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BIRDS DIVERSITY MAPPING USING QUANTUM GIS FOR ECOTOURISM IN THE MANGROVE FOREST OF KUALA BUBON, WEST ACEH

Riza Ulhaq[1], Ilham Juliwardi[2]
rizaulhaq@utu.ac.id, ilhamjuliwardi@utu.ac.id
[1,2] Teuku Umar University

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Abstract

The discourse on developing Kuala Bubon mangrove forest area in West Aceh as an ecotourism location has received a lot of sympathy and support among the community, considering that this forest has a high level of diversity of flora and fauna, one of which is bird species. In several ecotourism locations, birds attract tourists by enjoying various entertainment related to birds, such as bird watching, tours of bird habitats, and observing birds in the wild. The research was carried out in the Kuala Bubon mangrove forest, West Aceh, in September 2023. This research used a quantitative approach, calculating the level of diversity and mapping distribution based on bird location coordinates. The data collection method uses the point count and line transect method. Analysis of bird species diversity data using the Shannon-Wienner Diversity Index (H') formula was then carried out by mapping the coordinates of bird presence using the Quantum Gis software. The research results obtained 37 bird species from 22 families with a diversity index of 3.07 (high diversity), two species with the status of Near Threatened (*Aegithina Viridissima*) and Vulnerable Under (*Acridotheres javanicus*). Mapping bird species diversity with Quantum Gis provides opportunities for developing bird ecotourism, such as planning optimal bird-watching routes after knowing the distribution of bird species.

A. Introduction

The background to this research is the discourse of the West Aceh government, together with the Ministry of Tourism and Creative Economy of the Republic of Indonesia, to make the Kuala Bubon mangrove forest an ecotourism area. The funds allocated for this discourse reached 43 billion rupiahs. This discourse is expected to increase the income of the surrounding community through the tourism sector [1]. The development of the Kuala Bubon mangrove forest into an ecotourism area must be connected to the potential of this forest, which has a high level of biodiversity. Various types of flora and fauna live in this forest, one of which is a diversity of bird species which can be an attraction for tourist visitors.

Birds can be an attraction for tourist visitors. Tourists can enjoy the beauty and uniqueness of the birds that live in it so that it can be a potential for sustainable ecotourism development [2], [3]. Therefore, it is very important to carry out a mapping study on the diversity of bird species in the Kuala Bubon mangrove forest, West Aceh, as an effort to maintain biodiversity and utilize the ecotourism potential that exists in the area. Various research results have reported that birds are one of the species that can support and attract ecotourism areas. Ecotourism programs related to birds can include multiple types of activities such as birdwatching, tours of bird habitats, and observing birds in the wild. Apart from getting entertainment, ecotourism can also increase public awareness about bird conservation, such as in the ecotourism areas of Way Gambas National Park Ubud Bali, Bagan Percut Deli Serdang, Girimanik Central Java and Bantimurung Bulusaraung National Park with a high diversity of bird species to support ecotourism activities [4]–[6].

The diversity of bird species and their distribution in the Kuala Bubon mangrove forest area, West Aceh, has yet to be discovered with certainty. Data related to bird species diversity still needs to be improved, so further studies need to be carried out. This research can provide bird awareness mapping using Quantum Gis. This research can be used as a basis for developing ecotourism in the Kuala Bubon mangrove forest, West Aceh, which focuses on the conservation of birds that live in it, providing useful information for ecotourism managers and local communities in developing sustainable ecotourism conservation programs such as planning bird watching tourism transect routes and mark bird habitat areas. Thus, research on mapping bird species diversity using the Quantum Gis has an important background and is relevant to efforts to preserve the environment and develop ecotourism in the Kuala Bubon mangrove forest, West Aceh.

B. Research Method

This research uses a quantitative approach, calculating the level of bird species diversity and distribution mapping using the Quantum GIS to obtain spatial data visualization to see patterns and trends in bird species diversity. The research was carried out in September 2023 in Kuala Bubon mangrove forest, West Aceh. Data collection was carried out using the point count and line transect methods. The tools used in the research were cameras, binoculars, GPS, a Tally counter, observation sheets, Quantum Gis software and a bird identification book. Observations were carried out for 20 minutes at each observation point [7].

