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Short Communication: Vegetation and bird diversity in Pesanggrahan's lowland tropical forest, Malang, Indonesia

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Abstract. *Rohman F, Insani N, Purwanto, Dharmawan A, Fardhani I, Akhsani F. 2023. Short Communication: Vegetation and bird diversity in Pesanggrahan's lowland tropical forest, Malang, Indonesia. Biodiversitas 24: 6169-6176.* Universitas Negeri Malang proposes the designation of Pesanggrahan Forest as a Forest Area with a Specific Purpose or *Kawasan Hutan dengan Tujuan Khusus* (KHDTK). This study investigated plant and bird communities in the lowland tropical forest of Pesanggrahan. We observed 31 tree species, with Teak being the most dominant, with a medium level of diversity (H': 1.67) and an uneven distribution (E: 0.48). There were 104 species of shrubs and forest floor plants with a high diversity (H': 3.45) and an even distribution (E: 0.74) and 49 bird species, with some being protected by the Regulation of the Ministry of Environment and Forestry and listed as "vulnerable" or "near threatened" by International Union for Conservation of Nature (IUCN). These findings highlight the importance of the study site for conserving these species and their habitats. The interaction between plants and birds in Pesanggrahan's lowland tropical forest could be preserved by further investigation. This study can serve as preliminary data for future research on the interaction between the plant and bird species in this forest. Therefore, the designation of the forest as a protected area, or KDTK, would help conserve this habitat as one of the last remaining lowland forests on Java Island.

Keywords: Bird community, distribution, diversity, lowland tropical forest, plant community

INTRODUCTION

Indonesia has the second-highest biodiversity in the world. The high biodiversity represents a natural wealth for the country, providing versatile and strategic benefits, and the development and conservation of this biodiversity are important (Anggraini 2018). However, Indonesia's biodiversity is understudied, and its value has yet to be explored, considering its added value. Advances in biodiversity-related science and technology development should be accelerated to obtain optimal benefits. To manage and maintain the high biodiversity, many universities in Indonesia must produce the relevant human resources. Therefore, they should be able to provide their students with sufficient facilities and infrastructure. One of the facilities is a university-managed forest. A university-managed forest can facilitate students and researchers in studying forest ecosystems and biodiversity. There are various types of research results from forests managed by universities in Indonesia (Sataral et al. 2015; Putra 2020; Boer et al. 2021; Nugroho et al. 2021).

Moreover, to produce competent students and conduct qualified studies in forest biodiversity, Universitas Negeri Malang proposes the designation of a forest area as *Kawasan Hutan dengan Tujuan Khusus* (KHDTK), which means Forest Area with a Specific Purpose. The candidate area proposed is the Pesanggrahan Forest. This tropical lowland forest is located in the southern Malang District, East Java, and is in good condition. Therefore, it can potentially be designated as KHDTK for research and education. The other important reason is the drastic reduction in the lowland forest area on Java Island. Most tropical forests are in lowland regions, that is, forests that grow on flat lands at elevations generally less than 1000 m, though the elevation may vary (Mongabay.com 2012). Tropical lowland forests are found in humid regions, often between 10° north and south of the equator, where rainfall is abundant throughout the year, including wet evergreen and moist semi-evergreen forests (explorer.natureserve.org 2022).

Java Island retains less than 2.5% of its natural lowland forests (Lambert and Collar 2002). The conservation of lowland forests is important, as these forests are easily fragmented and converted (Jepson et al. 2001; Lewis et al. 2015; Gogoi and Sahoo 2018; Mikusiński et al. 2018; Kutnar et al. 2019; Loaiza et al. 2019) given their accessibility for human exploitation. In contrast, the tropical lowland forest in Java is a habitat for various rare and protected animals, such as the Javan slow loris, leopard cats, and rare bird species (Sodik et al. 2019; Irawan 2020).

In addition, undisturbed lowland tropical forests are increasingly rare and fragmented, particularly in Southeast Asia, where their extent is already surpassed by secondary forests and agricultural land (Slik 2005). Therefore, its conservation is of paramount importance.

