Bird species diversity in several types of land cover in Gunung Bromo University Forest, Karanganyar, Central Java

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Abstract. Gunung Bromo University Forest is a sub urban forest near human settlements that located in Karanganyar, Central Java. Still rarely research on bird species in this area. Therefore, it is necessary to do research on birds diversity in Gunung Bromo University Forest to help on understanding its habitat conditions. The data will be useful for determining forest management. The aims of this research were to identify birds diversity and to find out bird guild composition. This research was conducted in various land cover types at Gunung Bromo University Forest on April-August 2019. Observation was conducted in the morning and afternoon with IPA (Indices Ponctuel d’Abondance) methode. Research area were divided into 6 observation plots, S1, S2, S3, S4, S5, and S6. Total species found in this study were 44 species of birds from 25 families. There were 2 species of protected birds, crested serpent eagle (Spilornis cheela) and crested hawk-eagle (Spizaetus cirrhatus). Sooty-headed bulbul (Pycnonotus aurigaster), javan munia (Lonchura leucogastroides), common iora (Aegithina tiphia), linchi swiftlet (Collocalia linci), spotted dove (Spilopelia chinensis), collared kingfisher (Todiramphus chloris), and coppersmith barbet (Psilopogon haemacephalus) were the most common species in all observation plot. Insectivorous birds were the most common species found. Based on Margalef species richness index, S1 had the highest number of bird species while S6 had the lowest number of bird species. Eventhough total species that found in S3 was lower than S6, it had higher value of Margalef species richness index compare to S3.

1. Introduction
Vegetation diversity will affect the diversity of wildlife species [1]. The more diverse the vegetation, the higher the level of wildlife diversity [2]. It can be said that the changes in vegetation structure affect the level of wildlife diversity. Research that was conducted by Srinivas and Koh [3] and Larson [4] shows that birds and herpetofauna are animals that are vulnerable to environmental changes. Bird communities are groups of individuals of several different types of birds that live together at the same time and area [5-6]. One factor that affects the bird species diversity in a community is the condition of the vegetation structure. The more complex and heterogeneous vegetation structures will increase the diversity of ecological niches in a habitat, which is thought to increase the diversity of bird species in a community [7]. Changes in vegetation structure in a habitat can affect the condition of the bird community in it because birds are animals that are very sensitive to environmental changes [8],[9].
A guild is a group of species in a community that exploits resources in the same class in a similar manner [10], so that groups of bird species in a guild do not always belong to the same type and tribe but can originate from different types and tribes [11]. The grouping can be done by making a classification based on the type of feed, the technique of getting food, and where to find food [12]. Observation of guilds that occupy an area is highly recommended as an indicator of habitat use [13]. Wiens [5] explained that the pattern of habitat selection by a group of bird species in exploiting feed resources is related to the condition of the habitat itself.

Gunung Bromo University Forest is a suburban forest near human settlements located in Karanganyar, Central Java. This forest is a limited production forest that was originally managed by Perhutani. Then based on the Decree of the Minister of Environment and Forestry of the Republic of Indonesia No. SK.177 / MENLHK / SETJEN / PLA.0 / 4/2018, this area was changed to Gunung Bromo University Forest whose management was handed over to the Forestry Education and Training UPT Center Sebelas Maret University. The existence of this region plays an important role in the preservation of biodiversity. However, still, rarely research on bird species in this area. Therefore, it is necessary to do research on birds diversity in Gunung Bromo University Forest to help with understanding its habitat conditions. The data will be useful for determining forest management. The aims of this research were to identify bird diversity and to find out bird guild composition.

2. Method

2.1. Time and Location
The study was conducted in the Gunung Bromo University Forest in Karanganyar, Central Java in April-August 2019. The observation sites were divided into 6 locations, namely S1 (mixed forest), S2 (mahogany pine forest), S3 (fields), S4 (river), S5 (mahogany pine johar forest), and S6 (mahogany pine forest).

