

DIVERSITY OF BIRDS ACROSS LAND USE AND HABITAT GRADIENTS IN FORESTS, RUBBER AGROFORESTS AND RUBBER PLANTATIONS OF NORTH SUMATRA

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DIVERSITY OF BIRDS ACROSS LAND USE AND HABITAT GRADIENTS IN FORESTS, RUBBER AGROFORESTS AND RUBBER PLANTATIONS OF NORTH SUMATRA. Birds play a pivotal role in the ecosystem, but in disturbed areas their roles may be limited due to the changes of their natural habitats. This paper studies the birds' habitats in Simalungun and Asahan Districts, North Sumatra. The study was conducted in four habitats: natural forest, rubber agroforests, rubber monoculture plantations and emplacement areas. The birds were observed using descriptive survey methods by implementing a quick biodiversity survey, data were collected along one km transect. The results showed that in total, 142 species of birds from 42 families were observed in the four habitats. Natural forests had the highest diversity of bird species, followed by rubber agroforests, emplacement areas and rubber plantations, with a Shannon-Wiener index of 3.8, 3.6, 3.0 and 2.9, respectively. Regarding the IUCN red list species, 12 bird species of near-threatened status and 2 species of vulnerable status were recorded. Based on CITES categories, one species was listed in the Appendix I, 12 species were classified in Appendix II and 26 bird species were protected under Indonesian regulations. Changes in the structure and composition of the vegetation in disturbed forests and cleared land determined the richness of the bird species. The different tree compositions in the four habitats of the rubber estate plantations and surrounding areas influenced the number of bird species, bird diversity and species composition.

Keywords: Species composition, conservation, CITES, guild type

KERAGAMAN JENIS BURUNG PADA BERBAGAI PEMANFAATAN LAHAN DAN GRADASI DI HUTAN, AGROFOREST KARET DAN PERKEBUNAN KARET DI SUMATERA UTARA. Burung berperan penting dalam ekosistem, namun pada ekosistem yang terganggu peran mereka menjadi terbatas akibat perubahan habitat. Studi komunitas burung di berbagai tipe habitat, pada hutan, agroforest karet, monokultur karet dan daerah pemukiman telah dilakukan di Kabupaten Simalungun dan Asahan, Provinsi Sumatra Utara. Burung diamati dengan melakukan survei deskriptif dengan metode survei cepat biodiversitas, dengan mengkoleksi data pada transek sepanjang 1 km. Hasil studi di keempat tipe habitat menjumpai 142 jenis burung dari 42 suku. Burung yang dijumpai di hutan memiliki tingkat keragaman jenis tertinggi, selanjutnya habitat karet agroforest, daerah pemukiman dan karet monokultur, memiliki tingkat keragaman jenis yang lebih rendah, dengan index Shannon-Wiener secara berturut-turut 3,8, 3,6, 3,0 dan 2,9. Tercatat 12 jenis burung dengan status kelangkaan terancam punah dan dua species dengan status rentan, menurut red-list IUCN. Berdasarkan kategori CITES, tercatat satu jenis burung yang termasuk Appendix I, 12 jenis burung yang termasuk Appendix II, dan 26 jenis burung yang dilindungi berdasarkan peraturan perundang-undangan di Indonesia. Perubahan struktur dan komposisi vegetasi di hutan yang terganggu dan lahan terbuka menentukan kekayaan jenis burung. Perbedaan komposisi jenis pohon di keempat habitat di sekitar perkebunan karet monokultur mempengaruhi jumlah, keragaman, dan komposisi jenis burung.

Kata kunci: Komposisi jenis, konservasi, CITES, relung pakan

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I. INTRODUCTION

Sumatra has the lowest number of endemic bird species in Indonesia. This is related to its geological history of separation from the plains of Asia. Sumatra has about 306 bird species that are also found in Borneo, 345 species that can be found in the Malayan Peninsula and 211 species that also live in Java (MacKinnon & Phillips, 1993). A total of 583 recorded species inhabit the island of Sumatra and 438 species are breeding in Sumatra (Andrew, 1992). These numbers increase to 602 and 450 species, respectively when we include the small islands along the coast of Sumatra. There are 12 endemic bird species in the lowlands of Sumatra (Marle & Marle, 1988).

North Sumatra is covered by natural forests including Batang Gadis, Bohorok, Batang Toru and other forested areas, although most of these forests are fragmented and under considerable pressure from land-use changes (MacKinnon, Phillips, & van Balen, 1998; Sirait, 2007). Human activities change natural environments, such as turning forest into agricultural land, plantations and infrastructure for industrial activities. Forest areas of Sumatra remained at about 30% (13 million ha) of the total area of Sumatra in 2007 (Laumonier et al., 2010). Forest losses cause loss of bird habitat and decrease the number of bird species (Danielsen & Heegard, 1995; O'Brien & Kinnaird, 1996; Lane et al., 2011). Besides hunting and trade, deforestation and habitat destruction are the most dominant drivers in reducing the number of bird species and their possible extinction.

Agroforestry may reconcile ecological and economic objectives, balancing the need to generate income along with protecting the environment (Nair & Garrity, 2012). In 2005, agroforests covered about 16.3 million ha, or 8% of the total area of Indonesia (ICRAF, 2011). Rubber agroforests (RAFs) are part of Sumatra's man-made ecosystem and have been used by farmers for many decades. Farmers with limited resources plant rubber trees within the agroforestry system and manage the farm extensively. Rubber agroforests include a mixture of trees, lianas, shrubs and herbaceous

plants. Monoculture rubber plantations are managed by companies and farmers with greater resources. The basal area of rubber monocultures is lower than that in the natural forest, because there are no large trees in the plantations (van Noordwijk, Tata, Xu, Dewi, & Minang, 2012; Tata, van Noordwijk, & Werger, 2008).

In conservation, it is important to analyse the response of birds to habitat fragmentation and the diversity found in a fragmented habitat, such as rubber monocultures. Bird conservation activities tend to be focused on protected natural forests (NF) and emphasise threatened species faced with extinction, but most of the remaining forest in Sumatra is secondary (Ekadinata & Vincent, 2011). Currently little attention is given to common species or species that inhabit secondary forests and agroecosystems, such as rubber agroforests (RAF) and rubber monocultures (RMP). This paper studies at Simalungun and Asahan Districts, North Sumatra, Indonesia bird richness and diversity, the composition of bird communities and their roles in secondary and primary forests, RAF systems, rubber monoculture (RMP) and emplacement areas (EA) of RMP.

