

Research Article

Diversity of plants and birds as an ecotourism attraction in the Segara Guna Batu Lumbang Mangrove Forest, Pemogan Denpasar Bali, Indonesia

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Abstract

Mangrove forests, with their diverse flora and fauna, vegetation structure, unique root systems, mud flats, and intertidal habitats with high and low tides, are very attractive ecotourism attractions. The present study aimed to identify and interpret the diversity of mangrove flora and birds in the Batu Lumbang mangrove ecotourism area of Pemogan Denpasar Bali, Indonesia. Analysis of mangrove vegetation was carried out at four research stations using the square method, and observations of bird abundance were made using the point count method. The results showed that using mangrove forests in Batu Lumbang applies ecotourism principles. In the Segara Batu Lumbang mangrove forest, 9 species of true mangroves and 9 species of associated mangrove plants were found. There were 30 species of birds belonging to 20 families. The diversity index of mangrove plants was 2.55, including the medium category. Several bird species were quite common and easy to find in this area, including the Little Pied Cormorant (*Microcarbo melanoleucos*), cave swiftlet (*Collocalia linchi*), greater egret (*Egretta alba*), small blue kingfisher (*Alcedo coerulescens*), and great billed heron (*Ardea sumatrana*). The bird diversity index was 3.28, which is in the high category. This shows that the condition of the mangroves in Batu Lumbang is stable. Information on the existence and interpretation of the characteristics of mangrove species and birds, the conservation status of species, and habitat use by birds are attractions in ecotourism. The mangrove and birds is an important guide for guides or managers of ecotourism.

Keywords: Batu Lumbang mangrove, Birds diversity, Ecotourism attraction, Mangrove flora

INTRODUCTION

Mangrove forests' unique diversity of flora and fauna is very attractive for ecology-based tourism activities. Several mangrove areas in Bali have been developed as tourist attractions, especially nature-based and educational tourism. Some of these areas include the Nusa Lembongan mangrove area for mangrove tours, the Tahura Ngurah Rai mangrove area as an ecotourism attraction, the Kampoeng Kepiting mangrove forest ecotourism area as mangrove ecotourism, the mangrove forest in Pejarakan Buleleng village as an educational tourism attraction, and the mangrove forest in Perancak was developed as an ecotourism attraction

(Ginantra, 2022)

Ecotourism in mangrove forests is a tourism activity that applies three main aspects: ecology, sustainable economics and empowerment of local communities. Ecological aspects include the existence of the species that make up the mangrove ecosystem and also conservation efforts. Sustainable economics, namely that economic value is generated from ecotourism activities in sustainable mangrove forests, and some of the proceeds are returned for ecosystem restoration. The empowerment of local communities means that local communities are the primary managers and become the beneficiaries of these ecotourism activities (Indonesia Ecotourism Institute, 2022; Sudarto, 1999).

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The Segara Batu Lumbang mangrove forest is part of the Tahura Ngurah Rai mangrove forest area, which the Segara Guna Batu Lumbang Pemogan fishing group developed. The mangrove forest in Segara Batu Lumbang is also a tourist attraction based on conserving the diversity of mangrove flora and fauna. Ecotourism in the Segara Guna Batu Lumbang mangrove was developed by combining three main aspects of ecotourism, namely the ecology of the area being maintained, sustainable economic value and empowerment of local community groups (Segara Guna Batu Lumbang fishing group and Werdi Segara Group) (Ginantra, 2022). The mangrove ecotourism being developed includes mangrove tours with canoes/jukung, fishing tours, voluntourism tours and educational tours. The diversity of mangrove plant species plays an important role in the existence of birds in mangrove forests (Ginantra, 2022). The diversity of mangrove plants consists of two groups: true mangrove species and associated mangrove plants. Species of true mangroves are plants that grow exclusively in mangrove habitats, including Rhizopora sp., Bruguiera sp. Sonneratia sp., Xylocarpus sp., Avicennia sp. and the species of mangrove association are terrestrial plants that are able to grow adaptability in mangrove areas, including Hibiscus tiliaceus, Ipomoea pes-capre (Kitamura et al., 1997).