This study aimed to record the biodiversity of the Pesanggrahan Forest, particularly vegetation and bird diversities. Vegetation is integral to soil and atmospheric systems (Piao et al. 2015; Rambey et al. 2021). Birds in an ecosystem play an important role as dispersal agents, indicators of biodiversity, and an indicator determining the status of a conservation area (Hendrayana et al. 2022; Withaningsih et al. 2022). Therefore, an inventory of vegetation and birds can be useful for conservation planning and management strategies for the Pesanggrahan Forest area and ultimately designating it as KHDTK. Furthermore, the biodiversity records are also important to determine this region's research direction. In this context, this study provides the current state of the vegetation and avifauna in the Pesanggrahan Forest.

MATERIALS AND METHODS

Study period and area

A survey was conducted from 11-18 September 2022. The proposed KHDTK Pesanggrahan Forest was located inside both the eastern part of the Kawasan Hutan Lindung Malang Selatan (Southern Malang Protected Forest Area) and a productive forest area (8°23'34"S-8°24'15"S; 112°32'58"E-112°33'42"E). The total area was 95.28 ha, comprising 45.61 ha of protected forest and 49.68 ha of productive forest. This area is located in the village of Srigonco, Bantur, Malang District, at a distance of 66.3 km from Malang City, with a traveling time of approximately 3 hours.

Procedures

Vegetation survey

A vegetation survey was conducted using a combination of cruising and quadratic methods. Sampling plots were determined following the existing path of the forest purposively. We surveyed a total of 30 plots. Figure 1 shows a map of the sampling sites. Following the classification provided by Wyatt-Smith (1963), the plant species were recorded for each community structure in the sampling sites, i.e., trees, poles, saplings, and shrubs. The plots were conditioned for each structure, i.e., for trees and poles, the plot size used was 10×10 m^2, and it was 5×5 m^2 for shrubs. Plant species were identified using identification guidebooks (Backer and Bakhuizen van den Brink 1965).

Bird data collection

The birds were directly observed through individual encounters for each species and from their sounds heard along the observation path (Urfi et al. 2005). The tools used were binoculars, prosumer camera, android cellphones containing field guides for identifying bird species, and Locus Maps (Locusmap.app 2022) to observe the paths crossed, as well as recording devices such as cellphones, notebooks, and pencils.

