

Table 2. Comparison of results of mist-netting survey at Lunang (far right) with seven other lowland sites in the Greater Sundas. West Malaysia: virgin forest in Pasoh Forest Reserve (Wong 1986), UKM Forest Reserve in Bangi (Karim-Dakog *et al.* 1997); Borneo: Matang and Gading, Sarawak (Sodhi 2002); Gunung Palung National Park, Kalimantan (Gaither 1994); Sumatra: Sipisang (Novarino *et al.* 2002). Guilds as defined in text. Dipt., dipterocarp forests (originally); nr, not recorded.

	W Malaysia			Borneo			Sumatra	
	*Pasoh	UKM	Matang	Gading	GPNP	GPNP	Sipisang	Lunang
Forest type	Dipt.	Dipt.	Dipt.	Dipt.	Peat-sw	Dipt.	Dipt.	Swamp
Condition ¹	P	S	P, S	P, S	P	P	S	S
Species captured	83	91	27	35	34	39	73	40
Most species guild ²	FGI#	FGI#	nr	nr	FGI#	FGI#	IN/FR	FGI
Rare species (%) ³	64	87	59	69	62	56	79	61
Individuals captured	703	983	111	147	230	301	567	158
Effort (net-hours)	28,000	11,191	1,566	1,661	1,509	1,512	4,740	1,368
No. individuals/ 100 net-hours	2.5	8.8	71	8.9	15.2	199	12.0	11.5

¹ P, primary (virgin); S, secondary (previously logged or cultivated)

² guild with the highest number of species

³ species representing < 2% of total number of individuals captured (see text)

* Wong's (1985, 1986) regenerating forest plot is excluded, but yielded similar results to the virgin forest

Tree foliage-foraging insectivores combined with shrub foliage-foraging insectivores

The percentage of rare species (61%) at Lunang falls within the range (56-69%) for most of the abovementioned studies. The exceptions are Sipisang (79%) and the UKM Forest Reserve (87%), although the contribution of rare species at Pasoh was higher (77%) if Wong's (1995) two sites are combined. Mist-netting in these three sites also yielded substantially higher numbers of species than in Lunang or any of Bornean sites, suggesting that the relatively low proportion of rare species at Lunang is at least partly a function of species richness of the understory assemblage.

Typical of understory assemblages in other parts of Sundaland, Lunang was overwhelmingly dominated by foliage gleaning insectivores (Table 2). Due to the relatively low numbers of mist-netted species and lack of foraging data, we made no attempt to distinguish between tree foliage gleaning insectivores and shrub foliage gleaning insectivores at Lunang. Among mist-netted birds at Pasoh (virgin forest only) and Bangi (West Malaysia), and GPNP (Sarawak), partially frugivorous (FR/IN) species outnumbered or equaled tree or shrub foliage gleaning insectivores (data from Wong 1986; Gaither 1994; Karim-Dakog *et al.* 1997), but not when the latter two are combined into one (FGI) guild. The same trend holds in terms of their abundance, except at Bangi, where the number of captured individuals in the insectivore-frugivore guild was more than double that of foliage-gleaning insectivores (364 and 172 individuals, respectively), primarily due to the preponderance of bulbuls, which were attracted to the many fruiting trees at their disturbed and isolated site (Karim-Dakog *et al.* 1997). In his peat swamp forest site at GPNP (Sarawak), Gaither (1994) found a marked increase in insectivore-frugivores, predominantly bulbuls, during one month (June) when fruit was abundant. No such change in guild structure was evident in the swamp forest at Lunang, but we sampled for only two months, whereas

Gaither (1994) sampled for eight months. Moreover, care should be exercised when comparing guilds between studies due to our generally inadequate knowledge of the diets of many Southeast Asian species (see for example, Lambert 1992), as well as possible geographic variation in diets.

Although babblers (Timaliidae) dominated the understory avifauna at Lunang in terms of numbers of individuals captured (25% of all birds), they contributed only 15% of the species. In contrast, babblers constituted 23-27% of all species (and 45-47% of all individuals) captured at Pasoh (Wong 1985), and 30-41% of species (and 29-46% of all individuals) captured at two sites in Sarawak (data from Wong 1985 and Sodhi 2002, respectively). Similarly, they constituted about 30% of the species captured at GPNP in both peat swamp forest and dipterocarp forest (Gaither 1994). On the other hand, babblers were even less important at Bangi than at Lunang, contributing about 8% towards the total number of both species and individuals captured (data from Karim-Dakog *et al.* 1997), partly due to the predominance of bulbuls at the site studied. The relatively low number of babbler species at Lunang may reflect the relatively simple structure and poorly-developed litter layer of the swamp forest, which probably partly relates to its regular inundation.

