

Community Structure of Avifauna in The Rehabilitation Zone at Wonoasri Resort, Meru Betiri National Park

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Abstract. *The rehabilitation zone of Meru Betiri National Park (MBNP) needs to be measured in relation to the success of ecosystem restoration. It can be used as a bioindicator, such as the bird community structure, hence their sensitivity to environmental changes. Therefore, this study aims to determine the community structure of avifauna in the rehabilitation zone at Wonoasri Resort, MBNP, including bird diversity, richness, dominance, feeding guilds, and their correlation with forest cover. The research was conducted in January 2023 in the Bonangan Block at three observation points, namely low vegetation cover, medium vegetation cover, and high vegetation cover. The ecological data, such as species and abundance, were collected using the point count method, while additional information related to conservation statuses was collected by web browsing on the IUCN Red List, the CITES appendix, and Indonesian government regulation (LHK No.106/2018). Data analysis used the dominance index, species diversity index (Shannon Wiener), and evaluated for statistical data using a Kruskal-Wallis (KW) test in R version 3.2.1. We recorded 38 bird species belonging to 31 genera and 21 families during this study. Among the feeding guilds, the insectivorous birds (14 species) were recorded as the higher species richness, followed by omnivorous (eight species), frugivorous (five species), granivorous (five species), carnivorous (four species), and nectarivorous (two species). The Kruskal-Wallis test shows there is a significant correlation among the feeding guilds (value of 11.644, with p-value = 0.040). Furthermore, referring to species richness, high vegetation cover areas have the highest species richness (30 species) compared to medium vegetation cover areas (27 species) and low vegetation cover areas (26 species). The dominance of avifauna species at this location falls into the low category ($C = 0.07$). According to the diversity index, avifauna in Bonangan Block is classified as a high category ($H' = 3.01$).*

Keywords: *Avifauna, Community, Meru Betiri National Park, Rehabilitation Zone*

Citation

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INTRODUCTION

Meru Betiri National Park (MBNP) is a conservation area located in East Java, Indonesia which has an area of 52,626.04 Ha (Syarief et al., 2018). This conservation area has a management system in the form of zones, including the rehabilitation zone. This zone is an area that has degraded conditions due to illegal logging since 1997. Thus, for almost 20 years, an ecosystem restoration program has been conducted in this area by planting several native plants. Currently, the rehabilitation zone in MBNP has a quite dense canopy and it is overgrown with seedlings and understory vegetation (Hartoyo et al., 2019). Based on Sulistiyowati et al. (2023), the rehabilitation zone of Wonoasri Resort is dominated by Multi-Purpose Tree Species (MPTS) plants such as fruit trees (mango, jackfruit, avocado, papaya, soursop, kenitu, and durian). In addition, this zone also contains tree species that have large crowns. Therefore, these conditions have created a supporting habitat for wild animals, particularly bird communities (avifauna) (Hartoyo et al., 2019; Kurnianto et al., 2022).

The existence of avifauna in an ecosystem has a significant role, including as a predator, prey, pollinator, and seed disperser (Whelan et al., 2015). It also greatly affects energy flow balancing in an ecosystem. In this part, avifauna has roles as primary consumers (granivorous, nectarivorous, frugivorous, and folivorous), secondary consumers (insectivorous), and tertiary consumers (carnivorous/raptors) (Quin et al., 2008; Iskandar, 2017; Laursen, 2022). The existence of all these bird roles in the ecosystem indicates the complexity of an avifauna community structure (Darras et al., 2018; Simamora et al., 2021).

The information on avifauna species in MBNP was previously reported by Kurnianto et al. (2014) with a total of 168 species and

68 are classified as protected species by Indonesian regulations (P.106 /MENLHK /SETJEN /KUM.1/12/2018). Furthermore, in the rehabilitation zone (Rajegwesi Resort), it was reported that there were only 17 species (Kurnianto et al., 2014). Eight years later, Kurnianto et al. (2022) reported the presence of bird species in the rehabilitation zone including Wonoasri Resort (Donglo and Pletes Block) and Andongrejo (Kandangmotor) with total 22 species. This information about avifauna in the rehabilitation zone is important for use as an indicator of forest quality. Simamora et al. (2014) revealed that one of the assessments of strengthening the restoration of forest ecosystems is using the ecological value of birds as an indicator.

