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Research Article
Mangrove Vegetation and Bird Communities Around the Port of Tegal, Central Java, Indonesia

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Abstract

Background and Objective: The ecological balance of mangroves, avifauna (birds) and plants in the Tegal harbor area needs to get serious attention because it was feared that it will be damaged by Tegal port activities. The diversity of mangrove and bird could be used as a bio-indicator of the ecological stability of the region. Therefore, it was necessary to observe the diversity of vegetation and avifauna (birds). **Materials and Methods:** Parameters observed by mangrove community were dominating, density, frequency (Shannon-wiener index), identified and categorized based on the Indonesian weed and mangrove handbook in Southeast Asia. The parameters of the avifauna (birds) community were similar and diversity index, their conservation status was identified based on the IUCN red list convention. **Results:** Based on the analysis of mangrove vegetation, 73 species were identified with special attention to *Rhizophora mucronata* and *Avicennia marina*, because they had the highest important role in the observation area 2 (Tegal port) and 3 (Pantai alam indah). The number of avifauna (birds) species in the observation area 3 was 37 species from 18 families, with the highest similarity in region 1 (Muara reja) and 2 (Tegal harbor) with a value of 76.4%. **Conclusion:** Special consideration was needed, especially for vegetation and avifauna (birds) species which had important values and roles in the balance of the ecosystem in the Tegal port area.

Key words: Avifauna, community, diversity index, evenness index, ecological stability, mangrove vegetation

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Tegal port development is planned to utilize the sea and land area. Development planning in the marine area includes the construction of docks, breakwaters, dredging of port ponds, shipping lines and dumping activities. While development in the land area includes the construction of access roads and port facilities. The suitability of spatial planning for marine area regulations is regulated by Indonesian Regulations Number 23 of 2014 that the management of marine areas up to 12 miles (excluding oil and gas exploration) becomes the authority of the Regional Government of Central Java province[1], while conformity spatial planning for land area is regulated based on the Regional Regulations of Tegal city, No. 4 of 2012 concerning Tegal city spatial planning for the period 2011-2023, therefore, the development of the port of Tegal is in accordance with the regulations that have been set[2].

The development of Tegal port can certainly cause an impact on the surrounding environment, especially on the flora and fauna community around the Tegal port development area. The components of flora and fauna are environmental components that support the ecological system for the occurrence of an ecological balance, so that safeguards are needed especially for flora and fauna. The existence of flora and fauna communities with various species in the Tegal port area has the potential to develop into coastal forest areas and mangrove ecosystems that can form a habitat for flora and fauna life by adjusting to the environment around the port of Tegal[3].

Mangrove forest in the area around Tegal is a collection of mangrove trees that grow in the area around the coastline that is affected by tides (Java sea). Mangroves have special physiological adaptations to match the salt in their tissues. Mangroves also have adaptations through the root system to support themselves in mud sediments. Most of the mangrove ecosystems in the Tegal port area are the result of community restoration plantations coordinated by Tegal port management so that they are often referred to as mangrove forests created at Tegal Harbor. While most of the mangrove forests on the north coast around the port of Tegal have experienced severe degradation because of people themselves or are hit by waves. The actions of residents who cut down mangroves into shrimp ponds are used for firewood and logging of mangrove forests

The condition of mangroves on the coast of Tegal regency is very alarming. The depletion of mangroves along the coast of Tegal regency besides being caused by natural factors, there is also a change in the behavior of people who are not wise in using mangroves. The mangrove ecosystem of the Tegal port area is found around the Tegal harbor location, which is located in the pond area which is no longer used by the community. *Casuarina* sp., *Rhizopora mucronata*. *Avecennia marina* and *Terminalia catappa* are located around Alam Indah Beach, which is east of Tegal harbor. Some of the mangroves in the Alam Indah Beach location are artificial or planted mangroves. The species of mangroves found in Alam Indah Beach consist of *Avicinea marina*, *Rhizopora mucronata*, *Casuarina* sp. and *Terminalia catappa*. All mangroves in the Tegal harbor area are not mangrove conservation areas but it is expected to affect the habitat of various avifauna (birds) species and vegetation especially those that live in the mangrove ecological system[4].

Various species of avifauna (birds) have an important role in maintaining ecological balance and environmental sustainability especially as a controller and controlling pests helping pollination and pollinators. An environment that is suitable as a habitat for avifauna (birds) can function as a place for providing food, shelter and a suitable breeding ground for avifauna (birds). The birds can be used as bioindicators in assessing biodiversity in a region because avifauna (birds) can occupy a vast habitat of food chains, so avifauna (birds) species have very important values in the food chain and extensive ecological nets[5]. The loss of avifauna (birds) species from the food chain will cause ecological imbalances that cause interference in the ecological concomitant region. Each type of avifauna (birds) has the ability and adapt to its environment. Such adjustments can be in the form of behavioral changes and metabolic changes as a form of adaptive flexibility[6]. The birds distribution and diversity in each region are different, this is influenced by habitat characteristics, vegetation structure and the level of environmental quality in the region. The avifauna (birds) can be used as an indicator of ecosystem change in an environment because birds are animals that have dynamic flexibility and high mobilization so they can quickly respond to changes that occur in the environment[7]. The mangrove forest area around Tegal port has a diversity of species of birds and vegetation that have not been known specifically and scientifically, although it is not a conservation forest but is expected to affect the surrounding environment. Therefore it is necessary to do research on the species of bird diversity and vegetation around the Tegal port, especially in the mangrove forest area and there has been no research on bird diversity in this region because this study aimed to determine the diversity index and evenness of birds and vegetation in the neighborhood around the port of Tegal.

This study aims to identify species and analyze diversity, species of plants and avifauna (birds) that live in mangroves in the Tegal port development area.

MATERIALS AND METHODS

Time and place of research: Sampling and observation of research objects were carried out from 10 March-10 May, 2019. The general condition of the research environment is the average temperature at the study site ranged from 28°C and the average air pressure conditions ranged from 1009-1013 mb while the air humidity ranging from 77-80%. The study was conducted in 3 mangrove areas north of Tegal city. Area 1: Muara reja site (coordinates 109°7'25.787"E 6°50'57.057"S), Area 2: Tegal port site (coordinates 109°8'3.58"E 6°50'59.259"S) and Area 3: Pantai Alam Indah site (coordinates 109°8'42.23"E 6°50'56.929"S) as shown in Fig. 1.

This research is located in the Tegal port development area based on a map of the suitability of the business plan with spatial planning and the area of the city of Tegal, Central Java, Indonesia.

