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**BIRDS IN PEATSWAMP AT KLIAS FOREST RESERVE AND  
ENVIRONS, SABAH, MALAYSIAN BORNEO**

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## ABSTRACT

Periodically from 1998-2004, we surveyed birds in the Klias Forest Reserve, which is one of the last remaining pockets of peatswamp in western Sabah. We report here on those surveys. We also review prior work on birds in peatswamp and swamp forest in the Klias-Sipitang region of Sabah as it relates to the conservation of habitat and birds specialized on peatswamp. Peatswamp forest is in jeopardy from development and fires throughout Borneo, and particularly in the Malaysian State of Sabah, which had very little to start. Peatswamp in the Klias area is of particular importance for conservation and bird watching because Klias is close to the main tourist center of Borneo, Kota Kinabalu, and is the only easily accessible site for reliable sightings of Hook-billed Bulbul (*Setornis criniger*), Grey-breasted Babbler, (*Malacopteron albogulare*), and Scarlet-breasted Flowerpecker (*Prionochilus thoracicus*) in Sabah.

## INTRODUCTION

Bird communities in peatswamp forests of Borneo differ from those found in more typical mixed dipterocarp forest. A stand of peatswamp in Gunung Mulu National Park, Sarawak, for example, held half the number of species and 60% of the population density of birds occurring in the surrounding forest (Wells et al. 1978). Much the same result has been found in peatswamp forests in central and western Kalimantan (Gaither 1994; Page et al. 1997; Posa 2011; Posa and Marques 2012). The difference between the avifauna of peatswamp and other Bornean forests is exemplified by some common and rare species. The Little Spiderhunter (*Arachnothera longirostra*), which is ubiquitous in the primary and secondary dipterocarp forests of Borneo, can be remarkably uncommon in peatswamp. On the other hand, species such as Hook-billed Bulbul (*Setornis criniger*), Grey-breasted Babbler, (*Malacopteron albogulare*), and Scarlet-breasted Flowerpecker (*Prionochilus thoracicus*), which are rare in dipterocarp forests are common in Bornean peatswamp (Sheldon 1987; Holmes and Wall 1989). Beyond these simple observations of occurrence and abundance, however, we know remarkably little about the avifauna of peatswamp. We understand only vaguely how peatswamp bird communities differ from mixed dipterocarp communities, and we have little information on the historical and ecological forces responsible for the diversification and maintenance of bird species in peatswamp forests across Sundaland (Posa et al. 2011).

One reason for our ignorance is that peatswamp is unattractive to scientists and bird watchers. Peatswamp forests grow on soft, often saturated, soils that can be difficult to traverse. They are sometimes full of biting insects, and are often thickly populated with thin pole-like trees that impede human movement and visibility. Studying birds in mixed dipterocarp forest is much more enjoyable and productive than in peatswamp.

The need for faunal surveys in peatswamp, however, is paramount because these forests are increasingly threatened with destruction (Miettinen and Liew 2010; Miettinen et al. 2011; Posa et al. 2011). Many are located in coastal areas, where human population density and growth are greatest, and often the forests are patchily distributed and restricted in size, so that entire peatswamp populations can be jeopardized by development of a relatively small area. Peatswamp populations can also be extirpated by fire in times of drought or after logging, since the soil, when dry, is prone to fires that are difficult to extinguish (Siegert et al. 2001; Page et al. 2009). Moreover, peatswamp forests, although often considered wasteland, have intrinsic economic value that exposes them to exploitation. They comprise some particularly valuable tree species, such as jongkong (*Dactylocladus stenostachys*), ramin (*Gonystylus bancanus*), terentang (*Camptosperma* spp.), and kapur paya (*Dryobalanops rappa*), as well as the relatively abundant and merchantable alan (*Shorea albida*) (Anderson 1961; Andriessse 1988; Phillips 1998). When drained and aerated, peatswamp soil is useful for agriculture, and it has value as a fuel or as a source of materials for horticulture and industrial chemicals. It also may serve as an effective filter for landfill waste storage (Phillips 1998).

