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ANALYSIS OF BIRD DIVERSITY AND FEEDING GUILDS IN THE SIMPANG RUSA ECOSYSTEM RECOVERY AREA, SUSUKAN BARU RESORT, WAY KAMBAS NATIONAL PARK

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ABSTRACT

The presence, diversity, and abundance of bird species can be an indicator of whether an environment supports the life of organisms or not, because birds have a reciprocal and interdependent relationship with their environment.This study aimed to determine birds' diversity, richness, evenness, dominance, feeding groups, and conservation status in the Simpang Rusa Ecosystem Recovery Area. Data collection was done by direct observation in the field using the point count method. A total of 47 bird species from 24 families with a species diversity value (H') of 3.11 in the high category, species richness value (R) 7.62, species evenness value (E) of 0.8 in the good category, and species dominance (C) of 0.07 in the low category. 6 feeding groups were identified, namely insect eaters (53%), fruit eaters (18%), animal material eaters (12%), fish eaters (7%), seed eaters (6%) and nectar eaters (3%). Four protected bird species were found, namely *Elanus caeruleus* and *Spilornis cheela*, *Gorsachius melanolophus* and *Rhipidura javanica*. Based on the IUCN Redlist, there are two bird species with Near Treatened status, namely the *Phaenicophaeus diardi* and *Cyornis turcosus*, one species with Vulnerable status, namely the *Acridotheres javanicus*, and 42 other species with Least Concern status. Based on CITES, two bird species have Appendix II status. Monitoring and improving food resources by optimising the structure of the vegetation community is needed, which can also serve as a model for other conservation areas to increase bird populations.

***Keywords**: Birds, ecosystem recovery area, diversity, feeding guilds.*

INTRODUCTION

Birds are Aves class wildlife found in various habitat types, ranging from beaches, swamps, mountains, and lowlands. Birds are an object of biodiversity conservation and have indirect benefits to maintaining ecosystem stability (Zaen and Rita, 2018). The presence of birds can indicate whether the environment supports the life of an organism or not because it has a reciprocal and interdependent relationship with its environment (Fikriyanti *et al*., 2018). Birds can act as an indicator taxon that can measure the level of ecological recovery during the forest ecosystem recovery process and the progress of ecosystem recovery (Adelino *et al*., 2020). The diversity and abundance of bird species can indicate how the area is doing. Bird distribution in an area is influenced by habitat characteristics, where woody vegetation provides essential resources for shelter, nesting, and foraging. Understanding the interactions between bird communities and restored habitats is therefore critical to assessing the effectiveness of ecosystem restoration (Ortega-Álvarez and Lindig-Cisneros, 2012).

Ecosystem restoration is essential to increase previously declining biodiversity, help restore ecological processes and provide ecosystem services in disturbed or degraded areas (Latawiec *et al*., 2016). Ecosystem restoration is recognized by the 14th and 15th Aichi International Convention on Biological Diversity as a key action to prevent mass extinction (Navarro *et al*., 2017). Ecosystem restoration has become one of the crucial efforts in biodiversity conservation, including bird communities (Sihotang *et al*., 2013). Ecological restoration has been shown to increase the diversity of bird communities and promote equitable distribution of bird populations by providing habitat (Ortega-Álvarez and Lindig-Cisneros, 2012).

Way Kambas National Park has diverse vegetation that serves as a habitat for wildlife. WKNP has an ecosystem recovery area, especially in parts damaged by anthropogenic activities in the past, one of which is the Simpang Rusa Ecosystem Recovery (PESR) area. This ecosystem recovery area will have 30 hectares starting in 2022. To determine the success of habitat recovery in the ecosystem recovery area, birds can be a bioindicator of habitat recovery. Therefore, this study aims to determine the diversity, richness, evenness, dominance, feeding groups, and conservation status of birds in the Simpang Rusa Ecosystem Recovery Area. This study is expected to see the extent to which ecosystem recovery can support bird life as its natural habitat and whether the ecosystem recovery area can provide adequate habitat for birds, even though there are differences in species composition and community structure compared to natural forests.

METHODS

Simpang Rusa ecosystem recovery area is one of four ecosystem recovery areas located in Way Kambas National Park. Simpang Rusa ecosystem recovery is located at coordinates 4°59'59‘'S 105°34'54’'E in the Susukan Baru RPTN area, SPTN 1 Way Kanan, East Lampung Regency. Simpang Rusa ecosystem restoration is managed by KTH Wana bakti from April 2022 until now, this area has an area of 30 hectares with 5 planting blocks. Management activities in this area include planting, replanting, and weeding and watering if needed. the presence and presence of birds has only been felt in the past half year, after the planted vegetation began to grow, dense and there was natural emergence that made changes to the ecosystem, this is in accordance with the statement of Ortega-Álvarez and Lindig-Cisneros, (2012) that habitat changes and the success of ecosystem recovery efforts in providing suitable and supportive habitat for various bird species.

