

Bird Diversity, Abundance, and Evenness Rates in Ecotone Area of Sutan Syarif Hasyim Forest Park, Riau, Indonesia

Hadinoto Hadinoto^{1,2*}, Lili Zalizar³, Joko Triwanto⁴, Ervayenri Ervayenri², Roy Hendroko Setyobudi¹, Muhammad Chanan⁴, Nugroho Tri Waskitho⁴, Jabal Tarik Ibrahim⁵, Eni Suhesti², Nguyen Van Minh⁶, Rusli Tonda¹, Satrio Satrio², and Trias Agung Pakarti⁷

¹Department of Agriculture Science, Postgraduate Program, University of Muhammadiyah Malang, Jl. Raya Tlogomas No. 246, Malang, 65144, Indonesia

²Department of Forestry, Faculty of Forestry, University of Lancang Kuning, Jl. Yos Sudarso km 8 Rumbai, Pekanbaru 28265, Indonesia

³Department of Animal Science, Faculty of Agriculture and Animal Science, University of Muhammadiyah Malang, Malang 65144, East Java, Indonesia

⁴Department of Forestry, Faculty of Agriculture and Animal Science, University of Muhammadiyah Malang, Malang 65144, East Java, Indonesia

⁵Department of Agribusiness, Faculty of Agriculture and Animal Science, University of Muhammadiyah Malang, Malang 65144, East Java, Indonesia

⁶Faculty of Agriculture and Forestry, Tay Nguyen University, 567 Le Duan St., 63100 Buon Ma Thuot City, Dak Lak Province, Vietnam

⁷Mayantara School, Jl. Puncak Mandala No.40A, Malang 65146, East Java, Indonesia

Abstract. Ecotone – an area where two environments of different composition and structure meet due to land conversion – is prone to habitat loss and biodiversity devaluation as a result of fragmentation. Responsive to change, birds represent one of the common animals of all habitat types since their diversity and abundance are able to reflect ecological tendencies in different biodiversity. This study was aimed to analyze the diversity, abundance, and evenness of birds as well as determine their density and frequency in the ecotone area of Sutan Syarif Hasyim Forest Park, Riau, Indonesia. Six sections of the study area (natural forest-and-shrubbery, natural forest-and-palm oil plantation, natural forest-and-lake, shrubbery-and-palm oil plantation, shrubbery-and-lake, and palm oil plantation-and-lake) were observed by employing Line Intercept Transect. 1 182 individuals of 59 bird species were reported, with *Pycnonotusaurigaster* (Vieillot, 1818) as the dominant one. The total diversity index of 3.75, abundance 8.2 and evenness 0.92 were evident to high density and frequency of birds in the area.

Keywords: Abundance, conservative area, conservation, fragmentation land coverage

* Corresponding author: hadinoto@unilak.ac.id

1 Introduction

Forest conversion potentially leads to habitat fragmentation. Whether the land is used for agricultural or residential purpose, human activities involved are certainly affective towards the original structure and vegetation by limiting – even blocking – the species variety and variability. While habitat fragmentation is the main perpetrator of species extinction [1, 2], landscape modification often damages existing land cover, driving further fragmentation in the remaining ground [3]. Devaluing biodiversity between 13 % and 75 % and devastating the main role of ecosystem through biomass reduction and nutrient cycle change [4, 5], fragmentation – adding up to habitat loss – are threats to biodiversity itself.

In the area where converted land meets the remaining forest area, its environmental structure and vegetative composition drastically change [6] – usually indicated by distinctive variants of flora and fauna – and form a specific ecotone habitat [7]. It is therefore presumable that altered bird communities in a suburban-and-conservation ecotone occur. Suburban birds are characterized by exotic, native species which become accustomed to urban atmosphere [8].

Being aware of the considerably high probability of habitat loss in a forest park, an observation on bird species is called for. Information on bird abundance should indicate the environmental decency of an area [9–11], which underlines the importance of its execution. Particularly for Sultan Syarif Hasyim Forest Park, Riau, Indonesia, this study should serve as preliminary data for any future attempts on preserving bird natural diversity after the completion of land conversion program.