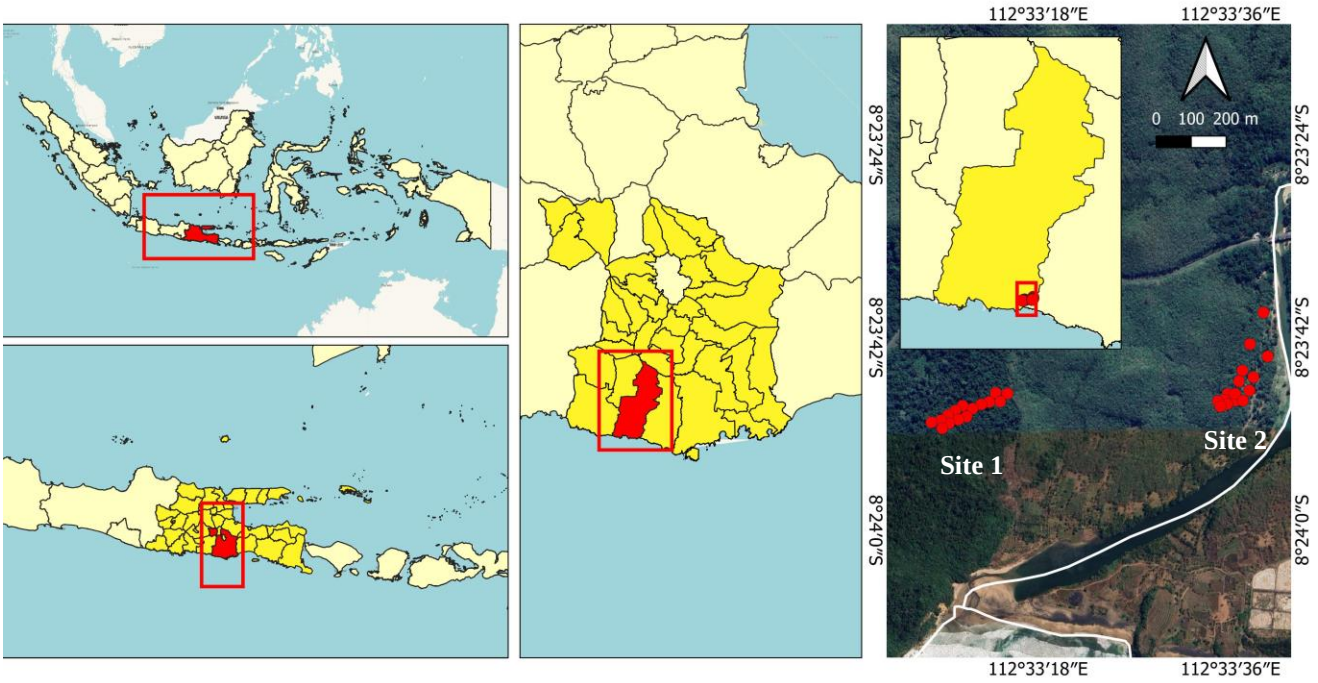

Figure 1. Map of the study area showing the sampling sites (red balloon) for vegetation and avifauna survey at Pesanggrahan Forest, Malang District, Indonesia

Table 1. Categorization of the diversity, evenness, and species richness for the TG and SG

Parameter	Range	Category
Diversity (H')	H'<1	Low diversity
	1<H'<3	Medium diversity
	H'>3	High diversity
Evenness (E)	E<0.3	Community is not even
	0.3<E<0.6	Community is less even
	0.6>E	Community is quite even
Species richness (R)	R<2.5	Species richness is low
	2.5<R<4	Species richness is medium
	R>4	Species richness is high

Data analysis

A vegetation analysis determined the diversity, evenness, and species richness index of the tree group (TG) and shrub, sapling and forest floor plant Species Group (SG). The diversity of the vegetation was represented by the Shannon-Wiener index (H') (Odum 1996; Fardhani et al. 2021). The Shannon-Wiener index can be calculated using the formula:

$$H' = -\sum_{i=1}^{s} (pi \ln pi)$$

The evenness index (E) was used to determine the evenness in the number of individuals that make up a community (Magurran 2004). This index can be calculated from H' as follows:

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

The species richness was determined using Margalef's species Richness Index (R) (Odum 1996) using the formula:

$$R = \frac{(S-1)}{\ln N}$$

Where:

S : Number of species in the community

pi : Proportion of total abundance represented by the ith species

N : Total number of individuals in the samples

Table 1 presents the diversity, evenness, and species richness index categories. The TG and SG's Important Value Index (IVI) was also analyzed. The IVI of each species was calculated by summing the relative density (%), relative frequency (%), and relative abundance (%) of the species (Fathoni et al. 2021).

The observation data on the birds were analyzed descriptively; every encounter was noted and identified. Later, the conservation status was identified based on the Ministry of Environment and Forestry Regulation number P.106/ MENLHK/SETJEN/KUM.1/12/2018 and the IUCN Redlist.

RESULTS AND DISCUSSION

During the study, 31 tree species (TG) were observed in the study site (Table 3). The most dominant species, with the highest IVI, was Teak (*Tectona grandis*) at 133.4. This agrees with previous research, where farmers found Teak to be the dominant tree species to be planted in lowland tropical forests (Caringal et al. 2019). The Diversity Index (H') of the tree species was 1.67, indicating a medium level of diversity. The Evenness Index (E) was 0.48, suggesting that the distribution of the tree community was less even. This uneven distribution pattern is common in tropical forests (Alroy 2017) and may be influenced by various factors, such as the availability of resources and past disturbance events.

