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The Diversity of Birds in Mangrove Forest at Biosite Pangpang Bay, Ijen Geopark

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Abstract

The Biosite Pangpang Bay Ijen Geopark (BPBIG) has a high potential biodiversity value outside the conservation area, particularly in the mangrove forest. However, this information is still incomplete. Therefore, the aim of this study is to determine the diversity of bird species in the BPBIG mangrove forest. The research was conducted in October 2023 using the point count method at six observation sites in the mangrove forest. Data analysis was carried out in two approaches, i.e., species composition and species diversity index using the Shannon Wiener index (H'). We recorded 39 bird species, consisting of 32 genera and 21 families, in the mangrove forest of BPBIG. One bird species has important conservation status based on the IUCN Red List and National Regulation, namely *Leptoptilos javanicus* (a vulnerable and protected species). Furthermore, there are also three migratory birds (*Todirhamphus sanctus, Numenius phaeopus*, and *Actitis hypoleucos*) that use the mangrove forest of BPBIG as stopover sites during migration periods. The results of the Shannon Wiener index showed that the bird diversity in the BPBIG mangrove ecosystem is in the medium category (H' = 2.02). Finally, based on these results, it can be concluded that the bird species in the mangrove forest of BPBIG are quite diverse, and it is shown that this forest has become a supporting habitat for birds.

Keywords: bird, diversity, mangrove forest, Biosite Pangpang Bay

Introduction

Pangpang Bay is an essential ecosystem area located on eastern Java Island, Indonesia. This wetland ecosystem is one of six biological sites (biosites) under the management of Ijen Geopark. The Biosite Pangpang Bay Ijen Geopark (BPBIG) has a high biodiversity value outside the conservation area and a tight correlation with existing geological processes (Geopark Ijen, 2023). Geographically, this biosite is located at the eastern tip of Java Island, bordering the Bali Strait and Alas Purwo National Park. Based on geomorphology, Geopark Ijen (2023) revealed this biosite is formed of karst hills by north-south fault lines and is downstream of rivers flowing from the Ijen Volcano complex. The BPBIG has a total water area of ±3000 ha (Ariyanto et al., 2020) , which is surrounded by mangrove forest covering ±571.68 ha (Hapsari & Permatasari, 2020). This mangrove forest has several functions, such as a barrier to coastal abrasion, carbon storage, and providing habitat for wildlife (Carugati et al., 2018; Biswas & Biswas, 2019; Dinilhuda et al., 2020).

Mangrove forests are essential habitats for bird communities. It is used by several birds to support ecological activities such as foraging, socializing, sheltering, breeding, and laying nests (Roshnath & Sinu, 2017; Oracion et al., 2022). In addition, the existence of birds in the ecosystem plays an important role as a component in the energy flow system, particularly in the food chain (Stratford & Sekercioglu, 2015; Maurice et al., 2020). Birds have ecological functions as primary, secondary, and tertiary consumers in the energy flows (Stratford & Sekercioglu, 2015). Furthermore, several birds have a high sensitivity to environmental change, so it can also be used as an indicator of biodiversity assessment and ecosystem change (Gregory et al., 2003; Alexandrino et al., 2016). Therefore, the diversity of bird species in mangrove forests is very important to determine and also needs to be reported periodically.

Scientific information related to bird diversity in the mangrove forest of BPBIG is still limited. A previous study revealed that there were 11 bird species recorded in this area (Rodiana et al., 2019). However, it is suspected that there are still several bird species that have not been recorded in the previous study, especially in those inner mangrove forest areas. Exploration of bird species in this area is urgently needed because it can be used as an

indicator of mangrove forest quality. In other words, the study of bird diversity can reveal the complexity of mangrove forests in the BPBIG area from the perspective of animal ecology. Therefore, it is necessary to research the diversity of bird species in the mangrove forest of BPBIG. These results will be completing or updating the biodiversity database, which can support Ijen Geopark programs such as education, conservation, and ecotourism based on birdwatching or avitourism.

