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An Inventory of Mangrove Forest Bird to Develop Ecotourism in Manggar River, Balikpapan City, Indonesia

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Abstract: Birdwatching is one of the popular activities for sustainable tourism in the mangrove ecosystem. An inventory has been carried out to record the composition and abundance of bird communities in the Manggar River. The birds were studied using the boat survey method along the Manggar River for ± 17 km. We have divided the study area into two segments, namely segment 1 (downstream to midstream) and segment 2 (midstream to upstream). A total of 29 species of birds were identified in the mangrove forest of Manggar River. Segment 2 had a higher bird species composition than segment 1. The relative abundance of birds in segment 1 was categorized into two “common” and eight species of “frequent”.There were no species included in the “abundant” category in segment 1. Furthermore, we found one species of“abundant”, three species of“common”, and 16 species of“frequent” in segment 2. Several species were commonly and easily observed in both segments, e.g*Egrettagarzetta*, *Ixobrychuseurhythmus*, *Todiramphuschloris,* and *Collocaliaesculenta.* Bird species in the Manggar River can be integrated with other biodiversity uniqueness to support other ecotourism development strategies.

Keywords: bird communities, birdwatching, ecotourism, mangrove, Balikpapan.

印度尼西亚巴厘巴板市芒加河开发生态旅游的红树林鸟类清单

摘要：观鸟是红树林生态系统可持续旅游的热门活动之一。已进行清点以记录芒加河鸟类群落的组成和丰度。使用船调查法沿芒加河对鸟类进行了±17公里的研究。我们将研究区域分为两个部分，即第1段（下游到中游）和第2段（中游到上游）。芒加河红树林共鉴定鸟类29种。第2区的鸟类物种组成高于第1区。第1区鸟类的相对丰度分为“常见”2种和“频繁”8种。第1区“丰富”类别中没有任何物种。此外，我们在第2部分发现了1种“丰富”、3种“常见”和16种“常见”。在这两个部分中发现了几种常见且容易观察到的物种，例如白鹭、木犀草节律、地兰和山茱萸.芒加河中的鸟类物种可以与其他生物多样性的独特性相结合，以支持其他生态旅游发展战略。

关键词：鸟类社区、观鸟、生态旅游、红树林、巴厘巴板.

1. Introduction

Mangrove forests in Indonesia's Archipelago are equal to 19.5% of the world's total area of mangrove forests [1]. Mangrove is an important habitat for bird communities in the Indo-Malayan region. This area provides an optional habitat for the bird population, which has strong interaction with the wetland. Eaton et al. [2] stated 1456bird species live in Indonesian

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Archipelago. Some of the species are migrants who visit mangrove forests during winter, and some are mangrove specialists [2], [3]. The existence of the mangrove birds mostly influenced by landscape heterogeneity and the structure of vegetation [4], [5].

Currently, bird populations globally have been declining due to habitat loss [6]. Though, the bird community is a good bioindicator to observe the changes in the mangrove forest. Birds also benefit from ecotourism by providing more activities, such as bird watching. Birdwatching has a higher market value, and it can still be improved [7]. It provides an incentive to the economic growth of the local community. From the conservation perspective, ecotourism also might be the alternative for mangrove management. It brings economic benefits without causing disturbance to the ecosystem.

Some studies of bird communities in the mangrove forest have been performed in Southeast Asia [2], [4], [5], [8]. Most of them aimed to understand ecological behavior and its interaction. A study on bird communities in the Balikpapan mangrove forests was also conducted before, but it was limited in the west part of Balikpapan [9]. The birds in the east part of Balikpapan, i.e., Manggar River, have not been completely observed. Additionally, Manggar River is a unique mangrove area. It is a mangrove riverine type that still exists amid the urban city of Balikpapan. Moreover, the knowledge of bird richness and biodiversity can be used as an object for developing ecotourism.

Variations in environmental conditions along the Manggar River can influence the species composition. By understanding this phenomenon, the suitable locations for birdwatching will be easier to determine. Thus, the objective of this research was to investigate the mangrove bird communities of mangrove forests as an effort to support ecotourism in Manggar River, Balikpapan City. The results of this study are expected to be useful for local guides and tourists in conducting birdwatching activities. Hopefully, it also could be used by stakeholders in developing better strategies for ecotourism.