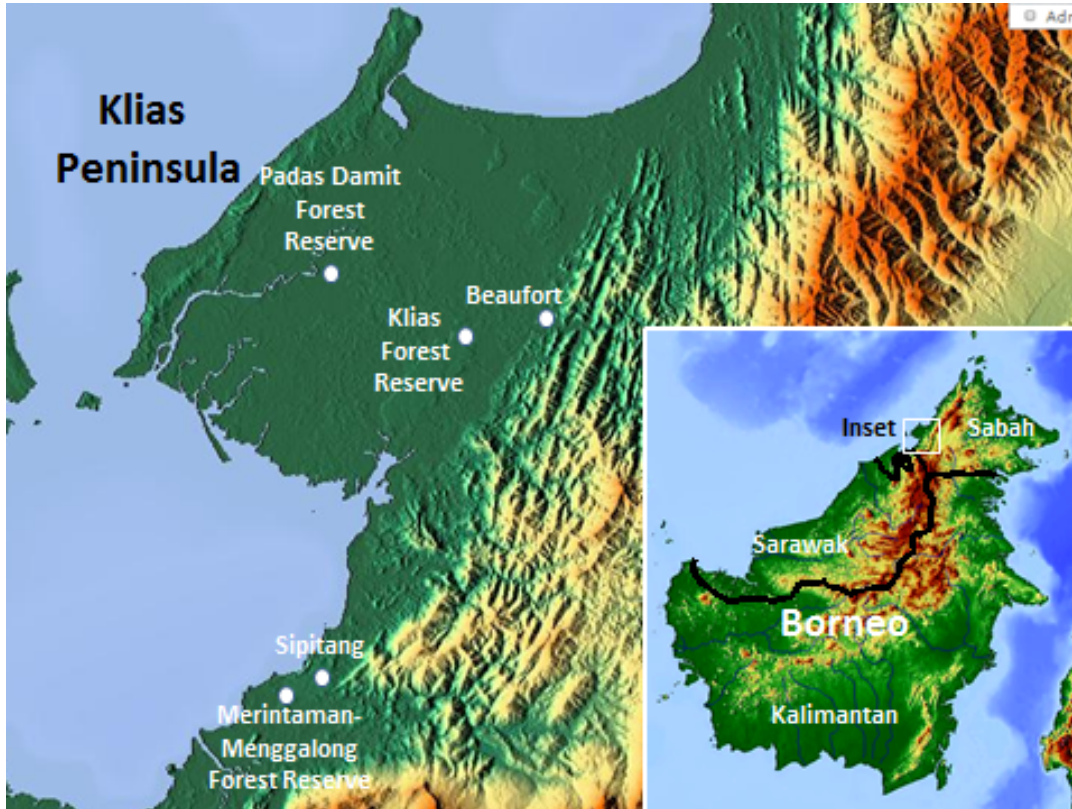
Another reason for focusing research on peatswamp forests is that ecological and molecular genetic comparisons among populations in such forests may provide insight into the evolution of biodiversity in the Indo-Malayan archipelago. Among birds, the three Bornean species that prefer peatswamp share similar distributions among the major Sunda islands: Hook-billed Bulbul on Sumatra, Borneo, and Bangka; Grey-breasted Babbler on the Malay Peninsula, Sumatra, and Borneo; and Scarlet-breasted Flowerpecker on the Malay Peninsula, Sumatra, Belitung, and Borneo (Smythies 1999). These distributions coincide with the peatswamp forests of Sundaland, which occur in fully developed form only on the Malay Peninsula, Sumatra, and Borneo (Whitmore 1984; Ahmad and Sugau 2000). The overlapping distributions of these bird species suggest that they may have an ancient relationship with peatswamp (or related habitats). Whether populations of these birds were united and interbred during the Pleistocene glaciations that connected Borneo, Sumatra, and Malaya (Heaney 1986; Whitmore 1987) or were reproductively isolated by earlier events (Lim et al. 2011; Gawin et al. 2014) is a matter of great interest vis-à-vis the diversification of Sundaic birds.

However, peatswamp, unlike the more widespread dipterocarp lowland forests of Sundaland, is ephemeral in geologic (glacial) time and no birds are actually endemic to it. Moreover, most current Bornean peatswamp soils were laid on top of marine sediments in coastal areas 4,000 to 5,000 years ago (Anderson 1983; Page et al. 1999), well after the last glacial maximum, ca. 20,000-10,000 years ago, that caused the most recent eustatic sea level drop and interconnection of Sunda islands. Thus, peatswamp appears and disappears quite rapidly. The only exceptions in Borneo are the interior, higher elevation peatlands of central Kalimantan, which at 10,000 years in age are still fairly young in terms of glacial

eustasy (Rieley et al. 1992; Page et al. 1999). The relatively ephemeral nature of peatswamp suggests that Hook-billed Bulbul, Grey-breasted Babbler, and Scarlet-breasted Flowerpecker may be widely represented in the mixed dipterocarp forest of Borneo but in such low numbers that they are rarely recorded. These species may be abundant in peatswamp forest simply because of ecological release from competitors that avoid that habitat. This phenomenon is suspected to occur in Peninsular Malaysia, where Rufous-tailed Shama (*Copsychus pyrropygus*) and Grey-chested Jungle Flycatcher (*Cyornis umbratilis*)—in the absence of other shamas and muscicapid flycatchers—are common in peatswamp forest (Wells 2007; pers. comm.).

