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Coastal Biodiversity of Tidung & Rambut Islands: Mangrove and Coral Reef Conservation Program

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Abstract

Kepulauan Seribu have different characteristics ecosystem to conduct in increasing of tourism and fishery activities. Thus, there is a need for efforts to restore damaged habitats as a result of tourism activities. Restoration of mangroves and coral reefs needs to be carried out to maintain existing natural resources. Based on this background, the research aims to determine the survival rate, composition, diversity and evenness of mangrove and coral reefs in Research area. The research was conducted in three location (Tidung Island, Rambut Island, and PT.Pertamina Plumpang) held along in May untill October 2022. The method for plant vegetation and mangrove based by quadran and non-transect sampling as the 10% representation of area, meanwhile in fauna method based by VES (Visual Encounter Survey), also Coral based by LIT (*Line Intercept Transect*). The diversity index value of flora is 3,176 in PT.Pertamina Plumpang, classified as high. The evenness index is 0.808; relatively high. The estimated value of biomass and carbon stock of plant tree in PT.Pertamina Plumpang is 57314,01 ton/Ha. The persentage existence of Mangrove in Tidung Island is 33%; Rambut Island 37%. The survival rate persentage of coral in Tidung Island is 97% existence, despite 3% in mortality. The composition of avifauna in PT.Pertamina Plumpang is 12 species include in 10 family. The avifauna diversity index value is 1.88, which indicates in medium category. The evenness index value of avifauna is 0.75, which is a high value. The composition of herpetofauna include in 2 species, besides in insecta found 6 species.

Keywords: coastal biodiversity, conservation, coral reef, mangrove

INTRODUCTION

The rapid development of the Thousand Islands makes it the most developed area among other archipelagic regions in Indonesia. One of the factors driving this development is the utilization of abundant natural resources in the form of fisheries and tourism were this area is very close to urban that attracts many tourist visits (Sachoemar, 2008).

Behind of the many opportunities for the people in Tidung Island, the economy depends on the use of marine resources for various purposes, while some of the people are not aware and sometimes ignore its sustainability even though there is always socialization about coastal ecosystems from government agencies, private companies, non-governmental organizations, and higher education as an effort to provide knowledge to communities around the island to maintain and

preserve coastal ecosystems (Statistic Indonesia Kep.Seribu, 2016). Thus, there is a need for efforts to restore damaged habitats as a result of snorkeling activities that can damage mangroves and corals. In addition, busy tourist activities will also pollute the sea with garbage if waste management is not good. Restoration of mangroves and coral reefs needs to be carried out to maintain existing natural resources.

The natural repair process on coral reefs conditions has been damaged will takes longer and requires environmental conditions that are completely undisturbed by human activities. Efforts to overcome damage to coral reef ecosystems can be done by developing coral transplantation techniques (COREMAP II, 2006). Coral transplantation is one of the acts to rehabilitate coral reefs through transplanting live corals into media that becomes a new habitat on vacant land. Tillers for direct coral transplantation can be obtained through nurseries or natural reefs.

Based on the background, it is necessary to conduct research that aims to determine the growth and survival rate, composition, and value of flora diversity (including biomass and carbon sequestration), fauna, and coral reefs in the Tidung Island, Rambut Island, and PT. Pertamina Plumpang area. The transplant process needs to take place effectively and quickly.

METHOD

Location

The research was conducted in three location (Tidung Island, Rambut Island, and Pertamina Plumpang Field) held along in May 2022 untill October 2022 (Figure 1 & 2).

Figure 1. Map of Area Research in Tidung and Rambut Island, Kepulauan Seribu

Figure 2. Map of Area Research in Pertamina Plumpang Field, DKI Jakarta

Materials

The materials used in the observations included digital camera, binocular, digital clock, 100 meters long rope, diameter tip, tagging tape, roll meters, newtop paper, snorkeling equipment, GPS (Global Positioning System), stationery, data tabulation, and identification guide books. The books are Introduction to Mangroves in Indonesia, "Birds in Sumatra, Kalimantan, Java, and Bali (Mackinnon *et al*, 2010), and The Identification of "Coral Finder Toolkit Indo Pacific 2.0" (Kelley, 2009).