II. MATERIAL AND METHOD

A. Study Area

The study was conducted from December 2010 to January 2011 in four habitat types: NF, RMP, RAF, and EA, in the Districts of Simalungun and Asahan in North Sumatra Province, Indonesia (02°43'4"N and 98°56'25"E) (Figure 1). The EA was located inside the rubber plantations. The RMPs have been intensively managed for many years with regular fertilisation, weeding and tapping, which affected the condition of the vegetation. The rubber stands in the RMP were grouped based on ages: 2-6 years, 12-15 years, and 22-25 years after planting. Two RAF plots were located in the surroundings of the RMPs. RAF plots were managed with less fertilisation and weeding. Other trees were allowed to grow on these farms, creating mixed vegetation of

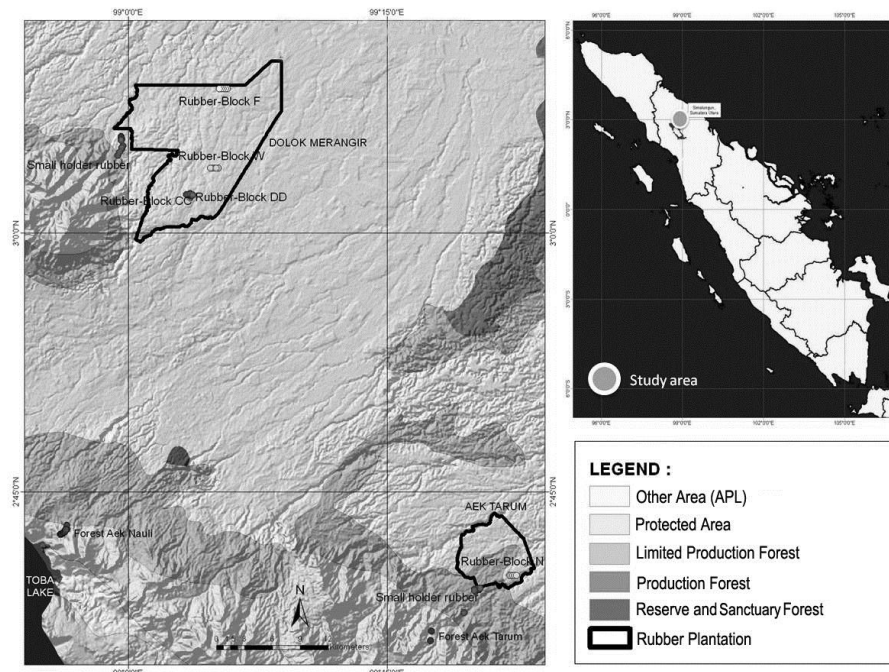


Figure 1. Study sites in Dolok Merangir (Simalungun District) and Aek Tarum (Asahan District), North Sumatra.

simple agroforestry system.

Forest plots were located in two sites: Aek Nauli (Bartong) forest research area in Dolok Merangir, Simalungun District and Aek Tarum forest in Asahan District. The elevation of the forest plots ranged from 1200 m to 1300 m above sea level (asl). The size of the Aek Tarum study area was 79,944.5 ha, and the Dolok Merangir study area was 139,353.93 ha. Each study site included RAFs, RMPs and EAs.

B. Data Collection

The birds were observed by descriptive survey methods using a quick biodiversity survey (QBSur) for birds (Tata et al., 2013), where data were collected along a 1 km transect, in total 12 transects; and from the list of 20 MacKinnon's bird species (MacKinnon & Phillips, 1993) simultaneously in four habitat types (e.g. NF, RMP, RAF, EA). The survey was completed within two weeks. The MacKinnon's list is an established method used to record and verify species and to calculate bird densities. Data was tabulated and birds were identified using this nomenclature (Sukmantoro et al., 2007).

Composition of guilds, which are defined as a group of species using the same resource in the same way, was adapted from Wiens (1989), the threat of fragmentation of bird species refers to Lambert and Collar (Lambert & Collar, 2002), while IUCN status refers to the IUCN Red List (IUCN, 2012).

C. Data Analysis

Comparison of abundance was calculated from the percentage ratio of the individual numbers of a species compared to the total individual number that was caught. Diversity was calculated using the Shannon-Wiener index (Magurran, 1988).

The Shannon-Wiener index was used to determine the diversity of mammal species on each transect (Krebs, 1999) and is described by the following equation:

$$H' = \sum_{i=1}^n -(p_i \ln p_i)$$

where,

H' = Shannon-Wiener diversity index

p_i = Probability of species (relative density)

n = Number of species

Evenness index (E') was used to estimate the evenness of the species distribution of the birds (Krebs, 1999) and is described by the following equation:

$$E' = \frac{H}{\ln s}$$

where,

H' = Shannon-Wiener diversity index

S = Number of species

Each bird species found in the study area was recorded in a list containing the names of the first 20 species encountered, after which a new list of the recording began. This list was used to generate a curve of bird species' richness among different sites. Observations were made twice a day, in the morning from 06:00 to 11:00 and in the afternoon from 15:00 to 17:30 (except on rainy days). Tools used in this activity were binoculars (Bushnell 10 x 25), GPS Garmin Oregon 300, a digital voice recorder (Olympus WS-560M) and a Nikon D80 (70–300 mm Tele Lens). Two field identification guides were used (King, Woodcock, & Dickinson, 1975; MacKinnon & Phillips, 1993).

III. RESULT AND DISCUSSION

A. Bird Richness and Diversity

In total, 142 species of birds from 42 families were recorded across all the areas (Appendix 1). From the total bird species recorded, 122 species were found in the NF, 30 in the RMP, 39 in the EA and 46 in the RAF. A total of 728 individual birds were observed across different habitats. Encountered species richness, abundance, diversity and density are summarized in Table 1 and Figure 2. NF was the most diverse in bird species, indicated by a Shannon-Wiener index of 3.8, followed by RAF (3.6), EA (3.0) and RMP (2.9). All bird species were distributed evenly in every types of habitat, as shown by the evenness index value of almost 1 (ranged 0.87–0.94).

In general, the richness of bird species in North Sumatra was high. Of the 1,589 bird

species found in Indonesia, 583 were found in Sumatra (Andrew, 1992). Rubber plantations and surrounding areas in the two Districts of North Sumatra have 124 of the total bird species of Sumatra or 8.9% of the whole of Indonesia.

The species' richness in Simalungun and Asahan area (142 species) was close to the richness of bird species encountered in Batang Toru (Jihad, 2009). RAF in Bungo, Jambi Province had even higher species richness (167 bird species) (Joshi et al., 2002). For comparison, in the forest habitat of Bukit Barisan Selatan National Park (Jambi-Sumatra), 276 bird species were found (O'Brien & Kinnaird, 1996).

The highest bird species' richness occurs in NF habitat (122 species), followed by RAF (46 species), EA (39 species) and RMP (30 species). Bird species were more diverse at the two NF sites than those in RAFs and RMPs. Although Aek Nauli was categorised as disturbed forest, bird composition was similar to that of the natural forest of Aek Tarum. Bird species richness in the three habitats decreased sharply from 122 species in the forest to 46 species in RAF to only 18 species in RMP (see Table 1).

The number of species in the RMP was the lowest, except along river banks, which have more diverse vegetation. RAF had greater richness of species compared with EA and RMP. Many food trees and trees suitable for nesting were still available in the RAF, such as durian (*Durio zibethinus*), candle nuts (*Aleurites moluccana*) and other fruit trees. RAF provides a compatible bird habitat, with mixed vegetation composed of fruit trees, such as durian (*Durio zibethinus*), duku (*Lansium domesticum*), jengkol (*Pithecellobium lobatum*), mangosteen (*Garcinia mangostana*) and cacao (*Theobroma cacao*). The mixed vegetations attract birds searching for food and nesting materials. In addition, RAFs provide a comfortable habitat, especially for the Helmeted Hornbill (*Rhinoplax vigil*). The bird species in the EA were fewer than those in RAF, although there were some food trees for birds, such as Ficus and other fruit trees.

