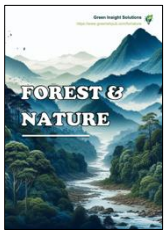
Vol. 1(2): 77-89, April 2025

FOREST AND NATURE

Homepage: https://www.greenishpub.com/fornature



RESEARCH ARTICLE

Diversity and Abundance of Waterbirds in Several Types of Wetlands (Case Study in Sumbernadi Village, South Lampung Regency)

Octavia Widya Maharany, Dian Iswandaru*, Gunardi Djoko Winarno, Sugeng Prayitno Harianto

Department of Forestry, Faculty of Agriculture, University of Lampung, Bandar Lampung, Indonesia
* Corresponding author: ndaruforest57@gmail.com

ARTICLE INFO

Article History:
Received: 27 February 2025
Revised: 28 March 2025
Accepted: 15 April 2025

Keywords:
Abundance
Coastal area
Diversity
Waterbirds
Wetlands

Citation: Maharany, O. W., Iswandaru, D., Winarno, G. D., Harianto, S. P. (2025). Diversity and Abundance of Waterbirds in Several Types of Wetlands (Case Study in Sumbernadi Village, South Lampung Regency). *Forest and Nature, 1*(2), 77-89.

ABSTRACT

Waterbirds are a group of birds that naturally spend most of their lives in aquatic areas. Sumbernadi Village is located in a coastal area that is part of the wetland ecosystem and includes mangrove, mudflat, fishpond, and ricefield habitats. The aim of this study is to obtain data on the species diversity, species richness, species evenness, species abundance, and species dominance of waterbirds in various wetland types in Sumbernadi Village, South Lampung Regency. The method used for bird data collection was the point count method. In this study, six observation points were established in each wetland habitat (mangrove, mudflat, fishpond, and ricefield), with a distance of 200 meters between each point, and an observation interval of 30 minutes. The results of the study identified 27 species of waterbirds, consisting of a total of 525 individuals from 9 families. These findings indicate that the mud and pond habitats have higher species diversity and richness compared to other habitats, with species diversity (H') values reaching 2.66 and 2.78, respectively. The species richness (R) values in these two habitats are also higher, indicating that environmental conditions in the mud and pond habitats are more supportive for various species of waterbirds to thrive. In contrast, the mangrove habitat shows lower diversity with an H' value of 2.06, indicating that the bird species in this habitat are less varied. On the other hand, the rice field habitat shows good evenness in species distribution with an E value reaching 0.94 and the absence of dominance of certain species (C = 0.11). This indicates a balance in the bird population in the rice field habitat, which can be an indicator of the health of the ecosystem in the area. The results of this study indicate the need for special attention in habitat management and conservation, especially to increase the diversity of waterbirds in less diverse habitats, such as mangroves. These efforts are essential to support healthier and more sustainable ecosystems and ensure that various waterbird species can adapt and survive in changing environments. The ecological index of waterbirds in several wetlands shows that mangroves have relatively low species diversity, while mudflats, ponds and rice fields have higher species diversity.

1. Introduction

Birds are one of the elements of biodiversity that can serve as indicators of environmental conditions (Malindu et al., 2016). In Indonesia, as of 2017, approximately 1,769 species of birds were recorded, a figure that is higher than the 1,672 species recorded in 2015 (Kusumahadi, 2020). This number increase is due to the discovery of new habitats and species and changes in taxonomic grouping. Indonesia also has a list of bird species threatened with extinction, with illegal hunting and the conversion of natural habitats being the main factors threatening the survival of bird species and their populations (Febrina and Faizah, 2022).

Waterbirds are a group of birds that naturally spend most of their lives in aquatic areas, whether for resting, foraging, or breeding (Siregar and Jumilawaty, 2019). Waterbirds have physical adaptations that enable them to survive and function in aquatic environments (Fayogi et al., 2019). Examples include waterproof feathers, long or webbed legs that facilitate swimming, and beaks suited

for foraging in the water (Siregar et al., 2018). Waterbirds prefer wetland habitats such as mangrove forests, mudflats, fishponds, and ricefields (Woghomugu and Warmetan, 2017). They choose these habitats because wetlands provide abundant food sources, protection from terrestrial predators, and safe nest locations (Tambunan et al., 2016).

Mangroves play a crucial role in the life of waterbirds. One of the functions of mangrove forests is to serve as a habitat for waterbirds (Makkatenni et al., 2020). Mangrove forest areas are transitional zones between terrestrial and marine environments, making this unique ecosystem rich in fauna and flora diversity (Pertiwi, 2021). The diversity and abundance of waterbird species can indicate a habitat (Amalia, 2021). Waterbirds help control insect populations and pollinate certain plant species; thus, the presence of waterbirds and their habitats support each other (Febrina and Faizah, 2022). Resident waterbirds that enter the breeding season will nest in fishponds previously used by migratory waterbirds for resting when the tide is low. Migratory waterbirds can be seen resting in other fishponds quite far from the fishponds where resident waterbirds nest (Siregar et al., 2018).

Waterbirds in mangrove areas, fishponds, ricefields, and mudflats often play important roles in the surrounding ecosystem. Mangroves are plants that live in tropical and subtropical coastal areas that are submerged by sea tides. Mudflats are a type of wetland that forms in coastal areas, especially in areas with strong tides such as bays or river estuaries. Fishponds are areas humans create to collect or process seawater or freshwater for fish or shrimp farming. Ricefields are a type of man-made wetland that functions as a rice planting area and is often flooded, especially during the planting season (Fayogi et al., 2019). Waterbirds can help in the dispersal of mangrove seeds and consume various small organisms living in those areas (Nurdin et al., 2021). In fishponds, birds such as gulls, herons, and sandpipers often utilize fishponds and ricefields as feeding grounds, especially when there are remnants of fish feed or invertebrates present in those fishponds (Herdiawan et al., 2018). Additionally, waterbirds can help control pest populations in fishponds (Pertiwi, 2021).

The diversity of waterbird species includes a variety of bird species that inhabit and depend on wetland habitats (Dima et al., 2022). Climate, environmental conditions, and resource availability can influence the diversity of waterbird species in a wetland area (Kusumahadi, 2020). Furthermore, migration seasons also significantly enhance the diversity of waterbird species, with many species undertaking long journeys each year to forage or breed in various types of wetlands (Lestari and Kurnia, 2023). The more diverse the types of wetlands in an area, the more species of waterbirds can be found (Lasantu et al., 2020).

Research on the diversity and abundance of waterbird species in Sumbernadi Village, South Lampung Regency, has never been conducted. Thus, information and data on the diversity of waterbirds in several types of wetlands in Sumbernadi Village, South Lampung Regency, are still limited. Therefore, research is needed on the diversity and abundance of waterbird species in several types of wetlands as one of the potential to support natural resource management in Sumbernadi Village, South Lampung Regency, which aims to obtain data on species diversity, species richness, species evenness, species abundance, and dominance of waterbirds.