Currently, information regarding the existence of avifauna in the Wonoasri Resort rehabilitation zone is still unclear. There are still several blocks of geographical areas that have not been explored. Therefore, this incomplete data cannot be used as a reference to assess the overall structure of the avifauna community in the rehabilitation zone of Wonoasri Resort. Consequently, it cannot determine whether the rehabilitation zone has recovered or not based on indicators of bird presence. So, this study aims to determine the structure of the avifauna community in the rehabilitation zone, particularly at Bonangan Block, Wonoasri Resort, MBNP. Hopefully, the results can complement aspects of assessing the success of ecosystem recovery in the rehabilitation zone using avifauna indicators.

MATERIAL AND METHODS

The research was conducted in January 2023 in the Bonangan Block rehabilitation zone, Wonoasri Resort, MBNP, East Java, Indonesia (Figure 1). The study area has approximately 65 ha, and the data

collection was carried out at three observation points (OP), i.e. OP1 (low vegetation cover: S 08°25'17.2" and E 113°39'42.4"), OP2 (medium vegetation cover: S 08°25'25.6", E 113°39'53.9"), and OP3 (high vegetation cover: S 08°25'38.0", E 113°39'54.8"). The distance between each observation plot is 300 meters. The ecological data were collected using the point count method introduced by Bibby et al. (2000). Point count is a method used to observe avifauna by taking samples from bird communities in an area to be calculated within a certain time. Observations were made in the morning at 06:00-09:00, this is related to the peak activity of avifauna (MacKinnon et al., 2010; Siddiq et al., 2023). Observations

on each OP were conducted for 30 minutes.

The data included the species names of birds and the number of individuals of each species. Furthermore, species identification and verification are based on morphology characters from the head to the feet (MacKinnon et al., 2010; Taufiqurrahman et al., 2022). These observations were using specific equipment, such as binocular Aculon Powerview 10x50, DSLR camera Canon EOS 60D, and telephoto lens Canon Tamron 75-300 mm. The detection of bird occurrence using sound observation was also performed using the Xeno Canto website. Xeno-canto is a website dedicated to sharing wildlife sounds from all over the world (<https://xeno-canto.org/>).