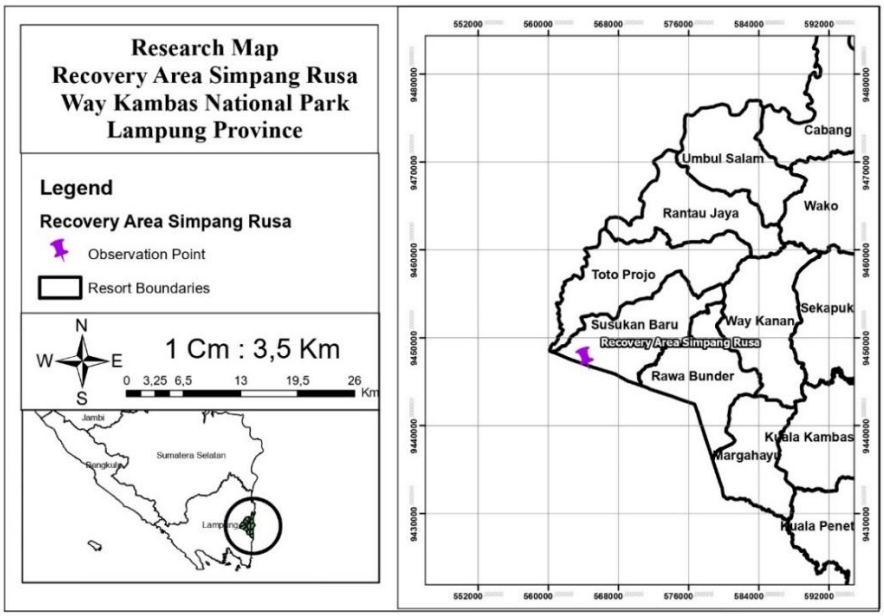

Figure 1. Research Location

Data collection was carried out by direct observation in the field using the point count method, namely making observations at a predetermined point. Determination of point counts is carried out using a systematic random sampling method, which represents the type of ecosystem in the observation area with a total of six-point counts. Observations were carried out for 15 - 20 minutes at each observation point, with an observation radius of ± 50m so that there was a distance of ± 200 m between points, to minimize repetition of recording birds found (Fikriyanti *et al*., 2018). All points were visited in the morning at 06.00 a.m until 09.00 a.m and in the afternoon at 15.00 WIB until 18.00 WIB. This time selection was done by considering that the peak of bird activity takes place in the morning, when they are looking for food, and they will return to their nests in the afternoon (Asrianny *et al*., 2018). Observations were repeated for four days at the same point (a total of 16 observations for each point), to maximise the number of bird species recorded. Birds found based on the naked eye or assisted with binoculars or based on the sound of the bird, then recorded on the observation tally sheet including species, number and activity. During the observation, pictures were also taken using a camera to document and assist in detailed species identification. Bird identification refers to MacKinnon et al (2010) and Taufiqurrahman et al (2022). To determine each observation point, the Avenza Maps application was used, and temperature, humidity and light intensity were measured at each observation point using a hygrometer, thermometer and luxmeter.

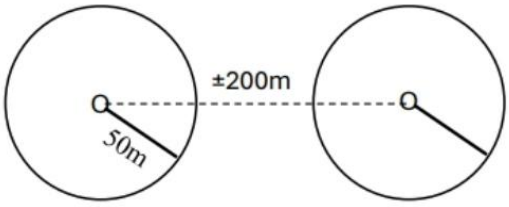

Figure 2. Illustration of point count

Data analysis was conducted as follows:

Diversity Index

Calculation of diversity (diversity index) was carried out using the Shannon-Wiener Diversity Index (H') as follows:

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

Where: $Pi = \frac{ni}{N}$

Description:
H' = Species diversity index
ni = = Number of individuals of species i
N = Number of individuals of all species
With the provisions according to Krebs (1985): If H' > 3 high diversity index; If H' 2 - 3 medium diversity index; and If H' < 2 low diversity index (Huzni *et al*, 2018)

Species Richness (Margalef)

Calculation of wealth using the Margalef wealth index (Margalef, 1958). Formula: $D_{mg} = \frac{S-1}{\ln (N)}$

where:
S: total number of species in the sample/community
N: total number of individuals in the sample/community (Mulya *et al*.., 2021)

The margalef species richness index refers to the number of species found, the more the number of species found, the greater the species richness index (Widiarti *et al*., 2017). The criteria for the value of the Margalef Species Richness Index are as follows: D < 2.5: low species richness level 2.5> D > 4: medium species richness level D > 4: high species richness level (Wahyuningsih, 2019).

Evennes

$$C = \frac{H'}{H_{max}}$$

H' is the Shannon Wiener Diversity index and Hmax is the natural log of the total number of species (Issa, 2019). E is bound between 0 and 1. As with H', evenness assumes that all species are represented in the sample (Bastola *et al*., 2022). The criteria of the evenness index (E) (Magurran, 1988) are as follows: E < 0.3 indicates low species evenness, 0.3 < E < 0.6 moderate evenness and 0.6 < E < 1 or close to 1 then evenness in the community has an even distribution (Komul and Hitipeuw, 2021).

