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Avian Diversity in Mt. Matutum Protected Landscape, Philippines

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ABSTRACT

This study was conducted to assess the species diversity and endemism of birds in Mt. Matutum Protected Landscape (MMPL). A combination of mist netting and transect walk methods was done in the six sampling sites of MMPL. Eighty-one bird species belonging to nine orders and 35 families with 35 endemic species consisting of 30 Philippine endemic and five Mindanao endemic (43.21% endemism) were documented. Species richness, abundance, and endemism were recorded to be higher in site 4 (undisturbed lowland dipterocarp forest) while higher species diversity was recorded in site 2 (disturbed montane forest). The Philippine endemic species, *Macronous striaticeps* (brown tit-babbler) was the dominant and most abundant species. Bray-Curtis cluster analysis showed that sites 3 and 6 had the highest similarity percentage (>48%) while Kruskal-Wallis test showed no significant difference between samples in disturbed and undisturbed sites. One vulnerable species, *Ficedula basilanica* (little slaty flycatcher) was recorded in sites 2, 4, and 5. Hunting and conversion of forest to farmland were the observed threats to the birds of MMPL.The presence of vulnerable species, the moderately high number of endemic species, and the presence of disturbance indicate the strong need for protection of the bird fauna and bird habitats in MMPL.

Keywords: biodiversity, birds, endemism, montane forest, lowland dipterocarp forest

INTRODUCTION

The Philippines is a treasure trove of biological diversity (Conservation International, 2011) with high species richness (Steppan *et al.,* 2003) and percentage of endemism than any other biogeographic province in the whole of the Indo-Malayan Realm (Turner *et al.,* 2003). Over 57% of species in the major faunal and floral groups occur nowhere else in the world (Oliver & Heaney, 1996). The Philippines is also identified as one of 17 megadiverse countries (Sampang, 2008) hosting 70%-80% of the world's biodiversity (Haribon Foundation, 2016). However, the high biodiversity and endemism have been put to great pressure because of the different anthropogenic disturbances (Myers *et al.,* 2000). Rapid changes to the natural habitat of flora and fauna are due to agricultural development (Palakova *et al.,* 2011). Many groups of animals are affected because of anthropogenic disturbances (Paz *et al.,* 2013). The Philippines is home to a high diversity of birds with high level of endemism (Haribon Foundation, 2014). Philippine birds consist of 695 species where 241 are endemic, 54 species are vulnerable, 25 endangered, 16 critically endangered (Wild Bird Club of the Philippines, 2018), and 93 are globally threatened (Avibase, 2018a). Thus, the high endemism and number of threatened species of birds in the Philippines call for more effective ways of managing natural resources to conserve this avifauna (Haribon Foundation, 2014). In addition, many of these endemic and threatened birds are restricted to one island or a group of islands and among the islands is Mindanao (Paguntalan *et al.,* 2011).

Mindanao, the second largest island in the country has a total of 418 species of birds with 36 endemic species and 46 globally threatened species (Avibase, 2016b). Birds play many roles as pollinators, predators, seed dispersers, scavengers, and ecosystem engineers (Whelan *et al.,* 2008). Birds are also very useful indicators of species richness and endemism patterns because changes in bird populations provide a useful indication of broad environmental change (BirdLife International, 2013). This reinforces the significant role of the birds in the ecosystem. Hence, regular bird survey is essential in order to provide information that could help us in the conservation and in the improvement of wildlife management in the area.

Several studies on birds have been conducted in Mindanao. Relox *et al.* (2011) documented 53 species in Mt. Hamiguitan and found that bird communities are distributed based on vegetation at increasing elevation in a tropical rainforest. Paguntalan *et al.* (2011) recorded 142 bird species with 68 (47%) endemic in Zamboanga. Cagod & Nuñeza (2012) found 88 species of birds in Agusan del Sur and Compostela Valley. Sucaldito—Salibad & Nuñeza (2014) identified 124 species of birds in Agusan del Sur while Calimpong & Nuñeza (2015) recorded 83 bird species of which 35 (42.17%) are endemic in Bega Watershed, Agusan del Sur. Mohagan *et al.* (2015) in their study on the avifauna in Four Long Term Ecological Research Sites in