Data Collection

a. Mangrove and other vegetation

Data collection and activities include sampling vegetation data using the searching per plot method to see the representation of area. A total of 30 plots were made with a size of 10m x 20m or each plot made at locations. Each plot was counted by the number of individual mangroves that were still alive, and the height of the mangrovess was measured from the substrate to the top of the leaf. The aim is to determine the success rate of mangrove planting in both locations.

Meanwhile, the determination of flora observation points at PT. Pertamina Plumpang represented 10% of the total area. The method used is a non-transect line for inventory by exploring each species found in the location and using the quadrant method for tree stand data with a diameter of more than 10 cm as representative data on carbon sequestration carried out in rectangular sample plots measuring 10 x 10 meters. Field data recorded included the name of plant species, the number of individuals, stand height, and tree diameter.

b. Fauna

Fauna data retrieval using the VES (Visual Encounter Survey) method by making direct observations at the location, documenting then recording the species name and number of individuals in the observed area, then identified with fauna identification book.

c. Coral Reef

Coral reef data retrieval the method used is LIT (Line Intercept Transect) with a predetermined transect length of 10 meters, observations are made by spreading the measure tape over coral reefs and then identified to the famili level (English *et al*, 1997).

Data Analysis

a. Species Composition

Species composition is an measurement of the species in an area, to determine the underlying composition whether there is a relationship between the number of species commonly found in two community areas and the total species (Rusmendro, 2004).

b. Diversity

Species diversity is calculated using the Shannon-Wiener diversity index (H') with the following formula (Magurran, 1988):

$$H' = -\sum Pi \, . \, \ln Pi$$

Where :

H’ = diversity index by Shannon-Wiener

pi = proportional abundance of each species

According Magurran (2004), states that the range of diversity index values is :

H’ ≤ 1 = diversity Low

1 < H’ < 3 = diversity Medium

H’ > 3 = diversity High

c. Evenness

The species evenness index (Evenness) serves to determine the evenness of each species in each community. Species evenness can be calculated using the formula (Fachrul, 2012), namely:

$$E = \frac{H'}{Ln\ (S)}\ x\ 100\%$$

where :

S = total number of species (species richness)

E = evenness index

H’ = diversity index

According to Krebs (1999), the evenness index value (E) is classified into 3, namely: 0 <E ≤ 0.4, so the population uniformity is small; 0.4 <E <0.6, then the population uniformity is moderate; E ≥ 0.6, then the population uniformity is high.

d. Estimated Value of Biomass and Carbon Stock (Flora)

Biomass of tree determined by measuring the diameter at breast height (dbh) in a 10x10 meter plot. Biomass estimation on this research uses the allometric approach proposed by Ketterings (2001), the formula used is:

$$BK = 0{,}11 \times \beta \times D2{,}62$$

Where:

BK = Biomass of tree (kg/ind)

D = Diameter at breast height

β = Specific gravity of wood (gr/cm^3) *secondary data

After the biomass value is obtained, the next step is to calculate the carbon stock of each tree based on SNI 7724:2011, which states the percentage of carbon in trees, litter, and dead trees is 47%, as follow to estimate the carbon uptake of each tree using the equation (Hardiansyah, 2012) :

$$C = 47\% \times BK$$

To determined carbon stock per hectare, used the formula of:

$$C = C\ tb/plot\ /1.000^* \ 10.000/X$$

Where:

C = Carbon Stock (kg)

BK = Biomass of tree (kg/ind)

47% = Constanta of carbon based on SNI 7724:2011

X = Plot area (m^2)

e. Growth Rate and Survival Rate (Coral Reef)

To calculate growth rate in diameter and length of Coral Reef, used the formula of (Effendie, 1979) ;

$$P = \frac{Lt - Lo}{t}$$

Where :

P = Coral growth (cm/year)

Lt = Average height or diameter in the t-month measurement (cm)

Lo = Average height or diameter at the beginning of the measurement (cm)

t = Observation time (years)

Meanwhile, survival rate (SR) of coral reef calculated by the formula of (Suharsono, 1999):

$$SR = \frac{Nt}{No}\ x\ 100\%$$

Where :

SR = Survival rate of transplanted corals (%)

Nt = Number of live corals at t-time (colonies)