Dominance

The Dominance Index was used to determine the dominant bird species. The Dominance Index was calculated using Simpson's dominance index formula (Odum, 1993; Fikriyanti *et al*., 2018):

$$D = \sum_{i=1}^{n} [\frac{n_i}{N}]^2$$

The dominance index ranges from 0 to 1, where the smaller the dominance index value, it shows that there is no dominating species, on the other hand, the greater the dominance, it shows that there are certain species (Odum, 1993; Fikriyanti *et al*., 2018).

Conservation Status

Conservation status in Indonesia based on the Minister of Environment and Forestry Regulation No. 106/2018 and government regulation No. 7/1999 is classified into two, namely Protected and Unprotected. Conservation status and international trade based on IUCN (International Union for Conservation of Nature) and CITES (International Trade in Endangered Species of Wild Fauna and Flora).

Feeding Guild

Feeding guild analysis of birds was determined based on their main food source, preferred foraging location, and feeding habits (Sitanggang *et al*., 2020). Feeding guild analysis was sourced from (Riefani, 2018).

CRIN (Carnivore Insectivore)	: Eaters of insects and animal material
FCI (*Fly Catching Insectivore*)	: A hovering insect eater
TFGI (*Tree Foliage Gleaning Insectivore*)	: Above-canopy insectivore
SFGI (*Shurb Foliage Gleaning Insectivore*)	: Insect eater on the forest floor.
BGI (*Bark Gleaning Insectivore*)	: Insect eater on branches & twigs
IN (*Imsectivore Nectivore*)	: Insect and nectar eater
IF (*Insectivore Frugivore*)	: Insect and fruit eater
OM (*Omivore*)	: Animal and plant eaters
AF (*Arboreal frugivore*)	: Fruit-eater in the crown
TF (*Terestrial frugivore*)	: Small fruit eater on the forest floor
SE (*Seed eater*)	: Grass seed eater

RESULTS AND DISCUSSION

Bird Community

A total of 47 bird species from 24 families were identified in the Simpang Rusa Ecosystem Recovery Area (SRERA) with the most common species being 5 species from the Columbidae family. Almost all bird species encountered have a permanent distribution, one species was found with a migratory distribution, namely *Gorsachius melanolophus*. There are 5 bird species that can be found at all observation points, namely *Todiramphus chloris*, *Collocalia esculenta*, *Lalage nigra*, *Orthotomus ruficeps*, and *Geopelia striata*.

Based on the conservation status of birds, Indonesia is among the most threatened with extinction despite having high bird diversity due to hunting, animal trade and deforestation that can threaten animals, especially birds (Irwanto *et al*., 2023) . It was recorded that in 2022 Indonesia had 1818 bird species with a conservation status of 30 critical species, 51 endangered species, 96 vulnerable species, 239 near threatened species, and 1,376 low risk species (Burung Indonesia, 2021; Irwanto *et al*., 2023). At the research location there are only 2 bird species that have Appendix II trade status, namely species that are not threatened with extinction, but have the potential to be endangered if traded without regulation. Meanwhile, in the national conservation status, there are 4 protected bird species, namely *Elanus caeruleus*, *Spilornis cheela*, *Gorsachius melanolophus* and *Rhipidura javanica*. Meanwhile, according to IUCN international conservation, there are 2 bird species categorized as Near Treatened, namely the *Phaenicophaeus diardi* and the *Cyornis turcosus*, *Acridotheres javanicus* is classified as Vulnerable and 42 other species are classified as Least Concern (Low risk).

