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Species Richness And Feeding Guilds Of Bird Communities In The Patuguran-Pasuruan Mangrove Area Estuary

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ABSTRACT

The existence of the Patuguran mangrove estuary area which is currently a great potential in the development of ecotourism can be a threat to the diversity of bird species that exist so that this study was conducted with the aim of knowing the richness of bird species and types of plant-eating bird communities in the Patuguran mangrove area of Pasuruan Regency which is expected that this estuary area is able to support the existence of birds with high diversity. Bird data collection was carried out in October 2024 using the point count method at 2 location points in the estuary area and the middle of the Patuguran Mangrove Area and data analysis using the Margalef species richness index. The results showed that the species richness index (R) value was 4.63 which was included in the high species richness category, while the feeding guild type of the bird community found was 8 species, namely Insectivores (33%), Carnivores and Insectivores (24%), Carnivores (15%), Fragivores (9%), Granivores (9%), Insectivores and Fragivores (3%), Nectivores (3%), and Omnivores (3%).

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1. INTRODUCTION

Estuaries are areas that have many potential sources of high biodiversity. One of the estuaries in Pasuran Regency is the Patuguran Village estuary, Rejoso District. Flora biological resources in the Patuguran estuary in the form of mangrove forests that have provided many benefits to the surrounding community, especially producing processed products from mangroves (Sonneratia caseolaris) [1], [2]. In addition, the Patuguran estuary area, which is dominated by mangrove forests, has been utilized by the surrounding community as an ecotourism site under the name Patuguran Mangrove Ecotourism [3]. Based on research Pratiwi [3], the Patuguran Mangrove Ecotourism area has the suitability and carrying capacity of ecotourism development with the category that is in accordance with its designation but has recommendation requirements including maintaining biota that make mangroves as their habitat, one of which is birds.

Birds are widely distributed across a wide range of landscapes and habitats, from mountainous to coastal and marine areas, and in natural and artificial habitats. The ability of birds to adapt to various environmental changes in estuaries that are vulnerable to environmental change, makes them an indicator of habitat development that can detect ecosystem changes [4]. The

Patuguran mangrove area has an abundance of food sources for birds, and birds also have diverse feeding guild characteristics. So that if there is a threat to the Patuguran mangrove ecosystem, it will have an impact on the existence of birds that use food resources in the area. Feeding guilds are groupings of species that use the same resources in the same way [5], [6], [7], [8]. Small fishes and invertebrates eaten by birds can be used as biological indicators of environmental disturbance by assessing bird responses based on their characteristics. Therefore, this study was conducted with the aim of analyzing the species richness of bird communities and their feeding guilds in the Patuguran mangrove area, so that it is hoped that bird food sources will always be sustainably available in the Patuguran mangrove area to maintain its diversity in the future.

2. METHOD

This research was conducted in October 2024 in the estuary area of Patuguran village, Rejoso District, Pasuruan Regency. The location of data collection was carried out at 2 points, namely Estuary of Patuguran Mangrove Area (KMP 1) and the middle of the Patuguran Mangrove Area (KMP2) (Figure 1 and Table 1). Bird data collection was conducted in the morning (07.00-10.00 WIB) and afternoon (14.00-16.00 WIB) using Nikon Monarch 5 binoculars with 10x42 magnification. Bird observations were conducted using the point count technique. The point count method is a method that is carried out by standing at an observation point, then recording all birds seen and heard within a radius of ± 50 meters for a period of 10 to 20 minutes [5], [9], [10]. At each location, observations were made for 30 minutes using an identification book by MacKinnon et al [11].

Table 1. Coordinates of Bird Data Collection Location Points in the Patuguran Mangrove area

No	Code	Name of Location Point	Coordinate
1	KMP1	Estuary of Patuguran Mangrove Area	7°37'24.87"S; 112°57'32.12"E
2	KMP2	The middle of Patuguran Mangrove Area	7°37'30.85"S; 112°57'31.19"E

Figure 1. Estuary Map of Patuguran Mangrove Area, Rejoso District, Pasuruan Regency

Data collection on bird feeding guilds was carried out by direct observation at the site and using literature studies based on MacKinnon [11] or other relevant [12]. Feeding guild type categories were divided into 6 independent feeding guild types: Insectivore, Carnivore, Frugivore, Granivore, Nectarivore, Omnivore [6]. Feeding guild types can also be developed for groups of birds that differ in the way they consume certain nutrients, such as insectivores and carnivores. The definition of feeding guilds is based on the bird's choice of food type, rather than the bird's niche or habitat, so birds from different habitats can belong to the same feeding guild.

