

# Diversity of birds captured by mist-netting in the understorey of Gunung Gading National Park, Sarawak, Borneo

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**Summary:** The diversity of understorey birds at Gunung Gading National Park was examined from November 2011 to April 2012 using mist nets with total effort of 177 net days, revealed 114 individuals representing 13 families and 38 species. Including previous studies, a total of 62 bird species have been netted in Gunung Gading National Park. The most diverse families were Pycnonotidae and Timaliidae, both with 9 species captured, followed by Muscicapidae represented by 4 species. The bird diversity ( $H' = 3.18$ ) was higher than that reported in previous studies. Cumulative results suggest that previous netting studies has been insufficient to reveal the total understorey bird diversity and the number of species netted and added shows little sign of tailing off suggests that additional effort is required.

**Ringkasan:** Keanekaragaman jenis burung di Taman Negara Gunung Gading telah diteliti dari November 2011 hingga April 2012 menggunakan jaring kabut. Selama 177 hari jaring tertangkap 114 individu dari 13 famili dan 38 spesies. Jumlah burung yang pernah dijaring di Taman Negara Gunung Gading adalah 62 spesies. Famili dengan kekayaan jenis yang tertinggi adalah Pycnonotidae dan Timaliidae (masing-masing 9 spesies) disusul oleh Muscicapidae (4 spesies). Keanekaragaman jenis burung ( $H' = 3.18$ ) melebihi yang pernah dilaporkan sebelum ini. Bagaimanapun juga grafik kumulatif tidak mendatar dan menunjukkan bahwa pengambilan data yang dilakukan tidak memadai dan perlu tambahan usaha.

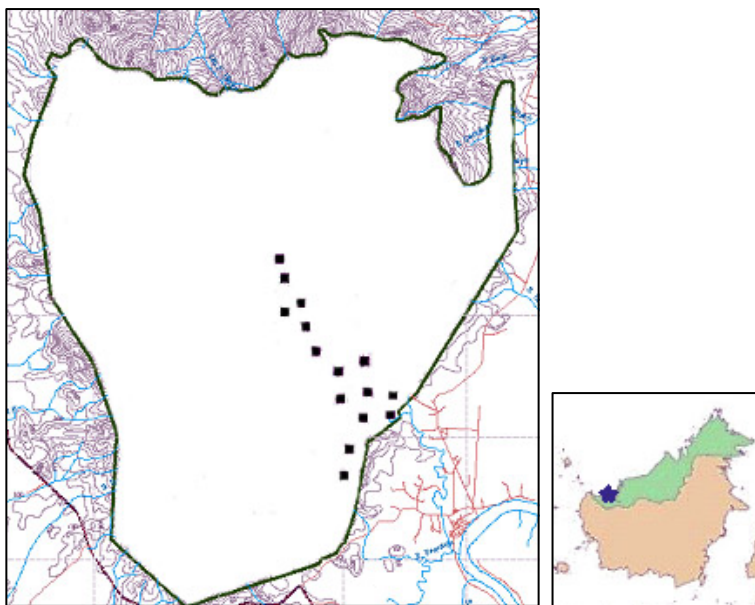
## Introduction

Borneo has some of the highest deforestation rates in the world (Koh 2007). Apart from logging and conversion to plantations, high demand for agricultural land through the conversion of secondary forest has resulted in the isolation of primary forest remnants, which now mostly lie in totally protected areas in Sarawak (Mohd-Azlan & Lawes 2011a). The protected areas of Sarawak now contain the best examples of what were once some of the most diverse and continuous mature rainforests in the world. The state of Sarawak has one of the most extensive protected area networks in Malaysia, with 37 nature reserves, wildlife sanctuaries, marine and national parks, and is the only line of defense in efforts to protect biodiversity and prevent regional extinction (Mohd-Azlan & Lawes 2011a). This network covers c.4.8% of the state's land surface area, but is concentrated along the coast. The marine protected area alone covers 26% of the overall protected areas of 799,628 ha. However, the proposed expansion of the oil palm estate and plantations from 1 million to 2 million ha before 2020 will further change the surrounding landscape of totally protected areas.

The alarming rate of forest fragmentation in Borneo has resulted in avian decline and local extinctions (Lambert 1992; Lambert & Collar 2002). Such rapid landscape change in Sarawak may have altered species distribution patterns and, in turn, species assemblages, especially when forest patch sizes fall below critical area limits of species (Lambert & Collar 2002). In view of this, the long term survival and reproductive capacity of birds depends heavily on the active management of national parks and other protected areas, including enforcement of laws protecting biodiversity.