The tree community's species Richness Index (R) was 5.05, indicating a high level of species richness (Table 2). This result suggests a diverse tree community at the study site but uneven distributions of the different species. The high species richness of the tree community at the study site may have been due to a wide range of environmental conditions supporting a diverse array of tree species (Gentry 1988). Moreover, the study site is located in a lowland tropical forest, which is known to support a diverse group of tree species (Clark et al. 2019; Osborne et al. 2020; Manaye et al. 2021; Sakai et al. 2022).

There were 104 shrubs, saplings, and forest floor plant Species Group (SG) species. The shrub, sapling, and forest floor plant species group was dominated by *Derris elliptica*, *Corypha utan*, and the saplings of *Leucaena leucocephala* (Table 4). The SG in the study site exhibited a diversity index of 3.45 and was classified as high-diversity. The Evenness Index (E) was 0.74, meaning the distribution of the shrubs and forest floor plant community was quite even. The species Richness Index (R) of the tree community was 15.92, which means that the species richness of the trees was high, with 104 species observed.

The high species richness of the shrub and forest floor plant community at the study site may have been due to a wide range of environmental conditions supporting a diverse array of plant species (Gentry 1988). The environmental condition of Pesanggrahan lowland tropical forest was mixed, comprising productive forest and secondary and primary lowland tropical forests, at a wide range of conditions. This wide range of conditions, such as open gaps and disturbed areas observed in this study site, might lead to abundant shrubs and forest floor species. The conservation of these plant species is important for maintaining ecosystem functions and services provided by the forest, such as nutrient cycling and soil stabilization (Debie and Anteneh 2022). Designating the lowland tropical forest in Pesanggrahan as a protected area helps ensure the conservation of these plant species and their important role in the ecosystem.

We observed 49 species of birds in the study site. Table 5 presents a list of the bird species. Based on their protection status, we found one bird species, namely *Centropus nigrorufus*, protected by the Regulation of the Ministry of Environment and Forestry and listed as Vulnerable (VU) by IUCN; one species (*Eurylaimus*

javanicus) listed as Near Threatened (NT) by IUCN; two species (*Hydrornis guajanus* and *Spilornis cheela*) listed as protected species by the Regulation of the Ministry of Environment and Forestry and listed Appendix II by CITES; one species (*Loriculus pusillus*) listed in the Regulation of the Ministry of Environment and Forestry, listed as NT species by IUCN and also listed in Appendix II by CITES; one species (*Psilopogon javensis*) listed as a protected species by the Regulation of the Ministry of Environment and Forestry and NT by IUCN. This species is often trafficked in Indonesia (Chng et al. 2018).

These findings highlight the importance of the study site for conserving these bird species, some of which are at risk due to various threats such as habitat destruction and illegal trade. Therefore, we emphasize that designating the lowland tropical forest in Pesanggrahan as a protected area helps conserve these species and their habitats.

Our observation regarding the plant and bird communities can serve as preliminary data to investigate the importance of the forest as a habitat for the animal community, including birds. A previous study suggested a strong positive correlation between plant and bird diversities in a lowland tropical forest of Panama (Rompré et al. 2007). Another study showed that bird assemblages in temperate forests correspond more closely with the plant species composition than the vegetation structure (Adams and Matthews 2019). This relationship is believed to be driven by how plant diversity supports bird diversity, including providing food resources, habitat, and other ecosystem services (Brockerhoff et al. 2017). One of the primary ways plant diversity supports bird diversity in lowland tropical forests is by providing food resources. Many bird species rely on fruit, nectar, and insects as a primary source of nutrition, and these resources are provided by a wide range of plant species (Husein and Sultan 2019; Maruyama et al. 2019; Pizo et al. 2021; Shahabuddin et al. 2021; Shafie et al. 2022; Lei et al. 2023). For example, a single tree in a lowland tropical forest may produce fruit consumed by dozens or even hundreds of different bird species (Bascompte and Jordano 2007). Thus, a diverse array of plant species supports a diverse bird community.

