



Research Article



Diversity of bird agroforestry species in Sapen Nusantara Conservation Park of Mount Arjuno, Pasuruan

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Article Information	ABSTRACT
Submitted: 2023-02-19 Accepted: 2023-06-06 Published: 2023-06-06	<p>The Sapen Nusantara Conservation Park is agroforestry that has certain vegetation. The vegetation in Sapen Nusantara Protected forest park seems to support the existence of birds as wildlife that need a living habitat. The presence of birds in the Sapen Nusantara Protected Forest Park is very important in supporting agroforestry vegetation. However, until now the diversity of bird species there has not been identified and recorded properly. The forest is one of the buffer forests of Mount Arjuno protection forest, the ecosystem must be protected. This study aims to analyze the diversity of bird species in the agroforest forest area in Sapen Nusantara Conservation forest park, Ledug Village, Pasuruan. The research was conducted in July 2021 using the direct observation method (point count) on ecotourism routes by calculating and recording the trails traversed using GPS, sampling by observing walking along the path/road accompanied by predetermined observation points, identification primarily based totally on MacKinnon et al., (2010) and information on the status of its protection. Data analysis used the Shannon-Wiener diversity index, evenness index, and species richness index. The results of the study identified 18 bird species from 16 families with a total of 169 individuals. Of all the birds found, 18 species are listed in IUCN status, and 4 are listed in the protected status PP No. P.106 of 2018 and 3 species are listed in the CITES category Appendix II. It is known that the Shannon diversity index ($H'=2,547$) is in the medium diversity category. species evenness index ($E=0.9$) with a high evenness category and stable community. Then the specific wealth index ($R=3.31$) with the category of species richness is classified as medium. The presence of birds in the Sapen Nusantara Conservation Park Forest indicates that the ecosystem in the forest is still maintained and this cannot be separated from the role of the community, especially the Ledug Lembaga Masyarakat Desa Hutan (LMDH), which manages and maintains the forest.</p>
	<p>Keywords: Agroforestry; birds; diversity; Sapen forest</p>
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INTRODUCTION

Birds are wild creatures that are effectively found in nearly every sort of natural environment and are one of the vertebrate groups that have the ability to fly because the forelimbs are modified into wings to fly. Birds are one of the key components of the biological system that can be utilized as seed dispersal, pointers of biodiversity, pointers of natural quality changes, and markers of the assurance of ensured regions (Withaningsih et al., 2022). The existence of birds is greatly affected by the transition of forest land, one of which is land such as rubber, coffee, cocoa, oil palm, and pepper plantations. Birds are animals that are sensitive to ecological changes. As an ecological bioindicator, the nearness of feathered creatures can clarify the degree to which human exercises alter territory quality and how it affects biodiversity (Krisanti et al., 2017). The decrease in bird species diversity is associated with a decrease in natural components such as canopy tallness, tree species diversity, and plant cover that determine bird species diversity (Ayat & Tata, 2015).

The role of birds in supporting the sustainability of the food chain cycle is very important in an ecosystem. In tropical timberlands, most tree species depend on birds for seed dispersal, and numerous fowls utilize natural products as a nourishment source (Subasinghe & Sumanapala, 2014). Since many bird species are often involved in these interactions, they have different roles in determining the tissue organization between plants and birds (Hendrayana et al., 2022). The tall diversity of birds in a woodland biological system implies that the environment is still in great and steady condition. The preservation of bird populations is the carrying capacity of the diversity function of agroforestry forest habitat types (Nurmaeti et al., 2018). Therefore, the presence of birds in agroforestry forest habitats can influence the presence and dissemination of plant species (Hiola & Bachtiar, 2018). One of them is the agroforestry forest, namely the Sapen Nusantara Conservation Park, which is identified as a bird habitat.

The Sapen Block Forest or commonly known as the Sapen Nusantara Conservation Park located in the Arjuno Mountains area is part of a protected forest area managed by UPT Tahura R Soerjo, Perum Perhutani and the East Java BKSDA (Ikerismawati et al., 2019). The Sapen Nusantara Conservation Park area is a Kedung Larangan watershed that administratively passes through a number of villages including Jatiarjo, Dayurejo, Ledug, Pecalukan, Prigen, and Lumbangrejo villages in Prigen District. The management of the Sapen Block protected forest by LMDH Ledug refers to the management of the intercropping system in the production forest by cultivating agricultural crops and animal feed such as kaliandra and elephant grass (Wibisono et al., 2017).