2. Materials and Methods

Data collection was carried out along the Manggar Riverin November 2020 (Fig. 1). The river has a total length of ± 20 Km. The estuary part is bordered by the Makassar Strait, while the upstream part is bordered by the Manggar Reservoir (ManggarRiver Protected Forest). Land use downstream was dominated by settlements and fishing ports. At the same time, many fishponds and agricultural farms existed in the middle to the upstream. Some fragments of secondary forest were also bordering the upstream.

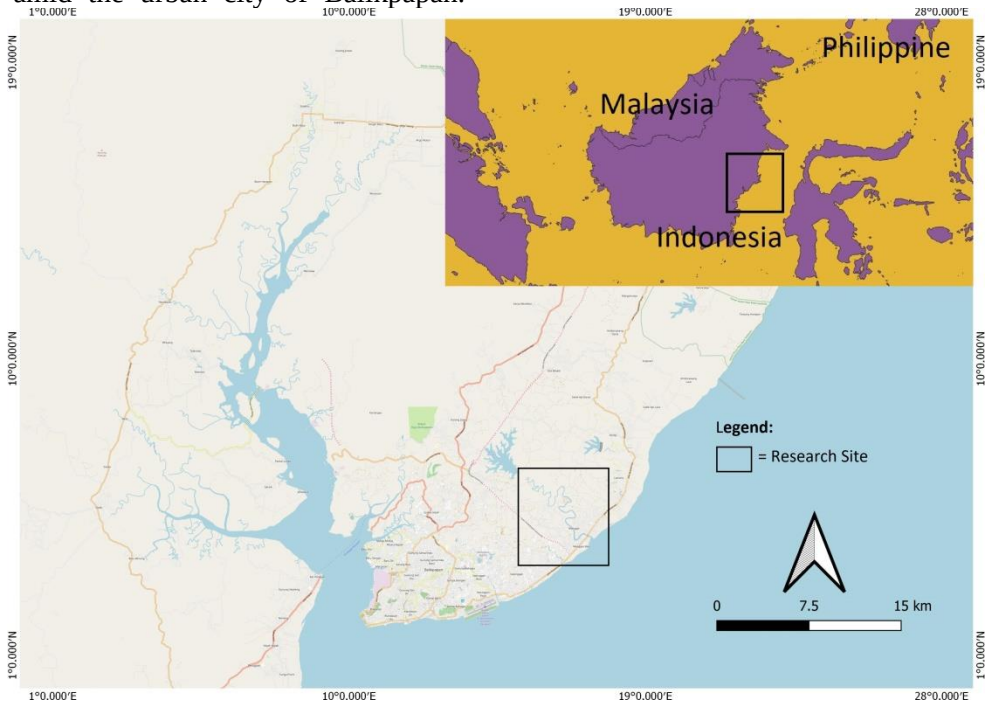

Fig. 1 Map of research site

Inventory of bird species was recorded using the boat survey method [10]. The observation was arranged throughout the river for ± 17 Km, start from the estuary to the upstream. The observation area is divided into two segments based on the mangrove vegetation structure. Segment 1 was from the river mouth to the middle of the river. The dominant plants were *Sonneratiaalba*, *Rhizophoramucronata*, and *Rhizophoraapiculata*. Segment 2 was from mid to upstream. This area was dominated by *Rhizophoramucronata*, *Rhizophoraapiculata*, and *Nypafruticans*. Getting to the upstream, *Nypafruticans* became the dominant and homogeneous mangrove plant species. Field observation was conducted in the morning and afternoon. The occurrence of birds in each segment was recorded, and total count was employed

to census the bird. Species identification was carried out by referring to Phillips and Phillips [11].

Data analysis was performed by tabulating the identified species according to their scientific name, family, and conservation status. Sorensen Similarity Index (IS) was computed to determine the similarity level in each segment. Furthermore, the relative abundance level was obtained by a simple abundance calculation based on the criteria used by Lowen et al. [12].

Table 1 Abundance categories based on the level of bird encounter

No	Number of individuals per 100 hours of observation	Value	Abundance categories
1	< 0.1	1	Rare
2	0.1-2.0	2	Uncommon
3	2.1-10.0	3	Frequent
4	10.1-40.0	4	Common
5	41.0 +	5	Abundant

3. Result

A total of 29 bird species had been observed in the Manggar River (Table 2). They were categorized into 27 genera and 15 families. Family Alcedinidae and Ardeidae were dominant with the highest number of bird species. Segment 2 recorded more bird species (28 species) compared to segment 1 (16 species). Yet, we found that 15 bird species existed in both segments.

