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COMMUNITY STRUCTURE OF WATERBIRDS IN SEVERAL TYPE OF WETLAND UTILIZATION IN EAST COAST OF SURABAYA

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ABSTRACT

Natural wetlands are the natural habitat of waterbirds, but it is very difficult to find an unspoiled wetlands without human intervention curently. East coast of Surabaya is wetlands area in Surabaya that most of the region have change into fishpond and residental. The aims of this reasearch are to determine the community structure of waterbirds in each type of wetland utilization and to determine if the different type of wetland utilization influence the community structure of waterbirds in East Coast of Surabaya. Data were collected during August 2012 to January 2013 with point count method. Six sampling plots have been selected. Six sampling plots representing four types of use of wetlands, which are bozem, the former fishpond, fishpond with vegetation, and fishponds without vegetation (fishpond 1, fishpond 2 and fishpond 3). In bozem recorded 19 species of waterbirds (1107 individual), dominated by shorebirds, with a diversity index (H') 1.86, and evenness index (J') 0.63. In former fishpond recorded 7 species of water birds (168 individual), dominated by rails and moorhen, with H' = 1.12 and J' = 0.57. In fishpond with vegetation recorded 12 species of water birds (137 individual), dominated by large wader, with H' = 1.85 and J' = 0.74. In fishpond 1 recorded 18 species of water birds (299 individual), dominated by terns, with H' = 1.96 and J' = 0.68. In fishpond 2 recorded 9 species of water birds (70 individual), dominated by terns, with H' = 1.73 and J' = 0.79. In fishpond 3 recorded 10 species of water birds (83 individual), dominated by terns, with H' = 1.84 and J' = 0.80. Chi-square test showed that X^2 count is greater than X^2 table with $\alpha < 0.05$, which indicates that there is a significant difference of the number of individuals of each species and the number of individual of each water birds' group for each type of use of wetlands, so it can be concluded that different types of use of wetlands affect water bird community structure in the East Coast Surabaya.

Key words: *community structure, waterbirds, and type of wetland utilization*

INTRODUCTION

Waterbirds have ecological functions that are important for the environment, one of them is carrying nutrients from water to terrestrial areas through veses, legs, or other body parts. The ecological function related to the role of water birds as nutrient cycling agent and contribution in soil formation process (Sekercioglu, 2006).

Most of the waterbirds are the top predator in their environment so the presence of waterbirds affect distribution and the abudance of another biota such as mollusca, crustacean, fish and minnow, etc., (Cintra, 2012). Waterbirds forming food chain cycle and will show some changes in the different component of ecosystem. (Custer and Osbrone, 1997 in Rajashekara and Venkatesha, 2010).

Natural wetland is the natural habitat of waterbirds, therefore the compotition and structure of waterbirds community are greatly influence by the presence of natural wetlands (Howes *et al.*, 2001). But currently, it is difficult to find unspoiled wetlands areas without human intervention (Fraser and Keddy, 2005). Many wetland utilization has changed nowadays. It resulted in shrinkage and degradation of wetland areas that means available habitat of waterbirds will be less.

Surabaya East Coast is a wetland area in Surabaya. Besides there are residental waterbirds that live in it, Surabaya East Coast is also frequently visited by migrating waterbirds. Most of the wetlands in the East Coast of Surabaya has been converted into aquaculture areas, but currently some areas began developed into recreational areas and settlements.

The aims of this study are to determine how the community structure of waterbirds in some different types of use of wetlands and how the effect of different types of use of wetlands for waterbirds community structure in the East Coast of Surabaya.

METHOD

This research was conducted in the East Coast of Surabaya at two location, fishpond areas in Wonorejo and settlements area in Medokan Ayu Tambak. Data collection was carried out during the six-month study, from August 2012 to January 2013.

The recorded data in this study are the number and the name of waterbirds species which perform the activity in each plot (using point count method), and the physical-chemical parameter data from each plot (water depth and salinity).