The existence of agroforestry bird species in Sapen Nusantara Conservation Park, Ledug Village, Pasuruan Regency is not yet known with certainty the level of diversity. To determine the level of bird diversity, conservation activities are carried out. Bird conservation in an agroforestry forest ecosystem can be done with the initial information about the bird species as a basis for developing a management

or mitigation plan. The forest is one of the buffer forests of Mount Arjuno Protection Forest, so the ecosystem must be maintained. Changes in land use to large-scale commercial agriculture not only eliminate shifting cultivation practices, but also reduce biodiversity and soil fertility, as well as increase soil erosion (Hakim et al., 2020). However, if the land changes, such as in the Sapen Nusantara Conservation Park area, do not have a direct impact on bird diversity by applying the principle of local wisdom. Principle bird community can coexist with the community, the habitat and existence of birds are safe from various forms of human disturbance (Wibisono et al., 2017). Anthropogenic activity is the most influential factor on the existence of birds such as the most densely populated residential areas. Agroforestry areas that are still preserved with bird diversity are areas that are not overcrowded by human activities, where local people carry out various limited activities such as hunting animals, harvesting seeds and fruits, making charcoal, collecting forest wood and grass (Krisanti et al., 2017). In addition, according to Ainiyah et al. (2017) the function of the Sapen Nusantara Conservation Park is as a buffer for the hydrology of the surrounding area, and has the potential as a place for education, research, and development of flora and fauna ecosystems.

Based on research around Mount Arjuno, such as the Gunung Baung Nature Tourism Park (TWA) area has a value that is classified as a medium category diversity index (Rohmatika, 2021) and the climbing of Mount Welirang also has a medium category diversity index (Fauzan et al., 2018). While in the Sapen Nusantara Conservasi Park Forest, the level of diversity has never been recorded. However, until now, there is no regarding the differences of bird species within the agroforestry forest region in Sapen Nusantara Conservation Park, Ledug Village, Pasuruan Regency. Therefore, exploratory research regarding birds in Sapen is needed. This think about pointed to analyze the diversity of winged creature species within the Agroforestry Forest region in Sapen Nusantara Conservation Park, Ledug Village, Pasuruan Regency. The comes about of this think about are anticipated to supply a logical information base on the diversity of bird species within the Sapen Nusantara Conservation Park, and be a recommendation for agencies or managers related to policies on managing areas that are natural habitats and bird conservation.

RESEARCH METHODS

The research was carried out in July 2021 in Agroforestry Forest in Sapen Nusantara Conservasi Park, Ledug Village, Pasuruan Regency. The time required is about one month, this is done to better obtain both diurnal and nocturnal observation data. The research area of the Sapen Nusantara Conservation Park is approximately 4.1 hectares and the circumference of the area is approximately 1395.072 meters and has an average height of 742.9 meters above sea level, you can see the map of the research location (Figure 1).

This observation was carried out using the Point Count method or point count combined with the Line Transect method by following the existing path. Sampling by observing walking along the path/road accompanied by predetermined observation points (Maas et al., 2015). So, the data collection method is calculated by direct observation of morphology, activity behavior and population records, as well as indirectly by identifying the voice, number and time of encounters by following the ecotourism path that has been determined by the manager of the Sapen Nusantara Conservation Park, Ledug Village, Pasuruan Regency. Bird identification primarily based totally MacKinnon et al., (2010) and the Burungnesia digital application. The conservation status of each species was assessed using the Control of the Serve of Environment and Forestry of the Republic of Indonesia No. P.106/MENLHK/SETJEN/KUM.1/12/2018, the Government Regulation of the Republic of Indonesia

Number 7 Year 1999 about the morphological identification. All bird species were categorized into four main types of food types, namely carnivores, omnivores, insectivores and herbivores.