Table 1. Bird Species in Simpang Rusa ecosystem recovery

No	Family	Local Name	Scientific Name	Internasional Name	Point Count						Conservation Status		
					1	2	3	4	5	6	CITES	IUCN	Permen LHK 106/2018
1	Accipitridae	Elang tikus	*Elanus caeruleus*	Black-winged Kite			1	1		1	AII	LC	P
2	Accipitridae	Elang ular bido	*Spilornis cheela*	Crested Serpent-eagle						1	AII	LC	P
3	Alcedinidae	Cekakak batu	*Lacedo pulchella*	Banded Kingfisher						1	NA	LC	NP
4	Alcedinidae	Cekakak belukar	*Halcyon smirnensis*	White-breasted Kingfisher	1					1	NA	LC	NP
5	Alcedinidae	Cekakak sungai	*Todiramphus chloris*	Collared Kingfisher	2	1	1	1	4	4	NA	LC	NP
6	Alcedinidae	Pekaka emas	*Pelargopsis capensis*	Stork-billed Kingfisher						2	NA	LC	NP
7	Apodidae	Walet sapi	*Collocalia esculenta*	Glossy Swiftlet	14	8	7	10	12	6	NA	LC	NP
8	Apodidae	Walet sapi	*Collocalia esculenta*	Glossy swiftlet			3	1			NA	LC	NP
9	Ardeidae	Kowak melayu*	*Gorsachius melanolophus*	Malayan-night Heron	1						NA	LC	P
10	Artamidae	Kekeb babi	*Artamus leucorhynchus*	White-breasted Wood-swallow	2		1	5	4	4	NA	LC	NP
11	Campephagidae	Kapasan kemiri	*Lalage nigra*	Pied Triller	5	1	2	2	2		NA	LC	NP
12	*Caprimulgidae*	Cabak kota	*Caprimulgus affinis*	Savanna Nightjar						1	NA	LC	NP
13	*Caprimulgidae*	Cabak maling	*Caprimulgus macrurus*	Large-tailed Nightjar						1	NA	*LC*	*NP*
14	Cisticolidae	Cinenen kelabu	*Orthotomus ruficeps*	Ashy Tailorbird	1	1	1	2	1	1	NA	LC	NP
15	Cisticolidae	Perenjak rawa	*Prinia flaviventris*	Yellow-bellied Prinia	2	1	3	4	1		NA	LC	NP
16	Columbidae	Delimukan zamrud	*Chalcophaps indica*	Asian Emerald Dove						1	NA	LC	NP
17	Columbidae	Perkutut jawa	*Geopelia striata*	Zebra Dove	3	5	7	4	1	1	NA	LC	NP
18	Columbidae	Punai gading	*Treron vernans*	Pink-necked Green Pigeon	1	3	1	1			NA	LC	NP
19	Columbidae	Punai penganten	*Treron griseicauda*	Grey-cheeked Green Pigeon	5	8	3		8	2	NA	LC	NP
20	Columbidae	Tekukur biasa	*Streptopelia chinensis*	Eastern Spotted Dove	4	8	6	2	7		NA	LC	NP
21	Cuculidae	Bubut alang alang	*Centropus bengalensis*	Lesser Coucal		1	2	2	1	1	NA	LC	NP
22	Cuculidae	Wiwik kelabu	*Cacomantis merulinus*	Plaintive Cuckoo		4	1	2	1		NA	LC	NP
23	Cuculidae	kadalan beruang	*Phaenicophaeus diardi*	Black-bellied Malkoha						2	NA	NT	NP
24	Cuculidae	kedasi hitam	*Surniculus lugubris*	Drongo Cuckoo	1					1	NA	LC	NP
25	Dicaeidae	Cabai jawa	*Dicaeum trochileum*	Scarlet-headed Flowerpecker	1		1	3	1	1	NA	LC	NP
26	Estrildidae	Bondol peking	*Lonchura punctulata*	Scaly-breasted Munia		4			2		NA	LC	NP
27	Laniidae	Bentet kelabu	*Lanius schach*	Long-tailed Shrike	2	1	1	2			NA	LC	NP
28	Meropidae	Kirik kirik Biru	*Merops viridis*	Blue-throated Bee-eater	4	12	6	5	2	2	NA	LC	NP
29	Meropidae	Kirik kirik laut	*Merops philippinus*	Blue-tailed Bee-eater			13				NA	LC	NP

No	Family	Local Name	Scientific Name	Internasional Name	Point Count						Conservation Status		
					1	2	3	4	5	6	CITES	IUCN	Permen LHK 106/2018
30	Muscicapidae	Kucica kampung	*Copsychus saularis*	Oriental Magpie-robin				3			NA	LC	NP
31	Muscicapidae	Sikatan rimba melayu	*Cyornis turcosus*	Malaysian Jungle-flycatcher	1			1	1		NA	NT	NP
32	Nectariniidae	Burung madu kelapa	*Anthreptes malacensis*	Brown-throated Sunbird				2			NA	LC	NP
33	Nectariniidae	Burung madu sriganti	*Cinnyris oranatus*	Ornate Sunbird				1			NA	LC	NP
34	Nectariniidae	Burung madu polos	*Anthreptes simplex*	Plain Sunbird				1			NA	LC	NP
35	Oriolidae	Kepudang kuduk hitam	*Oriolus chinensis*	Black-naped Oriole	2	4	2	3	8		NA	LC	NP
36	Phasianidae	Ayam hutan	*Gallus gallus*	Jungleflow			2	1		1	NA	LC	NP
37	Phasianidae	Gemak loreng	*Turnix suscitator*	Barred Buttonquail	1		1	1			NA	LC	NP
38	Picidae	Pelatuk besi	*Dinopium javanense*	Common Flameback				1		1	NA	LC	NP
39	Picidae	Pelatuk kijang	*Micropternus brachyurus*	Rufous Woodpecker						1	NA	LC	NP
40	Pycnonotidae	Cucak kutilang	*Pycnonotus aurigaster*	Sooty-headed Bulbul	16	25	19	7	11	5	NA	LC	NP
41	Pycnonotidae	Merbah belukar	*Pycnonotus plumosus*	Olive-winged Bulbul	1			2			NA	LC	NP
42	Pycnonotidae	Merbah cerucuk	*Pycnonotus analis*	Sunda Yellow-vented Bulbul	2	3	2	3			NA	LC	NP
43	Pycnonotidae	Merbah corok corok	*Pycnonotus simplex*	Cream-vented Bulbul	2						NA	LC	NP
44	Rhipiduridae	Kipasan belang	*Rhipidura javanica*	Sunda Pied Fantail		2					NA	LC	P
45	Sturnidae	Kerak kerbau	*Acridotheres javanicus*	Javan Myna	5	4	9	12	4	2	NA	VU	NP
46	Corraidae	Tiong lampu biasa	*Eurystomus orientalis*	Common Dollarbird	1				1	1	NA	LC	NP
47	Vangidae	Jingjing batu	*Hemipus hirundinaceus*	Black-winged Flycatcher-shrike			3	1			NA	LC	NP
Total					**80**	**96**	**98**	**86**	**72**	**45**			