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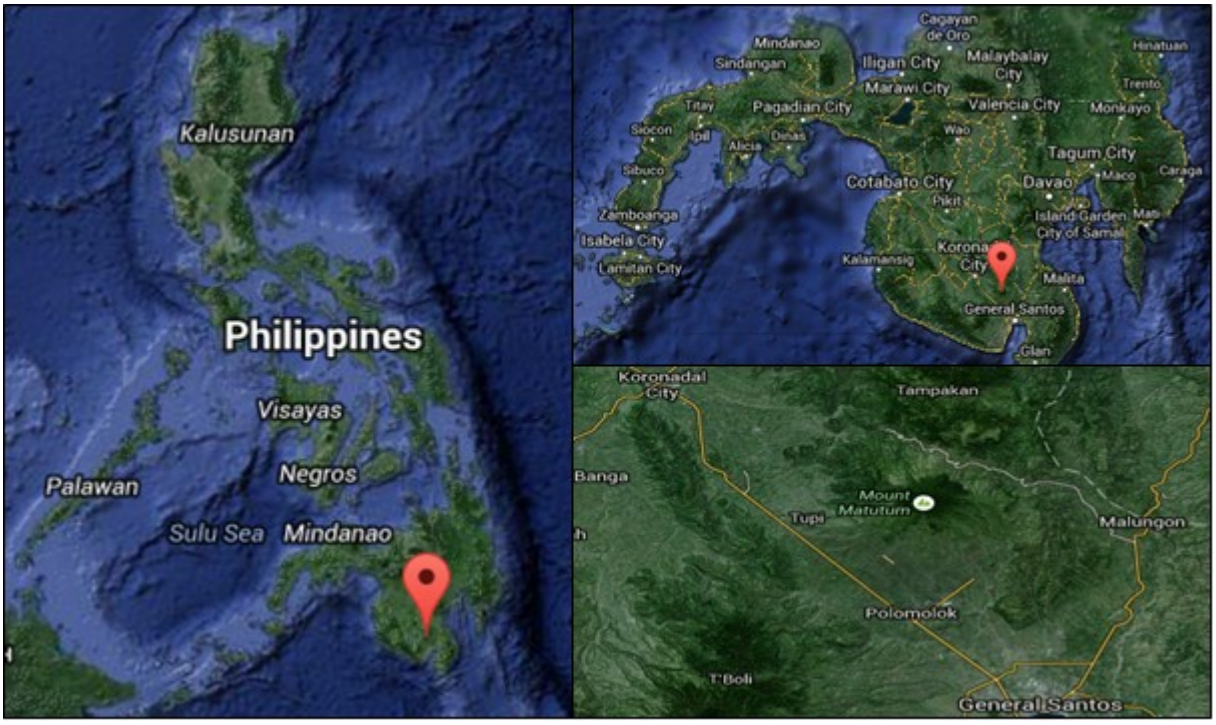

Figure 1. Map of the Philippines (A) and Mindanao (B) showing the location of Mt. Matutum in South Cotabato (C) (Google Maps, 2018).

Mindanao (Mts. Apo, Kitanglad, Hamiguitan, and Malindang) documented 65 bird species and found that each of the four LTER sites showcased a unique avian composition. Despite these studies, the diversity of birds in some of the forests in Mindanao remains poorly studied.

Mt. Matutum, a protected landscape located in Mindanao is one of the mountains in the country which has no published studies in terms of avifaunal diversity despite having forest cover that stands at 1,290 to 2,270m (BirdLife International, 2018). The only published faunal studies in Mt. Matutum were by Garciano *et al.* (2014) on the species richness of spiders and Nuñeza *et al.* (2015) on the species diversity of bats. However, avifaunal information in the area is still wanting. This study was conducted in Mt. Matutum Protected Landscape to assess species richness, diversity, and endemism of birds.

MATERIALS AND METHODS

Study Area

This research was conducted in Mt. Matutum Protected Landscape (MMPL) located in South Cotabato Province (Figure 1) in the southeastern part of Mindanao. Six sampling sites were surveyed of which three sites which are considered disturbed were established at three elevations representing the lowland dipterocarp, montane, and mossy forests while the other three sampling sites identified as relatively undisturbed sites were also established at three elevations.

Sampling Sites

Site 1 was at Upper Linan, Tupi, South Cotabato. The area is known to be a lowland mixed agricultural and secondary forest with elevation range of 500-800 meters above sea level (masl). Sampling was conducted for 55 net days on August 19-23, 2013. Soil is loamy with thin leaf litter. Bodies of water like river and stream were observed in the area. Dominant understory flora was "malaropit" (*Elaeocarpus* sp.) while dominant tree was "buyo-buyo" (*Piper arborescens*). Emergent trees were *Ficus ulmifolia* and *Erythrina subumbrans.* The sampling area was adjacent to a corn field and orchard dominated by fruiting durian trees (*Durio zibethinus*) and coffee.

Site 2 was located at Glandang, Tupi, South Cotabato (6˚21'4.1''N, 125˚3'39.6''E). The area is a montane secondary growth forest with elevation ranging from 1,323 masl to 1,370 masl. Sampling was conducted for 45 net days on October 2-8, 2013. Soil is loamy with dense cover of leaf litter approximately 1.5 inches thick with surface litter at initial stage of decomposition. Presence of small spring with water deposition in the pond was observed. Dominant understory plant was "osmunda" (*Calamus ornatus*) while dominant tree was "anislag" (*Securinega flexuosa*). Emergent tree was white lauan (*Shorea contorta*). Coffee was the most dominant fruiting plant in the area.

Site 3 was located at Glandang, Tupi (6˚21'48''N, 125˚4'15''E). The area surveyed is a mossy forest at elevation of 1600 masl-1714 masl. Sampling was done for 45 net days on December 2-6, 2013. A wide bare loamy ground covered approximately 25% of the sampling area while 25% of the forest floor has dense leaf litter of about 1 to 2 inches thick. Abundance of fallen logs approximately measuring more than 10 cm diameter was observed. Dominant understory plant observed was *Pteridium* sp. while the most dominant and emergent tree was "igim" (*Dacrycarpus imbricatus*). Epiphytes like ferns and wild coffee seedlings were plentiful in the area.

Site 4 was at Sitio Kawit, Barangay Maligo (6˚20'39.4''N, 125˚6'5.3''E), Polomolok, South

Cotabato. The area is a lowland mixed agricultural and secondary forest with elevation of 987-997 masl. Sampling was done for 64 net days on September 9-15, 2013. Substrate is loamy with thin leaf litter. Small riverine system near the lowest elevated sampling station was observed. Dominant understory plant observed was *Impatiens platypetala* while dominant trees were "anabiong" (*Trema orientalis*) and "buyo-buyo" (*Piper arborescens*). Emergent tree species was "taluto" (*Pterocymbium tinctorium*). Few durian trees, other fruit trees, squash vines, and corn were observed.