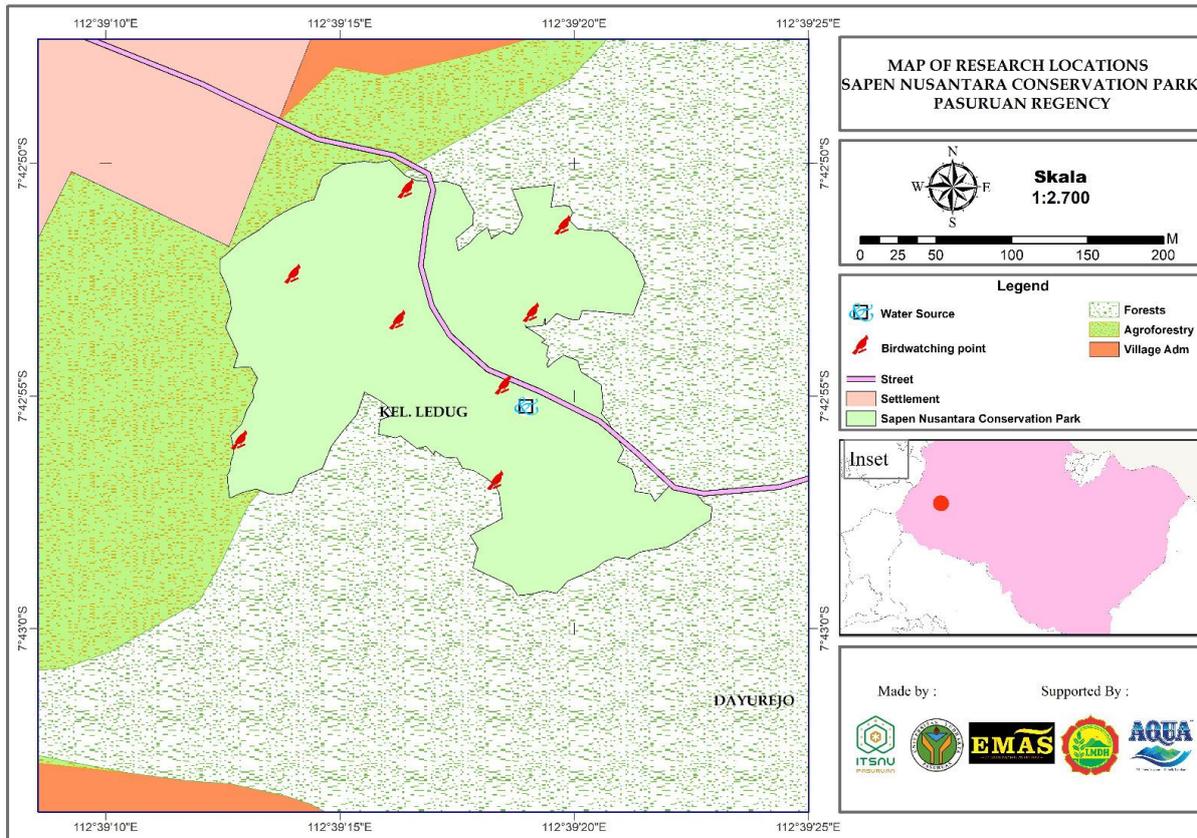


Figure 1. Research Location of Sapen Nusantara Conservation Park, Pasuruan Regency

Identification of bird species classification: (i) Carnivores: birds that feed mainly on vertebrates. (ii) Herbivora: birds that eat mainly fruits or eat fruits and nectar / seeds. (iii) Insectivores: birds whose main diet is insects, some of which also eat other arthropods. (iv) Omnivores: Bird species that eat plant and creature materials with comparable inclinations (Subasinghe & Sumanapala, 2014). Bird diversity was calculated using the Shannon-Wiener diversity index with the formula (Magurran, 1988).

$$H' = \sum p_i \ln p_i$$

Information:

- H' : Index of species diversity
- ni : Number of individuals of the i-th type
- pi : ni/N
- Ln : Total individuals

Criteria for the Shannon-Wiener diversity index value: $H' \leq 1$ Low diversity (very low productivity due to severe ecological stress and unstable ecosystem). $1 < H' < 3$ (H' value: 1-3) then medium diversity is defined (sufficient productivity, fairly balanced ecosystem conditions, and moderate ecological pressure). $h' \geq 3$ diversity is high, it means (very good ecosystem stability and high productivity).