Description:

AI : Appendix II
NA : Non-Appendix
LC : *Least conceren*
NT : *Near Treatened*
VU : *Vulnerable*
P : Protected
NP : Not Protected

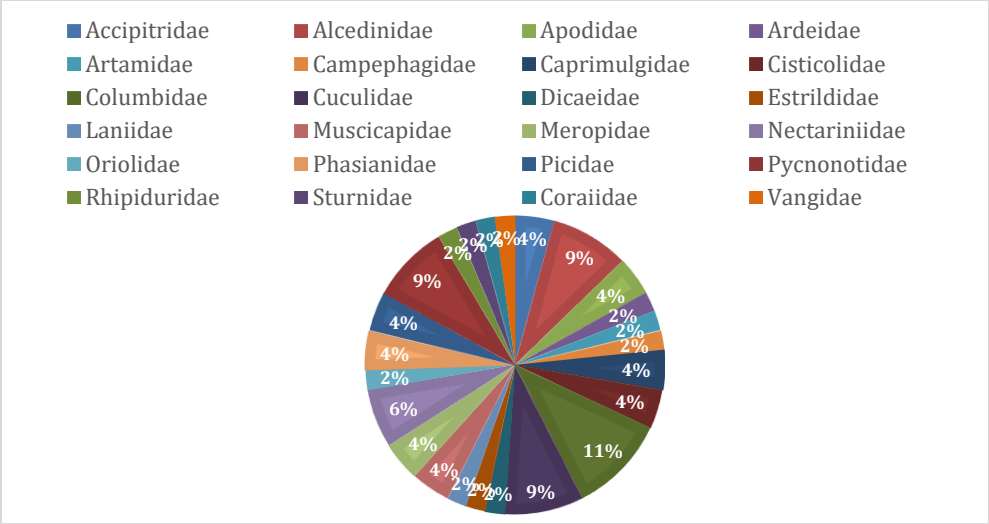

Figure 3. Percentage of families in the Simpang Rusa Ecosystem Recovery Area

There were 23 families dominated by the Columbidae family (11%), 5 species were found, namely *Treron vernans*, *Treron griseicauda*, *Streptopelia chinensis*, *Geopelia striata*, and *Chalcophaps indica*. The next most abundant family is the Cuculidae family (9%). The dominance of the Columbidae family in the bird community in the Simpang rusa ecosystem recovery area is since the habitat on this ecosystem recovery area still has a lot of open areas because the age of the plants is still new and there is very little or no canopy cover from trees. According to Soegiharto, (2020) *Streptopelia chinensis*, *Geopelia striata* can be found in habitats on open areas and at ground level which indicates the availability of food on the ground. Ecosystem recovery areas often have these characteristics, especially in the early stages of succession when vegetation has not fully recovered.

Figure 4. Simpang Rusa Restoration Ecosystem Area

The condition of vegetation in the Simpang Rusa Ecosystem Recovery Area shows significant variation in its growth stage. There is open ecosystem restoration area dominated by early-stage vegetation, such as seedlings and poles, with few trees. On the other hand, there are areas where vegetation has started to become denser, with ecosystem restoration plants showing good growth

and natural regeneration supporting denser canopy closure. The presence of *Dalbergia latifolia* and *Schima wallichi* trees, which were already present before ecosystem restoration began, also adds to the complexity of the vegetation structure in this area (Putri *et al*., 2017). Vegetation structure and food availability in habitats are key factors influencing species diversity, including birds. Habitats with a higher variety of vegetation tend to have greater bird species diversity compared to habitats with fewer vegetation types. This is due to the availability of more diverse food, which allows birds to choose from the various types of food available (Maulidya *et al*., 2021). Research shows that habitat diversity has a direct effect on bird species diversity, where habitats rich in vegetation can support more bird species. According to Tews *et al*. (2004) in their research it confirmed that the diversity of vegetation types in a habitat contributes to the availability of food for birds, with variation in plant species, birds can access a variety of food sources which in turn increases their chances of survival and breeding. Therefore, it is important to maintain and increase vegetation diversity in ecosystem restoration efforts, to support wider biodiversity, including healthy and diverse bird populations.