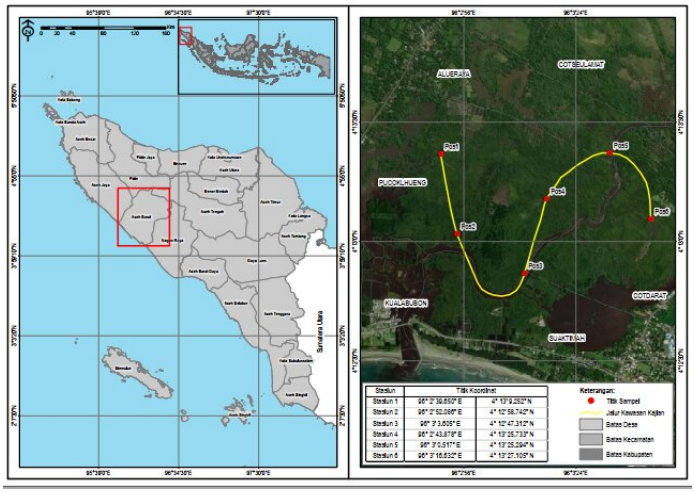


Figure 1. The study area at Kuala Bubon mangrove forest, West Aceh

The birds observed were bird species found in a radius of 10-100 meters (bullseye) with an observation point distance of 600 meters [8]. During the movement from the observation point, the types of birds encountered (Line Transect) were also recorded, along with the number of species found. Observations began in the morning and afternoon, which is the ideal time for birds to do activities such as sunbathing and looking for food [9]. During observations, coordinates of bird points were also recorded to map the distribution of bird species in their habitats.

The types of birds that have been observed will be identified and presented in table form containing the regional name, latin name, family, number and conservation status. Bird species diversity data is analyzed quantitatively by calculating using the Shannon-Wienner diversity index (H') [4], [10], [11]. while bird coordinate data will be analyzed using the Quantum Gis for mapping the distribution of bird species.

$$H' = H' = -\sum pi \ln pi \ (\text{pi} = \frac{ni}{N})$$

Information :

ni: Number of individuals of species 1
N: Number of individuals of all species
H': Species diversity index

Table 1. The level of bird species diversity

Index value (H')	Category
H' ≥ 3	High species diversity
1 < H' < 3	Moderate species diversity
H' ≤ 1	Low species diversity

C. Result and Discussion

The vegetation that makes up the Kuala Bubon mangrove forest, West Aceh, is composed of mangrove plants such as *R. apiculata, R. mucronata, R. stylosa, S. alba, and N. fruticans. A. aureum*. These plants provide grain food along with mangrove waters, which provide many food sources for birds. In this mangrove ecosystem, several types of birds dominate, with a significant number of species such as Herons,

Black-headed Gulls, Sandpipers and Swallows. So, the distribution at various observation stations is unevenly distributed. As at Station 1, which is close to residential areas, the most common species is the Swallow. This phenomenon is influenced by the presence of artificial swallow nests, which emit artificial swallow sounds to attract swallows to the nest. This is a form of human interaction with the environment that can influence the distribution of a species [12], [13].

At station 2, which is close to the coastal area, the most abundant species are Egreta, Sandpipers and Black-headed Gulls. This is due to the availability of food sources such as invertebrates in this area, which is an ideal habitat for several types of birds. At other observation stations, the distribution of bird species is almost even, and there is no dominant species. The distribution of this bird species reflects that environmental factors such as plant vegetation, habitat type and food availability influence bird distribution [14].