Materials and Methods

Study sites

The research was conducted in October 2023 in the mangrove forest of BPBIG (Figure 1). This mangrove area is located in Wringinputih, Banyuwangi District, East Java Province, Indonesia. Data collection was used point count method (Bibby et al., 2000) in six observation point (TP) including TP 1 (8°27'12.79"S - 114°21'0.99"E), TP 2 (8°27'19.99"S - 114°21'9.12"E), TP 3 (8°27'21.73"S - 114°21'11.22"E), TP 4 (8°28'17.70"S - 114°21'38.75"E), TP 5 (8°28'44.00"S - 114°22'16.10"E), and TP 6 (8°29'36.54"S - 114°21'36.24"E). Point count is a commonly used method of birdwatching that involves observing a specific point or sites for a set duration of time.

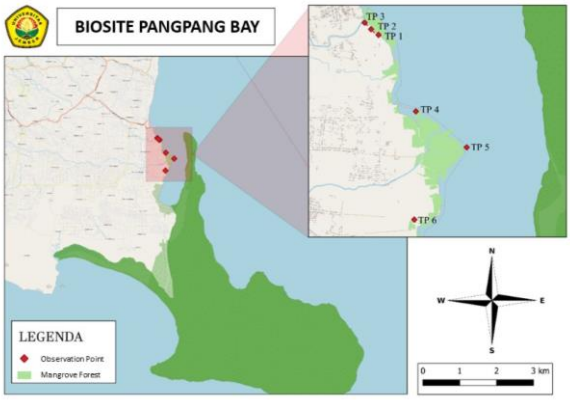

Figure 1. Study area in the mangrove forest of BPBIG

Bird Observation

Bird observation was carried out at several observation points with three observers. The observation was carried out in the morning (05.30–09.00 AM) considering the ecological activities of birds (Thunhikorn et al., 2016; Siddiq et al., 2023). There are two approaches for detecting birds in each observation point, i.e., sighting, and sound recording. Sighting observation using a Canon Eos 60D DSLR camera, telephoto lens 300 mm, and Nikon Aculon 10×50 binoculars, while sound recording using the BirdNET application (https://birdnet.cornell.edu/). The observation duration in each observation point is 20 minutes with 10 minutes of interval time for moving to the next TP. Data were collected on three consecutive days. Ecological data were observed, including bird species and their abundance. Identification of bird species based on morphology characters was used by the guideline book "Buku Lapangan Burung-burung di Indonesia Sunda Besar: Sumatra, Kalimantan, Jawa, Bali (Taufiqurrahman et al., 2022). Furthermore, identification based on sound recordings was used on the website of the Xeno-Canto Foundation and Naturalis Biodiversity Center (https://xeno-canto.org/).

Data analysis

Data analysis was carried out in two approaches, i.e., species composition and species diversity index. The species composition includes species taxonomy and seasonality (Taufiqurrahman et al., 2022), and also conservation status which refers to The International Union for Conservation of Nature's (IUCN) Red List of Threatened Species (https://www.iucnredlist.org/), Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (https://cites.org/eng), Indonesian Regulation (P.106 /MENLHK /SETJEN /KUM.1/12/2018). Furthermore, bird species diversity was analyzed by the Shannon-Wiener diversity index (H') (Magurran, 1988) with the following formula:

$$H' = -\sum (pi \ln pi)$$

Note:
H' = Species diversity index
Pi = ni/N
N = The total individual number of all species
ni = The total individual number of species-i

Results and Discussion

We recorded 39 bird species, consisting of 32 genera and 21 families in the mangrove forest of BPBIG (Table 2). It is suspected that this mangrove forest provides bird resources such as food, socializing areas, and nesting areas. This is also complementary information to the previous study, which found only 11 species in this area (Rodiana et al., 2019). The species richness in the mangrove forest of BPBIG is higher than the mangrove forest

of Kelagian Besar Island, Lampung, with 27 bird species (Nugraha et al., 2021) and Kapo-kapo Bay, Cubadak Island, West Sumatra, with 32 species (Novarino et al., 2023).