Table 2. Diversity Index, richness, evenness and dominance indices in Simpang Rusa ecosystem recovery

Point count	S	Indeks Value			
		H’	R	E	D
1	25	2,747	5,49	0,85	0,09
2	19	2,498	3,94	0,85	0,12
3	26	2,769	5,23	0,86	0,09
4	30	3,095	6,49	0,91	0,06
5	19	2,556	4,21	0,87	0,09
6	25	2,988	6,3	0,93	0,06

Description:
S : Number of species
H : Diversity
R : Richness
E : Evenness
D : Dominance

The overall value of bird species diversity obtained from Shanon winner diversity obtained several 3.11, which can be categorized as high diversity. The diversity value shows the estimated essential species in a community based on the number, biomass, and productivity (Tamnge *et al*., 2023). The highest diversity obtained from point 4 has a high diversity index (3.095>3), and other points are categorized as medium (2<2.498-2,988<3). In line with diversity, richness at the site has a high species richness index where the richness value of each point is > 4, overall reaching 7.62. The species richness index is influenced by the level of diversity (Kusmana and Azizah, 2022; Sari *et al*., 2023), that the higher the diversity value with the number of samples, the higher the species richness index value will be obtained. The richness at the four observation points has a high species richness index where the richness value is D > 4. The species evenness index value (E) can be used to indicate dominance symptoms among each species in a habitat (Pertiwi, 2021). The value of species evenness at all observation points is >0.6, close to 1 community, which is stable and has an even distribution of species where there are no dominating bird species. It can also be seen that the higher the evenness value, the smaller the dominance index. The dominance index ranges from 0 to 1, where the smaller the dominance index value, it shows no dominating species; conversely, the greater the dominance, it indicates certain species

(Odum, 1993). The dominance index shows a value of <0.3, meaning low dominance; this is in line with the opinion of Normagiat (2021), where the number 0 indicates that no species dominates other species. The highest dominance value is obtained from the second point count, a dominance value of 0.12 <0.3, classified as low; the species that dominate at this point is *Pycnonotus aurigaster* and *Merops viridis*.

Figure 5. Feeding types of jambon fruit (*Neolamarckia cadamba*) and salam (*Syzygium polyanthum*)

The diversity of bird-feeding guilds may indicate habitats that can fulfill abundant food sources. Bird feeding guilds are influenced by the availability of resources that birds choose to use as their food source (Rumblat *et al*., 2016); from this statement, the bird species obtained include all feeding groups, which means that the research location has abundant food resources ranging from fruits, seeds, insects, fish, nectar and so on. The food is available, which means that it can be reached and utilized by birds. Feeding guild types are based on six main feeding groups, namely (insectivore, granivore, frugivore, nectarivore, carnivore, and piscivore). The more guild categories found in a habitat reveal abundant food availability sufficient for bird life and represent a good environment (Riefani, 2018).

Table 3. Bird food groups in Simpang ecosystem recovery

No.	Family	Local name	Scientific Name	Guild Feed						Guild type
				IS	GR	FR	NC	CR	PS	
1	Accipitridae	Elang tikus	*Elanus caeruleus*	✔				✔		CRIN
2	Accipitridae	Elang ular bido	*Spilornis cheela*	✔				✔		CRIN
3	Alcedinidae	Cekakak batu	*Lacedo pulchella*	✔				✔	✔	CRIN
4	Alcedinidae	Cekakak belukar	*Halcyon smirnensis*	✔				✔	✔	CRIN
5	Alcedinidae	Cekakak sungai	*Todiramphus chloris*	✔				✔	✔	CRIN
6	Alcedinidae	Pekakak emas	*Pelargopsis capensis*	✔				✔	✔	CRIN
7	Apodidae	Walet sapi	*Collocalia esculenta*	✔						FCI
8	Apodidae	Walet sriti	*Collocalia linchi*	✔						FCI
9	Ardeidae	Kowak melayu*	*Gorsachius melanolophus*					✔	✔	CRIN

