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The potential of bird diversity in the urban landscape for birdwatching in Java, Indonesia

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Abstract. *Kurnia I, Arief H, Mardiastuti A, Hermawan R. 2021. The potential of bird diversity in the urban landscape for birdwatching in Java, Indonesia. Biodiversitas 22: 1701-1711.* Birdwatching is a recreational activity of observing birds in the wild with the naked eye¸ using tools such as telescopes and binoculars, or listening to bird sounds. The observation locations can be either natural landscape or urban landscapes with bird diversity. However, the dominance of built spaces and man-made vegetation differed from natural landscapes. This difference will affect the composition of birds found in the urban landscape. This paper aimed to analyze bird diversity in urban landscapes and their potential for birdwatching. The research was conducted from February to April 2020 in five cities in Java (Bogor, Sukabumi, Bandung, Yogyakarta, Surabaya). Bird data were taken using the IPA method and were carried out in 85 green open spaces. Total bird species found were 75 species, with the largest number found in Bogor (66 species), followed by Surabaya (36 species), Bandung (28 species), Sukabumi (26 species), and Yogyakarta (19 species). The locations with the highest species richness in each city are Bogor Botanical Gardens (53 species), Cikundul Agrotourism Area Sukabumi (18 species), Bandung Zoological Garden (21 species), Gembira Loka Zoo (14 species), and Pakal City Forest Surabaya (20 species). Commonly seen bird species are dominated by generalist species typical of urban landscapes (e.g., *Collocalia linchi*, *Passer montanus*, and *Pycnonotus aurigaster*). Bird species richness has a positive correlation with the local area and habitat diversity. A total of 74 bird species are resident species that can be found throughout the year as birdwatching objects. Only one species are migrant species namely *Merops philippinus*.

Keywords: Bird, birdwatching, urban parks, urban landscape

INTRODUCTION

Birds are a unique component of landscapes. Birds have been used as indicators of high and low diversity in habitat and also used as an indicator of the quality of a habitat (Gregory and Strien 2010; Fraixedas et al. 2020). The high diversity of bird species will be followed by the high diversity of other species in a habitat. Birds are also among the animals that are sensitive to changes in habitat structure and composition (Blinkova and Shupova 2017). Birds have a wide spatial range (Kordowska dan Kulczyk 2014), thus they can be found in various habitats, both natural landscapes and man-made landscapes, including urban landscapes. Urban landscapes are characterized by a dominant arrangement of socio-cultural components over biotic and biotic components (Pickett et al. 2001; Anderson 2006). Urban landscapes have their own form as a result of extreme changes in natural ecosystems over a certain time period, thus their natural forms change (Grimm et al. 2008). In the urban landscape, biological communities are often dissimilar to surrounding communities as urban species become reshuffled into novel communities (Angold et al. 2006). The dynamics of urban development have resulted in the dominance of built-up areas, which brings an impact on ecosystem components, including birds (Clergeau et al. 2006; McKinney 2006).

Birds are wildlife that can be found in urban landscapes (e.g., Tu et al. 2020; Rumblat et al. 2016). This condition is due to the ability of birds to adapt to their environment. The presence of birds in urban landscapes can be influenced by various factors (e.g., green open space, vegetation and human activity). The existence of green open spaces as a main habitat also affects the presence of birds (Callaghan et al. 2018; Rodrigues et al. 2018). High vegetation diversity in urban landscape results in high bird diversity (Blinkova and Shupova 2017; Pena et al. 2017). Birds respond negatively to high human activity (Fontana et al. 2011). Bird communities in urban landscape is related to the social conditions of the surrounding community, as in communities with higher economies tend to have higher bird diversity (Strohbach et al. 2009).

The existence of birds is important in relation to birdwatching, a form of natural recreation with a focus on watching birds in natural habitats (Schaffner 2009; Biggs et al. 2011). Birdwatching or avitourism is a recreational activity of observing birds in the wild with the naked eye or through assistive devices such as telescopes, binoculars, and cameras or simply listening to bird sounds. Birdwatching is the most sporty scientific activity, as well

as the most scientific sport thus lead to the emerging of the term ornithological tourism (Kordowska and Kulczyk 2014). Birdwatching has become a growing hobby, especially in developing countries (Sekercioglu 2002). This recreational activity is carried out in a very varied way, from watching birds, making a list of discoveries to competing to find new species in a location (Schaffner 2009). Studies on the potential of birdwatching in Indonesia were dominated by research in natural landscapes (e.g., Aditya et al. 2018; Asrianny et al. 2018; Ardi and Suardi 2020). The studies on the urban landscape were only performed at Andalas University Campus West Sumatra by Janra (2019), and Bogor Botanical Gardens by Hasibuan et al. (2018). Therefore, it is important to conduct a study on the potential for birdwatching in a city as a single area to determine the bird diversity and their distribution in various urban landscape locations in the cities of Bogor, Sukabumi, Bandung Yogyakarta, and Surabaya. This information will be the basis for the development of birdwatching in urban landscapes.