2 Materials and methods

The observation was conducted between February 2019 and April 2020 in *Taman Hutan Raya* Sultan Syarif Hasyim, a forest park in the province of Riau, Indonesia (101° 25' 45.8'' E, 0° 40' 22.1'' N). Six ecotone sections had been appointed in the study area, covering: (i) natural forest-and-shrubbery, (ii) natural forest-and-palm oil plantation, (iii) natural forest-and-lake, (iv) shrubbery-and-palm oil plantation, (v) shrubbery-and-lake, and (vi) palm oil plantation-and-lake.

2.1 Material and equipment

The basic information on native bird species were gained from the handbook on birds in Sumatra, Java, Bali, and Kalimantan [12]. Equipments involved were a camera (Canon EOS 100D DS126191, Taiwan), a recorder (Sony ICD-PX333, China), a GPS (Garmin eTrex 10 SEA, Switzerland), a compass (Suunto Compass KB-14/360R, China), a watch (Casio GShock GA 500, Thailand), an area map, stationary, and tally sheet.

2.2 Data gathering

Line Intercept Transect was the operated method where observer(s) recorded visually located birds on their variants, quantities, and activities while progressing in accordance with a predetermined transect line.

2.3 Data analysis

Data collated were scrutinized to discover the bird diversity, evenness, and abundance in each ecotone section, leading to their indexes of the entire study area. The frequency and dominance were also examined.

Based on Shannon-Wiener diversity index, the bird diversity was assessed as per Equation (1) [13]:

$$H' = -\sum P_i \ln P_i, \text{ Where } P_i = \left(\frac{N_i}{N} \right) \quad (1)$$

Where,

H' = Shannon-Wiener diversity index

N_i = number of i variant

N = number of individual

\ln = natural logarithm

Whether individuals are evenly distributed between species in each surveyed community was measured by running Equation (2) [13]:

$$E = \frac{H'}{\ln S} \times S \quad (2)$$

Where,

E = evenness index

H' = Shannon-Wiener diversity index

\ln = natural logarithm

S = number of variant

Equation (3) – adopted from [14] – was employed to evaluate the abundance index:

$$R = \frac{(S-1)}{\ln \times n} \quad (3)$$

Where,

R = Margalef abundance index

S = number of variant

N = number of individual

\ln = natural logarithm

The percentage frequency of bird [15] was calculated indicative to Equation (4):

$$\text{Frequency (F)} = \frac{\text{Number of plot in which species is recorded}}{\text{Sum of all species}} \quad (4)$$

The relative density of the population should represent the composition of each community in an observed habitat, thus dominance index [15] computed as Equation (5):

$$\text{Density (K)} = \frac{\text{Number of individual s of species}}{\text{Total areas sampled}} \quad (5)$$

3 Results and discussion

A total of 1 182 individuals belonging to 59 species were recorded in the study area (Table 1). Significant quantity gaps are notable when compared to records on *Hutan Kota* Pekanbaru – a city forest near the capital of the same province where the study area lies – as [16] stated it to house 490 individuals of 45 bird species, while [17] found 89 individuals of 12 species in nearby residential area.

Table 1. Bird species composition of Sutan Syarif Hasyim Forest Park ecotone area.

| No | Species | Total number of individuals | Percentage (%) |
|----|--|-----------------------------|----------------|
| 1 | <i>Pycnonotus aurigaster</i> Vieillot, 1818 | 91 | 7.70 |
| 2 | <i>Geopelia striata</i> Linnaeus, 1766 | 79 | 6.68 |
| 3 | <i>Pycnonotus goiavier</i> Scopoli, 1786 | 66 | 5.58 |
| 4 | <i>Lonchura punctulata</i> Linnaeus, 1758 | 65 | 5.50 |
| 5 | <i>Lonchura malaca</i> Linnaeus, 1766 | 53 | 4.48 |
| 6 | <i>Streptopelia chinensis</i> Scopoli, 1786 | 47 | 3.98 |
| 7 | <i>Anthreptes simplex</i> Müller, 1843 | 34 | 2.88 |
| 8 | <i>Arachnothera longirostra</i> Latham, 1790 | 32 | 2.71 |
| 9 | <i>Nectarinia jugularis</i> Linnaeus, 1766 | 32 | 2.71 |
| 10 | <i>Prinia familiaris</i> Horsfield, 1821 | 32 | 2.71 |
| 11 | <i>Anthreptes singalensis</i> Gmelin, 1789 | 31 | 2.62 |
| 12 | <i>Acridotheres javanicus</i> Cabanis, 1850 | 28 | 2.37 |
| 13 | <i>Orthotomus atrogularis</i> Temminck, 1836 | 28 | 2.37 |
| 14 | <i>Centropus bengalensis</i> Gmelin, 1788 | 26 | 2.20 |
| 15 | <i>Psittacula alexandri</i> Linnaeus, 1758 | 26 | 2.20 |
| 16 | <i>Psittacula longicauda</i> Boddaert, 1783 | 25 | 2.12 |
| 17 | <i>Dicaeum trochileum</i> Sparrman 1789 | 24 | 2.03 |
| 18 | <i>Centropus sinensis</i> Stephens, 1815 | 22 | 1.86 |
| 19 | <i>Turnix suscitator</i> Gmelin, 1789 | 22 | 1.86 |
| 20 | <i>Alcedo meninting</i> Horsfield, 1821 | 18 | 1.52 |
| 21 | <i>Coturnix chinensis</i> Linnaeus, 1766 | 18 | 1.52 |
| 22 | <i>Halcyon smyrnensis</i> Linnaeus, 1758 | 18 | 1.52 |
| 23 | <i>Phaenicophaeus sumatranus</i> Raffles, 1822 | 18 | 1.52 |

