



## Research Article

# Bird Diversity in The Plantation and Conservation Area of Oil Palm in Konawe Regency, Southeast Sulawesi

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**Abstract** | This study aimed to assess the diversity, evenness, and conservation status of bird species inhabiting the palm oil plantation and conservation land in Besulutu, Konawe Regency. Data collection conducted using the Point Count and Transect methods, with observations carried out at designated stations during the morning (06:00–08:30 WITA) and afternoon (15:00–17:30 WITA). Each station covered a distance of approximately 200 meters and included six observation points, with a 30-minute observation period at each point. The study identified 35 bird species belonging to 20 families. The highest number of species recorded at Station IV, followed by Stations V, II, III, and I, with Station I having the lowest species count. Station IV also reported the highest number of individual birds, followed by Stations II, III, and I, while Station V recorded the lowest. The overall diversity index for the area was 2.87, indicating moderate diversity, while the evenness index was 0.81, signifying a high level of species distribution uniformity. According to the IUCN conservation status, all 35 bird species were classified as Least Concern. However, based on CITES, four bird species are listed in Appendix II, reflecting their regulated trade status. These four species, Black-winged Kite (*Elanus caeruleus*), Sulawesi Hanging-parrot (*Loriculus stigmatus*), Brahminy Kite (*Haliastur indus*), and Sulawesi Serpent-eagle (*Spilornis rufipectus*) are also protected under the Minister of Environment and Forestry Regulation No. 106/2018 of Indonesia. This study highlights the ecological significance of the area and the need for conservation efforts to safeguard these bird species and their habitats.

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**Keywords** | Birds, Diversity index, Evenness index, Oil palm plantation, Conservation land



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## Introduction

As part from mining, the plantation industry, such as oil palm plantation, is one of the reasons for land clearing in Southeast Sulawesi. Sheil *et al.* (2009) explain that land-clearing for palm oil in Indonesia is commonly on an extended scale with a sizeable land-clearing system. Sari *et al.* (2021) say Indonesia is one of the biggest palm oil producers worldwide. Palm oil plays a vital role in Indonesia's economic growth. Syahza *et al.* (2020) and Munadi *et al.* (2023) revealed that Indonesia's palm oil industry can elevate the folk's economy. Recorded by the Indonesian Central of Statistics in 2021, the palm oil plantation in Southeast Sulawesi has achieved 9.303 ha. In Konawe, to be specific, 931 ha of palm oil area is under the management of 10 companies.

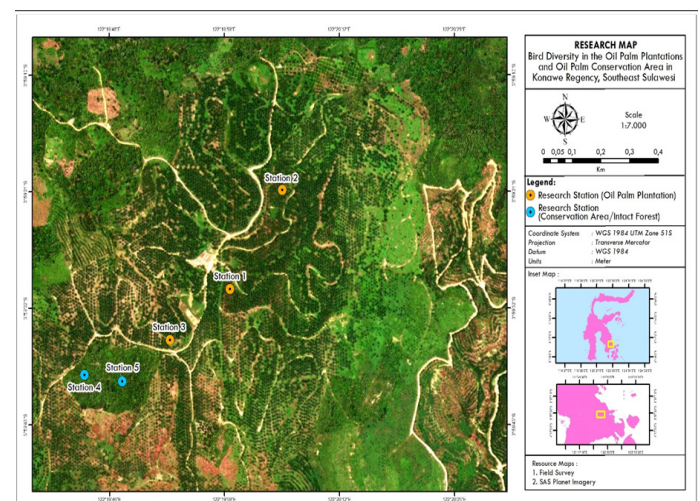
Land conversion has deteriorated the status of the forest state (Mansor and Sah, 2012) and threatened biodiversity (Prihandi and Nurvianto, 2022) regarding the ecological role of the forest as the natural habitat of a vast number of species such as birds (Teuscher *et al.*, 2015; Azman *et al.*, 2011). Forest land conversion for oil palm plantations has become one of the roots of decreasing biodiversity and plant species' structure and composition change (Alikodra, 2010; Sheil *et al.*, 2009; Amit *et al.*, 2023; Sani *et al.*, 2023). This is regrettable because Indonesia is renowned for its rich biodiversity, with an approximation of 1.700 species (Iskandar *et al.*, 2016; Eddy *et al.*, 2021). Birds are a group of animals that play a pivotal role in the ecosystem (Iskandar *et al.*, 2021). These animals are susceptible to ecological change (Krisanti *et al.*, 2017; Iskandar *et al.*, 2021), and they become a bio-indicator of environmental damage due to their rapid response to environmental change (Simamora *et al.*, 2021; Kaban *et al.*, 2017; Iskandar *et al.*, 2021; Hakim *et al.*, 2020). The change in the function of forest ecosystems significantly impacts birds. According to Sheil *et al.* (2009), forest conversion can reduce  $\pm 60\%$  of bird diversity. This is due to losing their nests, shelters, and forages (Defriansyah *et al.*, 2022). Several studies have exhibited that transformed vegetation due to timber harvest alters the abundance and diversity of bird species (Thompson *et al.*, 1999). Koh and Wilcove (2008) figured out that the conversion of primary forests and logged-over areas into oil palm plantations had reduced bird species richness by about 77% and 73%.

