The diversity of bird species based on the altitude of the protected forest area in Sirimau Mountain in Soya Village - Ambon City

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Abstract. This study is aimed to discover the diversity of bird species based on the altitude of the area and to discover the impact of vegetation as habitat towards the diversity of bird species in protected forest area in Sirimau Mountain in Soya Village located in Ambon City. The method used to discover the diversity of birds was the IPA-method (Indices Ponctuels d’Abondance) while observing the vegetation used the CSS-method (Continuous Strip Sampling) alongside the observation paths. The protected forest consists of three area of different altitudes, namely 300 meters above sea level (masl), 400 masl and 500 masl. The bird species found in the protected forest area in Sirimau Mountain in Soya Village as a whole were 16 species. The forest area at 300 masl was found 14 bird species with diversity index (H’) of 2.57, the forest area at 400 masl was found 12 bird species with diversity index (H’) of 2.42, while the forest area at 500 masl was found 11 bird species with diversity index (H’) of 2.10. There were 8 bird species found in every area of three different altitudes that were dominant such as Perling Ungu (Aplonis motalica), Walet Sapi (Collocalia esculenta), Perkicit Pelangi (Trichoglossus haematodus), Pergam Laut (Ducula bicolor), Sesap Madu Sriganti (Nectarinia jugularis), Srigunting Lencana (Dicrucus bracteatus), Nuri Pipi Merah (Geoffreyus geoffreji) and Tekukur Biasa (Streptopelia hinsensis). Meanwhile, the dominant types of vegetation found in the area were Damar (Agathis sp.), Kayu Merah (Eugenia jambolana) and Meranti (Shorea sp.)

1. Introduction

Birds have an important role in natural ecosystem control for both the short term such as water control, climate, air, pollination, pest control, etc., or the long term such as food chain, forest formation, etc. An even stage of pollination had made birds as a source of biological wealth that is used in the ecosystem and sensitive to environmental changes [1]. The forest structure and composition can create open spaces in the utilization of available sources (foods, water, cover, and space) that give an effect to the bird’s community at some habitat.

Lost and damaged habitat can disturb the life process that was natural before [2]. Habitat change occurs due to management by humans. This is shown by the diversity of local birds, therefore birds can be used as bio-indicator in determining damaged levels in some environments. The bird’s diversity is influenced by habitat type diversity. Vegetation structure and availability of feed in the habitat are the main factors that affect the species diversity in some habitats [3]. Therefore, habitats with more diverse vegetation would likely have more bird diversity compared to habitats with fewer vegetation

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types. The Moluccas area has 348 bird species with 90 species of them are Moluccas endemic species. These species spread in 5 Endemic Birds Area (EBA), with 116 species have limited distribution [4].

Mount Sirimau area was appointed as a protected forest based on the Decree of Forestry Minister number 430/Kpts-II/1996 on August 13th, 1996, which is located in the administrative area of Ambon City, Moluccas Province. The protected forest area in Mount Sirimau plays a significant role like diversity source cover for fauna and flora, also have an economic function for the locals. Soya Village is one of the villages located nearby the Protected Forest Area in mount Sirimau. The bird existence (species diversity) and its habitat as birds diversity support in this Protected Forest have not been known yet.

Based on the comprehension above, this study is aimed to discover the bird’s diversity based on the altitude and also to discover the habitat condition (vegetation) that affect bird's diversity existences in the Protected Forest area. The result of this study may benefit as base data in the Protected Forest Area Management, especially for birds management.

2. Methods
2.1. Date and location
This study took place in the Protected Forest in Mount Sirimau, Soya Village, Ambon City, Moluccas Province and lasts for 3 months (December 2019 until February 2020) and the equipment used during this research are GPS, Binocular Spyglass, Camera, Phiband, Haga, Hypsometer, and Birds Identification Book. [5]

2.2. Data collecting
The bird’s data collection was conducted by making the observation paths (Transek Lines) in each different altitude type (300, 400, 500 masl). This study was to observe the birds that are around observation paths, to record the species and the amount of them. The observation was done twice which is 06.00-10.00 a.m. and 14.00-18.00 p.m. (based on Eastern Indonesia Timezone). The bird's calculation used [6] IPA’s Method (Indices Ponctuels d’Abondance), which in each altitude were made 5 paths and in each path were made 5 observation points. The distance between each path is 200 meters. Meanwhile, the habitat data collection was made alongside the bird's observation paths, record the vegetation type, vegetations amount also habitat condition in each different altitude type.