Furthermore, the Sorensen Similarity Index (IS) between these segments was 68.18%. From their conservation status, there were 6 protected species under Indonesian conservation law. *Ichthyophagaichthyaetus* and *Haliasturindus* were listed in CITES as Appendix II.

Table 2 List of bird species in the Manggar River mangrove forest

				Segment		Conservation Status	
						IUCN	CITES
No	Family	Scientific Name	Common Name	1	2		
1	Accipitridae	*Ichthyophagaichthyaetus*	Grey-Headed Fish-Eagle*	-	+	NT	App II
2	Accipitridae	*Haliasturindus*	Brahminy Kite*	+	-	LC	App II
3	Alcedinidae	*Pelargopsiscapensis*	Stork-billed Kingfisher	+	+	LC	
4	Alcedinidae	*Ceyxerithaca*	Oriental Dwarf Kingfisher	+	+	LC	
5	Alcedinidae	*Alcedomeninting*	Blue-eared Kingfisher	+	+	LC	
6	Alcedinidae	*Todiramphuschloris*	Collared Kingfisher	+	+	LC	
7	Alcedinidae	*Halcyon coromanda*	Ruddy Kingfisher	-	+	LC	
8	Anatidae	*Dendrocygnaarcuata*	Wandering Whistling-duck	-	+	LC	
9	Anhingadae	*Anhinga melanogaster*	Oriental Darter*	-	+	NT	
10	Apodidae	*Apusnipalensis*	House Swift	+	+	LC	
11	Apodidae	*Collocaliaesculenta*	Glossy Swiftlet	+	+	LC	
12	Ardeidae	*Ixobrychuseurhythmus*	Schrenk's Bittern*	+	+	LC	
13	Ardeidae	*Egrettagarzetta*	Little Egret	+	+	LC	
14	Ardeidae	*Ardeaintermedia*	Intermedia Egret	-	+	LC	
15	Ardeidae	*Egretta sacra*	Pacific Reef-egret	-	+	LC	
16	Ardeidae	*Butoridesstriata*	Green-backerd Heron	-	+	LC	
17	Ardeidae	*Ardeapurpurea*	Purple Heron	-	+	LC	
18	Charadriidae	*Vanelluscinereus*	Grey-headed Lapwing*	+	+	LC	
19	Cisticolidae	*Orthotomusruficeps*	Ashy Tailorbird	+	+	LC	
20	Columbidae	*Treronvernans*	Pink-necked Green-pigeon	+	+	LC	
21	Columbidae	*Geopeliastriata*	Zebra Dove	+	+	LC	
22	Corvidae	*Corvusenca*	Slender-billed Crow	+	+	LC	
23	Cuculidae	*Centropussinensis*	Greater Coucal	-	+	LC	
24	Dicaedae	*Dicaeumtrigonostigma*	Orange-bellied Flowerpecker	-	+	LC	
25	Dicaedae	*Dicaeumcruentatum*	Scarlet-backed Flowerpecker	-	+	LC	
26	Laridae	*Chlidoniashybrida*	Whiskered Tern*	-	+	LC	
27	Pycnonotidae	*Pycnonotusgoiavier*	Yellow-vented Bulbul	+	+	LC	
28	Pycnonotidae	*Brachypodiusatriceps*	Black-headed Bulbul	-	+	LC	
29	Rhipiduridae	*Rhipidurajavanica*	Sunda Pied Fantail*	+	+	LC	

* Protected bird under Indonesian law in PermenLHK No.P106/2018; (+) = present; (-) = absent; LC = Least Concern; NT = Near Threatened

Most bird species around the Manggar River mangrove forest are easy to observe (Table 3). It showed that ecotourism and birdwatching activities would be easy to do along the Manggar River. *Egrettagarzetta* is the most common bird species in the mangrove forest. This species was categorized as frequent (Segment 1) and abundant (Segment 2).