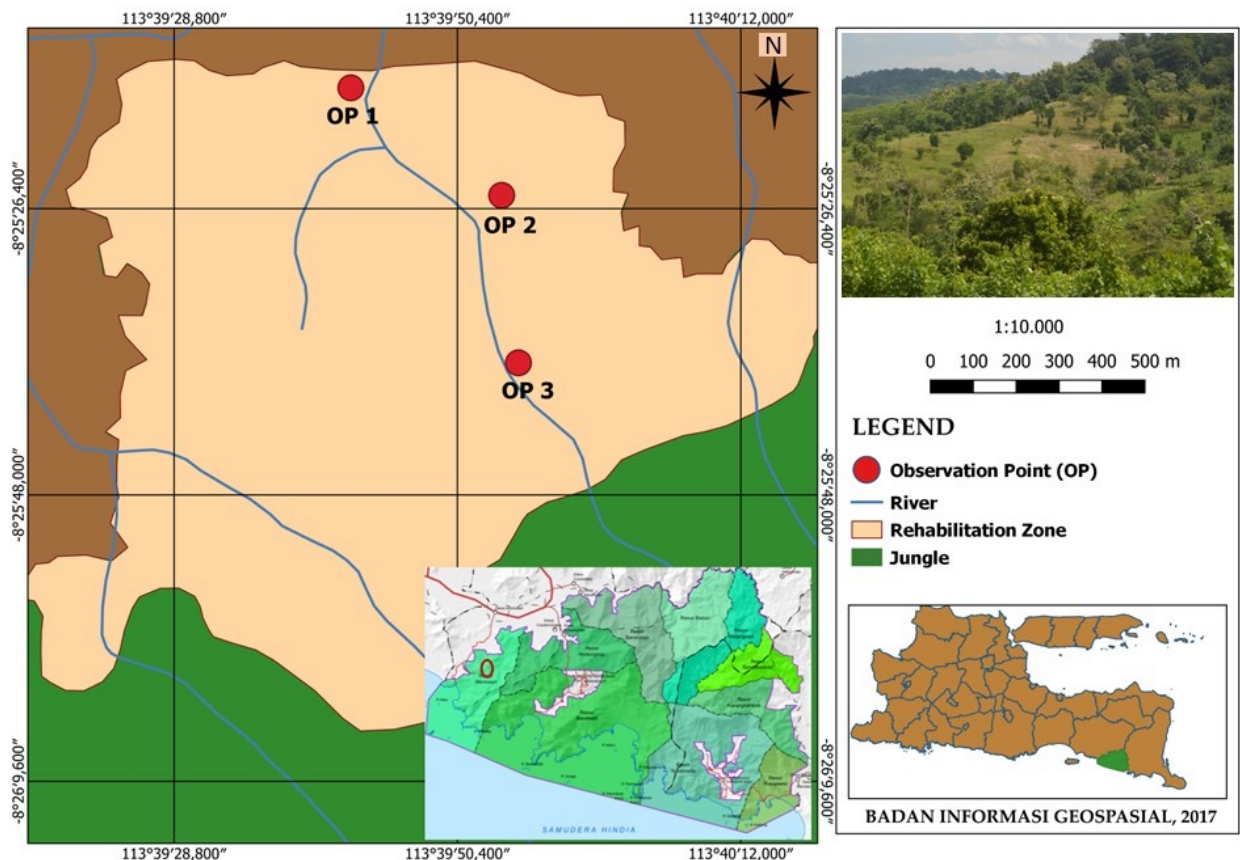


Figure 1. Study sites at Bonangan Block, Wonoasri Resort of MBNP, East Java, Indonesia

The determination of species composition including family, species names, common names, and feeding guilds refers to MacKinnon et al. (2010), Taufiqurrahman et al. (2022), and Shah & Sharma (2022). The additional information obtained from conservation status based on the IUCN Redlist (<https://www.iucnredlist.org/>), CITES Appendix (<https://cites.org/eng/app/index.php>), and Indonesian government regulation (LHK No.106/2018). Then determine the dominance of birds species was used Simpson index (C) (Magguran, 1988).

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

Where:

ni : Total individual of species-i

N : Total individual of all species

Furthermore, the determination of diversity of species was used Shannon Wiener index (H') (Magurran, 1988).

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

Whereas pi : The proportion of individuals belonging to the i-species in the community

We also tested for statistical data, including the correlation between bird abundance and vegetation type (low vegetation cover, medium vegetation cover, and high vegetation cover), bird feeding guilds correlation, and central tendency of feeding guilds using a Kruskal Wallis (KW) test in R version 3.2.1 (R Core Team, 2021).

RESULTS AND DISCUSSION

We recorded 38 bird species belonging to 31 genera and 21 families during this study

(Table 1). There are five families, i.e., Cisticolidae, Columbidae, Cuculidae, Megalaimidae, and Pycnonotidae, had the highest species richness (three species). According to the IUCN Red List, avifauna in the rehabilitation zone at Bonangan Block has three conservation statuses, i.e, least concern are 35 species, near threatened are two species (*Lophotriorchis kienerii* and *Psilopogon javensis*), and vulnerable is one species (*Rhyticeros undulatus*) (Table 1). Species *L. kienerii* is one of the raptor groups that has decreased population status in the world (Birdlife International, 2020). The main factor is threatened by elevated levels of deforestation throughout its range (Birdlife International, 2020; Birdlife International, 2023a). This species was found soaring in high vegetation cover areas in the Bonangan Block. The encounter of this species in the rehabilitation zone indicates the availability of the required resources, such as prey or perches. Taufiqurrahman et al. (2022) stated that *L. kienerii* often detected foraging in open areas and perched on trees with branching on the edge of the forest.

The existence of *Ps. javensis* in the rehabilitation zone is a noteworthy record. This bird is an endemic species to Java Island, and it has a declining population trend (Birdlife International, 2017). This is due to the extreme forest destruction causing its loss. On the other hand, it also causes trapped and traded as a cagebird (Birdlife International, 2017; Birdlife International, 2023b). In the rehabilitation zone at Bonangan Block, this species is found in all observation plot cover types but is more common in areas of high vegetation cover. In the high vegetation cover, this species was also observed foraging activity in papaya fruit. This species is a forest indicator bird that only resides in main forest habitats, particularly conservation areas. This is also in accordance with Taufiqurrahman et al. (2022), who state that *Ps. javensis* intently forages in

solitary fruit trees and sometimes in mixed groups in forest habitats. Meanwhile, the species *R. undulatus* has a vulnerable status with a significantly decreasing population trend. The main causes are forest destruction, conversion to agriculture (particularly plantations), and increasing pressure on the human population (Birdlife International, 2018). In the rehabilitation zone, this species was observed flying in pairs into primary forest. This is in accordance with Jarulis (2020) and Taufiqurrahman et al. (2022), who reported that *R. undulatus* inhabits primary forest, secondary forest, and hills as its main habitat. This species was not observed perching in the vegetation of observation plots but was only recorded flying past and utilizing the rehabilitation area for path connectivity. Therefore, this rehabilitation zone is suspected to be part of its home range.