The species density index used the Evenness evenness index with the formula (Odum, 1996).

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

Information:

- E : Specific Evenness Index
 H' : Species Diversity Index
 S : Number of Types
 ln : Natural logarithm

The evenness index value ranges from 0-1 with the following categories: 0 < e 0.4 then low evenness, community is depressed. 0.4 < e 0.6 then the evenness is medium, community stable. 0.6 < e 1.0 then high evenness, stable community.

Species or species richness (R) was calculated using the 1958 Margalef formula (Jorgensen et al., 2005).

$$R = \frac{(S - 1)}{\ln N}$$

Information:

- R : Species/species richness index
 N : Total index of individuals
 S : Number of Species observed

Margalef species richness index value criteria: If < 2.5 then the species richness is classified as low. If 2.5 - 4 then the species richness is classified as Medium.

FINDING AND DISCUSSION

Based on the comes about of observations and recognizable proof, there were 18 species from 16 families found in the Sapen Nusantara Conservation Park. The bird families are Accipitridae, Aegithinidae, Alcedinidae, Apodidae, Campephagidae, Cisticolidae, Columbidae, Dicaeidae, Dicruridae, Estrildidae, Muscicapidae, Oriolidae, Pittidae, Pycnonotidae, Strigidae, Zosteropidae. Table 1 shows the results of bird identification and findings in the Sapen Nusantara Conservation Park.

Table 1. List of Finds and Number of Species Aves (Birds)

No	Local name	Ordo	Famili	Genus	Spesies	Amount
1	Encit Merah (Cabai Jawa)	Passeriformes	Dicaeidae	<i>Dicaeum</i>	<i>Dicaeum trochileum</i>	9
2	Kutilang (Cucak Kutilang)	Passeriformes	Pycnonotidae	<i>Pycnonotus</i>	<i>Pycnonotus aurigaster</i>	9
3	Tekukur Biasa	Columbiformes	Columbidae	<i>Streptopelia</i>	<i>chinensis</i>	8
4	Sriti (Walet Sapi)	Caprimulgiformes	Apodidae	<i>Collocalia</i>	<i>Collocalia esculenta</i>	38
5	Terucuk (Merbah Cerukcuk)	Passeriformes	Pycnonotidae	<i>Pycnonotus</i>	<i>goiavier</i>	4
6	Cekakak Sungai	Coraciiformes	Alcedinidae	<i>Todiramphus</i>	<i>chloris</i>	11
7	Elang Ular Bido	Accipitriformes	Accipitridae	<i>Spilornis</i>	<i>Spilornis cheela</i>	4
8	Emprit (Bondol Jawa)	Passeriformes	Estrildidae	<i>Lonchura</i>	<i>leucogastroides</i>	19
9	Srigunting Hitam	Passeriformes	Dicruridae	<i>Dicrurus</i>	<i>macrocerus</i>	16
10	Perenjak Sawah	Passeriformes	Cisticolidae	<i>Prinia</i>	<i>Prinia Inornata</i>	5
11	Perenjak Jawa/ ciblek kuning*	Passeriformes	Cisticolidae	<i>Prinia</i>	<i>Prinia familiaris*</i>	7

No	Local name	Ordo	Famili	Genus	Spesies	Amount
12	Burung Hantu Beluk Watu Jawa*	Strigiformes	Strigidae	<i>Glaucidium</i>	<i>Glaucidium castanopterum*</i>	2
13	Cipoh Kacat (sirpu)	Passeriformes	Aegithinidae	<i>Aegithina</i>	<i>Aegithina tiphia</i>	12
14	Pleci Dakun / Kacamata Jawa*	Passeriformes	Zosteropidae	<i>Zosterops</i>	<i>Zosterops flavus*</i>	13
15	Sepah Hutan	Passeriformes	Campephagidae	<i>Pericrocotus</i>	<i>Pericrocotus flammeus</i>	8
16	Kepudang Kuduk-hitam	Passeriformes	Oriolidae	<i>Oriolus</i>	<i>Oriolus chinensis</i>	1
17	Paok Pancawarna*	Passeriformes	Pittidae	<i>Hydromis</i>	<i>Pitta guajana (Hydromis guajanus)*</i>	2
18	Cingcoang Coklat	Passeriformes	Muscicapidae	<i>Brachypteryx</i>	<i>Brachypteryx leucophris</i>	1
Number of Birds						169