Although many bird surveys have been undertaken in Sarawak over the last decade, most have been reported in unpublished documents and theses (e.g. Sreedharan 1998; Dino 2005; Razali 2007; Mansor *et al.* 2008; Boon 2010), while only a few studies have been formally published (e.g. Smith 1999; Rahman *et al.* 2002; Anwarali *et al.* 2008; Croxal 2008). To date, two bird surveys have been conducted in Gunung Gading National Park, Sarawak; Sreedharan (1998) mist-netted 27 bird species in the Park, while Sodhi (2002) netted 35 species.

The present study describes the species richness and diversity of mist-netted birds in Gunung Gading National Park, and supplements the above surveys carried out more than a decade ago, thereby providing a more comprehensive baseline dataset for monitoring understorey bird populations. Mist-netting is a useful technique for obtaining comprehensive avian inventories because inconspicuous (and less vocal) terrestrial species are often not detected when using traditional survey methods, especially if the field ornithologists are unfamiliar with the vocalisations of forest birds (Novarino *et al.* 2006; Woxvold & Noske 2011).



**Figure 1.** Map showing Gunung Gading National Park (GGNP) and the approximate net locations throughout the study period. Insert: The approximate location of GGNP in Sarawak.

## Materials and methods

The study was conducted at Gunung Gading National Park (GGNP) (1°42.00' N, 109° 50.20' E) (Fig. 1) over 14 non-consecutive days. The park has an area of approximately 41 km<sup>2</sup> and consists of a complex mountain system with several co-dominant peaks, including Gunung Gading (965 m asl), that has arisen from a huge body of intrusive granitic rocks and a fringe of strongly folded sedimentary rocks of the Serabang formation (Hazebroek & Abang Morshidi 2006).

The massif is largely covered by mixed dipterocarp forest, but above 700 m asl has lower montane forest, in which the trees are much shorter, more slender and have much smaller crowns. Lower montane forest occurs at lower elevations on mountains close to the coast, such as on Gunung Gading, than on mountains farther inland, such as Gunung Mulu (Hazebroek & Abang Morshidi 2006). This park is surrounded by agricultural land, including oil palm plantations and rural settlements that extend all the way up to the park boundary.

At any one time 10 to 20 mist-nets (2.5 m x 12 m x 36 mm mesh) were deployed in the understorey at 300-500 m intervals along forest edges and across small streams at sites in the Park ranging from 75 m to 650 m asl. The mist-nets were operated from 06:00 hrs to 18:00 hrs during 14 sampling days from November 2011 to April 2012. They were set at least 0.5 m above the ground to reduce the risk of captured birds at the bottom being exposed to ground-dwelling predators. The nets were supported by adjustable aluminium poles about 5 m in height. Nets were checked every two hours, and captured birds were measured, identified, banded and released as soon as possible near the net in which they were captured. The total effort over 177 net-days was 2,124 net-hours.

To compare the equitability of capture occurrence with that of previous studies, we used Shannon's species diversity index ( $H'$ ), which can be used for indefinitely large populations where all the individuals are sampled randomly.  $H'$  was computed using PAST software (Hammer *et al.* 2001). *EstimateS* 8.2 was used to calculate the upper and lower limits of expected species richness of the birds based on the rate of accumulation of newly recorded bird species with survey effort. Sampling completeness of birds in this study was calculated using the completeness ratio or  $C$  based on Soberon *et al.* (2000):

$$\text{Completeness ratio} = \frac{\text{Number of species observed}}{\text{Estimated number of species}}$$

## Results

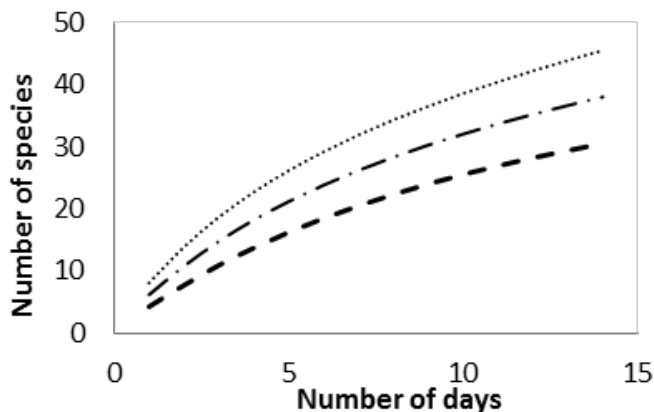
A total of 114 individuals of 38 species from 13 families were captured during the 14 non-consecutive sampling days at Gunung Gading National Park. Five (13%) of the species we captured are considered Vulnerable or Near Threatened by IUCN (2012). Five species (13%) are legally protected inside the Park under the Sarawak Wild Life Protection Ordinance, 1998, though none is globally threatened according to IUCN (Table 1).