2. Materials and Methods

2.1. Study Area

This research was conducted from November to December 2024 in Sumbernadi Village, Ketapang District, South Lampung Regency, Lampung Province (**Fig. 1**). The mangrove ecosystem in South Lampung covers 524.8 ha, consisting of 14 species (Kuncahyo et al., 2020; Simanjuntak et al., 2025). In Sumbernadi Village, the mangrove species consists of *Rhizophora* sp. Sumbernadi Village is a coastal area part of a wetland ecosystem that includes mangroves, mudflats, fishponds, and ricefields. The diversity of wetland types is related to environmental factors, and land management affects the distribution and diversity of waterbird species in the area.

2.2. Data Collection

The method used in collecting waterbird data is the point count method (Kiros, 2018). The point count method is carried out by observing at certain points in an area and recording all individual waterbirds seen or heard within a specified period (Fikriyanti et al., 2018). In this study, six

observation points were determined in each wetland (mangrove, mudflat, fishpond, and ricefield), with a distance of 200 meters between each point, with a time interval of 30 minutes. These observation points are used to avoid overlapping when calculating individual waterbirds in each type of wetland (Nurdin et al., 2021). Waterbird observations were carried out on several types of wetlands such as mangroves, mudflats, fishponds, and ricefields with two repetitions on each wetland, namely at 06.00–09.00 a.m. and at 03.00–06.00 p.m., where these times are when birds are actively looking for food, so they have a higher chance of being observed (Kamal, 2017). Observations were conducted for 3 days in each type of wetland, namely mangrove, mudflat, pond, and rice field. With 12 days of observation each month, this study covers a total of 24 days of observation carried out in November and December 2024. The data obtained were then analyzed descriptively to identify birds in threatened status based on the International Union for Conservation of Nature (IUCN) and protection status based on Indonesian Regulation (Regulation of the Minister of Environment and Forestry Number P.106/MENLHK/SETJEN/KUM.1/12/2018. In addition, literature studies were used to classify waterbird species based on feeding guilds.

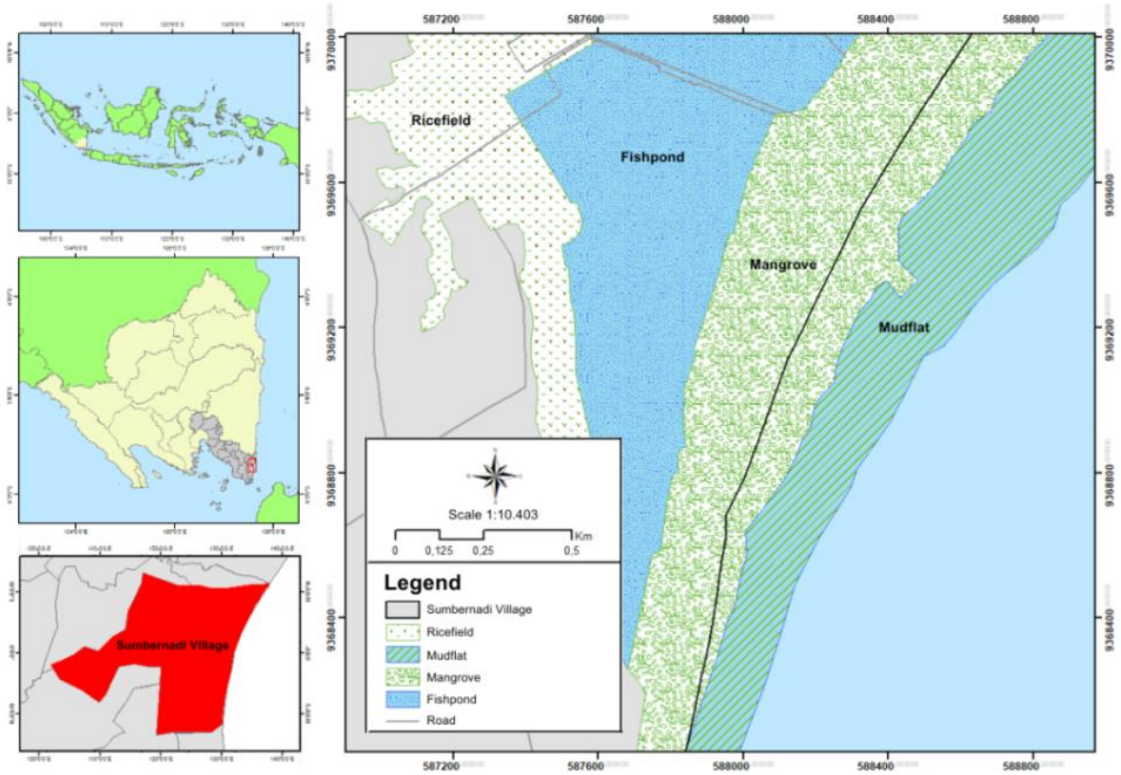


Fig. 1. Research location: Wetlands area in Sumbernadi Village, South Lampung Regency.

2.3. Data Analysis

The data analysis of this study consists of the analysis of species diversity index, species richness, species evenness, species abundance, and dominance of waterbird species. The data analysis is explained as follows.

2.3.1. Species diversity (H')

The species diversity index is a relationship between species abundance and species richness of waterbirds found in several wetlands (Meidita et al., 2018). The species diversity index can be calculated by the Shannon-Wiener formula using Equation 1 as follows (Magurran, 1988):

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

where *H'* is Shannon-Wienner diversity index, *ni* is number of individuals of the i-th species, *N* is number of individuals of all species, and *Pi* is proportion of individuals of the species. Criteria for the

value of the Shannon-Wienner diversity index (H'): H' ≤ 1 is low diversity, 1 ≤ H ≤ 3 is medium diversity, and H ≥ 3 is high diversity (Khalil et al., 2021).

2.3.2. Species richness (R)

The species richness index provides an overview of the diversity of species in an ecosystem (Baderan et al., 2021). The species richness index of waterbirds can be found using the Margalef species richness index formula with the following Equation 2 (Magurran, 1988):

$$R = S/\sqrt{n} \quad (2)$$

where *R* is richness index, *S* is number of species found, and *n* is total number of individuals. Species richness criteria (R): R < 2.5 is low species richness, 2.5 < R < 4 is medium species richness, and R > 4 is high species richness (Asrianny et al., 2018).