Given the need for more information about bird occurrence in peatswamp forest, we report in this paper on surveys of birds conducted periodically from 1998 to 2004 in Klias Forest Reserve on the Klias peninsula, Sabah (Figure 1). This reserve is a Class I (fully) protected forest under the jurisdiction of the Sabah Forestry Department. It consists of about 3,630 ha of peatswamp and about 2,500 ha of associated transitional wetland ecosystems, including *Gymnostoma* swamp forest, mangrove and riverine forest (Mohamed et al. 2000). The peatswamp of Klias Forest Reserve consists mainly of a thick pole forest from which larger trees have been removed by past logging, especially near the boundaries (Ahmad and Sugau 2000). In some places the forest is intact and features larger dominant trees, including kapur paya, katok (*Stemonurus scorpioides*), nytoh sidang (*Palaquium rostratum*), and *Callophyllum havilandii*. The more mature forest is bordered by areas of recently and thoroughly burned peatswamp forest and, further out, a melastome scrub growing on peaty soil. In addition to Klias Forest Reserve, we also report on bird occurrence in the now extirpated peatswamp forest of Merintaman-Menggalong Forest Reserve, located approximately 35 km to the southwest on the coast adjacent to Sipitang, Sabah (Figure 1). Until the mid-1980s, Menggalong exhibited Sabah's last stand of good quality coastal ramin (W. Meijer in Sheldon et al. 2001). Finally, for perspective, we include records of birds found in Padas Damit Forest Reserve and environs, an area on the Klias Peninsula to the north of the Klias Forest Reserve, which includes mangrove, freshwater marsh, and freshwater swamp forest (Figure 1). These observations are intended to help set the stage for examination of peatswamp forest bird ecology and molecular population genetics in Borneo. Although preliminary, they provide some information into the use of peatswamp and adjacent habitats by resident and migratory species of birds.

**Figure 1:** Sites in Sabah, Malaysian Borneo, referenced in this paper, and major towns nearby.



## BACKGROUND

Peatswamp forests are generally found on flat, poorly drained coastal lands or river flood-plains (Anderson 1961, 1983; Andriesse 1988; Bruenig and Droste 1995; Phillips 1998). Peat soil is formed by the accumulation of decayed plants in naturally low oxygen situations and becomes highly acidic. Classically, peat builds up into a convex dome, sometimes as much as 20 m in depth at the center of larger swamps, but in some areas the swamp can also be flat (Cranbrook and Edwards 1994). The central area of the swamp is generally isolated from external sources of nutrients and survives on rainwater and recycling of forest vegetation. Such forest is termed ombrogenous (e.g., Page et al. 1999). It is the most acidic and nutrient-poor segment of peatswamp forest. In accordance with an acidity-nutrient gradient, there tends to be concentric circling of forest zones from the margin to the center of peatswamp and a decrease in tree diversity (Anderson 1961, 1983). At the outer edge, where peat is shallowest, is mixed swamp forest that features the most valuable commercial trees: ramin, jongkong, terentang, geronggang padang (*Cratoxylum glaucum*), and swamp meranti (*Shorea* spp.). Inside the mixed swamp forest is alan butu forest, which is similar to the mixed swamp forest but contains an increased proportion of alan. Inside of this is alan bunga forest, dominated by an

even canopy of alan, no middle story, and a thick but depauperate lower story. Then comes padang butu forest. This is a dense pole-like forest completely dominated by alan trees. Finally comes padang paya forest, which is a mixture of forest types composed of a relatively small number of non-commercial trees, including geronggong padang, medang (*Litsea* spp.), bintangor (*Calophyllum* spp.), and keruntum (*Combretocarpus rotundatus*) (Cranbrook and Edwards 1994).

Sabah originally contained about 100,000 - 130,000 ha of peatswamp forest, most of which occurred in the Klias peninsula on the southwestern coast, with smaller stands in the swamp forests of the east coast (Table 1; Ahmad and Sugau 2000, Rashid Abdul Samad pers. comm.). This amount of peatswamp is relatively small compared to Sarawak, which originally had 1.5-1.7 million ha (Anderson 1961; Tuen and Darub 1999; [www.did.sarawak.gov.my](http://www.did.sarawak.gov.my)), and Kalimantan, which originally had 6.4-9.2 million ha, depending upon soil definitions and survey techniques (Phillips 1998; Page et al. 1999). The amount of peatswamp forest remaining in Sabah is now about half of what it was 30 years ago, and it is in various states of regeneration from harvesting and other disturbance (Rashid Abdul Samad, pers. comm.). Originally, as much as 60,700 ha of the Klias plain consisted of peatswamp (Table 1). From recent satellite images of the Klias peninsula, intact peatswamp forest now covers only about 8,000 ha, principally in the Klias and Binsulok Forest Reserves. Until recently, Binsulok Forest Reserve (12,196 ha) featured a good stand of peatswamp, but perhaps 90% of this was burned during the *El Nino* drought of 1997-1998, and substantial fires have occurred since (Ahmad and Sugau 2000; [www.sabah.gov.my/htan\\_caims](http://www.sabah.gov.my/htan_caims)). The excellent example of coastal ramin-jongkong peatswamp (ca. 800 ha) existing nearby at the Menggalong Forest Reserve, Sipitang, which we report on in this paper, has been entirely destroyed by logging and development.

