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

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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

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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]:

$$H' = -\sum \mathrm{Pi}\ \mathrm{Ln}\ \mathrm{Pi},\ \text{Where Pi} = \left(\frac{\mathrm{Ni}}{\mathrm{N}}\right) \tag{1}$$

Where,
H' = Shannon-Wiener diversity index
Ni = 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]:

$$E = H' \big/ Ln \times S \tag{2}$$

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:

$$R = \frac{(S-1)}{Ln \times n} \tag{3}$$

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):

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

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	*Pycnonotus aurigaster* Vieillot, 1818	91	7.70
2	*Geopelia striata* Linnaeus, 1766	79	6.68
3	*Pycnonotus goiavier* Scopoli, 1786	66	5.58
4	*Lonchura punctulata* Linnaeus, 1758	65	5.50
5	*Lonchura malaca* Linnaeus, 1766	53	4.48
6	*Streptopelia chinensis* Scopoli, 1786	47	3.98
7	*Anthreptes simplex* Müller, 1843	34	2.88
8	*Arachnothera longirostra* Latham, 1790	32	2.71
9	*Nectarinia jugularis* Linnaeus, 1766	32	2.71
10	*Prinia familiaris* Horsfield, 1821	32	2.71
11	*Anthreptes singalensis* Gmelin, 1789	31	2.62
12	*Acridotheres javanicus* Cabanis, 1850	28	2.37
13	*Orthotomus atrogularis* Temminck, 1836	28	2.37
14	*Centropus bengalensis* Gmelin, 1788	26	2.20
15	*Psittacula alexandri* Linnaeus, 1758	26	2.20
16	*Psittacula longicauda* Boddaert, 1783	25	2.12
17	*Dicaeum trochileum* Sparrman 1789	24	2.03
18	*Centropus sinensis* Stephens, 1815	22	1.86
19	*Turnix suscitator* Gmelin, 1789	22	1.86
20	*Alcedo meninting* Horsfield, 1821	18	1.52
21	*Coturnix chinensis* Linnaeus, 1766	18	1.52
22	*Halcyon smyrnensis* Linnaeus, 1758	18	1.52
23	*Phaenicophaeus sumatranus* Raffless, 1822	18	1.52

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Table 1. Continued

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

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Ttable 1. Continued

No	Species	Total number of individuals	Percentage (%)
55	*Pernis ptilorhynchus* Temminck, 1821	5	0.42
56	*Corvus enca* Horsfield 1822	4	0.34
57	*Ficedula dumetoria* Wallace, 1864	4	0.34
58	*Ictinaetus malayensis* Temminck, 1822	4	0.34
59	*Spilornis cheela* 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 Cerukcuk* (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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