No = Number of live corals at the beginning of transplantation (colonies)

RESULT

Tidung Island consists of Tidung Besar Island and Tidung Kecil Island. Tidung Besar Island with an area of 50.13 Ha, which functions as a residential area in the west. The location of Tidung Kecil Island, which is in the middle of a cluster of residential and tourism islands in the Kepulauan Seribu, facilitates coordination with the islands (dephut.go.id). In addition to Tidung Island, the location for planting and monitoring mangroves is also on Rambut Island, which is included in the area of Untung Jawa Island (Figure 3). This area is known as a habitat and nesting place for various types of merandai birds, you can find protected bird species such as Pecuk Ular, Bluwok, Egret, Kutilang, Iron Woodpecker, Herons, and Bondol Eagle which is famous as the mascot of DKI Jakarta (BKSDA DKI Jakarta, 2015).

Figure 3. Landscape view of Rambut Island

The location to collect data is in PT. Pertamina Plumpang, Jakarta with an area of 48,352 Ha (Figure 4). This location is engaged in business related to the oil and gas industry, in conduct to supplying oil and gas needs to all region of Indonesia. PT. Pertamina Plumpang continues to strive to minimize the negative environmental impacts caused by the company's operations. Therefore, in this location, there are still some green open spaces as habitats for flora and fauna which are continuously monitored for their level of biodiversity to be in line with the scope of the company's activities.

Figure 4. Landscape view of PT Pertamina Niaga Integrated Terminal Jakarta

Flora in Tidung Island and Rambut Island

The flora diversity on Tidung Island and Rambut Island was measured by indicators of the growth rate of *Rhizopora mucronata* from the number of living individuals and plant height from each plot. Based on the results, it shows that the percentage of trees that exist on average on Tidung Island is 33% with an average plant height of 71 cm and on Rambut Island it is 37% with an average plant height of 68.05 cm (Figure 5). This percentage is due to the presence of plants that are lost due to drifting by currents, drifting of garbage, and waves of ships passing through the observation plot. However, mangroves that are able to survive until now already have a strong root system and are able to adapt to the basic characteristics of the habitat.

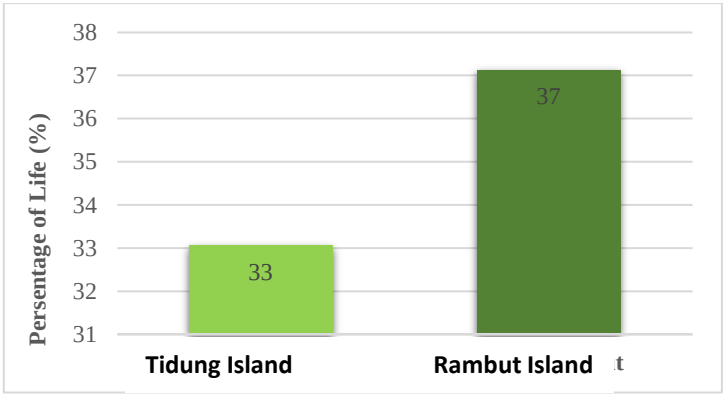

Figure 5. Life Rate Persentage in Mangroves

The percentage of mangrove plant survival is higher on Rambut Island than on Tidung Island. It happens because the area is relatively safer from visitors and already included in the wildlife reserve area, besides the mangroves on Rambut Island which were planted in June 2022 tend to increase their height faster. It can happen because the access to the Tidung Island area is more crowded by visitors, so the ocean wave currents are higher due to recreational water rides such as banana boats and transportation flows more often. In general, the planting and monitoring of mangrove in these two locations has slowly helped in the restoration of the coastal ecosystem. Figure 6 shows that the coastal location of Rambut Island before plantation is more arid than after the mangrove plots.

Figure 6. Condition before plantation (left); after plantation (right)

Flora in PT. Pertamina Plumpang

a. Biodiversity and Evenness

Community structure can be determinate from the diversity of species, it used to measure the stability of a community (Soegianto, 1994). The results were obtained as a whole in the PT. Pertamina Plumpang shows a diversity index (H') which varies by 3,176 and a species evenness index value (E) is 0.808.