2.2. Observation Method
Bird data retrieval was carried out using the IPA method (Indices Ponctuel d'Abondance), which is a bird observation method by taking samples from the bird community at a certain time and location [14]. Observations were made by placing the observer at a point that has been systematically chosen and predetermined, by recording and identifying the type and number of individuals of each type that are encountered both directly (visually) and indirectly (voice).

![IPA method design](image)

Figure 1 IPA method design

Observations were conducted on the observation path with a length of 1000 meters. The distance between observation points is 100 meters with a radius of 50 meters. Observation at each point was carried out for 10 minutes. Observation plot design as shown in figure 1. Data was collected by 3 times of repetition at each type of land cover. Observations were made through direct and indirect encounters (voice). The parameters are the type, number of individuals, time, activity, and type of vegetation that birds use for their activities. Observations were conducted in the morning at 06: 00-08: 00 WIB and in the afternoon at 15: 30-17: 30 WIB.
2.3. Data Analysis

2.3.1. Species diversity. Bird data were analyzed with the Shannon-Wiener diversity index to determine the value of species diversity index:

\[ H' = -\sum P_i \ln P \]

\[ P = \frac{n}{N} \]

Information:
- \( H' \) = Shannon-Wiener diversity index
- \( n \) = Number of individuals of a particular type
- \( \ln \) = natural logarithm
- \( N \) = Number of individuals of all types
- \( P_i \) = Proportion of species

2.3.2. Species richness. The data were analyzed with Margalef richness index to determine the value of species richness index:

\[ D_{mg} = \frac{S - 1}{\ln (N)} \]

Information:
- \( D_{mg} \) = Margalef Index
- \( S \) = Total species
- \( N \) = Total individuals

2.3.3. Evenness index

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

Information:
- \( E \) = Evenness Index
- \( H' \) = Shannon-Wiener diversity index
- \( S \) = Total species

2.3.4. Guild composition. Guild composition analysis was done by classifying species of birds that utilize the same type of feed.

3. Result and Discussion

The total number of species found was 43 species from 25 families. The most commonly found family is Pycnonotidae. *Pycnonotus aurigaster, Lonchura leucogasteroides, Spilopelia chinensis, Aegithina typhia, Callocalia linchi,* and *Psilopogon haemacephakus* were species that can be found in all observation plots. There were 2 protected bird species, namely *Spilornis cheela* and *Spizaetus cirrhatus*. The types found are shown in Table 1.