Sabah Forestry Department is attempting to protect remaining peatswamp forests in Sabah. To improve peatswamp management, several programs have been initiated, including a joint venture begun in 2002 between the Malaysian Government and the Danish International Development Assistance Programme (Danida) called "Management for Conservation and Sustainable Use of Peat Swamp Forests and Associated Water Regimes in Malaysia." The objective of the Danida project was to develop and implement plans to ensure the conservation and sustainable use of the significant genetic, species, and ecosystem diversity found in tropical peat swamp forests and associated wetland ecosystems. The Klias Peat Swamp Forest Project, co-funded by the United Nations Development Programme (UNDP), Global Environment Facility (GEF), and Danida, was an effort to produce a management plan for the forest reserve and adjacent buffer zone by monitoring hydrological issues and other effects of land use in the area of the reserve. Our study at Klias Forest Reserve benefited from the infrastructure set up for research by the Klias Peat Swamp Forest Project.



**Table 1:** Peatswamp areas in Sabah listed by Thomas et al. (1976)

Residency	Physiographic Region*	Location	Hectares	
Tawau			0	
Sandakan	Kinabatangan Lowlands	Gomantong	10,500	
		Lamag	1,600	
		Sukaru	1,600	
	Eastern Deltas	Manalunan	10,500	
		Sugut Delta	Lower Sugut	6,900
		Labuk Delta	Klangan to Sapi	1,600
West Coast	Crocker Plains	Bongawan-Benoni	6,270	
		Kota Belud	2,270	
		Kawang	1,740	
		Kota Kinabalu	1,500	
		Northern Islands	Balambangan	1,700
Interior and Labuan	Klias Plain	Klias Plain	60,700	
		Meligan Range	Ulu Pa Sia	1,600
		Crocker Plains	Sindumin	1,200
		Crocker Foothills	Kuala Menggalong	800
			Sipitang	400
		Total	110,880	

\*Classification from Collette (1963)

## METHODS

GD recorded birds in the peatswamp, riverine, and downstream mangrove forests at Klias Forest Reserve periodically in June 1998 and February 2002 (Appendix 1). LSU (FHS) and the American Museum of Natural History (RGM), with the help of Sabah Museum and Sabah Wildlife Department personnel (AW), surveyed and collected birds in the northwest corner of Klias Forest Reserve from a base at the UNDP/GEF-Forest Department resthouse (05°10'34"N 115°40'25"E) from 5-12 February 2004 (see Appendix 1). The latter area was about one km<sup>2</sup> and encompassed three basic habitats growing on deep peat: (1) mature peatswamp forest; (2) severely burned, barely regenerated peatswamp consisting of tall, dead trees, substantial forest-floor litter, and very little undergrowth; and (3) scrub dominated by relatively thick melastomes and other shrubs less than 3 m in height.

For comparison and historical context, we also present information in Appendix 1 from brief surveys and collections made ca. 30 years ago in two neighboring areas: Padas Damit (5°20'N 115°33'E) and the Merintaman-Menggalong Forest Reserve, Sipitang (5°02'N 115°32'). We also list birds from Gunung Mulu National Park, Sarawak. The Western Foundation of Vertebrate

Zoology visited Padas Damit on three occasions: 25-26 and 28-29 May and 4-5 June 1983 (Sheldon et al. 2001). During those trips, birds were observed and collected in swamp forest, freshwater marsh, brackish marsh, mangrove, and along rivers. Of particular interest for this report are the birds occurring in freshwater swamp forest because of the potential contrast to peatswamp forest. The coastal ramin peatswamp forest at the Merintaman-Menggalong Forest Reserve was briefly examined for Sabah Parks by Wells et al. (1975) during 19-20 March 1975 (Wells 1976), and the Western Foundation collected birds in the primary peatswamp forest and the surrounding scrub of in this reserve from 14-16 July 1983 (Sheldon 1987; Sheldon et al. 2001). The Royal Geographic Society's expedition to Gunung Mulu National Park (Wells et al. 1978) surveyed and mistnetted birds in a concentric succession of *Shorea alba* to dense pole forest that was growing on a plateau of peat overlying sand from 27 April and 1 May 1978 (Anderson et al. 1982).

Our survey in Klias Forest Reserve in February 2004 consisted primarily of mist-netting, viewing, tape-recording, and photographing birds. We kept a record of every bird we caught in mist-nets (discounting recaptures marked with clipped tail feathers) to provide a rough measure of abundance. Taking the size and number of mist-nets and total deployment hours, we apportioned our net effort as follows over a six day period (6-11 February 2004): 60% of netting effort was in primary forest (starting with 11 nets on Feb. 6<sup>th</sup> and ending with 28 nets on Feb. 11<sup>th</sup>); 21% effort was in the tall, burned forest (maximum 11 nets); and 19% effort was in the melastome scrub (maximum 12 nets).

Bird records from the various surveys and habitats are summarized in Table 2 and presented in full in Appendix 1. Specimens are deposited in the Sabah Museum and LSU's Museum of Natural Science.