Table 3 Abundance categories of birds

No.	Abundance Category	Percentage (%)	Species
	Segment 1		
1	Rare	0.00	-
2	Uncommon	37.50	*Ceyxerithaca, Alcedomeninting, Todiramphuschloris, Geosperliastriata, Corvusenca, Rhipidurajavanica*

3	Frequent	50.00	*Pelargopsiscapensis, Haliasturindus, Apusnipalensis, Egrettagarzetta, Vanelluscinereus, Orthotomusruficeps, Treronvernans, Pycnonotusgoiavier*
4	Common	12.50	*Collocaliaesculenta, Ixobrychuseurhythmus*
5	Abundant	0.00	-
	Segment 2		
1	Rare	0.00	-
2	Uncommon	28.57	*Ceyxerithaca, Halcyon coromanda, Anhinga melanogaster, Ardeapurpurea, Corvusenca, Centropussinensis, Dicaeumtrigonostigma, Dicaeumcruentatum*
3	Frequent	57.14	*Pelargopsiscapensis, Alcedomeninting, Ichthyophagaichthyaetus, Dendrocygnaarcuata, Apusnipalensis, Ardeaintermedia, Egretta sacra, Butoridesstriata, Vanelluscinereus, Orthotomusruficeps, Treronvernans Geosperliastriata, Pycnonotusgoiavier, Brachypodiusatriceps, Rhipidurajavanica, Chlidoniashybrida*
4	Common	10.71	*Collocaliaesculenta, Ixobrychuseurhythmus, Todiramphuschloris*
5	Abundant	3.57	*Egrettagarzetta*

We found 15 bird species were waterbirds. It equals 51.72% of the total recorded bird species. They were predominantly from the Alcedinidae, Anatidae, Anhingadae, Ardeidae, Charadriidae, and Laridae families. These birds are feed on aquatic biotas, such as fish, shrimp, crab, and other crustaceans. In addition, there are 2 species of eagles (Accipitridae) that were seen foraging around the mangrove forest.

4. Discussion

Avifauna along the mangrove forests of the Manggar River was never studied before because this area was outside the conservation area. Therefore, monitoring of its biodiversity has never been considered an important issue. Along with ecotourism development in the Manggar River, birdwatching was considered an attractive activity. Compared to the KariangauMangrove Forest, which is located in the western part of Balikpapan, bird species composition in the ManggarRiver was not much different [9]. However, this study specifically found that waterbirds in the Manggar River occupied a broader mangrove forest area than Kariangau. Several studies in other mangrove forest ecotourism areas in Indonesia found the number of bird species varied. Mardiastuti [13] reported that the number of waterbird species on PulauRambut, Jakarta, was recorded as 15 species. In comparison, Ginantra et al. [14] found 39 bird species (waterbird and terrestrial) in the mangrove forests of Buleleng, Bali Island.

The bird species composition in a mangrove forest varies depending on various environmental factors, such as landscape heterogeneity and vegetation structure [4], [5]. It is also in line with the results of this study. The dominance of mangrove vegetation has a clear difference between the downstream (Segment 1) and upstream (Segment 2). It was the result of differences in salinity that affect the adaptability of mangrove trees. Another factor that affects the bird communities in the Manggar River was human activities. Segment 1 tended to be more affected by human activities such as settlements and fishponds. Habitat connectivity also benefits the birds in segment 2 because it creates a wider variety of microhabitats. The upstream of Manggar River is still connected to the terrestrial forest (Manggar River Protection Forest).

Egrettagarzetta is a waterbird species that can be found along the Manggar River. This species is classified as "abundant" in segment 2 and "frequent" in segment 1. This finding was in line with another report states that this species has an increasing trend in Europe [15]. This unique species is always found in large groups foraging in the fishpond area or sometimes roosting in mangrove trees. According to Pang et al. [16], *E. garzetta* has a high habitat preference in fishponds as the main feeding ground. It also has a very extensive distribution globally, especially in wetland areas in Africa, Europe, Asia, and Australia [11], [15]. Its population in several mangrove forests has become an attractive attraction for birdwatching [8], [14]. Another species found in both segments, *Collocaliaesculenta*, was classified as a "common" category. This species is the sallying insectivore which is always found foraging in groups in the air. It has a wide distribution with high abundance in various other coastal forests [17], [18], [19]. But, it does not always depend on the presence of mangrove ecosystems [11].

Another bird species with a common category in the two observation segments is *Ixobrychuseurhythmus. Todiramphuschloris* was also "common" in segment 2, while in segment 1, it was categorized as "uncommon". The different levels of habitat suitability between the two segments strongly induced the appearance of both species. *Ixobrychuseurhythmus* and *Todiramphuschloris* have a solitary behavior along the Manggar River. Both of them were mostly found carrying out foraging activities amid the roots of mangrove forests. Todiramphuschloris is a mangrove-dependent bird species [3]. It is sensitive to changes in the size of the mangrove forest area. Therefore, it was more difficult to encounter this bird in segment 1 amidst high human activity. However, *Todiramphuschloris*was easily noticed by its loud voice than *Ixobrychuseurhythmus*.