The palm oil companies have been providing conservation of land surrounding the area of the palm oil plantation to solve the ecological issues. This strategy, hopefully, enables the continuous ecological function in that area. Moreover, this conservation land is a form of protection in a sustainable environment for the lives of both plants and animals. In its definition, conservation land is an area of preserved forest to sustain the functions of the forest and all life in it (Safe'i *et al.*, 2020). Therefore, it is necessary to research the diversity of avifauna around the location of the palm oil plantation and conservation land to observe the diversity, evenness, and conservation status of avifauna.

## Materials and Methods

### Study site

This research was in March-August 2024. It takes place on the palm oil plantation and conservation land of PT. Mega Utama Tani in Besulutu District, Konawe Regency (Figure 1). Meanwhile, the identification and analysis of avifauna diversity were managed in the observation location and the Laboratory of Ecology and Taxonomy of Math and Natural Science, Halu Oleo University.



**Figure 1:** Map of research location.

### Research procedure

**Research location:** The observations were conducted across five distinct stations, each strategically selected based on their unique environmental characteristics. Station I is positioned within a plantation area, approximately 200 meters away from residential zones. Station II is located at the center of an oil palm plantation, situated 200 meters from conservation land. Station III represents the boundary zone within the

conservation land itself, lying at a similar distance from the plantation area. Station IV is entirely within the conservation land, maintaining a separation of 200 meters from the nearest oil palm plantation. Lastly, Station V is situated deep within the conservation land, offering insights into the core conservation ecosystem.

**Data collection:** The research employed two primary methods: The Point Count method and the Transect method. The Point Count method was applied in conservation land areas, where establishing structured transects was not feasible due to environmental constraints. In contrast, the Transect method was utilized in plantation areas, which provided the necessary conditions for implementing this approach. Observations were conducted during two specific time periods: morning (06:00–08:30 WITA) and afternoon (15:00–17:30 WITA). At each station, three observation sessions were carried out, with a duration of 30 minutes per session. Each station was further divided into six observation points, spaced approximately 200 meters apart, ensuring comprehensive data collection across the study area.

#### Sample identification

The identification of bird species was conducted with the assistance of several authoritative references, including the books *Birds of the Philippines*, *Sumatra*, *Java*, *Bali*, *Sulawesi*, *The Lesser Sundas*, and the *Moluccas and Field Guide to Birds in the Wallacea Region of Sulawesi*, *Maluku*, and *Nusa Tenggara*. Additionally, the identification of Passeriformes species was supported by analyzing voice recordings. To ensure the accuracy of observations, the study also utilized the online resource eBird for validation. The conservation status of the identified bird species was determined using information from the International Union for Conservation of Nature (IUCN) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Furthermore, protected bird species were identified based on the regulations outlined in Indonesia's PERMEN LHK No. 106 of 2018 concerning endangered plants and animals.