Bird diversity at a given site may also

Table 1. Statistical summary of birds in the study areas of Simalungun and Asahan Districts, North Sumatra

Habitat Types	Abundance	Species Number	H'	E'
NF	267	122	3.8	0.94
RMP	147	30	2.9	0.88
2–6 yr	49	15	2.5	0.91
12–15 yr	37	18	2.7	0.95
22–25 yr	56	20	2.6	0.87
RAF	103	46	3.6	0.94
EA	211	39	3.0	0.84

Remarks : H' = Shannon-Wiener index, E' = Evenness index

NF = natural forests at a protected forest area in Aek Tarum and a research forest area in Aek Nauli

Rubber Agroforest (RAF) = mixed rubber trees with other valuable trees to form simple agroforestry system

Rubber Monoculture Plantation (RMP) = Young rubber plantation (2–6 years), medium rubber plantation (12–15 years) and older rubber plantation (22–25 years)

Emplacement Area (EA) = Settlement area of a rubber plantation with mixed fruit trees

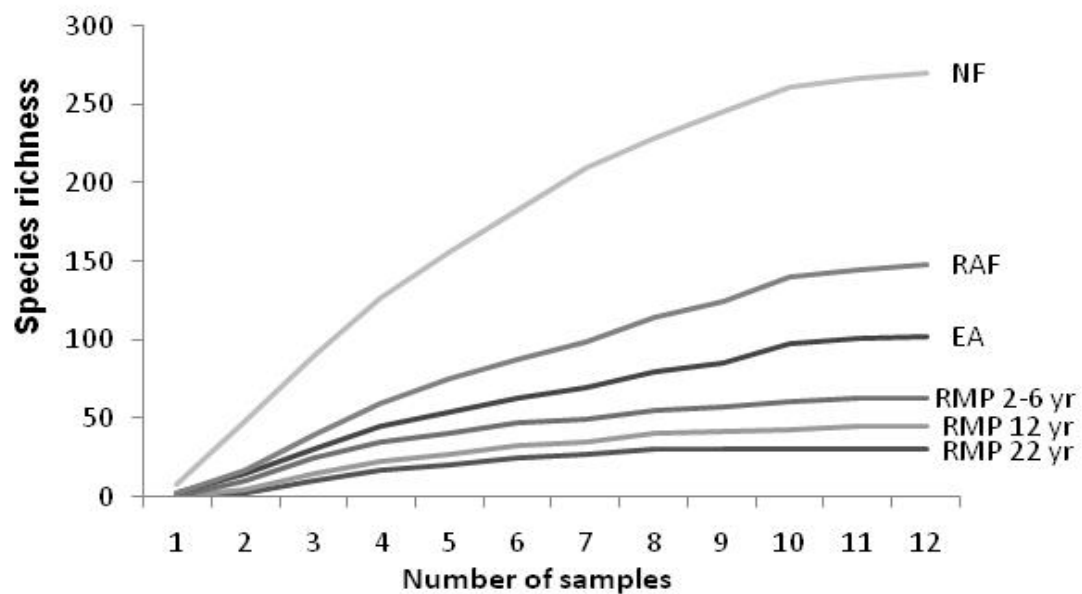


Figure 2. Species accumulation curves by habitat types (Natural Forests=NF, Rubber Agroforests=RAF, Emplacement Areas=EA and 3 differently aged Rubber Monoculture Plantations=RMP)

reflect a high biodiversity of other wildlife in the ecosystem (McNeely, 1988; Yoza, 2000). Bird species diversity in North Sumatra varied between 3.8 in forests to 2.9 in RMP areas. The diversity of bird species depends on environmental conditions. Species diversity decreased in the land use gradient from

NF to RMP, which relates to a decrease in environmental factors, such as structure and composition of the vegetation. Among the four habitats, the basal area of vegetation in RMP was the lowest owing to fewer large trees growing in monocultures. Bird diversity in RMP was categorised as 'middle value', based on

the Shannon-Wiener index. Environmental factors, such as canopy height, diversity of tree species, and crop coverage, determine the diversity of bird species (Welty, 1982). The decline in bird diversity is related to the decline of carrying capacity.

B. Bird Composition

The birds in the ecosystem were classified according to their roles. There were 17 guilds represented: arboreal frugivore (AF), arboreal foliage gleaning insectivore (AFGI), arboreal foliage gleaning insectivore-frugivore (AFGIF), arboreal frugivore-predator (AFP), aerial insectivore (AI), bark gleaning insectivore (BGI), miscellaneous insectivore-piscivore (MIP), nectarivore (N), nocturnal predator (NP), nectarivore-insectivore-frugivore (NIF), piscivore (P), raptor (R), sallying insectivore (SI), sallying substrate gleaning insectivore (SSGI),

terrestrial frugivore (TF), terrestrial insectivore (TI) and terrestrial insectivore-frugivore (TIF) (Figure 3).

The guilds were further categorised, based on feeding habits, into eight groups, namely frugivore, insectivore, nectarivore, nocturnal predator, insectivore-frugivore, piscivore, raptor and omnivore (Figure 4). Bird species composition in the rubber plantation was different from the three other habitats; two feeding groups of birds, i.e. omnivores and nectarivores, were not found. Aratrakorn et al. (2006) also found different bird composition and guild types in forest compared with oil palm and rubber plantation. Nectarivores birds are not found in oil palm and rubber plantations in southern Thailand.

The differences in the guild composition of the open-canopy areas (RMP) and closed-canopy areas (forest) indicated that the RAF

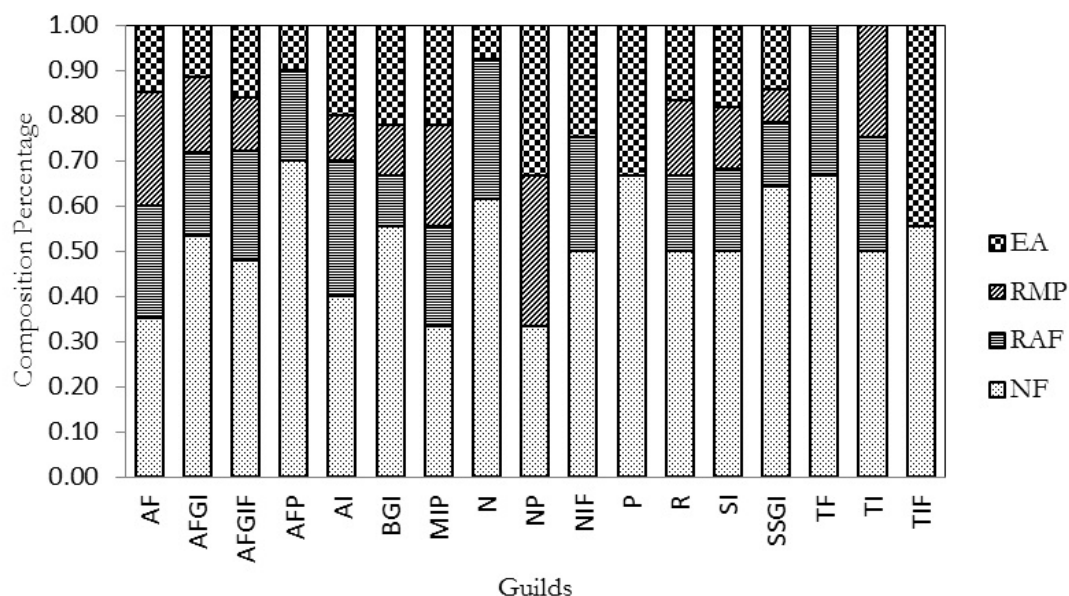


Figure 3. Bird composition guilds according to their roles in four habitats in Simalungun and Asahan Districts, North Sumatra. AF = arboreal frugivore; AFGI = arboreal foliage gleaning insectivore; AFGIF = arboreal foliage gleaning insectivore-frugivore; AFP = arboreal frugivore-predator; AI = aerial insectivore; BGI = bark gleaning insectivore; MIP = miscellaneous insectivore-piscivore; N = nectarivore; NP = nocturnal predator; NIF = nectarivore-insectivore-frugivore; P = piscivore; R = raptor; SI = sallying insectivore; SSGI = sallying substrate gleaning insectivore; TF = terrestrial frugivore; TI = terrestrial insectivore; and TIF = terrestrial insectivore-frugivore

areas were transition areas between forest and RMP, making rubber agroforest the second choice after forests as habitat for bird nesting, foraging, and breeding (Figure 4).