The high abundance of Ixobrychuseurhythmus in the Manggar River was intriguing because its population is decreasing in many places.

Some of the protected bird species were "uncommon", e.g., *Anhinga melanogaster* and *Ichthyophagaichthyaetus*. Both were only seen in segment 2, which was quite a remote area. *Anhinga melanogaster*, a large bird, requires adequate vegetation for foraging and nesting activities. It is registered as Near Threatened (NT) species in the IUCN Red List. Its encounter becomes rare in several places in Asia [5], [8], [20]. *Anhinga melanogaster* was only sighted once when it perched on a mangrove tree.

Meanwhile, *Ichthyophagaichthyaetus* was a type of predatory bird that occupied the upstream of the Manggar River. It was often sighted perching on a dead mangrove tree branch. This eagle's habitat never overlaps with other eagle species (*Haliasturindus*), only observed in segment 1.

The terrestrial bird species usually utilize the mangrove forest of the Manggar River only for roosting or stepping stones. These birds come from terrestrial forests and plantation areas around the mangrove ecosystem. However, some species naturally had overlapping habitats and utilized mangrove forests as a feeding ground, e.g., *Rhipidurajavanica*, *Dicaeumtrigonostigma*, *Orthotomusruficeps*, and *Treronvernans*. As an example, *Rhipidurajavanica* and *Orthotomusruficeps* were more frequently observed hunting insects in the mangrove roots. While *Dicaeumtrigonostigma* preferred to suck the nectar of mangrove plants. According to Iswandaru et al. [5], terrestrial birds in mangrove forests were dominated by generalist insectivores with a clear differentiation niche. More understanding of the feeding behavior of terrestrial birds and waterbirds will improve birdwatching activities.

The data of bird species provides basic information for the develop ecotourism in Balikpapan. We suggested that the birds be promoted as beautiful objects for birdwatching in the Manggar River. Visitors can observe the dominant waterbirds, e.g., *Egrettagarzetta*, *Todiramphuschloris*, *Ixobrychuseurhythmus*, *Pelargopsiscapensis*, *Alcedomeninting*, *Haliasturindus*, and *Butoridesstriata*. Different compositions of birds in two segments will also provide a different experience for the tourists. It corresponds with the purpose of the ecotourism trip, which increases new experiences and knowledge and responsibility for the environment [21]. By performing further study on the behavior, birds with the "uncommon" category, e.g., *Anhinga melanogaster*, *Ceyxerithaca*, *Alcedomeninting*, *Ardeapurpurea*, and *Halcyon coromanda*, could also be interesting objects for ecotourism. The result will inform the ideal time and spot for observing those species.

Considering the location, segment 2 can be the best observation area for birdwatching. The area has the highest composition and abundance of bird species. The activity should use an inflatable catamaran boat. This boat type is suitable for doing maneuver the upstream without disturbing the birds' behavior. Visitors can also explore some of the streams in the upstream part of the river to enjoy more experience. Mangrove roots, tall trees, and dead trees are some of the observation points that visitors need to pay attention to during birdwatching. The list of bird species with their pictures in this study can be compiled into a booklet as a practical guide for observations.

The ecotourism with the bird as an object could be integrated with the diversity of mangrove vegetation and other wildlife. The Manggar River is reportedly the last habitat in the eastern coastal area of Balikpapan for Borneo's endemic primates, Probosci's monkey (*Nasalislarvatus*) [22]. This fact will provide added value for the marketing of the Manggar River ecotourism. A branding strategy can emphasize the uniqueness of this ecosystem to attract more visitors. Wildlife-based ecotourism is an addition to existing tourism, i.e., boat tours, canoeing, fishing, and local cuisine.

5. Conclusion

The mangrove forest of ManggarRiver was a habitat for 29 species of birds. The waterbird group dominates them. The existence of the bird communities could be explored as an interesting object of ecotourism. It could be integrated with another potential biodiversity. Monitoring of bird population is advisable to maintain the sustainability of ecotourism. It is also to understand how the bird community responds to ecotourism activities. Studies on the bird's behavior that are categorized as an "uncommon" category could improve the ecotourism strategies of Manggar River.

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