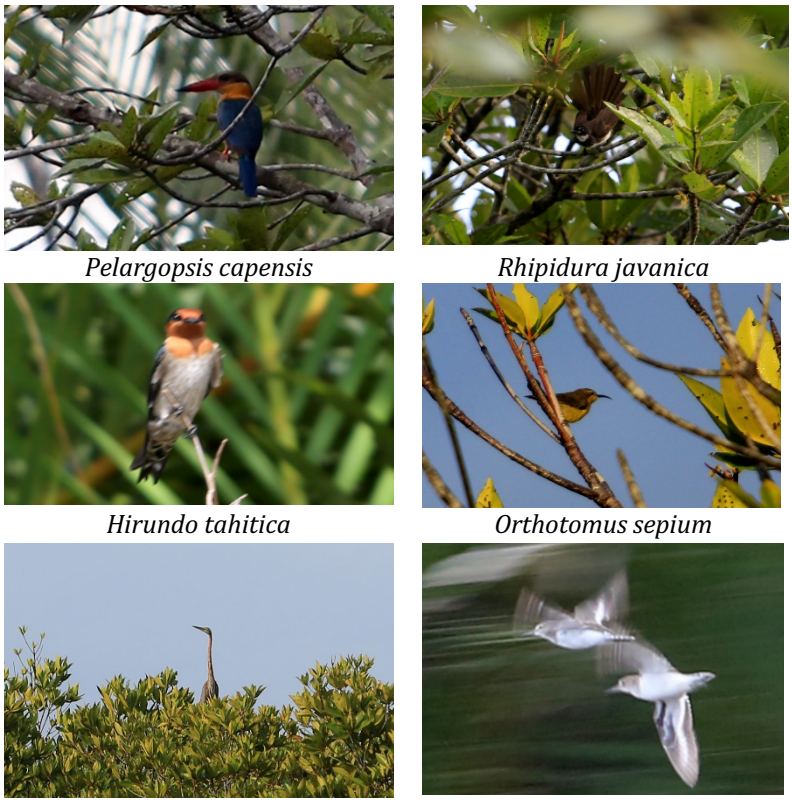


Figure 2. Bird Species At Kuala Bubon Mangrove Forest, West Aceh

Family, regional name, latin name, and conservation status, along with the bird species diversity index in the Kuala Bubon mangrove forest, West Aceh, are presented in Table 2.

Table 2. Family, latin name, regional name, and conservation status

Familia	No	Latin Name	Regional Name	Number Of Species at Stasiun						Total	S
				1	**2**	**3**	**4**	**5**	**6**		
Accipitridae	1	*Pandion haliaetus*	Elang tiram	1	-	1	-	-	-	2	L*C*
	2	*Haliaeetus leucogaster*	Elang laut dada putih	-	1	-	-	-	-	1	L*C*
	3	*Haliastur indus*	Elang bondol	-	1	2	-	-	-	3	L*C*
Aegithinidae	4	*Aegithina viridissima*	Cipoh jantung	2	-	-	-	-	1	3	NT
Alcedinidae	5	*Todiramphus chloris*	Cekakak sungai	2	1	3	-	-	5	11	L*C*
	6	*Pelargopsis capensis*	Pekaka emas	-	2	1	-	-	3	6	L*C*
Ardeidae	7	*Ardea sumatrana*	Cangak laut	2	1	-	1	1	-	5	L*C*
	8	*Egretta garzetta*	Kuntul kecil	16	50	4	-	-	-	70	LC
	9	*Egretta alba*	Kuntul besar	7	19	-	-	-	-	26	LC
Apodidae	10	*Collocalia linchi*	Walet linci	23	4	-	3	-	-	30	LC
Campephagidae	11	*Lalage nigra*	Kapasan kemiri	-	-	-	1	3	-	4	LC
	12	*Pericrocotus cinnamomeus*	Sepah kecil	2	-	-	3	-	3	8	LC
Cuculidae	13	*Centropus sinensis*	Bubut besar	-	-	-	-	-	2	2	LC
Columbidae	14	*Treron vernans*	Punai gading	-	-	-	-	6	3	9	LC
	15	*Streptopelia chinensis*	Tekukur	-	2	-	-	-	-	2	LC
	16	*Treron olax*	Punai kecil	-	-	-	-	1	-	1	LC
	17	*Geopelia striata*	Perkutut jawa	-	2	-	-	-	1	3	LC
Coraciidae	18	*Eurystomus orientalis*	Tiong lampu biasa	6	8	-	-	5	9	28	LC
Chloropseidae	19	*Aegithina tiphia*	Cipoh kacat	-	-	-	3	1	-	4	LC
Halcyonidae	20	*Halcyon smyrnensis*	Cekakak belukar	2	-	-	-	-	4	6	LC
Hirundinidae	21	*Hirundo tahitica*	Layang batu	10	9	-	8	6	-	33	LC
	22	*Hirundo rustica*	Layang-layang	6	7	-	3	-	-	16	LC
Laridae	23	*Chroicocephalus ridibundus*	Camar kepala hitam	3	23	-	-	-	-	26	LC
Meropidae	24	*Merops philippinus*	Kirik-kirik laut	4	2	-	-	-	-	6	LC
Muscicapidae	25	*Rhipidura albicollis*	Kipasan gunung	-	-	-	2	1	-	3	LC
	26	*Rhipidura javanica*	kipasan belang	2	-	-	6	3	-	11	LC
Nectarinidae	27	*Cinnyris jugularis*	Madu sriganti	-	-	-	1	4	2	7	LC
Pycnonotidae	28	*Pycnonotus plumosus*	Merbah belukar	-	1	2	-	-	1	3	LC
	29	*Pycnonotus goiavier*	Merbah cerucuk	-	-	2	4	2	8	16	LC
	30	*Pycnonotus aurigaster*	Cucak kutilang	-	-	-	-	3	-	3	LC
Silviidae	31	*Orthotomus sepium*	Cinenen jawa	-	-	-	-	2	-	2	LC
Scolopacidae	32	*Actitis hypoleucos*	Kedidi	9	18	8	-	-	-	35	LC
Sturnidae	33	*Acridotheres javanicus*	Jalak kerbau	-	-	-	-	2	-	2	VU
	34	*Sturnus sturninus*	Jalak kapas	-	-	-	-	-	2	2	LC
Sylviidae	35	*Orthotomus ruficeps*	Cinenen kelabu	-	-	2	-	3	1	6	LC
	36	*Ortoptomus atrogularis*	Cancirak	-	-	3	3	-	2	8	LC
Timaliidae	37	*Macronus gularis*	Kutau-kutau	1	3	-	-	-	4	8	LC
Number of species				**98**	**154**	**28**	**38**	**43**	**51**	**412**	
$H' = -\sum pi \ln pi$						**3,07**					