2.3.3. Species evenness (E)

The species evenness index is used to determine the evenness of the number of waterbird individuals that form a community in several types of wetlands, such as mangroves, mudflats, fishponds, and ricefields (Nurdin et al., 2021). The species evenness index is formulated with Equation 3 as follows (Ludwig and Reynolds, 1988):

$$E = \frac{H'}{\ln(S)} \quad (3)$$

where *E* is species evenness index, *H'* is species diversity index, and *S* is number of species. If the E value <0.20, it can be said that the species distribution condition is unstable, while if the E value is 0.21 <E <1, it can be said that the species distribution condition is stable (Pertiwi, 2021).

2.3.4. Species abundance (Di)

The relative abundance index of waterbirds in several types of wetlands, such as mangroves, mudflats, fishponds, and ricefields, can be determined using the following formula Equation 4 (Odum, 1993):

$$Di = \frac{ni}{N} \times 100\% \quad (4)$$

where *Di* is relative abundance index, *ni* is number of individuals of the i-th species, and *N* is total number of individuals. Criteria: Di 0 – 2% is a non-dominant species, Di 2 – 5% is a subdominant species, and Di > 5% is a dominant species.

2.3.5. Species dominance (C)

The dominance index of waterbird species in several types of wetlands, such as mangroves, mudflats, fishponds, and ricefields, can be determined using the Simpson Index formula Equation 5 as follows (Odum, 1993):

$$C = \sum \left(\frac{ni}{N}\right)^2 \quad (5)$$

where *C* is Dominance index, *ni* is number of individuals of a species, and *N* is number of individuals of all species. Criteria: C ≤ 0.5 indicates that no species can dominate other species, and C ≥ 0.8 indicates that there are species that dominate other species (Kurniawan and Prayogo, 2018).

3. Results and Discussion

3.1. Composition of Waterbirds in Several Types of Wetlands in Sumbernadi Village, South Lampung Regency

The research results found 27 species of waterbirds with 525 individuals belonging to 9 families (**Table 1**). Each observation location in the wetland habitat (mangrove, mudflat, fishpond, and ricefield) has a different number of species of waterbirds found. This is because Sumbernadi Village has different types of wetlands such as mangrove, mudflat, fishpond, and ricefield habitats, thus

showing that each species has different habitat preferences from other species (Iswandaru et al., 2023). Waterbirds utilize mudflats in mangrove forest areas to find food (Iswandaru et al., 2020). In addition, the presence of trees as perches and nesting sites, especially in higher locations, also contributes to the presence of waterbirds (Mahrudin and Arsyad, 2019). Wetlands such as mangroves, mudflats, ponds, and rice fields in Sumbernadi Village are ideal habitats for waterbirds because they provide abundant food and allow the birds to carry out various other activities, such as foraging, building or having nests, incubating eggs, and caring for their chicks.

Table 1. Diversity of Waterbird Species in Several Types of Wetlands in Sumbernadi Village, South Lampung Regency

No.	Common Name	Scientific Name	Family	Wetland Types				IUCN Status	Indonesian Regulation
				A	B	C	D		
1	Kentish Plover	*Charadrius alexandrinus*	Charadriidae		7	20		LC	NP
2	Grey Heron	*Ardea cinerea*	Ardeidae	3	1	5		LC	NP
3	Marsh Sandpiper	*Tringa stagnatilis*	Scolopacidae		2	3		LC	NP
4	Common Sandpiper	*Actitis hypoleucos*	Scolopacidae	7	5	13	2	LC	NP
5	Terek Sandpiper	*Xenus cinereus*	Scolopacidae	2	2	2	1	LC	NP
6	Wood Sandpiper	*Tringa glareola*	Scolopacidae	1	6	4		LC	NP
7	White-breasted Waterhen	*Amaurornis phoenicurus*	Rallidae		6	5	4	LC	NP
8	Javan Pond-heron	*Ardeola speciosa*	Ardeidae	5	1	14	5	LC	NP
9	Black-crowned Night Heron	*Nycticorax nyctcorax*	Ardeidae	5	1	6		LC	NP
10	Common Tern	*Sterna hirundo*	Sternidae		1	2		LC	P
11	Little Cormorant	*Microcarbo niger*	Phalacrocoracidae	31	4	20	6	LC	NP
12	Oriental Darter	*Anhinga melanogaster*	Anhingidae	1		4		LC	P
13	Striated Heron	*Butorides striata*	Ardeidae	2	3	4	1	LC	NP
14	Little Egret	*Egretta garzetta*	Ardeidae	29	10	24	4	LC	NP
15	Great Egret	*Ardea alba*	Ardeidae	5	1	8	4	LC	P
16	Cattle Egret	*Bubulcus ibis*	Ardeidae	49	5	60	6	LC	NP
17	Lesser Whistling-duck	*Dendrocygna javanica*	Anatidae			7		LC	NP
18	Intermediate Egret	*Egretta intermedia*	Ardeidae	4		14	3	LC	NP
19	Grey Plover	*Pluvialis squatarola*	Charadriidae		1	3		LC	NP
20	Javan Plover	*Charadrius javanicus*	Charadriidae		8	21		LC	P
21	Pasific Golden-plover	*Pluvialis fulva*	Charadriidae	1	3	4		LC	NP
22	Little Black Cormorant	*Phalacrocorax sulcirostris*	Phalacrocoracidae	8		13	2	LC	NP
23	Common Greenshank	*Tringa nebularia*	Scolopacidae		1	2		LC	NP
24	Cinnamon Bittern	*Ixobrychus cinnamomeus*	Ardeidae			2		LC	NP
25	Lesser Adjutant	*Leptoptilos javanicus*	Ciconiidae	2		1		NT	P
26	Purple Heron	*Ardea purpurea*	Ardeidae			1		LC	NP
27	Wandering Whistling-duck	*Dendrocygna arcuata*	Anatidae			2		LC	NP
		Amount		155	68	264	38		

Notes: A = Mangrove, B = Mudflat, C = Fishpond, D = Ricefield, LC = Least Concern, NT = Near Threatened, NP = Not Protected, and P = Protected.

Based on observations of the four types of wetlands, the Ardeidae family (**Fig. 2**) is the most common. This is because the wetlands provide various resources sufficient to support the life of waterbirds, especially the Ardeidae family. The abundant food availability makes waterbird species more dominant in a particular wetland (Indrayanti et al., 2015).