#### Data analysis

Data analysis includes the Shannon-Wiener diversity index and evenness index. The diversity index were analyzed using a formula (Odum, 1996):

$$H' = -\sum \left[ \left( \frac{n_i}{N} \right) \ln \left( \frac{n_i}{N} \right) \right]$$

Information;  $H'$  = Index score of species diversity;  $n_i$  = Sum of individuals of  $i$ -species;  $N$  = Total individuals.

The criteria for the Shannon-Wiener diversity index ( $H'$ ), according to Odum (1996), are as follows:

$H' < 1$  = Low level of species diversity;  $1 < H' < 3$  = Fair level of species diversity;  $H' > 3$  = High level of species diversity.

The species evenness index was analyzed using the following formula (Odum, 1996).

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

Information;  $E$  = Species evenness index;  $H'$  = Diversity index of Shannon-Wiener;  $\ln S$  = Total species found.

The criteria for the evenness index ( $E'$ ) are as follows:

$E < 0,4$  = Low evenness index

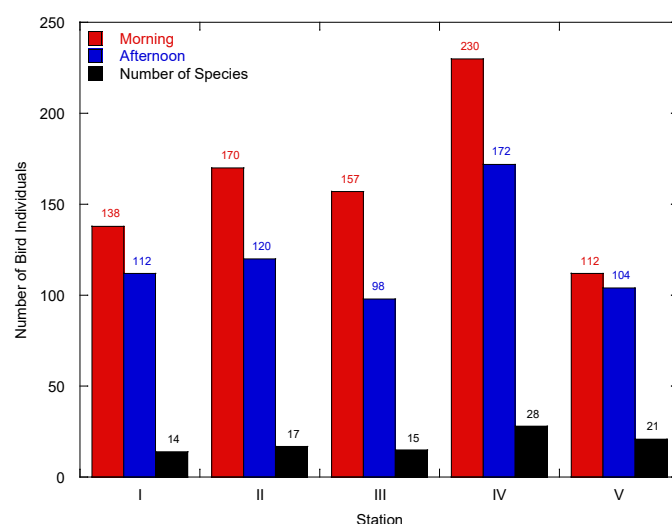
$0,4 < E < 0,6$  = Fair evenness index

$E > 0,6$  = High evenness index

## Results

### *Species and the number of birds observed in oil palm plantation and conservation area*

It was observed that, in the research location, there were 1413 individuals of birds, a total of 35 species from 20 families. This was higher than previous research under Ahmad *et al.* (2016), which discovered 17 species of birds from 14 families and 722 individuals. The individual graph and kind of species can be seen in Figure 2.



**Figure 2:** The number of species and individuals of birds found in the plantation area of oil palm and in the conservation land.

