Bird diversity in the Gumuk ecosystem in Jember

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Abstract. Gumuk is one of the important ecosystems in bird conservation in Jember Regency. Currently, many gumuk ecosystems are being degraded, and very rapid land-use change that threatens the preservation and conservation of birds. This study aims to determine the diversity of birds around the gumuk as an effort to explain the important role of the gumuk as a bird habitat. The research was conducted in January-February 2021 in Ledokombo District, Jember Regency. Bird observation method using Point Count method, observation time is in the morning (06.00-08.00 WIB) and afternoon (15.00-17.00 WIB). The results showed that there were 33 species of birds from 20 families. The families of Campephagidae and Estrildidae show the families with the most species found. The level of diversity shows the moderate category (H' = 2.253). Species with the highest abundance were Collocalia linchi (31.264%), and the lowest were Amandava amandava, Dicaeum concolor, Geopelia striata, Passer montanus, and Ardeola speciosa (0.044%). Evenness index (E) shows the condition of stable species distribution with a value of 0.644.

1. Introduction
Jember Regency has a unique landscape in the form of a small hill called a Gumuk, this city has been nicknamed the city of a Thousand Gumuk. Gumuk is a small hill (hillock) with a height of fewer than 60 meters, It is a geological phenomenon resulting from the eruption of Mount Raung [1]. Gumuk contains materials in the form of sand, gravel, slabs, and foundation stones [2–4]. Based on its geological characteristics, the gumuk is an example of a collapse from a young volcanic cone that has an unstable balance structure [1].

The large number of gumuk in Jember Regency can be an ecosystem that is quite important for bird habitat. The vegetation in the gumuk can provide space for certain animals, including birds, certain characteristics of a microhabitat are correlated with the use of habitat by an animal [5,6]. Gumuk can be a corridor for birds in foraging and migrating, the corridor will connect two types of habitats that function for migration and foraging for animals [7]. The presence of birds can reflect the availability of food with the availability of green open spaces that can support and provide opportunities for birds to get food, perches, and breed [8]. Bird abundance can be an indicator of ecosystem stability [9].

However, currently, the exploitation of gumuk is increasing due to mining activities; the content of gumuk material is a potential mining resource for improving the community's economy. Overexploitation can change the structure and function of the landscape, currently, massive land
conversion is inevitable. Changes in a landscape indicate changes in a habitat that can have an impact on changes and decreases in biodiversity, different habitats will be associated with species diversity [9]. The conversion of the land use of gumuk into a settlement has made Jember Regency experience a decrease in green open space, this has contributed to changes in the landscape on the island of Java. Changes in the landscape on the island of Java have been recorded as contributing to the loss of several bird species, the distribution of birds also shows an abnormal profile [10].

As an important ecosystem for bird habitat, it is necessary to conserve and use gumuk in a sustainable manner. As a unique geological landscape, gumuk has the potential to be managed through a geotourism approach, with integrated and sustainable principles of conservation, education, and community economic empowerment. The existence of birds can be an ecological attraction in the development of geotourism. This Study aims to determine the diversity of bird around the gumuk as an effort to explain the important role of the gumuk as bird habitat.

2. Methods
The research was conducted in January-March 2021 in Ledokombo District, Jember Regency. Ledokombo District is one of the areas close to Mount Raung, with an area of 157.03 km² which is divided into 10 villages (Figure 1). Bird observations were carried out on 50 gumuk randomly selected in each village. The determination of the gumuk is based on the classification of landforms processed by GIS, carried out by measuring the difference in elevation at the midpoint and the average height of the surroundings at a certain radius. Landform classification refers to Van Zuidam [11], namely the undulating/sloping hill topography category. Based on this classification, the gumuk category is with a height of 10-50 meters and an area of > 1 ha.

![Figure 1. Research locations in Ledokombo District, Jember Regency](image)

Bird observations were carried out by identifying and counting bird species found in gumuk and its surroundings. The bird observation method uses the Point Count Method, the number of point counts is adjusted to the number of gumuk selected. Observation time is in the morning (06.00-08.00 WIB) and afternoon (15.00-17.00 WIB). The tools used are binoculars, digital cameras, stationery, watches, Global Positioning System (GPS) and a MacKinnon identification book.