## RESULTS AND DISCUSSION

In six days of netting in February 2004, we captured 291 individual birds representing 55 species. The largest proportion of individual birds was netted in melastome scrub: 134 individuals captured (46% of total captures). If we had set more nets in the scrub, a much larger number of birds would have been caught in that habitat, perhaps as many as 400 individuals, if net-hours were normalized. However, the variety of birds in the scrub was low: 17 species captured (31% of total species captured) and 36 species recorded (26% of total species recorded). The most commonly netted and recorded bird in the melastome scrub was Yellow-vented Bulbul, *Pycnonotus goiavier* (60% of scrub captures). The habitat with the highest diversity, but lowest number of individual birds, was the primary forest: 76 individuals captured (26% total captures); 28 species captured (52% of total species captured); and 35 species recorded (36% of total species recorded). The burned forest yielded the fewest netted individuals and species: 81 individuals (28% of total captures); 10 species captured (19% of total species captured); and 25 species recorded (26% of recorded species). However, if we correct for net hours,

**Table 2:** Summary of bird occurrence by location and date from Appendix 1

Category	Klias Forest Reserve						Adjacent to Klias FR	Merintaman Menggalong	Padas Damit	Mulu N.P.
	5-12 Feb. 2004 <sup>a</sup>			June 1998	June 1998	Feb. 2002	June 1998	14-16 Jul. 1983	May-June 1983	27 Apr.-1 May 1978
	1°	2°	3°	Mixed Peatswamp	Riverine	Riverine & Peatswamp	Mangrove	Peatswamp	Swamp & Marsh	Peatswamp
Species recorded	35	25	36	59	33	42	40	85	78	64
Species netted	28	10	17							25
Individuals netted	76	81	134							92
Unique species <sup>b</sup>	26	9	25							

<sup>a</sup>1°, 2°, 3° refer to primary forest, burned forest, and secondary scrub growing on peatswamp at Klias Forest Reserve.

<sup>b</sup>Species unique to a given column in the table.

the burned area would have yielded many more captured individuals, perhaps 250 based on net-hour correction, but diversity of captured species would probably still be low. In general, quite a distinct line separated bird communities. For example, we found that the peatswamp species (Hook-billed Bulbul, Grey-breasted Babbler, and Scarlet-breasted Flowerpecker) occurred only in the old growth forest, whereas the most abundant bulbuls, Yellow-vented and Olive-winged (*P. plumosus*), occurred outside or on the edges of the old growth forest.

These simple observations do not adequately reflect the dynamics of birds in the area. The primary forest, with its large proportion of pole-like trees, was unusually thick, making it difficult to view and net birds. Thus, we would expect a longer study to find more species in the primary forest. The burned forest had little undergrowth and many tall, bare trees. Its simple structure resulted in a reduced number of undergrowth birds, but a large number of large-bodied treetop dwelling species that were easy to view. Thus, our sight records in the burned forest emphasized parrots, dollarbirds, woodpeckers, campephagids, orioles, and mynas. The melastome scrub was low and ideal for netting birds; thus, the large number of individuals caught in relatively few nets.

### **Future studies with good potential for scientific insight**

Because our February 2004 trip was short, and we devoted most of our time to netting and preparing specimens, we did not adequately survey birds in the area. There is substantial potential for further bird research at Klias Forest Reserve. The convenience of the Forestry Department rest station and the protection of the habitat from development optimizes the site for more intensive work. Among projects that would be interesting are the following.

*Comparison of peatswamp, freshwater swamp, and coastal primary dipterocarp bird communities.* The relative abundance and make-up of birds in the Klias peatswamp is outwardly quite different from that of dipterocarp and neighboring freshwater swamp forest. For example, we encountered almost no Little Spiderhunters, which is the most commonly netted species in dipterocarp forest. Although Mangrove Whistlers (*Pachycephala cinerea*) and Mangrove Blue Flycatchers (*Cyornis rufigastra*) are common in the swamp forest and mangrove of Padas Damit, none was found in the Klias peatswamp forest. (Wells [1976] found whistlers at Menggalong, but their occurrence there may have something to do habitat differences, such as the occurrence of forest streams.) Quantification of differences in distribution and foraging habits of easily netted species would provide much needed insight into causes and maintenance of local diversity.

*Studies of bird community changes due to forest succession.* Assuming that the peatswamp forest and surrounding areas in Klias Forest Reserve do not burn in the near future, it would be interesting to examine changes in the bird community as the previously burned forest fills in and the melastome scrub becomes taller. One question is whether peatswamp redevelops in the burned areas, or has it been extirpated by soil destruction.

*Study of the life-histories of Hook-billed Bulbul, Grey-breasted Babbler, and Scarlet-breasted Flowerpecker.* To our knowledge, Hook-billed Bulbul has only been recorded in Sabah in the Klias region (Sheldon et al. 2001). The other two species have been found elsewhere in Sabah, but only rarely, e.g., the ultrabasic forest of the Telupid region of Sabah, especially Ulu Rukuruku and Mt. Meliau (Davies and Payne 1982; Sheldon et al. 2001; Sheldon et al. 2009a). They all probably occur in low numbers throughout Sabah and may become more abundant in peatswamp and other poor-quality areas because of ecological release from competitors (D. Wells, pers. comm). Intensive study of the foraging and nesting of these three species would help explain their distinct habitat distribution and requirements.