Information :

S : Conservation Status based The IUCN Red List of Threatened Species in 2016
LC : Least Concern
NT : Near Threatened
Vc : Vulnerable Under

Based on the results of observations, 37 bird species from 22 families were obtained with a diversity index of 3.07, which means that the diversity of bird species is relatively

high. This diversity index is an important indicator indicating that the role of the mangrove ecosystem as a habitat for birds that is rich in food sources is still well maintained [15], [16].

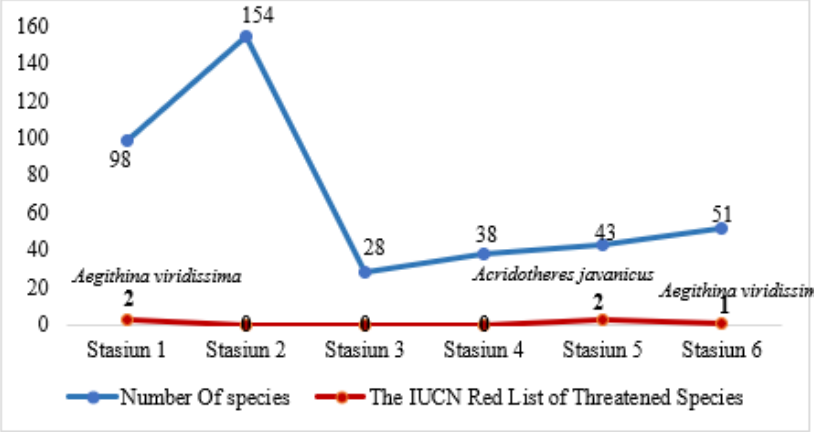
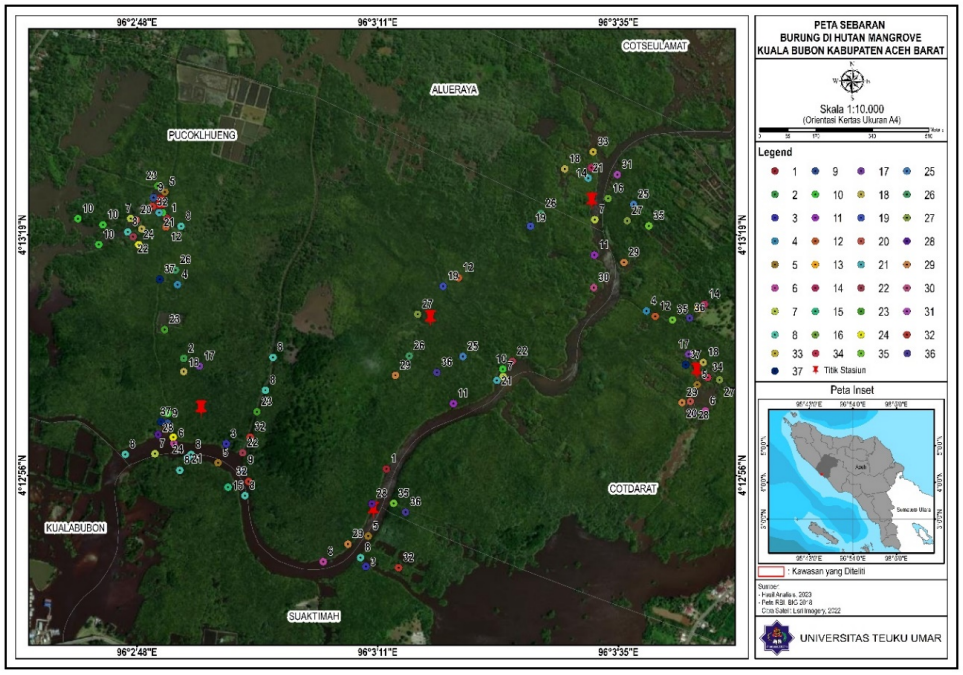