Various types of fauna are associated with the mangrove ecosystem, namely various species of birds, insects and primates that live in the tree canopy, as well as various types of fauna that live at the base of the mangrove such as wild boars, monitor lizards, crocodiles, snakes, shrimp, fish, shellfish, snails, crabs are an ecotourism attraction in the mangrove ecosystem (Ewaldo et al., 2023). Several species of birds that are commonly found in mangroves include the great egret (*Egretta alba*), little egret (*Egretta garzetta*), javan pond heron (*Ardeola speciosa*). Various species from the mollusks, crustaceans and fish groups are also common in mangrove habitat. The diversity of fauna is an interesting attraction for ecotourism visitors (Ginantra *et al.*, 2023; Muhaerin, 2008).

The forms of ecotourism activities in Mangroves can be quite varied. Sports and recreational tourism activities and attractions can include kayaking, fishing, canoeing, camping, bird watching. The facilities needed are kayaks, canoes, rafts, and camping grounds. Educational and research tourism attractions can include introducing mangrove vegetation, mollusks, crustaceans, and reptiles diversity, birth watching, and the characteristics of mangrove plants. The facilities needed can be natural resources, canoes, rafts, observation posts/ ecotower, and resting points. Health tourism, the attractions can be meditation, rehabilitation, and therapy and the facilities needed are shelter and shade (Ginantra, 2022; Novianti et al., 2021; Sudarto, 1999). including birds, molluscs, crustaceans, and reptiles, is a potential that can be developed for ecotourism activities. Wildlife has high aesthetic value, which can attract tourists. The data and information submitted regarding the diversity and uniqueness of wild animals can potentially develop wildlife-based ecotourism (Novianti et al., 2021; Hardansyah, 2012). In educational tourism or ecotourism in mangrove areas, the diversity of birds that interact with the mangrove ecosystem and the use of habitat by birds is an attraction/attraction (bird watching) for ecotourism activities. Thus, the present study aimed to identify and interpret the diversity of mangrove plants and birds in the Segara Guna Batu Lumbang mangrove ecotourism area.

MATERIALS AND METHODS

Study sites and periods

The research was conducted in the Segara Guna Batu Lumbang Pemogan Denpasar, Bali mangrove ecotourism area, in March - July 2023. This area is part of the Ngurah Rai Grand Forest Park (Tahura) mangrove area. Geographically, it is located at 80 44' 05 93" S and 1150 11'17 57" E, with an altitude of around 0 to 3.35 meters above sea level (m asl). Almost all of the areas are in the intertidal area (Fig. 1).

Methods

Analysis of mangrove vegetation was carried out at 4 research stations using the square method, namely Batu Lumbang Site 1 (BL1), Batu Lumbang Site 2 (BL2), Batu Lumbang Site 3 (BL3) and Batu Lumbang Site 4 (BL4). The parameters measured were the number of individuals and the frequency of presence of each plant species in each sample. Identification of mangrove plant species referred to Kitamura et al. (1997). Bird abundance was calculated using the point count method (Bibby et al., 2000). Counting points were carried out at 4 stations and each point, observations were made for 15 minutes with an observation distance to the left and right of 25 meters and a distance between points of 150 meters. The parameters observed at each counting point are the number of species and the number of individual birds. Identification of bird types is done directly with the help of binoculars. The birds were photographed with a digital camera. Identify types of birds based on morphological characters (including leg shape, feathers, feather color, wings, wing color, and beak). Identification referred to the field guidebook series on birds of Java, Bali and Sumatera (MacKinnon et al., 2010).

The conservation/rarity/protection and/or threat status of mangrove flora and bird species refers to the Regulation of the Minister of Environment and Forestry Number P106 of 2018 (Regulation of the Minister of Environment and Forestry of the Republic of Indonesia

The aesthetic value possessed by wild fauna/wildlife,



Fig. 1. Map of research locations (BL1 to BL4) in Batu Lumbang Mangrove Ecotourism, Ngurah Rai Forest Park

number P106/MENLHK/SETJEN/KUM.1/12/2018), concerning protected plant and animal species, International Union for Conservation of Nature Red List (IUCN, 2021). Data on the area's mangrove flora and bird species were compiled in a 15 cm x 20 cm handbook. The handbook displays three main sections: information on the mangrove area, the characteristics of each species of mangrove flora and fauna accompanied by color photographs and the distribution of species at the mangrove site.