10	Artamidae	Kekep babi	*Artamus leucorhynchus*	✔				FCI
11	Campephagidae	Kapasan kemiri	*Lalage nigra*	✔				TFGI
12	*Caprimulgidae*	Cabak kota	*Caprimulgus affinis*	✔				FCI
13	*Caprimulgidae*	Cabak maling	*Caprimulgus macrurus*	✔				FCI
14	Cisticolidae	Cinenen kelabu	*Orthotomus ruficeps*	✔				SFGI
15	Cisticolidae	Perenjak rawa	*Prinia flaviventris*	✔				SFGI
16	Columbidae	Delimukan zamrud	*Chalcophaps indica*	✔	✔	✔		TF
17	Columbidae	Perkutut jawa	*Geopelia striata*		✔	✔		TF
18	Columbidae	Punai gading	*Treron vernans*	✔				OM
19	Columbidae	Punai penganten	*Treron griseicauda*	✔				OM
20	Columbidae	Tekukur biasa	*Streptopelia chinensis*		✔	✔		TF
21	Cuculidae	Bubut alang alang	*Centropus bengalensis*	✔				SFGI
22	Cuculidae	Wiwik kelabu	*Cacomantis merulinus*	✔				IF
23	Cuculidae	Kadalan beruang	*Phaenicophaeus diardi*	✔				FCI
24	Cuculidae	Kedasi hitam	*Surniculus lugubris*	✔				FCI
25	Coraiidae	Tiong lampu biasa	*Eurystomus orientalis*	✔				FCI
26	Dicaeidae	Cabai jawa	*Dicaeum trochileum*			✔		AF
27	Estrildidae	Bondol peking	*Lonchura punctulata*		✔			SE
28	Laniidae	Bentet kelabu	*Lanius schach*	✔			✔	FCI
29	Meropidae	Kirik kirik Biru	*Merops viridis*	✔				FCI
30	Meropidae	Kirik kirik laut	*Merops philippinus*	✔				FCI
31	Muscicapidae	Kucica kampung	*Copsychus saularis*	✔		✔		IF
32	Muscicapidae	Sikatan rimba melayu	*Cyornis turcosus*	✔				BGI
33	Nectariniidae	Burung madu kelapa	*Anthreptes malacensis*		✔		✔	IN
34	Nectariniidae	Burung madu sriganti	*Cinnyris oranatus*		✔		✔	IN
35	Nectariniidae	Burung madu polos	*Anthreptes simplex*		✔		✔	IN
36	Oriolidae	Kepudang kuduk hitam	*Oriolus chinensis*	✔		✔		IF
37	Phasianidae	Ayam hutan	*Gallus gallus*	✔	✔			SFGI
38	Phasianidae	Gemak loreng	*Turnix suscitator*	✔	✔			SFGI

39	Picidae	Pelatuk besi	*Dinopium javanense*	✔				BGI
40	Picidae	Pelatuk kijang	*Micropternus brachyurus*	✔				BGI
41	Pycnonotidae	Cucak kutilang	*Pycnonotus aurigaster*	✔	✔			IF
42	Pycnonotidae	Merbah belukar	*Pycnonotus plumosus*	✔	✔			IF
43	Pycnonotidae	Merbah cerucuk	*Pycnonotus analis*	✔	✔			IF
44	Pycnonotidae	Merbah corok corok	*Pycnonotus simplex*	✔	✔			IF
45	Rhipiduridae	Kipasan belang	*Rhipidura javanica*	✔	✔			TFGI
46	Sturnidae	Kerak kerbau	*Acridotheres javanicus*	✔	✔	✔	✔	CRIN
47	Vangidae	Jingjing batu	*Hemipus hirundinaceus*	✔			✔	CRIN

Description:

1. IS = Insectivore (pemakan serangga), GR = Granivore (pemakan biji), FR = Frugivore (pemakan buah), NC = Nectarivore (pemakan nektar), PS = Piscivore (pemakan ikan), CR = Carnivore (pemakan material hewan)
2. CRIN = Carnivore Insectivore, FCI = Fly Catching Insectivore, OM = Omnivore (pemakan hewan dan tumbuhan), IN = Insectivore Nectarivore, IF = Insectivore Frugivore, AF = Arboreal Frugivore, TFGI = Tree Foliage Gleaning Insectivore, TF = Terestrial Frugivore, SE = Seed Eater, SFGI = Shrub Foliage Gleaning Insectivore, LGI= Litter Gleaning Insectivore, BGI = Bark Gleaning Insectivore

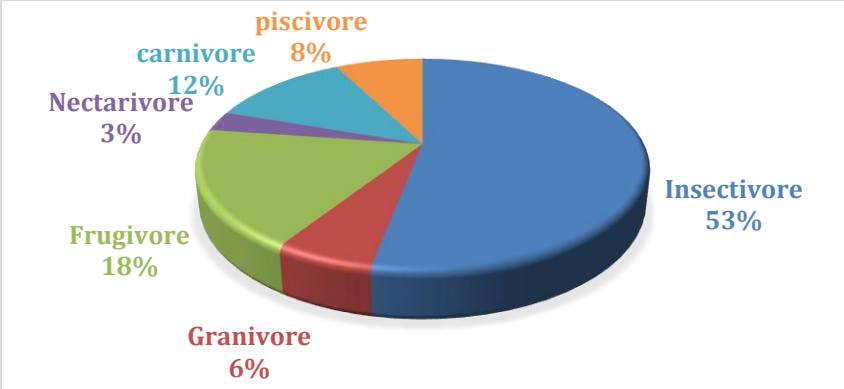

Figure 6. Percentage of feeding guilds in Simpang Rusa Ecosystem Restoration Area

The food group found was dominated by insectivorous birds. Vegetation in the Simpang Rusa ecosystem recovery area is still dominated by open areas overgrown with various shrubs such as *Imperata cylindrica* and other shrubs. Hence, insects such as grasshoppers, dragonflies, crickets, and butterflies are very much found in the observation location. The abundance of insects in an area attracts insectivorous birds of prey because birds tend to be found more often in places with abundant food availability. The availability of prey, the primary food source, is an essential factor that determines the presence of birds in a habitat (Ramadhani *et al*., 2022). Frugivore food sources were also commonly found (18%) due to the abundance of fruit food species such as *Syzygium polyanthum* and *Syzygium grande* (Figure 15).