MATERIALS AND METHODS

Study area

The study was performed from February to May 2020 in Bogor, Sukabumi, Bandung, Yogyakarta, and Surabaya (Figure 1). Observations were made in 85 open spaces consisting of city parks (60 locations), city forests (8 locations), research forests (1 location), field (9 locations), Zoo (3 locations), university campus (1 location), stadium (1 location), and tourism areas (2 locations). The habitat types of research sites are forests, parks, fields, gardens, beaches, rivers, and ponds.

Figure 1. Study sites in six cities on Java Island, Indonesia

Table 1. List of green open space as study sites

City	Name of Green Open Space (Code)
Bogor	Bogor Botanical Garden (a), Sempur Park (b), Sempur Kaler Park (c), Kencana Park (d), Malabar Park (e), Pangrango Park (f), Peranginan Park (g), Ahmad Yani City Forest (h), Heulang Park (i), Gunung Gede IPB Campus (j), Palupuh Park (k), Kampung Pakuan Park (l), Bogor Ka Bogor Park (m), Corat Coret Park (n), Gandaria Park (o), Kresna Field (p), Teplan Field (q), Pajajaran Stadium (r), Manunggal Field (s), Empang Field (t) and Dramaga Research Forest (u)
Sukabumi	Digital Park (a), Lapangan Merdeka Park (b), Aspirasi Park (c), Bunut Park (d), Cikondang Park (e) Kerkof City Forest (f), Sugema Park (g), Kibitay City Forest (h), Cikundul Agrotourism Area (i)
Bandung	Balai Kota Bandung Park (a), Maluku Park (b). Lansia Bandung Park (c), Kandaga Puspa Park (d), Cibeunying Park (e), Pet Park (f), Ganesha Park (g), Bandung Zoological Garden (h), Babakan Siliwangi City Forest (i), Teras Cikapundung Park (j), Pramuka Park (k), Musik Park (l), Tongkeng Park (m), Foto Park (n), Ciujung Park (o), Monumen Perjuangan Park (p), Sukajadi Park (q), Alun-alun Bandung Park (r), Regol Park (s), Tegalega Park (t), Ujung Berung Park (u)
Yogyakarta	North Alun-alun (a), South Alun-alun (b), Vredeburg Fort Park (c), Langgensari Pond (d), Gembira Loka Zoo (e), Minggiran Field (f), Jetis Field (g), Karang Field (h)
Surabaya	Balai Kota Surabaya Park (a), Apsari Park (b), Lansia Surabaya Park (c), Flora Park (d), Bungkul Park (e), Ronggolawe Park (f), Persahabatan Park (g), Korea Park (h), Bambu Runcing Park (i), Ekspresi Park (j), Prestasi Park (k), 10 Nopember Park (l), Surabaya Zoo (m), Sejarah Park (n), Mayangkara Parl (o), Petekan Park (p), Pakal City Forest (q), Harmoni Park (r), Incinerator Park (s), Kenjeran Lama Park (t), Bulak Park (u), Kenjeran Park (v), Suroboyo Park (w), Suramadu Park (x), Pelangi Park (y), Waru Park (z)

Procedures

Bird data were collected using the presence-absence in each location. Observations of the birds were carried out during morning (05.30−11.00) or evening (14.00−18.00). The weather conditions were sunny and not rainy. The species recorded were bird species that use urban space as their habitat, both perching, and flying either diurnal or nocturnal bird species. Bird identification was based on MacKinnon et al. (2010), while the nomenclature referred to Sukmantoro et al. (2007). Habitat area data was measured via google earth.

Data analysis

Bird data were analyzed whether or not they were present at a location. The status of bird species was analyzed according to the Indonesian Minister of Environment and Forestry Number P.20/MENLHK/SETJEN/ KUM.1/6/2018, the CITES Appendix, and the IUCN Red List. The distribution status was based on Sukmantoro et al. (2007). Comparison of bird species richness was tested using chi-square at degrees of freedom v = (r-1) (c-1) with a significant value of 5% (α <0.05). The composition of birds was determined using the Jaccard similarity index (Krebs 1998) and then made into a dendrogram. The correlation of habitat area with bird species richness was analyzed by linear regression and processed using IBM SPSS version 2.4.

RESULTS AND DISCUSSION

Bird species richness

In total, there were 75 species from 34 bird families. Bogor is ranked as the number one city with the highest number of bird species (66 species), followed by Surabaya (36 species), Bandung (28 species), Sukabumi (26 species), and Yogyakarta (19 species) (Table 2). From 75 species, 12 species are protected species according to the Indonesian Minister of Environment and Forestry Regulation Number P.20/MENLHK/SETJEN/KUM.1/6/2018. There are five species included in the CITES Appendix II, while based on the IUCN Red List, there are one species, including the endangered (EN) category, namely *Criniger bres.*

Distribution and composition of bird species

Locations that have the highest bird species richness in each city are Bogor Botanical Gardens (53 species), Cikundul Agrotourism Area, Sukabumi (18 species), Bandung Zoological Garden (21 species), Gembira Loka Zoo, Yogyakarta (14 species), and Pakal City Forest, Surabaya (20 species). The number of bird species found was significantly different for all locations in four city, namely Bogor (χ^2 = 211.63; df = 20; P <0.01), Sukabumi (χ^2 = 20.20; df = 8; P <0.01), Bandung (χ^2 = 51.45; df = 20; P <0.01) and Surabaya (χ^2 = 80.26; df = 25; P <0.01). Only Yogyakarta was not significally (χ^2 = 10.56; df = 7; P <0.05). The 100% community similarity (IS = 1) was found in Bandung between Kandaga Puspa Park with Pet Park as well as Regol Park with Ujung Berung Park (Figure 2).