**Table 1.** Comparison of mist net captures in current study ('A') and previous studies ('B' = Sreedharan 1998; 'C' = Sodhi 2002) and the conservation status of bird species according to the IUCN (2012; NT = Near Threatened; VU = Vulnerable) and Sarawak Wild Life Protection Ordinance 1998 (SWPO; P = Protected).

Species	IUCN	SWPO	A	B	C
Emerald Dove <i>Chalcophaps indica</i>			2		6
Plaintive Cuckoo <i>Coccyzus merulinus</i>			1		
Glossy Swiftlet <i>Collocalia esculenta</i>		P	1		
Rufous-backed kingfisher <i>Ceyx rufidorsa</i>		P	8		6
Blue-eared Kingfisher <i>Alcedo meninting</i>		P		1	
Blue-banded Kingfisher <i>Alcedo euryzona</i>	VU	P		1	1
Oriental Dwarf Kingfisher <i>Ceyx erithacus/rufidorsa</i>	NT	P		5	
Banded Kingfisher <i>Lacedo pulchella</i>		P		2	
Gold-whiskered Barbet <i>Megalaima chrysopogon</i>				2	
Rufous Piculet <i>Sasia abnormis</i>		P	1	1	1
Maroon Woodpecker <i>Blythipicus rubiginosus</i>		P	1		
Green Broadbill <i>Calyptomena viridis</i>	NT		2		
Black-and-red Broadbill <i>Cymbirhynchus macrorhynchus</i>			1		
Asian Fairy Bluebird <i>Irena puella</i>				1	
Yellow-bellied Bulbul <i>Alophoixus phaeocephalus</i>			10	9	11
Olive-winged Bulbul <i>Pycnonotus plumosus</i>			3		1
Yellow-vented Bulbul <i>Pycnonotus goiavier</i>			1	1	
Hairy-backed Bulbul <i>Tricholestes criniger</i>			3		
Cream-vented Bulbul <i>Pycnonotus simplex</i>			3		
Grey-cheeked Bulbul <i>Alophoixus bres</i>			4	1	2
Spectacled Bulbul <i>Pycnonotus erythrophthalmos</i>			3		2
Ochraceous Bulbul <i>Alophoixus ochraceus</i>			1		
Red-eyed Bulbul <i>Pycnonotus brunneus</i>			1		2
Puff-backed Bulbul <i>Pycnonotus eutilotus</i>	NT			2	2
White-rumped Shama <i>Copsychus malabaricus</i>		P	3		3
Chestnut-naped Forktail <i>Enicurus ruficapillus</i>	NT				1
Short-tailed Babbler <i>Malacocincla malaccensis</i>	NT		5	2	11
Chestnut-winged Babbler <i>Stachyris erythroptera</i>			2	4	3
Scaly-crowned Babbler <i>Malacopteron cinerum</i>			3	8	9
Grey-headed Babbler <i>Stachyris poliocephala</i>			6	6	16
Grey-throated Babbler <i>Stachyris nigriceps</i>			2		
Moustached Babbler <i>Malacopteron magnirostre</i>			1		4
Sooty-capped Babbler <i>Malacopteron affine</i>	NT		1		
Horsfield Babbler <i>Trichastoma sepiarium</i>			1		1
Black-capped Babbler <i>Pellornium capistratum</i>			1		1
Rufous-crowned Babbler <i>Malacopteron magnum</i>	NT			3	2
Chestnut-crested yuhina <i>Yuhina everetti</i>				1	
White-necked Babbler <i>Stachyris leucotis</i>	NT				2
Brown Fulvetta <i>Alcippe brunneicauda</i>	NT				1
White-bellied Yuhina <i>Yuhina zantholeuca</i>					1
Ashy Tailorbird <i>Orthotomus ruficeps</i>			1		
Rufous-tailed Tailorbird <i>Orthotomus sericeus</i>			3	9	5
Yellow-bellied Warbler <i>Abroscopus superciliaris</i>			2		
Dark-necked Tailorbird <i>Orthotomus atrogularis</i>					1
Large-billed blue Flycatcher <i>Cyornis caerulatus</i>	VU		2		
Grey-chested Jungle-flycatcher <i>Rhinomyias umbratilis</i>	NT		1		
Little Pied Flycatcher <i>Ficedula westermanni</i>			4		
Rufous Winged Philentoma <i>Philentoma pyrhopterum</i>			1	4	7
Spotted Fantail <i>Rhipidura perlata</i>				3	2