Bird inventory data that have been collected in this study then processed to obtain the dominance index, diversity index and evenness index. Besides that the data also analyzed using chi-square test and cluster analysis.

RESULT

At each study site (Wonorejo fishpond area and Medokan Ayu Tambak), taken three plots of data collection with different type of wetland utilization. Type of wetland utilization of each data collection plot are presented in Table 1.

Table 1. Type of wetland utilization of each data collection plot in each location

Location	Code of data collection plot	Type of wetland utilization
Wonorejo fishpond area	1	Bozem
	2	Fishpond 1
	3	Fishpond with vegetation
Medokan Ayu Tambak	1	Former fishpond
	2	Fishpond 2
	3	Fishpond 3

Table 2. Number of individuals of each species (ni) and index of abudance (Di) in each type of wetland utilization

	Name of species	Type of Wetland Utilization											
		Bozem		Former fishpond		Fishpond with vegetation		Fishpond without vegetation					
								Fishpond 1		Fishpond 2		Fishpond 3	
		ni	Di (%)	ni	Di (%)	ni	Di (%)	ni	Di (%)	ni	Di (%)	ni	Di (%)
1.	Tringa glareola	8	0,72	0	0	5	3,65	4	1,3	3	4,29	10	12
2.	T.hypoleucos	11	0,99	1	0,6	7	5,11	3	1	5	7,14	3	3,61
3.	T. stagnatilis*	7	0,63	0	0	8	5,84	0	0	0	0	3	3,61
4.	T. cinereus*	0	0	0	0	3	2,19	1	0,33	0	0	0	0
5.	T. totanus*	0	0	0	0	0	0	1	0,33	0	0	0	0
6.	T. nebularia*	0	0	0	0	0	0	3	1	0	0	0	0
7.	Calidris ferruginea*	441	39,8	0	0	0	0	0	0	0	0	13	15,7
8.	C. ruficollis*	164	14,8	0	0	0	0	0	0	0	0	0	0
9.	C. subminuta*	5	0,45	0	0	0	0	0	0	0	0	0	0
10.	Numenius phaeopus*	4	0,36	0	0	0	0	68	22,7	0	0	0	0
11.	Limosa limosa*	0	0	0	0	0	0	7	2,34	0	0	0	0
12.	Charadrius javanicus	76	6,87	0	0	2	1,46	0	0	4	5,71	0	0
13.	C. alexandrinus	59	5,33	0	0	0	0	7	2,34	0	0	0	0
14.	C. dubius*	2	0,18	0	0	0	0	0	0	0	0	0	0
15.	C. mongolus*	22	1,99	0	0	0	0	2	0,67	0	0	0	0
16.	C. hiaticula*	0	0	0	0	6	4,38	0	0	0	0	0	0
17.	C. leschenaultii*	10	0,90	0	0	0	0	0	0	0	0	0	0
18.	Pluvialis fulva*	2	0,18	0	0	1	0,73	0	0	2	2,86	2	2,41
19.	Stiltia Isabella*	3	0,27	0	0	0	0	0	0	0	0	0	0
20.	Butorides striatus	1	0,09	3	1,79	1	0,73	0	0	0	0	0	0
21.	Egretta garzetta	0	0	4	2,38	55	40,2	10	3,34	8	11,4	2	2,41
22.	E. eulophotes	0	0	0	0	15	11	2	0,67	0	0	0	0
23.	E. alba	0	0	1	0,60	0	0	1	0,33	1	1,43	1	1,20
24	Ardeola speciosa	68	6,14	0	0	5	3,65	2	0,67	3	4,29	3	3,61
25	Gallinula chloropus	211	19,1	103	61,3	0	0	0	0	0	0	0	0
26	Amaurornis phoenicurus	0	0	27	16,1	0	0	0	0	0	0	0	0
27	Porzana cinerea	0	0	29	17,3	0	0	0	0	0	0	0	0
28	Galliralus striatus	1	0,09	0	0	0	0	0	0	0	0	0	0
29	Sterna hirundo	0	0	0	0	0	0	63	21	0	0	0	0
30	S.albifrons	0	0	0	0	0	0	89	29,7	29	41,4	28	33,7
31	S. nilotica	0	0	0	0	0	0	9	3,01	0	0	0	0
32	Chlidonias hybridus	0	0	0	0	0	0	26	8,7	15	21,4	18	21,7
33	Himantopus leucocephalus	12	1,08	0	0	29	21,2	0	0	0	0	0	0
34	Alcedo coerulescens	0	0	0	0	0	0	1	0,33	0	0	0	0