Family Ardeidae had the highest species richness (seven species), including *Ar. speciosa, A. alba, A. intermedia, B. ibis, E. sacra, E. garzetta,* and *N. nycticorax*. This is related to the availability of food sources for Ardeidae groups. The mangrove forest of BPBIG, which is a wetland area, is a habitat for crustaceans, gastropods, insects, and small fish, which are food sources for the Ardeidae groups. Previous reports reveal that there are 19 species of Gastropoda in the mangrove forest at Jatipapak Block of Pangpang Bay (Susanti et al., 2021). MacKinnon et al (2010) revealed that Ardeidae groups prefer aquatic invertebrate food sources such as crustaceans, gastropods, and vertebrates such as small fish. In the Jatibarang landfill in Semarang, Ardeidae members (*B. ibis*) were foraging for the food of insects (Fadila et al., 2020) . Furthermore, among the Ardeidae species, *N. nycticorax* is suspected to belong to the migrant category. This species is a migratory bird, and some are resident in several places in Indonesia (Taufiqurrahman et al., 2022). In the BPBIG mangrove forest, this species was found in large groups (20–30 individuals) and was also recorded breeding in the upper canopy of mangroves. Therefore, the seasonality status of this species in the mangrove forest of BPBIG needs to be proven with further study.

According to the IUCN red list conservation status, 38 least-concerned birds and one vulnerable bird (*L. javanicus*) were found. This status is due to the declining population, which is thought to be due to *L. javanicus* having a high level of poaching and loss of nesting habitat (BirdLife International, 2017). The least-concerned category can be expected to have a global population that continues to increase and has a wide distribution. Meanwhile, based on CITES conservation status, all of the bird species found in the mangrove forest of BPBIG are classified in the non-appendix category, which means that globally, the bird group is still undetermined. Finally, based on the national regulation (No. P. 106 of 2018), there are four bird species that are protected, including *R. javanica, A. alba, L. javanicus,* and *N. phaeopus*. This protection status was established because some of these species are threatened to be traded as pets, so these species are protected in Indonesia. Based on these three conservation statuses, it shows that the mangrove forest of BPBIG is an essential habitat for several birds with important conservation statuses, including *L. javanicus, R. javanica, A. alba,* and *N. phaeopus*. (Figure 2).

The results of the Shannon Wiener index showed that the bird diversity in the BPBIG mangrove ecosystem is in the medium category (H' = 2.02). It can be influenced by the species richness and abundance of each species found in this area (Magurran, 1988). These results are similar to those in the Mangrove Forest of Yenanas Village, Raja Ampat Regency (medium category with H'=2.17) and in Mangrove Area Mangunharjo Semarang (medium category with H'=2.81). This comparison shows that bird diversity in mangrove forests is indeed average in the medium category, despite the fact that there are also those with low or high diversity. This diversity value is also influenced by environmental factors that support birds in mangrove forests, such as the availability of food diversity. The mangrove forest of BPBIG may provide food sources for birds such as fruit, seeds, nectar, insects, zoobenthos, and small fish. Food diversity in an ecosystem provides food preference for bird communities, both forest birds and water birds (Green & Elmberg, 2014; Tapp & Webb, 2015; De Dios Arcos et al., 2020; Liordos & Kontsiotis, 2020).

The abundance of birds found in the mangrove forest of BPBIG varies from one to 188 individuals per species. The lowest abundance of birds can be caused by the solitary behaviour of bird species. The sacred kingfisher (*T. sanctus*) is one of the birds with the lowest number of individuals (1 individual observed). This species is a migratory bird that is native to Australia and migrates to Indonesia by occupying mangrove forests as stopover sites (MacKinnon et al., 2010; Taufiqurrahman et al., 2022). In addition, the mangrove forest is also used as a resting and feeding area for forest birds around the ecosystem, such as the families Riphiduridae, Pycnonotidae, Picidae, Nectariniidae, Locustellidae, Laniidae, Estrildidae, Dicaeidae, Cuculidae, Columbidae, Cisticolidae, Campephagidae, Caprimulgidae, Camphepagidae, and Aegithinidae. This is due to

mangrove ecosystems functioning as edge habitat providers for birds (Nagelkerken et al., 2008).

Table 1. The composition of bird species in the mangrove forest at BPBIG. Abbreviation as follows: Least Concern (LC), Vulnerable (VU), Not Appendix (NA), National Status (NS), Protected (PR), Not Protected (NP), Resident (R), Migrant (M)