Table 1 shows that each type of wetland has a different number of waterbird individuals. Waterbirds in the mangrove habitat numbered 155 individuals, the mudflat habitat numbered 68 individuals, the fishpond habitat numbered 264 individuals, and the ricefield habitat numbered 38 individuals. The availability of abundant food resources in a wetland will make waterbird species more dominant in that location (Indrayanti et al., 2015). Waterbirds use mudflats in mangrove forest areas to find food (Iswandaru et al., 2020). In addition, the presence of trees as a place to perch and make nests, especially in high locations, also supports the existence of waterbirds (Mahrudin and Arsyad, 2019). Wetlands such as mangroves, mudflats, fishponds, and ricefields in Sumbernadi

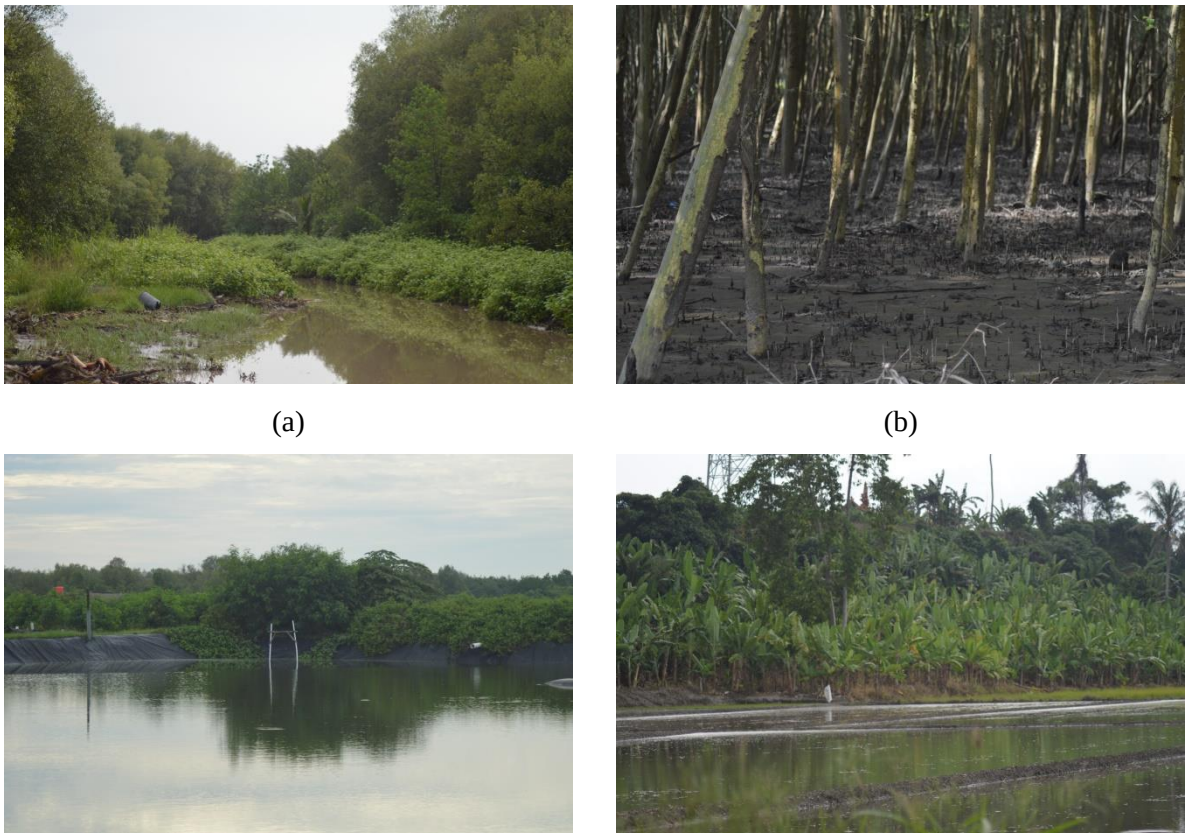
Village are ideal habitats for waterbirds because there is an abundant supply of food, and it allows waterbirds to carry out various other activities, such as foraging, building or having nests, incubating eggs, and caring for their chicks.

Fig. 2. Great Egret (*Ardea alba*).

The conservation status of birds in Sumbernadi Village (**Table 1**) shows 26 species with the least concern status and one near threatened status. However, one waterbird species has a conservation status with a Near Threatened (NT) category, namely the Lesser Adjutant (*Leptoptilos javanicus*). Conservation status based on the Indonesian Regulation (P.106/MNLHK/SETJEN/KUM.1/12/2028), it is known that there are 5 protected waterbird species, such as the common tern (*Sterna hirundo*), the oriental darter (*Anhinga melanogaster*), the great egret (*Ardea alba*), the javan plover (*Charadrius javanicus*), and the lesser adjutant (*Leptoptilos javanicus*), and 22 other species have unprotected conservation status.

There are several species that fall into the migrant and resident categories. Migratory birds that can be found include Kentish plover, marsh sandpiper, common sandpiper, terek sandpiper, wood sandpiper, common tern, grey plover, Pacific golden plover, and common greenshank. Meanwhile, resident birds that are often found include grey heron, white-breasted waterhen, javan pond-heron, black-crowned night heron, little cormorant, oriental darter, striated heron, little egret, great egret, cattle egret, lesser whistling-duck, intermediate egret, javan plover, little black cormorant, cinnamon bittern, lesser adjutant, purple heron, and wandering whistling-duck. Some species can be semi-migratory or have different populations in various locations so that this classification can vary depending on local conditions and observation time (Siregar et al., 2018).

Several activities that can threaten the sustainability of waterbirds in wetland areas include poaching, land conversion, and habitat destruction. This environmental damage can cause habitat loss and force waterbirds to move elsewhere (Riefani and Soendjoto, 2015). In addition, the distance between the observation location and residential areas also affects the difference in the number of waterbird species found in the four wetland locations; it might be due to the activities of residents around the settlements, which are a disturbing factor or threat to waterbirds (Angga et al., 2015). Conservation and management of wetlands in mangroves, mudflats, ponds, and rice fields are very important in maintaining biodiversity and the sustainability of ecosystems that support the lives of various species, including waterbirds (**Fig. 3**). One of the main steps in this conservation is the restoration of mangrove habitats, which can be done by replanting mangroves in degraded areas, thereby creating a better environment for waterbirds and other organisms. In addition, implementing sustainable management in muddy areas is crucial to maintain the balance of the ecosystem by reducing activities that can damage the habitat and ensuring that the area can continue to support the lives of various species. In ponds, applying environmentally friendly cultivation techniques, such as using natural feed and efficient water management, can help maintain water quality and support the existence of waterbirds and other organisms. Meanwhile, reducing the use of pesticides and chemical fertilizers in rice fields is very important to prevent pollution.



(a) (b)

(c) (d)

Fig. 3. Types of wetlands in Sumbernadi Village, South Lampung Regency, (a) Mangrove, (b) Mudflat, (c) Fishpond, and (d) Ricefield.

3.2. Diversity of Waterbird Species in Several Types of Wetlands in Sumbernadi Village, South Lampung Regency

Based on the results of observations conducted on the types of wetlands in Sumbernadi Village, South Lampung Regency, namely mangroves, mudflats, fishponds, and ricefields, the species diversity index (H'), species richness (R), species evenness (E), species abundance (Di), and species dominance (C) of waterbirds are known, which are presented in **Table 2** and **Fig. 4**.