Species that were absent from bird communities in different habitats (forests, RAF, RMP and EA) allowed comparison of habitat function. In general, species composition was dominated by insect-eaters (insectivores) and seed or fruit-eaters (frugivores). Each type of forest, e.g. primary forest at Aek Tarum and secondary forest at Aek Nauli education-forest, contained similar bird species. While RAFs and RMPs held different species compared to both the primary and secondary forests. Groups of insectivores, which were not found in RMPs, play the role as pollinators, as they feed on nectar and transfer pollen at the same time. However, rubber is not pollinated by birds, but usually through controlled pollination by insects

(Warmke, 1952). Rubber monocultures do not provide a suitable environment for specific bird species with particular roles.

The difference in guild composition between open-canopy areas (such as rubber plantations) and closed-canopy areas (such as natural forest) indicate that RAF and smallholder rubber plantations provide a transition area between forests and RMP. Insectivores, frugivores, and nectarivores were commonly found in secondary forests and the more open forest fringes, whereas arboreal frugivores, terrestrial frugivores and bark gleaning insectivores prefer to live in the middle of the forest.

Bird species in North Sumatra as shown in Figure 4 are dominated by the Nectariniidae and Pycnonotidae families. These birds prefer to live in secondary forests, forest edges and settlements (MacKinnon et al., 1998), where insects and nectar are available. Other studies

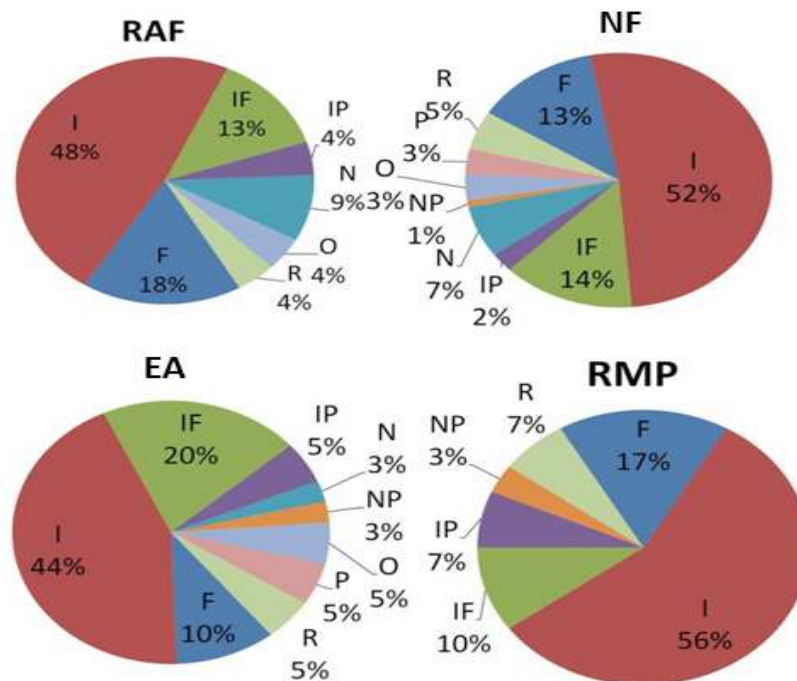


Figure 4. Bird composition guilds based on feeding habitat in four habitat types in Simalungun and Asahan Districts, North Sumatra

Remarks : F = frugivore (AF, AFGI, AFGIF, AFP, TF); I = insectivore (AI, BGI, MIP, SI, SSG, TI); N = nectarivore; NP = nocturnal predator; IF = insectivore-frugivore; (TIF), P = piscivore; R = raptor; and O = Omnivore (NIF)

show that bird communities are usually dominated by a few specific types, which have a high relative abundance, and most other species are much rarer (Karr, Schemske, & Brokaw, 1983; Prawiradilaga, Astuti, Marakarmah, Wijayamukti, & Kundarmasno, 2002).

Based on the guild feeding groups, species' compositions in forests and RAF were relatively similar, dominated by the insectivores and frugivores, and followed by nectarivores, piscivores, raptor and granivores. Bird communities in the study area clearly showed a mix of the species that prefer the central parts of forests (*Picidae*, *Capitonidae*, *Trogonidae*, *Pittidae*) and forest edges (such as *Pycnonotidae*, *Nectariniidae*, *Sylviidae*, *Laniidae*, *Timaliidae*). In the forests, we found frugivores (*Bucerotidae*, *Capitonidae*, *Columbidae*, *Pycnonotidae*, *Decidae* and *Chloropsidae*) suggesting the presence of fruit trees. Fruit trees create a good ecosystem for many species, providing refuge, perches and food.

Rubber monoculture plantations where food is depleted, has less support on birdlife. Therefore, an ecotone such as riparian and emplacement, is important as an intermediary region between two adjacent ecosystems. An ecotone allows various types of life which are better adapted to changes in the environment (Fitri & Ford, 2003). The diversity of bird species in an ecotone is a combination of species from the surrounding areas. Hence, bird species diversity in an ecotone is usually higher than that of the surrounding area (Odum, 1971; Baker, French, & Whelan, 2002).

Bird composition in rubber plantations was clearly different from bird composition in RAF. Only four guild groups of birds were found in RMP: insectivores, frugivores, piscivores and raptors. The other four groups found in the forests were not encountered in RMP. Bird compositions in the three differently aged stands of rubber trees were not significantly different. Bird types were dominated by *Alcedinidae*, *Pycnonotidae*, *Strigidae*, *Apodidae*, *Sylviidae*, *Cuculidae* and *Columbidae*. Insectivorous groups comprised large percentage in plantation areas

and were present in large numbers in all habitat types. We observed insectivore birds, such as Yellow-vented Bulbul (*Pycnonotus goiavier*), Common Tailorbird (*Orthotomus sutorius*), Ashy Tailorbird (*Orthotomus ruficeps*) and Yellow-browed Warbler (*Phylloscopus inornatus*). Various insectivore-piscivore species were abundant in the plantations, like White-throated Kingfisher (*Halcyon smyrnensis*) and Collared Kingfisher (*Halcyon chloris*). There were also groups of nocturnal predators, which play an important role in maintaining the biological balance, such as the Buffy Fish-Owl (*Ketupa ketupu*).

Birds play a role in controlling insect populations, consuming up to one third of their body weight (Hernowo, Soekmadi, & Ekaelawan, 1991) daily. Of the 494 bird species found in Java, 331 (67 %) are insectivorous, with 24 percent of these being primary insectivores, and 76 % secondary insect eaters (Andrew, 1992). Some insects such as Orthoptera (grasshoppers, crickets), Homoptera (leafhoppers, mites) and Heteroptera (ladybugs) are pests on plants, and therefore the insectivore birds play an important biological control in the ecosystem.

Frugivorous birds act as a dispersal agent for plants (Welty, 1982). Nectarivores birds act as pollinators (MacKinnon & Phillips, 1993). Birds also help nitrogen and phosphorus cycles (Odum, 1971). High numbers of large arboreal frugivores were encountered in the rubber plantation, such as Spotted Dove (*Streptopelia chinensis*) and Zebra Dove (*Geopelia striata*). In addition, two groups of birds were found in the ground-cover of the rubber plantation in all stand-ages, namely sallying insectivores and arboreal foliage gleaning-insectivores, such as the Tiger Shrike (*Lanius tigrinus*) and Hill Prinia (*Prinia atrogularis*). Velvet bean (*Mucuna*) as a cover crop provided insect food for these two species.