Data Analysis

The diversity of mangrove and bird species was calculated using the Shanon-Wiener diversity index (H), where H = - \sum [ni/N x Ln ni/N), where ni= the important value of the ith species and N= the total important value of all species. The important value was determined from 2 parameters: Relative density (Kr) = (Ki/ \sum K) x 100%. where Ki = Number of individuals in each habitat)/(area point count/total point count. \sum K = total density of all bird species. Frequency of presence (Fr)= Fi x 100%, where Fi = number of sampling plots containing species i)/total number of sampling plots). The importance value of each species was determined by adding up the relative density and relative frequency values . The diversity index criteria (H) are determined from the diversity index value, with the following criteria: H<1.00: low diversity; shows that environmental factors greatly influence low diversity; 1.00 < H < 3.00: moderate diversity; shows that environmental factors influence low diversity; H >3.00: high diversity; indicates that environmental factors do not have a negative effect on diversity (Stiling 1996). The species evenness index (E) is calculated using the formula: E = H/ LnS; where E is the evenness index, H is the diversity index and S is the number of species. The E value ranges from 0.00 to 1.00. E approaching 1 means that species evenness is high and E approaching zero means that the species composition is uneven or some species dominate (Stiling, 1996).

RESULTS AND DISCUSSION

Ecotourism in the Segara Guna Batu Lumbang Mangrove Forest

The Segara Guna Batu Lumbang mangrove forest is part of the Tahura Ngurah Rai mangrove conservation area. Batu Lumbang mangrove ecotourism is managed as a mangrove ecotourism attraction by several local community economic empowerment groups in Pemogan Village, Denpasar, Bali, namely: (1) the Segara Guna Batu Lumbang group (KUB), which was formed



Fig. 2. Facilities and activities at Batu Lumbang Mangrove:A.Gate marking the Batu Lumbang ecotourism area; B. Batu Lumbang fishermen group office building; C. canoe and "jukung" facilities; D. Mangrove forest monitoring post; E. mangrove nursery; F.collection of plastic waste in mangroves.

2005; (2) Community superviser group in (Pokmaswas) Mina Werdi was formed in 2006; (3) the Mina Lestari Batu Lumbang processing and marketing group (Poklahsar) was built in 2021; (4) The Mina Yowana Batu Lumbang group was formed in 2022. These community groups carry out mangrove management, namely mangrove tours, education about the existence of mangroves, conserving mangrove forests, cleaning up plastic waste (Fig. 2F), utilizing and processing mangrove fruit into food (for example, into syrup). Mangrove tourism being developed is mangrove tour with canoe and "jukung", fishing tourism, voluntourism (combining spiritual tourism and conservation tourism), educational tourism (education about the existence and role of mangrove forests in the ecosystem for students and the public), birdwatching, and research. Mangrove tourism facilities in the Batu Lumbang area include canoes, jukung, boats, canoe base posts, integrated mangrove forest monitoring posts, camping grounds and fishing trails (Fig. 2 A-F). The canoe/jukung base is equipped with a post in the form of a house on stilts to

provide information and facilities for tourists exploring mangroves, fishing trips, voluntourism tourism and an integrated forest security post from the Regional Technical Implementation Unit (UPTD) Tahura Ngurah Rai forestry and environment service together with the Segara Guna Batu Lumbang fishermen group, who are also in CSR from PT Indonesia Power (Bali Power Generation Unit).

As a conservation area, implementing tourism activities at this location was initially motivated by limited operational funds from local communities for managing environmental conservation activities. The management community is part of the Segara Guna Batu Lumbang Fisherman's Group and the Mina Werdi Batu Lumbang Supervisory Community Group, then the Mina Lestari processor and marketer group which developed the processing and marketing of mangrove fruit into sweets, syrup and "dodol". The problem faced at this location is that it is a river estuary, causing consignments of waste that need to be collected periodically and limited operational funds. The community realizes

