of Waterbirds

Based on the analysis, it was found nine species of birds visitors mangrove *Rhizophora* Sp. protected by Indonesian Government Regulation No. 7 of 1999 on Preservation of Plants and Animals. Details of bird species protected is king blue shrimp (Alcedo coerulescens), purple heron (Ardea purpurea), blekok rice (Ardeola speciosa), Pacific Reef Heron (Egretta sacra), goose foot stone (Sula-sula), herons buffalo (Bubulcus ibis), cekakak river (Halcyon chloris), white-breasted woodswallow (Arthamus leucorhynchus), and honey sriganti (Nectarina jugularis). The rest belong to species of birds which are not Protected, namely ducks livid (Anas gibberifrons), striated heron (Butorides striatus), seriti (Collocalia esculenta), swallows cow (Collacalia fuciphaga), golden-bellied gerygone (Gerygone sulphurea), cici rice (Cisticola juncidis), cinenen gray (Orthotomus ruficeps), common tailorbird (Orthotomus sutorius), gray night herons (Nycticorax nycticorax), and turtledove (Streptopelia chinensis).

The presence of bird visitors on mangrove *Rhizophora* Sp. does not form a specific pattern of mangrove stands with age. Based on the number of individuals, the presence of birds of the lowest in the age of 4 years (34 people), and the highest age of 29 years (165 people). Based on the type, the lowest was found at the age of 4 and 29 years (8 types), and the highest at the age of 12 years (13 species). Comparison of the presence of birds based on the number and types are useful for determining the Shannon diversity index (H`) and the equality index (E).

Results of calculation (Appendix G.1) indicates that the highest value (H` = 2.2 and E = 0.6) at the age of 12 years and the lowest age of 29 years (H` = 0.9 and E = 0.2. Index diversity between 1.5 to 3.5, including the medium category (Soegianto, 1994). The higher the evenness index, the higher the uniformity among the species found (Kartijono et al, 2010).

Utilization of mangrove habitat by birds according Kartijono et al (2010) is divided into five types, namely a shelter, a place for prey fish, a source of food for insectivorous birds, interesting place for bird-eating flowers, and places to stop. In this case the function of *Rhizophora* sp. mangrove as a habitat for birds can be explained as follows:

1. Shelter. Mangrove ecosystem used as a refuge by birds due to lack of predators (Utomo et al, 2012). The results showed the largest reef egret found in stands of 38 years old (13.1%), striated heron at the age of 21 years (12.2%) and gray herons night at the age of 12 years (5.36%).
2. A place for catching fish. Birds of prey fish

often utilize water areas, fish ponds, clearing of mangrove forests, to find prey such as bivalves, gastropods, crustaceans, Polychaeta and Pisces (Howes et al, 2004). Among all birds of prey fish, buffalo egrets (*Bubulcus ibis*) is dominant in mangrove stands age of 4 years (47.1%), 29 years (73.3%), and age 38 years (23%). Livid duck (*Anas gibberifrons*) is the highest at the age of 12 years (19.6%), while the king of blue shrimp (*Alcedo coerulescens*) is the highest at the age of 21 years (24.4%).

3. A source of food for insectivorous birds. Insectivorous birds will look for various types of insects including aerial insects, beetles, bees, leafhoppers and caterpillars on mangroves as a source of food (Kartijono et al, 2010). The results showed the presence of white-breasted woodswallow (*Arthamus leucorhynchus*) and golden-bellied gerygone (*Gerygone sulphurea*) at most (11.8%) at the age of 4 years; Zitting cisticola (*Cisticola juncidis*) found the highest (5.36%) at the age of 12 years and (4.88%) at the age of 21 years. Bird seriti (*Collocalia esculenta*) found the highest (6.67%) at the age of 29 years, and the white-breasted woodswallow (*Arthamus leucorhynchus*) highest at age 38 years (23%).
4. Interesting place for bird-eating flowers. Flowering mangrove vegetation will attract birds sucking flower arrival of the family Nectariniidae (Kartijono et al, 2010). On *Rhizophora* sp. mangrove 12 years old its just found a kind of bird (*Nectarina jugularis*) with a 21.4% attendance rate.
5. A places to stop. Eating bird seeds, ie Streptopelia chinensis species can be found (2.94%) at the age of 4 years, and (1.21%) at the age of 29 years. This location is suspected to be a place to rest after a bird foraging in the fields or ponds located around the forest.

3. Abiotic Factors

The measurement of abiotic environmental conditions in *Rhizophora* sp. mangrove stands of varying planting ages have a range of relatively equal value at a certain observation day. Through the one-way ANOVA analysis its known that the condition of air temperature and humidity did not differ between planting of age ($P > 0.05$); Meanwhile, the light intensity indicate a difference between planting of age ($P < 0.05$).

CONCLUSION

1. *Rhizophora* sp. mangrove of varying planting ages affects many vegetation structure especially in height, Diameter of Breast Height (DBH) and biomas. In the youngest age (4 years) the average height of the tree is 1.56 $\pm$ 0.33 meters; DBH of 2.92 $\pm$ 0.23 cm; and biomass of 1.45 kg m-2, while at the oldest age (38 years), the average height reached 8.13 $\pm$ 5.63 meters; DBH 16.29 $\pm$ 7.23 cm; biomass 108.62 kg.
2. The patterns of bird presence did not show a clear trend or pattern among *Rhizophora* Sp. mangrove stands. The most visitors of birds (46%) is found at 29 years old of *Rhizophora* Sp. mangrove stand, and the smallest is found at 12 tears old with 21.4 percentage of visiting.
3. Based on abiotic factors, all locations have a same range of values a certain observation day. Nevertheless, some parameters showed a difference, especially in terms of light intensity.
4. Conclusions of this research is that structure and function parameters can change over time. The complexity of relations between ages are not always apparent, or proportional, especially in terms of ecosystem functioning for bird habitat.

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