Table 1. Diversity and Evenness Index Value in PT. Pertamina Plumpang

Index Flora	Value	Category
H’	3,176	High
E	0,808	High

Based on Table 1, the criteria for the Shannon-Wiener H' Diversity Index (1987) in this location has a high diversity of flora. The high value indicates that the diversity of plants found in PT Pertamina Niaga, Plumpang as a whole is overgrown by many types of plants and only a few dominate, thus indicating a balance of species. Communities that have a higher diversity value, the relationship between components in the community will be more complex. According to Indriyanto (2012), this affects the stability of the community if there are disturbances to its constituent components (Indriyanto, 2017).

This is similar to the evenness index which is included in the high category because it shows the number 0.808 which means it is close to 1. This category is supported by the statement of Odum (1993), that the evenness index can be said to be high if the value is > 0.60. The evenness of plant species at PT. Pertamina Plumpang has a high value because the number of individuals of each species does not dominate significantly or has the highest number in one community. The value of the species evenness index will be evenly distributed if all the plants found at the observation location are spread out in the same number of individuals.

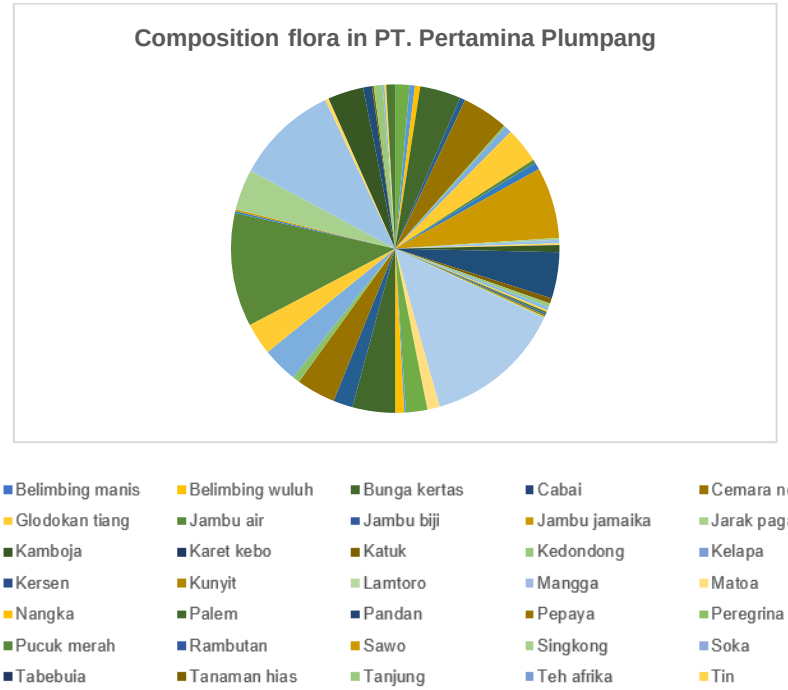

Figure 7. Composition species in flora

Based on Figure 7, the plant species at PT. Pertamina Plumpang is very varied. The plants were found in 583 individuals from 51 species. On the basis of these variations, the most common species found were Mangoes with a total of 78 individuals, followed by Pucuk merah with 64, and Soka with 58 individuals. Therefore, plants that already exist around the location need periodic maintenance and monitoring so that their existence remains sustainable in the balance of the ecosystem, as a habitat for local fauna, and able to absorb carbon from factory emissions, so that environmental problems can be minimized early on.

b. Estimated Value of Biomass and Carbon Stock

Based on the research at PT Pertamina Niaga, which has an area of 48.352 hectares, various types of plants were founded. The results used for estimating biomass and carbon stock came from tree stands with a diameter of more than 20 cm. Calculation of the amount of carbon is carried out by following standard SNI 7724:2011, which states that the carbon content is 47% of the biomass, while the estimation of biomass uses the allometric method is equipped with secondary data on tree density from ICRAF (2019). Table 2 shows the carbon absorption contained in PT. Pertamina Plumpang, where took samples from tree stands around the area. It is known that the resulting carbon stock can be an important improvement in nature conservation in the future.