No	Scientific name	Indonesian	English name	Family	Important	Conservation
		name	•	-	value	status
1	Rhizophora mucro- nata	bakau kurap	true mangrove	Rhizophoraceae	55.23	LC, decreasing
2	Rhizophora apicu- late	bakau merah	red mangrove	Rhizophoraceae	46.10	LC, decreasing
3	Excoecaria agalocca	buta buta	milky man- grove	Euphorbiaceae	7.25	-
4	Xylocarpus gran- atum	bakau Meriam	cannonball Mangrove	Meliaceae	14.34	LC, decreasing
5	Sonneratia alba	Perapat	mangrove ap- ple	Lythraceae	40.79	LC, decreasing
6	Bruguiera gymnorhi- za	tanjang me- rah	black man- grove	Rhizophoraceae	7.48	LC, decreasing
7	Lumnitzera race- mosa	Teruntum	black man- grove	Combretaceae	13.81	LC, decreasing
8	Aegiceras floridum	Teruntung	river mangrove	Myrsinaceae	7.44	NT, decreasing
9	Avicennia marina	sia sia	Grey man- grove	Avicenniaceae	7.56	LC, decreasing
10	Leucaena leuco- cephala	Lamtoro	white lead tree/ pearl wattle	Mimosaceae	31.46	-
11	Acacia auriculiformis	Akasia	Ear-leaf acacia	Fabaceae	8.68	LC
12	Morinda citrifolia	mengkudu	noni	Rubiaceae	6.45	-
13	Hibiscus tiliaceus	waru	Sea hibiscus	Malvaceae	15.68	-
14	Pandanus tectorius	pandan duri	Screw pine	Pandanaceae	8.56	LC
15	Terminalia cattapa	ketapang	Tropical al- mond	Combretaceae	6.45	-
16	Thespesia populnea	waru laut	rosewood Pasifik	Malvaceae	11.16	LC
17	Acrostichum aureum	paku laut	Coast leather fern	Pteridaceae	13.34	-
18	Casuarina equiseti- folia	cemara laut	Coastal She- oak	Casuarinaceae	6.32	LC, stabil

Table 1. Diversity of mangrove plants in Segara Guna Batu Lumbang

Diversity index (H): 2.55, Evenness index (E):2.88

Scarcity: LC: Least Concern, - : common, refers to the IUCN Red List, 2022 version

the importance of protecting the environment, especially the Mangrove Forest area, which is a green belt that prevents abrasion and tsunamis. According to Tyas and Arida (2020), voluntourism is one type of alternative tourism that can be developed in Mangrove Forests. This type of tourism combines volunteer activities in conserving mangrove areas and recreation and enjoying the beautiful landscape of mangrove forests. Because mangrove forests are areas with beautiful natural potential and are very important to conserve.

The Tahura Ngurah Rai mangrove forest, which was developed by a group of local fishing communities in Pemogan Denpasar, is based on ecotourism, namely the use of mangrove areas while maintaining the ecological function of the mangrove forest, having sustainable economic value, and empowering local communities. Segara Guna Batu Lumbang Ecotourism was developed by fulfilling the 8 principles of ecotourism, namely: (1) Minimizing physical, social, behavioral and psychological impacts on the surrounding area; (2) Building awareness, culture and concern for the environment; (3) able to provide positive experiences for tourists and managing communities regarding mangrove forest conservation; (4) Provide direct economic value for environmental preservation; (5) Generate economic value for local communities, private industry (6) Provide an impressive interpretation of the physical and biological environment in the Batu Lumbang mangrove forest; (7) developing facilities and infrastructure that minimize negative impacts on the mangrove environment; (8) respecting the spiritual beliefs of local indigenous communities and empowering them (Duangjai *et al.*, 2017; Indonesia Ecotourism Institute, 2022; Sudarto, 1999).

Mangrove plants diversity and ecotourism attraction

Nine species of true mangroves and nine species of associated mangroves were found in the area. True mangrove species are mostly components of major mangroves. The mangrove plant species in the Batu Lumbang mangrove tourist area are dominated by true mangrove (*Rhizophora mucronata*), red mangrove (*Rhizophora apiculata*) and mangrove apel (*Sonneratia alba*). And minor mangrove groups include *Xylocarpus* sp., *Excoecaria* sp. Apart from that, associated man-

grove vegetation is also found, including Pacific rosewood (*Thespesia populnea*), tropical almond (*Terminalia cattapa*), and screw pine (*Pandanus tectorius*) (Table 1).

