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BIRD COMMUNITIES IN DISTURBED LOWLAND FOREST HABITATS OF SOUTHERN THAILAND

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ABSTRACT

The bird community in a disturbed mature forest was compared with that found in secondary forest and a regenerating clearing. The mature forest sample areas had only slightly higher species richness, but relatively greater diversity as measured by Fisher's α index of diversity. The commonest species were relatively more abundant in the secondary forest and clearings than in mature forest habitat. The secondary forest nevertheless was still rich in bird species, supporting some nationally or internationally threatened species including terrestrial insectivores such as Gurney's Pitta *Pitta gurneyi* and Large Wren-Babbler *Napothera macrodactyla*. However, specialist frugivores such as pigeons, Green Broadbill *Calyptomena viridis* and Asian Fairy Bluebird *Irena puella* and some arboreal insectivores such as malkohas, woodpeckers and *Malacopteron* babblers, were much less frequent in the secondary forest than in the tall forest. Secondary forest and clearing were similar in the overwhelming abundance of a few species of bulbuls which were generalist insectivore-frugivores. Patches of secondary or degraded forest outside the margins of parks or sanctuaries may offer the only option for the expansion of protection into the lowland forest biome since there is virtually no mature forest left in the Thai lowlands. More work needs to be done to judge the conservation attributes of the smaller and more isolated forest fragments.

INTRODUCTION

Most studies of Southeast Asian forest bird communities have been conducted in the only weakly seasonal lowland forests of peninsular Malaysia (JOHNS, 1986, 1989; WELLS, 1978, WONG, 1985, 1986) and Borneo (FOGDEN, 1972, LAMBERT, 1992). Southern Thailand, usually defined as that part of the country south of the Isthmus of Kra, ca. 10° N (MEDWAY & WELLS, 1976), though having a predominantly Sundaic flora and fauna, differs from Malaysia in some important respects. Peninsular Malaysian forests are dominated by *Shorea* spp. of the "red meranti" group, whereas the Thai forests are of the "white meranti" *Shorea* floristic formation (WHITMORE, 1984). A few species of lowland bird are confined to Malaysia, or shared between Malaysia and the extreme south of Thailand, while southern Thailand supports a few Indochinese birds which do not reach Malaya. The forests of southern Thailand, subject to a more seasonal (monsoonal) climate, with a pronounced four to five month dry season, may have been more vulnerable to human interference than forests farther south with a consequently longer history of intensive

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human settlement and use. More than 80 years ago ROBINSON (1915) noted the high incidence of forest cutting for agriculture: "Much destruction of jungle has taken place . . . the abandoned land growing up in bamboo and secondary growth . . ." Further, rapid post-war population growth, and the expansion of the road network, including logging roads, particularly during the 1970s, has since allowed widespread immigration into forest with the result that by the early to mid-1980s, virtually all of southern Thailand's lowland forest had been cleared (ROUND, 1988).

WELLS (1976, 1985) drew attention to the great conservation importance of forests of the level lowlands, below the hill-foot boundary, and identified roughly 40 species of Sundaic forest bird which were wholly or mainly associated with the level lowlands. He thought that hill slope habitats were a marginal habitat for such species, and postulated that slope populations of many species were not self-sustaining, or were sustained only by immigration from adjacent lowlands. Such a viewpoint has particular relevance for southern Thailand, where the majority of protected areas were established in the 1970s, after most lowlands had already been cleared or partially settled. Apart from an 80-km^2 remnant of peat-swamp forest at Chalerm Prakiat Wildlife Sanctuary in Sungei Golok and Sungei Padi Districts of Narathiwat, close to the border with Malaysia, all the major (non-marine) parks and sanctuaries are centered upon the steep hill slopes of the peninsular mountain spine, and their boundaries either follow the 100-m contour, or are set even higher than this.

One further area, Khao Nor Chuchi in Khlong Thom District, Krabi Province, was established as the Khao Pra-Bang Khram Non-Hunting Area in 1987 (later upgraded to a wildlife sanctuary in 1993) specifically in order to protect a lowland forest remnant identified by COLLAR, ROUND & WELLS (1986), and ROUND & TREESUCON (1986). The site is the last known stronghold of Gurney's Pitta *Pitta gurneyi,* a highly endangered, endemic, terrestrial forest bird, and supports a rich variety of other lowland forest birds which are scarce or absent from other protected areas. However, it is heavily disturbed and, even here, the most extensive patches of lowland forest were excluded from the sanctuary boundary because of the scattering of households throughout the area.

The many small fragments of degraded secondary forest and scrub lying outside the boundaries of other southern Thai protected areas may present a possible option for salvaging what little remains of the lowland forest biome, provided that the boundaries of existing protected areas can be expanded to incorporate them. An understanding of their properties is therefore essential for improved conservation management. This paper compares the bird communities found in mature forest; regenerating secondary forest, and a recent, regenerating clearing at Khao Nor Chuchi.

STUDY AREA AND METHODS

The study area lies within 1 km of the village of Ban Bang Tieo (7° 56' N; 99° 16' E) at 80–90 m above sea-level, close to where the lowlands abut the hill slopes. It comprises part of an area of approximately 30 km^2 of lowlands, of which roughly 70% is still covered with forest or secondary growth, with the remainder occupied by plantations or cleared areas, which lies adjacent to the wildlife sanctuary. It is also contiguous with roughly 100 km^2 of forest on hill slopes which rise to a maximum elevation of 650 m on the mountain of Khao Nor Chuchi. The forest is classified as semi-evergreen rain forest (WHITMORE, 1984) and is apparently typical of southern Thai lowland dipterocarp forests in the predominance of *Dipterocarpus kerrii* and the deciduous tree *Intsia palembanica* (WHITMORE, 1984). Very few *Intsia* trees remain today, however, since this valuable hardwood was among the first trees to be logged out. There is still a high level of human use of the area for forest products, including collection of fruits and seeds, cutting of rattans and polewood, and some small-scale cutting of timber. Some trees (genus *Dipterocarpus*) are also tapped for resin (*namman yang*). A moderate level of hunting and fishing of streams is also evident. Some birds and mammals such as Lesser Mouse Deer *Tragulus javanicus* are still shot for food, while lines of snares are sometimes set to catch terrestrial birds such as junglefowl. In spite of such disturbance, the area is still rich in bird species. A total of 318 species, both residents and migrants, have so far been found in forests and open-country at the site (ROUND & TREESUCON, 1998).