Species	IUCN	SWPO	A	B	C
Rufous-chested Flycatcher <i>Ficedula dumetoria</i>	NT			2	1
Asian Paradise Flycatcher <i>Terpsiphone paradisi</i>					1
Brown-chested Flycatcher <i>Rhinomyias brunneata</i>	VU				1
Asian-brown Flycatcher <i>Muscicapa dauurica</i>					1
Yellow-breasted Flowerpecker <i>Prionochilus maculatus</i>			5		1
Crimson-breasted Flowerpecker <i>Prionochilus percussus</i>			1		
Yellow-rumped Flowerpecker <i>Prionochilus xanthopygius</i>				1	1
Orange-bellied Flowerpecker <i>Dicaeum trigonostigma</i>				1	
Purple-naped Sunbird <i>Hypogramma hypogrammicum</i>			1	1	3
Little Spiderhunter <i>Arachnothera longirostra</i>			22	11	33
Grey-breasted Spiderhunter <i>Arachnothera modesta</i>				1	
Dusky Munia <i>Lonchura fuscans</i>				2	
Greater Racket-tailed Drongo <i>Dicrurus paradiseus</i>					1
<b>Total individuals</b>			<b>114</b>	<b>85</b>	<b>147</b>
<b>Total number of orders</b>			<b>6</b>	<b>3</b>	<b>4</b>
<b>Total number of families</b>			<b>13</b>	<b>11</b>	<b>11</b>
<b>Total number of species</b>			<b>38</b>	<b>27</b>	<b>35</b>
<b>Shannon's Index</b>			<b>3.18</b>	<b>2.94</b>	<b>2.95</b>

The capture rate was 54 individuals/1000 net hours with a recapture rate of 17.5%. The number of birds netted per net per day was 0.046. The five most common species netted were the Little Spiderhunter *Arachnothera longirostra* (19.3%), Yellow-bellied Bulbul *Alophoixus phaeocephalus* (8.8%), Rufous-backed Kingfisher *Ceyx rufidorsa* (7.0%) and Grey-headed Babbler *Stachyris poliocephala* (5.3%). The least diverse families were Cuculidae and Apodidae, each represented by a single species and individual. Passerines represent 84% of the overall understory birds captured at our sites. Shannon's species diversity index ( $H'$ ) for understory birds in this study was 3.18 (Table 1). The number of species captured increased until the last day of sampling (Fig. 2). The calculated completeness ratio was 0.84, suggesting that a total of 45 bird species may be present.



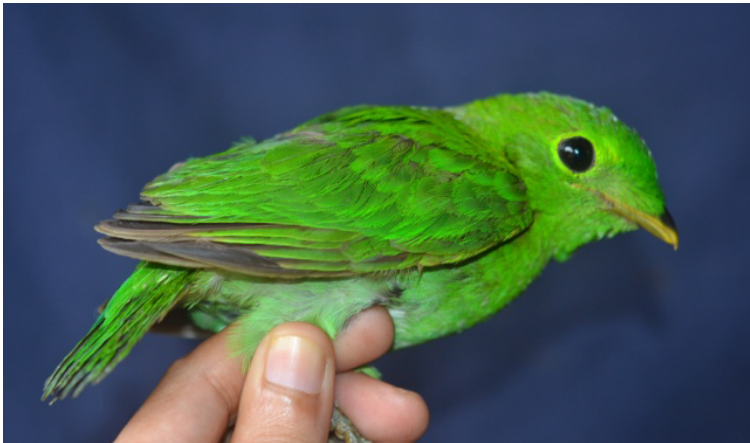
**Fig. 2.** Species accumulation curve for mist netted birds at Gunung Gading National Park. Upper and lower curves represent 95% upper and lower confidence limits, while the center curve represents species observed.