Several characteristics of mangrove plants are attractive to ecotourism visitors, including the characteristics of mangrove habitus, the growth substrate, flower characteristics, the shape of the propagules and characteristics of the roots. The propagules often referred to as fruit; some are spherical/ball, cylindrical, like chili, and heart-shaped, the characteristics of the roots include pneumatophore roots, stilt roots, and knee roots (Fig. 3). The conservation status of mangrove plants is also an interesting aspect of ecotourism attractions. For example, several mangrove species are considered rare or in the Least Concern (LC) category based on the IUCN redlist. Several species are experiencing a decline in global population (Table 1). Several characteristics of mangrove plants are important to interpret so that visitors gain positive knowledge and experience about the diversity of mangrove plants.

Bird diversity and ecotourism attractions

Thirty species of birds belonging to 20 families were found. Several bird species that are quite common and easy to find in this area, both in person and from their sound, include the blue-tailed bee-eater (*Merops philippinus*), little pied cormorant (*Microcarbo melanoleucos*), cave swiftlet (*Collocalia linchi*), greater egret (*Egretta alba*), common iora (*Aegithina tiphia*), small blue kingfisher (*Alcedo coerulescens*), yellow vented bulbul (*Pycnonotus goiavier*) and black faced munia (*Lonchura punctulata*). Of the 30 species of birds found, they are groups of birds from the feeding guilds carnivore (fish eaters, frogs, crustaceans, small reptiles, fish), granivore (seed eaters), insectivore (insect eaters), frugivore (fruit eaters) and nectarivore (nectar eaters/honey). Carnivore and insectivore bird groups appear to dominate. This is related to the mangrove habitat type, which is more favorable for birds that eat fish, mollusks, crabs and insects. Detailed data on bird diversity during observations is presented in Table 2.

Several species of birds are quite abundant in population, including the cave swiftlet (Collocalia linchi), yellow vented bulbul (Pycnonotus goiaver), the Blackfaced munia (Lonchura punctulata), the turtle dove (Streptopelia chinensis), Blue-tailed bee-eater (Merops philippinus). These bird species are generally distributed from the lowlands to the highlands (MacKinnon et al.,2010). Some birds are quite rare (low population), including the wood sandpiper (Tringa glareola), common whimbrel (Numenius phaeopus) and pacific swallow (*Hirundo tahitica*). These species, which are quite abundant in population, can be found flying above vegetation, perching on vegetation, walking/foraging in mud, water, manarove roots and flving above the beach. Cave swiftlets are often found flying above coastal vegetation, which can be observed in the morning and evening. Yellow vented bulbul can often be found perched on mangrove trees, walking on the



Fig. 3. Several unique mangrove species in the area

No	Scientific name	English name	Family	Conservation status	Feeding guilds	Important value
1	Gerygone sulphurea	golden-bellied	Acanthizidae	LC, decreasing	Insectivore	3.48
2	Aegithina tiphia	Common iora	Aegithinidae	LC	Insectivore	9.81
3	Alcedo coerulescens	Small blue Kingfisher	Alcedinidae	LC	Granivore	6.70
4	Todirhamphus chloris	Sacred kingfisher	Alcedinidae	LC, decreasing	Frugivore	4.47
5	Alcedo meninting	Blue-eared king- fisher	Alcedinidae	LC, decreasing	Nektarivore	4.47
6 7 8 9 10	Collocalia linchi Bubulcus ibis Egretta intermedia Egretta garzeta Egretta alba	Cave swiftlet Cetle egret Intermedia egret Litle egret Greater egret	Apodidae Ardeidae Ardeidae Ardeidae Ardeidae	LC LC LC LC	Insectivore Granivore Carnivore Carnivore Carnivore	18.87 4.47 5.09 7.57 2.86
11	Ardeola speciosa	Javan Pond Heron	Ardeidae	LC	Insectivore	4.47
12	Ardea sumatrana	Great billed heron	Ardeidae	LC	Carnivore	10.43
13	Butorides striata	Striated heron	Ardeidae	LC, Decreasing	Insectivore	10.80
14	Orthotomus sepium	Olive-backed Tailorbird	Ciscicolidae	LC, Endemic of Indonesia	Insectivore	3.48
15	Streptopelia chinensis	Spotted dove	Columbidae	-	Carnivore	4.47
16	Corvus macrorhynchos	Large-billed crow	Corvidae	LC	Carnivore	10.68
17	Dicrurus macrocercus	Black drongo	Dicruridae	LC	Insectivore	5.09
18	Lonchura punctulata	faced munia	Estrildidae	LC	Carnivore	10.93
19	Hirundo tahitica	Pacific Swallow	Hirundinidae	LC	Carnivore	10.43
20	Merops philippinus	bee-eater	Meropidae	LC	Carnivore	5.34
21	Nectarinia jugularis	Olive- backed sunbird	Nectariniidae	LC	Carnivore	4.10
22	Microcarbo melanoleucos	Little Pied cormo- rant	Phalacrocorac- idae	LC	Carnivore	11.05
23	Phalacrocorax sulcirostris	Little Black Cor- moran	Phalacrocorac- idae	LC	Insectivore	5.71
24	Pycnonotus goiavier	Yellow vented bulbul	Pycnonotidae	-	Insectivore	8.57
25	Amaurornis phoenicurus	white breasted waterhen	Rallidae	LC	Carnivore	2.86
26	Rhipidura javanica	Sunda Pied Fan- tail	Rhipiduridae	LC, L	Carnivore	4.47
27	Numenius phaeopus	common whim- brel	Scolopacidae	LC, Decreas- ing, L.	Carnivore	7.32
28	Tringa glareola	Wood Sandpiper	Scolopacidae	LC	Carnivore	2.86
29	Nycticorax nycticorax	Black-crowned night heron	Ardeidae	LC, decreasing	Carnivore	5.09
30	Sterna bergii	Great Crested- Tern	Sternidae	LC, stable	Carnivore	4.10