Table 2. Estimated biomass value on tree base

No	Indonesia name	n	Diameter	p	Biomass total (kg)	Biomass (kg/m2)	Biomass (ton/Ha)
1	Akasia	1	21,66	0,53	184,62	22316,78	22,32
2	Bacang	2	22,29	0,62	462,66	55926,20	55,93
3	Karet kebo	26	63,69	0,44	67227,59	8126470,90	8126,47
4	Jambu jamaika	40	23,57	0,56	9732,71	1176490,21	1176,49
5	Kelapa	2	28,03	0,62	841,56	101727,88	101,73
6	Mangga	78	95,54	0,60	790810,73	95593200,99	95593,20
7	Matoa	7	19,11	0,71	1238,67	149730,69	149,73
8	Nangka	5	12,74	0,60	258,44	31240,25	31,24
9	Sukun	20	42,99	0,60	25032,11	3025880,96	3025,88
10	Tanjung	5	111,46	0,88	112144,20	13555990,50	13555,99
11	Trembesi	5	21,34	0,52	874,59	105720,70	105,72

*p value based in ICRAF, 2019

Based on Table 2, estimating the carbon biomass of trees is needed to determinate the amount of carbon absorption. The greater the biomass value of a tree, the greater its carbon absorption also. The carbon sequestration data collection only applies to tree stands because most tree species are classified as woody plants that experience cambium development, then the cambium will accommodate carbon absorption. Therefore, when compared to stands of shrubs, herbs, Palmae, saplings, and poles, the carbon absorption capacity will be greater in tree stands due to the development of cambium activity. The next estimation of carbon absorption by following SNI 7724:2011 is as follows:

Table 3. Estimated carbon stock on tree base

No	Local name	Scientific name	Biomass (ton/Ha)	C (ton/Ha)
1	Akasia	*Acacia mangium*	22,32	10,49
2	Bacang	*Mangifera foetida*	55,93	26,29
3	Karet kebo	*Ficus elastica*	8126,47	3819,44
4	Jambu jamaika	*Syzygium malaccense*	1176,49	552,95
5	Kelapa	*Cocos nucifera*	101,73	47,81
6	Mangga	*Mangifera indica*	95593,20	44928,80
7	Matoa	*Pometia pinnata*	149,73	70,37
8	Nangka	*Artocarpus heterophyllus*	31,24	14,68
9	Sukun	*Artocarpus communis*	3025,88	1422,16
10	Tanjung	*Mimusops elengi*	13555,99	6371,32
11	Trembesi	*Samanea saman*	105,72	49,69
			Total C	**57314,01**

Total carbon stock that can be accommodated by trees at PT. Pertamina Plumpang amounted to 57314.01 tons/ha. This figure must be maintained and needs to be increased with regular monitoring so that carbon absorption is stable.

Coral Reef Conservation Program in Tidung Island

a. Growth rate and Survival Rate

The growth rate of coral transplants for one year can be seen in Table 4. There are differences in growth rates that can be caused by growth forms in the form of branches will allow them to grow faster than corals form are sheet and massive. The Acropora genus has a characteristic growth form of branching so this genus has a high growth rate compared to the Porites genus which has a massive or rock-like growth form.

Table 4. Growth rate in Coral Reef Transplantation

No	Genus	Coral height (cm)		cm/years
		2021	2022	
1	Acropora	20	30	10
2	Echinopora	7	10	3
3	Pachyseris	13	15	2
4	Pocillopora	14	17	3
5	Porites	5	8	3
6	Stylophora	13	15	2
7	Symphyllia	7	10	3

Total data on coral reefs contained 218 colonies, in the form of 212 colonies being observed alive and 6 colonies observed dead. The percentage of coral reef transplant survival rate is the percentage of coral reef transplant success during 2 years of planting. The average percentage of coral transplant success was 97% with the coral transplant failure rate was 3%. There were 6 colonies that died because they could not compete with *turf algae* or moss which caused coral colonies to be covered by *turf algae*.

Avifauna in PT. Pertamina Plumpang

Based on the research conducted at PT. Pertamina Plumpang recorded as many as 12 bird species belonging to 10 tribes (Table 5). There are only one species that is classified as *Vulnerable* according to the IUCN, namely Kerak kerbau (*Acridotheres javanicus*), eleven other species that are classified as *Least Concern*, and there are no species that are included in the protection of the Ministry of Environment and Forestry Regulation and CITES trading status. Figure 8 shows some species of birds that were found in the PT. Pertamina Plumpang.