Table 2. Important value index (IVI) of the tree group at the study site

Group	Diversity Index (H')	Evenness Index (E)	Species Richness (R)
Tree Group (TG)	1.67	0.48	5.05
Shrub, sapling, and forest floor plant Species Group (SG)	3.45	0.74	15.92

Table 3. Important Value Index (IVI) of the tree group at the study site

Species name	Local name	English name	n	IVI
Tectona grandis	Jati	Teak	236	133.40
Schleichera oleosa	Kesambi	-	40	27.27
Corypha utan	Gebang	Cabbage Palm	8	21.89
Garcinia celebica	Baros	-	9	13.45
Swietenia macrophylla	Mahoni	Mahogany	19	12.16
Pterocymbium tinctorium var. Javanicum	Munung	-	3	10.66
Streblus asper	Serut	Siamese Rough Bush	9	10.64
Vitex pinnata	Laban	-	4	6.94
Alstonia spectabilis	Legaran	Bitterbark	2	6.24
Pterospermum diversifolium	Walangan	-	3	5.68
Diospyros javanica	Kayu Budengan	-	3	5.46
Senna siamea	Johar	Siamese Cassia	6	4.27
Artocarpus elasticus	Benda, Bendo, Kokap	-	1	3.99
Senna multijuga	Mengeng	False Sicklepod	4	3.96
Musa acuminata	Gedang	Banana	10	3.90
Acacia auriculiformis	Kasia	Earleaf Acacia	2	3.21
Dracontomelon dao	Rawu	Pacific Walnut	2	3.21
Mallotus peltatus	Tutupan Peltatus	-	3	2.13
Delonix regia	Flamboyan	Flamboyant	2	1.87
Aphanamixis polystachya	Dandang Gulo	The Pithraj Tree	1	1.82
Pterygota alata	-	Buddha Coconut	1	1.82
Arenga obtusifolia	Langkap	-	1	1.61
Barringtonia racemosa	Beder	Powder-puff Tree	1	1.61
Canthiumera glabra	Kayu Balung	-	1	1.61
Ficus variegata	Gondang	-	1	1.61
Guioa diplopetala	Sampar Kidang	-	1	1.61
Lepisanthes rubiginosa	Kepikan, Kelayu	Mertajam	1	1.61
Parkia timoriana	Kedawung	Tree Bean	1	1.61
Peltophorum pterocarpum	Sogo, Saga	-	1	1.61
Psydrax dicoccos	Kopen	-	1	1.61
Zanthoxylum rhetsa	Geger Boyo	Indian Prickly Ash	1	1.61

Besides providing food resources, the plants in a lowland tropical forest may support bird diversity by providing habitat and nesting sites. Many bird species require specific vegetation types for nesting, and a diverse array of plant species provides these birds with a wider range of options. For example, a study conducted in a neotropical forest showed that removing lianas decreased the total bird abundance by 78.4% and the diversity by 77.4% (Schnitzer et al. 2020). One of the protected bird species found in the study site, the Yellow-throated Hanging Parrot (*Loriculus pusillus*), is known to occupy a mixed garden-tree habitat (Mardiastuti 2019), which is present in Pesanggrahan's lowland tropical forest.

In conclusion, our results suggest that the interaction between plants and birds in Pesanggrahan's lowland tropical forest needs further investigation. Our results can serve as preliminary data for future research on the interaction between the plant and bird species in this forest. Therefore, the designation of the forest as a protected area (KHDTK) would help conserve this habitat as one of the last remaining lowland forests on Java Island.

Table 4. Important value index (IVI) of the shrub, sapling, and forest floor plant species group at the study site