Population and samples: The study population was all species of mangrove vegetation and all species of avifauna (birds) and parameters that were related to both taxa and samples in this study included the species of mangroves in each strata (trees, poles and sapling) found in the study quadrant and species of avifauna (birds) observed at observation points in each observation area. Determination of the mangrove category is in accordance with the "Mangrove Guide Book for Southeast Asia"[8]. The parameters observed included dominance, density and frequency in each type of mangrove found in 5 squared observations in each area, while the birds parameter observed was the number of individuals per type at the observation points in each area. Observations were made by listing the species of avifauna (birds) and minimizing data bias on the richness of avifauna (birds) species at the study site.

General description of the research location as follows in Fig. 2.

Sampling and observation

Vegetation sampling: Taking vegetation samples by making 5 squared observations measuring 10×10 in the study area in accordance with the principle of purposive random sampling. At each square of observation measurements of Diameter at Breast Height (DBH) were carried out for each individual mangrove based on strata: trees, poles and sapling. Each individual obtained is identified directly in the field based on

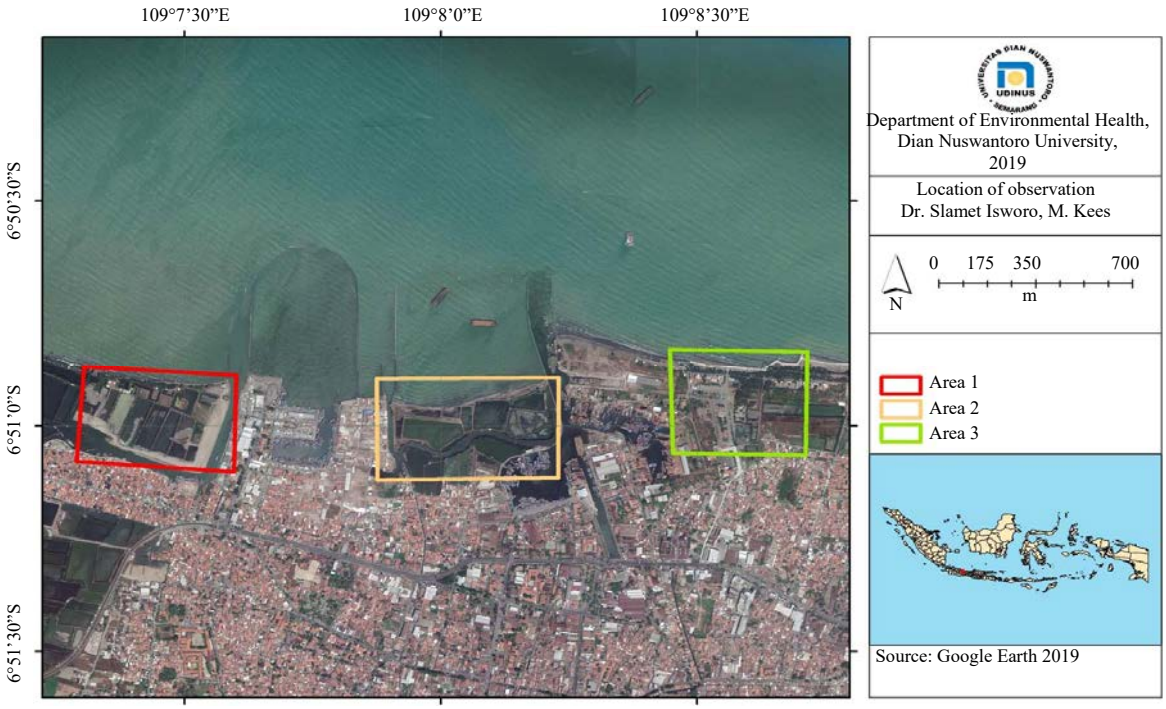

Fig. 1: Location of observation

Fig. 2: Overview of research locations

the guidebook used. Unknown species of scientific identity are labeled with temporary naming then samples are collected and further identified. In each area determined by 5 observation points, each observation point represented a 50 m radius, observed for 20 min[8]. In each radius of the observation point counted the number of individuals per type of avifauna (birds) observed, each type present in each area outside the observation point was recorded as additional data, the species that have not been identified are documented or simple sketches for further identification and each area is observed[9].

Mangrove community: The composition of mangrove species is determined by identifying all species of mangroves obtained in the observation square and outside the square of the observation in each area. Type identification is based on morphological characters observed during the study using a guidebook: Weed of Rice of Indonesia[10] and Mangrove Guide Book for Southeast Asia. The sample categorization was analyzed based on the "Mangrove Guide Book for Southeast Asia"[11]. Specifically for the tree category, the growth stage is determined based on the size of the stem Diameter at Breast Height (DBH). The location in question is as follows: Category of tree category (diameter classes): DBH>10 cm, Pole category (diameter classes) tree: 10 cm >DBH>5 cm, category of sapling trees: DBH<5cm, height>1.5 m and the sapling tree category: saplings category that are less than 150 cm tall. The level of role of each type found in each observation square in each area is known by conducting an important value analysis (NP). The higher the important value (NP) of a type, the greater the contribution of this type to the community[12]. The calculation of important values (NP) using the relative value of 3 parameters includes dominance, density and frequency of each type according to the following formula[13]:

$$NPi = DoRi + DeRi + FRi$$

Where:

Npi = Important value of type i
DoRi = Relative dominance of type i
DeRi = Relative density type i
Fri = Relative frequency type i

The relative values for each parameter are determined based on the calculation below:

$$NRi = \frac{ni}{N}$$

Where:

Nri = Relative type i (DoR, DeR, FR)
ni = Quantitative value of type I (dominance, density or frequency)
N = Total quantitative values of all species

To determine the stability of the mangrove community, a species diversity index was determined in the tree category at each growth stage according to the following formula:

$$H' = -\Sigma pi.\ InPi$$

Where:

H' = Species diversity index
Pi = Quantitative value of type i/total all quantitative values of all species

The similarity of the mangrove community in the tree category for each growth stage in areas 2 and 3 is known by the Sorensen formula as follows[13]:

$$S\ (\%) = \frac{2W}{a+b} \times 100$$

Where:

S = Similarity value of Sorensen
W = Lowest number of quantitative values of the species in the two communities compared
a = Quantitative values of all species in the area a
b = Quantitative values of all species in the area b

Avifauna community: The wealth of avifauna (birds) type is known based on observations at each point and observation outside the observation point. The observed species were identified referring to a reference from MacKinnon's book on the identification of avifauna (birds) in Sumatra, Java, Bali and Kalimantan in Indonesia[14]. Each type is determined by its conservation status under the Republic of Indonesia and Red List of the International Union for Conservation of Nature[15] and Implementation of the Convention on Convention on International Trade in Endangered Species of Wild Fauna and Flora[16]. The level of species diversity is known to use the Shannon-Wiener diversity index (H')[17].