The sites with the highest number of bird species in each city have more diverse habitat types than other sites in the same city. Bogor Botanical Garden, Bandung Zoological Garden, and Gembira Loka Zoo consist of forest habitats with large and tall trees, gardens with various flower plants, open fields, and bodies of water, namely rivers and lakes/ponds. Cikundul Agrotourism Area consists of habitats of large trees, fields, shrubs, paddy fields, and rivers. Meanwhile, Pakal City Forest Surabaya consists of trees, bush, and pond.

The most widespread species were *Collocalia linchi* (found at 99% of sites), followed by *Passer montanus* (95% location) and *Pycnonotus aurigaster* (89% location). Most of the species found, namely 27 bird species (36%) were found in one location only. However, there are only six locations where the bird species are distributed, namely Bogor Botanical Garden (16 species), Dramaga Research Forest (4 species), Cikundul Agrotourism Area (2 species), Pakal City Forest (2 species), Kenjeran Park (2 species), and Kenjeran Lama Park (1 species). The birds found were predominantly arboreal groups inhabiting tree canopies. Only a few birds belonged to the group of bush birds.

Table 2. Distribusi of bird species in the research site

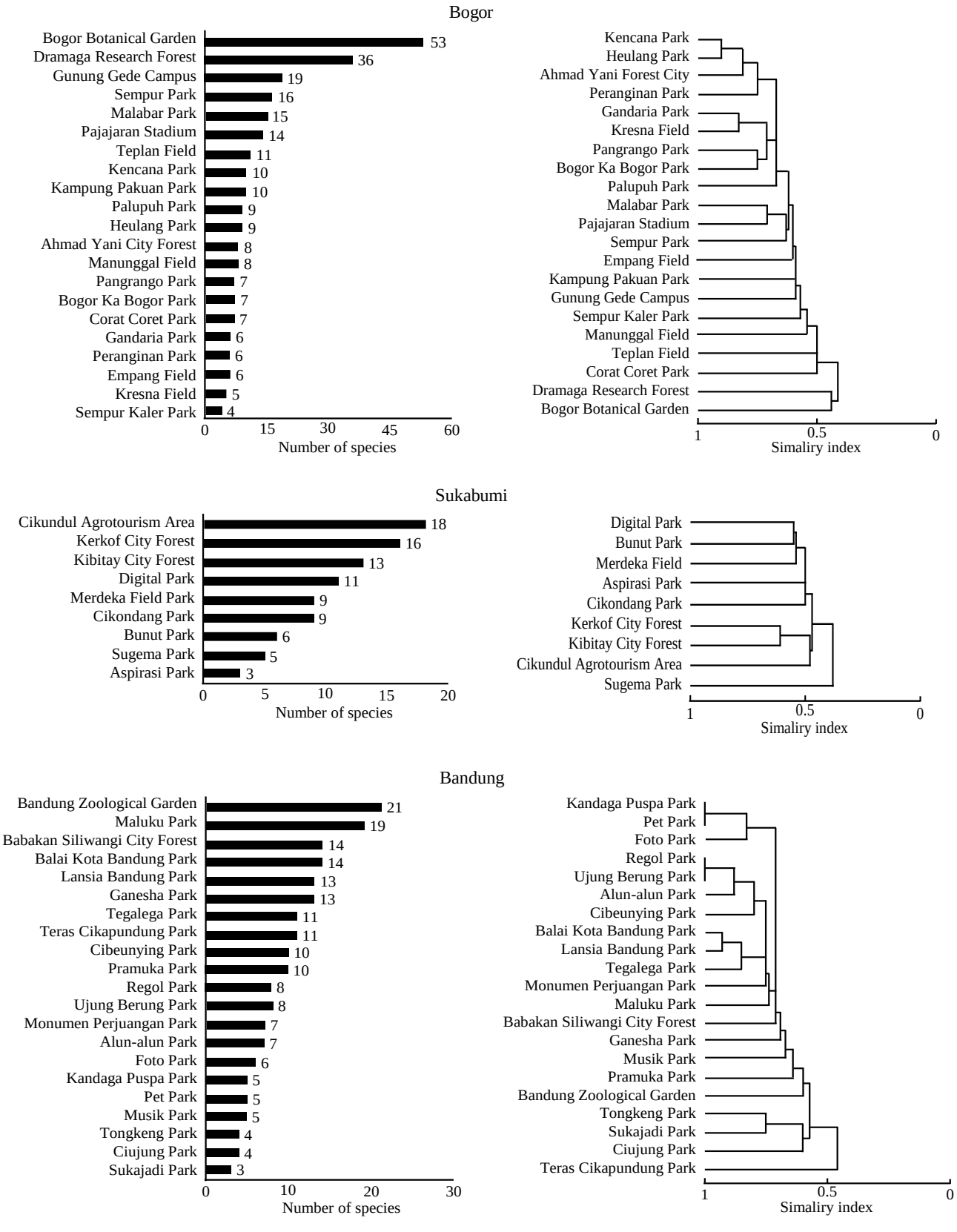
Family	Species	City				
		Bogor	Sukabumi	Bandung	Yogyakarta	Surabaya
Ardeidae	*Ardea alba*[1]					q
	Bubulcus ibis[1]					s,v
	Nycticorax nycticorax	a		h		a,b
	Ixobrychus cinnamomeus	u				
Accipitridae	*Haliastur indus*[1,2]					t
	Accipiter trivirgatus[1,2]	u		h		
Falconidae	*Microhierax fringillarius*[1,2]		i			
Turnicidae	*Turnix suscitator*	u				s
Rallidae	*Amaurornis phoenicurus*	a,u				a,b

