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Wild birds diversity in Mount Tumpa Forest Park, North Sulawesi, Indonesia

Trina Ekawati Tallei^{1*}, Saroyo¹ and Vierta Ramlan Tallei²

¹Department of Biology, Faculty of Mathematics and Natural Sciences, Sam Ratulangi University. Kampus UNSRAT Kleak, Manado 95115, **Indonesia**

²Architecture Study Program, Faculty of Engineering, Gorontalo State University. Jl. Jenderal Sudirman No.6, East Dulalowo, Gorontalo 96128, **Indonesia**

*Correspondence: trina_tallei@unsrat.ac.id Accepted: 10 Feb. 2018 Published online: 25 Mar. 2018

The objective of this research was to analyse the diversity of wild birds in Mt. Tumpa Forest Park. The park is a conservation area in a protected forest in Manado, North Sulawesi. For this purpose, randomly selected line transects were established across four types of habitat: primary and secondary rain forests, shrub, meadow, and agricultural land. A total of 403 individuals of birds consisting of 33 species from 19 families were recorded. Among these, *Passer montanus* (Passeridae) and *Scissirostrum dubium* (Sturnidae) were the most abundant with the number of 100 individuals/km², respectively. The value of Shannon-Wiener index 2.94 indicates that the diversity, the spread of number of individuals in each species, and community stability are moderate. The value of evenness below one (0.713) indicates that there is a dominant species in the community, and the distribution of the species is uneven. The species richness (Margalef index) was high based on its value 5.334. Deforestation and hunting of wild birds in this area are urgently needed to be controlled for the sake of better bird conservation, especially those of endemic and endangered species.

Keywords: birds, Coracina bicolor, diversity, endemic, Mt. Tumpa, North Sulawesi, species richness

INTRODUCTION

Sulawesi has a biodiversity of flora and fauna that are unique to the location, guite diverse, and is a center of bird edemism with 42 species and 14 genera found only in this island and its surrounding islands (Coates & Bishop, 1997; Stattersfield et al., 1998). Mount Tumpa Forest Park is a nature conservation located in the province of North Sulawesi. The park is located on the top of the mountain with an area of 208.81 Ha and an altitude of 175 - 627m above sea level. There are 4 main ecosystem types in Mt. Tumpa Forest Park: primary and secondary rain forests, shrub, grassland, and agricultural land (Tallei et al., 2015). The park is dominated by dry forest. which is inhabited by some bird species endemic to Sulawesi. This area has been used as one of

the destinations for bird watching of Wallacean birds. However, the shrinking of forest area in the forest park will threaten endangered bird species with a limited distribution. This leads to changes in habitat conditions in the forest park, causing the succession or changes in community structure. Bird watching is an activity that requires space and certain facilities in the urban environment forest. The arrangement of space and the facility requires caution so the habitats of birds that exist in the environment are not impaired.

The main problem of the decline of bird populations Sulawesi, primarily due to habitat destruction and poaching. Saroyo (2011) reported that in North Sulawesi, at least there are 39 type of wild fauna consumed by the local community, including wild birds. Mount Tumpa as protected forests provide protection against all organisms in it, including birds. However, the implementation does not necessarily run as expected. Close supervision is necessary to ensure the effective protection. On the other hand, the government is constrained by limited human resources in conducting surveillance. Imprvement of the status of Mt. Tumpa as forest park based Indonesian Law SK.434/Menhut-II/2013 provides substantial opportunities to streamline surveillance.

Respond of biological communities to global change is inevitable for conservation (Ladin et al., 2016). One imperative aspect in ecosystem maintenance is bird conservation. The study of bird species diversity is very important to perform, because it can provide the basic data that can be used as one of the guidelines for the management of a conservation area. The present study focuses on birds diversity analysis in Mt. Tumpa Forest Park.

MATERIALS AND METHODS

Study Area

The study of diversity of birds in Mt. Tumpa Forest Park (Figure 1) was conducted from February to July 2016. The coordinate of the site is Latitude, Longitude: 1.56436, 124.84350.

Sampling of Birds

Birds sampling was carried out using IPA (Les Indices Ponctuels d'Abondance) method (Blondel et al., 1977). This method is suitable to be used in large and uniform area. In this method, the observer stopped at a point at the observed habitat and counted all the birds detected during an interval of 20 minutes. Observation began in the morning at 6:00 to 9:00 on a predetermined observation path. Determination of observation paths were conducted directionally, so that birds encountered were the bird species in the habitat. The results obtained with this method was in the form of relative abundance.