Different compositions of bird communities were found in the EA. Emplacement sites, which are located inside the RMP, were planted with a variety of large trees. Some trees, such as ficus, pine, palm, banana, mango, rambutan and cocoa and woody-tree species provide

Table 2. Status of birds according to IUCN, CITES and Indonesian law

Scientific Name	English Name	Status		Habitats				
		IUCN ¹	CITES ²	UU/ PP RI ³	NF	RMP	RAF	EA
<i>Ardea alba</i>	Great Egret			AB	#			
<i>Egretta garzetta</i>	Little Egret			AB	#			
<i>Haliastur indus</i>	Brahminy Kite		II	AB	#			
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle		II	AB	#			
<i>Ictinaetus malayensis</i>	Black Eagle		II	AB	#		#	#
<i>Spizaetus cirrhatus</i>	Crested Hawk-Eagle		II	AB	#			#
<i>Spizaetus alboniger</i>	Blyth's Hawk-Eagle		II	AB	#			
<i>Spilornis cheela</i>	Crested Serpent Eagle		II	AB	#	#	#	
<i>Accipiter virgatus</i>	Besra		II	AB		#		
<i>Argusianus argus</i>	Great Argus	NT	II	AB	#			
<i>Treron capellei</i>	Large Green Pigeon	VU			#			
<i>Loriculus galgulus</i>	Blue-crowned Hanging Parrot		II		#		#	
<i>Rhopodytes diardi</i>	Black-bellied Malkoha	NT			#			
<i>Tyto alba</i>	Barn Owl		II					#
<i>Ketupa ketupu</i>	Buffy Fish-Owl		II			#		
<i>Glaucidium brodiei</i>	Collared Owlet		II		#			
<i>Collocalia vulcanorum</i>	Volcano Swiftlet	NT			#			
<i>Harpactes kasumba</i>	Red-naped Trogon	NT		AB	#			
<i>Alcedo meninting</i>	Blue-eared Kingfisher			AB	#			
<i>Halcyon smyrnensis</i>	White-throated Kingfisher			AB	#	#	#	#
<i>Halcyon chloris</i>	Collared Kingfisher			AB	#	#	#	#
<i>Buceros rhinoceros</i>	Rhinoceros Hornbill	NT	II	AB	#			
<i>Rhyticeros undulatus</i>	Wreathed Hornbill		II	AB	#			
<i>Rhinoplax vigil</i>	Helmeted Hornbill	NT	I	AB	#			
<i>Rhipidura javanica</i>	Pied Fantail			AB	#			
<i>Anthreptes simplex</i>	Plain Sunbird			B	#			
<i>Anthreptes singalensis</i>	Ruby-checked Sunbird			AB	#		#	
<i>Anthreptes malacensis</i>	Brown-throated Sunbird			AB	#			
<i>Cinnyris jugularis</i>	Olive-backed Sunbird			AB	#		#	#
<i>Arachnothera longirostra</i>	Little Spiderhunter			AB	#			
<i>Arachnothera affinis</i>	Streaky-breasted Spiderhunter			B	#		#	
<i>Anthreptes malacensis</i>	Brown-throated Sunbird			AB	#		#	
<i>Anthreptes rhodolaema</i>	Red-throated Sunbird	NT		AB	#			
<i>Padda oryzivora</i>	Java Sparrow	VU	II					
<i>Gracula religiosa</i>	Common Hill Myna		II	AB	#	#		
<i>Dicrurus sumatranus</i>	Sumatran Drongo	NT			#		#	#

¹Status based on IUCN; ²CITES; ³Indonesian laws: A = Republic of Indonesia of Act no. 5/1990; B = Regulation of Indonesian Government no. 7/1999

suitable sites for nesting, resting and foraging. The number of birds that like forest edges or open areas increased, such as mynas, barbets,

sparrows, bulbuls, pigeons, cuckoos, doves, prinias, white-eyes, woodpeckers and raptors. Nonetheless, forest-edge is important as a

buffer zone for bird diversity and as an area for the succession process of bird communities (Novarino & Salsabila, 2005).

In the EA, *Ficus* trees were the food source for the frugivores. A total of 23 species of birds from 11 families were recorded in three *Ficus* trees that grew in the emplacement, 17 of which were recorded eating fruit. Barbets and bulbuls were common on *Ficus caulocarpa* and *Ficus microcarpa*, which have relatively small fruits. Large frugivores, such as Imperial Pigeon and hornbills, were not observed in these trees, although they were frequently seen flying overhead. Frugivore birds in the emplacement of RMP in Dolok Merangir were lower than that found in lowland tropical forest in Kuala Lumpur, Malaysia (Lambert & Marshall, 1991). Twenty nine bird species were reported as *Ficus* dispersal agents. *Ficus* forms an exclusive group within the subset of plants with bird-eaten fruit owing to the synchronized fruit ripening of each tree, the relatively short intervals between fruiting seasons, large crop sizes and different fruiting seasons in each population. These factors make *Ficus* an important keystone plant resource (Lambert & Collar, 2002).

Birds are one of the most important seed dispersal agents in tropical forests (Jordano et al., 2007). Plants are food sources for animals and effective seed dispersal may reduce competition between plants and their derivatives, as well as enabling the distribution of plant species to new locations. If there are no animals to disperse the seeds, the seeds will fall on the ground and will grow around the parent tree only, affecting plant regeneration.

C. Prominence of Protected Birds

Bird species encountered in the four habitats were grouped based on their status according to the International Union for Conservation of Nature and Natural Resources (IUCN). Twelve near-threatened (NT) species and 2 vulnerable (VU) species we recorded. Referring to the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), one species was listed in Appendix

I, and 12 species were listed in Appendix II. Regarding Indonesian regulations, under Law no. 7/1999, we found that 26 species were listed as protected species (Table 2).

Nine species of the 24 restricted range species were found. A restricted range species is one with a known breeding area of less than 50,000 km² (Sujatnika, Soehartono, Crosby, & Mardiatuti, 1995) and, by virtue of its small range, is suitable for identifying areas for conservation. It was reported that there were five Important Bird Areas (IBA) in North Sumatra and 24 restricted range species (Holmes & Rombang, 2001).

Some noteworthy bird species that are protected under Indonesian law were encountered in North Sumatra, such as the Great Argus (*Argusianus argus*), Red-naped Trogon (*Harpactes kasumba*), Rhinoceros Hornbill (*Buceros rhinoceros*), Wreathed Hornbill (*Rhyticeros undulatus*), Blue-masked Leafbird (*Chloropsis venusta*), Java Sparrow (*Padda oryzivora*), Sumatran Drongo (*Dicrurus sumatranus*), Finsch's Bulbul (*Criniger finschii*), Large Green Pigeon (*Treron capellei*), Blue-crowned Hanging Parrot (*Loriculus galgulus*), Black-bellied Malkoha (*Rhopodytes diardi*), Volcano Swiftlet (*Collocalia vulcanorum*), Barn Owl (*Tyto alba*), Buffy Fish Owl (*Ketupa ketupu*), Collared Owlet (*Galucidium brodiei*), Helmeted Hornbill (*Rhinoplax vigil*), Buff-necked Woodpecker (*Meiglyptes tukki*), Green Broadbill (*Calyptomena viridis*) and the Common Hill Myna (*Gracula religiosa*).