Information: * Identified as endemic birds

Based on the table above, there are 169 individuals, consisting of 6 orders, 16 families and 18 species. Observations appeared that 4 bunches of birds were recognized based on the type of nourish. The bird groups are herbivores (plant eaters), insectivores (insect eaters), carnivores (meat eaters), omnivores (fruit eaters, seeds, meat, insects, etc.). The percentage of birds by type of feed is shown in Figure 2. The largest percentage of birds found were omnivorous birds (39%), while the smallest percentage were herbivores (5%). The presence of a few species of birds is a pointer of biological system conditions and capacities, counting indicators of the nourishment chain, characteristic living space quality, water quality, riparian living space conditions, and open or aggravated living space conditions. This is in accordance with the conditions in the Sapen Nuantara Conservation Park Forest which has a water source, mixed plants such as mahogany, pine and fruit trees. A few birds are too related with certain territories, such as characteristic timberland, riparian, a combination of normal woodland and open living space, coffee manors, and cavities (Husodo et al., 2020).

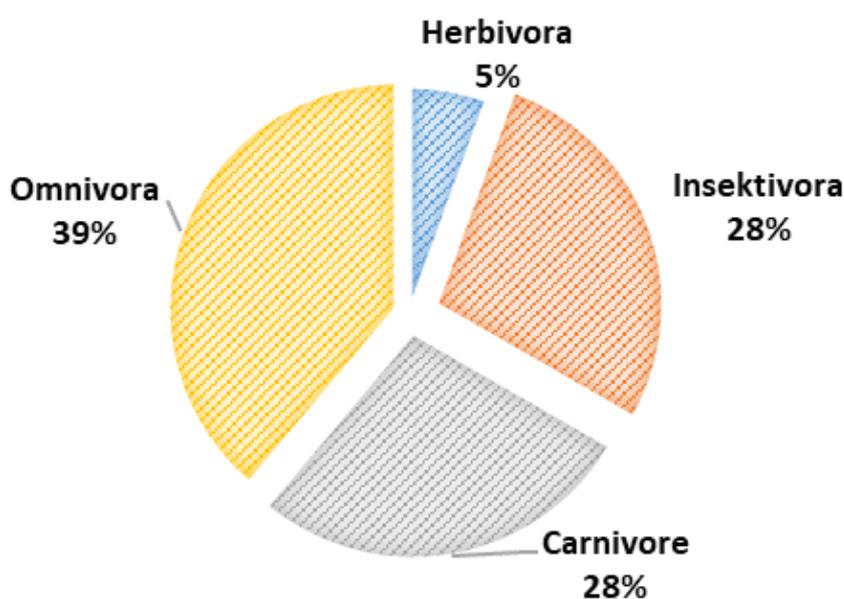


Figure 2. The percentage of bird species grouping in Sapen Nusantara Conservation Park

Each bird species was found for habitats associated with the type of food available. The main factor influencing bird diversity is the structure of vegetation as cover and breeding grounds and food supply in the habitat. The main factor influencing bird diversity is the structure of vegetation as cover and breeding grounds and food supply in the habitat (Alghifari et al., 2021). The groups of omnivorous bird species (*Dicaeum trochileum*, *Pycnonotus aurigaster*, *Pycnonotus goiavier*, *Lonchura leucogastroides*, *Zosterops flavus*, *Pericrocotus ammeus*, and *Oriolus chinensis*) were more commonly found in the Sapen Nusantara Conservation Park area (39%). This is because the location of the Sapen Nusantara Conservation Park is an agroforestry location, where community farms cultivate forestry agriculture such as pine, coffee, cocoa, pepper, fruits and vegetables.