At each location, six observation points were established (Figure 2). The distance between each point was 200 m. Observation was replicated 5 times in each location. Data taken during the observation were bird species, the number of individuals and bird activity. Calculation of population density was done using modified line transect method, with the length and width of the line were determined based on the type of bird and its habitat conditions (Bibby et al., 2000; Huff et al., 2000).

Data Analysis

Identification of bird was performed using the following books: A Guide to the Birds of Wallacea: Sulawesi, the Moluccas and Lesser Sunda Islands, Indonesia (Coates et al., 2000), The Birds of Sulawesi (Images of Asia) (Holmes 1997), and Panduan Lapangan Burung-burung di Kawasan Wallacea (Coates et al., 2000). Data analysis included bird abundance, diversity of birds, species richness, and speceis evenness. Bird abundance is the number of individuals for a species (ni) divided by the total of bird invididual found during observation (N). This formula was adopted from Krebs (1999). Diversity of birds was be determined using Diversity Index of Shannon-Wiener (H') (Krebs 1999). Margalef's index (Dmg) was used as a simple measure of species richness (Ludwig and Reynolds, 1988). The evenness (E) of the sample was calculated according to Krebs (1999). Simpson's Index (D) is the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species) Krebs (1999). Simpson's Diversity Index (SID) was mesured with the following formula: (1-D).

RESULTS AND DISCUSSION

Mt. Tumpa Forest Park has a hilly topography with the humidity between 70 (in June) and 90 percent (in December). The average temperatures range from about 23° C to 31° C. It has a very wet rain with precipitation of 3.187 year-1 (Tallei et al., 2017). The vegetation was dominated by Spathodea campanulata and Ficus sp. (Tallei et al., 2015). In this study, a total of 403 individuals belonging to thirty three species and nineteen families of birds were recorded from Mt. Tumpa Forest Park (Table 1), among other was Coracina bicolor (common name is Pied Cuckooshrike, local name is Kepudang-sungu belang). This bird is an endemic species and considered as near threatened according to IUCN Red List ver 3.1. Other endemic species of Sulawesi and its surrounding islands found in this park were Turacoena manadensis, Accipiter griseiceps, Pelargopsis melanorhyncha, Ducula forsteni, Phaenicophaeus calvorhyncus. Dicaeum Pachycephala celebicum. sulfuriventer, Amaurornis isabellinus, Scissirostrum dubium, and Zosterops atrifrons.



Figure 1. Location of Mt. Tumpa Forest Park in North Sulawesi (Tallei et al., 2015).



Figure 2. Observation point using point count method.

Family	Species	Local Name	Common Name	Endemicity	Population trend (IUCN)*	IUCN*	Gov. Reg. No. 7/1999
Acanthizidae	Gerygone sulphurea	Remetuk Laut	Golden-bellied Gerygone/Flyeater	-	Decreasing	LC	Not protected
Accipitridae	Haliastur indus	Elang Bondol	Brahminy Kite	-	Decreasing	LC	Protected
Accipitridae	Accipiter griseiceps	Elang-Alap Kepala-Kelabu	Sulawesi Goshawk	Sulawesi	Decreasing	LC	Protected
Accipitridae	lctinaetus malayensis	Elang Hitam	Black Eagle	-	Decreasing	LC	Protected
Alcedinidae	Todiramphus chloris	Cekakak Sungai	Collared Kingfisher	-	Decreasing	LC	Protected
Alcedinidae	Pelargopsis melanorhyncha	Pekaka Bua-bua	Great-billed Kingfisher	Sulawesi and Sula islands	Decreasing	LC	Not protected
Apodidae	Collocalia esculenta	Walet Sapi	Glossy Swiftlet	-	Stable	LC	Not protected
Ardeidae	Egretta garzetta	Kuntul Kecil	Little Egret	-	Increasing	LC	Protected
Campephagidae	Coracina bicolor	Kepudang-sungu Belang	Pied Cuckoo- shrike	Sulawesi, the Togian Islands, Muna, Buton and the Sangihe and Talaud islands	Decreasing	NT	Not protected
Columbidae	Turacoena manadensis	Merpati-hitam Sulawesi	Sulawesi Black Pigeon	Sulawesi and Togian islands	Stable	LC	Not protected
Columbidae	Streptopelia chinensis	Tekukur Biasa	Spotted Dove	-	N/A	N/A	Not protected
Columbidae	Macropygia amboinensis	Uncal Ambon	Brown Cuckoo Dove/	-	Stable	LC	Not protected
Columbidae	Ducula forsteni	Pergam Tutu	White-bellied Imperial Pigeon	Sulawesi	Stable	LC	Not protected
Columbidae	Ducula bicolor	Pergam Laut	Pied Imperial Pigeon	-	Decreasing	LC	Not protected
Columbidae	Ducula aenea	Pergam Hijau	Green Imperial Pigeon	-	Decreasing	LC	Not protected
Corvidae	Corvus enca	Gagak Hutan	Slender-billed Crow	-	Stable	LC	Not protected
Cuculidae	Eudynamys scolopacea	Tuwur Asia	Asian Koel	-	Stable	LC	Not protected
Cuculidae	Phaenicophaeus calyorhyncus	Kadalan Sulawesi	Yellow-billed Malkoha	Sulawesi	N/A	N/A	Not protected
Cuculidae	Centropus bengalensis	Bubut Alang-alang	Lesser Coucal	-	Increasing	LC	Not protected
Cuculidae	Centropus celebensis	Bubut Sulawesi	Bay Coucal	Indonesia	Stable	LC	Not protected
Dicaeidae	Dicaeum celebicum	Cabai Panggul-kelabu	Grey-sided Flowerpecker	Sulawesi	Stable	LC	Not protected
Estrildidae	Lonchura malacca	Bondol Rawa	Chestnut Munia	-	Stable	LC	Not protected