Bird diversity analysis was carried out by calculating the Dominance (Di), Simpson’s Index (D’), Shannon Wiener Diversity Index (H’), and Index of Evenness (E) which were processed using Paleontological Statistics (PAST) software Version 4.06.

3. Result and discussion
3.1. Habitat condition
Bird observations were carried out on 50 gumuks scattered in Ledokombo District (Figure 2). Land use is dominated by mixed gardens with various plantation commodities. The most common plants found were Sengon (Abizia chinensis), Mahoni (Swietenia mahagoni), Papaya (Carica papaya), Banana (Musa sp.), Jati Putih (Gmelina arborea), Balsa (Ochroma lagopus), Bamboo (Bambusa sp.), and Coffee
Several *gumuk* are located around rice fields and also around residential areas. The average light intensity is 7803.26 lux, the average temperature is 28.46° C, and the average humidity is 78.50%.

3.2. Bird diversity

Based on MacKinnon's identification, 33 bird species were found, consisting of 20 families and 8 orders (Table 1). The conservation status of all bird species found based on the IUCN Red List is in the LC (Least Concern) category. The most frequently encountered families are Campephagidae, Estrildidae and Cuculidae. Campephagidae and Estrildidae are a group of songbirds living in groups, living in forests and gardens, including groups of birds that can adapt to noisy areas. Campephagidae eats insects and some also eat fruit, Estrildidae eats seeds and are often considered pests because they eat rice on agricultural land. Cuculidae, including birds that are widespread in the world, these insectivorous birds are nicknamed shy birds because their voices are more often heard than seen.

Passeriformes has the highest number of families and species of 10 families and 19 species. Passeriformes or chirping birds are the order that accounts for the most species of bird species, these birds have a fairly high level of adaptation [10]. The song of this bird is usually a form of communication with other members of the same species [12]. Species of birds in the order Songbirds have complex muscles to regulate their vocal organs and most of the birds in this order have relatively smaller body sizes than birds in other orders [10].

| Ordo         | Family      | Local Name       | Species          | Number of species |
|--------------|-------------|------------------|------------------|-------------------|
| Accipitriformes | Accipitridae | Elang hitam      | *Ictinaetus malaiensis* | 2                 |
|              |             | Elang Sikep Madu| *Pernis ptilorhyncus* | 3                 |
| Apodiformes  | Apodidae    | Walet linci      | *Collocalia linchi* | 705               |
| Cuculiformes | Cuculidae   | Wiwik kelabu     | *Cacomantis merulinus* | 3                 |
|              |             | Bubut alang-alang| *Centropus bengalensis* | 7                 |
|              |             | Wiwik uncuing    | *Cuculus sepalurus* | 16                 |

**Figure 2.** Bird watching location
3.3. Dominance (Di)

*Collocalia linchi* is the species with the highest dominance value of 31.264% (Table 2). *Collocalia linchi* is a small insectivorous bird from the family Apodidae that can live in various types of forests and agricultural lands and even in urban areas [10]. The survival ability of this species is quite high because of its adaptation to various types of habitats, including landscape changes. *Collocalia linchi* is recorded as one of the bird species that are often found in urban landscapes in Java [13], insectivorous bird species are a group of birds that are proven to have a high level of adaptation to urbanization [14].

The lowest dominance of bird species was found in several species, they were *Amandava amandava*, *Ardeola speciosa*, *Dicaeum concolor*, *Geopelia striata*, *Lonchura maja*, and *Passer montanus*, each with a value of 0.044% (Table 2). *Amandava amandava* is a species of grain-eating birds that live in small colonies, preferring shrubs, grasslands, agricultural land, rice fields, and reed clumps [10]. *Geopelia striata* and *Passer montanus* are bird species that like open areas and eat above ground and eat more