Note for table 2

= shorebirds
= large wader
= ratis/moorhen
= stilt
= king fisher
ni = number of individuals
Di = Dominance index (%)
= tern
* = migratory bird

During the process of collecting data from August 2012 to January 2013 recorded 33 species in Wonorejo fishpond area and 12 species in Medokan Ayu Tambak with total species encountered are 34 species. While in each type of use of wetland found the different number of species and individuals of waterbirds which presented in Table 2.

From 34 species that found in all data collection plots during August 2012 until January 2013, *Tringa hypoleucos* or common sandpipers is the only species of waterbirds that found in all sixth data collection plot with the highest abudance in bozem. There are 11 species that found in both location (Wonorejo fishpond area and Medokan Ayu Tambak) i.e., *T. glareola, T. hypoleucos, C. ferruginea, C. javanicus, P. fulva, B. striatus, E. garzetta, E. alba, A. speciosa, G. chloropus, S. albifrons,* and *C. hybridus.* While the only species of waterbirds encountered in Wonorejo fiahpond area are *T. stagnatilis, T. cinereus, T. totanus, T. nebularia, C. ruficollis, C. subminuta, N. phaeopus, L.limosa, C. alexandrines, C. dubius, C. mongolus, C. leschenaultii,C. hiaticula, S. isabella, E. eulophotes, G. striatus, S. hirundo, S. nilotica, H. leucocephalus,* and *A. coerulescens,*and the only species of waterbirds encountered in Medokan Ayu Tambak are *P. cinerea* and *A.phoenicurus*.

Based on the data presented in Table 2, the number of individuals and species encountered in each type of use of wetlands is not equal to one another. Various group of waterbirds that are found in each type of use of wetland was not equal to each other too, as well as species that dominate in each type of use of wetland is also different. The most dominant species in bozem is a species from group of shorebird i.e. *Calidris ferruginea* with the dominance index (Di) 39,8%, while in the former fishpond, the most dominant species is *Gallinula chloropus* from group of rails and moorhen with dominance index (Di) 61,3%. In fishpond with vegetation, the most dominant species is *Egretta garzetta* from wader group with dominance index (Di) 40,2%. For fishpond without vegetation, i.e. fishpond 1, fishpond 2, fishpond 3, dominated by *Sterna albifrons* with the dominance index (Di) respectively are 29,7%; 41,4%; and 33,7%.

Based on the results of non-parametric statistical analysis using chi-square test (results are presented in Table 3), was significantly different between the waterbird community structure of each type of use of wetlands, especially in the number of individuals of each species of waterbirds and the number of individuals of each group of waterbirds. It shows that the habitat conditions required by each species of waterbirds are not the same, so the number and species of waterbirds of each type of use of wetlands is also different.

Table 3. The result of *chi-square* (X^2) test between types of use of wetland with number of individuals of each species and the number of individuals of each group of waterbirds.

Variable	X2	df	Asymp. Sig. (2-side)
Type of use of wetlands and the number of individuals of each species of waterbirds	4062.755a	160	.000
Type of use of wetlands and the number of individuals of each group of waterbirds	2262.527a	25	.000

DISCUSSION

The difference of the most dominant species in each type of wetland utilization can be caused by the level of human intervention and disturbance or availability of the preferred habitat of waterbirds.