Soils are mainly sandy clays and loams, derived from Triassic sandstones, with small areas of limestone (data supplied by Department of Land Development, and Department of Mineral Resources). Annual rainfall, measured on-site during 1991–1994, ranged from 1635–2165 mm (Table 1). Average daily temperatures, measured at Trang, ranged from 26.4 °C in November to 29.0 °C in April (SARIGABUTR *ET AL.*, 1982).

The forest study plots lay in the level lowlands close to the hill-foot boundary (Figure 1). Transects were laid out in three different habitat types: disturbed mature, tall forest; secondary forest; and clearing. These will be described further below, following explanations of the methods used.

Table 1. Rainfall data from Bang Tieo. Column a = no. of wet days; column b = monthly rainfall (mm).

	1991		1992		1993		1994	
Month	a	b	a	b	a	b	a	b
Jan	4	22.6	2	18.3	3	9.0	0	0.0
Feb	2	48.2	0	0.0	0	0.0	2	54.5
Mar	6	106.2	3	34.3	7	135.9	6	76.5
Apr	6	37.0	6	28.4	9	94.7	13	181.1
May	24	377.9	11	156.0	14	154.3	19	219.9
Jun	7	58.4	13	116.0	14	175.0	16	222.2
Jul	19	424.3	16	237.8	19	281.5	15	183.8
Aug	22	257.6	16	408.0	13	159.5	15	184.1
Sep	15	161.8	17	262.9	18	271.4	19	269.6
Oct	17	137.6	18	239.5	19	336.9	17	220.2
Nov	9	67.2	12	128.9	15	284.7	14	188.3
Dec	13	95.6	6	5.3	11	259.8	3	14.4
Total	144	1794.4	120	1635.4	142	2162.7	139	1814.6

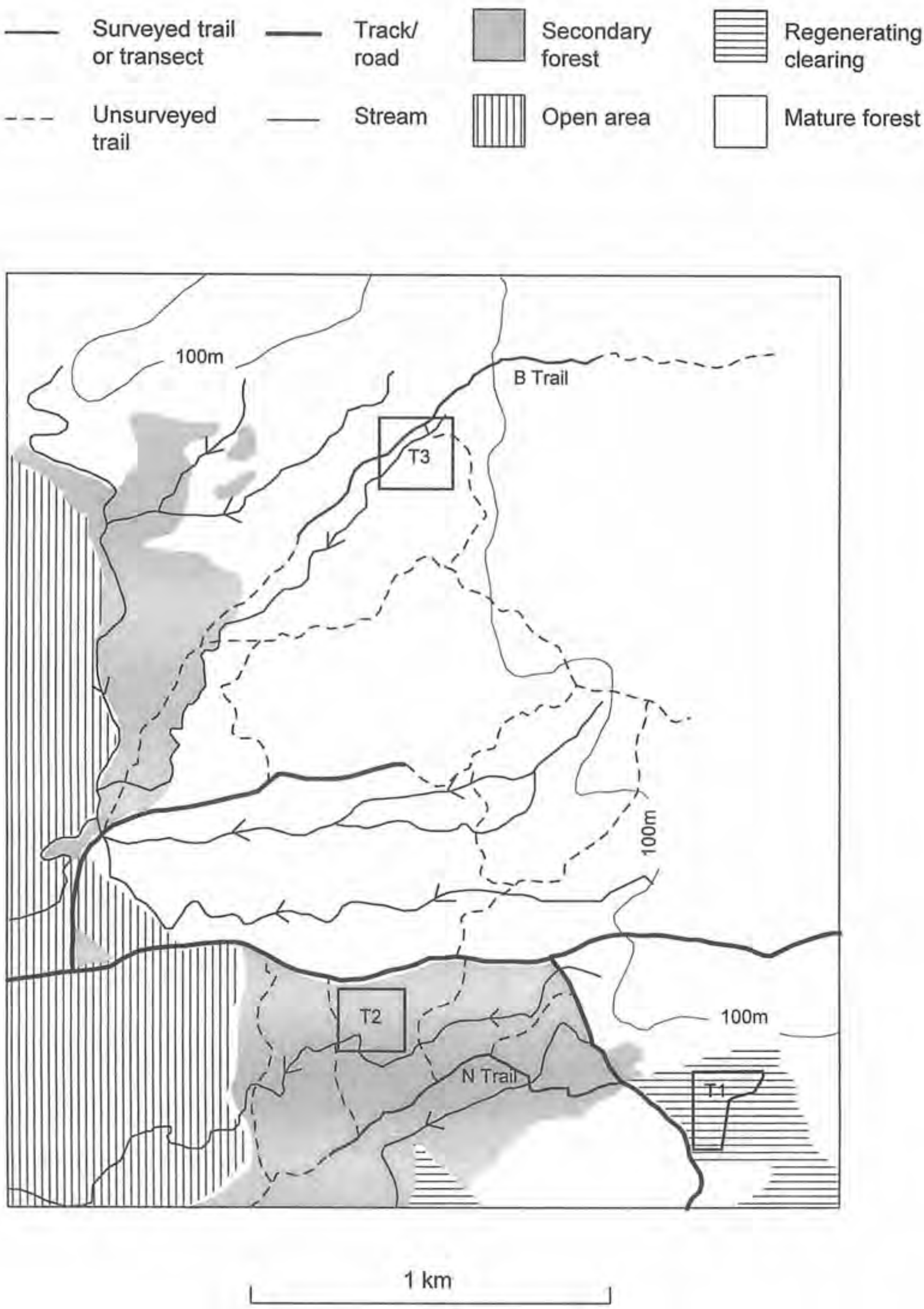


Figure 1. Map of study area and surroundings.

Forest Structure Measurement

The selectively logged mature forest (MF) and the secondary forest (SF) were characterized in terms of mean canopy surface height, percentage cover of canopy, and the density and diameter frequency distribution of trees. The height and cover measurements followed the methods of BROCKELMAN (1998), in which canopy surface height is measured directly over replicated points on the ground (the point-intercept method), and "canopy cover" is measured as the percentage of points that have branches or leaf cover directly above any given height. The canopy and its limits are not defined *a priori*. Rather, a curve is obtained which indicates the percentage of points with cover over them above any given level above the ground. The points are also used as sample reference points for obtaining tree density and diameter data (see below).

Placement of sample points. In each forest type, sample points were placed along 1200 m of straight transects cut around four square hectares placed contiguously to make a 4-ha square plot 200 m on a side. This yielded 100 sample points spaced 12 m apart.