Furthermore, according to international trade status, there are 35 species that are non-appendix, and three species are Appendix II (*Spilornis cheela*, *L. kienerii*, and *R. undulatus*) (Table 1). Appendix II is a category form for species that will be threatened with extinction due to continued trade. Species *S. cheela* is a common raptor that is found in various habitat types (MacKinnon et al., 2010; Taufiqurrahman et al., 2022; Siddiq et al., 2023). However, it is also quite risky because there will be more opportunities to be caught by hunters. This species was observed soaring in the rehabilitation zone in low and medium vegetation cover. This is thought to be related to foraging activities and their socialization behavior. Taufiqurrahman et al. (2022) stated that *S. cheela* is often found soaring on the forest edge and catches prey (small mammals, snakes, and other reptiles) by flying down to the forest floor. Finally, based on the government regulation of P.106 /MENLHK /SET-JEN /KUM.1/12/2018, there are 33 unprotected species and five protected species such as *S. cheela*, *L. kienerii*, *R. undulatus*, *Crypsiri-*

na temia, and *Ps. javensis* (Table 1). The existence of protected species in the rehabilitation zone is essential information for the MBNP, in this case, to increase efforts to protect both the population and the habitat of these birds.

Among the feeding guilds, the insectivorous birds (14 species) were recorded as the higher species richness, followed by omnivorous (eight species), frugivorous (five species), granivorous (five species), carnivorous (four species), and nectarivorous (two species) respectively. This indicates that the rehabilitation zone at Bonangan Block provides the required resources for birds, such as feed, socialization, resting, and nesting areas. Stratford and Şekercioğlu (2015) revealed that the existence of birds in the forest is significantly influenced by the availability of resources, one of which is feed. Insectivorous species in Bonangan Block had a higher species number than the other feeding guilds. These results are related to Shah and Sharma (2022), who reported that insectivorous birds (56 species) out of 98 species were dominant at Dullu Municipality, Nepal. Meanwhile, the lowest species number at Bonangan Block was the nectarivorous species. Loiseau et al. (2020) revealed that as a proportion of ecologically, nectarivorous or frugivorous mammals and birds are significantly rare in the ecosystem. Globally, the number of species from this group is indeed exceedingly insignificant compared to other feeding guilds.

Based on the total of 83 samples recorded, the insectivorous had the highest abundance (33 individuals), followed by omnivorous (16 individuals), granivorous (13 individuals), frugivorous (10 individuals), carnivorous (eight individuals), and nectarivorous (three individuals) respectively (Figure 2). The Kruskal-Wallis test shows that there is a significant difference between the responses among the feeding guilds (value of 11.644, with p -value = 0.040). This reveals that the

abundance of each type of bird is based on the feeding guilds. Furthermore, in a follow-up test (post hoc), the results of pairwise comparisons revealed that there were four significant feeding guild correlations, including nectarivorous-insectivorous (29.697 with p-value 0.039), carnivorous-granivorous (-23.130 with p-value 0.031), omnivorous-granivorous (20.724 with p-value 0.20), and necta-

vorous-granivorous (37.859 with p-value 0.013). While based on central tendency, the granivorous had the highest value (54.69), followed by insectivorous (46.53), frugivorous (39.30), omnivorous (33.97), carnivorous (31.56), and nectarivorous (16.53) respectively. However, the mean rank of frugivorous central tendency was not significant with the other feeding guilds mean ranks (Figure 2).