Based on the data which presented in Figure 1, appears that there are significant differences between the number of waterbird individu that encountered in bozem compared to the number of waterbird individu in other types of wetland utilization. That result showed that bozem which is an natural artificial wetland that receive low human intervention and distruption preferred by waterbird than other types of wetland utilization. That condition was also influenced by the presence of mangrove vegetation in plot of bozem. According to Froneman et al., (2001), vegetation is one of the important elements that contribute to the structure

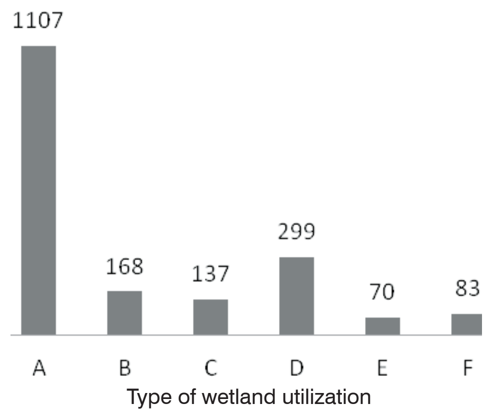

Figure 1. Diagram of overall waterbird individual number in each type of use of wetland in the East Coast of Surabaya (A = bozem; B = former fishpond; C = fishpond with vegetation; D = fishpond 1; E = fishpond 2; F = fishpond 3).

of waterbird communities because vegetation determine the availibility of food in the habitat. The existence of mangrove vegetation in bozem affect the existence of crustaceans and molluscs which are food sources of waterbirds. Based on research by Pratama (2009), crustaceans in this case crabs, found more abundant in mangrove areas than in areas with little or no mangroves, because mangrove litter is a food source for these crustaceans.

In the fishpond, both with vegetation and without vegetation individu of waterbirds tend to be more prevalent when the water in the plot is vacated so that the only remaining stretch of mud (mud flats) with a little puddle of water in some spots, but if the water depth in that plot too in the individual of waterbirds are rarely found. That's because the water depth directly determination the foraging access of waterbirds, it is related to the morphological structure of waterbirds (Collazo et al., 2002; Darnell and Smith, 2004). In these conditions are rare shorebirds group (shorebird) which has a short beak and tarsus, usually only encountered one to five individual of tern which seem to fly and catch fish in the fishpond except in fishponds with vegetation, because amount of vegetation which restrict the foraging area of tern. According to Fujiko et al. (2001) and Bancroft et al. (2002), the high number and density of vegetation may limit the accessibility of wetlands, besides that according to White and Main (2004), the vegetation will limit the activity of waterbirds in foraging and pray detection.

In the fishpond with vegetation, frequently encountered long-legged waterbirds from group of wader bird. This fishpond frequently flooded, therefore long-legged waterbirds are more common because the tarsus of wader birds long enough allowing the birds foraging in the the pond with sufficient water depth (Baker, 1997).

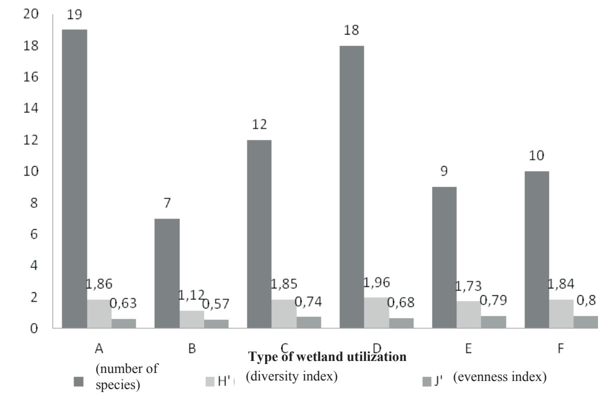

Figure 2. Diagram number of species, diversity index (H'), evenness index (J') number in each type of use of wetland in the East Coast of Surabaya (A = bozem; B = former fishpond; C = fishpond with vegetation; D = fishpond 1; E = fishpond 2; F = fishpond 3).