Site 5 was located at Sitio Kawit, Barangay Maligo, Polomolok, South Cotabato (6˚21'9.9''N, 125˚4'15''E). The area is a montane secondary growth forest with elevation of 1325 masl-1339 masl. Sampling was done for 52 net days on October 13-17, 2013. Soil is loamy with dense cover of leaf litter approximately 1.5 inches thick with surface litter at the initial stage of decomposition. Dominant understory plant observed was *Calamus ornatus* while dominant tree species was *Securinega flexuosa.* Emergent trees observed in the area were "agoho del monte" (*Gymnostoma rumphianum*) and "igim" (*Dacrycarpus imbricatus*).

Site 6 was at Sitio Kawit, Barangay Maligo, Polomolok, South Cotabato (6˚21'21.1''N, 125˚5'8.0''E). The area surveyed is a mossy forest that is partially disturbed with an elevation of 1612 masl-1719 masl. Sampling was done for 40 net days on December 9-13, 2013. Leaf litter was very dense, approximately more than 2 inches thick with surface litter at initial stage of decomposition. A large part of the area was covered with bryophytes. Dominant understory plants observed were "lagulo" (*Blechnum egregium*) and "pandan baging" (*Freycinetia maxima*). The dominant and emergent tree species in the area was "igim" (*Dacrycarpus imbricatus*). Bryophytes were abundant on the bark of trees.

Collection of samples, processing, and identification

Bird survey employed mist netting and transect walk methods. Mist nets were set along flight paths of birds, opened day and night to also catch nocturnal birds, and checked from time to time to retrieve captured specimens. Seventeen mist nets where 15 are understory nets and two are canopy nets were put up covering a total of 70 net days in the first sampling, 59 net days in the second sampling, 59 net days in the third sampling, 60 net days in the fourth sampling, 65 net days in the fifth sampling, and 40 net days in the sixth sampling for a total of 353 net days throughout the entire duration of the sampling. Birds captured were measured for morphometric data and body weight was taken before they were released back to the wild.

For transect method, a 2 km transect line was established. Birds heard and seen within a 100m range were then recorded. A total of 194 hrs of transect walk was done all throughout the sampling broken down into 48hrs in the first sampling, 41hrs in the second sampling, 40hrs in the third sampling, 21hrs in the fourth sampling, 22hrs in the fifth sampling, and 22 hrs in the sixth sampling.

Species were identified using Birds of the Philippines by Kennedy *et al.* (2000) and other published references. Distribution and conservation status was based on IUCN Red List for Threatened Species (2018) while classification into orders and families was based on Avibase (2016c).

Data analysis

Paleontological Statistics Software (PAST) version 3.04 was used to calculate biodiversity indices and perform cluster analysis and Kruskal-Wallis test.

RESULTS AND DISCUSSION

Species richness and endemism

Eighty-one bird species belonging to nine orders and 35 families were recorded in Mt. Matutum Protected Landscape (Table 1). The results are relatively higher compared to the survey conducted by Mohagan *et al.* (2015) in the four LTER sites of Mindanano, Relox *et al.* (2011) in Mt. Hamiguitan, Pagaduan & Afuang (2012) along elevation gradient of Mt. Makiling, Alviola *et al.* (2010) in Malagos Watershed, and Vallejo *et al.* (2009) in Manila's last green spaces. However, the result is relatively lower compared to the survey conducted by Calimpong & Nuňeza (2015) in Bega Watershed, Cagod & Nuňeza (2012) in oil palm plantations of Agusan Del Sur and Compostela Valley, Allen *et al.* (2006) in Babuyan Islands and Sucaldito-Salibad & Nuňeza (2014) in Agusan Marsh. Four species (4.94%) were found to be restricted to site 1, eight (9.88%) in site 2, three species (3.70%) in site 3, 13 (16.05%) in site 4, and one (1.23%) in sites 5 and 6. Order Passeriformes had the highest number of bird species comprising 54 species (66.67%). The same result was obtained by Cagod and Nuňeza (2012) in their bird survey at Agusan del Sur and Compostela Valley where Order Passeriformes has the highest number of bird species. According to Unwin (2011) Order Passeriformes is by far the largest order of birds, comprising close to 6,000 species. In addition, Passeriformes is the largest and most diverse commonly recognized clade of birds having worldwide distribution with representatives in all continents except in Antarctica with greatest diversity in the tropics (Edwards & Harshman, 2013).

Four species (4.82%) were present in all sampling sites of which three are endemic, namely, *Phapitreron leucotis* (White-eared Brown-dove), *Dicaeum australe* (Red-keeled Flowerpecker), and *Pachycephala philippinensis* (Yellow-bellied Whistler). The Philippine endemic, *Macronus striaticeps* (Brown Tit-babbler) was the most dominant and abundant (8.27%) species and was found in all the sampling sites except site 6, an undisturbed mossy forest. This could be due to the high elevation of site 6 which could limit the resource availability of birds like *M. striaticeps*. Goerck (1999) reported that areas with high elevation tend to be structurally less complex, hence reduced microhabitat for many bird species. It was also observed that *M. striaticeps* was the most dominant and abundant species (61 individuals; 13.93%) in site 4, an undisturbed lowland dipterocarp forest. Achondo *et al.* (2011) reported that *M. striaticeps* feeds on caterpillars, weevils, and other insect pests and thus could be the reason for the dominance of this species in site 4 since the area is also a mixed agricultural and secondary forest

Table 1. Avifauna found in Mt. Matutum Protected Landscape, South Cotabato.