A number of raptor species were also found in the area, such as the Brahminy Kite (*Haliastur indus*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Black Eagle (*Ictinaetus malayensis*), Crested Hawk-Eagle (*Spizaetus cirrhatus*), Blyth's Hawk-Eagle (*Spizaetus alboniger*) and the Crested Serpent Eagle (*Spilornis cheela*). All these raptors are protected under Indonesian law. Moreover, the high number of raptor birds in this area implies it is a part of their home range. Raptors are known to have a wide home range compared to other bird species. Their prey includes various mammals and reptiles, including squirrels, rats and lizards. The study

Table 3. Number of protected bird species in four habitat types

Habitats	Status		
	IUCN	CITES	UU/PP RI
NF	9	13	26
RAF	1	3	8
RMP	0	4	5
EA	1	3	5

¹Status based on IUCN; ²CITES; ³Indonesian laws: A = Republic of Indonesia Act no. 5/1990; B = Regulation of Indonesian Government no. 7/1999.

area in North Sumatra may provide significant amounts of food. Some bird species (predator and raptor guild types) benefit to agriculture. Predators, like eagles (family: Accipitridae) and owls (family: Strigidae) prey rodents, which are pests to crops and tree crops, such as oil palm. However, there are very few studies of the potential relationship of birds in either natural or agricultural ecosystems.

Number of protected birds based on IUCN status, CITES, and Indonesian regulations are summarized in Table 3. High number of protected bird species found in NF, consecutively followed by RAF, RMP and EA. Forests provide suitable habitat for protected bird species, which can not be replaced by any other habitats.

D. Implications for Conservation

Forest per se is not sufficient to protect bird diversity in a given habitat. Each species of birds occupies a particular habitat in accordance with its needs and plays a certain role in the environment (Mulyani, 1985). The diversity of bird species is affected by a decline in the carrying capacity of the habitat. Changes in vegetation structure and species composition in disturbed forests and cleared land affect on richness of bird species, thus altering composition of bird species. Habitat fragmentation in the study area consisted of patchy forest, RAFs and RMPs which are composed of different species. Forest has the highest index diversity compared with RAF and RMP (Ningsih, Rahayu, & Tata, 2011). Differences in tree composition in the three habitats of North Sumatra affected bird

species richness, diversity and composition. Gonzalez-Oreja et al. (2012) reported there is a positive correlation between tree diversity and bird diversity.

Rapid land-use change and high deforestation are threatening the diversity and conservation status of birds (Rittenhouse et al., 2010). Forest cover in Aek Tarum study area has lost dramatically from 45 018 ha (56.03%) in 1970 to 10 220 ha (12.80%) in 2010 (Said, Ekadinata, & Widayati, 2011). Habitat fragmentation will cause the loss of specialist types (interior species) which includes terrestrial birds. Another consequence of the habitat fragmentation is the presence of edge effects. The area will be occupied by the edge of the bird species that are at risk of ecological disturbance or interference from outside. Degraded and fragmentation areas will impact on the dynamics and meta-population (Wiens, 1989; Lunberg & Moberg, 2003). Our observation showed that bird species in the study area have different tolerances of fragmentation and canopy openings. Some, such as hornbills and woodpeckers, were only encountered in forest habitat, being very sensitive to habitat change. Other species have a wider range of adaptive abilities, such as Pycnonotidae (bulbul), Columbidae (pigeon and dove) and Sylviidae (prinias and wabler), which were found across different land uses.

Implications of forest fragmentation caused three important processes, namely extinction, migration and colonization. Fragmented region will lead to solving the sub-sub-populations and reduces movement (migration) types among

sub-populations thereby increasing the risk of extinction. Separation between sub-populations will decrease colonization opportunities for regeneration (Wiens, 1989; André, 1994). Birds with large territorial requirements, such as raptors, apparently are sensitive to habitat fragmentation.

Birds act as mobile conduits, transferring energy among ecosystems, and contribute to ecosystem functions and resilience with their foraging. Bird-plant interactions like pollination and seed dispersal have a high impact on ecosystems (Lunberg & Moberg, 2003). The pollination process of some tree species is assisted by birds. Nectarivore birds (family: Nectariniidae) that only consume nectar, pollinate some trees species and were encountered in both forests and RAF, but not found in RMP. Four species of nectarivore were found in both forest and RAF, namely *Anthreptes singalensis*, *Cinnyris jugularis*, *Arachnothera affinis* and *Anthreptes malacensis*.

Birds disperse seeds through fruit consumption. Frugivore birds (family: Columbidae and Sturnidae) that only consume fruit, were encountered in the four habitats. Birds disperse seeds of many woody plant species of value to humans for timber, medicine, food and other uses. A number of frugivore birds and those who combine frugivore with other food were encountered in forests, however far fewer frugivores were found in RAF and RMPs.

Large frugivore birds, such as Bucerotidae, were not found in RAF and RMP, as they are very susceptible to anthropogenic and environmental change. Larger fruits require larger birds to carry and disperse the fruit at a distance from the mother trees. A lower density of frugivores birds may result in seedlings being concentrated under the mother trees and not widely dispersed (Wenny et al., 2011), which in turn may decrease tree diversity in the ecosystems.

Birds also contribute to the nutrient cycling in the ecosystems. Aquatic and marine birds produce guano, which is a valuable phosphorous fertilizer (Wenny et al., 2011). Aquatic birds

belonging to the piscivore type that consume fish were found in the forest only (*Ardea* spp. and *Egretta garzetta*). The landscape of the study area consisted of hilly mountains, valleys, and lowlands along the rivershed of Aek Tarum and Sigura-gura of North Sumatra. Forest area concentrated at the hilly mountains (Asahan and Bukit Barisan landscape) for birds' habitat of mountain species up to 700 m asl level such as Silver-breasted Broadbill (*Serilophus lunatus*), Long-tailed Broadbill (*Psarisomus dalhousiae*) and Fire-tufted Barbet (*Psilopogon pyrolophus*). Although piscivores are considered predators, they also contribute to nutrient cycling in their habitats. All birds contribute to maintaining the equilibrium of the food chain in the ecosystems.

When forest habitat is degraded, RAFs become an alternative sanctuary where birds can nest and forage. The vegetation in RAFs provides good carrying capacity for bird diversity. To improve biodiversity in the area it is recommended to preserve intermediary regions, such as along riverbanks and main roads in the RMPs. An intermediary region could be a corridor between one region and another along the border of the RMPs. In such places, planting rubber trees mixed with fruit trees, such as *Ficus*, that could provide habitat for birds is recommended.

IV. CONCLUSION

Natural forests have the highest bird diversity compared with RAFs, RMPs and EAs. Changing natural ecosystems to man-made ecosystems affected bird species' composition and numbers. Habitat loss reduced bird composition, and birds with specialist roles have the highest risk of extinction. Compared with RAFs, RMPs are less suitable for all bird species. Birds provide many ecosystem services, especially regulating and supporting services, which directly and indirectly benefit humans. Efforts to conserve habitats and bird populations will maintain the diverse services provided by ecosystems, thus contributing to human well-being.