Table 2. Ecological Index of Waterbirds in Several Types of Wetlands

No.	Wetland Types	H'	R	E	Di	C
1	Mangrove	2.06	3.17	0.74	1.0%	0.18
2	Mudflat	2.66	4.74	0.89	1.0%	0.08
3	Fishpond	2.78	4.84	0.84	1.0%	0.09
4	Ricefield	2.26	3.02	0.94	1.1%	0.11

The diversity of waterbird species varies in each wetland due to differences in environmental conditions. The diversity of bird species in an area can indicate the conditions in the area (Iswandaru et al., 2018). In mangrove habitats, varying salinity and tree vegetation provide perches and nests, but the diversity of waterbirds tends to be moderate because salinity and tides limit the species that can survive (Riefani and Soendjoto, 2015). In mudflat habitats, it is rich in invertebrates as food, supporting higher diversity, especially with the arrival of migratory birds (Tambunan et al., 2016). Meanwhile, fishponds have a more complex habitat and abundant food availability, supporting high diversity, including migratory waterbird species (Pertiwi, 2021). In ricefield habitats, although providing food such as insects and rice, the diversity of waterbirds is lower due to intensive agricultural activities (Febrina and Faizah, 2022). These differences are caused by physical factors such as salinity, water depth, type of food, and the influence of human activities in each habitat

(Mahar et al., 2023). The research results show that the ecological index of waterbirds in several types of wetlands has varying values, reflecting different environmental conditions and varying levels of biodiversity in each wetland location.

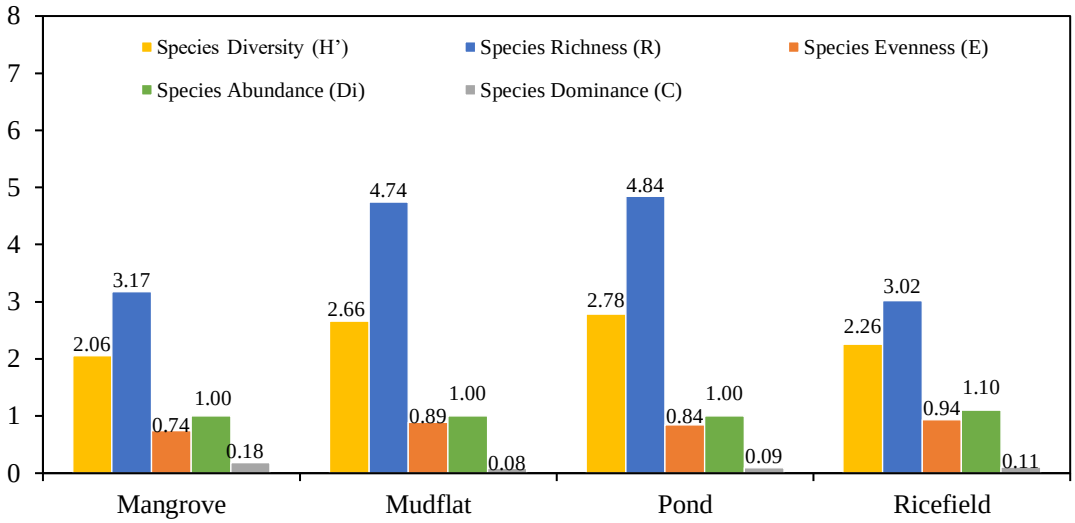


Fig. 4. Ecological index diagram of waterbirds in several types of wetlands in Sumbernadi Village, South Lampung Regency.

Based on the data presented regarding the ecological index of waterbirds in several wetlands, the diversity, richness, evenness, abundance, and dominance of waterbird species found in mangrove habitats can be determined (**Table 2**). The species diversity value (H') for the mangrove habitat is 2.06, which indicates that this habitat has moderate diversity. This indicates that the mangrove habitat can support various types of waterbirds, although not as diverse as habitats with higher H' values. Furthermore, the species richness value (R) recorded was 3.17, also in the moderate species richness category. This shows that the mangrove habitat has quite good species variation, although there is still potential to increase the number of species present (Taylor et al., 2010). The species evenness (E) in the mangrove habitat obtained a value of 0.74, which indicates that the distribution conditions of waterbird species in this habitat are stable. This means no species dominates excessively, and species distribution is relatively even, a positive indication of ecosystem health (Fathani et al., 2025). Furthermore, the species abundance value (Di), which reached 1.0%, indicates that the types of waterbirds in the mangrove habitat are not dominant, with a low percentage of abundance. This shows that although some species may be more common, no single species dominates significantly. The species dominance value (C) was obtained at 0.18, indicating that no species dominates other species in the mangrove area.

The ecological index of waterbirds on the mudflat has a significant value (**Table 2**). The species diversity value (H') for the mudflat habitat was recorded at 2.66, indicating that this habitat has moderate diversity. This means the mudflat habitat can support several varied waterbird species, although not as diverse as habitats with higher H' values (Schéré et al., 2023). Furthermore, the species richness (R) obtained a value of 4.74, indicating that the mudflat habitat has high species richness. This shows that this habitat can support many species of waterbirds, a positive indicator of ecosystem health and diversity. The species evenness (E) in the mudflat habitat reached 0.89, indicating that the distribution of waterbird species in this habitat is stable. This value indicates that species distribution is relatively even, without any species dominating excessively, which is a good sign for ecosystem balance (Chanate et al., 2020). Furthermore, the species abundance value (Di) recorded was 1.0%, indicating that the types of waterbirds in the mudflat habitat are not dominant, with low abundance. This shows that although some species may be more common, no single species dominates significantly in this ecosystem (Kurniawan and Prayogo, 2018). The species dominance value (C) recorded was 0.08, indicating that no species dominates other species in the mudflat habitat.

Based on the data presented, it is known that the species diversity value (H') for the fishpond habitat was recorded at 2.78, indicating that this habitat has moderate diversity. This indicates that the fishpond habitat can support several varied waterbird species (Bai et al., 2018). Furthermore, the species richness value (R) recorded was 4.84, indicating that the fishpond habitat has high species richness. This shows that this habitat can support many species of waterbirds, which is a positive indicator for the health and diversity of the ecosystem (Kaur et al., 2018). The species evenness (E) in the fishpond habitat reached 0.84, indicating that the distribution of waterbird species in this habitat is stable. This value indicates that species distribution is relatively even, without any species that dominate excessively. Furthermore, the species abundance value (Di) recorded was 1.0%, indicating that the types of waterbirds in the fishpond habitat are not dominant, with low abundance. This shows that although some species may be more common, no single species dominates significantly in this ecosystem (Kurniawan and Prayogo, 2018). The recorded species dominance value (C) was 0.09, indicating that no species dominates other species in the fishpond habitat.