Family	Species	Common Name	Conservation Status			Seasonality
			IUCN	NS	CITES	
Acanthizidae	*Gerygone sulphurea*	Golden-bellied Gerygone	LC	NP	NA	R
Alcedinidae	*Halcyon cyanoventris*	Javan Kingfisher	LC	NP	NA	R
	Todirhamphus sanctus	Sacred Kingfisher	LC	NP	NA	M
	Todirhamphus chloris	Collared Kingfisher	LC	NP	NA	R
	Alcedo coerulescens	Cerulean Kingfisher	LC	NP	NA	R
	Alcedo meninting	Blue-eared Kingfisher	LC	NP	NA	R
Apodidae	*Collocalia linchi*	Cave Swiftlet	LC	NP	NA	R
Ardeidae	*Ardeola speciosa*	Javan Pond-heron	LC	NP	NA	R
	Ardea alba	Great Egret	LC	PR	NA	R
	Ardea intermedia	Intermedia Egret	LC	NP	NA	R
	Bubulcus ibis	Cattle Egret	LC	NP	NA	R
	Egretta sacra	Pacific Reef-egret	LC	NP	NA	R
	Egretta garzetta	Little Egret	LC	NP	NA	R
	Nycticorax nycticorax	Black-crowned Night heron	LC	NP	NA	R
Aegithinidae	*Aegithina tiphia*	Common lora	LC	NP	NA	R
Campephagidae	*Lalage nigra*	Pied Triller	LC	NP	NA	R
Caprimulgidae	*Caprimulgus affinis*	Savanna Nigthjar	LC	NP	NA	R
Ciconiidae	*Leptoptilos javanicus*	Lesser Adjutant	VU	PR	NA	R
Cisticolidae	*Orthotomus ruficeps*	Ashy Tailorbird	LC	NP	NA	R
	Orthotomus sutoris	Common Tailorbird	LC	NP	NA	R
Columbidae	*Geopelia striata*	Zebra Dove	LC	NP	NA	R
	Spilopelia chinensis	Eastern Spotted Dove	LC	NP	NA	R
	Streptopelia bitorquata	Sunda Collared-dove	LC	NP	NA	R
	Treron griseicauda	Grey-cheeked Green-pigeon	LC	NP	NA	R
Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	LC	NP	NA	R
Dicaeidae	*Dicaeum trochileum*	Scarlet-headed Flowerpecker	LC	NP	NA	R
Estrildidae	*Lonchura leucogastroides*	Javan Munia	LC	NP	NA	R
	Lonchura punctulata	Scaly-breasted Munia	LC	NP	NA	R
Laniidae	*Lanius schach*	Long-tailed Shrike	LC	NP	NA	R
Locustellidae	*Megalurus palustris*	Striated Grassbird	LC	NP	NA	R
Muscicapidae	*Cyornis rufigastra*	Mangrove Blue-flycather	LC	NP	NA	R
Nectariniidae	*Anthreptes malacensis*	Brown-throated Sunbird	LC	NP	NA	R
	Cinnyris jugularis	Olive-backed Sunbird	LC	NP	NA	R
Picidae	*Picoides moluccensis*	Sunda Pygmy Woodpecker	LC	NP	NA	R
Pycnonotidae	*Pycnonotus aurigaster*	Sooty-headed Bulbul	LC	NP	NA	R
	Pycnonotus goiavier	Yellow-vented Bulbul	LC	NP	NA	R
Riphiduridae	*Rhipidura javanica*	Sunda Pied Fantail	LC	PR	NA	R
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	LC	NP	NA	M
	Numenius phaeopus	Whimbrel	LC	PR	NA	M