RESULTS

Overview of mangrove conditions at the research site: Based on observations on the mangrove community, 73 plant species were identified which were dominated by herbs and grasses (Table 1).

The next step is to calculate the important value and index diversity in the plants making up the mangrove community. The role of each type of mangrove in each area is illustrated through a quantitative number called the Important Value (NP). The higher the importance of a species, the greater the contribution of this type to the community. The species diversity index is used to determine the types of mangrove standing plants species as follow.

Table 1: Percentage of plant species by category in the study area

Plant category	Total (%)
Herbs	38
Fern	1
Tree	14
Grass and the like grass	29
Bush	8
Vines	10
Total	100

Table 2 and 3 showed the results of calculations and analyzes of Do = Dominance, De = Density, Freq = Frequency, DoR = Relative Dominance, DeR = Relative Density, FR = Relative Frequency, NP = Importance Value and Diversity Index (H') in each strata of plants which comprise the mangrove plant in the observation area.

Based on Table 2, it is known that the species that has the highest importance at the tree level is *Rhizophora microposra* with an index value of 161 and at the stratum level is *Avicennia marina* with an index value of 114, while at the pole level that has the highest importance, 192 is *Rhizophora apiculata* , while based on Table 3, it is known that the species has the highest importance at the tree level is *Cassuarina equisetifolia* with a significance value of 188, while the highest importance at the pole and sapling level is *Rhizophora mucronata* with important index values of 160 and 241.

The species diversity can be used to measure community stability, namely the ability of a community to keep itself stable. Approach to the calculation of biodiversity index at the ecosystem level through vegetation analysis uses the Shannon-Wiener Index (H') method. Data on the stability of mangrove communities in area 2 and 3 are determined based on the stage of growth (Table 4).

Based on Table 4, the diversity index value in the 2 areas being compared shows the low category in each stratum. In the strata of trees and sapling area 2 shows a higher diversity index, so this is a sign that the area 2 in the stratum in question (tree strata and sapling) have better stability. Whereas in the pole strata area 3 can be said to have better stability.

The similarity of the community is not enough to be known through the composition of its type. The quantitative calculations have better accuracy because in a community there are differences in the value of each parameter owned by each type . Therefore, Sorensen calculations need to be done to find out how the similarity of the community in the mangrove community, especially the category of trees with each stage of its growth (Table 5).

Table 2: Analysis of importance value and diversity index (H') area 2

		Plot														
Strata	Species name	1	2	3	4	5	Do	De	Frek	DoR	DeR	FR	NP	Pi	lnPi	PilnPi
Tree																
1	*Avicennia marina*			22.6		174.5	197.1	0.02	0.40	32.98	27.91	22.22	83.11	0.28	1.28	0.36
2	*Bruguiera cyllindrica*		42.4				42.4	0.00	0.20	7.09	2.33	11.11	20.52	0.07	2.68	0.18
3	*Excoecaria agallocha*					11.5	11.5	0.00	0.20	1.92	2.33	11.11	15.35	0.05	2.97	0.15
4	*Rhizophora apiculata*	23.9					23.9	0.00	0.20	4.00	4.65	11.11	19.76	0.07	2.72	0.18
5	*R. mucronata*	113.4	12.1	68.8		128.7	322.9	0.05	0.80	54.02	62.79	44.44	161.26	0.54	0.62	0.33
Total								597.8	0.09	1.80	100.00	100.00	100.00	300		1.20
Pole																
1	*Avicennia marina*	5.7		18.5	24.8	21.0	70.1	0.02	0.80	12.76	14.10	33.33	60.20	0.20	1.61	0.32
2	*Bruguiera cyllindrica*	11.1	5.4				16.6	0.01	0.40	3.02	3.85	16.67	23.53	0.08	2.55	0.20
3	*Rhizophora apiculata*	16.9					16.9	0.00	0.20	3.07	2.56	8.33	13.97	0.05	3.07	0.14
4	*R. mucronata*	108.9	132.5	167.8		30.9	440.1	0.12	0.80	80.16	78.21	33.33	191.70	0.64	0.45	0.29
5	*Xylocarpus moluccensis*		5.4				5.4	0.00	0.20	0.99	1.28	8.33	10.60	0.04	3.34	0.12
Total								549.0	0.16	2.40	100.00	100.00	100.00	300		1.00
Sapling																
1	*Avicennia marina*				183.4	11.1	194.6	0.12	0.40	50.62	50.00	13.33	113.95	0.38	0.97	0.37
2	*Bruguiera cyllindrica*	8.0	4.1	7.0		4.1	23.2	0.02	0.80	6.05	6.78	26.67	39.49	0.13	2.03	0.27
3	*Excoecaria agallocha*			2.9		4.5	7.3	0.00	0.40	1.91	1.69	13.33	16.93	0.06	2.87	0.16
4	*Rhizophora apiculata*	4.1					4.1	0.00	0.20	1.08	0.85	6.67	8.59	0.03	3.55	0.10
5	*R. mucronata*	43.0	22.6	46.5		34.4	146.5	0.09	0.80	38.11	37.29	26.67	102.07	0.34	1.08	0.37
6	*R. stylosa*	5.7	2.9				8.6	0.01	0.40	2.24	3.39	13.33	18.96	0.06	2.76	0.17
Total								384	0.24	3.00	100.00	100.00	100.00	300		1.44

Do: Dominance, De: Density, Freq: Frequency, DoR: Relative dominance, DeR: Relative density, FR: Relative frequency, NP: Importance value, Pi: Quantitative value of type i