Species name	Local name	English name	n	IVI
Derris elliptica	Jenu	Tuba	164	28.11
Corypha utan	Gebang	Cabbage Palm	74	16.00
Leucaena leucocephala	Lamtoro	River Tamarind	30	7.37
Mallotus rufidulus	Tutup Croton	Mallotus	16	6.57
Bridelia stipularis	Kutu	Climbing Bridelia	14	5.80
*Mimosa pudic*a	Putri Malu	Shameplant	31	5.71
Orophea hexandra	Kalak Tiripan	-	8	4.88
Syzygium littorale	Jambu Alas	-	16	4.75
Drypetes teysmannii	Balungan	-	8	4.42
Tetracera scandens	Kasapan	-	17	4.00
Ficus septica	Awar-Awar	-	14	3.99
Mitrephora polypyrena	Kalak Jombor	-	6	3.66
Wollastonia biflora	Wedelia, Seruni Laut	Sea Daisy	14	3.53
Centrosema pubescens	Kacangan	Butterfly Pea	6	3.20
Licuala rumphii	Palm Kol Sulawesi	-	15	2.78
Chromolaena odorata	Kirinyuh	Jack in The Bush	9	2.76
Pterospermum diversifolium	Walangan	-	5	2.59
Carapichea ipecacuanha	Akar Ipeka	-	10	2.46
Capparis micracantha	Sanex	Caper shrub	7	2.45
Buchanania arborescens	Poh Pohan	Sparrow's Mango	4	2.44
Myxopyrum nervosum	Suson	-	4	2.44
Leea angulata	Girang	-	6	2.29
Drynaria quercifolia	Paku Berang-Berang	Oakleaf Fern	5	2.14
Microcos tomentosa	Talok	-	5	2.14
Cenchrus purpureus	Kolonjono	Napier Grass	10	2.00
Cleistanthus brideliifolius	Kandri	-	4	1.98
Glochidion obscurum	Dempul Lelet	-	4	1.98
Memecylon caeruleum	Memecylon, Delek Jambu	-	4	1.98
Litsea glutinosa	Adem Ati	Bollywood	3	1.83
Solanum spirale	Lengki	-	3	1.83
Streblus asper	Serut	Siamese Rough Bush	3	1.83
Barringtonia racemosa	Beder	Powder-puff Tree	5	1.68
Mallotus peltatus	Tutupan Peltatus	-	5	1.68
Lygodium circinnatum	Paku Hata	-	4	1.53
Alstonia spectabilis	Legaran	Bitterbark	3	1.37
Ixora smeruensis	Suko	-	3	1.37
Rivina humilis	Getihan	Bloodberry	5	1.23
Canarium hirsutum	Kenari Hutan, Kacangan	-	2	1.22
Dracaena elliptica	Pleomale Eliptica	-	2	1.22
Ficus hispida	Luwingan	the opposite leaf fig	2	1.22
Flagellaria indica	Wawo	-	2	1.22
Flemingia strobilifera	Hahapan	Wild Hops	2	1.22
Hyptis capitata	Knop Hijau	Knopweed	2	1.22
Melanolepis multiglandulosa	Tutup Melanolepis	-	2	1.22
Murraya paniculata	Kemuning	Orange Jessamine	2	1.22
Uvaria grandiflora	Gedangan, Kalak Liana	-	2	1.22
Vitex pinnata	Laban	-	2	1.22
Ziziphus javanensis	Sisipan Jaran	-	2	1.22
Other species (56 species)	-		80	37.82