Calculation analysis was carried out for the value of Shannon Wiener species diversity index (H'), Evennes evenness index (E), Dominance Index (C) and species richness index (R) [13].

The formula for the Shannon Wiener species diversity index (H') is as follows:

$$H' = -\sum Pi \ln Pi \text{ dan } Pi = \sum \frac{ni}{N} \quad \text{.....(1)}$$

Description
H' = species diversity index;
Pi = abundance value;
ni = number of individuals of the species; and
N = number of all species [14].
The categories of Shannon Wiener species diversity index (H') are low species diversity (0<H'≤1), medium diversity (1<H'≤3), and high diversity (H'>3) [5].

The formula for Evennes' evenness index (E) is as follows:

$$E = \frac{H'}{\ln s} \quad \text{.....(2)}$$

Description
E = evenness index,
S = number of bird species per location [9].
The categories of evenness index values based on Krebs (1978) are low species evenness (0<E≤0.4), medium species evenness (0.4<E≤0.6), and high species evenness (E>0.6).

The formula for the dominance index (C) is as follows:

$$C = \sum \left(\frac{ni}{N}\right)^2 \quad \text{.....(3)}$$

Description
C= dominance index;
ni = number of the i-th species;
N = total of all individuals.
Categories of dominance index values based on Krebs (1978) are low species dominance (0<C≤0.5), medium species dominance (0.5<C≤0.75), and high species dominance (0.75<C≤1).

The formula for Margalef's species richness index (R) is as follows:

$$R = \frac{(s-1)}{\ln N} \quad \text{.....(4)}$$

Description
R = species richness value; and
N = number of all species.
Categories of species richness index values based on Tuhumury reasearch [14] are low species richness (0<R≤2.5), medium species richness (2.5<R≤4.0), and high species richness (R>4.0) [13], [15].

3. RESULTS AND DISCUSSION

It is known that the estuary area and the middle area of the Patuguran Mangrove Area (KMP1 and KMP2) have 328 individual birds consisting of 33 species and the results of the correlation determinant R Square between total species and total individuals are 100% correlated. This means that if the total species increases, the total individuals will also increase (Figure 2). The 33 bird species were divided into 22 families and 11 orders (Table 2). The species with the highest number of individuals were seen in Cave Swiftlet (*Collocalia linchi*) with 67 individuals, Javan Pond Heron (*Ardeola speciosa*) with 50 individuals, Little Egret (*Egretta garzetta*) with 49 individuals, and Common Sandpiper (*Actitis hypoleucos*) with 30 individuals. Mangrove forest areas located in estuarine areas such as the Patuguran mangrove area, have very prominent tidal dynamics, so that at certain periods of time, for example at low tide, more birds are seen utilizing visible substrates to walk on them by looking for food in the form of invertebrates [16]. This is done by most shorebirds including Little Egret (*Egretta garzetta*) and Common Sandpiper (*Actitis hypoleucos*).

Based on Table 3, the calculation of Shannon wiener diversity index (H') obtained an average value of 2.47 (H'_{KMP1} = 2.60 and H'_{KMP2} = 2.34), so that it is included in the medium diversity category (1<H<3), this is supported by the average value of the dominance index (C) of 0.13 (C_{KMP1} = 0.11 and C_{KMP2} = 0.16) which means that in the bird community in the Patuguran mangrove area there is no dominating species. The average value of Evennes' evenness index (E) was also obtained as follows 0.77 (E_{KMP1} = 0.78 and E_{KMP2} = 0.77) which shows that the diversity of species in the Patuguran mangrove area is relatively high (E>0.6) while the results of the calculation of the species richness index Margalef (R) has an average value of 4.63 (R_{KMP1} = 5.03 and R_{KMP2} = 4.22) which means that bird species richness in the Patuguran mangrove area is included in the high category.