Canopy height measurement. The highest leafy branch of any type of plant was measured to the nearest meter with an optical rangefinder (Forestry Suppliers, Inc., Jackson, MI, U.S.A.). Two models were used: model 123X for heights below 15 m, and model 620 for heights above 15 m. Before height measurement, the zenith point was first established by standing over the point and aiming a Suunto Clinometer. If no living vegetation was directly above a point, height was recorded as 0. The mean vegetation height over all 100 points is defined as "mean forest height".

Cover analysis. The frequency distribution of heights is summed cumulatively from the top down, and plotted on a graph which shows the percentage of points above every 5-m height interval, in relation to height (Fig. 2). From the slope of this curve one can determine where the main canopy lies, and the percentage canopy cover above any selected height. These curves have been found to be very sensitive to changes in forest density and disturbance.

Tree density and diameter distribution. The density of trees > 10 cm in diameter at breast height (dbh) was estimated using the point-centered quarter method (COTTAM & CURTIS, 1956), in which the distance (r) is measured from every point to the nearest tree within each of the four 90° quadrants surrounding the point. Tree density can be estimated as the overall mean of $1/r^2$ values. The sample of 400 trees near the 100 points was used to obtain a diameter distribution, which was summarized into geometric size classes for easy comparison between plots: 10–19, 20–39, 40–79, and > 80 cm dbh.

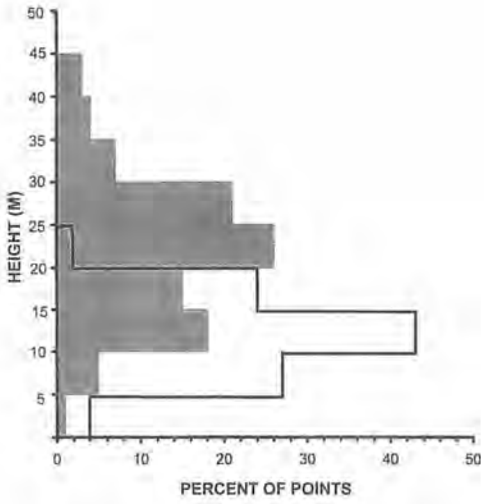
Study Plots

1. *Disturbed mature, tall forest*

Mean canopy height was 21.6 m (Table 2), but the main canopy extended to approximately 30 m (Fig. 2). Only 14 % of points had emergent trees above that level. The density of trees greater than 10 cm dbh was estimated at 585 per hectare. Ten percent of trees measured in the plot were at least 40 cm in dbh, but only 1 % were large trees greater than 80 cm. This is somewhat less than we expect to find in virgin tropical forest.

The bamboo *Schizostachyum zollingeri* was abundant, probably reflecting a high degree of former disturbance, including occasional cutting of large timber trees to satisfy local construction needs. According to local people, the area has never been logged by any timber company. *Dipterocarpus kerrii* trees were still being tapped for resin. *Intsia*, though once common in adjacent lowland areas, was absent from the study plot. Though no detailed floristic inventory has ever been conducted, some other trees of this tall forest included *Dipterocarpus baudi, Hopea odorata, Irvingia malayana, Shorea* spp. and *Ficus* spp. The understorey was rich in palms, especially *Licuala* sp. and *Salacca rumphii.*

The area encompassed one stream gulley which remained moist throughout the year though it was reduced to small, stagnant pools at the height of the dry season. The forest in which the plot was situated was contiguous with a major permanent stream, the Khlong Bang Tieo, which lay 0.5 km to the west (Fig. 1). For convenience, the terms tall forest or mature forest are used interchangeably for this habitat.



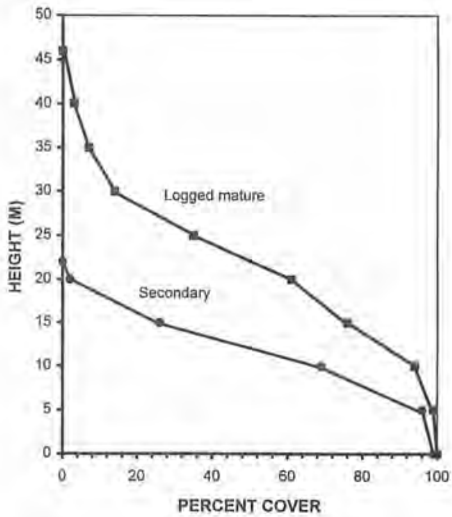


Figure 2. Forest height distribution (left), and height-cover profile (right) for disturbed mature tall forest (shaded in left figure) and secondary forest plots.

Table 2. Forest measurement data for disturbed mature tall forest and secondary forest

Measure	Disturbed mature forest	Secondary forest
Mean height, m	21.6	11.6
Standard deviation (CV)	8.25 (38)	4.14 (36)
Height at 50% cover	22.2	12.3
No. trees >10 cm dbh per ha	585	506
Tree diameter distribution, no. (%)		
10–19 cm	249 (62.3)	332 (83.0)
20–39	111 (27.8)	64 (16.0)
40–79	36 (9.0)	4 (1.0)
80 +	4 (1.0)	0
Total	400 (100)	400 (100)

2. *Secondary forest*

Parts of the secondary forest area were said by local villagers to have been buffalo pasture as recently as 30–40 years ago. Typically such areas were used non-intensively so that even at the height of clearance, some large forest trees would have remained among open grassy areas. At time of the survey, the area had reverted to dense forest, but a low level of harvesting of the wood of the tree *Cratoxylum cochinchinense* for charcoal continued until at least 1986.

The average canopy height was 11.6 m and the top of the main canopy was no higher than 20 m (Table 2; Fig. 2). The mean density of trees having dbh > 10 cm was 506 per hectare. The great majority of trees measured (83 %) lay in the smallest size class. Only 1.0% exceeded 40 cm dbh and there were no trees greater than 80 cm. This plot had a high density of saplings and shrubs.

The predominant tree species included *Cassia* sp., *Millettia atropurpurea, Cratoxylum cochinchinense* and *Dillenia obovata.* Dipterocarp trees were very scarce and *Ficus* spp. were less frequent than in the mature forest. There was a dense understorey, which was rich in palms including *Licuala* sp., *Salacca rumphii, Calamus longisetus* and *C. palustris. Pandanus humilis* was frequent in ground storey vegetation. The area was transected by two small stream gullies which remained moist throughout the year, though water was much reduced during the dry season. The secondary forest habitat was contiguous with the tall (mature) forest and graded into it.