Species Name	Conservation status	Distribution status	Disturbed Sites			Undisturbed Sites			Total
			Site 1 Lowland Dipterocarp Forest	Site 2 Montane Forest	Site 3 Mossy Forest	Site 4 Lowland Dipterocarp Forest	Site 5 Montane Forest	Site 6 Mossy Forest	
			500-800 masl	1,323 -1,370 masl	1600 -1,714 masl	987-997 masl	1325 -1339 masl	1612 -1719 masl	
			Linan, Tupi	Glandang, Tupi	Glandang, Tupi	Kawit, Polomolok	Kawit, Polomolok	Kawit, Polomolok	
APODIFORMES									
Apodidae									
Collocalia esculenta (Glossy Swiftlet)	LC	R	0	1	0	4	0	0	5 (0.49)
Collocalia troglodytes (Pygmy Swiftlet)	LC	E	3	1	0	21	0	0	25 (2.46)
Hemiprocne comata (Whiskered Treeswift)	LC	R	0	4	0	1	0	0	5 (0.49)
COLUMBIFORMES									
Columbidae									
Chalcophaps indica (Common Emerald Dove)	LC	R	16	1	0	18	4	0	39 (3.84)
Ducula aenea (Green Imperial-pigeon)	LC	R	0	0	4	0	0	0	4 (0.39)
Macropygia amboinensis (Slender-billed Cuckoo-dove)	LC	R	0	0	3	0	0	2	5 (0.49)
Phapitreron amethystinus (Amethyst Brown-dove)	LC	E	0	0	2	0	0	1	3 (0.30)
Phapitreron leucotis (White-eared Brown-dove)	LC	E	6	12	5	25	1	2	51 (5.02)
Ramphiculus occipitalis (Ptilinopus occipitalis) (Yellow-breasted Fruit-dove)	LC	E	0	21	3	0	1	1	26 (2.56)
Ramphiculus leclancheri (*Ptilinopus leclancheri*) (Black-chinned Fruit Dove)	LC	R	0	0	4	0	1	3	8 (0.79)

Table 1. Continued

CORACIIFORMES									
Alcedinidae									
Halcyon smyrnensis (White-throated Kingfisher)	LC	R	3	0	0	0	1	0	4 (0.39)
Todiramphus chloris (*Halcyon chloris*) (White -collared Kingfisher)	LC	R	2	0	0	1	1	0	4 (0.39)
CUCULIFORMES									
Cuculidae									
Cacomantis merulinus (Plaintive Cuckoo)	LC	R	0	0	0	1	0	0	1 (0.10)
Cacomantis variolosus (Brush Cuckoo)	LC	R	0	1	4	0	0	0	5 (0.49)
Centropus melanops (Black-faced Coucal)	LC	E	0	4	0	2	0	0	6 (0.59)
Centropus viridis (Philippine Coucal)	LC	E	6	1	0	3	0	0	10 (0.98)
Cuculus saturatus (Oriental Cuckoo)	LC	M	0	1	0	0	0	0	1 (0.10)
Hierococcyx fugax (Malay Hawk-cuckoo)	LC	M	1	0	0	0	0	0	1 (0.10)
Hierococcyx sparverioides (Large Hawk-cuckoo)	LC	M	0	1	0	0	0	0	1 (0.10)
GALLIFORMES									
Phasianidae									
Gallus gallus (Red Junglefowl)	LC	R	0	0	1	0	0	0	1 (0.10)
PASSERIFORMES									
Artamidae									
Artamus leucorynchus (White-breasted Woodswallow)	LC	R	0	7	0	7	0	0	14 (1.38)
Campephagidae									
Coracina striata (Bar-bellied Cuckooshrike)	LC	R	0	2	0	0	0	0	2 (0.20)
Cisticolidae									
Orthotomus nigriceps (Black-headed Tailorbird)	LC	E	0	1	0	4	0	0	5 (0.49)
Corvidae									
Corvus macrorhynchos (Large-billed Crow)	LC	R	0	1	0	0	0	0	1 (0.10)

Table 1. Continued

Dicaeidae									
Dicaeum aeruginosum (Striped Flowerpecker)	LC	E	0	0	0	1	0	0	1 (0.10)
Dicaeum anthonyi (Flame-crowned Flowerpecker)	NT	E	0	0	0	2	0	0	2 (0.20)
Dicaeum australe (Red-keeled Flowerpecker)	LC	E	9	7	10	26	2	7	61 (6.00)
Dicaeum bicolor (Bicolored Flowerpecker)	LC	E	0	2	6	3	2	4	17 (1.67)
Dicaeum ignipectus (Fire-breasted Flowerpecker)	LC	R	0	0	0	1	0	0	1 (0.10)
Dicaeum hypoleucum (Buzzing Flowerpecker)	LC	E	0	0	0	2	0	0	2 (0.20)
Dicaeum pygmaeum (Pygmy Flowerpecker)	LC	E	4	4	0	3	0	0	11 (1.08)
Dicaeum trigonostigma (Orange-bellied Flowerpecker)	LC	R	0	4	3	9	1	2	19 (1.87)
Dicruridae									
Dicrurus balicassius (Balicassiao)	LC	E	0	0	0	2	0	0	2 (0.20)
Dicrurus bracteatus (Spangled Drongo)	LC	R	0	0	0	1	1	0	2 (0.20)
Estrildidae									
Lonchura malacca (Chestnut Munia)	LC	R	0	0	0	15	0	0	15 (1.48)
Hirundinidae									
Hirundo rustica (Barn Swallow)	LC	M	0	1	0	0	0	0	1 (0.10)
Laniidae									
Lanius cristatus (Brown Shrike)	LC	M	0	0	0	4	0	0	4 (0.39)
Lanius schach (Long-tailed Shrike)	LC	R	0	5	0	4	0	0	9 (0.89)
Monarchidae									
Hypothymis azurea (Black-naped Monarch)	LC	R	2	2	2	6	0	2	14 (1.38)