The species diversity value (H') for the ricefield habitat recorded at 2.26, meaning that this habitat has a moderate diversity category. Furthermore, the recorded species richness value (R) was 3.02, also in the moderate species richness category. This shows the ricefield habitat has quite good species variation (Paulino et al., 2024). The species evenness (E) in the ricefield habitat reached 0.94, indicating that the distribution of waterbird species in this habitat is stable. This value indicates that the distribution of waterbird species in the ricefield habitat is relatively even, without any excessively dominant species (Sesser et al., 2016). The species abundance value (Di) obtained a value of 1.1%, indicating that the types of waterbirds in the ricefield habitat are not dominant, with low abundance. This indicates that although there are several species that may be more common, no single species dominates significantly in this ecosystem (Kurniawan and Prayogo, 2018). The species dominance value (C) obtained a value of 0.11, indicating that no species dominates other species in the ricefield habitat.

3.3. Waterbird Feeding Guild in Several Types of Wetlands in Sumbernadi Village, South Lampung Regency

Waterbirds play an important role in maintaining ecosystem balance in wetland ecosystems through their interactions with various natural resources, including food (Artika et al., 2019). A feeding guild is a species with similar feeding methods or sources (Taylor et al., 2010). Based on the results of the study, waterbirds found in wetland habitats such as mangroves, mudflats, fishponds, and ricefields have feeding guild types that are grouped into several categories, namely piscivore, insectivore, carnivore, and omnivore (**Fig. 5**).

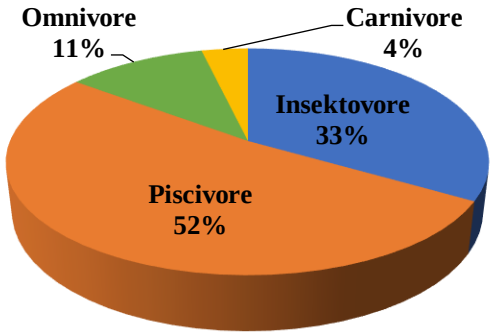


Fig. 5. Waterbirds feeding guild diagram.

Waterbird feeding guild data is crucial because it can provide an overview of the environment's capacity to support bird survival through energy flow in the food chain (Ramadhani et al., 2023). Waterbird feeding guilds in wetlands show significant variation in the diet of birds in the habitat. The diagram above shows that the dominance of the piscivorous type reaches 52%. This shows that waterbirds in wetlands are highly dependent on aquatic resources, such as fish and other aquatic organisms, such as the Great Egret (*Ardea alba*), Javan Pond-heron (*Ardeola speciosa*), Oriental Darter

(*Anhinga melanogaster*), and Little Black Cormorant (*Phalacrocorax sulcirostris*). The existence of wetlands rich in biodiversity, including various types of fish, shrimp, and other living things, is the main factor supporting the survival of these birds (Huang et al., 2024).

The insectivore guild type reaches 33%, which shows that insects also play an important role in the diet of waterbirds in Sumbernadi Village. Waterbird species with insectivorous feeding guild types, such as the Common Sandpiper (*Actitis hypoleucos*) and the Javan Plover (*Charadrius javanicus*). The abundant presence of insects can provide opportunities for waterbirds to utilize available food sources. Insects are often an important source of protein for birds, especially during the reproductive period when nutritional needs increase (Kurnia et al., 2024). The adaptation of waterbirds to changes in seasons and food availability is very important for their survival. For example, when water levels increase during the rainy season, the insect population will tend to increase, so that waterbirds can take advantage of this moment to find food. By utilizing various food sources, waterbirds can increase their chances of survival and reproduction (Rumblat et al., 2016).

The omnivore guild type contributed 11%, indicating flexibility in the diet of waterbirds. Waterbirds with an omnivorous feeding guild type can utilize the resources around them, including seeds, fruits, and even leftovers from other animals, such as the White-breasted Waterhen (*Amaurornis phoenicurus*). This flexibility is very important, especially in uncertain environmental conditions, where food availability can vary (Kurnia et al., 2024). Although the percentage of carnivores is relatively small at 4%, this shows that there are waterbird species that rely on other animals for food, although not as many as other feeding guild types, such as the Lesser Adjutant (*Leptoptilos javanicus*). The diversity of feeding guild types shows the complexity of wetland habitats as providers of various types of food sources that support the diversity of waterbirds (Nababan et al., 2021).

4. Conclusion

The conclusion obtained from the research on the diversity and abundance of waterbird species conducted in several types of wetlands in Sumbernadi Village, South Lampung Regency, is the discovery of 27 species of waterbirds with a total of 525 individuals belonging to 9 families. Mangrove has a species diversity value (H') of 2.06 which indicates a moderate category, species richness (R) of 3.17 which is included in the moderate category, species evenness (E) of 0.74 which indicates that the distribution of waterbird species in this habitat is stable, species abundance (Di) reaching 1.0% which indicates that waterbird species in mangroves are not dominant, with a low abundance percentage, and species dominance (C) obtained at 0.18 which indicates that no species dominates other species in the mangrove area. Mudflat has a species diversity value (H') of 2.66, which indicates a moderate category, species richness (R) of 4.74 which indicates a high category, species evenness (E) reaching 0.89, which indicates that the distribution of waterbird species in this habitat is stable, species abundance (Di) of 1.0% which indicates that waterbird species in mudflat are not dominant, and species dominance value (C) of 0.08 which indicates that no species dominates other species. Fishponds have a species diversity value (H') of 2.78 indicating a moderate category, species richness (R) of 4.84 indicating a high category, species evenness (E) reaching 0.84 indicating that the distribution of waterbird species in this habitat is stable, species abundance (Di) of 1.0% indicating that the species of waterbirds in the fishpond are not dominant, and species dominance (C) of 0.09 indicating that no species dominates other species in the fishpond habitat. Ricefields have a species diversity value (H') of 2.26, indicating a moderate category, species richness (R) of 3.02, indicating a moderate category, and species evenness (E) reaching 0.94, indicating that the distribution of waterbird species in this habitat is stable. The species abundance value (Di) obtained a value of 1.1%, indicating that the species of waterbirds in the ricefield habitat are not dominant, and the species dominance (C) obtained a value of 0.11, indicating that no species dominates other species in the ricefield habitat. The results of this study indicate the need for special attention in habitat management and conservation, especially to increase the diversity of waterbirds in less diverse habitats, such as mangroves. These efforts are essential to support healthier and more sustainable ecosystems and ensure that various waterbird species can adapt and survive in changing environments.

Acknowledgments: The authors would like to thank the head of Sumbernadi Village and the community for their cooperation in supporting this research.