**Table 1:** Details the bird species found in the oil palm plantation and the conservation land in Besulutu, Konaawe.

| No    | Bird species                                     |                                      | Number of individuals |     | Total | Species composition (%) |
|-------|--------------------------------------------------|--------------------------------------|-----------------------|-----|-------|-------------------------|
|       | Local name (Common name)                         | Scientific Name                      | PS                    | LK  |       |                         |
| 1     | Cabai panggul kelabu (Grey-sided flowerpecker)   | <i>Dicaeum celebicum</i>             | 5                     | 11  | 16    | 1,13                    |
| 2     | Cabai panggul kuning (Yellow-sided flowerpecker) | <i>Discaeu aureolimbatus</i>         | 20                    | -   | 20    | 1,42                    |
| 3     | Kacamata sulawesi (Pale-bellied white-eye)       | <i>Zosterops consobrinorum</i>       | 52                    | 20  | 72    | 5,10                    |
| 4     | Kacamata laut (Lemon-bellied white-eye)          | <i>Zosterops chloris</i>             | 46                    | -   | 46    | 3,26                    |
| 5     | Cekakak suci (Sacred kingfisher)                 | <i>Todirhamphus sanctus</i>          | 18                    | 22  | 40    | 2,83                    |
| 6     | Cekakak sungai (Collared kingfisher)             | <i>Todirhamphus chloris</i>          | 34                    | 54  | 88    | 6,23                    |
| 7     | Bubut sulawesi (Bay coucal)                      | <i>Centropus celebensis</i>          | 14                    | 20  | 34    | 2,41                    |
| 8     | Kadalan sulawesi (Yellow-billed malkoha)         | <i>Phaenicophaeus calyborhynchus</i> | 9                     | 11  | 20    | 1,42                    |
| 9     | Wiwik uncuing (Brush cuckoo)                     | <i>Cacomantis sepulcralis</i>        | 2                     | 1   | 3     | 0,21                    |
| 10    | Kedasi gould (Little bronze-cuckoo)              | <i>Chrysococcyx russatus</i>         | -                     | 5   | 5     | 0,35                    |
| 11    | Delimukan zamrud (Grey-capped emerald dove)      | <i>Chalcophaps indica</i>            | -                     | 3   | 3     | 0,21                    |
| 12    | Merpati hitam sulawesi (White-faced cuckoo-dove) | <i>Turacoena manadensis</i>          | 6                     | 9   | 15    | 1,06                    |
| 13    | Uncal ambon (Little cuckoo-dove)                 | <i>Macropygia ruficeps</i>           | -                     | 50  | 50    | 3,54                    |
| 14    | Walik kembang (Black-naped fruit-dove)           | <i>Ptilinopus melanospila</i>        | -                     | 4   | 4     | 0,28                    |
| 15    | Elang bondol (Brahminy kite)                     | <i>Haliastur indus</i>               | -                     | 3   | 3     | 0,21                    |
| 16    | Elang ular sulawesi (Sulawesi serpent-eagle)     | <i>Spilornis rufipectus</i>          | -                     | 2   | 2     | 0,14                    |
| 17    | Elang tikus (Black-winged kite)                  | <i>Elanus caeruleus</i>              | 3                     | -   | 3     | 0,21                    |
| 18    | Puyuh batu (Asian blue quail)                    | <i>Coturnix chinensis</i>            | 13                    | 2   | 15    | 1,06                    |
| 19    | Perling kecil (Short-tailed starling)            | <i>Aplonis minor</i>                 | 44                    | 29  | 73    | 5,17                    |
| 20    | Mandar padi-zebra (Barred rail)                  | <i>Gallirallus torquatus</i>         | 6                     | -   | 6     | 0,42                    |
| 21    | Madu sriganti (Olive-backed sunbird)             | <i>Nectarinia jugularis</i>          | 43                    | 36  | 79    | 5,59                    |
| 22    | Madu hitam (Black sunbird)                       | <i>Leptocoma sericea</i>             | 13                    | 20  | 33    | 2,34                    |
| 23    | Madu kelapa (Brown-throated sunbird)             | <i>Anthreptes malacensis</i>         | 9                     | -   | 9     | 0,64                    |
| 24    | Pelanduk sulawesi (Sulawesi babbler)             | <i>Trichastoma celebense</i>         | -                     | 12  | 12    | 0,85                    |
| 25    | Malia sulawesi (Malia)                           | <i>Malia grata</i>                   | -                     | 11  | 11    | 0,78                    |
| 26    | Kepudang sungu sulawesi (Sulawesi cicadabird)    | <i>Edolisoma morio</i>               | -                     | 15  | 15    | 1,06                    |
| 27    | Kapasan sulawesi (White-rumped trilled)          | <i>Lalage leucopygialis</i>          | -                     | 6   | 6     | 0,42                    |
| 28    | Gagak hutan (Slender-billed crow)                | <i>Corvus enca</i>                   | 5                     | 6   | 11    | 0,78                    |
| 29    | Kepudang kuduk hitam (Black-naped oriole)        | <i>Oriolus chinensis</i>             | -                     | 53  | 53    | 3,75                    |
| 30    | Tepekong jambul (Grey-rumped treeswift)          | <i>Hemiprocne longipennis</i>        | -                     | 35  | 35    | 2,48                    |
| 31    | Serindit sulawesi (Sulawesi hanging-parrot)      | <i>Loriculus stigmatus</i>           | -                     | 41  | 41    | 2,90                    |
| 32    | Srigunting jambul rambut (Hair-crested drongo)   | <i>Dicrurus hottentottus</i>         | 59                    | 58  | 117   | 8,28                    |
| 33    | Kehicap ranting (Black-naped monarch)            | <i>Hypothymis azurea</i>             | 35                    | 6   | 41    | 2,90                    |
| 34    | Cucak kutilang (Sooty-headed bulbul)             | <i>Pycnonotus aurigaster</i>         | 66                    | -   | 66    | 4,67                    |
| 35    | Layang-layang batu (Tahiti swallow)              | <i>Hirundo tabitica</i>              | 295                   | 71  | 366   | 25,90                   |
| Total |                                                  |                                      | 795                   | 618 | 1413  | 100                     |