Figure 3. Number of species & The IUCN Red List of Threatened Species

Based on the conservation status, 35 species of birds have the status of Least Concern or low risk, meaning that many species in this status are still in the wild and are not the focus of conservation. The population is relatively stable, and its existence in the wild is still maintained. However, there are two species, namely *Aegithina Viridissima* with near threatened status, possibly threatened with extinction in the near future, and *Acridotheres javanicus* with vulnerable status, at high risk of extinction. The results of this research provide important information on bird species that are vulnerable to extinction as well as conservation efforts that can be carried out to maintain their survival in the Kuala Bubon mangrove forest, West Aceh.

The diversity of bird species in mangrove forests can be an opportunity for developing ecotourism that focuses on bird watching. The discourse of the West Aceh government, together with the Ministry of Tourism and Creative Economy of the Republic of Indonesia, make this mangrove an ecotourism location [1]. Mapping the distribution of bird species provides important information for planning detailed bird-watching routes and strategies for developing bird ecotourism. Ecotourism managers can plan optimal bird-watching routes after knowing the distribution of certain bird species in their habitat. For example, if bird watching focuses on groups of Egreta, the target location is a mangrove area close to the sea coast. Mapping of bird species in the Kuala Bubon mangrove forest area, West Aceh, can be seen in Figure 4.



1 (*Pandion haliaetus),* 2 *(Haliaeetus leucogaster)*, 3 (*Haliastur indus), 4 (Aegithina viridissima),* 5 *(Todiramphus chloris),* 6 *(Pelargopsis capensis),* 7 *(Ardea sumatrana), 8 (Egretta garzetta),* 9 *(Egretta alba),* 10 (*Collocalia linchi),* 11 (*Lalage nigra),* 12 (*Pericrocotus cinnamomeus),* 13 (*Centropus sinensis),* 14 (*Centropus sinensis*), 15 (*Streptopelia chinensis*), 16 (*Treron olax),* 17 (*Geopelia striata),* 18 (*Eurystomus orientalis*), 19 (*Aegithina tiphia),* 20 (*Halcyon smyrnensis*), 21 (*Hirundo tahitica*), 22 (*Hirundo rustica*), 23 (*Chroicocephalus ridibundus),* 24 (*Merops philippinus),* 25 (*Rhipidura albicollis),* 26 (*Rhipidura javanica),* 27 (*Cinnyris jugularis),* 28 (*Cinnyris jugularis),* 29 (*Pycnonotus goiavier),* 30 (*Pycnonotus aurigaster),* 31 (*Orthotomus sepium),* 32 (*Orthotomus sepium),* 33 (*Orthotomus sepium),* 34 (*Sturnus sturnisus*), 35 (*Orthotomus ruficeps),* 36 (*Ortoptomus atrogularis),* 37 (*Macronus gularis).*

Figure 4. Distribution of bird species in Kuala Bubon mangrove forest, West Aceh,

Bird ecotourism is a form of tourism that focuses on observing birds in their natural habitat. Bird ecotourism aims to preserve wild bird populations, educate people about the importance of bird conservation, and provide interesting experiences for visitors. In bird ecotourism, visitors have the opportunity to see beautiful birds in their natural habitat. This is usually done through trips to national parks, forests, or areas that are used as ecotourism locations.

There are various forms of developing bird ecotourism, such as birdwatching, tours to bird habitats, and observing birds in the wild. Marking the coordinates of where birds are located makes it easier for tourism managers to reach bird observation spots and develop supporting infrastructure. Ecotourism development is in line with conservation efforts. Ecotourism can raise public awareness of the importance of protecting birds and mangrove forests as their habitat. Apart from conservation benefits, ecotourism can also provide benefits for the economic development of local communities, such as becoming a bird tour guide [17], [18].

D. Conclusion

The research results obtained 37 species of birds consisting of 22 families. There are two species included in the IUCN Red List of Threatened Species: *Aegithina viridissima* and *Acridotheres javanicus*. Mapping the distribution points of bird species using the Quantum Gis provides benefits for planning bird observation routes.

E. Acknowledgment

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