Author Contributions: O.W.M.: resources, investigation, data analysis, writing – initial draft; D.I.: supervision, conceptualization, methodology, data validation, writing – review and editing; G.D.W.: supervision, methodology; S.P.H.: methodology, validation. All authors have read and agreed to the published version of the manuscript.

Funding: The authors received no financial support for this article's research, authorship, and/or publication.

Data Availability Statement: The datasets generated and analyzed during the current study are not publicly available but are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

References

Amalia Z. M. R. (2021). Keanekaragaman dan Kelimpahan Jenis Burung di Kawasan Mangrove Mangunharjo Semarang Diversity and Abundance of Bird Species in Mangrove Area Mangunharjo Semarang. *Bioma*, *23*(2), 100-106.

Angga, Setyawati, T. R., & Yanti, A. H. (2015). Keragaman Jenis Burung Air di Kawasan Hutan Mangrove Primer dan Hutan Mangrove Hasil Reboisasi di Kabupaten Mempawah. *Jurnal Protobiont*, *4*(3), 118-125.

Artika, E., Darmawan, A., & Hilmanto, R. (2019). Perbandingan Metode Maximum Likelihood Clasification (MLC) dan Object Oriented Classification (ooc) dalam Pemetaan Tutupan Mangrove di Kabupaten Lampung Selatan. *Jurnal Hutan Tropis*, *7*(3), 1-19.

Asrianny, A., Saputra, H., & Achmad, A. (2018). Identifikasi Keanekaragaman dan Sebaran Jenis Burung Untuk Pengembangan Ekowisata Bird Watching di Taman Nasional Bantimurung Bulusaraung. *Perennial*, *14*(1), 17.

Baderan, D. W. K., Rahim, S., Angio, M., & Salim, A. I. B. (2021). Keanekaragaman, Kemerataan, dan Kekayaan Spesies Tumbuhan dari Geosite Potensial Benteng Otanaha sebagai Rintisan Pengembangan Geopark Provinsi Gorontalo. *Al-Kauniyah: Jurnal Biologi*, *14*(2), 264-274.

Bai, M. L., Chih, W. C., Lai, Y. C., Lee, P. F., & Lien, Y. Y. (2018). Aquaculture Ponds as Important High-Tide Habitats for Waterbirds Along the West Coast of Taiwan. *Ornithological Science*, *17*(1), 55-67.

Chanate, W., Wasan, D., Pisarut, Y., & Rungtip, S. A. (2020). The Diversity, Population, Ecology and Conservation Status of Waterbirds in the Wetland of Bangpu Nature Education Center, Thailand. *Biodiversitas*, *21*(8), 3910-3918.

Dima, A. O. M., Septa, F. M. I., Bana, J. J., Ati, V. M., Meye, E. D., & Neno, M. R. H. (2022). Keanekaragaman dan Kelimpahan Jenis Burung Pantai di Kawasan Taman Wisata Alam Menipo. *Jurnal Biotropikal Sains*, *19*(2), 38-46.

Kurnia, I., Fajari, M. F., Qohhar, J. A., Rahmawati, N., Affandi, M. R., & Aeni, A. Z. K. (2024). Keanekaragaman Jenis Burung di Kawasan Wisata Pantai Sawarna Kecamatan Bayah Kabupaten Lebak Provinsi Banten. *Konservasi Hayati*, *20*(1), 48-61.

Fathani, M. H., Mulyani, Y. A., & Mardiastuti, A. 2025. Factors Affecting Bird Diversity in the Wetlands of Muara Gembong, Indonesia. *Journal of Tropical Forest Management*, *31*(1), 61-71.

Fayogi, M. I., Harianto, S. P., Dewi, B. S., & Setiawan, A. (2019). Analisis Keanekaragaman Jenis Burung Air di Desa Penyangga Taman Nasional Way Kambas (Studi Kasus Desa Braja Harjosari). *Seminar Nasional Konservasi*.

Febrina, R., & Faizah, U. (2022). Keanekaragaman dan Kelimpahan Jenis Burung di Kawasan Mangrove Bee Jay Bakau Resort (BJBR) Kota Probolinggo. *Jurnal Sains dan Matematika*, *7*(1), 1-7.

Fikriyanti, M., Wulandari, W., Fauzi, I., & Rahmat, A. (2018). Keragaman Jenis Burung pada Berbagai Komunitas di Pulau Sangiang, Provinsi Banten. *Jurnal Biodjati*, *3*(2), 157-165.

Herdiawan, B., Rukmana, R., & Najiyah, F. (2018). Peran Petani Tambak Trunojoyo dalam Pelestarian Burung di Kawasan Pantai Timur Surabaya. *Sains dan Matematika*, *6*(2), 33-37.

Indrayanti, M. D., Fahrudin, A., & Setiobudiandi, I. (2015). Penilaian Jasa Ekosistem Mangrove di Teluk Blanakan Kabupaten Subang. *Jurnal Ilmu Pertanian Indonesia, 20*(2), 91-96.

Iswandaru, D., Febryano, I. G., Santoso, T., Kaskoyo, H., Winarno, G. D., Hilmanto, R., Safe'i, R., Darmawan, A., & Zulfiani, D. (2020). Bird Community Structure of Small Islands: A Case Study on the Pahawang Island, Lampung Province, Indonesia. *Silva Balcanica*, *21*(2), 5-18.

Iswandaru, D., Hariyono, & Rohman, F. (2023). Birding and Avitourism: Potential Analysis of Birds in the Buffer Villages Around Conservation Area. *Jurnal Sylva Lestari*, *11*(2), 247-269.

Iswandaru, D., Khalil, A. R. A., Kuniawan, B., Pramana, R., Febryano, I. G., & Winarno, G. D. (2018). Kelimpahan dan Keanekaragaman Jenis Burung di Hutan Mangrove KPHL Gunung Balak. *Indonesian Journal of Conservation*, *7*(1), 57-62.

Kamal, S. (2017). Keanekaragaman Jenis Burung di Kawasan Pesisir Deudap Pulo Aceh Kabupaten Aceh Besar. *Prosiding Seminar Nasional Biotik, 5*(1), 252-259.

Kaur, S., Kaur K. T., Javed, M., & Tejdeep K. K. C. (2018). Abundance and Diversity of Water Bird Assemblages in Relation to Village Ponds in Punjab. *Journal of Entomology and Zoology Studies*, *6*(1), 1375-1380.

Khalil, A. R. A., Mulyani, Y. A., Mardiastuti, A., & Iswandaru, D. (2021). Diversity of Waterbirds in Mudflat and Fishpond Habitats in Coastal Wetlands of East Lampung, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *948*(1), 1-6.

Kiros, S. (2018). A Preliminary Study on Bird Diversity and Abundance from Wabe Fragmented Forests Around Gubre Subcity and Wolkite Town, Southwestern Ethiopia. *International Journal of Avian and Wildlife Biology*, *3*(4), 333-340.