PS: Perkebunan Sawit (Oil Palm Plantation); LK: Laban Konservasi (Conservation Land).

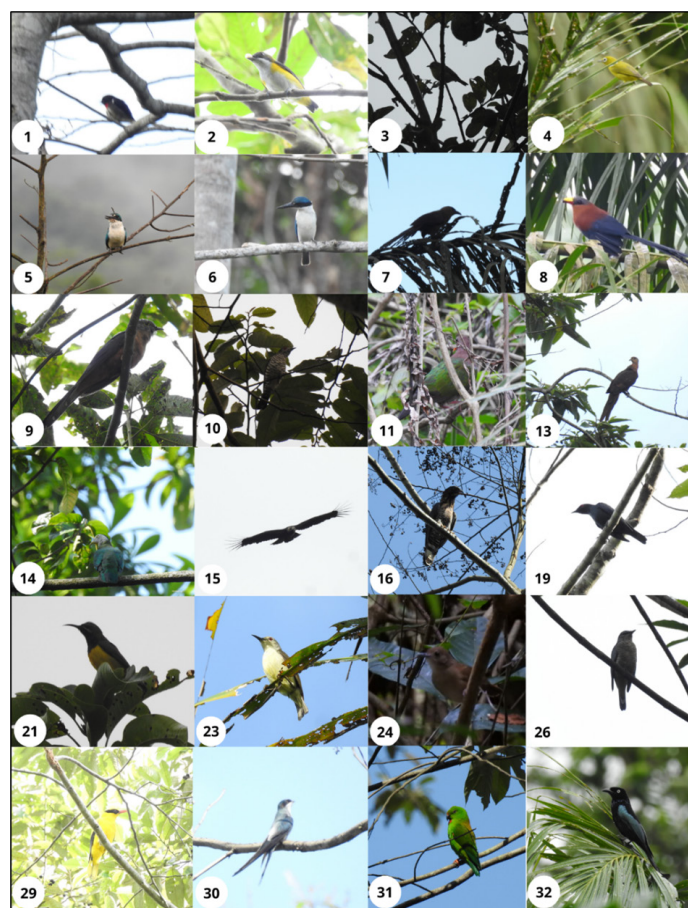
The details of bird species found in the oil palm plantation and the conservation land in Besulutu can be seen in [Table 1](#) and [Figure 3](#).