Table 2. Bird diversity in the Segara Batu Lumbang mangrove tourist attraction

Scarcity; LC: Least Concern, -: common, refers to the IUCN Red List, 2022 version; L: protected status according to Regulation of the Minister of Environment and Forestry of the Republic of Indonesia number P106/MENLHK/SETJEN/KUM.1/12/2018

grass while looking for food. The diversity of vegetation in the area provides resources for a wide variety of birds. In the context of vegetation resources for bird life, it provides three main functions, namely (1) providing shelter, perching and nesting for birds (accommodation); (2) providing food (providing food) either directly or indirectly, fruit, seeds, flowers and leaves become food for herbivore/nectarivore birds and indirectly, namely that plants provide food for carnivorous birds , in the form of insects, molluscs, small reptiles, spiders that interact with plants; (3) being a shelter from environmental conditions (rain, heat) or avoiding enemies. In the Segara Batu Lumbang mangrove tourism area, 26 bird species were recorded as being included in the IUCN redlist in the LC (Least Concern) category, even in the global population trend decreasing category. These species include golden-bellied gerygone (*Gerygone sulphurea*), Black-crowned night heron (*Nycticorax nycticorax*), Sacred kingfisher (*Todirhamphus chloris*), Blue-eared Kingfisher (*Alcedo*) meninting), Striated heron (Butorides striata), common whimbrel (Numenius phaeopus). In the study area, one species, an endemic bird to Indonesia, was also found, namely the olive-backed Tailorbird (Orthotomus sepium). Two species of birds are protected species according to Minister of Environment and Forestry Regulation Number P106/MENLHK/SETJEN/ KUM.1/12/2018, namely common whimbrel (Numenius phaeopus) and Sunda pied fantail (*Rhipidura javanica*) Based on the Shanon-Wiener diversity index, the bird diversity index was 3.28 and the species evenness index (E) was 0.96. From the magnitude of this index, the diversity of bird species in the Segara Batu Lumbang Mangrove area is included in the high category. The high category of bird diversity is because the number of species/species richness was quite high; namely 30 species, and the evenness of individuals among the species was quite even, with an E value close to 1 (0.96). This indicated that the condition of the Batu Lumbang mangrove forest is still good or stable.