| No | Familia        | Scientific Name          | Plot |
|----|----------------|--------------------------|------|
| 1  | Acanthizidae   | *Gerygone sulphurea*     | √    |
| 2  | Accipitridae   | *Spilornis cheela*       | √    |
| 3  | Accipitridae   | *Spizaetus cirrhatus*    | √    |
| 4  | Aegithinidae   | *Aegithina typhia*       | √    |
| No | Famili       | Scientific Name             | Plot |
|----|------------|----------------------------|------|
| 5  | Alcedinidae | Todiramphus chloris        | ✓    |
| 6  | Alcedinidae | Halycon cyanoreta           | ✓    |
| 7  | Alcedinidae | Alcedo meninting           | ✓    |
| 8  | Apodidae    | Collocalia linchi           | ✓    |
| 9  | Apodidae    | Apus nipalensis            | ✓    |
| 10 | Artamidae   | Artamus leucorynchus        | ✓    |
| 11 | Champepagidae | Pericrocotus cinnamomeus    | ✓    |
| 12 | Champepagidae | Lalage sueurii             | ✓    |
| 13 | Cisticolidae | Orthotomus sepium          | ✓    |
| 14 | Cisticolidae | Orthotomus sutorius         | ✓    |
| 15 | Cisticolidae | Prinia inornata            | ✓    |
| 16 | Columbidae  | Spilopelia chinensis       | ✓    |
| 17 | Columbidae  | Chalcophaps indica         | ✓    |
| 18 | Columbidae  | Geopelia striata           | ✓    |
| 19 | Corvidae    | Crisprina temia            | ✓    |
| 20 | Cuculidae   | Cacomantis sonnerati        | ✓    |
| 21 | Cuculidae   | Centropus bengalensis       | ✓    |
| 22 | Dicaeidae   | Dicaem trochoem              | ✓    |
| 23 | Estrildidae | Lonchura leucogastroides   | ✓    |
| 24 | Estrildidae | Lonchura punctulata        | ✓    |
| 25 | Estrildidae | Erythura prasina           | ✓    |
| 26 | Hemiprocnidae | Hemiproce longipennis      | ✓    |
| 27 | Hirundinidae | Hirundo tahitica           | ✓    |
| 28 | Lanidae     | Lanius schach              | ✓    |
| 29 | Megalalimidae | Psilopogon haemacephalus   | ✓    |
| 30 | Monarchidae | Hypothymis azurea          | ✓    |
| 31 | Nectarinidae | Cinnyris jugularis         | ✓    |
| 32 | Pellorneidae | Malacocincla sepia         | ✓    |
| 33 | Phasianidae | Gallus varius              | ✓    |
| 34 | Picidae     | Dinopium javanense         | ✓    |
| 35 | Picidae     | Piciodes moluccensis       | ✓    |
| 36 | Picidae     | Dendrocoops maceli         | ✓    |
| 37 | Pycnonotidae | Pycnonotus goavier         | ✓    |
| 38 | Pycnonotidae | Pycnonotus aurigaster      | ✓    |
| 39 | Pycnonotidae | Pycnonotus melanicterus   | ✓    |
| 40 | Pycnonotidae | Alphoixus bres            | ✓    |
| 41 | Strigidae   | Otus lempiji               | ✓    |
| 42 | Sturnidae   | Acridotheres javanicus     | ✓    |
| 43 | Turnicidae  | Turnix suscitator          | ✓    |
Species richness is one of the keywords that need to be considered on biodiversity [15]. Boontawe et al. [16] says that the Margalef index value will increase along with the breadth of sample plots were used, and the higher the diversity indicated also by the greater worth of its kind. Whilm [17] says that the index is used when a community has a specific diversity in a particular area is quite large. The index of Margalef has a high sensitivity to the structure of a community, in particular, the number of species is low.

Figure 1 shows that plot S1 which is a plot with mixed forest land cover had the highest species richness index value of 4,714. This is in accordance with Alikodra [18] which states that each forest stratum has the ability to support the lives of certain types of wildlife. So that the more diverse strata canopy, the more species of birds that live in the forest by occupying their respective ecological niches. A relatively heterogeneous composition of vegetation creates ecological niches, more varied, and more types of trees mean that it will create a lot of ecological niches, allowing a variety of birds can live together [19]. Besides Edwards et al. [20] states that the remaining degraded forest can serve as refuges (refugia) for biodiversity. Rivers in the forest also influence species diversity. Alikodra [21] revealed that riparian areas are important for the existence of wild animals because: (1) the availability of water as a component of habitat, (2) enough water available for plants will increase plant diversity so as to produce a good living place for wildlife, (3 ) riparian areas can produce a better microclimate for wildlife, (4) can be a corridor of migration paths, (5) riparian areas are a link between various habitat conditions that produce a meeting area between habitats that are favored by wildlife.

| Location | S1 | S2 | S3 | S4 | S5 | S6 |
|----------|----|----|----|----|----|----|
| S        | 26 | 26 | 19 | 22 | 25 | 21 |
| Dmg      | 4.714 | 4.667 | 4.237 | 4.349 | 4.547 | 3.696 |
| \(H')    | 2.668 | 2.585 | 2.515 | 2.385 | 2.588 | 2.241 |
| E        | 0.819 | 0.793 | 0.854 | 0.772 | 0.804 | 0.736 |