| Order          | Family       | Species                               | Dominance (Di) |
|---------------|--------------|---------------------------------------|----------------|
| Columbiformes | Columbidae   | *Streptopelia chinensis*              | 16             |
|               |              | *Geopelia striata*                    | 1              |
| Coraciiformes | Alcedinidae  | *Halcyon cyanovenotris*               | 59             |
|               |              | *Todiramphus chloris*                 | 32             |
|               | Meropidae    | *Merops leschenaulti*                 | 8              |
| Pelecaniformes| Ardeidae     | *Ardea speciosa*                      | 1              |
| Piciformes    | Picidae      | *Dendrocopos macei*                   | 5              |
|               | Capitonidae  | *Megalaima haemacephala*              | 3              |
| Passeriformes | Aegithinidae | *Aegithina tipher*                    | 42             |
|               | Artamidae    | *Artamus leucorynchus*                | 2              |
|               | Campephagidæ| *Lalage nigra*                        | 30             |
|               |              | *Lalage sueurii*                      | 37             |
|               |              | *Pericrocotus cinamomeus*             | 413            |
|               |              | *Pericrocotus flammeus*               | 4              |
| Dicaeidae     | Cabe polos   | *Dicaeum concolor*                    | 1              |
|               | Kemade/ Cabe Jawa | *Dicaeum trochileum*              | 19             |
| Estrildidae   | Pipit benggala | *Amandava amandava*                | 1              |
|               | Bondol Jawa  | *Lonchura leucogastroides*            | 287            |
|               | Bondol haji  | *Lonchura maja*                      | 1              |
|               | Bondol peking | *Lonchura punctulata*             | 134            |
| Hirundinidae  | Layang layang loreng | *Hirundo striolata*              | 3              |
| Laniidae      | Bentet kelabu | *Lanius schach*                      | 3              |
| Nectariniidae | Madu kelapa  | *Anthreptes malaccensis*              | 44             |
|               | Madu sriganti/ sogon | *Nectarinia jugularis*               | 57             |
| Passeridae    | Burung Gereja | *Passer montanus*                    | 1              |
| Pyconotidae   | Kutilang     | *Pyconotus aurigaster*                | 199            |
|               | Terucuk      | *Pyconotus goiavier*                  | 116            |
|               |              | **Total**                             | 2255           |
seeds, even *Passer montanus* can coexist with humans [10]. Likewise, *Lonchura maja* is also a grain eater who prefers grass and plantation habitats in open areas. The availability of food and habitat requirements make the gumuk ecosystem less favorable for some of these species so that the dominance value is low. The discovery of several species of birds is because several gumuks are located side by side with plantations, agriculture, and residential areas so that at certain times birds can pass around gumuk.

*Ardeola speciosa* and *Dicaeum concolor* are also species that are rarely found in the gumuk ecosystem. *Dicaeum concolor* is a type of bird that lives in hilly forests, secondary forests, and agricultural land, its food is parasites, fruits, and small insects [10]. The gumuk Ecosystem seems to be less favored by this species because it does not provide much food for them. *Ardeola speciosa* is a bird species that lives in rice fields or watery areas, its main food is insects, fish, and crabs [10]. The discovery of *Ardeola speciosa* because at that time the gumuk he visited happened to be adjacent to a very large rice field area.