The recapture rate between months in this study was 20%, very similar to that found in forest fragments in Singapore (Sodhi 2002). In West Malaysia, recapture rates in largely pristine forest at Pasoh were high (36-40%; data in Wong 1985), whereas at the UKM forest remnant in Bangi, the recapture rate between years was extremely low (1.5%; Karim-Dakog *et al.* 1997). Such results suggest that high recapture rates are a feature of undisturbed forest, where most birds are probably long-lived residents (e.g. insectivorous babblers) with stable territories, while low recapture rates might be expected in disturbed and/or isolated forest patches due to a greater number of mobile species exploiting temporally super-abundant resources (e.g. frugivorous bulbuls; see Gaither 1994) and possibly, higher mortality of residents around clearings and at the forest edge.

Although comparisons between studies from different regions may be limited because of disparities in sampling effort, design and habitats, mist-netting at Lunang was useful in providing objective measures of the diversity and guild composition of the understory birds. Moreover, this technique enables the detection of terrestrial species that are cryptic or vocalize infrequently/seasonally (Blake & Loiselle 2000). In the present study, six species (5.3% of all species recorded) caught in mist nets were not detected during censuses. Similarly, of 134 species recorded over 18 days at Maruwai, East Kalimantan, including 38 captured in mist nets, six captured species (4.5%) were never recorded during censuses (Noske in prep). Such findings highlight the importance of mist-netting as a survey technique in short-term surveys, in which a comprehensive inventory is desired.

Conservation significance of Lunang

Our findings indicate that freshwater swamp forests, even after selective logging, represent significant habitats for birds. Given the limited area and period of the survey the total species count of 110 species for Lunang compares favourably with the 144 species recorded for both freshwater and peat swamp forests (combined) in the province of South Sumatra by Verheugt *et al.* (1993). Gaither (1994) concluded that the avifauna of peat swamp forest was somewhat depauperate compared to that of dipterocarp forest at GPNP, but our

study indicates that the understory assemblage at Lunang is as rich as the latter, and even richer than that of the Bornean forests sampled by Sodhi (2002). The importance of degraded habitats, such as regenerating secondary forests, forest gardens and abandoned farms, for the conservation of birds has been well documented for Sulawesi (Sodhi *et al.* 2005; Waltert *et al.* 2005), but requires further study for Sundaic birds (see also Lambert 2002).

Censuses conducted during this study indicate that Lunang swamp forest may also be regionally important for the conservation of waterbirds, due to the presence of two endangered species. Three White-winged Ducks *Cairina scutulata* (listed in CITES Appendix I) were seen during one census, confirming the first report of the species at Lunang by Holmes & Rombang (2001). A single Storm's Stork *Ciconia stormi* was also seen and photographed on the river during a census (listed in CITES Appendix II). Most reports of these two species on Sumatra are from the south and east (see Holmes 1996). Lunang is also home to, or visited by, five species of raptors and four species of hornbills that are listed on CITES appendices (Appendix 1).

Davie & Sumardja (1997) concluded that the protection of Sumatra's coastal wetlands is failing, not because of a lack of protected areas, but due to a lack of regional planning strategies in which nature conservation is integrated with the economic and social needs of the human communities living around them. An example of the failure of the single-use protected area approach is the severe degradation of the Pantai Timur Nature Reserve adjoining Berbak National Park in Jambi Province (Davie & Sumardja 1997). Originally proposed for the protection of several species of waterbirds, including the threatened Milky Stork *Mycteria cinerea*, two-thirds or more of the original reserve area remains, much of it converted to coconut gardens or degraded through cutting. Similarly, the long-term security of Lunang swamp forest may depend on its incorporation into a regional land use plan, wherein the economic and social conditions of local people are duly considered rather than ignored.

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Appendix 1 Birds recorded in Lunang swamp forest during April-June 2001, showing number of 20 species lists on which species seen and/or heard, and total number of individuals banded. Species in bold, listed in CITES appendices.