Table 3: Analysis table of importance value and diversity index (H') area 3

		Plot														
Strata	Species name	1	2	3	4	5	Do	De	Frek	DoR	DeR	FR	NP	Pi	lnPi	PilnPi
Tree																
1	*Cassuarina junghuhnii*			45.5	70.7	285.0	401.3	0.1	0.6	74.1	71.4	42.9	188.4	0.6	0.5	0.3
2	*Hibiscus tiliaceus*			31.2			31.2	0.0	0.2	5.8	4.8	14.3	24.8	0.1	2.5	0.2
3	*Rhizophora mucronata*	76.1	22.3				98.4	0.0	0.4	18.2	21.4	28.6	68.2	0.2	1.5	0.3
4	*Terminalia cattapa*				10.5		10.5	0.0	0.2	1.9	2.4	14.3	18.6	0.1	2.8	0.2
Total						541.4	0.1	1.4	100	100.0	100.0	300.0			1.0	
Pole																
1	*Avicennia marina*	19.4			13.4		32.8	0.0	0.4	7.2	4.0	18.2	29.4	0.1	2.3	0.2
2	*Cassuarina junghuhnii*			16.9	15.6	29.3	61.8	0.0	0.6	13.5	6.5	27.3	47.3	0.2	1.8	0.3
3	*Excoecaria agallocha*	101.3					101.3	0.0	0.2	22.2	12.1	9.1	43.4	0.1	1.9	0.3
4	*Hibiscus tiliaceus*		32.2				32.2	0.0	0.2	7.1	4.0	9.1	20.2	0.1	2.7	0.2
5	*Rhizophora mucronata*	103.5	227.4	138.5		146.5	228.0	0.2	0.8	50.0	73.4	36.4	159.8	0.5	0.6	0.3
Total						456.1	0.2	2.2	100	100.0	100.0	300.0			1.3	
Sapling																
1	*Avicennia marina*	11.5			32.2		43.6	0.0	0.4	3.3	3.4	20.0	26.7	0.1	2.4	0.2
2	*Cassuarina junghuhnii*				7.3		7.3	0.0	0.2	0.5	0.5	10.0	11.0	0.0	3.3	0.1
3	*Excoecaria agallocha*	3.8					3.8	0.0	0.2	0.3	0.2	10.0	10.5	0.0	3.4	0.1
4	*Hibiscus tiliaceus*		3.2				3.2	0.0	0.2	0.2	0.2	10.0	10.5	0.0	3.4	0.1
5	*Rhizophora mucronata*	242.0	356.4	249.4	91.7	343.3	1,282.8	0.8	1.0	95.7	95.7	50.0	241.3	0.8	0.2	0.2
Total						1,340.8	0.9	2.0	100	100.0	100.0	300.0				0.7

Do: Dominance, De: Density, Freq: Frequency, DoR: Relative dominance, DeR: Relative density, FR: Relative frequency, NP: Importance value, Pi: Quantitative value of type i

Based on Table 5, the tree level category has a community similarity is 22.73%, the pole level category has a community similarity is 63.05% and the category of sapling level has a community similarity of 46.4%.

Community avifauna (birds) at the study site

Avian community (Avifauna): Based on observations, it shows that the area with the highest species richness is area 1 with 29 species, then area 2 with 25 species and area 3 with 22 species. Wealth of avifauna (birds) species in three regions

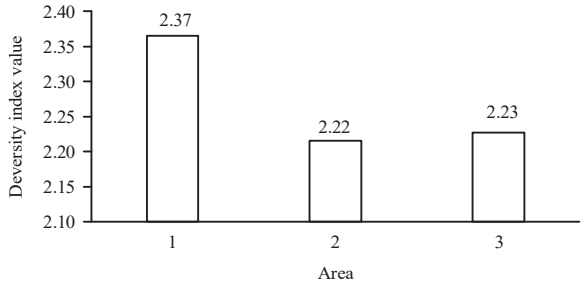

Fig. 3: Diversity index graph in the observation area 1, 2 and 3 (Shannon-Wiener index)

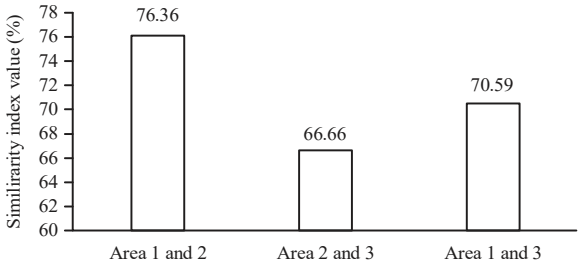

Fig. 4: Comparison of similarity index values in the observation area

is 37 avifauna (birds) species from 17 families, with the percentage of avifauna (birds) present at the observation site as presented in Table 6.

Observations were also made on daily avifauna (birds) bird activities for three consecutive days in the observation area. Daily activities are observed based on the activities of flying, descending, looking for food, looking for food on the ground, perching and making noise as shown in Table 7-9.

The stability of the avifauna (bird) community in an area can be assessed by its diversity index, the higher the value of diversity, the avifauna (birds) community will be more stable. Figure 3 shows the avifauna (birds) diversity index in each observation area.

Based on Fig. 3 shows that area 1 has the highest diversity index compared to the other 2 locations. This is a sign that area 1 has a more stable avifauna (birds) community than other areas. Based on the similarity index for bird communities

Table 4: Diversity index values in area 2 and 3 at each stage level

Parameters	Area 2	Area 3
Tree stage	1.20	1.01
Pole stage	1.07	1.32
Sapling stage	1.44	0.75

Table 5: Community similarities is based on the Sorensen formula

		Important value (NP)		
Stratum	Species name	2	3	S (%)
Tree	*Avicennia marina*	83.12		
	Bruguiera cyllindrica	20.52		22.73
	Excoecaria agallocha	15.35		
	Rhizophora apiculata	19.76		
	Rhizophora mucronata	161.25	68.18	
	Cassuarina equisetifolia		188.40	
	Hibiscus tiliaceus		24.81	
	Terminalia cattapa		18.61	
Total		300.00	300.00	
Pole	*Avicennia marina*	60.20	29.42	
	Cassuarina equisetifolia		47.27	
	Excoecaria agallocha		43.39	
	Hibiscus tiliaceus		20.18	
	Rhizophora mucronata	191.70	195,75	63.05
	Bruguiera cyllindrica	23.53		
	Rhizophora apiculata	13.97		
	Xylocarpus moluccensis	10.60		
Total		300.00	300.00	
Sapling	*Avicennia marina*	113.95	26.69	
	Cassuarina equisetifolia		11.00	
	Excoecaria agallocha	16.93	10.51	
	Hibiscus tiliaceus		10.47	
	Rhizophora mucronata	102.07	241.33	46.42
	Bruguiera cyllindrica	39.49		
	Rhizophora apiculata	8.59		
	Rhizophora stylosa	18.96		
Total		300.00	300.00	

Tree: Tree level is the level of trees, i.e., trees with a diameter of 20 cm and above, Pole: Pole level, the tree young with a diameter of 10 cm up to less than 20 cm, Sapling: Sapling level is the regeneration stage of plants with a height of more than 1.5 m to tillers less than 10 cm in diameter

were determined using Sorensen's calculations. Communities are said to be identical if Sorensen's similarity value reaches more than 60%. Calculations are made to compare the level of similarity between observation areas 1 and 2, observation areas 2 and 3, observation areas 1 and 3. The two areas that have the most identical identity are observation area 1 and observation area 2 as shown in Fig. 4.