### Table 2. The Dominance (Di) of bird species in the Gumuk ecosystem

| No. | Spesies                  | Dominance (Di) |
|-----|--------------------------|----------------|
| 1   | Aegithina tiphia         | 1.863          |
| 2   | Amandava amandava        | "0.044         |
| 3   | Anthreptes malaccensis   | 1.951          |
| 4   | Ardeola speciosa         | "0.044         |
| 5   | Artamus leucorynchus     | 0.089          |
| 6   | Cacomantis merulimus     | 0.133          |
| 7   | Centropus bengalensis    | 0.310          |
| 8   | Collocalia linchi        | 0.31 264       |
| 9   | Cuculus sepaleralis      | 0.710          |
| 10  | Dendrocoops macei        | 0.222          |
| 11  | Dicaeum concolor         | "0.044         |
| 12  | Dicaeum trochileum       | 0.843          |
| 13  | Geopelia striata         | "0.044         |
| 14  | Halcyon cyanoventris     | 2.616          |
| 15  | Hirundo striolata        | 0.133          |
| 16  | Ictinaetus malaiensis    | 0.089          |
| 17  | Lalage nigra             | 1.330          |
| 18  | Lalage sueurri           | 1.641          |
| 19  | Lanius schach            | 0.133          |
| 20  | Lonchura leucogastroides | 12.727        |
| 21  | Lonchura maja            | "0.044         |
| 22  | Lonchura punctulata      | 5.942          |
| 23  | Megalaima haemacephala   | 0.133          |
| 24  | Merops leschenaulti      | 0.355          |
| 25  | Nectarinia jugularis     | 2.528          |
| 26  | Passer montanus          | "0.044         |
| 27  | Pericrocotus cinamomeus  | 18.315         |
| 28  | Pericrocotus flammeus    | 0.177          |
| 29  | Pernis ptilorhyncus      | 0.133          |
| 30  | Pycnonotus aurigaster    | 8.825          |
31 *Pycnonotus goiavier* 5.144
32 *Streptopelia chinensis* 0.710
33 *Todiramphus chloris* 1.419

* Highest Score, ** Lowest Score

### 3.4. Dominance Index (D), Simpson’s Index (D’), Shannon Wiener Diversity Index (H’), and Index of Evenness (E)

The dominance index (D) of bird species in the *gumuk* ecosystem shows a value of 0.164 (Table 3) which means low dominance, this means that no species dominates. Dominance index 0.50 indicates no species dominates, dominance index 0.50 - 0.75 indicates moderate dominance, while 0.75 – 1 indicates high dominance [15]. The Simpson index (D’) of bird species in the *gumuk* ecosystem shows a value of 0.836 (Table 3), which means that the diversity is high. Diversity index 0.50 indicates low diversity, diversity index 0.50 - 0.75 indicates moderate diversity, while 0.75 - 1 indicates high diversity index [15].

| Indeks                  | Value Index |
|-------------------------|-------------|
| Dominance D             | 0.164       |
| Simpson_1-D             | 0.836       |
| Shannon_H               | 2.253       |
| Evenness_e^H/S          | 0.644       |

Table 3. Dominance Index (D), Simpson’s Index (D’), Shannon Wiener Diversity Index (H’), and Index of Evenness (E)

Based on the Shannon Wiener Diversity Index (H’) the diversity of bird species in the *gumuk* ecosystem shows a value of 2.253 (Table 3), which means the level of diversity is in the medium category. This can be caused by the landuse of *gumuk* which is widely used for plantations with less diverse vegetation. This condition ultimately does not provide too much alternative food for birds. The higher the diversity of vegetation in an area will affect the diversity of birds that exist [16–18]. Almost all of the *gumuk* show a relatively low level of vegetation. Although they are lush, they are only dominated by a few types of plants. Diversity is closely related to ecosystem stability, if the ecosystem is stable, the level of diversity tends to be high. Meanwhile, in disturbed ecosystems, species diversity tends to be low [15].

The evenness index (E) shows a value of 0.644 (Table 3) which means that the distribution of birds in the *gumuk* ecosystem is in a stable category. The evenness index value (E) is limited between 0 – 1, where getting closer to 1 indicates a situation where all species have an even abundance [15,19]. This even distribution of birds can be caused by the presence of a dune that is close to each other, the position of the adjacent *gumuk* can be a corridor for birds. Corridors can connect two habitats that have different vegetation that can be used by birds for foraging and migrating [7].

### 4. Conclusions

A total of 33 species were found in the *gumuk* ecosystem, consisting of 20 families and 8 orders with LC (Least Concern) conservation status. Order Passeriformes has the highest number of families and species, namely 10 families and 19 species. *Collocalia linchi* had the highest dominant value (31.264%), while *Amandava amandava, Ardeola speciosa, Dicaeum concolor, Geopelia striata, Lonchura maja,* and *Passer montanus* had the lowest dominant value (0.044%). Dominance index (D) of bird species in the low category (0.164). The Shannon Wiener diversity index (H’) has a value of 2.253, which means the level of diversity is in the medium category. Evenness index (E) with a value of 0.644 which means the distribution of birds is in a stable category.
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