Kuncahyo, I., Pribadi, R., & Pratikto, I. (2020). Komposisi dan Tutupan Kanopi Vegetasi Mangrove di Perairan Bakauheni, Kabupaten Lampung Selatan. *Journal of Marine Research*, *9*(4), 444-452.

Kurniawan, A. J., & Prayogo, H. (2018). Diurnal Bird Spesies Diversity in Temajo Island in Sungai Kunyit of Mempawah District West Kalimantan. *Strofor Journal*, 6(1), 230-237.

Kusumahadi, K. S. (2020). Analisis Keanekaragaman Jenis Burung di Kawasan Pantai Indah Kapuk Kota Jakarta Utara. *Jurnal Ilmu dan Budaya*, *41*(69), 8155-8168.

Lasantu, T. W. N., Tasirin, J. S., & Nurmawan, W. (2020). Keanekaragaman Jenis Burung Air di Kecamatan Kakas, Sulawesi Utara. *Cocos*, *6*(6).

Lestari, D. F., & Kurnia, I. (2023). Keanekaragaman Jenis Burung pada Berbagai Tipe Habitat di Pulau Belitung. *Bioscientist: Jurnal Ilmiah Biologi*, *11*(1), 1-19.

Ludwig, J. A., & Reynolds, J. F. (1988). *Statistical Ecology: A Primer in Methods and Computing*. John Wiley and Sons, New York.

Magurran, A. E. (1988). *Ecological Diversity and Its Measurement*. Princeton University Press, New Jersey.

Mahar, N., Habib, B., Hussain, S.A., Shawl, T., & Takpa, J. (2023). Influence of Anthropogenic Factors on the Waterbirds in Trans-Himalayan Wetlands. *Global Ecology and Conservation, 46*(6), e02567.

Mahrudin, M., & Arsyad, M. (2019). Keanekaragaman Burung Air di Lahan Basah Desa Sungai Rasau Kecamatan Bumi Makmur Kabupaten Tanah Laut. *Wahana-Bio: Jurnal Biologi dan Pembelajarannya*, *11*(1), 59-67.

Makkatenni, M., Husnaeni, H., & Amirullah, A. (2020). Keanekaragaman Jenis Burung Air di Kawasan Ekowisata Hutan Bakau Desa Lakawali Kecamatan Malili Kabupaten Luwu Timur. *Jurnal Biotek*, *8*(2), 189-207.

Malindu, F. D., Labiro, E., & Ramlah, S. (2016). Asosiasi Jenis Burung dengan Vegetasi Hutan Mangrove di Wilayah Pesisir Pantai Kecamatan Tinombo Selatan Kabupaten Parigi Moutong. *Warta Rimba*, *4*(1), 112-118.

Meidita, E., Utami, M. N., & Armanda, F. (2018). Keanekaragaman Jenis Burung di Wilayah Indonesia. *Prosiding Seminar Nasional Pendidikan Biologi*, *1*(1), 38-48.

Nababan, B. R. R., Harianto, S. P., & Setiawan, A. (2021). Diversitas Spesies Burung dalam Penentuan Kualitas Ruang Terbuka Hijau di Universitas Lampung. *Jurnal Hutan Tropis*, *9*(1), 30-42.

Nurdin, Kosasih, D., Supartono, T., Ghojali, N. M., & Rahardian, H. (2021). Keanekaragaman Jenis dan Karakteristik Habitat Burung di Ekosistem Mangrove Indramayu. *Jurnal Penelitian Universitas Kuningan: Logika*, *12*(2), 130-140.

Odum, E. P. (1993). *Dasar-Dasar Ekologi. Terjemahan Tjahjono Samingan. (Edisi Ketiga)*. Universitas Gadjah Mada Press, Yogyakarta.

Pertiwi, H. J. (2021). Keanekaragaman Jenis Burung di Cagar Alam Pulau Dua, Banten. *Biosel: Biology Science and Education, 10*(1), 55-70.

Ramadhani, R., Setiawan, A., Iswandaru, D., & Fitriana, Y. R. (2023). Guild Pakan Spesies Burung di Ekosistem Savana Taman Nasional Way Kambas. *Jurnal Hutan Lestari, 11*(1), 187-194.

Riefani, M. K., & Soendjoto, M. A. (2015). Keragaman Jenis Burung Air di Kawasan Selat Sebuku Kotabaru, Kalimantan Selatan. *Seminar Nasional XI Pendidikan Biologi FKIP UNS*. 714-720 pp.

Rumblat, W., Mardiastuti, A., & Yeni, A. M. (2016). Guild Pakan Komunitas Burung di DKI Jakarta. *Media Konservasi, 21*(1), 58-64.

Schéré, C. M., Dawson, T. P., & Schreckenberg, K. (2023). Un-Muddying the Waters: Using Benthic and Shorebird Population Data to Assess Intertidal Mudflat Conditions and Inform Management Strategies in Two Irish Sea Marine Protected Areas. *Ecological Indicators, 154*(6), 110632.

Siregar, N. H., & Jumilawaty, E. (2019). Diversitas dan Ekologi Makan Burung Pantai di Kawasan Pantai Baru, Kabupaten Deli Serdang Sumatera Utara. *Journal of Science and Application Technology*, *2*(1), 8-15.

Siregar, N. H., Perwitasari-Farajallah, D., & Mulyani, Y. A. (2018). Pengaruh Kehadiran Burung Pantai Migran terhadap Keberadaan Burung Pantai Penetap di kawasan Tambak Wonorejo, Surabaya. *Jurnal Education and Development*, *6*(2), 37-40.

Simanjuntak, M., Duryat, & Riniarti, M. (2025). Harnessing the Blue Economy: Ethnobotanical Insights into Mangrove-Derived Functional Foods for Climate-Resilient Futures. *Forest and Nature*, *1*(1), 1-8.

Tambunan, M. F., Nurdjali, B., & Siahaan, S. (2016). Identifikasi Jenis-Jenis Burung Pantai yang Bermigrasi di Tanjung Bunga Kecamatan Teluk Pakedai Kabupaten Kubu Raya. *Hutan Lestari,* 4(4), 394-400.

Taylor, A. R., Lanctot, R. B., Powell, A. N., Huettman, F., Nigro, D. A., & Kendall, S. J. (2010). Distribution and Community Characteristics of Staging Shorebirds on the Northern Coast of Alaska. *Arctic*, *63*(4), 451-467.

Woghomugu, D. V. S., & Warmetan, H. (2017). Pengelolaan Kawasan Lahan Basah sebagai Habitat Burung Migran di Taman Nasional Wasur. *Jurnal Kehutanan Papuasia, 3*(2), 111-119.