3. *Clearing*

The clearing was an area of approximately 0.17 km^2 which was clear-cut and burned during the 1985–1986 dry season. At the time the survey began, in May 1991, it was therefore supporting secondary regrowth of age five years. The area was bordered by a rubber plantation on one side, by tall forest on two sides, and by a moist gully with some forest vegetation. A line of trees up to 8–10 m in height remained in one part of the clearing, though it was otherwise covered with low scrub, including *Melastoma* sp. and lalang grass *Imperata cylindrica.* A few rubber trees had been planted. Many small pioneer forest trees such as *Dillenia obovata* and *Macaranga* sp. had become established. It was transected by a moist gully.

Transect Counts

A total of 1.8 km of transect was established in each of two habitats, disturbed mature forest and secondary forest. Each consisted of 1 km of established nature trail (B Trail and N Trail in mature and secondary forest, respectively), and an adjacent 800 m around the square plots 200 m on a side described above (T3 and T2 in mature and secondary forest, respectively). We laid out 860 m of transect in the clearing (T1) in the form of an irregular polygon (Fig. 1). The length of transect in each habitat was shorter than originally desired, and constrained by the high degree of disturbance: it was difficult to find large patches of sufficiently homogeneous habitat in which to lay out longer transects. The secondary forest transects were, at the starting point, separated only by an 8-m wide dirt track from where the secondary forest began to grade into tall forest.

Each transect was visited 17–19 times during the period April 1991 to July 1992. This made a total of 35 survey visits in mature forest, 36 in secondary forest, and 19 in the regenerating clearing (Table 3). Survey visits were spread more or less evenly throughout

Table 3. Seasonal distribution of survey visits among transects studied

	Disturbed mature forest		Secondary forest		Clearing
	T3	B Trail	T2	N Trail	T1
May 91	1		1		1
June 91	1		2		2
July 91	3		1		1
Aug 91		2		2	
Sept 91					1
Oct 91	1		1		
Nov 91		1			
Dec 91					1
Jan 92	2	2	2	2	2
Feb 92	1	2	2	2	2
Mar 92	1	2	2	2	2
Apr 92	2	2	1	3	1
May 92	2	2	2	3	2
June 92	2	2	2	2	2
July 92	2	2	2	2	2
Total	18	17	18	18	19

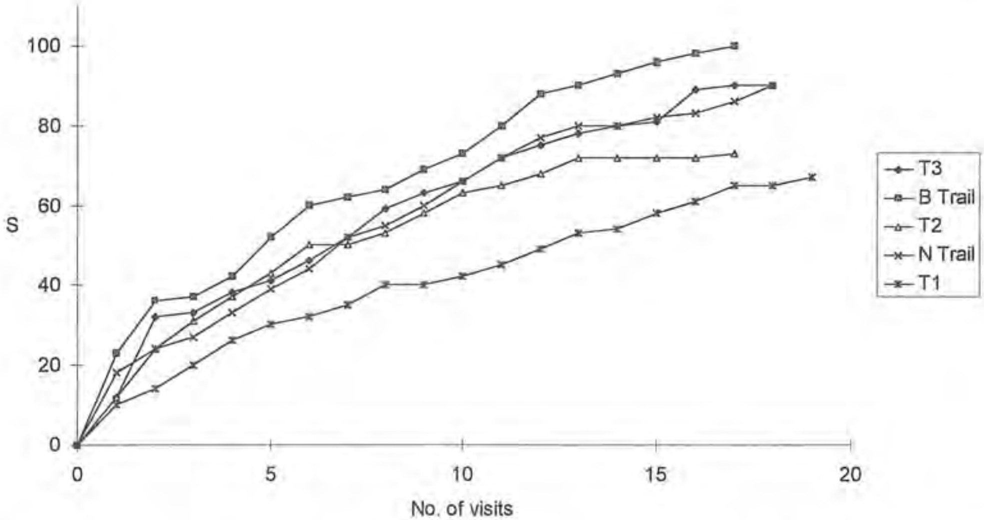


Figure 3. Species accumulation curves for study plots in mature forest, secondary forest, and regenerating clearing.

the year, though slightly fewer visits were made during the early part of the winter, October to December. Censuses were usually made during the morning, between 0700 h and 1100 h. It usually took only 1 to 2 hours to complete each transect. Every bird seen or heard within an estimated 30 m of the transect line was noted. The observers had a high degree of familiarity with the birds of the area, so the great majority of birds could be easily identified by call. The chief difficulty experienced was in separating some of the vocalizations of leafbirds, *Chloropsis* spp., and some *Pycnonotus* bulbuls. Bird species were classified according to feeding guild, following the classification used in JOHNS (1986).

Measurement of Species Diversity

Species diversity was measured in two ways in the plots and transects: as the total number of species, S ("species richness"), and as Fisher's index, α (FISHER, CORBET & WILLIAMS, 1943; see also HAYEK & BUZAS, 1997; MAGURRAN, 1988; MAY, 1975; for methods of calculation and discussion). Fisher's α is a good comparative index of diversity when the number of species and individuals is relatively large, and when the distribution of frequency classes is fit reasonably well by the logarithmic series distribution. Fisher's α does not change markedly with increases in total sample size N.

In order to provide a crude visual test of fit of the data to the logarithmic series distribution, we plotted, for each area sampled, log n_i against i, the species sequence number in decreasing order of abundance (Fig. 4). These curves are straight if the data conform to the logarithmic series, and they also provide a more intuitive picture of how the data may differ between plots in diversity.

RESULTS

Species Accumulation

Species discovery curves for the plots (Fig. 3) did not reach asymptotes although those for rectangular plots, T3 and T2, tended to level off more than did curves from the longer trail-plots (B and N), presumably because they were sampling a much more limited area of forest. The curves for the mature forest plots climbed more steeply than those for the secondary forest plots or the clearing. The shape of these curves is typical for tropical forest habitats where there are a great number of rare species (JOHNS, 1986). It is clear that the total numbers of species found in these habitats do not yet reflect the real "true" species richness expected to be there.