Table 5. Composition and conservation status avifauna in PT. Pertamina Plumpang

No	Family	Scientific name	Indonesia name	UU	IUCN	CITES
1	Apodidae	*Collocalia linchi*	Walet linci		LC	
2	Ardeidae	*Egretta garzetta*	Kuntul kecil		LC	
3	Columbidae	*Spilopelia chinensis*	Tekukur biasa		LC	
4	Columbidae	*Geopelia striata*	Perkutut jawa		LC	
5	Corvidae	*Corvus enca*	Gagak hutan		LC	
6	Dicaeidae	*Dicaeum trochileum*	Cabai jawa		LC	
7	Estrildidae	*Lonchura punctulata*	Bondol peking		LC	
8	Nectariniidae	*Cinnyris jugularis*	Burung madu sriganti		LC	
9	Passeridae	*Passer montanus*	Burung gereja erasia		LC	
10	Pycnonotidae	*Pycnonotus goiavier*	Merbah cerukcuk		LC	
11	Pycnonotidae	*Pycnonotus aurigaster*	Cucak kutilang		LC	
12	Sturnidae	*Acridotheres javanicus*	Kerak kerbau		VU	

Note:

- ✓ Global conservation status in **IUCN** (*International Union for Conservation of Nature*) (NE. *Not Evaluated*; LC. *Least Concern*; NT. *Near Threatened*; VU. *Vulnerable*; EN. *Endangered*; CR. *Critically Endangered*; EX. *Extinct*)
- ✓ Regulation on animal traffic status in **CITES** (*Convention on International Trade of Endangered Species of Wild Fauna and Flora*) (Appendix I; Appendix II; Appendix III)
- ✓ Regulation status in **Peraturan Republik Indonesia** (PerMen LHK No. 106 in 2018)

Passer montanus

Pycnonotus aurigaster

Figure 8. Some Species of Avifauna in PT. Pertamina Plumpang

From the results of the study, the diversity index value of bird species at PT. Pertamina Plumpang is 1.88 (Figure 9). According to the diversity index criteria (Maguran, 1988) the diversity in this location is included in the medium category (value of H' 1 - 3). The diversity of a community can be related to the balance of species with having a high diversity value then the balance in the

community is also high, on the contrary, if it has a low diversity value, there will be an imbalance in the community (Sukandar *et al*., 2015). In addition to the absence of a very dominant number of individuals in the PT. Pertamina Plumpang has a variety of habitats, from those with closed and open vegetation to shrubs and rivers.

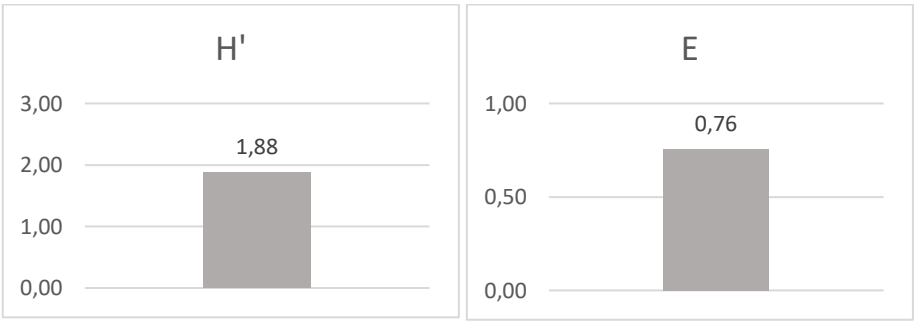

Figure 9. Biodiversity index value (H') and Evenness index value (E) in Avifauna

Based on the results of this study, the evenness index value of bird species (Figure 9) was found at PT. Pertamina Plumpang is 0.76. According to Odum (1993), the evenness index value can be said to be high if > 0.60. Evenness of bird species in PT. Pertamina Plumpang has a high value because the number of individuals from each type does not dominate or have the highest number in one community.

Herpetofauna in PT. Pertamina Plumpang

Based on the results conducted at PT. Pertamina Plumpang obtained one species from the amphibian and one species from the reptile (Table 6).