Columbidae	*Treron griseicauda*	a				
	Treron vernans	a,e,s		b,g,h		
	Ptilinopus melanospila	a				
	Streptopelia bitorquata	a				
	Streptopelia chinensis	Ex. g,k,l,n,o,p,q	a	Ex. d,f,l,n,o	a,b,d,e,f	Ex.c,e,g,h,I,n,t,u,w,y
	Geopelia striata			a,b,g,i	g	c,d,e,f,k,q,r,t,u,v,y,z
Psittacidae	*Psittacula alexandri*[2]	a		a,b,c,g,h,k,n		
	Loriculus pusillus[2]	a				
Cuculidae	*Cacomantis sonneratii*	u	h	h		
	Cacomantis merulinus	Ex. c,m,n,o,p,q,s,t	b,e,f,h,i	Ex. j,l,m,o,p,q		d,e,q,r,v
	Cacomantis sepulcralis	a,u	e,f	j		
	Surniculus lugubris	a				
	Centropus bengalensis		i			a,c
Apodidae	*Collocalia fuciphagu*	a,u	f,h			
	Collocalia linchi	All	All	All	All	Ex. e,i,p
	Apus nipalensis	a,b,e,r,u	a,b,f,h	h,p	b,d	a,d,e,f,g,I,j,m,r,z
Alcedinidae	*Alcedo meninting*[1]	a,j,k,u	f,g,h	h,j	e	
	Halcyon cyanoventris[1]	u	f.h.i	b,h		
	Halcyon chloris[1]	a,b,j,k,u	f,i		e	v
Meropidae	*Merops philippinus*					q
Capitonidae	*Megalaima haemacephala*	a,j,q,r		a,b,c,g,h,i,j,k,t	a,f	
Picidae	*Dendrocopos macei*	a		b,e,i,k,t		
	Dendrocopos moluccensis	a,j,k,q				
Hirundinidae	*Hirundo tahitica*	a,b,e,j,m,n,r,s,u	i	Ex. d,f,g,k,l,m,q	c,e	d,e,f,k,n,a,r,s,t,u,v,x,y
	Hirundo striolata	j,q,u	a,d,e,h,i		e,g,h	d,k,q,r,t
Campephagidae	*Lalage nigra*	u				
	Lalage sueurii					v
	Pericrocotus cinnamomeus	b				q,t
Aegithinidae	*Aegithina tiphia*	Ex. c,g,k,l,m,n,o,p,q,s,t	f.h.i	a,b,c,h,j,t	d,e	a,d,e,m,r,s,v
Chloropseidae	*Chloropsis cochinchinensis*	a				
Pycnonotidae	*Pycnonotus atriceps*	a				
	Pycnonotus melanicterus	a				
	Pycnonotus aurigaster	All	a,b,c,d,f,i	Ex. m,o,q	a,c,d,e	Ex. p
	Pycnonotus goiavier	b,d,e,i,j,q	b,f,i		b,e,f,g	a,b,c,d,e,f,k,m,p,q,r,u,y
	Pycnonotus simplex	a				
	Pycnonotus brunneus	a				
	Criniger bres[3]	a				
Laniidae	*Lanius schach*	a,e				
Timaliidae	*Pellorneum capistratum*	a,u				
	Malacocincla sepiarium	a,u	f,g,i	h,j		
Sylviidae	*Cisticola juncidis*	u				
	Prinia familiaris	a,u				
	Prinia flaviventris					v
	Orthotomus sutorius	a,b,d,j,l,u	i	b,h,j		
	Orthotomus sepium	Ex. c,n	Ex. c,g	Ex. j.q	d,e	d,m,q,v
Muscicapidae	*Eumyias indigo*	a				
	Cyornis banyumas	a				
Acanthizidae	*Gerygone sulphurea*	a				d,q,r,v
Rhipiduridae	*Rhipidura javanica*[1]	a,u				d,e,q
	Parus major	a				
Dicaeidae	*Dicaeum concolor*	a				
	Dicaeum trochileum	Ex. c,f,m,n,o,p,s,t	a,b,i	a,b,c,e,g,i,k,l,t	b,e	a,d,m,n,p,q,r,s,t,u,v
Nectariniidae	*Anthreptes malacensis*[1]	a,u				
	Cinnyris jugularis[1]	Ex. c,d,g,h,i,l	a,e,i	a,b,c,e,h,i,s,t,u	a,d,e,f	a,b,d,e,h,k,m,n,r,t,u,q,v
	Arachnothera longirostra[1]	a,u				
Zosteropidae	*Zosterops palpebrosus*	a,b,u		a,b,c,g		d,q,r
Estrildidae	*Lonchura leucogastroides*	a,e,j,l,o,r,s,t,u	Ex. c		c,d,e	r
	Lonchura punctulata	a,j,l,n,u	e,f,h		a,b,f	a,d,o,q,u,v,w
	Lonchura maja	a,q	a			d,q
Ploceidae	*Passer montanus*	All	All	All	All	Ex. a,h,i,j,o,v
Sturnidae	*Acridotheres javanicus*	r		i	a,b	m
Oriolidae	*Oriolus chinensis*	a,u				
Dicruridae	*Dicrurus macrocercus*	a		b,h,i		r,s,u,v
	Dicrurus leucophaeus	a				
Artamidae	*Artamus leucorhynchus*	n		g		v
Corvidae	*Corvus enca*	u				a,b