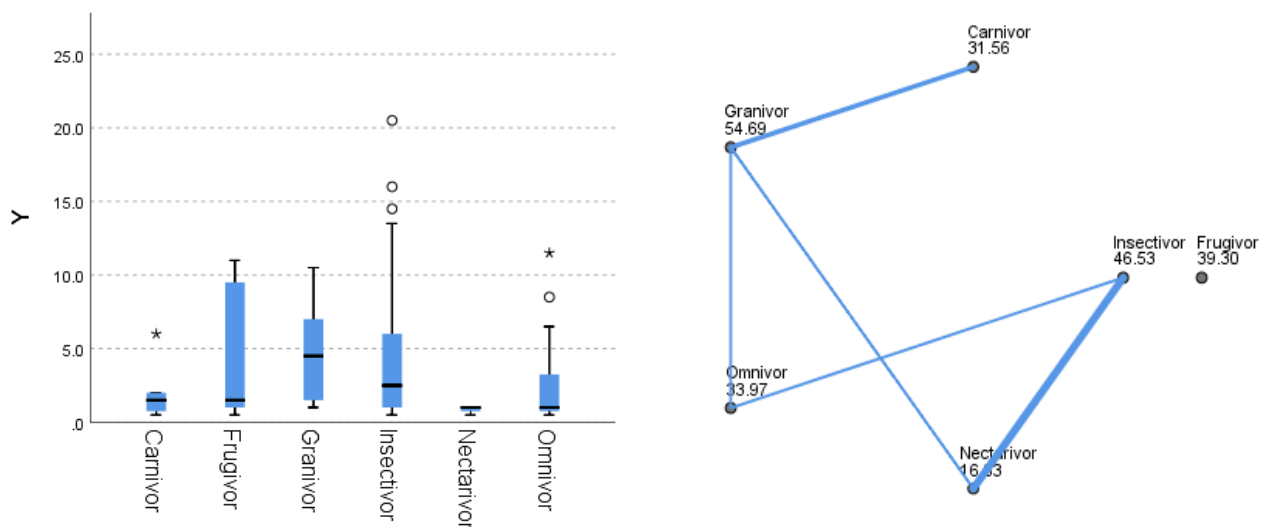


Figure 2. The bird abundance of six feeding guilds (left) and central tendency of each six feeding guilds at Bonangan Block, Wonoasri Resort of MBNP

The abundance of birds based on feeding guild in the three vegetation covers also varied. Based on the median rank, carnivorous birds had the highest recorded value in medium vegetation cover (1.5), whereas frugivorous birds in low vegetation cover (4.5), granivorous birds in low vegetation cover (6.0), nectarivorous birds in high vegetation cover (1.0), omnivorous birds in medium vegetation cover (2.0), and insectivorous birds had a similar value in each vegetation cover (Figure 3). It is also related to the need for essential resources, particularly food. Based on the results, nectarivorous birds had the highest recorded abundance in high vegetation cover, which is suggested to be related to the need

for food in the form of nectar from flowering trees or nesting sites. There are several flowering plants in this observation plot, such as mango, jackfruit, avocado, papaya, soursop, kenitu, and durian, which are food sources for nectarivorous birds. However, the five feeding guilds (carnivorous, frugivorous, granivorous, and omnivorous) tend to be recorded in medium vegetation cover and low vegetation cover. It is also related to Tu et al. (2020), who revealed that forestland decreased bird numbers and abundance. Similarly, in the forest of Nepal, birds were more abundant in areas with low vegetation cover (Poudel et al., 2021).

Tabel 1. Spesies composition of avifauna in Bonangan Block at Rehabilitation Zone