Table 6: Percentage and amount of avifauna (birds) species per family in all areas

Family name	Percentage	Amount
Scolopacidae	4	3
Glareolidae	4	3
Columbidae	4	3
Sternidae	4	3
Cuculidae	4	3
Nectariniidae	4	3
Artamidae	4	3
Chloropsidae	4	3
Pycnonotidae	5	4
Hirundinidae	5	4
Meropidae	5	4
Charadriidae	5	4
Silvidae	5	4
Rallidae	5	4
Apodidae	8	6
Alcedinidae	11	8
Ardeidae	19	14
Total	100	76

In this study, avifauna (birds) species were identified based on their conservation status based on Indonesian government regulations, IUCN (The International Union for Conservation of Nature) and CITES (Convention on International Trade in Endangered Species) as shown in Table 10.

DISCUSSION

The observations showed that the composition of plants arranged in three research areas consisted of 73 species of plants which were divided into several categories. The categories with the most successful species were: Herbs (38%), Grass and the like (29%), Trees (14%), Vines (10%), Shrubs (8%) and Ferns (1%). Herbs are composed of various species of weeds that have a very high rate of reproduction both vegetative and generative. Plant species from the grass category have resistance to extreme environmental stresses. Weed species especially grass and the like are able to withstand extreme temperatures. Based on observations, the families with the most species are Poaceae (13 species), Cyperaceae (8 species) and Asteraceae (8 species). The species of Poaceae and Cyperaceae are the main feed of the Ploceidae. Directly the plant species of the Poaceae family are

Table 7: Avifauna (birds) activity was observed in the observation area (Area 1. Muara Reja)

Local name	Family name	Scientific name	Observed activity
Bambangan Kuning	Ardeidae	*Ixobrychus sinensis*	Fly, find food
Blekok Sawah	Ardeidae	*Ardeola speciosa*	Fly, find food
Bondol Haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol Peking	Ploceidae	*Lonchura punctulata*	Fly, find food, nest
Burung Gereja Erasia	Ploceidae	*Passer montanus Lonchura*	Fly, perch, find food
Burung Madu Sriganti	Nectariniidae	*Nectarinia jugularis*	Fly, perch, find food
Cangak Abu	Ardeidae	*Ardea cinerea*	Fly
Cekakak Australia	Alcedinidae	*Todirhamphus sanctus*	Fly, perch, find food
Cekakak Sungai	Alcedinidae	*Todirhamphus chloris*	Fly, perch, find food
Cerek Kalung Kecil	Charadriidae	*Charadrius dubius*	Look for food
Cerek Tilil	Charadriidae	*Charadrius alexandrinus*	Look for food
Cici Padi	Silvidae	*Cisticola juncidis*	Fly, perch, find food
Cipoh Kacat	Chloropsidae	*Aegithina tiphia*	Roost, find food
Cucak Kutilang	Pycnonotidae	*Pycnonotus aurigaster*	Fly, perch, find food
Dara Laut Sayap Putih	Sternidae	*Chlidonias leucopterus*	Fly, find food
Kareo Padi	Rallidae	*Amaurornis phoenicurus*	In the bush looking for food
Kapinis Rumah	Apodidae	*Apus pacificus*	Fly
Kirik-kirik Laut	Meropidae	*Merops philippinus*	Fly
Kokokan Laut	Ardeidae	*Butorides striatus*	Fly, perch, find food
Kuntul Kecil	Ardeidae	*Egretta garzetta*	Fly, perch, find food
Layang-layang Batu	Hirundinidae	*Hirundo tahitica*	Fly, find food on the ground
Layang-layang Loreng	Hirundinidae	*Hirundo striolata*	Fly
Merbah Cerukcuk	Pycnonotidae	*Pycnonotus goiavier*	Fly, perch, find food
Raja Udang Biru	Alcedinidae	*Alcedo coerulescens*	Fly, perch, find food
Remetuk Laut	Silvidae	*Gerygone sulphurea*	Noiseless flying
Tekukur Blasa	Columbidae	*Streptopelia chinensis*	Fly, perch, on the ground foraging
Trinil Pantai	Scolopacidae	*Tringa hypoleucos*	looking for food on the beach
Walet Linchi	Apodidae	*Collocalia linchi*	Fly
Walet Sarang Putih	Apodidae	*Collocalia fusiphaga*	Fly

Table 8: Avifauna (birds) activity was observed in the observation area (Area 2.Tegal Sari)

Local name	Family name	Scientific name	Observed activity
Blekok Sawah	Ardeidae	*Ardeola speciosa*	Fly, find food
Bondol Haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol Peking	Ploceidae	*Lonchura punctulata*	Fly, find food, nest
Burung Gereja erasia	Ploceidae	*Passer montanus*	Fly, perch, find food
Burung Madu Sriganti	Nectariniidae	*Nectarinia jugularis*	Fly, perch, find food
Cangak Besar	Ardeidae	*Ardea alba*	Fly, perch, find food
Cekakak Australia	Alcedinidae	*Todirhamphus sanctus*	Fly, perch, find food
Cekakak Sungai	Alcedinidae	*Todirhamphus chloris*	Fly, perch, find food
Cerek Kalung Kecil	Charadriidae	*Charadrius dubius*	Look for food
Cici Padi	Silvidae	*Cisticola juncidis*	Fly, perch, find food
Cucak Kutilang	Pycnonotidae	*Pycnonotus aurigaster*	Fly, perch, find food
Kareo Padi	Rallidae	*Amaurornis phoenicurus*	Fly
Kokokan Laut	Ardeidae	*Butorides striatus*	Fly
Kowak-malam abu	Ardeidae	*Nycticorax nycticorax*	Fly
Kuntul Kecil	Ardeidae	*Egretta garzetta*	Fly, find food
Layang-layang Batu	Hirundinidae	*Hirundo tahitica*	Fly, find food on the ground
Merbah Cerukcuk	Pycnonotidae	*Pycnonotus goiavier*	Fly, find food on the ground
Raja Udang Biru	Alcedinidae	*Alcedo coerulescens*	Fly, perch, find food
Remetuk Laut	Silvidae	*Gerygone sulphurea*	Noiseless flying
Tekukur Biasa	Columbidae	*Streptopelia chinensis*	Fly, perch, on the ground foraging
Terik Asia	Glareolidae	*Glareola maldivarum*	Noiseless flying
Bambangan Kuning	Ardeidae	*Ixobrychus sinensis*	Fly, perch, find food
Tikusan Merah	Rallidae	*Porzana fusca*	looking for food on the beach
Walet Linchi	Apodidae	*Collocalia linchi*	Fly