Note: [1] Protected; [2] The CITES Appendix II; [3] The IUCN Red List. Study site description: See Table 1. All= All location, Ex=Exclude location

Habitat association

Analysis of site area on bird species richness showed a positive correlation value, which means that the area has a positive effect on bird species richness. The wider the location, the higher the bird species richness. This value exists for all city locations (Table 2; Figure 3). The P-value for all analysis was <0.05, meaning that area had a significant effect on bird species richness.



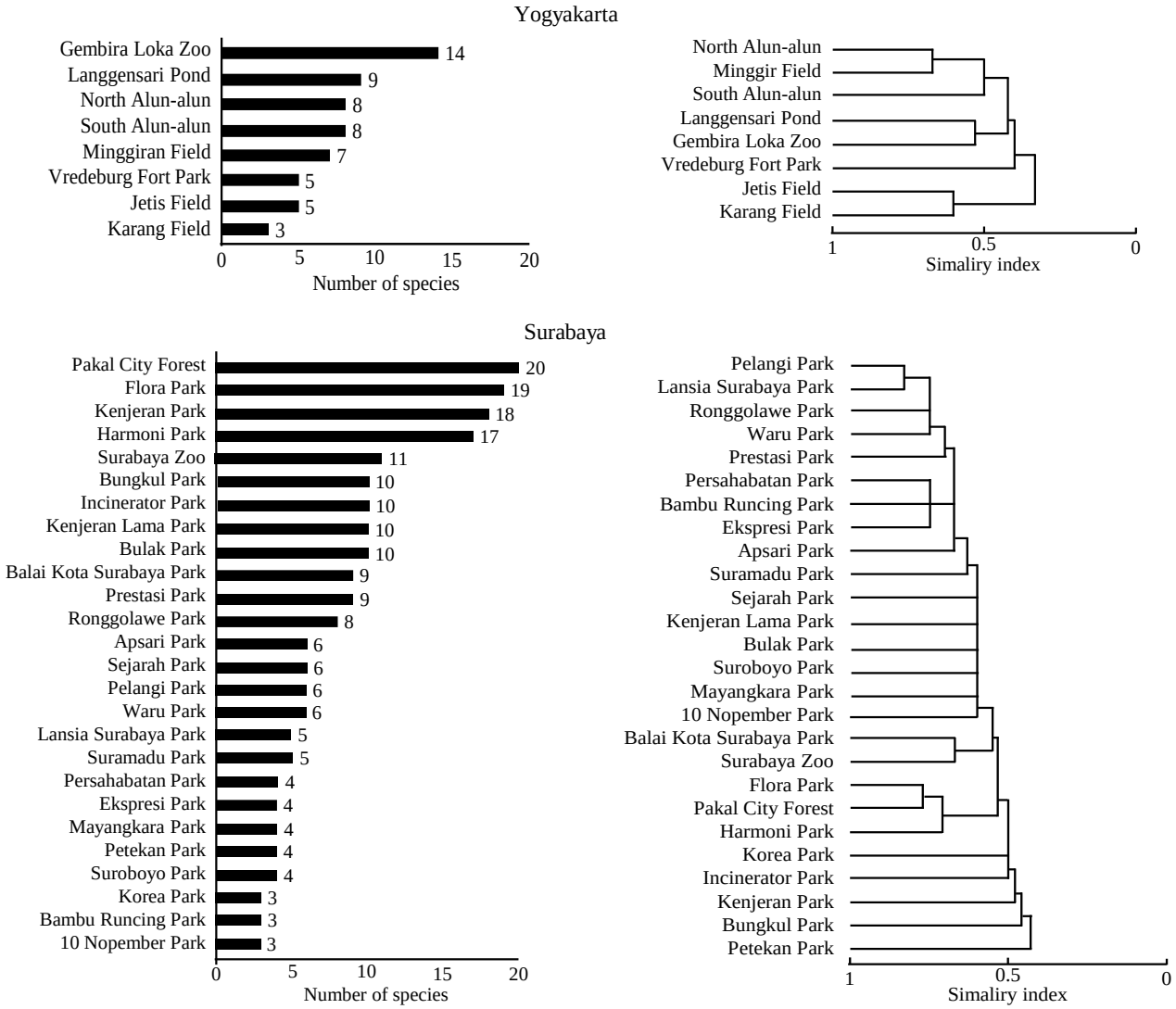


Figure 2. Number of bird species richness (*left*) and dendodram of bird community similarity (*right*)