#### Diversity index ( $H'$ ) and species evenness ( $E'$ )

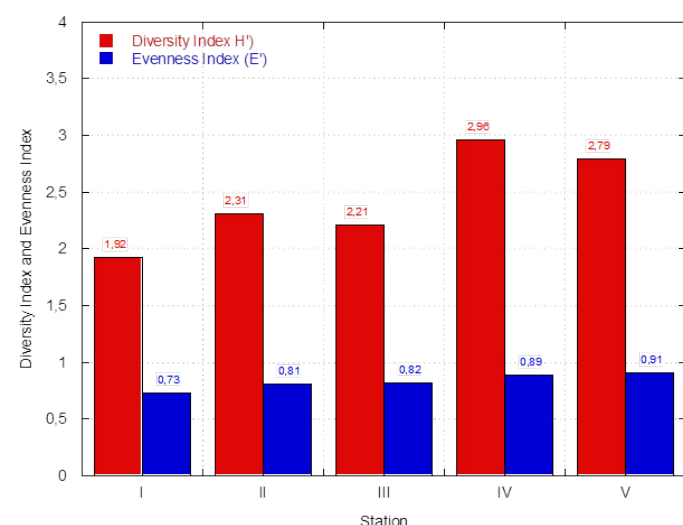
The bird species diversity index across all observation stations, encompassing both the oil palm plantations and the conservation area, was recorded at 2.87,

categorizing it as medium. This value suggests that the ecosystems at all observation stations exhibit a balanced condition, characterized by low environmental stress and minimal residential activity. The balance between biotic and abiotic components at these locations is well-maintained. According to [Odum \(1996\)](#), ecosystem diversity is closely associated with stability. Higher diversity within an

ecosystem typically reflects greater stability, while moderate disturbances can occur in ecosystems with medium diversity. Conversely, ecosystems with low diversity are more prone to instability. The bird species diversity index values observed in the oil palm plantations and conservation areas are depicted in Figure 4, illustrating the ecological conditions of the study sites.



**Figure 3:** Species composition share of birds in the oil palm plantation and the conservation land in Besulutu, Konawe.



**Figure 4:** The bird species diversity index in oil palm plantations and the conservation areas in the Besulutu district.

## Discussion

The number of individuals and types of birds from the five observation stations (Figure 2) shows that the highest number of bird species was at Station IV, with 28 species, followed by Station V, with 21 species and Station II, with 17 species. The lowest number of species was at Station I and Station III, with 14 and 15 bird species, respectively. The observations in the morning and evening show that more individual birds were observed in the morning than in the afternoon. The high number of individuals during morning observations was because birds were active at that time looking for food. This is in line with the statement by Desantoro *et al.* (2020). They figured out that birds attempt to be active as much as possible, looking for food in the morning and returning to their nests in the afternoon.

Generally, there were a total of 29 species of birds seen in the conservation land and 22 species in the area of oil palm plantation (Table 1). Some birds only appeared in the conservation land, namely the Grey-capped Emerald Dove (*Chalcophaps indica*), Sulawesi Babbler (*Trichastoma celebensis*), Malia (*Malia grata*), Black-naped Oriole (*Oriolus chinensis*), Grey-rumped Treeswift (*Hemiprocne longipennis*), Little Cuckoo-dove (*Macropygia ruficeps*), Sulawesi Hanging-parrot (*Loriculus stigmatus*), Brahminy Kite (*Haliastur indus*), Sulawesi Serpent-eagle (*Spilornis rufipectus*), Black-naped Fruit-dove (*Ptilinopus melanospila*), Sulawesi Cicadabird (*Edolisoma morio*), White-rumped Trilled (*Lalage leucopygialis*) and Little Bronze-cuckoo (*Chrysococcyx russatus*).

Meanwhile, the bird species that were only found in the plantation, namely Sooty-headed Bulbul (*Pycnonotus aurigaster*), Yellow-sided Flowerpecker (*Dicaeum aureolimbatum*), Lemon-bellied White-eye (*Zosterops chloris*), Barred Rail (*Gallirallus torquatus*), Brown-throated Sunbird (*Anthreptes malacensis*) and Black-winged kite (*Elanus caeruleus*).

The difference in bird species that appeared on plantation and conservation land was influenced by vegetation structure. Conservation land had vegetation dominated by trees that prop up birds' living in forage sources and perching and nesting places. Kaban *et al.* (2017) found similarities in the species of birds that perched, although there were differences in size, height, and type of tree. Still, differences in

size, height, and type of tree affected the birds' food availability. [Rahayuningsih et al. \(2007\)](#) explained that the existence of birds is strongly influenced by several natural factors such as biogeography, topography, habitat type, climate change, and disturbance from human activities. Besides, [Mulyani et al. \(2023\)](#) and [Alikodra \(2010\)](#) explained that the heterogeneity and complexity of habitat, vegetation structure and availability of food sources influence the presence of bird species in an area. Conservation land has diverse vegetation dominated by trees, thus supporting the needs of birds in terms of food availability, roosting, and nesting sites.