## Discussion

Although comparisons between studies are invariably constrained by differences in sampling effort, design, and habitat (Novarino *et al.* 2006), as well as mist-net characteristics, this study has proved valuable in characterising the diversity of the understorey birds in Gunung Gading National Park. We added 16 bird species to those reported previously by Sreedharan (1998) and Sodhi (2002) (Table 1), bringing the total number of species to 62 (c. 11% of all Bornean bird species). The accumulative species curve did not reach an asymptote (Fig. 2), indicating that not all possible bird species were captured, and that further netting in which mist-nets are periodically moved or left for longer periods would probably yield further additions. Furthermore, some ground-dwelling species, such as pittas, were missed in our mist nets (set 0.5 m above ground) and so placement of some mist nets at ground level would also enable additional bird species to be captured. However such nets would need to be checked at shorter intervals, which would require greater manpower.

Overall, this study failed to capture several species of understorey kingfishers, and recorded a partly different suite of understorey babblers (Timaliidae) and flycatchers (Monarchidae and Muscicapidae) to that captured by Sreedharan (1998) and Sodhi (2002). A total of 16 bird species was only captured in this study, contributing an additional 26% to the list of birds captured by mist nets in GGNP. The most notable additions were Green Broadbill *Calyptomena viridis* (Plate 1), Sooty-capped Babbler *Malacopteron affine* and Grey-chested Jungle-flycatcher *Rhinomyias umbratilis*, all of which are Near-Threatened (Table 1). This is probably due to differences in the vegetation structure and complexity surrounding the mist-nets, as well as the seasonal availability of food resources. We captured some forest edge, canopy and aerial species that would not normally be recorded if sampling were restricted to the interior parts of the forest.

The present mist-netting study resulted in a higher species diversity index ( $H' = 3.18$ ) than that obtained by either Sodhi (2002;  $H' = 2.95$ ) or Sreedharan (1998;  $H' = 2.94$ ). The current study not only captured a greater number of bird species, but the individuals were distributed more equitably among these species. Consistent with the results of the previous studies (Sreedharan 1998; Sodhi 2002), the most abundant species in this study was the Little Spiderhunter. However, in terms of speciose taxonomic groups, there were some important differences between the studies. In the present study, bulbuls dominated the understorey avifauna at GGNP in terms of number of individuals captured (25% of individuals of all species) and species richness (24% of the total bird species). This was followed by babblers with 22 individuals of nine species. In contrast both Sreedharan (1998) and Sodhi (2002) captured more babblers than bulbuls (28-33% of all birds with 6-9 species vs 15-16% of all birds with 4-8 species, respectively). The influx of bulbuls during the present study period could be due to temporary abundance of edible fruits, which are patchy in distribution and erratic in seasonality in Sarawak (Fogden 1972).



**Plate 1.** Green Broadbill *Calyptomena viridis*, a Near-Threatened species recorded during the present study, but not in previous mist net studies.

Five bird species listed by the IUCN (2012) as threatened or Near-Threatened were recorded in the present study: Large-billed Blue-flycatcher *Cyornis caerulatus* (Vulnerable); and Green Broadbill, Short-tailed Babbler *Malacocincla malaccensis*, Sooty-capped Babbler and Grey-chested Jungle-flycatcher (Near-Threatened). On the other hand, the previous studies reported two Vulnerable species and seven Near-Threatened species that were not recorded in this study (Table 1). As some of these species were captured only once, it is likely that they occur at low densities in the Park. Yet three Near-Threatened species (Rufous-crowned Babbler *Malacopteron magnum*, Puff-backed Bulbul *Pycnonotus eutilotus* and Rufous-chested Flycatcher *Ficedula dumetoria*) were recorded by both previous studies, and it is conceivable that their populations have already declined. Approximately 79% of the birds captured in this study receive higher protection status (Totally Protected) in Peninsular Malaysia under Wildlife Conservation Act 2010 (WCA 2010), which is the most updated wildlife legislation in Malaysia. Given the lack of congruence between the IUCN's list of threatened species, WCA 2010 and the bird species that receive protection under SWLPO 1998, there is an urgent need to review and update the SWLPO 1998.

Gunung Gading National Park is an isolated patch of primary forest within a matrix of cultivation and settlements, perched on an isolated mountain massif within a landscape of low-lying land. The topographical and ecological isolation of the Park suggests that its avifauna is vulnerable to the effects of small area and small population size, including reduced gene flow, chance extinctions, and long term factors such as climate change and habitat degradation. Therefore there is an urgent need for extensions to the park boundaries and/or buffer zones, as well as for the creation of corridors connecting the park with nearby secondary forest patches.

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