*Study of hybridization in Oriental Magpie-Robins.* We collected two subspecies of magpie-robin at Klias Forest Reserve, *Copsychus saularis musicus* and *C. s. adamsi*. *C. s. musicus* is a white-bellied bird with white in its tail, and *adamsi* is a black-bellied bird. Molecular genetic comparisons have shown these two morphs in Klias to be genetically distinct taxa (Sheldon et al. 2009b), with *musicus* most closely related to white-bellied birds in the Malay Peninsula and Sumatra, and *adamsi* closest to black-bellied and black-tailed subspecies in eastern Borneo (*pluto*). It would be interesting to discover whether the two forms are hybridizing in the Klias region, which seems likely given the preponderance of intermediate forms in Sabah (Mees 1986), and whether there is a tendency towards assortative mating.

*Migrational movement of frugivores and nectarivores for nesting and feeding.* Several ornithologists have speculated that the remarkable number of frugivores (e.g., parrots, pigeons, bulbuls, starlings & mynas, and flowerpeckers) and nectarivores (e.g., sunbirds) found in the Klias and Binsulok areas may be the result of seasonal abundance of fruit from February to May (Wells 1976; Sheldon 1985). We found many of these frugivorous and nectarivorous species were in breeding condition, suggesting a relationship between the rich fruit supply and nesting.

*Population biology and ecology of Yellow-vented Bulbul.* These bulbuls were remarkably abundant during our February 2004 survey. They are also easily viewed and netted. Several questions could be investigated concerning their life-history: Is the February congregation normal or associated with breeding? What specifically are the birds eating that allows so many individuals to coexist? What is their family structure and breeding schedule? Is the large number of parasitic cuckoos in the area to take advantage of the bulbul's seasonal influx?

*Assessment of use by foreign migrants.* We observed and captured several migratory birds, including two Chestnut-winged Cuckoos (*Clamator coromandus*) in the primary peatswamp forest. This species is not commonly recorded in Sabah (particularly not in dipterocarp forest) and the possibility that it is preferentially using peatswamp is intriguing. The Klias Forest Reserve is an excellent site for banding (ringing) and habitat studies.

### **Value of Klias Forest Reserve in bird conservation and ecotourism**

The peatswamp forest of Klias Forest Reserve is home to one of the rarest birds in Sabah, the Hook-billed Bulbul. There are no reliable records of this species anywhere in the state except in the peatswamp of the Klias area (Sheldon 1987; Sheldon et al. 2001). However, at Klias the birds are abundant and easy to see. Grey-breasted Babblers and Scarlet-breasted Flowerpeckers are also easy to find there. Conserving the peatswamp forest at Klias, therefore, would be an effective way to make these birds available to bird-watching ecotourists. Using the forest as an ecotourist destination also makes excellent sense, because it is not far from Kota Kinabalu by car, and it is on the way from Kota Kinabaly to Padas Damit, a popular ecotourist destination for Proboscis Monkeys and the other abundant wildlife of the Padang Teratak area.

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**Appendix 1:** Birds recorded in peatswamp and other habitats in Klias and Menggalong Forest Reserves and environs, and in peatswamp at Mulu National Park, Sarawak.

Scientific Name <sup>a</sup>	Common Name <sup>a</sup>	Klias Forest Reserve				Adjacent to Klias FR	Merintaman Menggalong	Padas Damit	Mulu N.P.			
		5-12 Feb. 2004 <sup>b</sup>								June 1998 <sup>c</sup>	June 1998 <sup>c</sup>	Feb. 2002 <sup>c</sup>
		1°	2°	3°	Br.	Mixed Peatswamp	Riverine	Riverine & Peatswamp	Mangrove	Peatswamp	Swamp & Marsh	Peatswamp
<i>Anhinga melanogaster</i>	Darter						R	R	R		R	
<i>Ardea purpurea</i>	Purple Heron							R	R		C	
<i>Ardea alba</i>	Great Egret							R	R		R	
<i>Egretta intermedia</i>	Intermediate Egret			R				R	R		C	
<i>Egretta garzetta</i>	Little Egret						R	R	R		R	
<i>Bubulcus ibis</i>	Cattle Egret							R	R			
<i>Butorides striata</i>	Little Heron					R	R	R	R		R	
<i>Ixobrychus sinensis</i>	Yellow Bittern						R		R			
<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern								R		R	
<i>Ixobrychus eurhythmus</i>	Von Schrenck's Bittern					R						
<i>Leptoptilos javanicus</i>	Lesser Adjutant							R			R	

<i>Haliastur indus</i>	Brahminy Kite		R	R		R	R	R	R		C	
<i>Butastur indicus</i>	Grey-faced Buzzard					R	R					
<i>Ichthyophaga ichthyaetus</i>	Grey-headed Fish Eagle					R						
<i>Ichthyophaga humilis</i>	Lesser Fish Eagle						R	R				
<i>Spilornis cheela</i>	Crested Serpent Eagle					R			R	R,W	R	R
<i>Microheirax latifrons</i>	White-fronted Falconet									R		
<i>Falco peregrinus</i>	Peregrine Falcon							R				
<i>Rollulus roulroul</i>	Crested Partridge									W		
<i>Argusianus argus</i>	Great Argus											R
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen			1			R	R	R		C	
<i>Pluvialis fulva</i>	Pacific Golden Plover										R	
<i>Tringa totanus</i>	Common Redshank										C	
<i>Tringa nebularia</i>	Common Greenshank										R	
<i>Tringa glareola</i>	Wood Sandpiper						R					
<i>Actitis hypoleucos</i>	Common Sandpiper			R					R			
<i>Calidris ruficollis</i>	Rufous-necked Stint										R	
<i>Gallinago sp.</i>	Snipe species					R						