Birds with a high competition of species were averagely dominated by species in ordo of Passeriformes ([Table 1, Figure 3](#) No. species 1-4, 19, 21-29, 32-35). This is because Passeriformes was the biggest ordo, making up 59% of the total species of birds ([MacLeod et al., 2013](#)). Moreover, Passeriformes was also a type of cosmopolitan bird that spread broadly in three habitat types ([Putra et al., 2021](#)).

The graph shows that the highest diversity index was at stations IV ( $H': 2,96$ ) and V ( $H': 2,79$ ). This indicates that those stations provided bird space to search for food, nest, and shelter to prevent predators. Moreover, because trees dominated the vegetation, this area would be an optimal place for food source and shelter. Thus, it played an ordinary role in the birds' presence. According to [Alghifari et al. \(2021\)](#), the habitat characteristic has a positive relationship with the diversity of bird species that inhabit them. In general, the availability of areas as adequate habitat, as well as the availability of food, supports a higher richness of bird species. Commonly, the availability of place as a habitat and food store supports the diversity of bird species. More particularly, [Mulyani et al. \(2023\)](#) and [Rohman et al. \(2023\)](#) stated that converted land for agriculture, such as oil palm plantation, greatly influenced bird diversity.

On the other hand, the station I came out with the lowest diversity index, which was 1,92. This is assumed to be the effect of the monoculture vegetation state, which was covered by palm trees. Accordingly, that situation affected the birds' existence and food source ([Koh and Wilcove, 2008](#)). Diverse and broad vegetation habitat strongly determines the presence of birds ([Azman et al., 2011](#)). Additionally, [Azman et al. \(2011\)](#) obtained that the bird diversity index in

secondary forests was much higher ( $H' 3.561$ ) when compared to the bird diversity index in rice fields ( $H' 3.183$ ), especially in oil palm plantation areas ( $H' 1.042$ ). The diversity index is influenced by the presence of various bird species at that location due to the availability of habitat and food sources for birds.

Another factor that influences the presence of birds at this station is the high level of human activity because this station is close to residential areas. The activities of workers around the observation station greatly influence the presence of birds, so birds will be disturbed and avoid this area. [Alghifari et al. \(2021\)](#) said that human activities can disrupt the bird population in one location.

The evenness of bird species found at all stations ([Figure 4](#)) is categorized as even ( $E'$  is close to 1) because there are no significant differences between stations. [Pertiwi et al. \(2021\)](#) stated that an evenness value close to 1 means the distribution between species is relatively uniform. However, if the evenness value is close to 0, the distribution between species is low. Evenness will reach a maximum and be classified as homogeneous if all species have the same number of individuals at each observation station. This is also supported by [Ekowati et al. \(2016\)](#), who state that the species evenness index value in a habitat is considered high if it is more than 0.6. The highest evenness index is at observation Station V with  $E' = 0.91$ , while the moderate evenness index is at Station I with  $E' = 0.73$ . According to [Munadi et al. \(2023\)](#), the evenness index can be affected by several factors, the most important of which is the variation in vegetation. Therefore, the more variation in vegetation in a community, the more varied the number of species.