Table 1. Continued

Muscicapidae									
Brachypteryx montana (White-browed Shortwing)	LC	R	0	5	3	13	1	2	24 (2.36)
Cyornis rufigastra (Mangrove Blue Flycatcher)	LC	R	0	0	0	0	2	0	2 (0.20)
Ficedula basilanica (Little Slaty Flycatcher)	V	E	0	1	0	1	1	0	3 (0.30)
Ficedula crypta (Cryptic Flycatcher)	LC	ME	0	0	1	3	1	3	8 (0.79)
Ficedula hyperythra (Snowy-browed Flycatcher)	LC	R	0	0	0	0	0	1	1 (0.10)
Ficedula narcissina (Narcissus Flycatcher)	LC	M	0	0	1	5	1	0	7 (0.69)
Muscicapa griseisticta (Grey-streaked Flycatcher)	LC	M	0	2	0	0	0	0	2 (0.20)
Saxicola caprata (Pied Bushchat)	LC	R	0	0	0	3	0	0	3 (0.30)
Nectariniidae									
Aethopyga pulcherrima (Metallic-winged Sunbird)	LC	E	10	4	2	0	1	3	20 (1.97)
Aethopyga shelleyi (Lovely Sunbird)	LC	E	6	8	0	3	2	0	19 (1.87)
Arachnothera clarae (Naked-faced Spiderhunter)	LC	E	2	0	0	2	3	0	7 (0.69)
Arachnothera longirostra (Little Spiderhunter)	LC	R	0	4	0	3	1	0	8 (0.79)
Cinnyris jugularis (Nectarinia jugularis) (Olive-backed Sunbird)	LC	R	16	4	0	9	0	0	29 (2.85)
Leptocoma sperata (Nectarinia sperata) (Purple-throated Sunbird)	LC	R	0	0	0	5	0	0	5 (0.49)
Pachycephalidae									
Pachycephala philippinensis (Yellow-bellied Whistler)	LC	E	2	24	2	7	6	4	45 (4.43)
Paridae									
Pardaliparus elegans (formerly Parus elegans) (Elegant Tit)	LC	E	0	1	10	2	0	1	14 (1.38)
Passeridae									
Hypocryptadius cinnamomeus (Cinnamon Ibon)	LC	ME	0	1	0	0	0	0	1 (0.10)
Pellorneidae									
Ptilocichla mindanensis (Streaked Ground-babbler)	LC	ME	0	2	0	0	0	1	3 (0.30)

Table 1. Continued

Phylloscopidae									
Phylloscopus borealis (Arctic Warbler)	LC	M	0	0	0	2	0	0	2 (0.20)
Phylloscopus trivirgatus (Mountain Leaf-warbler)	LC	R	0	4	2	0	0	0	6 (0.59)
Pycnonotidae									
Hypsipetes philippinus (Ixos philippinus) (Philippine Bulbul)	LC	E	6	0	2	41	1	1	51 (5.02)
Poliolophus urostictus (Pycnonotus urostictus) (Yellow-wattled Bulbul)	LC	E	5	9	0	3	0	0	17 (1.67)
Pycnonotus goiavier (Yellow-vented Bulbul)	LC	R	4	13	0	20	4	0	41 (4.04)
Rhipiduridae									
Rhipidura javanica (Pied Fantail)	LC	R	3	0	0	0	0	0	3 (0.30)
Rhipidura nigrocinnamomea (Black-and-cinnamon Fantail)	LC	ME	0	3	3	0	1	2	9 (0.89)
Rhipidura superciliaris (Blue Fantail)	LC	ME	0	0	2	1	0	0	3 (0.30)
Scotocercidae									
Phyllergates cucullatus (Orthotomus cuculatus) (Mountain Tailorbird)	LC	R	8	1	0	2	1	0	12 (1.18)
Sittidae									
Sitta frontalis (Velvet-fronted Nuthatch)	LC	R	0	0	2	1	0	6	9 (0.89)
Stenostiridae									
Culicicapa helianthea (Citrine Canary-flycatcher)	LC	R	0	0	0	2	0	0	2 (0.20)
Sturnidae									
Sarcops calvus (Coleto)	LC	E	0	7	3	5	0	2	17 (1.67)