<i>Cypsiurus balasiensis</i>	Asian Palm-Swift			R		R					R	
<i>Hemiprocne comata</i>	Whiskered Treeswift									R		
<i>Hemiprocne longipennis</i>	Grey-rumped Treeswift		R							R		
<i>Harpactes diardi</i>	Diard's Trogon			1								R
<i>Harpactes kasumba</i>	Red-naped Trogon											R
<i>Harpactes duvaucelii</i>	Scarlet-rumped Trogon									R		R
<i>Lacedo pulchella</i>	Banded Kingfisher									W		R
<i>Todiramphus chloris</i>	Collared Kingfisher						R	R			R	
<i>Halcyon coromanda</i>	Ruddy Kingfisher					R		R			R	
<i>Halcyon pileata</i>	Black-capped Kingfisher					R	R					
<i>Halcyon capensis</i>	Stork-billed Kingfisher						R	R	R		C	
<i>Alcedo atthis</i>	Common Kingfisher			1				R	R			
<i>Alcedo meninting</i>	Blue-eared Kingfisher					R						
<i>Ceyx erithaca</i>	Oriental Dwarf Kingfisher	2								C,W		
<i>Merops viridis</i>	Blue-throated Bee-eater			R		R				R		
<i>Nyctiornis amictus</i>	Red-bearded Bee-eater									R		R
<i>Eurystomus</i>	Dollarbird		R			R						



<i>Dendrocopus canicapillus</i>	Grey-capped Pygmy Woodpecker		R						R		
<i>Dendrocopus moluccensis</i>	Sunda Pygmy Woodpecker				R	R		R		C	
<i>Hemicircus concretus</i>	Gray-and-buff Woodpecker								C		R
<i>Dinopium javanense</i>	Common Goldenback	R								C*	
<i>Dinopium rafflesii</i>	Olive-backed Woodpecker									C	
<i>Dryocopus javensis</i>	White-bellied Woodpecker		R		R				C,W	C	
<i>Mulleripicus pulverulentus</i>	Great Slaty Woodpecker								W		R
<i>Reinwardipicus validus</i>	Orange-backed Woodpecker								R	R	
<i>Calyptomena viridis</i>	Green Broadbill								R		R
<i>Cymbirhynchus macrorhynchos</i>	Black-and-red Broadbill				R	R	R		R	R	
<i>Eurylaimus ochromalus</i>	Black-and-yellow Broadbill	R	R		R				R,W	R	R
<i>Eurylaimus javanicus</i>	Banded Broadbill								R		
<i>Pitta granatina</i>	Garnet Pitta										R
<i>Hirundo tahitica</i>	Pacific Swallow			R	♂♀	R		R	R		C*
<i>Hirundo rustica</i>	Barn Swallow			1 0		R		R	R		
<i>Motacilla cinerea</i>	Grey Wagtail					R					





	Forktail											
<i>Pellorneum capistratum</i>	Black-capped Babbler	4								C	C	4
<i>Trichastoma rostratum</i>	White-chested Babbler									R,W	C	
<i>Malacocincla malaccensis</i>	Short-tailed Babbler											4
<i>Malacocincla sepiarium</i>	Horsfield's Babbler											8
<i>Malacocincla abbotti</i>	Abbott's Babbler						R		R			
<i>Malacopteron magnum</i>	Rufous-crowned Babbler											2
<i>Malacopteron cinereum</i>	Scaly-crowned Babbler									C*,W		5
<i>Malacopteron affine</i>	Sooty-capped Babbler					R	R					
<i>Malacopteron albogulare</i>	Grey-chested Babbler	2			♂					C		6
<i>Ptilocichla leucogrammica</i>	Bornean Wren Babbler											2
<i>Kenopia striata</i>	Striped Wren Babbler											2
<i>Macronus bornensis</i>	Bold-striped Tit-Babbler		1 0	7		R	R	R		R	C*	
<i>Macronus ptilosus</i>	Fluffy-backed Tit-Babbler	4	1	1	♀					R,W	C	1
<i>Stachyris nigricollis</i>	Black-throated Babbler	2			♂					C		2
<i>Stachyris maculata</i>	Chestnut-rumped	2			♂♀					C,W		2