2.3. Data analysis
2.3.1. Birds data
a) Birds species diversity
The determination of bird’s species diversity index based on Species Diversity index (H’), Shannon – Wiener [7]

\[ H' = - \sum_{i=1}^{s} (p_i)(\ln p_i) \]

H’ = diversity of species 
pi = proportion of individuals of the total sample belongings to the i-th species 
s = number of species 
i = the i-th species 
Species diversity level category:
H’ = 1, Low Diversity; individual amount spreading in each species is low, with low habitat stability
H’ = 1-3, Medium Diversity; individual spreading amount in each species is medium, with medium habitat stability
H’ = 3, High Diversity; individual spreading amount in each species is high, with high habitat stability.

b) Index of Evenness (E)
Index of evenness (E) is used to discover the evenness of each species (spreading) in each found habitat. The evenness depicts the balance between one community to another [6]

\[ E = \frac{H'}{\ln s} \]
E = index of evenness (index between 0 – 10)
H’ = diversity of species
In = natural logarithm
s = number of species

c) Similarity Index (IS)
Similarity index is used to compare certain index of bird species in different habitat. Similarity Index – Sorensen [8] is:

\[
IS = \frac{2C}{A + B} \times 100\
\]

IS = Sorensen’s similarity index
A = number of bird species found in Habitat A
B = number of bird species found in Habitat B
C = number of bird species found in Habitat A and B

| Similarity Index | Information   |
|------------------|---------------|
| 0 - 20 %         | Very Low      |
| 21 - 40 %        | Low           |
| 41 - 60 %        | Medium        |
| 61 - 80 %        | High          |
| 81 - 100 %       | Very High     |

2.3.2. Habitat
The vegetation analysis as bird’s habitat by inventory the vegetations types using Continuous Sampling (CSS) method. The inventory result was analyzed to discover the INP (IVI) index of each habita, [9] that is:

- **Density (D)** = \( \frac{\text{The amount of one species}}{\text{Sample plot area}} \)
- **Relative Density (RD)** = \( \frac{\text{One species density}}{\text{All species density}} \times 100\% \)
- **Frequency (F)** = \( \frac{\text{The amount of plot that found one species}}{\text{The total amount of plot}} \)
- **Relative Frequency (RF)** = \( \frac{\text{All species frequency}}{\text{The total amount of the base area}} \times 100\% \)
- **Dominance (Di)** = \( \frac{\text{Sample plot area}}{\text{One species dominance}} \times 100\% \)
- **Relative Dominance (RDi)** = \( \frac{\text{One species dominance}}{\text{All species dominance}} \times 100\% \)

Important Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance
3. Results and discussion

3.1. Bird species diversity and index of evenness

The result showed the amount of bird species that found in the Protected Forest Area are 16 species (Table 1).

| No | Bird Species                  | Habitat |
|----|-------------------------------|---------|
| 1  | Kicuit Kerbau                 | A       |
| 2  | Walet Sapi                    | B       |
| 3  | Elang Bondol                  | C       |
| 4  | Kacamata Ambon                |         |
| 5  | Perling Ungu                  |         |
| 6  | Nuri merah                    |         |
| 7  | Perkici Pelangi               |         |
| 8  | Pergam Laut                   |         |
| 9  | Pergam Tarut                  |         |
| 10 | Sesap Madu Sriganti           |         |
| 11 | Srigunting Lencana            |         |
| 12 | Nuri Pipi Merah               |         |
| 13 | Tekukur Biasa                 |         |
| 14 | Betet Kelapa Paruh Besar      |         |
| 15 | Nuri Raja                     |         |
| 16 | Raja Udang Erasia             |         |

Tabel 1. Bird species in protected forest area in Mount Sirimau (Soya Village)

| No | Indonesian’s Name | Scientific’s Name | A | B | C |
|----|-------------------|-------------------|---|---|---|
| 1  | Kicuit Kerbau     | Motalica flava    |   | * |   |
| 2  | Walet Sapi        | Collocalia esculenta | * |   | * |
| 3  | Elang Bondol      | Haliastur indus   |   |   | * |
| 4  | Kacamata Ambon    | Zosterops kuehni  |   | * |   |
| 5  | Perling Ungu      | Aplonis motalica  |   | * |   |
| 6  | Nuri merah        | Eos bornea        |   |   | * |
| 7  | Perkici Pelangi   | Trichoglossus haematodus | * |   | * |
| 8  | Pergam Laut       | Ducula bicolor    |   | * |   |
| 9  | Pergam Tarut      | Ducula concinna   |   | * |   |
| 10 | Sesap Madu Sriganti | Nectarinia jugalaris | * |   |   |
| 11 | Srigunting Lencana | Dicrurus bracteatus | * |   |   |
| 12 | Nuri Pipi Merah   | Geoffroyus geoffroyi | * |   |   |
| 13 | Tekukur Biasa     | Streptopelia chinensis | * |   |   |
| 14 | Betet Kelapa Paruh Besar | Tanygnathus megalorynchas | * |   |   |
| 15 | Nuri Raja         | Alisterus amboinensis |   | * |   |
| 16 | Raja Udang Erasia | Alcedo atthis     |   |   |   |

Notes: A: altitude of 300 masl
B: altitude of 400 masl
C: altitude of 500 masl
* : bird species were found
– : bird species not found

Table 1 above shows that there are 16 bird species were found, their different existence correspond to their habitat condition and where the birds were comfortable in making their habitat, searching for food, playing around, or even to rest. Therefore, some bird species were found only at 300 masl, some were only found at 400 masl, some were only found at 500 masl, and some can be found at every altitude.