Meanwhile, the insectivorous (*Collocalia esculenta*, *Dicrurus macrocercus*, *Prinia Inornata*, *Prinia familiaris*, and *Aegithina tiphia*) and carnivorous (*Todiramphus chloris*, *Spilornis cheela*, *Glaucidium castanopterum*, *Hydornis guajanus*, and *Brachypteryx leucophris*) bird groups, respectively (28%). Conversion of forest into plantation or agricultural areas will result in changes in the composition of bird food depending on habitat changes and disturbances such as insectivores and carnivores (Subasinghe & Sumanapala, 2014). Meanwhile, the percentage of herbivorous bird species (*Streptopelia chinensis*) was 5%, the smallest based on the findings, this was because the time of the study had not yet entered the harvest season for fruiting and flowering plants. Herbivorous birds like to be in trees and bushes that create natural product and blossoms. They are frequently found in bushes and auxiliary timberland vegetation that produces natural product and seeds (Eddy et al., 2021). Based on identifiable evidence, there were 4 species of birds with endemic status, namely the Yellow Ciblek (*Prinia familiaris*), the Javan Watu Beluk Owl (*Glaucidium castanopterum*), East Java Yellow Chest Pleci (*Zosterops flavus*), and Pancawarna Paok (*Hydornis guajanus*).

Data from bird observations in the Agroforestry Forest area in the Sapen Nusantara Conservation Park found 18 species, with 16 families and a total number of 169 individuals. The existence of the bird community that was found is one of the impacts of the Ngeramut Wareh Sapen program initiated by Farmers and LMDH Bumi Lestari who actively carry out nurseries and tree planting so that the Sapen Nusantara Conservation Park becomes a suitable habitat for the bird community (Wibisono et al., 2017). We can see in Table 2 that the diversity index, species richness index and evenness index obtained good results.

Table 2. Number of Species, Number of Families, Individuals, Diversity Index, Species Richness and Evenness

Parameter	Amount	Catagory
Number of species	18	
Number of family	16	
Number of individual	169	
Diversity Index (H')	2.547	Moderate Diversity
Eveness Index (E)	0.9	High Eveness
Species Richness (R)	3.3	Moderate Richness

Observations appeared that 4 bunches of feathered creatures were recognized based on the sort of nourishment. These groups are herbivores (plant eaters), insectivores (insect eaters), carnivores (meat eaters), omnivores (eaters of fruits, seeds, meat, insects, etc.). The group of omnivorous bird species was more commonly found in the Sapen Nusantara Conservation Park area (39%). This is because the location of the Sapen Nusantara Conservation Park is an agroforestry location, where community farms cultivate forestry agriculture such as pine, coffee, cocoa, pepper, fruits, and vegetables. While the insectivorous and carnivorous bird species groups respectively (28%), Conversion of forest into plantation

or agricultural areas will cause changes in the composition of bird food based on changes and disturbances in habitats such as insectivorous and carnivorous birds (Subasinghe & Sumanapala, 2014). Meanwhile, the percentage of herbivorous bird species group (5%) was the smallest based on the findings, this was because the time of the study had not yet entered the harvest season for fruiting and flowering plants. Herbivorous birds prefer to live in flowering trees and shrubs.

They are commonly found in bushes and auxiliary timberland vegetation that produces natural product and seeds (Eddy et al., 2021). The principle of competitive exclusion is also shared by birds, which will lead to segregation by niche. Even for food that will be eaten by various types of birds, such as insects, birds will differentiate based on space (air altitude, tree height, plant parts and time), day, night, sunset) (Mardiastuti, 2020). The findings of these birds are in accordance with the conditions in the Sapan Nusantara Conservation Park Forest which has the character of water sources, mixed plants such as mahogany, pine, fruit plants, coffee and vegetables and ecosystem conditions that are not massively disturbed. Based on the identification, there are 4 species of birds with endemic status, namely the Yellow Ciblek (*Prinia familiaris*), the Javan Watu Beluk Owl (*Glaucidium castanopteron*), East Java's Yellow Chest Pleci (*Zosterops flavus*), and Pancawarna Paok (*Hydrornis guajanus*). Even though it is protected by regulations, endemic birds are increasingly rare due to logging activities in their habitats, and buying and selling for cultural or economic trends (Putri et al., 2021).