Table 1. Continued

Timaliidae									
Macronus striaticeps (Brown Tit-babbler)	LC	E	8	3	10	61	2	0	84 (8.27)
Turdidae									
Turdus poliocephalus (Island Thrush)	LC	R	0	1	4	0	0	1	6 (0.59)
Zosteropidae									
Zosterops everetti (Everett's White-eye)	LC	R	3	0	0	0	0	0	3 (0.30)
Zosterops meyeni (Lowland White-eye)	LC	E	0	0	10	20	0	0	30 (2.95)
Zosterops montanus (Mountain White-eye)	LC	R	0	3	0	33	1	15	52 (5.12)
PICIFORMES									
Picidae									
Chrysocolaptes lucidus (Greater Flameback)	LC	E	0	0	2	1	0	0	3 (0.30)
Dryocopus javensis (White-bellied Woodpecker)	LC	R	0	0	2	0	0	0	2 (0.20)
Picoides maculates (Dendrocopos maculatus) (Philippine Pygmy Woodpecker)	LC	E	0	0	0	2	0	0	2 (0.20)
Ramphastidae									
Psilopogon haemacephalus (*Megalaima haemacephala*) (Coppersmith Barbet)	LC	R	5	17	5	21	1	3	52 (5.12)
PSITTACIFORMES									
Psittaculidae									
Loriculus philippensis (Philippine Hanging-parrot)	LC	E	0	15	2	1	0	1	19 (1.87)
STRIGIFORMES									
Strigidae									
Otus everetti (Mindanao Lowland Scops-owl)	LC	E	0	1	0	0	0	0	1 (1.10)
Otus megalotis (Philippine Scops-owl)	LC	E	1	0	0	0	0	0	1 (0.10)
Total number of individuals			131	217	115	438	45	70	1016
Total number of species			24	45	31	53	27	24	81
Total number of endemic species			13	22	17	27	13	14	35
Total net hours			55	45	45	64	52	40	301

with presence of riverinesystem where insects could be present and abundant. Calimpong & Nuňeza (2015) also found *M. striaticeps* to be abundant at 312 masl. Kennedy *et al.* (2000) found this species to be common in dense foliage near the ground in forest and forest edge up to 1500 masl or more. Furthermore, the natural habitats of *M. striaticeps* are subtropical or tropical moist lowland forests and subtropical or tropical moist montane forests (Global Biodiversity Information Facility, 2017) which coincides with the distribution of this species in this study. The Philippine endemic species, *Dicaeum australe* (Red-keeled Flowerpecker) which was present in all sampling sites was second in dominance and abundance (6%). The dominance of this species was observed to be attributed to the presence of fruiting trees which could serve as food since this species feeds on fruit, nectar, and pollen of mistletoes (Loranthaceae) (Cheke & Mann, 2008). According to Kennedy *et al.* (2000), this species dwells in the canopy of forests, forest edge, second growth, and shrubs in open countries in fruiting trees; singly or in groups and in mixed flocks usually below 1000 masl. Furthermore, Tanalgo *et al.* (2015) reported that *D. australe* is usually found in primary and secondary forests and also in fruiting and flowering trees in the 1024-hectare campus of the University of Southern Mindanao in south-central Mindanao. Relox *et al.* (2011) only found this species in the Lowland Dipterocarp Forest (75-370 masl) of Mt. Hamiguitan while this study shows that it can also be found in the undisturbed and disturbed mossy forests at an elevation range of 1600-1719 masl.

In terms of sampling sites, site 4 an undisturbed lowland dipterocarp forest had the highest species richness (S=53) and abundance (43.11%) with 438 individuals. The richness of bird species in this site was observed to be due to its undisturbed complex vegetation structure and cover which provide food availability, perching sites, roosting sites, and nesting sites for birds. In addition, the low elevation of site 4 (987-997masl) could also be one of the factors for this bird's richness and abundance. Relox *et al.* (2011) and Silvosa *et al.* (2007) also recorded high number of species in the lowland dipterocarp forest of Mt. Hamiguitan. Sites 1 and 6 had the lowest number of species (S=24) since site 1 is a disturbed lowland dipterocarp forest and site 6 had a high elevation which could limit food sources. Waterhouse *et al.* (2002) reported that as elevation increases, the availability of resources for birds diminishes reflecting differences in forest stand structure, site productivity, vegetation composition, distribution pattern, secondary biotic interactions, and available land area. Terborg (1977) described increasing elevation as associated with decreased species richness. Moreover, disturbed sites generally contribute to the low species richness and abundance of birds (Vijayan & Gokula, 2006) because disturbance changes the habitat quality and could decrease the population size of species (Pardini *et al.,* 2009). Furthermore, Paz *et al.* (2013) observed that the abundance and richness of bird species positively correlate with understory structure and cover. This relationship is in agreement with the findings of the study where the species-rich site is the undisturbed lowland dipterocarp forest (site 1) which has complex understory structure.