Based on the Table 1 above, in protected forest area at 300 masl there were 14 species with the total amount of population were around 185 birds, at 400 masl there were 12 species with the total amount of population were around 110 birds, and at 500 masl there were 11 species with the total amount of population were 64 birds. According to [10]), habitat and altitude are correlated, which in every height addition will affect to species abundance loss. Other factor, like climate and soil fertility also altitude, really determine the bird species diversity on habitat level.
### Table 2. Bird species diversity index ($H'$) and index of evenness ($E$)

| Altitude | $H'$ | $E$ |
|----------|------|-----|
| 300 masl | 2.57 | 0.98 |
| 400 masl | 2.42 | 0.94 |
| 500 masl | 2.10 | 0.88 |

The result of this study shows the difference between the Species Diversity Index with Index of Evenness at different altitudes (Table 2). Altitude with high Species Diversity Index and high Index of Evenness shows that spreading and habitat control from bird species are better in the lower altitude due to the more complex community composition and structure it has, also have higher diversity than in higher altitude conditions. At 300 masl, the habitat shows the availability of resources that support the life of bird species.

#### 3.2. Bird species similarity

The Altitude at the Mount Sirimau in Protected Forest Area shows the level of species similarity between the 300 masl and the 400 masl of 89%. The level of species similarity between 400 masl and 500 masl is 75%, while the lowest level of species similarity is obtained between 300 masl with 500 masl at 64%. The similarity in species between the 3 types of altitude shows a value of 64% - 89%, this shows that between 3 habitats have a high level of species similarity, because the species of birds found in the study location are relatively similar.

#### 3.3. Correlation between bird species diversity and altitude (habitat)

The results of the vegetation analysis at 300 masl found 29 tree level vegetation types dominated by Damar (*Agathis damara*) (INP = 51.95 %), Kayu merah (*Eugenia jambolana*) (INP = 28.05 %), Meranti (*Shorea Sp*) (INP = 17.93 %), Kayu burung (*Elaeocarpus sphericus*) (INP = 16.125 %), Lenggua (*Petrocarpus Indicus*) (INP = 15.795). At 400 masl found 22 species of tree level vegetation dominated by Damar (*Agathis Damara*) (INP = 31.28 %), Kayu merah (*Eugenia jambolana*) (INP = 25.58 %), Kayu burung (*Elaeocarpus sphericus*) (INP = 16.52 %). Altitude 500 masl found 18 types of tree level vegetation, which are dominated by Kayu merah (*Eugenia jambolana*) (INP = 26.812 %), Lenggua (*Pterocarpus indicus*) (INP = 24.89 %), Belo hitam (*Diospyros celebica*) (INP = 19.496 %), Kayu burung (*Elaeocarpus sphericus*) (INP = 20.96 %).

Based on the types of vegetation that are used as bird feed at altitudes of 300 masl, 400 masl, and 500 masl, it is found that the species of birds that are often encountered are fruit / seed-eating birds, such as the type of Pergam laut (*Ducula bicolor*), Perkicit Pelangi (*Trichoglossus haematodus*), Nuri Pipi Merah (*Geoffroyus geoffroyi*), Tekukur Biasa (*Streptopelia chinensis*). Insectivorous birds such as Walet sapi (*Collocalia esculenta*), dan Srigunting lencana (*Dicrurus bracteatus*). Nectar birds likes Sesap madu sriganti (*Nectariana jugularis*), while carnivorous birds like Elang bondol (*Haliastur indus*) dan Raja udang erasia (*Alcedo atthis*).

Altitude factors affect the presence of birds because they directly affect the diversity of vegetation which is a source of bird feed. The variety of vegetation types found in a habitat supports the availability of food for birds, so that with a variety of vegetation types, birds will have more choices to choose the type of feed [11].
4. Conclusion
Based on the description of the results and the discussion above, it can be concluded that:

a) In the habitat with the altitude of 300 masl was found 14 species of birds, the altitude of 400 masl was found 13 species of birds, and the altitude of 500 masl was found 11 species of birds. The number of bird species found in the 3 types of altitude was 16 types of birds.

b) The highest bird species diversity index value is the altitude of 300 masl \( (H' = 2.57) \) followed by 400 masl \( (H' = 2.42) \) and the lowest is 500 masl \( (H' = 2.10) \). The altitude of the place affects the level of diversity of vegetation types which also affects the diversity of bird species, due to the complexity of the structure and composition of their habitat.

c) The most frequently used vegetation by bird species at the 3 altitude types is Damar (Agathis damara), Kayu Merah (Eugenia jambolana) and Kayu Burung (Elaeocarpus sphericus). Vegetation types as a habitat for bird species in the research location massively contributes to the existence of bird species in fulfilling the basic needs of bird species such as food, drink, breeding grounds and bird’s cover.

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