All observed birds in the oil palm plantation and conservation land showed the least concern status by IUCN (International Union for Conservation and Nature). Of a total of 35 birds, there were 12 endemic birds of Sulawesi, namely the Grey-sided Flowerpecker (*Dicaeum celebicum*), Yellow-sided Flowerpecker (*Dicaeum aureolimbatum*), Pale-bellied White-eye (*Zosterops consobrinorum*), Bay Coucal (*Centropus celebensis*), Yellow-billed Malkoha (*Phaenicophaeus calyrorhynchus*), Sulawesi Babbler (*Trichastoma celebensis*), Malia (*Malia grata*), White-faced Cuckoo-dove (*Turacoena manadensis*), Sulawesi Hanging-parrot (*Loriculus stigmatus*), Sulawesi Serpent-eagle (*Spilornis rufipectus*), Sulawesi

Cicadabird (*Edolisoma morio*) and White-rumped Trilled (*Lalage leucopygialis*). Standing from the list of the [Convention on International Trade in Endangered Species of Wild Fauna and Flora \(2021\)](#), there were four species in the category of Appendix II. According to PERMEN LHK No. 106 in 2018, the four species were endangered. They are Black-winged Kite (*Elanus caeruleus*), Sulawesi Hanging-parrot (*Loriculus stigmatus*), Brahminy Kite (*Haliastur indus*) and Sulawesi Serpent-eagle (*Spilornis rufipectus*).

Compared to preceding studies, [Eddy et al. \(2021\)](#) discovered that there were 38 species of birds along the protected forest of Air Telang, South Sumatera, 2 of which were in the Near Threatend (NT) category according to IUCN. [Riefani et al. \(2019\)](#) found that of 101 bird species in South Kalimantan, more than 91% were categorized as Least Concern (LC). Going to another location in South Kalimantan, she figured out that 14 over 87 birds around the industrial area of Semen Tarjun were put in the protected category based on Kepmen LH No P.92, year 2018. In addition, a study conducted by [Soendjoto et al. \(2018\)](#) in the area of coal mining in South Kalimantan found 30 species of birds in 2013. This number increased to 53 species in four rehabilitated locations.

## Conclusions and Recommendations

The study identified 35 bird species from 20 families inhabiting the palm oil plantation and conservation land in Besulutu. The diversity index across all observation stations was calculated at 2.87, categorizing the area as having moderate biodiversity. The evenness index was recorded at 0.81, indicating a high level of species distribution uniformity. Based on the IUCN conservation status, all 35 bird species are classified under the Least Concern (low risk) category. However, four bird species are listed in Appendix II of CITES, highlighting their regulated trade status. These species, which are also protected under Indonesian law (PERMEN LHK No. 106 of 2018), include the Black-winged Kite (*Elanus caeruleus*) observed at Station II and three species seen at Station IV: the Sulawesi Hanging-parrot (*Loriculus stigmatus*), the Brahminy Kite (*Haliastur indus*), and the Sulawesi Serpent-eagle (*Spilornis rufipectus*). This study emphasizes the area's ecological importance and underscores the need for ongoing conservation efforts to protect these species and their habitats.

## Acknowledgements

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## Novelty Statement

The research findings significantly contribute to biodiversity conservation, particularly in understanding avian diversity within oil palm plantations and conservation areas. The study identified 35 bird species from 20 families, highlighting the coexistence of diverse avian species in a human-modified landscape. The diversity index score of 2.87 (moderate category) and an evenness index of 0.81 (high category) underscore the balanced distribution of bird species across the study area, reflecting a stable ecosystem with considerable biodiversity. Furthermore, while the majority of species are classified as Least Concern by the IUCN, the identification of four bird species Black-winged kite (*Elanus caeruleus*), Sulawesi Hanging-parrot (*Loriculus stigmatus*), Brahminy Kite (*Haliastur indus*), and Sulawesi Serpent-eagle (*Spilornis rufipectus*) in Appendix II of CITES and protected under Indonesian regulation (PERMEN LHK No. 106 of 2018) highlights critical conservation priorities. Their presence in the area emphasizes the ecological importance of these habitats as refuges for threatened species, particularly in regions undergoing rapid agricultural expansion.

## Author's Contribution

**Sitti Wirdhana Ahmad, Amirullah, Adi Karya, Muhammad Yusuf, La Ode Muh. Munadi and Damhuri:** Conceived and designed the study, gathered samples, and conducted examinations. All authors contributed to drafting and revising the manuscript. Each author has read, reviewed, and approved the final version of the manuscript.

## Conflict of interest

The authors declared no conflicts of interest.

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