Among the recorded 81 bird species in MMPL, 35 (43.21%) are endemic of which 30 are Philippine endemic and five species are Mindanao endemic, 38 resident and eight migrant species. Site 4, an undisturbed lowland dipterocarp forest had the highest number (S=27) of endemic species. This high number of endemic species in site 4 was observed to be due to its undisturbed vegetation as well as its vegetation cover which includes dipterocarp trees that provide resources and microhabitat for birds. The same finding was reported by Relox *et al.* (2011) in their study at Mt. Hamiguitan that species endemism is relatively high in lowland forest because of the large area covered by dipterocarp trees. In addition, reduced habitat and anthropogenic activities (Aloy *et al.,* 2007) could also contribute to high existence of endemic bird species which is characterized by site 4. Site 2 had the second highest number of endemic species (S=17) even if it is a disturbed montane forest. In addition, it was observed that all of the sampling sites had endemic species. This shows that some of the endemic bird species in MMPL can tolerate disturbed sites. The study conducted in Mt. Hamiguitan also found that the avifauna is able to tolerate disturbances like mining explorations, hunting, and logging (Relox *et al.,* 2011). However, *Dicaeum hypoleucum* (Buzzing Flowerpecker), *Dicaeum aeruginosum* (Striped Flowerpecker), *Dicaeum anthonyi* (Flame-crowned Flowerpecker), *Dicrurus balicassius* (Balicassiao), and *Picoides maculatus* (Philippine Pygmy Woodpecker) which were only found in site 4 are the only endemic species found to be present only in undisturbed site while *Otus megalotis* (Philippine Scops-owl), *Otus everetti* (Mindanao Lowland Scops-owl), and *Hypocryptadius cinnamomeus* (Cinnamon Ibon) are endemic species that were only found in disturbed sites. Furthermore, the least number of endemic species in sites 1, 3, and 6 could be due to the disturbances present in sites 1 and 3 and the high elevation of sites 3 and 6.

Most of the documented bird species in MMPL are categorized as least concern by IUCN (2018) except for two Philippine endemic species: *Dicaeum anthonyi* (Flame-crowned Flowerpecker) classified as near-threatened species which was found (only two individuals) in site 4 (an undisturbed site) and *Ficedula basilanica* (Little Slaty Flycatcher) classified as vulnerable species which was found in both disturbed and undisturbed sites (sites 2, 4 and 5). This indicates that protection of MMPL is strongly needed to conserve these endemic and vulnerable species.

Table 2 shows that MMPL has high species richness (S=81) and species diversity (H'=3.748) with even distribution of species. All the sampling sites have high species diversity and among them, site 2 a disturbed montane forest had the highest diversity (H'= 3.321). The high diversity of species in site 2 could be due to the diverse vegetation of the area where understory plant, "osmunda" (*Calamus ornatus*), the tree species "anislag" (*Securinega flexuosa*), White Lauan (*Shorea contorta*), and fruiting coffee plants were present and abundant which could provide microhabitats, food, and breeding sites that could support several bird species with different habitat requirements. According to Peris & Montelongo (2014), areas with less diverse or reduced

Table 2. Biodiversity indices across elevation and disturbance gradient in MMPL.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Total
Species richness	24	45	31	53	27	24	81
Individuals	131	217	115	438	45	70	1016
Dominance	0.06416	0.05048	0.04922	0.05604	0.05679	0.08449	0.03366
Shannon (H')	2.938	3.321	3.213	3.294	3.094	2.835	3.748
Evenness	0.787	0.6155	0.8019	0.5083	0.8173	0.7093	0.524

Legend: Disturbed Sites: Site 1 -Lowland Dipterocarp Forest (500-800 masl), Site 2- Montane Forest (1,323-1,370 masl), Site 3-Mossy Forest (1600-1,714 masl). Undistubed Sites: Site-4 Lowland Dipterocarp Forest (987-997 masl), Site-5 Montane Forest Site (1325 -1339 masl), Site -6 Mossy Forest (1612 -1719 masl).

tree cover decrease both the abundance and diversity of birds since most of bird species are strongly dependent on the vegetation cover for feeding and breeding, thus, diverse vegetation in site 2 contributes to the diversity of bird species. In addition, the remarkable diversity in montane forest reflects the uniqueness of the native habitat including the physical condition of the environment which is a combination of several factors such as moisture, disturbance, availability of nutrients, and food that change over space and time (Smith, 1990).

Sampling site 6 had the highest dominance index. The high dominance index value implies that dominant bird species exist in the site (Cagod & Nuňeza, 2012). The Mountain White-eye (*Zosterops montanus*) was the dominant species found in site 6. Furthermore, evenness index is useful in giving an insight on the degree of diversity in a particular area (Pagaduan & Afuang, 2012).

The evenness values obtained in the six sampling sites showed that the number of individuals within each species was moderately even in sites 1, 3, 5, and 6 while less evenly distributed in sites 2 and 4. Furthermore, it was observed that species diversity and species richness in disturbed sites increased in site 2 at an elevation of 1,323 -1,370 masl but decreased at site 3 with an elevation of 1600-1,714 masl while the species diversity and richness in undisturbed sites decreased as elevation increased. Styringa *et al.* (2011) reported that the increase in species richness and diversity of bird community is due to contributing factors like canopy height and secondary canopy developmen while Joshi *et al.* (2012) reported that it is due to the variety and number of plant species.

Figure 2 shows the similarity of the six sampling sites of MMPL where sites 3 and 6 formed the first clade and had the highest similarity percentage of >48% which means that these two sites shared mostly the same bird species. This is expected since sites 3 and 6 are both mossy forests with high elevation. According to Tubelis & Cavalcanti (2001), sites having high similarity percentage could have the same type of habitat and a tendency of having the same species composition. Sites 2 and 4 formed the second clade with a similarity percentage of >38%. Both sites have diverse vegetation cover which serves as microhabitat for some bird species. Fruiting trees in the site also serve as source of food for the birds. Site 5 clustered to sites 3 and 6 with a similarity percentage of >32% which is attributed to the nine bird species found in these two sites. Site 1 clustered to sites 2 and 4 with a similarity percentage of >30% where 15 species are the shared species of the three sites. Furthermore, all