| Family | Species Name | Common Name | FG | Conservation Status | | |
|---------------|---------------------------------|-----------------------------|----|---------------------|-------|----|
| | | | | IUCN | CITES | IR |
| Accipitridae | <i>Spilornis cheela</i> | Crested Serpent-eagle | C | LC | A.II | PT |
| | <i>Lophotriorchis kienerii</i> | Rufous-bellied Eagle | C | NT | A.II | PT |
| Aegithinidae | <i>Aegithina tiphia</i> | Common lora | I | LC | NA | NP |
| Alcedinidae | <i>Halcyon cyanoventris</i> | Javan Kingfisher | C | LC | NA | NP |
| | <i>Todiramphus chloris</i> | Collared Kingfisher | C | LC | NA | NP |
| Apodidae | <i>Collocalia linchi</i> | Cave Swiftlet | I | LC | NA | NP |
| Bucerotidae | <i>Rhyticeros undulatus</i> | Wreathed Hornbill | F | VU | A.II | PT |
| Campephagidae | <i>Lalage nigra</i> | Pied Triller | I | LC | NA | NP |
| | <i>Pericrocotus cinnamomeus</i> | Small Minivet | I | LC | NA | NP |
| Cisticolidae | <i>Orthotomus sepium</i> | Olive-backed Tailorbird | I | LC | NA | NP |
| | <i>Orthotomus ruficeps</i> | Ashy Tailorbird | I | LC | NA | NP |
| | <i>Orthotomus sutorius</i> | Common Tailorbird | I | LC | NA | NP |
| Columbidae | <i>Geopelia striata</i> | Zebra Dove | G | LC | NA | NP |
| | <i>Streptopelia bitorquata</i> | Sunda Collared-dove | G | LC | NA | NP |
| | <i>Spilopelia chinensis</i> | Eastern Spotted-Dove | G | LC | NA | NP |
| Corvidae | <i>Corvus enca</i> | Slender-billed Crow | O | LC | NA | NP |
| | <i>Crypsirina temia</i> | Racket-tailed Treepie | O | LC | NA | PT |
| Cuculidae | <i>Centropus bengalensis</i> | Lesser Coucal | O | LC | NA | NP |
| | <i>Centropus sinensis</i> | Greater Coucal | O | LC | NA | NP |
| | <i>Cacomantis merulinus</i> | Plaintive Cuckoo | I | LC | NA | NP |
| Dicaeidae | <i>Dicaeum trochileum</i> | Scarlet-headed Flowerpecker | F | LC | NA | NP |
| Estrildidae | <i>Lonchura leucogastroides</i> | Javan Munia | G | LC | NA | NP |
| | <i>Lonchura punctulata</i> | Scaly-breasted Munia | G | LC | NA | NP |
| Hemiprocnidae | <i>Hemiprocne longipennis</i> | Grey-rumped Treeswift | I | LC | NA | NP |
| Hirundinidae | <i>Cecropis daurica</i> | Red-rumped Swallow | I | LC | NA | NP |
| Laniidae | <i>Lanius schach</i> | Long-tailed Shrike | I | LC | NA | NP |
| Megalaimidae | <i>Psilopogon australis</i> | Yellow-eared Barbet | F | LC | NA | NP |
| | <i>Psilopogon javensis</i> | Black-banded Barbet | F | NT | NA | PT |
| | <i>Psilopogon haemacephalus</i> | Coppersmith Barbet | F | LC | NA | NP |
| Meropidae | <i>Merops leschenaulti</i> | Chestnut-headed Bee-eater | I | LC | NA | NP |
| Nectariniidae | <i>Anthreptes malacensis</i> | Brown-throated Sunbird | N | LC | NA | NP |
| | <i>Cinnyris jugularis</i> | Olive-backed Tailorbird | N | LC | NA | NP |
| Phasianidae | <i>Gallus varius</i> | Green Junglefowl | O | LC | NA | NP |
| Picidae | <i>Picoides moluccensis</i> | Sunda Pygmy Woodpecker | I | LC | NA | NP |
| | <i>Dendrocopos analis</i> | Freckle-breasted Woodpecker | I | LC | NA | NP |
| Pycnonotidae | <i>Brachypodius atriceps</i> | Black-headed Bulbul | O | LC | NA | NP |
| | <i>Pycnonotus aurigaster</i> | Sooty-headed Bulbul | O | LC | NA | NP |
| | <i>Pycnonotus goiavier</i> | Yellow-vented Bulbul | O | LC | NA | NP |

Note: Feeding Guilds (FG), Carnivorous (C), Insectivorous (I), Frugivorous (F), Granivorous (G), Omnivorous (O), Nectarivorous (N), Least Concern (LC), Near Threatened (NT), Non-Appendix (NA), Indonesia Regulation (IR), Not Protected (NP), Protected (PT)