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Table 1. Continued

| No | Species | Total number of individuals | Percentage (%) |
|----|---|-----------------------------|----------------|
| 24 | <i>Amaurornis phoenicurus</i> Pennant, 1769 | 17 | 1.44 |
| 25 | <i>Aegithina tiphia</i> Linnaeus, 1758 | 16 | 1.35 |
| 26 | <i>Aegithina viridissima</i> Bonaparte, 1850 | 16 | 1.35 |
| 27 | <i>Passer montanus</i> Linnaeus, 1758 | 16 | 1.35 |
| 28 | <i>Pycnonotus atriceps</i> Temminck, 1822 | 16 | 1.35 |
| 29 | <i>Pycnonotus simplex</i> Lesson, 1839 | 16 | 1.35 |
| 30 | <i>Zosterops palpebrosus</i> Hartlaub, 1865 | 16 | 1.35 |
| 31 | <i>Orthotomus sericeus</i> Temminck, 1836 | 15 | 1.27 |
| 32 | <i>Rhipidura javanica</i> Sparrman, 1788 | 15 | 1.27 |
| 33 | <i>Indicator archipelagicus</i> Temminck, 1832 | 14 | 1.18 |
| 34 | <i>Cyornis umbratilis</i> Strickland, 1849 | 12 | 1.02 |
| 35 | <i>Arborophila orientalis</i> Horsfield, 1821 | 11 | 0.93 |
| 36 | <i>Calorhamphus fuliginosus</i> Temminck, 1830 | 11 | 0.93 |
| 37 | <i>Gallus gallus</i> Linnaeus, 1758 | 11 | 0.93 |
| 38 | <i>Merops viridis</i> Linnaeus, 1758 | 11 | 0.93 |
| 39 | <i>Chalcophaps indica</i> Linnaeus, 1758 | 10 | 0.85 |
| 40 | <i>Arachnothera crassirostris</i> Reichenbach, 1854 | 9 | 0.76 |
| 41 | <i>Megalaima australis</i> Horsfield, 1821 | 9 | 0.76 |
| 42 | <i>Anthus novaeseelandiae</i> Gmelin, 1789 | 8 | 0.68 |
| 43 | <i>Corvus macrorhynchos</i> Wagler, 1827 | 8 | 0.68 |
| 44 | <i>Malacocincla sepiarium</i> Horsfield, 1821 | 8 | 0.68 |
| 45 | <i>Treron vernans</i> Linnaeus, 1771 | 8 | 0.68 |
| 46 | <i>Elanus caeruleus</i> Desfontaines, 1789 | 7 | 0.59 |
| 47 | <i>Oriolus xanthonotus</i> Sharpe, 1892 | 7 | 0.59 |
| 48 | <i>Turnix sylvatica</i> Desfontaines, 1789 | 7 | 0.59 |
| 49 | <i>Dinopium rafflesii</i> Vigors & Horsfield, 1830 | 6 | 0.51 |
| 50 | <i>Phaenicophaeus curvirostris</i> Shaw, 1810 | 6 | 0.51 |
| 51 | <i>Picus miniaceus</i> Pennant, 1769 | 6 | 0.51 |
| 52 | <i>Treron olax</i> Temminck, 1823 | 6 | 0.51 |
| 53 | <i>Anthracoceros malayanus</i> Raffles, 1822 | 5 | 0.42 |
| 54 | <i>Dicrurus paradiseus</i> Linnaeus, 1766 | 5 | 0.42 |