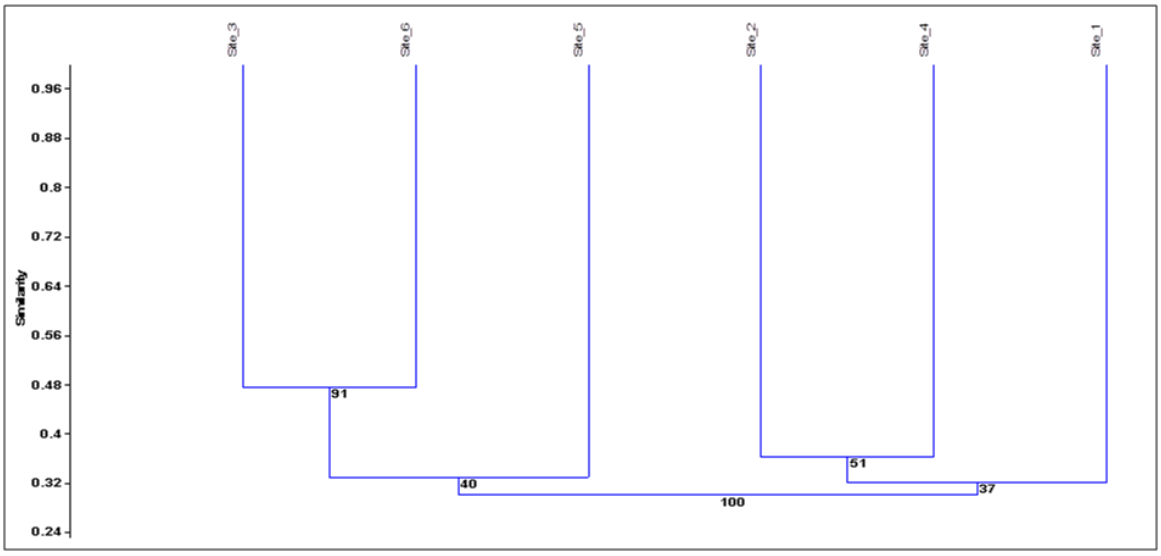

Figure 2. Cluster analysis (Bray-Curtis Cluster Analysis – single link) of birds across the six sampling sites of MMPL (Site 1 - Lowland Dipterocarp Forest; Site 2- Montane Forest; Site 3-Mossy Forest; Site-4 Lowland Dipterocarp Forest; Site-5 Montane Forest; Site, Site -6 Mossy Forest).

Table 3. Kruskal-Wallis test of bird species in disturbed and undisturbed sites of MMPL.

Test	Kruskal-Wallis Test		Interpretation
	H (chi $^{2)}$	P (same)	
Species Diversity	0.4286	0.5127	No significant difference between samples.
Evenness	0.04762	0.8273	No significant difference between samples.

the sampling sites were clustered due to the shared three species, *Phapitreron leucotis* (White-eared Brown-dove), *Dicaeum australe* (Red-keeled Flowerpecker) and *Pachycephala philippinensis* (Yellow-bellied Whistler) which are present in all the sampling sites.

Table 3 shows the comparison of the diversity and evenness in the disturbed and undisturbed sites of MMPL. Both species diversity and evenness showed no significant differences between species in disturbed and undisturbed sites. This indicates that there are bird species in this study like *Phapitreron leucotis* (White-eared Brown-dove), *Dicaeum australe* (Red-keeled Flowerpecker), *Pachycephala philippinensis* (Yellow-bellied Whistler), and *Macronus striaticeps* (Brown Tit-babbler) which can tolerate and inhabit both disturbed and undisturbed sites.

Threats to Mt. Matutum Protected Landscape

Hunting and conversion of forest to farmland were the observed threats to the birds of MMPL. Hunting is one of the most important anthropogenic activities which impacts species populations and their likelihood of extirpation (Bodmer *et al.*, 1997). Thus, it could cause the decline of the population of certain species and if unmanaged could trigger changes in the ecosystem (Cullen *et al.*, 2000). In addition, hunting of birds as a source of food and money through pet trade makes birds locally threatened (Sucaldito-Salibad & Nuñeza, 2014). Furthermore, the conversion of forest to farmland has profound impact on biological diversity and ecosystem functions (Reid, 2005). Changes in the structural and floristic composition brought about by forest degradation such as conversion of forest into agriculture, timber poaching, and hunting are threats to the birds (Sucaldito-Salibad & Nuñeza, 2014). They not only affect the habitats of birds but alter avian movement pattern because birds require appropriate land cover to navigate over great distances (Johnson *et al.*, 2007). Other studies on birds conducted by Mulwa *et al.* (2012) in the montane forests of Kenya, Naidoo (2004) in Uganda, and Fjeldså (1999) in Tanzania also documented a decrease in forest specialists and an increase in overall species numbers with forest disturbance or conversion. Furthermore, endemic species are the most affected avian groups because they are very sensitive to ecological change (Crosby, 1998).

CONCLUSION

Mt. Matutum Protected Landscape has high species diversity and species richness with an endemism of 43.21%. Among the sampled sites, site 4 an undisturbed lowland dipterocarp forest had the highest species richness and endemism while site 2, a disturbed montane forest had the highest species diversity. The most abundant and dominant species documented was the Philippine endemic, *Macronus striaticeps* (Brown Tit-babbler) and the only vulnerable species was *Ficedula basilanica* (Little Slaty Flycatcher). Hunting and conversion of forest to farmland were the observed threats to the birds of MMPL indicating that protection of habitats needs to be strongly implemented to conserve endemic and vulnerable species in the area.

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