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Appendix 1. List of birds found in different habitat types in North Sumatra

Scientific Name ¹	English Name	Guild ²	Status ³		UU/ PP RI ⁵	P		Habitat		
			IUCN	CITES ⁴			NF	RMP	RAF	EA
Ardeidae										
<i>Ardea cinerea</i>	Grey Heron	P				s	#			#
<i>Ardea purpurea</i>	Purple Heron	P				s	#			#
<i>Ardea alba</i>	Great Egret	P			AB	s	#			
<i>Egretta garzetta</i>	Little Egret	P			AB	s	#			
Accipitridae										
<i>Haliastur indus</i>	Brahminy Kite	R		II	AB	s	#			
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	R		II	AB	s	#			
<i>Ictinaetus malayensis</i>	Black Eagle	R		II	AB	s	#		#	#
<i>Spizaetus cirrhatus</i>	Crested Hawk-Eagle	R		II	AB	s	#			#
<i>Spizaetus alboniger</i>	Blyth's Hawk-Eagle	R		II	AB	s	#			
<i>Spilornis cheela</i>	Crested Serpent Eagle	R		II	AB	#	#	#	#	
<i>Accipiter virgatus</i>	Besra	R		II	AB	s	#	#		
Phasianidae										
<i>Lophura inornata</i>	Salvadori's Pheasant	TIF				h+r	#			
<i>Gallus gallus</i>	Red Junglefowl	TIF				h+r	#			
<i>Argusianus argus</i>	Great Argus	TIF	NT	II	AB	h	#			
Turnicidae										
<i>Turnix suscitator</i>	Barred Buttonquail	TIF				s	#			
Rallidae										
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	TIF				s	#			
Columbidae										
<i>Treron capellei</i>	Large Green Pigeon	AF	VU			s	#			
<i>Treron olax</i>	Little Green Pigeon	AF				s	#			
<i>Treron vernans</i>	Pink-necked Green Pigeon	AF				s	#	#	#	#
<i>Macropygia ruficeps</i>	Little Cuckoo Dove	AF				s+h	#			
<i>Streptopelia chinensis</i>	Spotted Dove	AF				s+h	#	#	#	#
<i>Geopelia striata</i>	Zebra Dove	AF					#	#	#	
Psittacidae										
<i>Loriculus galgulus</i>	Blue-crowned Hanging Parrot	AF		II		s	#		#	
Cuculidae										
<i>Cuculus saturatus</i>	Oriental Cuckoo	AFGI				s		#		
<i>Cacomantis sepulchralis</i>	Rusty-breasted Cuckoo	AFGI				h				#
<i>Surniculus lugubris</i>	Asian Drongo-Cuckoo	AFGI				h	#	#		
<i>Eudynamys scolopaceus</i>	Asian Koel	AFGI				h	#			
<i>Rhopodytes diardi</i>	Black-bellied Malkoha	AFGI	NT			s	#			
<i>Rhinortha chlorophaeus</i>	Raffles's Malkoha	AFGI				s	#			
<i>Centropus sinensis</i>	Greater Coucal	TI				s+h	#			
<i>Centropus bengalensis</i>	Lesser Coucal	TI				h	#	#	#	
Tytonidae										
<i>Tyto alba</i>	Barn Owl	NP		II		s				#
Strigidae										
<i>Ketupa ketupu</i>	Buffy Fish-Owl	NP		II		s		#		
<i>Glaucidium brodiei</i>	Collared Owlet	NP		II		s	#			
Apodidae										
<i>Collocalia vulcanorum</i>	Volcano Swiftlet	AI	NT			s	#			
<i>Collocalia fuciphagus</i>	Edible-nest Swiftlet	AI				s				#
<i>Collocalia esculenta</i>	Glossy Swiftlet	AI				s	#	#	#	
<i>Collocalia linchi</i>	Cave Swiftlet	AI				s			#	
<i>Hirundapus caudacutus</i>	White-throated Needletail	AI				s	#			
<i>Apus nipalensis</i>	House Swift	AI				s	#		#	#
Hemiprocnidae										
<i>Hemiprocne comata</i>	Whiskered Treeswift	SI				s	#			#
Trogonidae										
<i>Harpactes kasumba</i>	Red-naped Trogon	SSGI	NT		AB	s+r	#			
Alcedinidae										
<i>Alcedo meninting</i>	Blue-eared Kingfisher	MIP			AB	s	#			
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	MIP			AB	s	#	#	#	#
<i>Halcyon chloris</i>	Collared Kingfisher	MIP			AB	s	#	#	#	#
Meropidae										
<i>Merops leschenaulti</i>	Chestnut-headed Bee-eater	SI				s			#	
<i>Merops viridis</i>	Blue-throated Bee-eater	SI				s	#	#		#
Bucerotidae										
<i>Buceros rhinoceros</i>	Rhinoceros Hornbill	AFP	NT	II	AB	h	#			
<i>Rhyticeros undulatus</i>	Wreathed Hornbill	AFP		II	AB	s+h	#			
<i>Rhinoplax vigil J</i>	Helmeted Hornbill	AFP	NT	I	AB	h+r	#			
Capitonidae										
<i>Psilopogon pyrolophus</i>	Fire-tufted Barbet	AFP				s	#			
<i>Megalaima chrysopogon</i>	Golden-whiskered Barbet	AFP				s	#			
<i>Megalaima oorti</i>	Black-browed Barbet	AFP				s+h	#			
<i>Megalaima haemacephala</i>	Coppersmith Barbet	AFP				s+h	#		#	#
<i>Calorhamphus fuliginosus</i>	Brown Barbet	AFP				s			#	