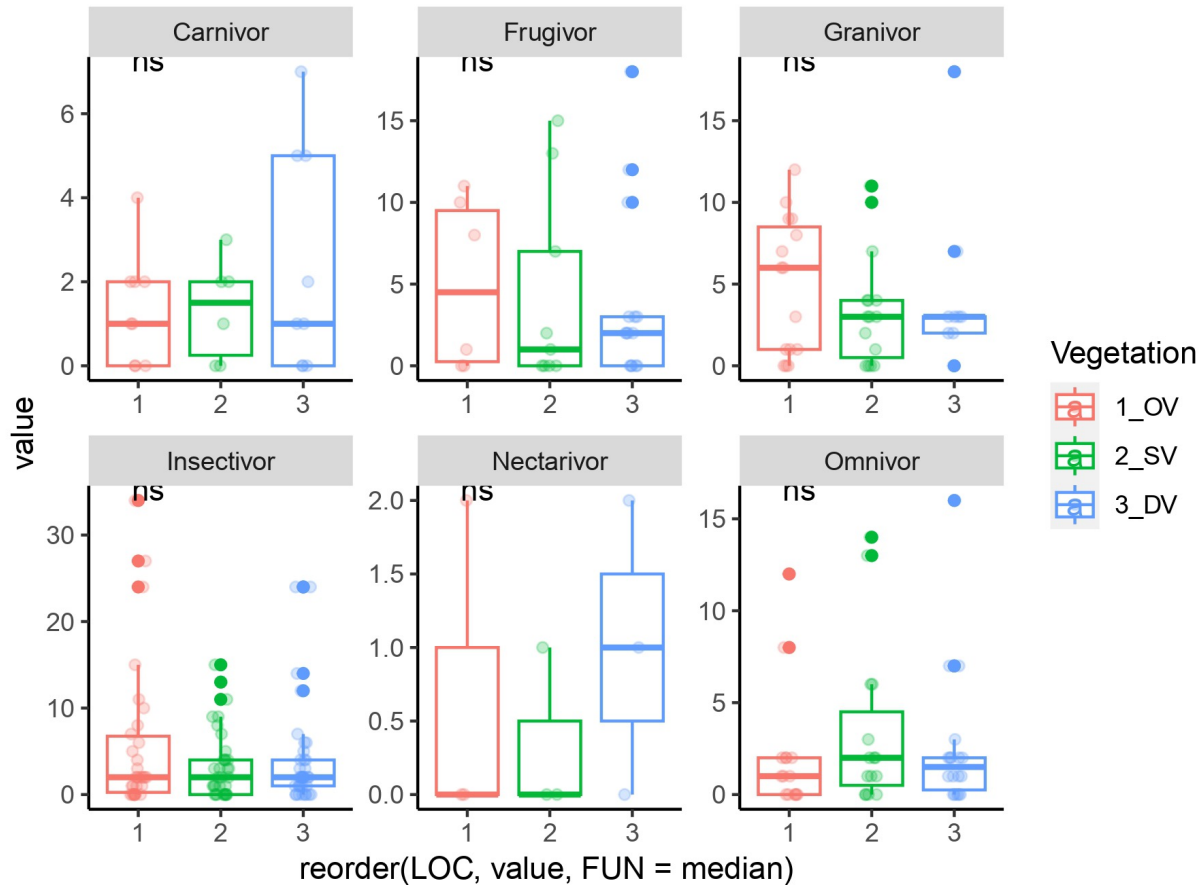


Figure 3. The bird's abundance of six feeding guilds on three vegetation types at Bonangan Block, Wonoasri Resort of MBNP. Open Vegetation (OV), Semi-Dense Vegetation (SV), and Dense Vegetation (DV).

Furthermore, referring to species richness, high vegetation cover areas had higher species richness (30 species) compared to medium vegetation cover areas (27 species) and low vegetation cover areas (26 species) (Figure 4). It is believed to be due to geographical factors. The high vegetation cover area was directly adjacent to the buffer zone, allowing some birds from this zone to use the high vegetation area as a foraging or crossing route. Kurnianto et al. (2014) also stated that birds in MBNP have quite varied habitats, from rehabilitation land to buffer and core forest. All bird species vary in abundance affecting ecological values such as dominance and diversity.

The dominance of avifauna species at

this location falls into the low category ($C = 0.07$). This is because the abundance of each species tends to be evenly distributed. The species with the highest abundance was *C. linchi* (45 individuals), followed by the codominant *Ps. haemacephalus* (35 individuals) (Figure 4). Species *C. linchi* is a cosmopolitan species commonly found in various habitat types and is often found in large flocks. Kurnianto et al. (2022) also stated that *C. linchi* was found in a high number of individuals in the Pletes Block area, Wonoasri Resort, MBNP. Siddiq et al. (2023) also found *C. linchi* to be a common bird species in Ereke-erek Geoforest, Ijen Geopark.