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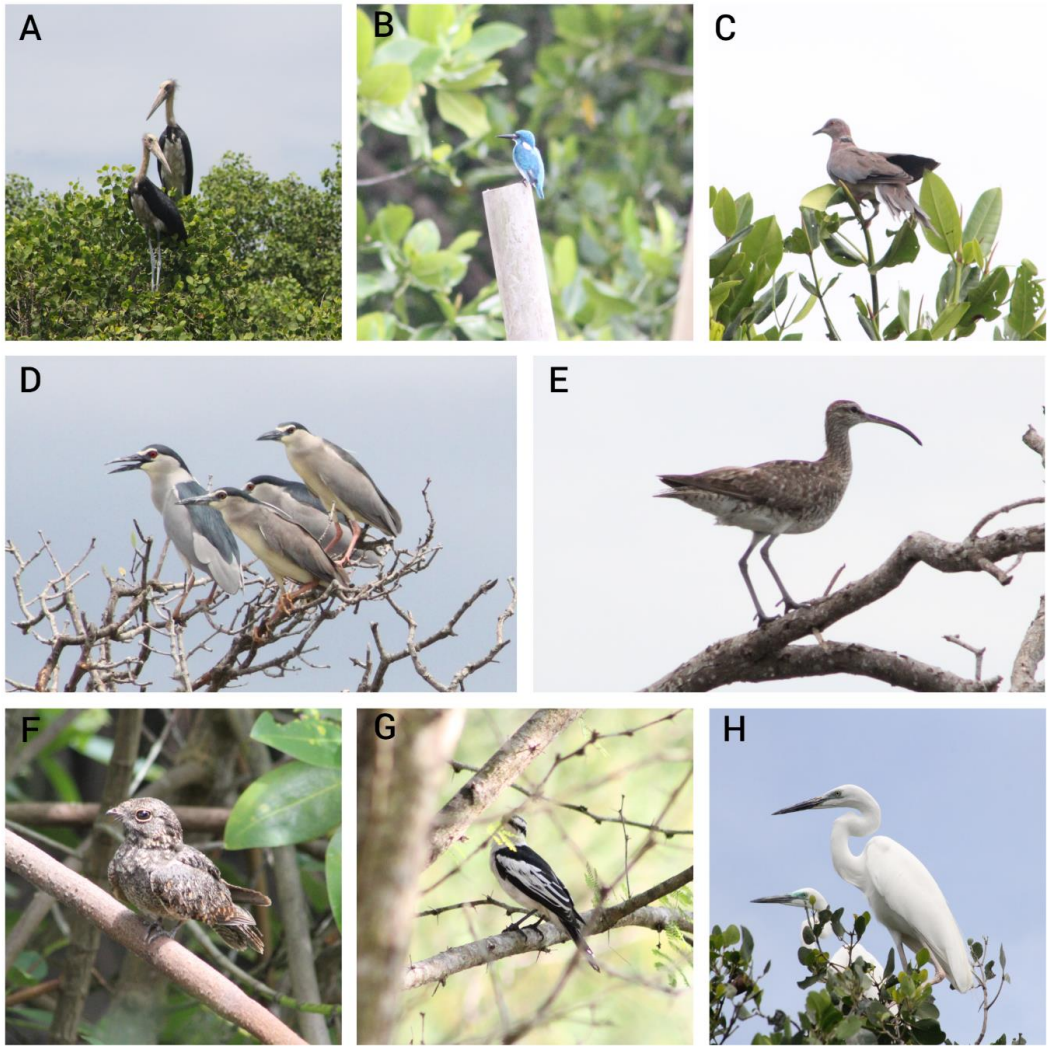

Figure 2. Representative of Birds Documentation in the Mangrove Forest of BBPIG: Lesser Adjutant (A), Cerulean Kingfisher (B), Sunda Collared-dove (C), Black-crowned Night-heron (D), Whimbrel (E), Savanna Nightjar (F), Pied Triller (G), Little Egret (H)

There are two species with the highest abundance, i.e., *N. nycticorax* (188 individuals) and *A. alba* (168 individuals), respectively. These species were found in small to large groups with flying, perching, and foraging activities in the mangrove forest BPBIG. Species *N. nycticorax* is a heron member that prefers food sources such as fish, shrimp, and insects (MacKinnon et al., 2010). Furthermore, *A. alba* also has a high abundance in this wetland ecosystem, and it was recorded mix-flock with *E. garzetta* and *N. nycticorax*. It is suspected that the mangrove forest of BPBIG has sufficient food availability, such as zoobenthos, insects, and small fish (Taufiqurrahman et al., 2022). In addition, both species are cosmopolite birds in the mangrove area on Java Island, which means that they have a very wide distribution and have high adaptability to wetland habitat types, particularly in the mangrove (MacKinnon et al., 2010; Taufiqurrahman et al., 2022).

Finally, based on the results, it can be concluded that the bird species in the mangrove forest of BPBIG are quite diverse. There is one bird species that has important conservation status based on the IUCN Red List and National Regulation, namely *L. javanicus* (a vulnerable and protected species). Furthermore, there are also three migratory birds (*T. sanctus, N. phaeopus, and A. hypoleucos*) that use the mangrove forest of BPBIG as stopover sites during migration periods. Thus, the biosite status in this ecosystem is a good conservative strategy to

protect bird communities and their habitats. Further research on the population and habitat of each bird species is important, especially for those with vulnerable and protected status.

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