The presence of birds, bird activities, and habitat use by birds in mangrove habitats were attractions in ecotourism. Information about the types of birds found, whether they were protected or not, rare or common, and whether they were migratory or resident birds is important information in ecotourism activities. The activities and habitat used by birds that were observed, whether perching on mangrove branches, flying from tree to tree, looking for food, or walking on mud flats, are interesting attractions for bird-watching activities. Ecotourism World (2021) stated that interest in bird watching continues to increase, along with the increasing appreciation of observers for the balance of the surrounding natural ecosystem and Arini et al. (2018), also stated that birds are very interesting wild animals to observe as ecotourism attractions in mangrove areas because birds have interesting feather colors, morphology and behavior. In Fig. 4, several species of birds in the mangrove ecosystem are presented, and these are interesting attractions. Visitors could observe bird activity while exploring the mangrove forest using a canoe or traditional bout. Some bird species were looking for food (foraging), flying above vegetation, flying above water, perching on vegetation branches, mangrove roots, walking on mud flats, or walking in water.

Shelar, (2016); Hakim, (2017); Kim *et al.* (2020) stated that utilizing the diversity of bird species in a habitat for tourism purposes is a sustainable conservation strategy. Avitourism contributes positively to the conservation of bird diversity and their habitats. In this case it refers to the concept of ecotourism, namely that the existence of biodiversity of flora and fauna (especially birds), local communities have a positive role and impact from tourism activities and there is sustainable economic value. Part of the economic value obtained is reused for restoration of the object area.

Bird-watching ecotourism guides should have good competence (knowledge, skills and behavior) so that



Fig. 4. Some birds' activities in the Batu Lumbang Mangrove

they can interpret the presence of birds in mangrove forest habitats well. It is necessary to compile a bird presence handbook to assist bird-watching ecotourism guides in interpreting birds in mangrove habitats. It is important to display a handbook or information board about the presence of flora and fauna in ecotourism areas because it can provide an interpretation of the presence of birds in mangrove habitats. The display of information on the existence of biodiversity needs to be packaged in an attractive way that can be understood by all groups so that biodiversity truly becomes an attraction for ecotourism. These important aspects include photos of birds, bird activity, morphological characteristics, ecology, distribution of birds and the status of the bird's existence. This information is important for bird watchers, both beginners and experienced. The information in this handbook is also important to increase ecotourists' insight and knowledge about the existence of birds.

The status of bird presence is also important information in ecotourism because it can provide an overview of the important role of mangrove vegetation in bird conservation. Of the 30 species of birds found in the Batu Lumbang mangrove ecosystem, 26 species were included in the rare category according to the IUCN (Least Concern/LC category). Two species were protected under the regulation of the Minister of Environment and Forestry of the Republic of Indonesia, number P106/MENLHK/SETJEN/KUM.1/12/2018 and one species was an Indonesia endemic species. This shows that the mangrove ecosystem in Batu Lumbang contributes greatly to the conservation of rare bird species.

Conclusion

The use of mangrove forests in Batu Lumbang applies the principles of ecotourism. In the Segara Batu Lumbang mangrove forest, 9 species of true mangroves and 9 species of associated mangrove plants were found. There were 30 species of birds belonging to 20 families. The diversity of mangrove flora and fauna indicated that the condition of the Batu Lumbang mangroves was stable. Species diversity, uniqueness, conservation status, unique characteristics of mangrove species and birds, and bird habits in their habitats are attractions for ecotourism activities in the Batu Lumbang mangroves.

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Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