Table 1. Bird species recorded in Mt. Tumpa Forest Park.

Hirundinidae	Hirundo tahitica	Layang-layang Batu	Pacific Swallow	-	Unknown	LC	Not protected
Meliphagidae	Myzomela sanguinolenta	Myzomela Merah-tua	Scarlet Honeyeater	-	Stable	LC	Protected
Nectariniidae	Nectarinia aspasia	Burung-madu Hitam	Black Sunbird	-	Stable	LC	Protected
Nectariniidae	Nectarinia jugularis	Burung-madu Sriganti	Olive-backed Sunbird	-	Stable	LC	Protected
Oriolidae	Oriolus chinensis	Kepudang Kuduk-hitam	Black-naped Oriole	-	Unknown	LC	Not protected
Pachycephalidae	Pachycephala sulfuriventer	Kancilan Perut-Kuning	Sulphur-bellied Whistler	Sulawesi	Decreasing	LC	Not protected
Passeridae	Passer montanus	Burung Gereja Erasia	Eurasian Tree Sparrow	-	Decreasing	LC	Not protected
Rallidae	Gallirallus torquatus	Mandar-Padi Zebra	Barred Rail	-	Unknown	LC	Not protected
Rallidae	Amaurornis isabellinus	Kareo Sulawesi	Isabelline Bush Hen	Sulawesi	Unknown	LC	Not protected
Sturnidae	Scissirostrum dubium	Jalak Tunggir-merah	Finch-billed Myna	Sulawesi	Decreasing	LC	Not protected
Zosteropidae	Zosterops atrifrons	Kacamata Dahi-hitam	Black-fronted White-Eye	Sulawesi	Unknown	LC	Not protected

* IUCN Redlist of Threatened Species (2017)

Species	Density	Relative	Dmg	H'	É	1-D
-	(individual	abundance	-			
	/km²)	(%)				
Gerygone sulphurea	2	0.4963				
Haliastur indus	1	0.2481				
Accipiter griseiceps	1	0.2481				
Ictinaetus malayensis	1	0.2481				
Todiramphus chloris	10	2.4814				
Pelargopsis melanorhyncha	5	1.2407				
Collocalia esculenta	2	0.4963				
Egretta garzetta	2	0.4963				
Coracina bicolor	2	0.4963				
Turacoena manadensis	4	0.9926				
Streptopelia chinensis	10	2.4814				
Macropygia amboinensis	5	1.2407				
Ducula forsteni	4	0.9926				
Ducula bicolor	4	0.9926				
Ducula aenea	4	0.9926				
Corvus enca	5	1.2407				
Eudynamys scolopacea	5	1.2407				
Phaenicophaeus	20	4.9628				
calyorhyncus						
Centropus bengalensis	2	0.4963				
Centropus celebensis	2	0.4963				
Dicaeum celebicum	10	2.4814				
Lonchura malacca	50	12.4069				
Hirundo tahitica	1	0.2481				
Myzomela sanguinolenta	2	0.4963				
Nectarinia aspasia	10	2.4814				
Nectarinia jugularis	5	1.2407				
Oriolus chinensis	2	0.4963				
Pachycephala sulfuriventer	2	0.4963				
Passer montanus	100	24.8139				
Gallirallus torquatus	10	2.4814				
Amaurornis isabellinus	10	2.4814				
Scissirostrum dubium	100	24.8139				
Zosterops atrifrons	10	2.4814				
	403	100	5.334	2.94	0.713	0.8554