The assessment of specific bird groups based on ecological criteria or functional attributes (such as feeding groups or foraging strategies) allows linkages to functions and ecosystem services provided by birds (Rodrigues and Fischer, 2018). For example, fruit-eating birds (18%) are important seed dispersers and thus play a key role in forest regeneration, as in ecosystem recovery areas, such ecosystem services are critical in habitat recovery, according to Chowfin and Leslie (2021). Birds are used as bioindicators to measure wildlife responses to the progress of ecosystem recovery through natural regeneration efforts, as they are considered capable of responding to ecosystem recovery efforts at an early stage. 18% of bird species are fruit eaters, which shows that there is progress in forest regeneration in the ecosystem recovery area at an early stage. Furthermore, the ecosystem service of bird species as a response organism is pollination. Pollination is critical to ecosystem function, as it directly affects the survival and fitness of plant populations that form the basis of terrestrial ecosystems (Bustamante-Castillo *et al*., 2018). Bird species that play a role in pollination include Nectariniidae (Nurdin *et al*., 2019); at this location, 3 species of birds were found, namely *Anthreptes malacensis*, *Cinnyris oranatus*, and *Anthreptes simplex*

The high proportion of insectivores, reaching 53%, indicates a significant abundance of insect food. This may indicate that the site is in an early stage of ecosystem recovery, characterized by an abundance of young plants with leaves and stems that are a significant food source for insects such as Lepidoptera (butterflies and moths) and Coleoptera (beetles) where insectivorous birds play an essential pest control function (Johnson *et al*., 2010). The insectivorous birds found, such as (Turdidae), play a vital role in controlling pest insect populations in forest ecosystems. They eat various insects that could damage plants, thus maintaining the balance of the ecosystem. In addition, Muscicapidae and Sturnidae are also known to help control pest insect populations. The presence of high numbers of insectivorous birds can be a positive indicator of successful ecosystem restoration. This indicates that the area can provide sufficient food sources for birds while helping to control insect populations that can inhibit plant growth.

The Simpang Rusa recovery also has water bodies such as swamps and artificial ponds used as water providers for watering plants in the dry season and the needs of surrounding animals. The presence of piscivores (8%) in the Simpang Rusa ecosystem recovery indicates that this ecosystem recovery has succeeded in creating habitats that support complex food chains. Artificial ponds and swamps provide water sources and a suitable environment for fish to breed. These fish attract fish-eating birds, allowing them to forage and survive in the ecosystem recovery area. This shows that the Simpang Rusa ecosystem is focused on providing food for rhinos and creating a diverse and balanced ecosystem that supports a wide variety of wildlife. In addition to insectivore, frugivore, granivore, and piscivore groups, nectarivore (nectar-eating) groups from the Nectariniidae family were also found where food was available in the form of flowers from several trees, such as puspsa (*Schima wallichi)*, kaliandara (*Calliandra calothyrsus)*, akasia (*Acacia mangium)* and jambon (*Syzygium grande)*.

CONCLUSION

There were 47 bird species from 23 families with a total of 477 individuals, with a species diversity value (H') of 3.11 in the high category, species richness value (R) of 7.62, species evenness value (E) of 0.8 in the good category, and species dominance (C) of 0.07 in the low category. Sixfeeding groups were identified, namely insect eaters (53%), fruit eaters (18%), animal material eaters (12%), fish eaters (7%), seed eaters (6%) and nectar eaters (3%). Four protected bird species were found, namely *Elanus caeru*leus and *Spilornis cheela*, *Gorsachius melanolophus* and *Rhipidura javanica*. Based on the IUCN Redlist, there are 2 bird species with Near Treatened status, namely the *Phaenicophaeus diardi* and *Cyornis turcosus*, 1 species with Vulnerable status, namely the *Acridotheres javanicus* and 42 other species with Least Concern status. Based on CITES, 2 bird species have Appendix II status. Enriching plant species in ecosystem restoration programs is likely to increase the diversity of bird food plants, reflecting the abundance of food resources in the habitat. The diversity of bird-feeding guilds can indicate the progress of ecosystem restoration. Thus, regular monitoring and maintenance of plant growth in ecosystem restoration areas can also serve as a model for other conservation areas to increase bird populations.

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