Based on the diagram in Figure 2 can be seen that the value of diversity index (H') and evenness index (J') in each type of use of wetlands is not much different from one another. Values of diversity and evenness index on six types of use of wetland in the East Coast of Surabaya show the diversity and evenness of each individual species are medium, which means that the spread of the number of individuals of each species and stability of the community are medium (Harjadi et al., 2010) with the evenness of the distribution of individuals of each species are good but not maximum (Soegianto, 1994 and Stiling, 2002).

Although the number of species and number of individuals that found in each of types of wetlands utilization are different but the values of evenness and diversity index of waterbirds from those types of wetland utilization are not much different. This is because there are several species too dominant, thus making the value of diversity index and evenness of each species becomes low.

Based on the results of the chi-square test, a group of water birds that dominate in each type of use of wetlands is not the same. Can be seen in the diagram in Figure 3. In bozem, the most dominant group is shorebird whereas in other types of use of wetlands shorebirds are not too dominant. This is dues to the type of this wetland is rarely observed submerged by water, so it is provides a fairly extensive mudflats (mudflat) which are a favorite foraging place for shorebirds. Mudflats generally consist of silts and clays with a high organic content (Jason and Kidney, 2007). While in the former fishponds, the most dominant group of waterbirds is rail/moorhen. This group of waterbird is also frequently encountered in bozem. It shows that rail/moorhen prefers the type of wetland that get less human intervention in the management of the wetland. Also based on the data obtained, rail/moorhen also like the type of wetland with vegetation which are often used to hide when approached by humans.

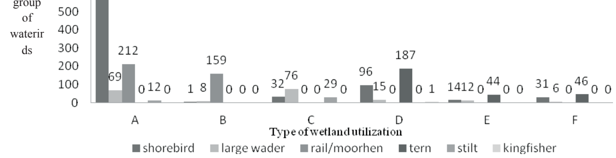

Figure 3. Diagram of the number of individuals of each group of waterbirds in each type of use of wetlands on the East Coast of Surabaya (A = bozem; B = former fishpond; C = fishpond with vegetation; D = fishpond 1; E = fishpond 2; F = fishpond 3).

Unlike bozem and the former fishponds, fishpond with vegetation of grass and several mangrove in the middle of the plot is dominated by large wader or the long-legged bird. These results because the plots are almost always submerged by water during the process of data collection. For the fishpond, in the fishpond 1, fishpond 2 and fishpond 3 are all dominated by terns. This is because the condition during the process of data collection, these plots are often recorded under water until the upper limit, and limit other water birds to foraging in the plot, it is due to the limitations of morphology, especially the tarsus and beak length (Collazo et al., 2002; Darnell and Smith, 2004 and Ma et al., 2009). On August 2012 the water had receded in this plot (post-harvest) so recorded many shorebird species in a large group, but on further observations when the fish farmer fill the plots with water, the number of individuals and species of waterbirds were recorded at this point decreases. When the water in the fishpond receded, a fairly extensive mudflats, which are a fovorite place for shorebirds' foraging activity, available (Helmers, 1992).

Clustering results based on the number of individual waterbirds, the amount of water bird species, diversity index (H'), evenness index (J') and the number of individuals of each waterbirds' group in each type of use of wetland is shown in the dendogram (Fig. 4.). Based dendogram in Fig.4, six observation plots consisting of four types of use of wetlands grouped into two types of land use bozem and other wetlands.

In addition to analyzing the results of an inventory of aquatic birds, in this study also taken the environment variable (salinity and water depth). According to Ma et al. (2009), the water depth directly restrict foraging access of waterbirds, this is due to the limitations of morphology, especially waterbirds' tarsus length. While salinity is also an important factor in the management of wetlands as habitat for waterbirds, because water with high salinity can lead to dehydration on waterbirds, beside that most of the water birds avoid high salinity because the salt water will reduce the resilience of the water in bird feathers.