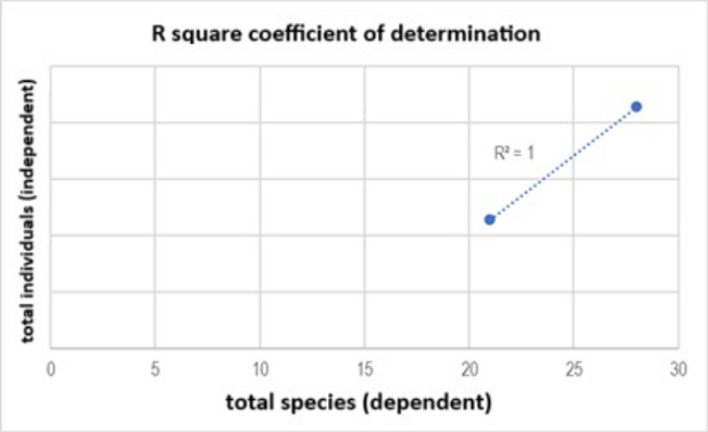

Figure 2. Coefficient of Determination R Square Total Bird Species with Total Bird Individuals

Tabel 2. Species composition of bird communities in Patuguran mangrove area, Pasuruan

No	Species name	Indonesian Name	English Name	KMP1	KMP2
				ni	
1	*Acridotheres javanicus*	Kerak Kerbau	*white-vented myna*	1	0
2	*Actitis hypoleucos*	Trinil Pantai	*Common sandpiper*	28	2
3	*Aegithina tiphia*	Cipoh Kacat	*Common iora*	1	0
4	*Aerodramus maximus*	Walet sarang hitam	*Black-nest Swiftlet*	4	0
5	*Alcedo meninting*	Raja udang meninting	*Blue-eared kingfisher*	2	2
6	*Amaurornis phoenicurus*	Kareo Padi	*White-breasted waterhen*	2	3
7	*Ardea alba*	Kuntul Besar	*The great egret*	16	4
8	*Ardea cinerea*	Cangak abu	*Grey Heron*	2	2
9	*Ardea purpurea*	Cangak Merah	*The purple heron*	1	0
10	*Ardeola speciosa*	Blekok Sawah	*Javan pond heron*	19	31
11	*Artamus leucorynchus*	Kekep Babi	*White-breasted woodswallow*	0	1
12	*Butorides striata*	Kokokan laut	*Green-backed Heron*	2	0
13	*Cacomantis sonneratii*	Wiwik lurik	*Banded bay cuckoo*	0	1
14	*Centropus bengalensis*	Bubut Alang-alang	*Lesser Coucal*	5	0
15	*Collocalia linchi*	Walet Linci	*Cave Swiftlet*	39	28
16	*Dendrocopos macei*	Caladi Ulam	*Fulvous-breasted Woodpecker*	2	1
17	*Dicaeum trochileum*	Cabai Jawa	*Scarlet-headed flowerpecker*	4	12
18	*Egretta garzetta*	Kuntul Kecil	*Little Egret*	43	6
19	*Geopelia striata*	Perkutut Jawa	*Javanese Turtledove*	4	0
20	*Gerygone sulphurea*	Remetuk Laut	*Golden-bellied Gerygone*	1	2
21	*Lonchura leucogastroides*	Bondol Jawa	*Javan munia*	4	3
22	*Merops leschenaulti*	Kirik-kirik Senja	*Chestnut-headed Bee-eater*	0	1
23	*Nectarinia jugularis*	Burung Madu Sriganti	*Olive-backed sunbird*	0	2
24	*Numenius arquata*	Gajahan Erasia	*Eurasian Curlew*	1	0
25	*Nycticorax nycticorax*	Kowak Malam Abu	*Black-crowned Night-heron*	1	0
26	*Passer montanus*	Gereja Eurasia	*Eurasian tree sparrow*	5	0
27	*Pericrocotus miniatus*	Sepah gunung	*Sunda Minivet*	1	0
28	*Prinia inornata*	Perenjak padi	*Plain prinia*	3	4
29	*Pycnonotus aurigaster*	Cucak Kutilang	*Sooty-headed bulbul*	0	3
30	*Pycnonotus goiavier*	Merbah Cerucuk	*Yellow-vented bulbul*	3	1
31	*Sterna hirundo*	Dara Laut Biasa	*Common Tern*	6	0
32	*Sternula albifrons*	Dara laut kecil	*Little Tern*	12	3
33	*Todiramphus chloris*	Cekakak Sungai	*Collared kingfisher*	2	2
			Total number of individuals	**214**	**114**
			Total number of species	**28**	**21**

The H' value of bird species in the Patuguran mangrove area which falls into the medium category, may occur due to the influence of the composition of mangroves that make up the ecosystem [13] and the periodization of tides [17]. Bird communities that have moderate to high diversity tend to be more stable without the dominance of certain bird species due to the distribution

and diversity of mangrove vegetation species. The diversity of mangrove vegetation species in Patuguran consists of Rhizopora mucronata, Avicennia alba, Sonneratia alba and Sonneratia caseolaris), thus supporting food sources, shelter, nursery ground and bird reproductive behavior that can reduce competition for limited resources [5]. This evenness of bird species can also mean that each habitat niche in the Patuguran mangrove area has the same ability to meet the needs of birds [18]. The high value of the Margalef richness index (R) (average R = 4.63) can be influenced by the presence of human activities in the Patuguran mangrove area which is not a threat to bird species, so that birds are able to coexist with the community around the Patuguran mangrove area without feeling disturbed.