Scientific name	English name	Total censuses	Total banded
<i>Ardea purpurea</i>	Purple Heron	2	
<i>Egretta sacra</i>	Eastern Reef-egret	1	
<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	3	
<i>Ciconia stormi</i>	Storm's Stork	3	
<i>Elanus caeruleus</i>	Black-winged Kite	7	
<i>Haliaeetus leucogaster</i>	White-bellied Fish-Eagle	1	
<i>Spilornis cheela</i>	Crested-Serpent Eagle	1	
<i>Accipiter trivirgatus</i>	Crested Goshawk	1	
<i>Microhierax fringillarius</i>	Black-thighed Falconet	2	
<i>Dendrocygna javanica</i>	Lesser Whistling-Duck	1	
<i>Cairina scutulata</i>	White-winged Duck	1	
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	5	
<i>Treron curvirostra</i>	Thick-billed Green Pigeon	1	
<i>Treron vernans</i>	Pink-necked Green-Pigeon	1	
<i>Ducula aenea</i>	Green Imperial-Pigeon	7	
<i>Ducula badia</i>	Mountain Imperial-Pigeon	1	
<i>Streptopelia chinensis</i>	Spotted Dove	1	
<i>Chalcophaps indica</i>	Emerald Dove	1	1
<i>Psittacula alexandri</i>	Red-breasted Parakeet	1	
<i>Psittacula longicauda</i>	Long-tailed Parakeet	1	
<i>Psittinus cyanurus</i>	Blue-rumped Parrot	2	
<i>Loriculus galgulus</i>	Blue-crowned Hanging Parrot	2	
<i>Cuculus saturatus</i>	Oriental Cuckoo	1	
<i>Cacomantis merulinus</i>	Plaintive Cuckoo	3	1
<i>Cacomantis sepulcralis</i>	Rusty-breasted Cuckoo	1	
<i>Chrysococcyx xanthorhynchus</i>	Violet Cuckoo		
<i>Rhopodytes diardi</i>	Black-bellied Malkoha	2	
<i>Rhopodytes sumatranus</i>	Chestnut-bellied Malkoha	2	
<i>Rhinorhiza chlorophaea</i>	Raffles's Malkoha	8	
<i>Rhamphococcyx curvirostris</i>	Chestnut-breasted Malkoha	1	
<i>Centropus sinensis</i>	Greater Coucal	5	1
<i>Bubo sumatranus</i>	Barred Eagle-owl	1	
<i>Eurostopodus temminckii</i>	Malaysian Eared Night jar	1	
<i>Caprimulgus indicus</i>	Grey Night jar	1	
<i>Collocalia esculenta</i>	Glossy Swiftlet	3	
<i>Apus affinis</i>	Little Swift	1	
<i>Hemiprocne comata</i>	Whiskered Tree-swift	10	
<i>Alcedo atthis</i>	Common Kingfisher	1	
<i>Alcedo meninting</i>	Blue-eared Kingfisher	8	14
<i>Ceyx erithacus</i>	Oriental Dwarf Kingfisher	2	2
<i>Pelargopsis capensis</i>	Stork-billed Kingfisher	5	1
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	5	
<i>Rhyticeros corrugatus</i>	Wrinkled Hornbill	5	
<i>Rhyticeros undulatus</i>	Wreathed Hornbill	1	
<i>Anthracoceros malayanus</i>	Asian Black Hornbill	3	
<i>Anthracoceros albirostris</i>	Oriental Pied Hornbill	7	
<i>Buceros rhinoceros</i>	Rhinoceros Hornbill	2	
<i>Rhinoplax vigil</i>	Helmeted Hornbill	1	