Table 9: Avifauna (birds) activity was observed in the observation area (Area 3. Pantai Alam Indah)

Local name	Family name	Scientific name	Observed activity
Bambangan Kuning	Scolopacidae	*Tringa hypoleucos*	Fly, find food
Bondol Haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol Peking	Ploceidae	*Lonchura punctulata*	Fly, find food, nest
Burung Gereja Erasia	Ploceidae	*Passer montanus*	Fly, perch, find food
Cekakak Australia	Alcedinidae	*Todirhamphus sanctus*	Fly, perch, find food
Cekakak Sungai	Alcedinidae	*Todirhamphus chloris*	Fly, perch, find food
Cici Padi	Silvidae	*Cisticola juncidis*	Fly, perch, find food
Cucak Kutilang	Pycnonotidae	*Pycnonotus aurigaster*	Fly, perch, find food
Kekep Babi	Artamidae	*Artamus leucorhynchus*	Fly, perch, find food
Kokokan Laut	Ardeidae	*Butorides striatus*	Fly
Kuntul Kecil	Ardeidae	Egretta garzetta	Fly, perch, find food
Layang-layang Batu	Hirundinidae	*Hirundo tahitica*	Fly
Loreng	Hirundinidae	*Hirundo striolata*	Fly
Merbah Cerukcuk	Pycnonotidae	*Pycnonotus goiavier*	Fly, find food on the ground
Raja Udang Biru	Alcedinidae	*Alcedo coerulescens*	Fly, perch, find food
Meninting	Alcedinidae	*Alcedo meninting*	Fly, perch, find food
Remetuk Laut	Silvidae	*Gerygone sulphurea*	Noiseless flying
Tekukur bIasa	Columbidae	*Streptopelia chinensis*	Fly, perch, foraging
Trinil Pantai	Scolopacidae	*Tringa hypoleucos*	Fly, perch, find food
Walet Linchi	Apodidae	*Collocalia linchi*	Fly
Wiwik Uncuing	Cuculidae	*Cuculus spulcralis*	Noiseless flying

helped by their distribution of birds from the Ploceidae family. This shows the existence of strong mutualism between the two families so that these two species have the number of individuals among the species of other families. While the species of the Asteraceae family are capable of producing seeds reaching 10,000 per fertilization period, with a fertilization period throughout the year with modified seeds that are easily carried by the wind, thus helping to spread widely[20].

The composition of mangrove-making plants in the 3 observation areas has identical mangrove-making plants. Proven 54 species out of a total of 73 plant species are found in all 3 areas, which indicate the 3 areas studied have characteristics that are not much different in terms of plant species composition. In the observation area 2 is included as a mangrove forest with type *Rhizophora mucronata* and *Avicennia marina* as the main constituent. While area 3 is categorized as coastal forest with the Cypress sea

Table 10: Avifauna observation results based on the conversion status of protection

			Conservation status			Population development
Family name	Indonesian name	Scientific name	IPL	IUCN	CITES	IUCN
Ardeidae	Kuntul Kecil	*Egretta garzetta*	Not protected	LC	-	Increasing
Ardeidae	Cangak Abu	*Ardea cinerea*	Not protected	LC	-	Unknown
Ardeidae	Cangak Besar	*Ardea alba*	Protected	LC	-	Unknown
Ardeidae	Kokokan Laut	*Butorides striatus*	Not protected	LC	-	Decreasing
Ardeidae	Blekok Sawah	*Ardeola speciosa*	Not protected	LC	-	Unknown
Ardeidae	Kowak-malam Abu	*Nycticorax nycticorax*	Not protected	LC	-	Decreasing
Ardeidae	Bambangan Kuning	*Ixobrychus sinensis*	Not protected	LC	-	Unknown
Rallidae	Tikusan Merah	*Porzana fusca*	Not protected	LC	-	Decreasing
Rallidae	Kareo Padi	*Amaurornis phoenicurus*	Not protected	LC	-	Unknown
Charadriidae	Cerek-kalung Kecil	*Charadrius dubius*	Not protected	LC	-	Stable
Charadriidae	Cerek Tilil	*Charadrius alexandrinus*	Not protected	LC	-	Decreasing
Scolopacidae	Trinil Pantai	*Tringa hypoleucos*	Not protected	LC	-	Decreasing
Gareolidae	Terik Asia	*Glareola maldivarum*	Protected	LC	-	Decreasing
Sternidae	Dara-laut Sayap-putih	*Chlidonias leucopterus*	Not protected	LC	-	Stable
Columbidae	Tekukur Biasa	*Streptopelia chinensis*	Not protected	LC	-	Increasing
Cuculidae	Wiwik Uncuing	*Cuculus spulcralis*	Not protected	LC	-	Stable
Apodidae	Walet Linci	*Collocalia linchi*	Not protected	LC	-	Decreasing
Apodidae	Kapinis Rumah	*Apus pacificus*	Not protected	LC	-	Increasing
Apodidae	Walet Sarang Putih	*Collocalia fusiphaga*	Not protected	LC	-	Decreasing
Alcedinidae	Meninting	*Alcedo meninting*	Not protected	LC	-	Decreasing
Alcedinidae	Raja-udang Biru	*Alcedo coerulescens*	Not protected	LC	-	Stable
Alcedinidae	Cekakak Sungai	*Todirhamphus chloris*	Not protected	LC	-	Decreasing
Alcedinidae	Cekakak Australia	*Todirhamphus sanctus*	Not protected	LC	-	Increasing
Meropidae	Kirik-kirik Laut	*Merops philippinus*	Not protected	LC	-	Stable
Hirundinidae	Layang-layang Batu	*Hirundo tahitica*	Not protected	LC	-	Unknown
Hirundinidae	Layang-layang Loreng	*Hirundo striolata*	Not protected	LC	-	Stable
Pycnonotidae	Cucak Kutilang	*Pycnonotus aurigaster*	Not protected	LC	-	Decreasing
Pycnonotidae	Merbah Cerukcuk	*Pycnonotus goiavier*	Not protected	LC	-	Increasing
Chloropsidae	Cipoh Kacat	*Aegithina tiphia*	Not protected	LC	-	Unknown
Silvidae	Remetuk Laut	*Gerygone sulphurea*	Not protected	LC	-	Decreasing
Silvidae	Cici Padi	*Cisticola juncidis*	Not protected	LC	-	Increasing
Artamidae	Kekep Babi	*Artamus leucorhynchus*	Not protected	LC	-	Stable
Nectariniidae	Burung-madu Sriganti	*Nectarinia jugularis*	Not protected	LC	-	Stable
Ploceidae	Burung-gereja Erasia	*Passer montanus Lonchura*	Not protected	LC	-	Decreasing
Ploceidae	Bondol Jawa	*leucogastroides*	Not protected	LC	-	Stable
Ploceidae	Bondol Peking	*Lonchura punctulata*	Not protected	LC	-	Stable
Ploceidae	Bondol Haji	*Lonchura maja*	Not protected	LC	-	Stable