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Table 1. Continued

| No | Species | Total number of individuals | Percentage (%) |
|----|---|-----------------------------|----------------|
| 55 | <i>Pernis ptilorhynchus</i> Temminck, 1821 | 5 | 0.42 |
| 56 | <i>Corvus enca</i> Horsfield 1822 | 4 | 0.34 |
| 57 | <i>Ficedula dumetoria</i> Wallace, 1864 | 4 | 0.34 |
| 58 | <i>Ictinaetus malayensis</i> Temminck, 1822 | 4 | 0.34 |
| 59 | <i>Spilornis cheela</i> Latham, 1790 | 2 | 0.17 |

Cucak Kutilang (No.1 on Table1) was the most frequently perceived species in the study area. Mostly found in groups, this particular type of bird seemed unruffled by human activities in its surroundings. Other birds in the area were of granivores, insectivores, and nectarivores.

Bird abundance was generally high – especially insectivores [18] – with the dominant species of *Cucak Kutilang* (1), *Perkutut Jawa* (2), *Merbah Cerucuk* (3), *Bondol Peking* (4), *Bondol Rawa* (5), and *Tekukur Biasa* (6). Adequacy of feed sources as well as of vegetation in the habitats – allowing the birds to live and breed well – is deduced to be the cause of their high numbers of individuals. [19] cited that a high bird diversity rate in an area relied on high habitat diversity due to the habitat's function as a place to get feed, water, and home to rest and reproduce. Supporting the above point, [20] also emphasized how different habitats in an area served their own purposes depending on their types. While the listed species typically eat fruit, insects, and grains, some of them were seen to eat caterpillars and nectar. The observed individuals were generally active in all sections of the study area.

With collective indexes of diversity of 3.75, abundance of 8.2 and evenness of 0.92, the study area contained convincingly high rate in each variable. The habitat's diverse types should be the most significant factor of it. An ecotone area composes its own bird communities that positively influences their abundance [1] – which is commonly higher than in a forest or in an open land – since it welcomes insectivores, ground feeders, cavity nesters, and migrants [21]. More bird variants are marked the closer it is to an ecotone area for wider range of vegetation, especially shrubs [22]. Frugivorous birds are more abundant in ecotone areas, and they are beneficial in seed dispersal [23]. The index rates of each section of the study area are detailed in Table 2.

Table 2. Index rates by section of Sutan Syarif Hasyim Forest Park ecotone area.

| No. | Ecotone section | Diversity index (H') | Abundance index (R) | Evenness index (E) |
|-----|--|----------------------|---------------------|--------------------|
| 1 | Natural forest-and-shrubbery | 3.68 | 9.28 | 0.92 |
| 2 | Natural forest-and-palm oil plantation | 3.49 | 7.18 | 0.95 |
| 3 | Natural forest-and-lake | 3.40 | 6.81 | 0.94 |
| 4 | Shrubbery-and-palm plantation | 3.29 | 5.96 | 0.95 |
| 5 | Shrubbery-and-lake | 3.14 | 5.63 | 0.93 |
| 6 | Palm oil plantation-and-lake | 3.00 | 4.71 | 0.94 |

Sections bordering the natural forest have higher diversity rates compared to others. This finding is in sync with one of a previous observation in North Sumatra listing diversity

indexes of natural forest, rubber agroforest, rubber monoculture plantation, and emplacement area to be 3.8, 3.6, 3.0 and 2.9 respectively [24] and with another in *Hutan Kota Pekanbaru* – which is far from any natural forests, thus lower rates – of which diversity index was between 2.85 and 3.29, abundance of 4.67 to 6.70, and evenness of 0.87 to 0.93 [16].