Figure 2. Some of the birds found in the Sapan Nusantara Conservation Park

(A) *Pycnonotus goiavier*, (B) *Spilornis*, (C) *Brachypteryx leucophris*, (D) *Cheela Pitta guajana* (*Hydrornis guajanus*)

It is known that the diversity index with a value of 2.547 is in the medium category. This means that the condition of the ecosystem is balanced, the conditions of productivity, and conditions of ecological

pressure are sufficient. The vegetation of the forest habitat of Sapen Nusantara Conservation Park has many flowers and some are still bearing fruit and there are quite tall stands of trees such as pine trees, mahogany and Sapen Trees, which allow birds to get food and places to make nests, as a place to play and rest. According to Krebs (2014) there are factors that influence insect diversity, namely time, spatial heterogeneity, competition, predation, climate stability, and productivity. Tall basic heterogeneity and differences of plant species gives specialties for numerous feathered creature species, and thus can bolster a huge number of bird species sharing the same living space. The existence of species is also an important factor in habitat assessment and decision making regarding habitat management, and species can survive in a habitat if environmental conditions can meet their needs (Soendjoto & Gunawan, 2003). The diversity of bird communities can be maintained by a number of agroforestry management practices, including agroforestry management by planting various trees using an intercropping system with other crops (Prabowo et al., 2016).

The species richness index with a value of 3.3 is categorized as medium species richness. This means having safe and good habitat conditions for bird communities and this species richness is related to the value of diversity. Sapen Nusantara Conservation Park Forest As a component of bird habitat, trees can work as cover for pine and mahogany trees (protect from climate and predators, settling, resting play, and child rearing). In expansion to giving tree parts (takes off, blooms, and natural products) a tree can serve as environment (or specialty living space) for different other sorts of living beings that are accessible nourishment for feathered creatures. According to Magurran (1988) explained that species richness is a characteristic of a community related to the number of species or the abundance of species, and diversity is a component of a community. According to Riefani & Soendjoto (2021) it is imperative to note that the condition of the record of winged creature species lavishness and diversity is transitory (subject to alter) depending on the sort of observation and recognizable proof of as it were certain diurnal or nighttime winged creature species, their environment sorts, or timberlands with thick canopy cover, or watching transitory birds that require a longer term or recurrence of perception. The richness of bird communities also varies depending on their habitat. In agroforestry, bird species richness is mainly in coffee plantations, which accounts for a higher proportion of nectarivorous and frugivorous birds (in the case of traditional polyculture coffee farming), while birds are omnivorous (monocultural coffee farming) and herbivorous birds in mixed coffee cultivation (Imron et al., 2022).

The Evenness Index with a value of 0.9, is categorized as high evenness. It means having a Stable Community. This shows that there is no particular bird species that dominate the habitat of the Sapen Nusantara Conservation Park. This is because the forest has varied vegetation that is suitable for birds to live and feed in. In other words, all winged creature species found were categorized as environment generalists, or no particular bird species dominated. According to Iswandaru et al. (2020) this is due to the same distribution and condition of vegetation in each habitat to provide food sources and places for nesting, breeding, resting (roosting and investigating) to bolster the life of each wild winged creature species, in this manner minimizing competition due to constrained resources. Withaningsih et al. (2020) stated that birds also have food preferences, and if a location cannot meet their needs, birds will move to locations with better resources. Odum (1992) also stated that the evenness value ranges between 0 and 1, which when close to the value 1 describes a condition where all species in the community are quite abundant. The evenness index refers to how close each species (in terms of number) is to each other in a given plantation, indicating significant dominance of the bird community (Kaban et al., 2017).

CONCLUSION

The conclusion of this study is that there are 18 bird species from 6 orders and 16 families, with a total of 169 individuals. The percentage of omnivorous birds (39%), carnivorous birds and insectivorous birds respectively (28%), while the smallest percentage is herbivorous birds (5%). Overall of all the birds found, 18 species are listed in IUCN status, 4 bird species are listed in the protected status PP No. P.106 of 2018 and 3 species are listed in CITES category Appendix II. Diversity index ($H' = 2.547$) with medium diversity category with species evenness index ($E = 0.9$) with high evenness category and stable community, Then the species richness index ($R = 3.31$) with species richness category classified as Medium. The presence of birds in the Sapen Nusantara Conservation Park Forest indicates that the ecosystem in the forest is still maintained and this cannot be separated from the role of the community, especially the Ledug Lembaga Masyarakat Desa Hutan (LMDH), which manages and maintains the forest.

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