Indonesian animal protection law (IAPL)[18,19], IUCN[15], CITES[18], LC: Least concern

(*Casuarina equisetifolia)* which dominates along with the species of shrubs in sandy areas. The important value index of a plant type is a value that describes the role of the existence of a plant species in the community. The greater the importance value indexes of a plant species, the greater the role of the species in the community. Evenness indexes are equally distributed across many species as an indicator of the increasing biodiversity in an ecosystem. The important value index can also be said as a quantitative parameter that can be used to express the level of dominance of species in a plant community. The dominant species in a plant community will have a high importance value index, so the most dominant species naturally has the highest importance value index[11,21]. Important Value Index (IVI) is an index of importance that can be used to express the level of abundance and control of a type of vegetation in its ecosystem, starting from the Relative Frequency (FR), Relative Density (KR) and Relative Dominance (DR)[22,23]. The importance value index (INP) for the compilation of mangrove forest areas in mangrove forest around the port of Tegal is calculated based on the level of vegetation species of trees, poles, saplings and seedlings. The important value of plant species in the mangrove community in area 2 is in the category of trees and pole because it has an important role as a constituent of the mangrove community in the area[21]. This was proven when observing identified the species of birds relatively used these two growth stages to make nests, breed and fulfill their lives. For this reason, further community analysis is carried out in this category. Table 2 shows the documentation of plant species observed in the study area.

In general, each tree species has an important role in the mangrove community, especially in the category of growth of the tree and pole stages[24]. It was proven at the time of observation, species of birds relatively used these two growth stages to support their lives, especially for making nests. For this reason, further community analysis is carried out in this category. Results in the observation area 2 (Tegal sari), the *Rhizophora mucronata* plant has the highest important value index in the tree and pole category, while in the sapling category *Avicennia marina* becomes the type with the highest important value index. Observation results in observation area 3 (Pantai Indah Indah) have different structure and composition, especially in the category of trees when compared to area 2. In general, area 3 is a tourist area with Cypress sea (*Cassuarina equisetifolia*) as the main type of tree stage and several parts of mangrove species (*Rhizophora mucronata*) that still in the category of young plants in the growth. This can be seen with the highest important value index in the tree growth stage owned by Cypress sea (*Cassuarina equisetifolia*), while in the pole and sapling stage growth is owned by *Rhizophora mucronata*. In addition to showing the importance of the type of Cypress sea (*Cassuarina equisetifolia*) in area 3, this data can indicate the direction of community development that leads to the development of the mangrove species in the future namely the dominance of *Rhizophora mucronata*.

Rhizophora mucronata is a type of vegetation that has a high density level, high frequency level and high dominance in other vegetation species so that the presence of *Rhizophora mucronata* species has a very large role in the mangrove forest community in influencing the stability of the ecosystem compared to other vegetation species making up the mangrove forest area. Species with a higher value index of mangrove communities compilers than other species indicate that species have a greater role for the mangrove constituent community. Based on this understanding, *Rhizophora mucronata* at the tree and pole stages and *Avicennia marina* at the pole stage have the most roles in the observation area 2. Direct observation also reinforces this statement with the discovery of various species of the Ardeidae family that nest in the *Rhizophora mucronata* plant in areas 2 and 3 whereas *Avicennia marina* at the sapling level becomes a nest of various species of leucogastroides sp., *Lonchura punctulata* dan *Lonchura maja*. The species of the genus *Rhizophora* and *Avicennia* generally dominate the Indonesian coastal region. This shows the existence of strong mutualism between the two families so that these two species have the most number of individuals among the species of other families[25].

Based on this description, *Rhizophora mucronata* and *Avicennia marina* can form mutual support communities for coastal ecosystems and mangrove areas, even though both observation areas (area 2 and 3) have semi-natural vegetation area and are not legally protected. However, mangroves from the genus *Rhizophora* and *Avicennia* that live in coastal environments can form an ecological system that is interrelated and forms the stability of the community in this study, general description of the current ecological conditions was provided so that the impacts resulting from Tegal port activities can be carried out without damaging the surrounding environment and being sustainable[26]. In general, the condition of mangrove forest compilers in the Tegal harbor and Pantai Indah area has low diversity stability, but at the tree and sapling stage is more diverse as well as the sapling stage. This shows that the pressure on the environment is quite high, which causes only a few plant species to be able to live and dominate the ecosystem[27]. Similarities in area 2 and 3 communities in the tree stage shows that the two areas only scored 22.7%. While at the pole level it reaches 63% and the sapling level reaches 46.4%. This is due to the different species of vegetation in the area studied. In the observation area 2 tends to be an area with mangrove forest type, while area 3 tends to show the type of coastal forest. In addition, the species that dominate in the two areas are clearly different in the tree growth stage and dominated by *Rhizopora mucronata*, while area 3 is dominated by *Cassuarina equisetifolia*. Area 3 is unique in the structure and composition of the vegetation inside. Although area 3 is a coastal forest area in the tree growth stage, the pole and sapling stages in area 3 tend to have a forest type.

The community similarity index illustrates the level of structural similarity and species composition of the stands being compared. The similarity index value ranges from 0-100%, where the higher the value of the index of species similarity indicates the higher the level of similarity of species between the two communities compared can also be interpreted that the higher the index value of the similarity of species[28].