From the bird species composition in Patuguran mangrove area, it is known that there are 8 types of feeding guilds of the birds found, namely Insectivore =33%; Carnivore and Insectivore =24%; Carnivore =15%; Frugivore =9%; Granivore =9%; Insectivore and Frugivore =3%; Nectarivore =3%; and Omnivore =3%. The most common type of bird feeding guild is the Insectivore type with 11 species, namely Javan Myna (*Acridotheres javanicus*), Common Iora (*Aegithina tiphia*), Black-nest Swiftlet (*Aerodramus maximus*), White-breasted Woodswallow (*Artamus leucorynchus*), Lesser Coucal (*Centropus bengalensis*), Cave Swiftlet (*Collocalia linchi*), Fulvous-breasted Woodpecker (*Dendrocopos macei*), Golden-bellied Gerygone (*Gerygone sulphurea*), Chestnut-headed Bee-eater (*Merops leschenaulti*), Sunda Minivet (*Pericrocotus miniatus*), and Plain Prinia (*Prinia inornata*).

Table 3. The results of the calculation of the ecological index value of the bird community in the Patuguran mangrove area, Pasuruan

No	Location	C	H'	E	Total number of species	Total number of individuals	R
1	KMP1	0.11	2.60	0.78	28	214	5.03
2	KMP2	0.16	2.34	0.77	21	114	4.22

Insectivore feeding guilds are birds that feed on insects, including caterpillars. Small insects commonly found in mangrove estuaries tend to be found in mangrove root hollows or on trees. Birds with this type of feeding guild prefer to feed on insects in open areas and bushes, including above the surface of the estuary substrate at low tide [12]. Based on Fuadi's research [5] states that the rabbit swallow is a type of insectivore bird that has a wide range of food resources in the presence of tree vegetation [9], [19].

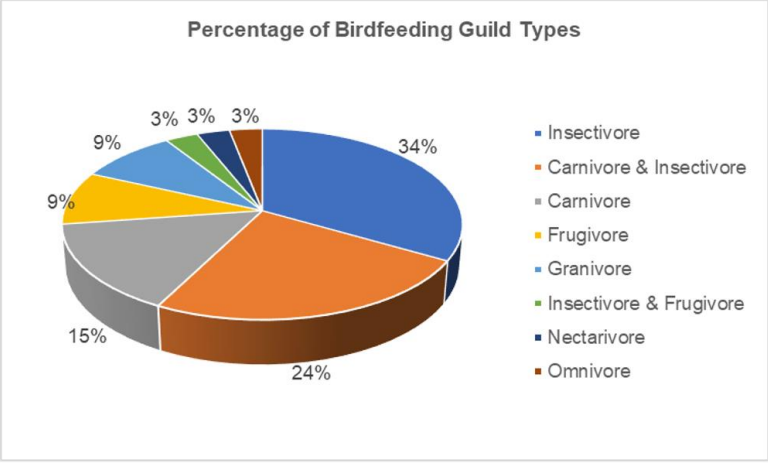

Figure 3. Percentage of Bird Feeding Guild Types Found in Patuguran Mangrove Area, Pasuruan

Carnivore insectivore feeding guilds tend to consist of waterbirds that have long and strong beak morphology, short tails, and long and strong legs. This is why many birds with this type of feeding guild are found in the Patuguran mangrove area. Estuaries that are affected by tides and are included in wetland ecosystems have abundant insect and small fish resources [12]. There are 8 species that have carnivore insectivore feeding guild types, namely Common Sandpiper (*Actitis hypoleucos*), Great White Egret (*Ardea alba*), The purple heron (*Ardea purpurea*), Javan Pond Heron (*Ardeola speciosa*), Little Egret (*Egretta garzetta*), Eurasian Curlew (*Numenius arquata*), Black-crowned Night Heron (*Nycticorax nycticorax*), and Little Tern (*Sternula albifrons*).