Frequency Distribution

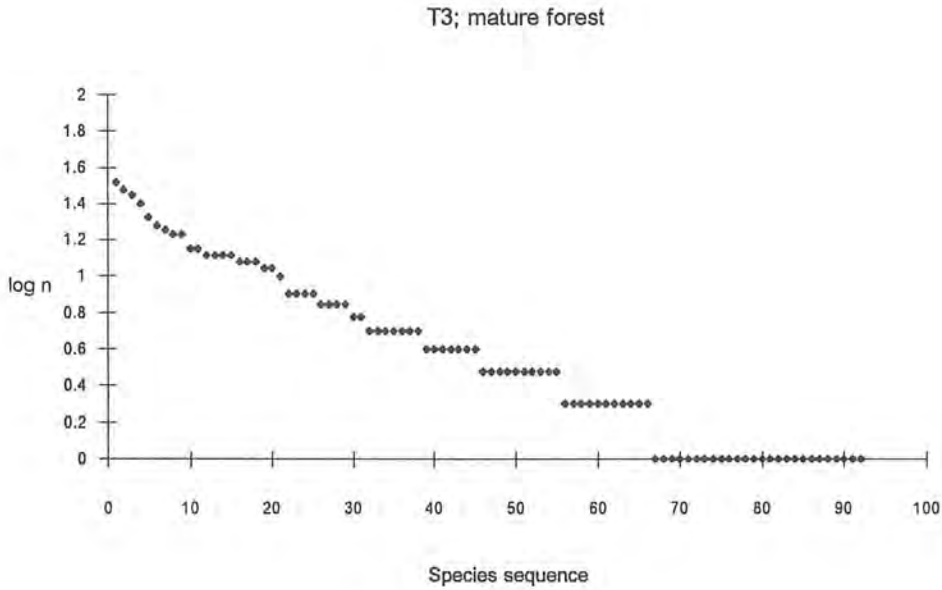
The frequency curves for all five plots were similar, with a few abundant species, and a long "tail" of rare species with a large number represented by only one individual. The more disturbed plots (secondary forest and regenerating clearing) showed a less even distribution, with greater predominance of a few, highly abundant species than did the mature forest plots (compare Figures 5 and 6 with Figure 4). The pattern in all plots could be satisfactorily described by the log-series mathematical model. (Mature forest plots: T3, $\chi^2 = 2.4$, df = 4, $P>0.5$; B Trail, $\chi^2 = 8.4$, df = 4, $P>0.05$; secondary forest plots: T2, $\chi^2 = 3.0$, df = 4, $P>0.5$; N Trail, $\chi^2 = 4.9$, df = 5, $P>0.3$; regenerating clearing T1, $\chi^2 = 7.0$; df = 5, $P>0.2$).

Species Richness and Diversity

A total of 162 species of birds was recorded during the entire census period (Appendix 1). The total number of species in the tall forest areas (110) was almost identical with the total for the secondary forest habitat (109); however, the numbers of species for the respective plots and trails were greater in the tall forest by 19 and 9 species (Table 4).

Table 4. Summary of species richness and diversity indices for all plots and trails

Habitat	No. of species	No. exclusive species	Fisher's α	No. of observations
Mature forest	110	35		
T3 plot	92	–	31.0	569
B trail	100	–	32.8	657
Secondary forest	109	24	–	–
T2 plot	73	–	22.6	551
N trail	91	–	27.0	757
Clearing, T1	67	13	19.2	613



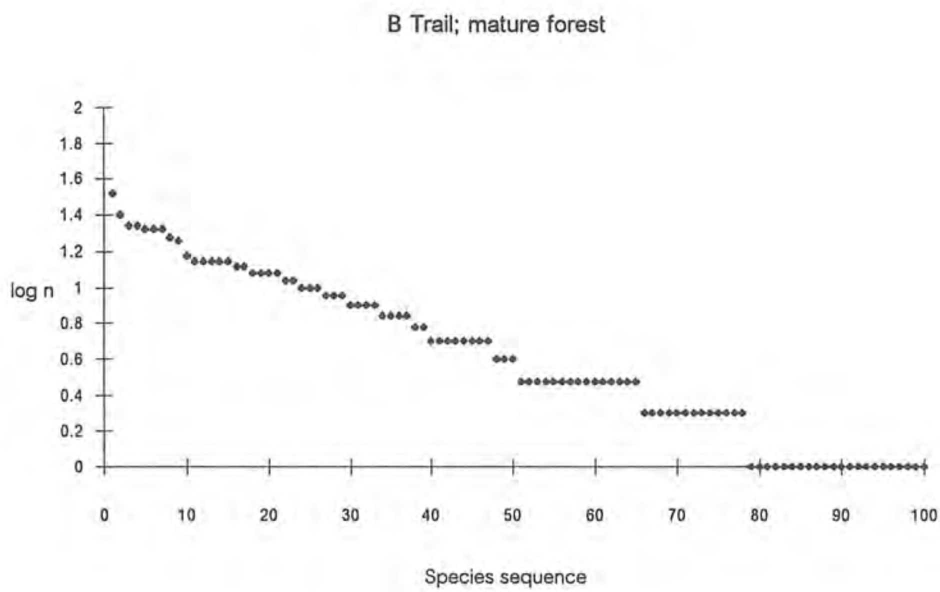


Figure 4. Frequency distribution curves for study plots in mature forest.