Table 5. Bird species observed in the study site and its protection status

Bird species			Protection status		
Scientific name	**Local name**	**English name**	**Permen LHK No. P.106/ MENLHK/ SETJEN/ KUM.1/ 12/ 2018**	**IUCN***	**CITES**
Aegithina tiphia	Cipoh Kacat	Common Iora	-	LC	-
Alcedo coerulescens	Raja Udang Biru	Cerulian Kingfisher	-	LC	-
Alcedo meninting	Raja Udang Meninting	Blue Eared Kingfisher	-	LC	-
Anthreptes malacensis	Burung Madu Kelapa	Brown-throated Sunbird	-	LC	-
Apus nipalensis	Kapinis Rumah	House Swift	-	LC	-
Arachnothera longirostra	Pijantung Kecil	Little Spiderhunter	-	LC	-
Artamus leucorynchus	Kekep Babi	White-breasted Woodswallow	-	LC	-
Brachypodius atriceps	Cucak Kuricang	Black-headed Bulbul	-	LC	-
Cacomantis merulinus	Wiwik kelabu	Plaintive Cuckoo	-	LC	-
Centropus bengalensis	Bubut Alang-alang	Lesser Coucal	-	LC	-
Centropus nigrorufus	Bubut Jawa	Sunda Coucal	Protected	VU	-
Chalcophaps indica	Delimukan Zamrud	Common Emerald Dove	-	LC	-
Cinnyris jugularis	Burung Madu Sriganti	Olive-backed Sunbird	-	LC	-
Collocalia linchi	Walet Linchi	Cave Swiftlet	-	LC	-
Dendrocopos moluccensis	Caladi Tilik	Sunda Pygmy Woodpecker	-	LC	-
Dicaeum trigonostigma	Burung Cabai Bunga Api	Orange-bellied Flowerpecker	-	LC	-
Dicaeum trochileum	Cabai Jawa	Scarlet-headed Flowerpecker	-	LC	-
Dicrurus macrocercus	Srigunting Hitam	Black Drongo	-	LC	-
Eurylaimus javanicus	Sempur Hujan Rimba	Banded Broadbill	-	NT	-
Geopelia striata	Perkutut Jawa	Zebra Dove	-	LC	-
Halcyon cyanoventris	Cekakak Jawa	Javan Kingfisher	-	LC	-
Hemiprocne longipennis	Tepekong Jambul	Grey-rumped Treeswift	-	LC	-
Hemipus hirundinaceus	Jingjing Batu	Black-winged Flycatcher-shrike	-	LC	-
Hirundo striolata	Layang-Layang Loreng	Striated Swallow	-	LC	-
Hirundo tahitica	Layang-Layang Batu	Pacific Swallow	-	LC	-
Hydrornis guajanus	Paok Pancawarna	Javan Banded Pitta	Protected	LC	Appendix II
Hypothymis azurea	Kehicap Ranting	Black-naped Monarch	-	LC	-
Lonchura leucogastroides	Bondol Jawa	Javan Munia	-	LC	-
Loriculus pusillus	Serindit Jawa	Yellow-throated Hanging Parrot	Protected	NT	Appendix II
Malacocincla sepiarium	Pelanduk Semak	Horsfield's Babbler	-	LC	-
Orthotomus sepium	Cinenen Jawa	Olive-backed Tailorbird	-	LC	-
Orthotomus sutorius	Cinenen Pisang	Common Tailorbird	-	LC	-
Pericrocotus cinnamomeus	Sepah Kecil	Small Minivet	-	LC	-
Psilopogon australis	Takur Tenggeret	Yellow-eared Barbet	-	LC	-
Psilopogon haemacephala	Takur Ungkut-ungkut	Coppersmith Barbet	-	LC	-
Psilopogon javensis	Takur Tulung-tumpuk	Black-banded Barbet	Protected	NT	-
Ptilinopus melanospilus	Walik Kembang	Black-naped Fruit Dove	-	LC	-
Pycnonotus aurigaster	Cucak Kutilang	Sooty-headed Bulbul	-	LC	-
Pycnonotus goiavier	Merbah Cerukcuk	Yellow-vented Bulbul	-	LC	-
Pycnonotus plumosus	Merbah Belukar	Olive-winged Bulbul	-	LC	-
Rhamphococcyx curvirostris	Kadalan Birah	Chestnut-breasted Malkoha	-	LC	-
Rubigula dispar	Cucak Kuning	Ruby-throated Bulbul	-	VU	-
Spilornis cheela	Elang Ular Bido	Crested Serpent Eagle	Protected	LC	Appendix II
Streptopelia bitorquata	Dederuk Jawa	Sunda Collared Dove	-	LC	-
Streptopelia chinensis	Tekukur Biasa	Spotted Dove	-	LC	-
Timalia pileata	Tepus Gelagah	Chestnut-capped Babbler	-	LC	-
Todiramphus chloris	Cekakak Sungai	Collared Kingfisher	-	LC	-
Treron griseicauda	Punai Penganten	Grey-cheeked Green Pigeon	-	LC	-
Turnix suscitator	Gemak Loreng	Barred Buttonquail	-	LC	-

Note: *LC: Least Concern; NT: Near Threatened; VU: Vulnerable

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