Table 2. The Population Density, Relative Abundance (%), Margalef's Richness Index (Dmg), Diversity Index (H'), Evenness Index (E), and Simpson's Diversity Index (1-D)

The existence and the number of birds in a habitat are affected by physical or environmental factors include soil, water, temperature, light intensity, and biological factors, among others, vegetation and interaction with other animals (Welty and Baptista, 1988). The relative abundance of a species indicates the dominance of these species in the type of habitat where they inhabit. Relative abundance index values are classified into three categories: high (> 20%),

moderate (15% -20%), and low (<15%).Table 2 shows that among the 33 species of birds Passer recorded. *montanus* (Passeridae: Passeriformes) Scissirostrum dubium and (Sturnidae; Passeriformes) were the most abundant species, each contributing to 100 individuals (24.8139%)/km². The least abundant species were Haliastur indus, Accipiter griseiceps, Ictinaetus malayensis, and Hirundo tahitica, each contributing to 1 individuals (0.2481%)/km². Birds from family Columbidae were the most number of species found on these observation areas and all are the typical Wallaceas species. Cuckoo family (Cuculidae) is a family with the second largest number of species. All of family Accipitridae, Alcedinidae, Meliphagidae, Nectariniidae, and from the genera *Egretta*, are protected by Indonesian Law. Interestingly, *C. bicolor*, a bird endemic to Sulawesi, the Togian Islands, Muna, Buton and the Sangihe and Talaud islands, is not protected by Indonesian Law, but unfortunately, its existence is already endangered. It is suggested that the law needs to be revised.

Rhyticeros cassidix (or Aceros cassidix), also known as Sulawesi wrinkled hornbill, is endemic to Sulawesi, Buton, Lembeh, Togian and Muna Island. It inhabits evergreen forest at an elevation of up to 1,800 m. This species is included in CITES appendix II. However, during the research, this species was not encountered, while local community reported that they sometimes see this bird and Macrocephalon maleo (Maleo) in the forest park. Mangi et al. (2013) reported that the population of R. cassidix had declined. Maleo is also endemic to Sulawesi and Buton islands, and has been categorized by IUCN ver 3.1 as endangered. The population of this bird is also decreasing. Martin and Blackburn (2010) reported that abundance of R. cassidix and C. Bicolor decreaseed rapidly with increasing disturbance of Lambusango forest in South East Sulawesi.

Christita et al. (2015) reported that Mt. Tumpa forest park still had a well preserved niche as a habitat for some birds. The availability of trees as well as insects that are relatively abundant as bird feed are also important in maintaining the carrying capacity of the survival of birds, in addition to good vegetation cover. The abundance of a species in a habitat is influenced by many things, includina habitat suitability. success in implementing adaptation strategies, a high tolerance for interference, and high enough reproduction rate. A community that is dominated by one or two species is considered to be less diverse than a community which has a relatively same abundance. The species with hiah abundance are least threatened by extinction, especially those with large geographical range and high tolerance to habitat destruction. Passer and dubium posses montanus S. these characteristics for their survival. The abundance of both bird species is also supported by the habitat of, among others, the trees used by birds for food and activities. The availability of food in a habitat is one of the main factors for the presence of bird populations (Wiens, 1989). Christita et al.

(2015) added that type of diurnal birds in Mt. Tumpa forest park were honey eater (4%), fruiteater (18%), polyphagous (18%), carnivore (21%), and insectivore (39%). In addition to providing food, the tree was also used by birds for nesting and breeding, making it a suitable habitat to the availability of resources to support their survival. They also needed the space to make the trip to find a partner and avoid predators. This habitat requirements depend on the type of bird (Parsons, 2007). Low relative abundance of some bird species is due to habitat conditions that do not support, especially for species that prefer activities of individuals, not in groups.

The Shannon-Wiener index (H') has diversity equivalent to one community containing equallycommon species of e^H which is termed as the effective number of species, which is the number of equally abundance species needed to produce the observed diversity values (Jost, 2007). The H' value of birds at Mt. Tumpa Forest Park was 2.494 (Table 2). This has the equivalent value of diversity as a community with an effective number of species (true diversity) (e^{2.494}) of 12.12. The value 2.494 indicates that the diversity level of birds is moderate. This explains that the forest has enough productivity, park balanced ecosystem condition, and moderate ecological pressure. The H' value is generally between 1.5 and 3.5 in most ecological studies, and is rarely greater than 4. Alikondra (2002) stated that factors contributing to H' is environmental condition, number of species, and distribution of individual of each species. According to Wani et (2005), diversity index provides more al. information about the composition of a community than counting species richness only. Diversity index explains the quantitative estimate of the biological variability. This can be used to compare the biological entity composed of discrete components (Heip et al., 1998) for example, the species itself. Moderate diversity in this area is most likely caused by deforestation and unsustainable birds hunting. The values of diversity index and evenness index are maximum if all birds have relatively equal abundance. The index increases as both the richness and the evenness of the community increase.