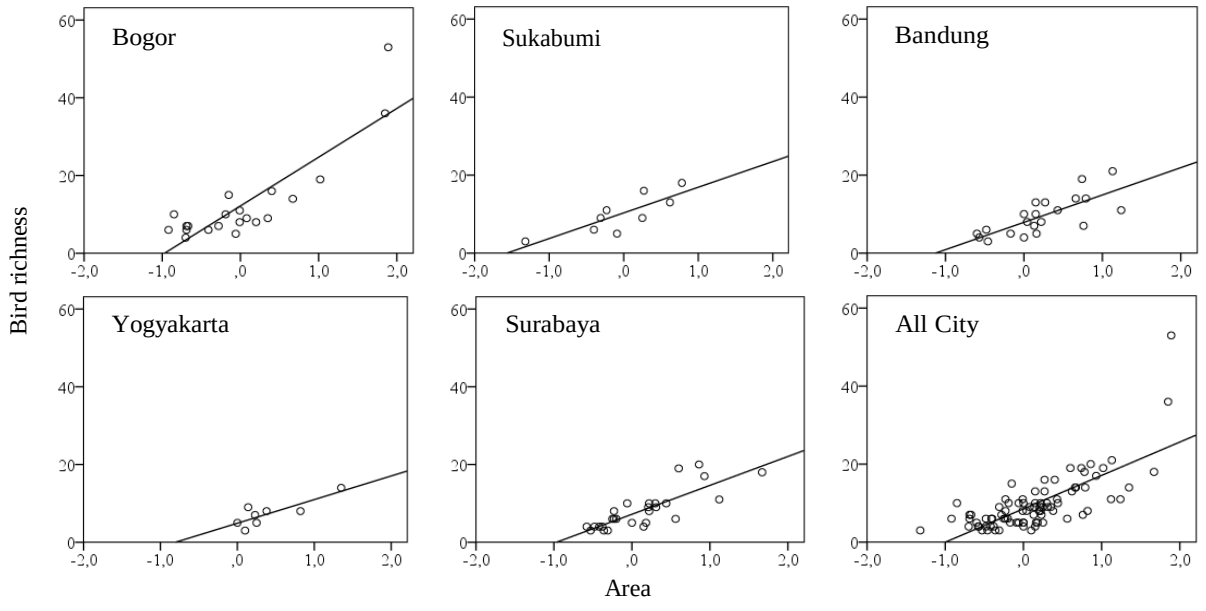


Figure 3. Graph of correlation between site area and bird species richness

Table 2. Correlation value between site area and bird species richness

City	Correlation (r)	Formula	P
Bogor	0.858	12.17 + 12.54 area	0.000
Sukabumi	0.824	10.31 + 6.58 area	0.006
Bandung	0.749	7.90 + 7.01 area	0.000
Yogyakarta	0.829	4.89 + 6.01 area	0.011
Surabaya	0.818	7.19 + 7.44 area	0.000
All-City	0.730	8.54 + 8.56 area	0.000

Habitat utilization by bird

In general, birds use the habitats for food sources, water, shelter, and cover. Several vegetation species produce bird food, namely fruit (banyan, palm), seeds (grass), and nectar (orchid tree, false bird of paradise, peacock flower, bird's cherry). In addition, aquatic habitats in the form of rivers and lakes/ponds are a source of food for fish and aquatic insects. Insects are a source of feed, which is also found in the research sites.

A small proportion of the birds found were known to use the habitat for nesting. There are seven species build nests, namely *Nycticorax nycticorax* (Bogor Botanical Garden and Bandung Zoological Garden), *Geopelia striata* (Harmoni City Forest Surabaya), *Psittacula alexandri* (Ganesha Park Bandung), *Pycnonotus aurigaster* (Minggiran Field Yogyakarta, Pakal City Forest Surabaya and Flora Park Surabaya), *Dicaeum trochileum* (Pakal City Forest Surabaya), *Lonchura leucogastroides* (Cikondang Park Sukabumi and Sugema Park Sukabumi), *Lonchura punctulata* (Cikondang Park Sukabumi), and *Lonchura maja* (Digital Park Sukabumi). *Geopelia striata* is known to make use of artificial nests installed by humans in Harmoni City Forest Surabaya.

The encounter for birdwatching

Most of the bird species, 74 species (98%) are resident, only one species are migrant species, namely *Merops philippinus*. The species of migratory raptors were not found in all research sites. Most bird species are easy to find visually. Only a few birds are difficult to be seen directly, like the ones that belong to Capitonidae and Sylviidae families that often make sounds. In general, shorebirds are found resting or foraging in sand and mud. It is very rare for shorebirds to be found perching in vegetation. Meanwhile, all Apodidae (swift and swiftlet) were only found flying in the air, never perching on tree branches, including during their feeding and collecting nest material.