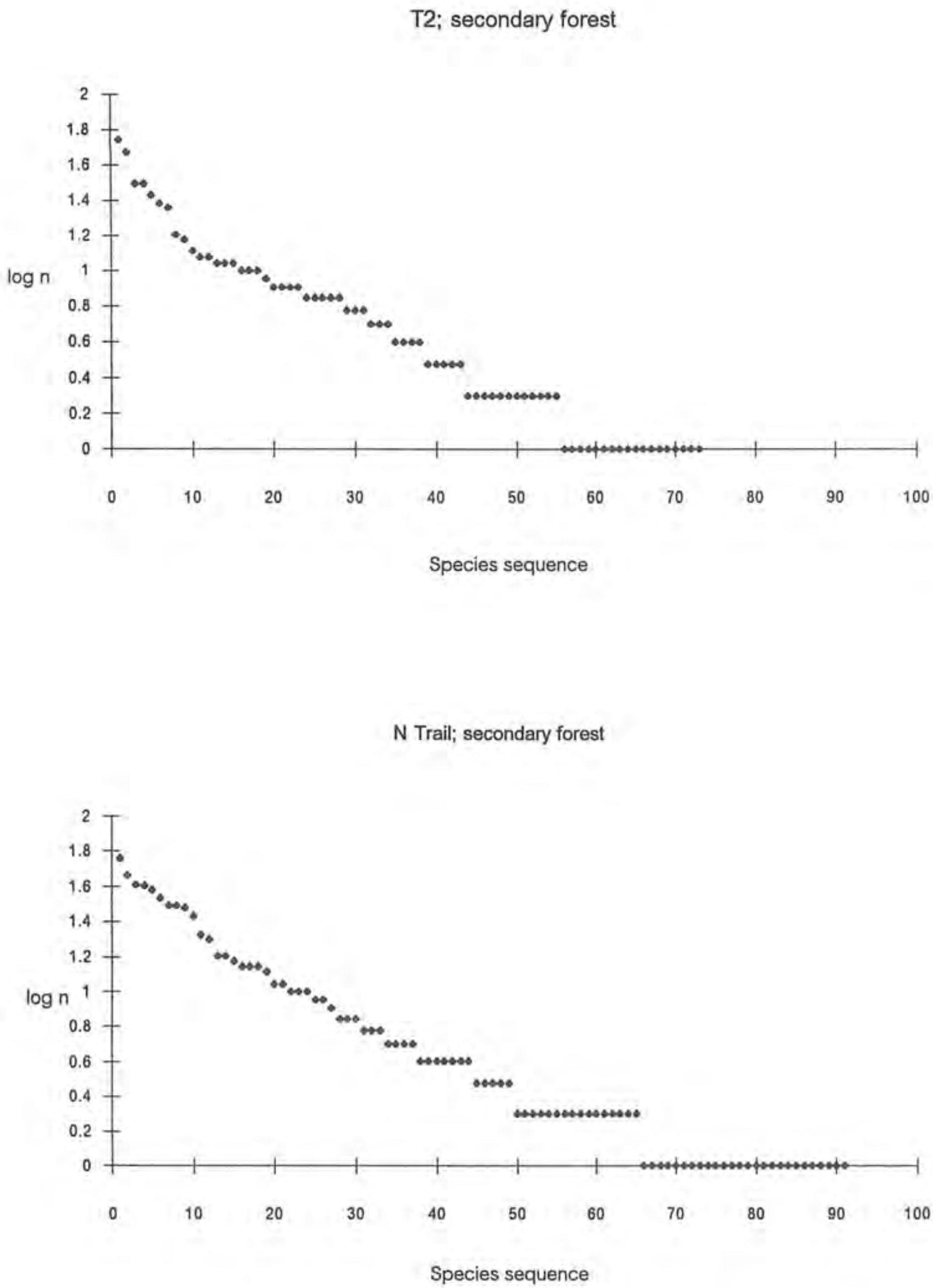


Figure 5. Frequency distribution curves for study plots in secondary forest.

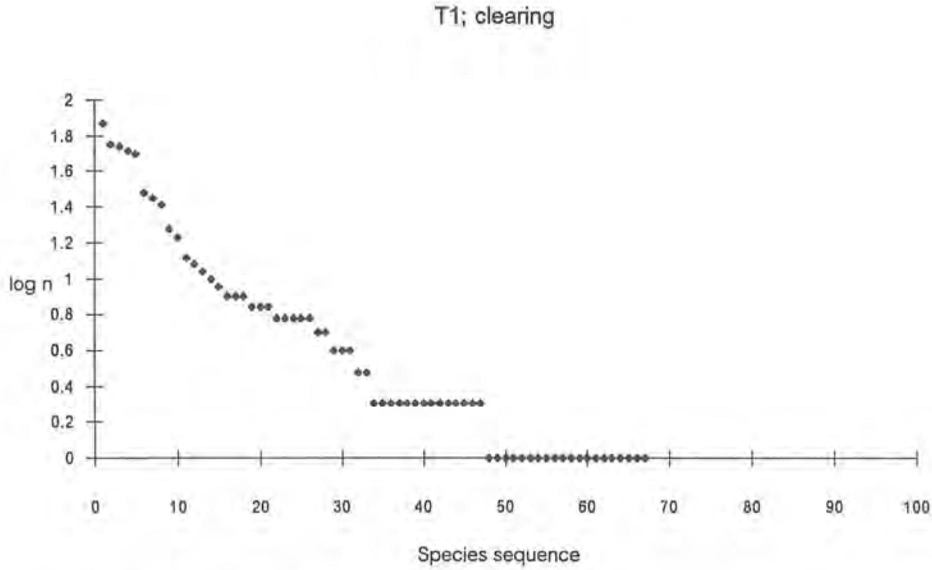


Figure 6. Frequency distribution curve for study plot in regenerating clearing.

These differences were still surprisingly small, although the total from the secondary forest included a number of open-country species which had colonised small open areas inside the secondary forest, including *Turnix suscitator, Caprimulgus macrurus, Pycnonotus goiavier* and *Lonchura striata.* A total of 34 species was found in all three habitats; 35 species were observed only in mature forest; 37 were shared between both mature and secondary, and 24 species were in secondary forest only. Only 13 species were found in the clearing but not elsewhere, and a further 14 were shared between the clearing and secondary forest. Five species *(Rhyticeros undulatus, Megalaima australis, Pericrocotus flammeus, Pycnonotus erythropthalmos* and *Arachnothera affinis)* were found in both the clearing and the mature forest, but not in any other habitat.

The apparent continued species-richness of the clearing, which had 67 species, was partly due to the fact that it was bordered on three sides by tall forest and was therefore visited by forest-living species. On occasion, some canopy or upper storey species *(e.g., Pericrocotus flammeus* and *Oriolus xanthonotus)* descended into small trees in the clearing. A number of others (*e.g.,* the three raptors, *Accipiter trivirgatus, Spilornis cheela* and *Spizaetus alboniger*; Vernal Hanging Parrot, *Loriculus vernalis,* Violet Cuckoo *Chrysococcyx xanthorhynchus,* swiftlets *Aerodramus* sp., Grey-rumped Treeswift *Hemiprocne longipennis* and Wreathed Hornbill *Rhyticeros undulatus*) were seen flying overhead. Such species would have been more likely to have been recorded in the clearing because of the easier viewing conditions. Most of them would not have been detected in a closed canopy forest or secondary forest unless heard calling.

The differences in species richness between the mature forest and degraded habitats were nevertheless considerably less than we would predict from the differences in habitat structure alone (Table 2, Fig. 2). The logged mature forest is nearly twice as tall as the secondary forest, and has more large trees; one would think that a much higher diversity of species would find living space there.