	Babbler											
<i>Stachyris erythroptera</i>	Chestnut-winged Babbler	4			♂♀	R	R			R,W		3
<i>Gerygone sulphurea</i>	Golden-bellied Gerygone					R			R			
<i>Orthotomus atrogularis</i>	Dark-necked Tailorbird									C		
<i>Orthotomus sericeus</i>	Rufous-tailed Tailorbird		3			R		R		R		
<i>Orthotomus ruficeps</i>	Ashy Tailorbird	1			♂	R	R	R	R	R		R
<i>Prinia flaviventris</i>	Yellow-bellied Prinia			R				R			R	
<i>Rhipidura javanica</i>	Pied Fantail		1	3	♂♀		R	R	R	C	C*	
<i>Cyornis rufigastra</i>	Mangrove Blue Flycatcher								R		C*	
<i>Rhinomyias umbratilis</i>	White-throated Jungle-Flycatcher	2			♂	R				C,W		20
<i>Hypothymis azurea</i>	Black-naped Monarch	6			♂							1
<i>Pachycephala grisola</i>	Mangrove Whistler								R	W	C*	
<i>Sitta frontalis</i>	Velvet-fronted Nuthatch									R		R
<i>Prionochilus thoracicus</i>	Scarlet-breasted Flowerpecker	2			♂♀					C		R

<i>Prionochilus xanthopygius</i>	Yellow-rumped Flowerpecker	2			♂					R	C	
<i>Prionochilus maculatus</i>	Yellow-breasted Flowerpecker									C*		7
<i>Dicaeum trigonostigma</i>	Orange-bellied Flowerpecker			1	♂	R	R			C	C	
<i>Anthreptes simplex</i>	Plain Sunbird	1								R		
<i>Anthreptes malacensis</i>	Brown-throated Sunbird					R		R	R		C*	
<i>Anthreptes singalensis</i>	Ruby-cheeked Sunbird	4			♂			R				
<i>Hypogramma hypogrammicum</i>	Purple-naped Sunbird	2			♂							1
<i>Leptocoma sperata</i>	Purple-throated Sunbird					R					R	
<i>Cinnyris jugularis</i>	Olive-backed Sunbird					R	R	R	R	R	C	
<i>Aethopyga siparaja</i>	Crimson Sunbird	1			♀					W	C*	
<i>Arachnothera longirostra</i>	Little Spiderhunter	1				R	R			R		R
<i>Arachnothera robusta</i>	Long-billed Spiderhunter											1
<i>Zosterops palpebrosus</i>	Oriental White-eye										C*	
<i>Aplonis panayensis</i>	Philippine Starling			R		R		R	R		R*	
<i>Gracula religiosa</i>	Hill Myna		R			R				C*,W	R	R

<i>Lonchura fuscans</i> <sup>1</sup>	Dusky Munia			R				R		C*		
<i>Lonchura malacca</i>	Black-headed Munia			1	♂						R*	
<i>Dicrurus annectans</i>	Crow-billed Drongo									W		
<i>Dicrurus paradiseus</i>	Greater Racquet-tailed Drongo	2				R	R			R,W	R	
<i>Oriolus xanthonotus</i>	Dark-throated Oriole	R	R							R		R
<i>Platylophus galericulatus</i>	Crested Jay											R
<i>Platysmurus leucopterus</i>	Black Magpie									C*		

<sup>a</sup>Classification follows the order of Smythies (1999) and the bird names of Gill and Donsker (2014).

<sup>b</sup>Birds recorded by a team from LSU, Sabah Museum, and Sabah Forest Wildlife Department from 5-12 February 2004. Columns are as follows: 1<sup>o</sup> (mature) primary peatswamp forest; 2<sup>o</sup> severely burned, barely regenerating peatswamp forest consisting of tall, dead trees and not much undergrowth; 3<sup>o</sup> scrub dominated by relatively thick melastomes and other shrubs less than 3m in height. Numbers refer to netted bird (recaptures omitted) and "R" indicates sight and voice records. Br. = breeding status; ♂♀ indicates male and female birds in breeding condition based on gonadal and sex organ development.

<sup>c</sup>Sight records by GD in June 1998 and February 2002. "Mixed peatswamp" includes disturbed and undisturbed forest.

<sup>d</sup>Records from the Western Foundation of Vertebrate Zoology visit to the Merintaman-Menggalong (Peatswamp) Forest Reserve, Sipitang (5°02'N 115°32'), 14-16 July 1983, and from a Sabah Park survey, 19-20 March 1975 (Wells et al. 1975, Wells 1976). R indicates sight records, C indicates specimens collected by the Western Foundation, and W indicates net and sight records from Wells (1976). Asterisks indicate birds in breeding condition in July 1983 based on their gonad and sex organ development.

<sup>e</sup>Records from the Western Foundation of Vertebrate Zoology visits to Padas Damit (5°20'N 115°33'E) and adjacent Padang Taratak on three occasions, 25-26 and 28-29 May and 4-5 June 1983 (Sheldon et al. 2001). Relevant habitats are swamp forest, freshwater marsh, brackish marsh, riverine forest, and mangrove. Asterisks mark birds in breeding condition based on their gonad and sex organ development.

<sup>f</sup>Data from Wells et al. (1978). R indicates species recorded, numbers refer to mistnetted individuals.

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