Evenness index is used to determine each bird species within a predetermined observation area.By calculating the evenness, the value of the actual diversity (Hs) can be compared with the maximum possible diversity (H_{max}) (Maiti, 2013). The eveness value (E) of birds in this area was 0.713 (Table 2). According to Krebs (1999), equity

indices ranges between 0-1. If the value of E <0.20 then the spread of bird species is unstable and there is a dominant species in the community. If the value of E between 0.21 and 1, the spread of bird species is in stable condition. Therefore, dispersion of bird species was stable, although interestingly there were two dominant species in this area. This E value is a measurement of the balance towards a community with one another, and are influenced by the number of species present in a community. This value is also a measure of how similar the abundance of bird species that exist in a community. So if there is a similar proportion of all species, the eveness value is close to 1.

Evenness can also be measured using the Lorenz curve (Rousseau, 1998). The farther the curve off the line of perfect evenness (diagonal), the more diverse the birds species and the more uneven the abundance of each species. The Lorenz curve for the birds in Mt. Tumpa forest park is on the blue line (Figure 3) which lies under the line of perfect evenness, hence the evenness of birds in this area is uneven. The less uneven of birds' dispersion is caused by vegetation composing the habitat that support for the survival of many species of birds living there.



Figure 3. Lorenz Curve for evenness distribution of birds species in Mt. Tumpa forest park. The diagonal line represents a perfect evenness

To calculate the number of different species in a particular area, Margalef richness index (species richness) (Karikalan, 2015) was used. This is the simplest measurement of the biodiversity. Species richness in this area was high (5.334) (Table 2). Margalef index criteria R<2.5 indicates a low level of species richness, 2,5> R>4 shows that the level of species richness is moderate, R>4 shows a high level of species richness. Species richness also refers to as alphadiversity, and along with other factors, it is commonly used to determine the overall health of ecosystems. According to Schwartz et al. (2000), high species richness refers to a high level of stability in a given ecosystem, thus allowing the ecosystem to better withstand natural or anthropogenic disturbance. It indicates that the ecosystem in Mt. Tumpa forest park is still healthy and robust.

Simpson index (D) is also called the dominance index because it gives more weight to the common or dominant species. In this case, the rare types with little representation will not affect diversity. In essence, it measures the probability that two individuals randomly selected from an area will belong to the same species. The value D has a range from 0 to 1. With this index, the value of 1 represents the infinite diversity and the value 0 represents the absence of diversity. The D is a measure of dominance, so as D increases. diversitv (in the sense evenness) of decreases. The D in Mt. Tumpa forest park was 0.1446, therefore Simpson Diversity Index (1-D or 1-Diversity) is 0.8554 (Table 2). This index is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. When the richness and evenness of species increases, the species diversity is also increased. This value indicates that the species of birds in this location is quite diverse. The higher the SID, the more diverse the species in one location, therefore there is a higher probability of sampling two different species in a plot.

So far there has been not many research on bird diversity in Mount Tumpa forest park. A research conducted by Christita et al. (2015) in this area was on diversity of birds based on their diet, conservation status, and endemicity. Thus, this research on indepth recorded bird bioversity has been done to provide a data base for bird conservation strategies in this area. Birds are an important component in food chains, food webs, nutrient cycles, and the structure and function of ecological an system. But poaching and deforestation is ongoing in this area (Tallei et al., 2015). This activity must be controlled immediately for the sake of faunal conservation, especially for endemic and endangered bird species. Conservation strategies can be done for

example by infusion conservation lessons into the curriculum of local schools (Tallei and Saroyo, 2009).

CONCLUSION

This study reveals that the diversity of wild birds in Mt. Tumpa Forest Park is moderate, with two dominant species: *P. montanus* (Passeridae) and *S. dubium* (Sturnidae). The distribution of 33 species is uneven but the species richness is high. This study contributes to the prevention of wild birds declining in Mt. Tumpa Forest Park, and help the researchers to propose model for wild animal conservation in this area.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed to the research and manuscript preparation. TET prepared the manuscript and its revision. S performed the research in the field. VRT did the data analysis. All authors read and approved the final version of the manuscript.

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