Fisher's α diversity index shows somewhat more marked differences between the mature forest and other habitats than does simple species richness. Inspection of the curves in Figures 4, 5 and 6 indicates that the differences are due not only to differences in total S, but to the somewhat greater relative abundances of the most common species in the secondary forest and clearing habitats. The fact that the most common species were more common in these habitats than in the mature forest causes the curves to deviate more from linearity on the left, and therefore to fit the logarithmic series less well. In a more diverse habitat, species should differ less in relative abundance. This is seen in the somewhat lower slopes of the two curves for the mature forest in comparison with other habitats.

Species Composition

A trophic breakdown (Table 5) shows that in both mature and secondary forest plots, there was an overwhelming predominance of foliage-gleaning insectivores, followed by arboreal insectivore/frugivores, and arboreal frugivores. This apparent similarity conceals some profound differences in species composition between mature and secondary forest, especially among frugivores. Asian Fairy-bluebird *Irena puella* was the single most frequently recorded bird in mature forest, and four other species which are more or less obligate frugivores (*Calyptomena viridis, Loriculus vernalis, Chalcophaps indica* and *Prionochilus maculatus*, listed in decreasing order of abundance) all featured in the top 10

Table 5. Numbers of individuals (n) and number of species (s) recorded per guild in tall forest, secondary forest and clearing. (See Appendix for assignment of species to guilds.)

Guild	Mature forest		Secondary forest		Clearing	
	n	s	n	s	n	s
R	18	2	5	2	4	3
P	1	1	1	1	1	1
AF	182	9	164	11	46	7
TF	27	1	10	1	0	0
AIF	237	20	388	18	210	13
TIF	2	1	13	5	2	1
TI	61	7	117	12	41	3
FGI	424	41	320	34	232	22
BGI	20	7	10	3	0	0
SwI	12	2	21	4	19	1
SaI	142	9	174	8	14	6
FF	10	2	8	2	4	1
IN	88	5	105	8	46	7

Table 6. The twenty most frequently recorded bird species in mature forest, secondary forest, and clearings, listed in order of abundance. Figures are number and percentage of sightings.

Mature forest		Secondary forest		Clearing	
Irena puella	63 5.04	*Pycnonotus atriceps*	113 8.43	*Macronous gularis*	74 11.75
Abroscopus superciliaris	54 4.32	*Orthotomus atrogularis*	93 6.94	*Pycnonotus atriceps*	56 8.89
Arachnothera longirostra	50 4.00	*Arachnothera longirostra*	62 4.63	*Orthotomus atrogularis*	55 8.73
Copsychus malabaricus	47 3.76	*Pellorneum ruficeps*	58 4.33	*Pycnonotus finlaysoni*	52 8.25
Terpsiphone paradisi	46 3.68	*Hypothymis azurea*	58 4.33	*Pycnonotus plumosus*	50 7.94
Calyptomena viridis	40 3.20	*Cyornis tickelliae*	53 3.96	*Pellorneum ruficeps*	30 4.76
Orthotomus atrogularis	39 3.12	*Pycnonotus finlaysoni*	51 3.81	*Prinia flaviventris*	28 4.44
Loriculus vernalis	31 2.48	*Dicaeum cruentatum*	51 3.81	*Arachnothera longirostra*	26 4.13
Prionochlus maculatus	31 2.48	*Terpsiphone paradisi*	45 3.36	*Aerodramus fuciphagus*	19 3.0
Chalcophaps indica	27 2.16	*Copsychus malabaricus*	44 3.28	*Copsychus malabaricus*	17 2.70
Megalaima mystacophanos	27 2.16	*Pycnonotus simplex*	40 2.99	*Prionochilus maculatus*	13 2.06
Malacopteron magnirostre	25 2.00	*Pycnonotus melanicterus*	37 2.76	*Pycnonotus simplex*	12 1.90
M. cinereum	25 2.00	*Macronous gularis*	32 2.39	*Lonchura striata*	11 1.75
Rhinomyias olivacea	25 2.00	*Prionochilus maculatus*	32 2.39	*Stachyris erythroptera*	10 1.59
Criniger ochraceus	24 1.92	*Irena puella*	27 2.02	*Hemiprocne longipennis*	9 1.4
Pellorneum capistratum	22 1.76	*Luscinia cyane*	25 1.87	*Pycnonotus melanicterus*	8 1.27
Hypsipetes criniger	20 1.60	*Pycnonotus plumosus*	21 1.57	*Pycnonotus erythropthalmos*	8 1.27
Hypsipetes charlottae	20 1.60	*Calyptomena viridis*	19 1.42	*Stachyris rufifrons*	8 1.27
Criniger phaeocephalus	19 1.52	*Hypsipetes criniger*	19 1.42	*Pericrocotus flammeus*	7 1.11
Harpactes diardii	19 1.52	*Hypsipetes charlottae*	19 1.42	*Prinia rufescens*	7 1.11

species (Table 6) with the insectivore/frugivore *Megalaima mystacophanos* being the 11th most frequently recorded. None of these featured in the top 10 species of secondary forest, and only two (*I. puella* and *C. viridis*) featured in the top 20, being 15th and 18th most abundant respectively. Flowerpeckers, especially the highly ecologically tolerant Scarlet-backed Flowerpecker *Dicaeum cruentatum*, contributed more to arboreal frugivores in secondary forest (Appendix 1).

In secondary forest, by far the most abundant species overall was the Black-headed Bulbul *Pycnonotus atriceps* which is an ecologically tolerant, edge-loving, species which feeds to a great extent on the small fruits of pioneer tree species. *Pycnonotus finlaysoni* was also frequent in secondary forest, being seventh most abundant, while it was not recorded from mature forest. This preponderance of commoner, edge-loving bulbuls is reflected in the proportionately greater number of arboreal insectivores/frugivores, of fewer species, in secondary forest and clearing than in tall forest (Table 5).

Among insectivorous birds (TI and FGI) the terrestrial insectivore *Pellorneum ruficeps* was the fourth commonest species in secondary forest and was one of only two babbler species in the top 20 species for secondary forest (the other was the generalist, middle-storey and forest edge forager, *Macronous gularis*). In tall forest, *P. ruficeps* was absent and was replaced by its congener, *P. capistratum*, placed 16th most abundant, which has similar terrestrial feeding habits. Another example of a similar ecological replacement was among flycatchers. Fulvous-chested Flycatcher *Rhinomyias olivacea* was 13th most abundant species in tall forest, but was replaced by Tickell's Blue Flycatcher *Cyornis tickelliae,* sixth most abundant, in secondary forest. Both species are understorey-inhabiting, sallying insectivores. While *Cyornis* was once recorded in disturbed mature forest, *Rhinomyias* was never found in secondary forest.