In observation area 2, it tends to be dominated by mangrove forest vegetation, while observation area 3 tends to indicate coastal forest type. So that, there are differences, especially in the tree level growth stage, namely in the observation area 2, the vegetation is dominated by *Rhizophora. mucronata*, while area 3 is dominated by *Cassuarina equisetifolia.* In the observation area 3 it is unique in the structure and composition of the vegetation in it, although area 3 is a coastal forest area at the tree growth

stage but at the pole and sapling stage tends to have a mangrove type. This is a form of human intervention that designs the area in such a way that the development of vegetation in the area. Based on ecological principles, the level of poles in observation areas 2 and 3 has a similarity of >60% so that the 2 areas seen from the pole stands can be said to be identical, while at the level of stakes have a similarity value: 46.4% (S-value <60%), this is due to the presence of *Avicennia marina* which dominates region 2 while in region 3 is dominated by *Rhizophora mucronata.*

The status causes *A. marina* is almost always found in each mangrove ecosystem. Most species are pioneering and opportunistic and are easy to grow back. *Avicennia marina* that is damaged can immediately grow back, thus accelerating the recovery of damaged stands. Dense and numerous breath roots are very effective for capturing and holding the mud and rooting intertwined. This is also a place to find food for various species of flora and fauna among other avifauna (birds), mangrove crabs, snails and fish, resulting in a symbiotic mutualism between organisms[29]. *Rhizophora mucronata* is one type of mangrove that is easy to grow in areas of high tidal inundation or low inundation. *Rhizophora mucronata* is a type of mangrove plant, which is a group of tropical plants that are halophytic or salt tolerant. Mangroves have a special ability to adapt to extreme environmental conditions, such as; stagnant soil conditions, high salinity and unstable soil conditions. Such environmental conditions cause some species of mangroves to develop mechanisms that enable them to actively extract salt from the tissues, while others develop a root breath system to help obtain oxygen for their root systems[30]. Therefore, *Avicennia mari*na and *Rhizophora mucronata* plants usually dominate the plants that make up mangrove communities.

Based on the results of the observations, the richness of avifauna (birds) species in all three areas has been identified as many as 37 species of avifauna (birds) from 18 families. Wealth of the highest to lowest species in a row is area 1 with 29 species, then area 2 with 25 species and area 3 with 22 species. Based on the percentage of the avifauna (bird) family that is most frequently observed is 19% of the Ardeidae family with 7 species of 37 species of avifauna (birds) observed, percentage of data from lowest to highest as Table 7. This shows that mangrove habitat is suitable for the Ardeidae family with the smallest concern status with two birds (avifauna) protected is *Ardea alba* and *Glareola maldivarrum,* both found in the observation[31] area 2. Area 3 has the lowest type of wealth compared to other areas. As mentioned earlier, area 3 has a coastal forest vegetation with a dominance of *Lonchura punctulata* and *Passer montanu.* All species in the 3 areas are Least Concern (IUCN), the only 2 species included in the national protection law are *Ardea alba* and *Glareola maldivarrum* (*Terik Asia*), both species are found in area 2. Based on the Asian Waterbird Census 2008-2015: Results of coordinated counts in Asia and Australasia, it is said there are 98 species of settlers and wanderers of 112000 individuals observed in Indonesia. The details 80 species are categorized as low risk (least concern), 11 species approaching endangered (near threatened), 5 species of endangered and 2 species of vulnerable for 2017, there will be an increase of 142 locations with a total of 103 monitored and wandering waterbirds monitored, including *Glareola maldivarum* and *Ardea alba*. This is due to disturbance in the habitat of both birds due to anthropogenic activity[32]. *Ardea alba* including water birds that have the behavior of flying more often alone or in small groups, tend to be solitary and unusual in the presence of humans[33]. *Glareola maldivarum* is a species of avifauna (birds) from the Glareolidae family of the genus *Glareola*, living in groups, flying to catch insects in the air, resting on the ground, foraging for food mingling with other scaffolds, but separated by flight. This avifauna (birds) is a type of insectivorous worms, worms, invertebrates and has habitats in swamps, rice fields, spread to a height of 500 m above sea level[15].

The impact of the development of the port of Tegal causes the reduction of mangrove vegetation, so that the avifauna (birds) community, especially *Ardea alba* and *Glareola maldivarum* in area 2 becomes increasingly difficult to find, because places to find food, breeding places and places to rest are disturbed, they will leave their habitat if there is an ecological imbalance in their place of life.

Based on calculations using the Sorensen diversity index calculation, it is known that the observation area 1 has the highest diversity value compared to the other two areas. This shows that the region has better avifauna community stability than in the other two regions. This situation is caused because in the observation 1 area, there are no species that is very dominating. The value of diversity is strongly influenced by species abundance if there is one species that dominates can reduce the diversity index numbers. In addition, a higher diversity index value in the observation area 1 is also due to the high species richness compared to other regions the value of diversity is directly proportional to species richness In general, the three regions have diverse values that are not much different. But it cannot be said that the avifauna (bird)

communities in the three regions are identical. Therefore, further analysis of the similarities between avifauna (bird) communities in the area under study was carried out[34].

The value of species diversity is strongly influenced by species abundance, if there is one species that dominates it can reduce the value of the diversity index[35]. The diversity index value in the observation area 1 was higher compared to areas 2 and 3. In general, the three areas had similar diversity values.

The Sorensen similarity index for avifauna (birds) in the observation area is 76% between regions 1 and 2, an index value of 70% between 1 and 3 and an index value of 66% between 2 and 3. The communities are said to be identical if Sorensen's similarity value reaches more than 60%. In all observation areas the percentage of species similarity is above 60%. The highest percentage of similarity in areas 1 and 2.

The avifauna (bird) species similarity index is used to determine the composition that underlies the presence or absence of a relationship between the number of species that are common in the two community areas and the total species. The avifauna (birds) populations living in mangroves in the study area can spread between regions 1, 2 and 3. The species avifauna (birds) can spread from population sources or diversity if the location is no longer able to contain them, so they will find suitable areas for their lives. The greater the percentage of species similarity between regions, the more suitable and will move to the area[36].

Based on the discussion, there is a difference with the plant community that forms the mangrove community which shows a significant difference in the plant category, then the avifauna community in the three areas shows its identicality. This was seen especially in the observation areas 1 and 2 which showed a community similarity index reaching 76% and areas of observation 1 and 3 also showed community similarities reaching 70%, while areas 2 and 3 showed similarities reaching 66%. Based on these data, it can be estimated that area 1 is the most suitable area for the habitat of various avifauna (birds) species in the three areas studied.

Based on the description above, it is possible to move avifauna species from areas 2 and 3 to more ecologically suitable habitats, namely to area 1 (around the Muara Reja Beach area). For this reason, further research is also needed to determine the ability or capacity of area 1 to accommodate avifauna species movements from areas 2 and 3.

CONCLUSION

Special considerations are needed, especially for vegetation and avifauna (bird) species which have important values and roles in the balance of ecosystems in the Tegal port area, especially if development of Tegal port operations and alternative sustain ability of mangrove vegetation and bird communities is to be carried out.

SIGNIFICANCE STATEMENT

This research found the need for good thinking if the expansion and development of the Tegal port would be carried out, especially the sustain ability of the mangrove forest vegetation life and the community of birds that had lived and had adapted to support around the Tegal port. The results of this study are that it can be used as a basis by Tegal port management in making decisions to develop port operations and assist researchers to identify critical areas, especially the importance and diversity of mangrove vegetation and bird communities around the port of Tegal, Central Java, Indonesia.

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