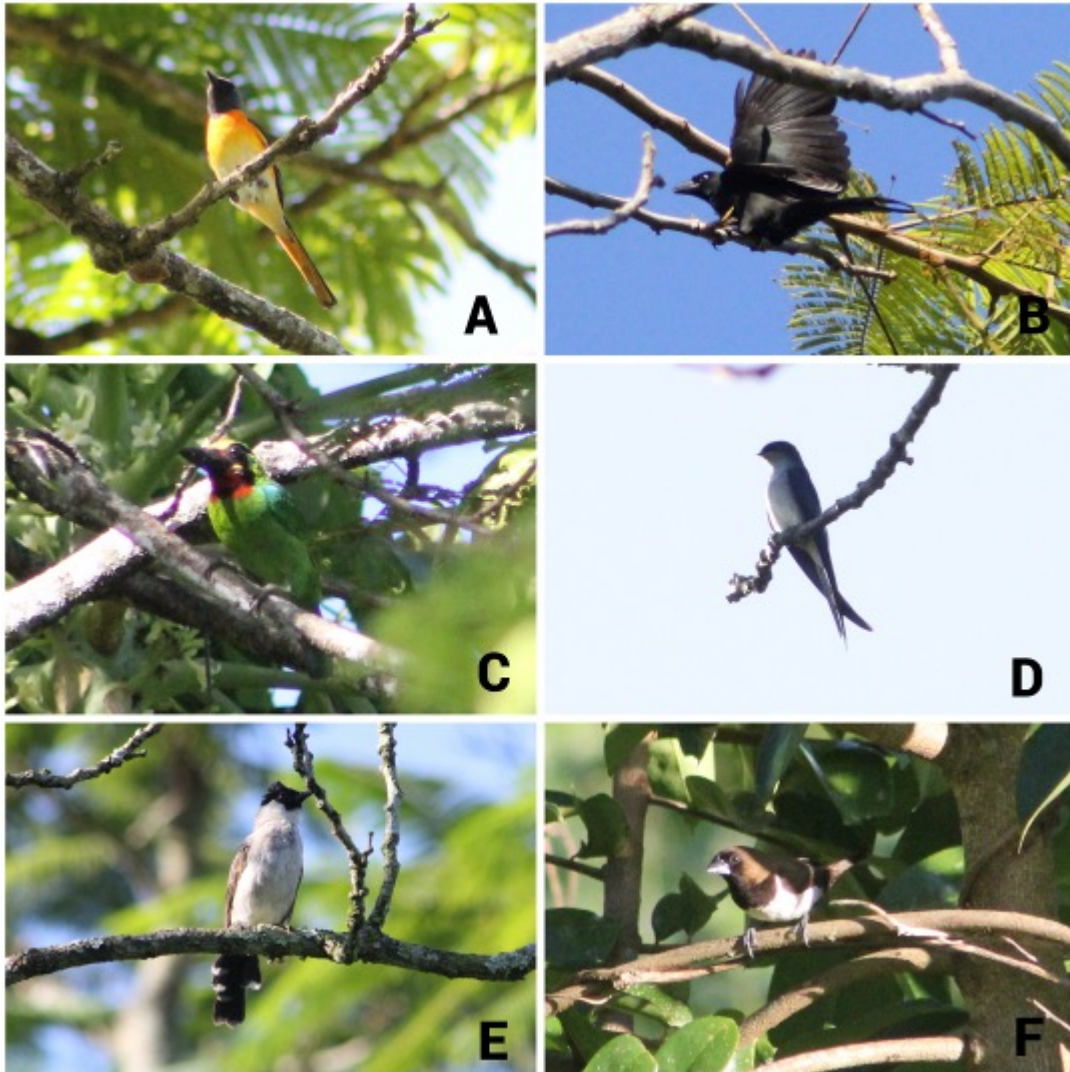


Figure 5. Documentation of Avifauna species at Bonangan Block, Wonoasri Resort, MBNP. *P. cinnamomeus* (A); *C. temia* (B); *Ps. javensis* (C); *H. longipennis* (D); *Py. aurigaster* (E); *L. leucogastroides* (F).

According to the Shannon-Wiener index, the species diversity of avifauna in Bonangan Block is classified as high category ($H' = 3.01$). It is supported by the high species richness (38 species) and the abundance of each species, which is evenly distributed. This is in accordance with Magguran (1988), who states that species diversity is strongly influenced by the richness and abundance of each species. On the other hand, the diversity index is also influenced by the availability of resources such as food, shelter, and other

abiotic factors (Girma et al., 2017; Shah & Sharma, 2022). Based on this, we can conclude that the rehabilitation zone (Bonangan Block) is thought to support the existence of avifauna. This shows that the ecosystem recovery efforts by MBNP have gone well. The MBNP officer could also improve ecosystem recovery efforts by controlling the land and vegetation. Along with these programs, it will increase the species richness and abundance of avifauna in the rehabilitation zone.

CONCLUSION

According to the results, we recorded 38 bird species belonging to 31 genera and 21 families during this study. Among the feeding guilds, the insectivorous birds (14 species) were recorded as the higher species richness, followed by omnivorous (eight species), frugivorous (five species), granivorous (five species), carnivorous (four species), and nectarivorous (two species) respectively. Furthermore, referring to species richness, high vegetation cover areas had higher species richness (30 species) compared to medium vegetation cover areas (27 species) and low vegetation cover areas (26 species). The dominance of avifauna species at this location falls into the low category ($C = 0.07$), and the diversity index is classified as high category ($H' = 3.01$). Therefore, these results also indirectly measure the success of the rehabilitation program in MBNP using avifauna as a bioindicator of forest quality.

AUTHOR CONTRIBUTION

A.M.S. designing, collecting, analyzing data, and drafting manuscripts. Then, M.A.U. contributed to data collection and analysis, F.B.U. and F.F. contributed to statistical data analysis, and H.S. supervised all the processes.

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CONFLICT OF INTEREST

The published results of our research do not contain any conflicts of interest, either between researchers or with third parties.

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