- Arini, D. I. D., Kinho J., Diwi, M. S., Christita, M. Halawane, J. E., Fahmi, M. F. & Kafiar Y. (2018). Wildlife Diversity for ecotourism at Aqua Lestari Forest Park, North Minahasa. *Journal WASIAN*, *5*(1), 01-14.
- Bibby, C., Jones, M. & Marsden, S. (2000). Field expedition techniques: Bird surveys. Translation by S.N. Kartikasari and Jeni Shannas. BirdLife International-Indonesia Programme. Bogor.
- Duangjai, W., Tuntates, U. and Kroeksakul, P. (2017). The Comparative Evaluation of Community-based Ecotourism Management at Mangrove Forest Communities in Satun Province, Thailand. *International Journal of Emerging Technology and Advanced Engineering*. 4(6), 42 – 48.
- Ecotourism World. (2021). Sustainable Bird Watching and Birding Trips. Available at: https://ecotourism- world.com/ sustainable-bird-watching-and-birding-trips/
- Ewaldo, K. , Karuniasa, M. & Takarina, N. D. (2023). Carrying capacity of mangrove ecotourism area in Pantai Indah Kapuk, North Jakarta, Indonesia. *BIODIVERSITAS*, 24 (10), October:5808-5819. DOI: 10.13057/biodiv/ d241063
- Ginantra, I. K., Muksin, I. K., Joni, & Yuni, L.P.E.K. (2022). Bird Diversity as a Support of Ecotourism Activities in the Mangrove Ecosystem of Lembongan Island Bali-Indonesia. *Journal of Environmental Management and Tourism*, (Volume XIII, Winter), 7(63), 1840-1850. DOI:10.14505/jemt.v13.7(63).04
- Ginantra, I.K. (2022). Mangrove Conservation: An Ecotourism Approach. Chapter in Book title: Mangrove Biology, Ecosystem, and Conservation. IntechOpen. Available from:https://www.intechopen.com/online-first/85464. DOI:10.5772/intechopen.109253
- Ginantra, I. K., Muksin, I. K., Joni, M. & Wijaya, I. M. S. (2023). Diversity and distribution of crustaceans in the mangrove forest of Nusa Lembongan, Bali, Indonesia. *BIODIVERSITAS*, 24, (8), 4533-454. DOI: 10.13057/ biodiv/d240834
- Hakim. L. (2017). Managing Biodiversity for a Competitive Ecotourism Industry in Tropical Developing Countries: New Opportunities in Biological Fields. 8th International Conference on Global Resource Conservation (ICGRC 2017) AIP Conf. Proc. 1908, 030008-1–030008-10; https://doi.org/10.1063/1.501270.
- Hardansyah, R. (2012). Wildlife-Based Ecotourism in Balikpapan Bay. Pusat Pengendalian Pembangunan Ekoregion Balik Papan (P3e-K).
- 11. IUCN. (2022). The IUCN Red List of Threatened Species. Available at: https://www.iucnredlist.org/
- 12. Indonesia Ecotourism Institute. (2022). Prinsip Prinsip Ecotourism. Available at : https://www.indonesiaecotour ism.com/

- Kim, Y. J., Lee, D.K. & Kim, C.K. (2020). Spatial trade off between biodiversity and nature-based tourism: Considering mobile phone-driven visitation pattern. *Global Ecology* and *Conservation*, 2,1-13. https://doi.org/10.1016/ j.gecco.2019.e00899
- Kitamura, S., Anwar C., Chaniago, A. & Baba, S. (1997). Handbook of Mangroves in Indonesia. The Development of Sustainable Mangrove.
- MacKinnon, J., Phillips, K. & van Ballen, B. (2010). Birds of Sumatra, Java, Bali and Kalimantan (Including Sabah, Sarawak and Brunei Darussalam) [LIPI-Field Guide Series]. Bogor: Puslitbang Biologi-LIPI.
- Muhaerin, M. (2008). Study of Mangrove Ecosystem Resources for Ecotourism Management in the Perancak Estuary, Jembrana, Bali. Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Bogor Agricultural Institute (Thesis).
- Novianti, R., Afandi, A.Y., Tampubolon, B.I., Rahmadya, A. & Sulawest, F. (2021). Mangrove Resource and Ecotourism Development in Karangsong, Indramayu Regen-

cy, West Java, Indonesia. *IOP Conf. Ser.: Earth Environ. Sci.* 1062 012039

- Regulation of the Minister of Environment and Forestry of the Republic of Indonesia (2018). Number P106/ MENLHK/SETJEN/KUM.1/12/2018, concerning protected plant and animal species.
- Shelar, S.K. (2016). Ecotourism as a Conservation Strategy of Biodiversity in Maharashtra, India. *International Journal of Applied Research*, 2(7), 943-949.
- 20. Stiling, P. (1996). Ecology, Theories and Aplications. Prentice Hall Internationan Inc. New Jersey.
- Sudarto, G. (1999). Ecotourism. Nature conservation efforts, sustainable economic development and community empowerment. Kalpataru Bahari Foundation and Indonesian Biodiversity Foundation.
- Tyas, S. & Arida, I. N. M. S. (2020). Opportunities for Community-Based Voluntourism Development in the Batu Lumbang Mangrove Forest, Suwung, Pemogan, Denpasar. *Jurnal Destinasi Pariwisata*, 8 (2), 2020. DOI: https://doi.org/10.24843/JDEPAR.2020.v0 8.i02.p24