Scientific Name ¹	English Name	Guild ²	Status ³		P	Habitat					
			IUCN	CITES ⁴		UU/ PP RI ⁵	NF	RMP	RAF	EA	
Picidae											
<i>Picumnus innominatus</i>	Speckled Piculet	BGI				s					#
<i>Picus flavinucha</i>	Greater Yellownape	BGI				s	#				
<i>Dinopium javanense</i>	Common Goldenback	BGI				s	#				
<i>Meiglyptes tukki</i>	Buff-necked Woodpecker	BGI	NT			s	#				
<i>Dendrocopos moluccensis</i>	Sunda Pygmy Woodpecker	BGI				s	#	#	#	#	#
<i>Reinwardtipicus validus</i>	Orange-backed Woodpecker	BGI				s	#				
Eurylaimidae											
<i>Serilophus lunatus</i>	Silver-breasted Broadbill	SSGI				s	#				
<i>Psarisomus dalhousiae</i>	Long-tailed Broadbill	SSGI				h	#				
<i>Calypomena viridis</i>	Green Broadbill	SSGI	NT			h	#				
Hirundinidae											
<i>Delichon dasypus</i>	Asian House Martin	AFGI				s	#	#	#	#	#
Campephagidae											
<i>Pericrocotus divaricatus</i>	Ashy Minivet	AFGI				s	#				
<i>Pericrocotus flammeus</i>	Scarlet Minivet	AFGI				s	#				
<i>Hemipus picatus</i>	Bar-winged Flycatcher-shrike	AFGI				s	#				
Aegithinidae											
<i>Aegithina tiphia</i>	Common Iora	AFGI				s+h	#			#	#
Chloropseidae											
<i>Chloropsis venusta</i>	Blue-masked Leafbird	NIF	NT			s	#				
<i>Chloropsis sonnerati</i>	Greater Green Leafbird	NIF				s	#				
Pycnonotidae											
<i>Pycnonotus atriceps</i>	Black-headed Bulbul	AFGIF				s	#				
<i>Pycnonotus melanicterus</i>	Black-crested Bulbul	AFGIF				s	#			#	
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	AFGIF				s	#	#	#	#	#
<i>Pycnonotus bimaculatus</i>	Orange-spotted Bulbul	AFGIF				s	#				
<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul	AFGIF				s	#	#	#	#	#
<i>Pycnonotus simplex</i>	Cream-vented Bulbul	AFGIF				s	#		#	#	
<i>Pycnonotus erythrophthalmos</i>	Spectacled Bulbul	AFGIF				s	#				
<i>Crinifer finschii</i>	Finsch's Bulbul	AFGIF	NT			s	#				
Laniidae											
<i>Lanius tigrinus</i>	Tiger Shrike	SI				s	#	#	#		
<i>Lanius cristatus</i>	Brown Shrike	SI				s	#				
<i>Lanius schach</i>	Long-tailed Shrike	SI				s	#			#	#
Turdidae											
<i>Brachypteryx montana</i>	White-browed Shortwing	AFGI				h+s				#	
<i>Copsychus saularis</i>	Oriental Magpie-robin	AFGI				s	#	#	#	#	#
<i>Copsychus malabaricus</i>	White-rumped Shama	AFGI				h+s	#		#	#	
Timaliidae											
<i>Malacocincla sepium</i>	Horsfield's Babbler	AFGI				h	#				
<i>Malacocincla abbotti</i>	Abbott's Babbler	AFGI				h	#				
<i>Stachyris rufifrons</i>	Rufous-fronted Babbler	AFGI				h	#				
<i>Macronous gularis</i>	Striped Tit-Babbler	AFGI				h	#				
<i>Garrulax leucolophus</i>	White-crested Laughingthrush	AFGI				h+r	#				
<i>Garrulax lugubris</i>	Black Laughingthrush	AFGI				h+r	#				
Sylviidae											
<i>Cettia vulcania</i>	Sunda Bush-warbler	AFGI				h	#			#	
<i>Prinia atrogularis</i>	Hill Prinia	AFGI				s	#	#	#	#	
<i>Prinia familiaris</i>	Bar-winged Prinia	AFGI				s	#			#	
<i>Orthotomus cuculatus</i>	Mountain Tailorbird	AFGI				s	#				
<i>Orthotomus sutorius</i>	Common Tailorbird	AFGI				s	#	#	#	#	
<i>Orthotomus atrogularis</i>	Dark-necked Tailorbird	AFGI				s	#				
<i>Orthotomus sericeus</i>	Rufous-tailed Tailorbird	AFGI				s	#				
<i>Orthotomus ruficeps</i>	Ashy Tailorbird	AFGI				s	#				#
<i>Phylloscopus inornatus</i>	Yellow-browed Warbler	AFGI				s	#	#	#	#	
<i>Phylloscopus borealis</i>	Arctic Warbler	AFGI				s	#	#	#	#	
<i>Phylloscopus trivirgatus</i>	Mountain Leaf Warbler	AFGI				s	#				
<i>Seicercus grammiceps</i>	Sunda Warbler	AFGI				s	#				
<i>Abroscopus superciliaris</i>	Yellow-bellied Warbler	AFGI				s	#			#	#
Muscicapidae											
<i>Saxicola caprata</i>	Pied Bush Chat	SI				s	#			#	
<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	SI				s	#				
<i>Ficedula hyperythra</i>	Snowy-browed Flycatcher	SI				s	#				
<i>Ficedula westermanni</i>	Little Pied Flycatcher	SI				s	#			#	
Acanthizidae											
<i>Gerygone sulphurea</i>	Golden-bellied Geryone	SI				s+h	#	#			#
Rhipiduridae											
<i>Rhipidura javanica</i>	Pied Fantail	SI			AB	h	#				
Paridae											
<i>Parus major</i>	Great Tit	SI				s					
Dicacidae											
<i>Dicaeum sanguinolentum</i>	Blood-breasted Flowerpecker	NIF				s	#				
<i>Dicaeum cruentatum</i>	Scarlet-backed Flowerpecker	NIF				s	#			#	
<i>Dicaeum trochileum</i>	Scarlet-headed Flowerpecker	NIF				s+h				#	#
<i>Dicaeum trigonostigma</i>	Orange-bellied Flowerpecker	NIF				s					#

Scientific Name ¹	English Name	Guild ²	Status ³		UU/ PP RI ⁵	P		Habitat		
			IUCN	CITES ⁴			NF	RMP	RAF	EA
Nectariniidae										
<i>Anthreptes simplex</i>	Plain Sunbird	N			B	s	#			
<i>Anthreptes singalensis</i>	Ruby-cheeked Sunbird	N			AB	s	#		#	
<i>Anthreptes malacensis</i>	Brown-throated Sunbird	N			AB		#			
<i>Cinnyris jugularis</i>	Olive-backed Sunbird	N			AB	s	#		#	#
<i>Arachnothera longirostra</i>	Little Spiderhunter	N			AB	s	#			
<i>Arachnothera affinis</i>	Streaky-breasted Spiderhunter	N			B	s	#		#	
<i>Anthreptes rhodolaema</i>	Red-throated Sunbird	N	NT		AB	s	#			
Zosteropidae										
<i>Zosterops palpebrosus</i>	Oriental White-eye	AFGI				s	#	#		#
<i>Zosterops everetti</i>	Everett's White-eye	AFGI				s	#			
<i>Zosterops montanus</i>	Mountain White-eye	AFGI				s	#	#		
Estrildidae										
<i>Lonchura striata</i>	White-rumped Munia	TF				s	#			#
<i>Lonchura leucogastroides</i>	Javan Munia	TF				s	#		#	#
<i>Lonchura maja</i>	White-headed Munia	TF				s				#
<i>Padda oryzivora</i>	Java Sparrow	TF	VU	II		s				
Ploceidae										
<i>Passer montanus</i>	Eurasian Tree Sparrow	TF				s				#
Sturnidae										
<i>Acridotheres javanicus</i>	White-vented Myna	AF				s		#	#	#
<i>Gracula religiosa</i>	Common Hill Myna	AF		II	AB	r	#	#		
Oriolidae										
<i>Oriolus chinensis</i>	Black-naped Oriole	AFGIF				s	#	#	#	#
Dicruridae										
<i>Dicrurus macrocercus</i>	Black Drongo	SSGI				s	#	#		
<i>Dicrurus leucophaeus</i>	Ashy Drongo	SSGI				s	#			
<i>Dicrurus remifer</i>	Lesser Racquet-tailed Drongo	SSGI				s+h	#		#	
<i>Dicrurus sumatranus</i>	Sumatran Drongo	SSGI	NT			s	#		#	#
Artamidae										
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	SSGI				s	#			#
Corvidae										
<i>Dendrocitta occipitalis</i>	Sumatran Treepie	AFGIF				s	#			
<i>Corvus enca</i>	Slender-billed Crow	AFGIF				s	#			
<i>Corvus macrorhynchos</i>	Large-billed Crow	AFGIF				s	#		#	#
TOTAL							122	30	46	39

Remarks :

¹Clasification name based on Sukmantoro et al. (2007)

²Clasification of guild composition based on Lambert and Collar (2002): AF=arboreal frugivore, AFGI=arboreal foliage gleaning insectivore, AFGIF= arboreal foliage gleaning insectivore-frugivore, AFP=arboreal frugivore-predator, AI=aerial insectivore, BGI=bark gleaning insectivore, MIP=miscellaneous insectivore-piscivore, N=nectarivore, NP=nocturnal predator, NIF=nectarivore-insectivore-frugivore, P=piscivore, R=raptivore, SI=sallying insectivore, SSGI=sallying substrate gleaning insectivore, TF=terrestrial frugivore, TI=terrestrial insectivore and TIF=terrestrial insectivore-frugivore. AI, N, NIF, SI, MIP, SSGI: This group of birds for age in the air, while flying. BGI: This group for ages in trees, by searching in or disassembling bark. TF, TI, TIF: This group for ages on the ground or the forest floor.

³Status: IUCN=International Union Conservation of Nature, CITES=Convention on the International Trade in Endangered Flora and Fauna, A = Undang-undang RI No. 5/1990; B = Peraturan Pemerintah No. 7/1999

⁴Birds' presence in location survey (P): s=seen, h=heard, r=reported

⁵Habitat: NF (Natural Forest), RAF (Rubber Agroforest), RMP (Rubber Monoculture Plantation), EA (Emplacement Area)