Carnivore (meat-eating) bird feeding guild type in Patuguran mangrove area was found as many as 5 species, including Blue-eared Kingfisher (*Alcedo meninting*), Grey Heron (*Ardea cinerea*), Green-backed Heron (*Butorides striata*), Common Tern (*Sterna hirundo*), and Collared Kingfisher (*Todiramphus chloris*). Birds belonging to this type of feeding guild are generally birds of prey that like to eat meat from vertebrates (small mammals, amphibians, reptiles, and fellow birds) so that their food sources can be lizards, frogs and others. It is also characterized by a strong, hooked beak and large, strong claws.

Frugivore (fruit-eating) birds tend to have short beak morphology. Three species of birds of this type were found in the Patuguran mangrove area, namely Scarlet-headed Flowerpecker (*Dicaeum trochileum*), Sooty-headed Bulbul (*Pycnonotus aurigaster*), and Yellow-vented Bulbul (*Pycnonotus goiavier*). These three bird species favor small and soft fruits such as oranges or bananas [5]. Food sources in the form of small fruits are generally located in mangrove areas associated with fruits produced by shrub vegetation.

Granivore (grain-eating) feeding guild type in Patuguran mangrove area was found as many as 3 species, namely Zebra Dove (*Geopelia striata*), Javan Munia (*Lonchura leucogastroides*), and Eurasian Tree Sparrow (*Passer montanus*). Birds belonging to this type generally have a strong, hard and short beak morphology because it functions in crushing coarse and hard grains. Food sources in the form of seeds are found in the area of seedling vegetation around the Patuguran mangrove estuary [12].

The bird species, each totaling 1 species, are divided into 3 types of feeding guilds including Insectivore and Frugivore (insect and fruit eater) Banded Bay Cuckoo (*Cacomantis sonneratii*), Nectarivore (nectar eater), Olive-backed Sunbird (*Nectarinia jugularis*), and Omnivore (all eater), White-breasted Waterhen (*Amaurornis phoenicurus*). The Insectivore and Frugivore (insect and fruit-eating) feeding guild types are unique in that these birds use insect resources as their main food, but if insects are caged, they will eat fruits instead of their main food. In contrast, the Nectarivore (nectar-eating) feeding guild type specializes in nectar as its main food source. Generally, these nectar birds have a morphology that is very different from other bird types, namely having a long beak. Omnivores (all-eaters) have a wide range of food resources as they are able to eat anything that is edible. The large number of birds with different types of feeding guilds in the Patuguran mangrove area indicates that the availability of food resources in the Patuguran mangrove area is still abundant. This is in accordance with research conducted at Way Canguk Research Station, Bukit Barisan Selatan National Park [20], there were 115 bird species grouped into seven types of feeding guilds, with a dominance in the Insectivora guild which reached 55.65% of the total species. This suggests that the availability of food resources, especially insects, is still abundant in the area [21]. On the other hand, research in the savanna ecosystem of the Elephant Training Center of Way Kambas National Park found 30 bird species divided into six types of guilds, with the Insectivora guild also dominating (40%) [22]. This indicates that although the habitat is different, the availability of food resources in the savanna is also good enough to support bird diversity [19]. Furthermore, in DKI Jakarta's green open spaces, 162 bird species were found with the Insectivora guild as the most numerous (22.22%). This study shows that despite being in an urban environment, the availability of food resources still plays an important role in supporting bird diversity [6]. From this comparison, it can be concluded that both in the Patuguran mangrove area and in other locations such as savannas and urban green spaces, the presence of various bird feeding guilds indicates the abundance of food resources that support bird species diversity.

4. CONCLUSION

Bird species richness in the Patuguran Mangrove Area is categorized as high. (R_{KMP1}=5.03 dan R_{KMP2}= 4.22), which consists of 11 orders, 22 families and 33 species. The value of the Shannon Wiener bird diversity index (H') was 2.47 (moderate diversity), the dominance index value (C) was 0.13 (no dominance), and the uniformity index value (E) was 0.77 (high uniformity). Bird diversity in the Patuguran Mangrove Area is divided into 8 types of feeding guilds, namely Insectivore (33%); Carnivore and Insectivore (24%); Carnivore (15%); Frugivore (9%); Granivore (9%); Insectivore and Frugivore (3%); Nectarivore (3%); and Omnivore (3%).

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