Table 6. Composition on Herpetofauna

No	Class	Ordo	Family	Scientific name	Indonesia name
1	Amphibi	Anura	Bufonidae	*Bufo melanostictus*	Kodok buduk
2	Reptile	Squamata	Agamidae	*Calotes versicolor*	Bunglon taman

The condition of the observation site still contains waterways and shrubs, creating humid conditions. Herpetofauna is a group consisting of reptiles and amphibians. Amphibians need sufficient moisture to protect themselves from drying out their skin (Iskandar, 1998) while reptiles need a heat source from outside their bodies to increase body temperature in order to function normally. To raise their body temperature to a suitable temperature, reptiles usually bask in the sun or absorb heat from warm rock or soil surfaces. On the other hand, to lower their body temperature or regulate their body temperature to remain optimal, reptiles usually take shelter under leaf litter or holes in the ground. This is the documentation of the herpetofauna found in the PT. Pertamina Plumpang (Figure 10).

Calotes versicolor

Bufo melanostictus

Figure 10. Some Species of Herpetofauna in PT. Pertamina Plumpang

Insecta in PT. Pertamina Plumpang

Based on the results of research conducted at PT. Pertamina Plumpang recorded as many as two species of dragonflies and four species of butterflies (Table 7).

Table 7. Composition of Species in Insecta

No	Class	Ordo	Scientific name
1	Insecta	Odonata	*Orthetrum sabina*
2	Insecta	Odonata	*Crocothemis servilia*
3	Insecta	Lepidoptera	*Hympolinas bolina*
4	Insecta	Lepidoptera	*Junonia orithya*
5	Insecta	Lepidoptera	*Catopsilia pomona*
6	Insecta	Lepidoptera	*Ideopsis vulgaris*

One of the insect orders that has a fairly high diversity and also has a beneficial role for the environment is the dragonfly (Figure 11). Dragonflies have a high sensitivity to habitat changes. Dragonflies only live in specific habitats, especially in habitats that are clean of harmful residues. So its existence is used as an indicator for a clean environment. Beside dragonflies, butterflies (order: Lepidoptera) are easily recognized by the presence of fine scales on their wings and body surface. These scales contain pigments that give the wings and body variations in color. Butterfly color variation is one of the essensial characters in butterfly identification (Kirton, 2014).

Orthetrum sabina

Crocothemis servilia

Figure 11. Some species of Insecta (Dragonfly) in PT. Pertamina Plumpang

Butterflies is a bioindicator of habitat change, caused by the presence of butterflies can be influenced by the presence of plants as hosts and as feed (Ruslan, 2012). The diversity of butterflies can be influenced by abiotic and biotic factors. Abiotic factors that affect butterfly diversity include temperature, humidity, rainfall, and light intensity. The biotic factor that affects butterfly diversity is the composition of the vegetation (Fileccia *et al*, 2015).

DISCUSSION

Conservation efforts and provision of mangrove seedlings and coral reefs need to be carried out and integrated with the development of ecotourism areas in the future. In order to create independence with the development of tourism activities, but not to damage the environment and conservation activities. Because the concept of ecotourism is restrictions on tourism activities, such as the number of visitors, and others. It is necessary to provide local plant seeds and mangroves on a regular basis so that the seeds that have not had time to grow but have been eroded by ocean currents can be maintained and develop sustainably. It is necessary to expand the conservation of coral reefs around the Cinta Bridge together with intensive management and maintenance of coral reefs.

CONCLUSION

The biodiversity index value of flora is 3,176 in Pertamina Plumpang Field. The value of this diversity index is classified as high. The evenness index is 0.808; This is relatively high, close to the value of One. The estimated value of biomass and carbon stock of plant tree in Pertamina Plumpang Field is 57314,01 ton/Ha. The persentage existence of Mangrove espescially *Rhizopora mucronata* in Tidung Island is 33% also in Rambut Island 37%. The survival rate persentage of coral in Tidung Island is 97% existence, despite 3% in mortality. The composition of avifauna in Pertamina Plumpang Field is 12 species include in 10 famili. The avifauna diversity index value is 1.88, which indicates that the diversity belongs to the medium category. The evenness index value of avifauna is 0.75, which is a high value. The composition of herpetofauna include in 2 species besides in insecta found 6 species.

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