**Figure 2.** Species richness, diversity, and evenness index

Plot S3 had the smallest total number of species found, which is 19 species. However, this plot had higher species richness and evenness index than S4 and S6 which had a higher number of species. This was because, in the S3 plot, the number of individual birds found was smaller, so the possibility of species dominance was smaller. Ludwig and Reynold [22] state that the value of evenness is influenced by the number of species found in a community. Evenness of bird species in a habitat can be characterized by the absence of dominant species. If each species has the same number of individuals, then the evenness of species in the community has a maximum value, but if the number of individuals in each species is very different then it causes the evenness of species to have a minimum value [23]. Overall, the evenness of species from each plot was quite high, ranging from 0.736 - 0.854, where the value was almost close to 1, so it can be said that evenness in the area was balanced because there was no dominant type. The lowest level of evenness was found in location S6 because the
location had a large number of species and individuals that were found, thus affecting the level of evenness.

![Figure 3](image)

Figure 3 Guild composition

According to figure 3, guilds that can be found in the Gunung Bromo University Forest were omnivores, nectarivores, frugivores, granivores, piscivores, carnivores, and insectivores. Insectivorous guilds can be found throughout the observation plot. This was because in all plots have bushes so that there were many insects available. Shrubland cover types have a high level of insect species diversity compared to other land cover types [24]. Insect eaters are the most types because insects are a type of feed that is abundant in nature so that it is easily obtained by all types of birds [25]. Insects that are a source of feed for this bird species are the types of feed available throughout the year so that the feed conditions are always stable [26].

Carnivorous birds are species of birds that eat the meat of other animals as a source of food. Carnivorous birds can be found in all locations. This shows that Gunung Bromo University Forest can provide a source of feed for carnivorous birds. The abundance of feed resources is directly proportional to the abundance of carnivorous birds in a habitat [27]. Group of piscivorous birds can be found in almost all observation sites. Habitat components such as river basins are habitat components that affect the presence of piscivorous guild groups in a habitat type [28].

Granivorous birds are species that eat seeds and grains as a source of food. Birds with granivorous guilds can be found throughout the observation plot. The availability of feed for granivores was quite abundant at Gunung Bromo Forest University due to the presence of fields near forest areas and the existence of agroforestry practices. This is confirmed by the results of research Girma et al. [29] that granivorous guild types are often found in plantation or agroforestry habitats due to the abundance of cultivated plants such as corn and coffee as sources of food. Nektarivora birds can be found in plots S1, S2, S4, S5, and S6. This is presumably due to a large amount of undergrowth in the area. The presence of undergrowth and shrubs provide abundant nectar for nektarivore birds [30]. While for omnivorous birds can be found in plots S1, S3, and S5. This shows that fragmented habitats such as Gunung Bromo University Forest can still provide a source of food for omnivorous bird species.

According to Partasasmita [31], the abundance of ripe fruit in patches (places where forage plants are often used by fruit-eating birds) will affect the presence of fruit-eating birds. Types of fruit trees that can be found on Gunung Bromo University Forest include mango (Mangifera indica), buni (Antidesma bunius), and duwet (Syzygium cumini). The lack of variety of fruit-producing tree species can be one of the causes of the low number of frugivorous bird species that can be found because the
presence of a particular fruit type is important because frugivores are known to be selective in the selection of fruit species as food [32]. Also, the availability and abundance of fruit depend on the season and weather conditions [33]. The condition of trees that are bearing fruit influences the presence of frugivorous birds in a habitat type [32]. Overall, the composition of bird guilds in Gunung Bromo University Forest is dominated by insectivorous guilds. This is directly proportional to the research of Darmawan [25], Dewi [34], Idaman [35], Novarino [13], Sayogo [36], and Sastranegara [11] who obtained insectivorous bird species that dominated the birds compared to other birds.

4. Conclusion
S1 plot with mixed forest land cover had the highest value of species diversity and richness index. Overall, all observation plots have a high evenness index value so that it can be said that evenness in the area was balanced because there is no dominant type. The guild birds found were omnivores, nectarivores, frugivores, granivores, piscivores, carnivores, and insectivores.

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