Based on previous research, each group of waterbirds choose different water depths in foraging activity. In this study, the results are not much different from previous studies, was recorded at a depth of less than 5 cm are often found a small shorebird such as, *T.hypoleucos*, *C.alexandrinus*, *C.javanicus*, and *C.ferruginea*, but when the depth is more than 5 cm, these birds are not found. If the water depth is more than 20 cm, which frequently observed are large wader such as herons, egrets and another long-legged bird. When the depth is more than 25 cm, sometimes still recorded long-legged bird in small amounts (1–2 individual) and frequently encountered terns. Variations in water depth and waterbirds encountered are presented in Figure 5.

In this study, the highest abundance of waterbirds recorded at a salinity of 20‰ to 37‰. Water salinity affect zoobenthos distribution and other aquatic animals that are food sources for waterfowl (Ma et al., 2009). Based on research by Onrizal et al., (2009), crustaceans and molluscs prefers moderate salinity. So the food source of waterbird is more abundant in the types of wetland with moderate salinity range.

Based on the discussion above we can conclude the community structure of waterbirds in each type of wetland utilization in East Coast of Surabaya. In bozem recorded 19 species of waterbirds (1107 individuals), dominated by shorebirds, with a diversity index (H ') of 1.86, and evenness index (J') 0.63; in former fishponds types recorded 7 species (168 individuals), dominated by rails or moorhen, with H ' = 1.12 and J' = 0.57; in ponds with vegetation types recorded

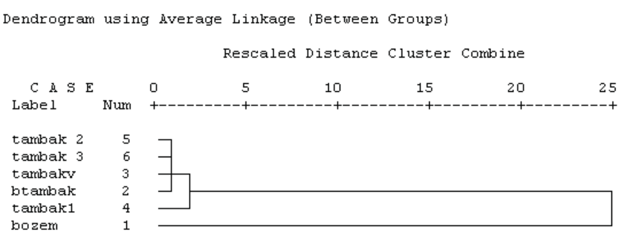

Figure 4. Dendogram, clustering results of the type of use of wetlands based on waterbird community structure (number of species, number of individuals, diversity index (H '), evenness index (J'), and the number of individuals of each group of waterbirds).

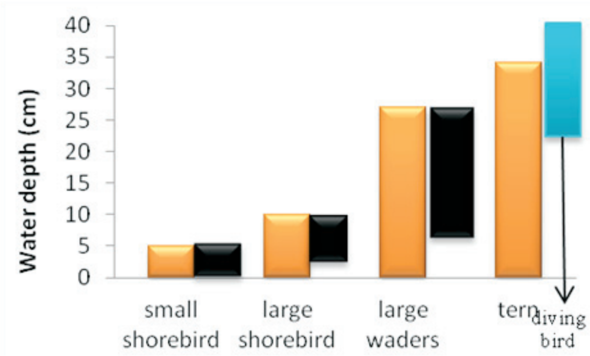

Figure 5. Diagram comparing the observed data (orange bar) and the data by Ma *et al*. (2009) (black bar and blue bar for diving waterbirds which not found during the research), regarding the water depth variations in foraging locations among groups of waterbirds. *Small shorebird* (*Charadrius, sandpipers*); *Large shorebird* (*godwits, stints, whimbrels*, etc); *Large waders* (*egrets* and *herons*); *Tern*; *diving waterbird* (*cormorant* and *grebes*).

12 species of waterbirds (137 individuals), dominated by long-legged waterbirds (large waders), with H' = 1.85 and J' = 0.74; in fishpond 1 recorded 18 species of waterbirds (299 individuals) with H' = 1.96 and J' = 0.68. In fishpond 2 recorded 9 species of waterbirds (70 individuals) with H' = 1.73 and J' = 0.79, and in fishponds 3 recorded 10 species of waterbirds (83 individual) with H' = 1.84 and J' = 0.80, group of waterbirds which dominate in ponds 1, 2 and 3 are a group of terns. Based on the result of *chi-square* analysis, the differences types of use of wetland affect the structure of waterbirds community in the East Coast of Surabaya especially the number of individuals of each species of waterbirds and the number of individuals of each group of waterbirds.

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