3.1 Natural forest-and-shrubbery section (101° 25' 34.67" E, 0° 41' 11.654" N)

Amount of 302 individuals of 54 bird species have been discovered in the section. With diversity index of 3.68, which is high, each species is evenly dispersed and the community is steady. The abundance rate of 9.28 shows hefty existing variants. The evenness index of 0.92 represents good species distribution in each community. *Cucak Kutilang* (1) was the dominant species with 20 individuals. While habitats of natural land and farmland enhance bird abundance, natural habitats improve species evenness [14]. However, forestland habitats typically contain wider variants of bird than farmland. Environmental parameters such as water resource, canopy, and distance to the nearest forest also play their roles in determining bird existence [19].

3.2 Natural forest-and-palm oil plantation section (101° 25' 41.479" E, 0° 40' 22.635" N)

Amount of 229 individuals of 40 bird species have been detected in the section. With diversity index of 3.49, which is medium, each species is adequately dispersed and the community is quite steady. The abundance rate of 7.18 indicates high prosper of variants. The evenness index of 0.95 characterizes good species distribution in each community. *Cucak Kutilang* (1) was the dominant species with 15 individuals. The small establishment of < 36 ha with long crop period and its being connected to the remaining natural forest seem to be bird friendly [25].

3.3 Natural forest-and-lake section (101° 25' 3.580" E, 04° 0' 25.508" N)

Amount of 197 individuals of 37 bird species have been identified in the section. The diversity index of 3.40, which is medium, explains that each species is sufficiently dispersed and the community is rather steady. The abundance rate of 7.18 signifies medium richness in variety. The evenness index of 0.94 represents good species distribution in each community. *Cucak Kutilang* (1) was the dominant species with 18 individuals. The small establishment of < 36 ha with long crop period and its being connected to the remaining natural forest seem to be bird friendly [25]. Again, environmental factors like water resource, canopy, and distance to the nearest forest seem to be essential for bird survival [19].

3.4 Shrubbery-and-palm plantation section (101° 25' 55.931" E, 0° 41' 3.454" N)

Amount of 181 individuals of 32 bird species have been recognized in the section. The diversity index of 3.29, which is medium, underlines adequate dispersion of each species and quite stable community. The abundance rate of 5.96 implies medium richness in variety. The evenness index of 0.95 means good species distribution in each community. *Bondol Peking* (4) was the dominant species with 15 individuals. Also living in groups like

Cucak Kutilang, this species has better ability in adapting to food sources existing in ecotone areas [26].

3.5 Shrubbery-and-lake section (101° 25' 5.803" E, 0° 40' 22.337" N)

Amount of 144 individuals of 29 bird species have been spotted in the section. The diversity index of 3.14 specifies medium dispersion rate of each species and fairly stable community. The abundance rate of 5.63 implies medium richness in variety. The evenness index of 0.95 suggests good species distribution in each community. *Cucak Kutilang* (1) was the dominant species with 14 individuals. Shrubbery and savannah in an ecotone area are less safe for birds since they are prone to fire and are often surrounded by grazing animals [27].

3.6 Palm oil plantation-and-lake section (101° 24' 57.969" E, 0° 40' 26.599" N)

Amount of 132 individuals of 24 bird species had been discovered in the section. With diversity index of 3.00, which is medium, each species was fairly dispersed and the community was considerably steady. The abundance rate of 4.71 states medium number of existing variants. The evenness index of 0.94 represents good species distribution in each community. *Perkutut Jawa* (2) and *Bondol Peking* (4) were the two dominant species with 20 individuals each. That the alteration in vegetation structure and composition of a forest due to land conversion is influential towards bird abundance is apparent. This result approves a previous research stating that the composition change in a rubber tree plantation and its surrounding areas affected the species quantity, diversity, composition of birds [24].

4 Conclusion and recommendation

The relatively high diversity, abundance, and evenness rates – leading to high frequency and density – of bird in the study area are evident to its being an ideal locality for them. The diverse types of habitat as divided in each section should be keys to provide not only comfortable dwellings for native species but also welcoming new homes for migrating ones. The ecotone area of Sutan Syarif Hasyim Forest Park should be able to serve as a model for other ecotone areas regarding land conversion management in an attempt to prevent habitat loss while fragmentation is unavoidable.

The study area itself is still open for improvement, particularly in sections with medium rates of bird diversity, abundance, and evenness. Planting more trees in shrubbery is recommended to invite more bird species to live in and encourage native birds to grow. Returning palm oil plantation into forest is also a way for the same purpose.

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