<i>Megalaima chrysopogon</i>	Gold-whiskered Barbet	1	
<i>Megalaima mystacophanos</i>	Red-throated Barbet	1	
<i>Megalaima australis</i>	Blue-eared Barbet	2	
<i>Sasia abnormis</i>	Rufous Piculet	2	7
<i>Celeus brachyurus</i>	Rufous Woodpecker	1	1
<i>Picus miniaceus</i>	Banded Woodpecker	2	
<i>Meiglyptes tristis</i>	Buff-rumped Woodpecker	2	1
<i>Meiglyptes tukki</i>	Buff-necked Woodpecker	1	2
<i>Dendrocopos macei</i>	Fulvous-breasted Woodpecker	1	
<i>Blythipicus rubiginosus</i>	Maroon Woodpecker	2	
<i>Reinwardtipicus validus</i>	Orange-backed Woodpecker	1	
<i>Cymbirhynchus macrorhynchus</i>	Black-and-red Broadbill	4	4
<i>Eurylaimus ochromalus</i>	Black-and-Yellow Broadbill	4	3
<i>Hirundo rustica</i>	Barn Swallow	1	
<i>Pericrocotus igneus</i>	Fiery Minivet	2	
<i>Hemipus picatus</i>	Bar-winged Flycatcher-Shrike	1	
<i>Hemipus hirundinaceus</i>	Black-winged Flycatcher-Shrike	5	
<i>Aegithina viridissima</i>	Green Iora	2	
<i>Chloropsis sonneratii</i>	Greater Green Leafbird	3	
<i>Chloropsis cyanopogon</i>	Lesser Green Leafbird	1	1
<i>Chloropsis cochinchinensis</i>	Blue-winged Leafbird	2	
<i>Pycnonotus atriceps</i>	Black-headed Bulbul		5
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	1	
<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul	4	
<i>Pycnonotus plumosus</i>	Olive-winged Bulbul		1
<i>Pycnonotus simplex</i>	Cream-vented Bulbul	3	3
<i>Pycnonotus brunneus</i>	Red-eyed Bulbul	7	4
<i>Pycnonotus erythrophthalmos</i>	Spectacled Bulbul	1	5
<i>Lanius cristatus</i>	Brown Shrike	1	
<i>Copsychus saularis</i>	Magpie Robin	3	
<i>Trichastoma rostratum</i>	White-chested Babbler	4	13
<i>Stachyris maculata</i>	Chestnut-rumped Babbler		2
<i>Stachyris nigricollis</i>	Black-throated Babbler	1	2
<i>Stachyris erythroptera</i>	Chestnut-winged Babbler	1	4
<i>Macronous gularis</i>	Striped Tit-Babbler	1	13
<i>Macronous ptilosus</i>	Fluffy-backed Tit-Babbler	8	5
<i>Prinia familiaris</i>	Bar-winged Prinia	6	
<i>Orthotomus atrogularis</i>	Dark-necked Tailorbird		1
<i>Orthotomus sericeus</i>	Rufous-tailed Tailorbird	1	2
<i>Orthotomus ruficeps</i>	Ashy Tailorbird	8	7
<i>Cyornis turcosus</i>	Malaysian Blue-Flycatcher	5	6
<i>Hypothymis azurea</i>	Black-naped Monarch	1	2
<i>Terpsiphone paradisi</i>	Asian Paradise-Flycatcher	1	
<i>Rhipidura javanica</i>	Pied Fantail	1	3
<i>Rhipidura perlata</i>	Spotted Fantail	2	1
<i>Prionochilus maculatus</i>	Yellow-breasted Flowerpecker	2	
<i>Dicaeum trigonostigma</i>	Orange-bellied Flowerpecker	3	2
<i>Antheptes malacensis</i>	Plain-throated Sunbird	1	4
<i>Antheptes singalensis</i>	Ruby-cheeked Sunbird	7	8
<i>Hypogramma hypogrammicum</i>	Purple-naped Sunbird	2	7
<i>Nectarinia sperata</i>	Purple-throated Sunbird	3	
<i>Aethopyga siparaja</i>	Crimson Sunbird		2
<i>Arachnothera longirostra</i>	Little Spiderhunter	2	8
<i>Lonchura striata</i>	White-rumped Munia	1	1
<i>Lonchura punctulata</i>	Scaly-breasted Munia	1	

<i>Lonchura maja</i>	White-headed Munia	1	
<i>Passer montanus</i>	Eurasian Tree Sparrow	2	
<i>Ploceus hypoxanthus</i>	Asian Golden Weaver	2	1
<i>Gracula religiosa</i>	Hill Myna	7	
<i>Dicurus paradiseus</i>	Greater Racquet-tailed Drongo	8	1
<i>Corvus enca</i>	Slender-billed Crow	7	
<i>Corvus macrorhynchos</i>	Large-billed Crow	1	