Most of the bird species only found in an individual or small groups of less than ten individuals. Several species are sometimes found in groups with more than ten individuals, including *Nycticorax nycticorax*, *Psittacula alexandri*, *Pycnonotus aurigaster*, *Collocalia linchi*, *Apus nipalensis*, *Lonchura leucogastroides*, *Lonchura punctulata*, *Lonchura maja* and *Passer montanus*.

Discussion

The bird species richness found in all study locations constituted 21.3% of the total bird species recorded in Java (Sukmantoro et al. 2007). The present only part of Java's bird species is due to the relatively narrow study area compared to the entire area of Java island, and the research sites are only an urban landscape. Although the urban landscape is a habitat used by birds, the disadvantage of urban landscape chosen as research site is it have a lower bird species richness than natural landscapes. Ayat and Tata (2015) found that forest areas had higher bird diversity than outside forest areas in North Sumatra. Similar results were also obtained by Kontsiotis et al. (2019) in Greece. The richness of birds in urban landscapes is also lower than in rural landscapes as found by Tu et al. (2020) in Taiwan, Carvajal-Castro et al. (2019) in Colombia, Pal et al. (2019) in India, and Clergeau et al. (2006) in Europe.

The birds encountered in this study differ from previous studies in the same city. There were birds that were previously found, but in this study, they were not found. Likewise, the opposite happens. Differences can be caused by the timing of the study as well as the coverage of locations. Wahyuni et al. (2018) found 70 birds in Bogor covering the Bogor City and parts of Bogor Regency. Likewise, Kaban et al. (2018) found 75 birds in Bogor, with the observed coverage of all habitat types not limited to urban parks. This research also found some of the birds found by Endah and Partasasmita (2015). Suripto and Badriah (2020) found 22 birds in Yogyakarta public cemetery. Most of these species can be found again in this study, plus other species that were not previously recorded. However, not all birds in the bird list of Yogyakarta City (Taufiqurrahman et al. 2015) were found in this study.

The existence of bird species in the urban landscape means that the urban landscape is an inseparable part of the ecosystem. Although bird species' richness is lower than the richness of bird species in natural and rural landscapes, the urban landscape is part of the conservation synergy. The encounter of protected species which is included in the IUCN Red List category, shows the role of the urban landscape as part of the habitat of wild birds that can provide protection. Currently, conservation is not only focused on natural areas but has also been integrated with non-natural areas as a unit for biodiversity conservation (Sodhi et al. 2010; Goddard et al. 2009), because conservation can support the sustainability of urban development (Kowarik et al. 2020).

Bird species richness in urban landscapes is also not influenced by adjacent landscapes (Clergeau et al. 2001). It can be proved by the fact that the distance between Sukabumi and Gede Pangrango National Park (GPNP) does not affect the richness of bird species in Sukabumi. GPNP is a conservation area of 22.55 km^2 with 250 species of birds (Mulyana et al. 2015), which is located ± 10 km from the center of Sukabumi. The very different habitat composition may be the reason why bird species richness from GPNP to Sukabumi is not affected. The GPNP area is

a protected natural forest, very different from the urban landscape habitat conditions in Sukabumi.

Habitat factors on a local scale have more influence on bird species diversity in urban landscapes than the broad-scale factors. The presence of birds is generally positively correlated with the presence of urban space and negatively correlated with buildings' presence (Fontana et al. 2011, Silva et al. 2015, Gagne and Fahrig 2011). Exposure to noise was the most limiting factor for this bird community in the urban landscape (Pena et al. 2017). Open space is the remaining habitat in the urban landscape; thus, the presence of green open space in urban areas can reduce the loss of bird diversity in urban landscapes (Callaghan et al. 2018) and have a positive effect on bird diversity (Rodrigues et al. 2018).

The location area factor that influences the richness of bird species in the study location is the same as that found by Lazarina et al. (2020), Callaghan et al. (2018), Fadrikal et al. (2015), and Reis et al. (2012). Locations with broader areas tended to have a higher bird species richness as well. The broad area influence on species richness is in accordance with the concept of island biogeography theory proposed by MacArthur and Wilson (1967). The number of species will increase as the area increases; although the increment curve decreases, it remains positive (Lomolino 2001). The increase in the green area of several square meters in urban areas is sufficient to affect the increase in bird species richness (Strohbach et al. 2013). The broad area influence on bird species richness also applies to fragmented habitats (Yu et al. 2012), including urban habitats in general.

Habitat conditions influence bird species richness. The high bird species richness in Bogor and the higher bird species richness in each city are thought to be due to the higher diversity of habitat types compared to other locations. Environmental heterogeneity is an important factor influencing the species richness of various taxa, not just birds, but also provides more ecological niches (Carrasco et al. 2018). High habitat diversity will support high bird species diversity (Leveau 2019). Likewise, plant diversity will have a positive impact on bird diversity (Blinkova and Shupova 2017; Paker et al. 2014). Urban spaces with a higher number of tree species will have more bird species (Fadrikal et al. 2015; Fontana et al. 2011). This is because vegetation has an important role for bird communities in urban landscapes because it provides a function for food and shelter (Sulaiman et al. 2013). The ability to gain the required nutrients in urban habitats is a key trait of successful urban birds (Coogan et al. 2018).

The distance from the city center also affects the diversity of bird species. The bird richness increases with increasing distance from the city center (Jokimaki and Kaisanlahti-Jokimaki 2003). This phenomenon generally occurs in all cities, that the species richness of birds existing in urban areas is higher than those in the city center. However, this phenomenon does not occur in Bogor Botanical Gardens, which is located in the city center but has the highest bird richness. The age of the city park is assumed as the cause of these different phenomenons to occur. Park age affects the high species richness of birds, as Zivanovic and Luck (2017) found that the older urban space is the higher bird diversity. Loss et al. (2009) also found that housing age was a positive correlate of bird species.

In general, urbanization has had a negative impact on bird species richness. Urban landscapes have less bird species richness than non-urban areas (Reis et al. 2012). Urbanization, in general, has an impact on species uniformity (McKinney 2006) and, in particular, has an impact on decreasing the richness and the uniformity of bird species (Ibanez-Alamo et al. 2017). Urbanization has also had a homogeneous impact by reducing birds' flocks that favor scrub habitats (Clergeau et al. 2006). This situation is in line with that found in the research site that the composition of the bush birds group is very low, only a few species remained, namely *Pellorneum capistratum*, *Malacocincla sepiarium*, *Orthotomus sutorius*, and *O. sepium*. In urban landscapes, the majority of species found belong to the arboreal birds group. Homogeneity causes the diversity of bird species in urban landscapes is relatively low and low in variety. Though in the urban landscape, increasing the volume of understorey vegetation and the percentage of native vegetation had uniformly positive effects (Threlfall et al. 2017).

Bird species that are commonly seen in urban landscapes generally are groups of birds with the capability to adapt to urban habitats. Bird species that are widely distributed in the urban landscape can be called urban exploiter, while those that are scattered in an intermediate distribution are referred to as urban adapters, the rest that is narrowly distributed is called urban avoiders (Mardiastuti et al. 2020). Dominant bird species encountered, similar to that found by Ghifari et al. (2016) in Semarang, Central Java's Capital, such as *Collocalia linchi*, *Passer montanus*, *Pycnonotus aurigaster*, and *Streptopelia chinensis*.

The low diversity of bird species in urban landscapes does not mean that urban landscapes are not attractive destinations for birdwatching. The low variety of bird species in urban landscapes may not appeal to specialist birdwatchers, but may still appeal to generalist birdwatchers. In general, the existence of birds in urban landscapes has long been used as objects of birdwatching as seen from birdwatcher data in the United States, that 41 of 48 million birdwatchers in the United States do birdwatching in their home environment (Carver 2013). Recent research related to the current state of the COVID-19 pandemic has shown a change in behavior to choose a birdwatching location closer to a living location or house (Randler et al. 2020). Therefore, the bird species richness in urban landscapes is an attractive potential as an object of birdwatching. The utilization of urban parks for birdwatching was also done in Beijing (Zhang and Huang 2020), which found a link between the number of birdwatching activities and several aspects of the park such as its size, age, distance to the city center, and accessibility. The larger, older, nearer, and more accessible the park, the higher the birdwatching number. If these factors being used and compared to research sites, then the locations with high potential in each city in Indonesia are Bogor Botanical

Gardens, Cikundul Agrotourism Area, Bandung Zoological Garden, Gembira Loka Zoo, and Pakal City Forest.

Birdwatching in the urban landscape is also expected to provide environmental education value, especially for the younger generation, children, and society in general. Birds used by White et al. (2018) in England as an object of study related to the awareness of school students. Birdwatching has also become an integrated part of school lessons in Turkey (Can et al. 2017). Research by Gunnarsson et al. (2017) showed that people with nature orientation would have better perceptual values regarding the relationship between trees and plants and birds in green urban spaces compare to people who are not oriented towards nature. High interaction with urban forest on children had a different effect from children with low interaction with urban forest (Sampaio et al. 2018). This effect can be seen through better knowledge and well-informed of native animals in urban forests. These results indicate that interactions with urban forests, in this case, birdwatching, can be a starting point for increasing public knowledge in general and children in particular about the existence of urban forests and bird components as part of the ecosystem. In general implementing species, knowledge in early childhood education promotes an interest in the natural world. It may form a significant contribution to nature and sustainability education for early childhood teachers to further teach the children (Wolff and Skarstein 2020).

In conclusion, there were 75 species found in the research sites; these birds have used the urban landscape as their habitat. Bogor is the city with the highest numbers of birds, and Bogor Botanical Garden is the site with the most birds. Most species of birds are resident birds; thus they can be found all year round. The existence of birds in urban landscapes is an object of birdwatching close to human residence; therefore, it is more accessible and easier to birdwatching here than doing this activity in natural areas. Birdwatching in urban landscapes can provide environmental education value for the community members.

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