The great scarcity of *Malacopteron magnum,* one of the more abundant species in mature, unlogged forest in Malaysia (JOHNS, 1986,1989; WELLS, 1978) was very noticeable. *M. magnum* was only recorded twice during the present study: once in tall forest and once in secondary forest. However, two congeners, *Malacopteron magnirostre* and *M. cinereum,* generally outnumber *M. magnum* in lowland forest; the latter being commoner on hill slopes (WELLS, 1978 and *in litt.*). During this study, *M. magnirostre* and *M. cinereum* were the 12th and 13th most frequently recorded species respectively in mature forest. *M. cinereum* was not recorded in secondary forest, and *M. magnirostre* was much less frequent there than in the mature forest. (JOHNS (1986) observed that both *Malacopteron* and some *Stachyris* babblers were much less frequent in areas of logged forest.)

The pattern for *Stachyris* babblers was less clear at Khao Nor Chuchi. The most frequently observed species, Chestnut-rumped Babbler *S. maculata,* was found at similar frequency in both mature and secondary. Neither *S. nigriceps* nor *S. poliocephala* was found in secondary forest though both of these were extremely scarce in any case. *S. nigriceps* is widespread in montane and submontane forest and moist scrub in Thailand and the only sighting at Khao Nor Chuchi was close to the end of the tall forest transect, where it reached the foothills. There was only one sighting of *S. nigricollis* and, surprisingly, that was in the clearing.

While resident terrestrial insectivores, apart from the two *Pellorneum* babblers, were scarce, some species of pittas (*Pitta* spp.) and the two wren-babblers, Large Wren-Babbler *N. macrodactyla* and Striped Wren-Babbler *Kenopia striata,* were present in both forest-types at Khao Nor Chuchi, though were scarcer in secondary forest than in mature forest. A number of medium sized, arboreal foliage-gleaners such as malkohas, *Phaenicophaeus* spp., and bark-gleaners such as woodpeckers, were also scarcer in secondary forest. The broadbills *Corydon sumatranus* and *Eurylaimus javanicus* were not recorded in secondary forest though the smaller and perhaps more ecologically tolerant *E. ochromalus* was fairly frequent in both habitats. *E. javanicus* has, however, been recorded in old, overgrown rubber in Malaysia (G.W.H. Davison, *in litt.*; D.R. Wells, *in litt.*). The only trogon which was frequent in both mature and secondary forest was *Harpactes oreskios*. *H. diardii* was confined to mature forest while there was only one sighting of *H. duvaucelii* in secondary forest compared with 8 in mature (Appendix).

Clearing resembled secondary forest in the predominance of *Pycnonotus atriceps,* the second most abundant species, and other bulbuls. However, the most frequently recorded bird was *Macronous gularis*. Another babbler, *P. ruficeps,* showed a similar level of abundance in clearing and secondary forest.

Migrant species are represented at a lower frequency than resident species since only 41 visits out of a total of 88 survey visits were made during the period October-April, when a more-or-less full complement of migrants could be expected. Only one migrant, Siberian Blue Robin *Luscinia cyane,* featured in the top 20 most frequently recorded species. Undoubtedly, this species was extremely abundant in both mature and secondary forest. However, being mainly terrestrial in habit, it was relatively difficult to detect and easily overlooked and it probably occurred at even greater abundance than recorded. Most were detected on call and the majority of records were in autumn and spring. There are two possible reasons for this. Birds would still be moving through on passage at such times, so there could be more birds present then. Alternatively birds might be more vocal when they have either just arrived (and may need to establish winter territories), or when they are about to depart for their breeding grounds. WELLS (1990) found *L. cyane* to be by far the most abundant migrant wintering in lowland forest in Malaysia.

The only other Palearctic migrant to approach Siberian Blue Robin in abundance was Inornate Warbler, *Phylloscopus inornatus,* in mature forest. This was surprising since *P. inornatus* has hitherto been generally assumed to be mostly limited to secondary growth, plantations and open areas, at least in southern Thailand. In Malaysia, this species winters in montane forest (WELLS, 1990). Its abundance in the tall forest at Khao Nor Chuchi may be due to the proximity of the study plots to the forest edge and perhaps partly due to its loud, easily recognisable call. Those leaf-warblers thought to be more typical of lowland mature forest in the peninsula, Arctic Warbler *P. borealis* and Eastern Crowned Warbler *P. coronatus,* were recorded much less commonly.

DISCUSSION

Mature forest at Khao Nor Chuchi, though rich in bird species compared with other southern Thai protected areas (ROUND & TREESUCON, 1998), showed a reduced bird diversity compared to most Malaysian and Bornean forests which have been studied. This may be attributed to a combination of hunting pressure and habitat degradation. No galliformes other than *Gallus gallus* were recorded in the course of this census study, while green pigeons, *Treron* spp., were scarce too: Thick-billed Pigeon *Treron curvirostra* was the only member of the genus recorded. Great Hornbill *Buceros bicornis,* though still frequent in the larger protected areas elsewhere in Thailand, was absent from the study area. Its disappearance may have been hastened by the absence of large-fruited figs *Ficus* spp., perhaps destroyed incidentally by logging operations in former logging concessions adjacent to the study area.

In general, the findings of this study reflect those found elsewhere (JOHNS, 1986, 1989; LAMBERT, 1992). A relatively large proportion of bird species were found in both secondary and mature forests, but there was a sharp reduction in the numbers of some specialist frugivores, particularly Green Broadbill, as well as some insectivores, including malkohas, woodpeckers and babblers, in secondary forest. The high level of disturbance, even of the tall forest, was reflected in the similar abundance of Little Spiderhunter, *Arachnothera longirostra,* in both tall forest and secondary forest. This species is associated with forest herbs such as bananas *Musa* spp. and has been regarded as indicative of disturbance in other studies (*e.g.*, LAMBERT, 1992). The great abundance of Yellow-bellied Warbler *Abroscopus superciliaris,* the second most commonly recorded bird in tall forest, was due to the high frequency of bamboo with which it is almost always associated. Though bamboo is itself indicative of disturbance, it was much less frequent in the secondary forest plots than in the disturbed mature forest. Diard's Trogon *Harpactes diardii* was the 18th most frequently recorded bird in the disturbed mature forest, to which it was restricted. This may be a function of its detectability, due to its loud call, rather than its abundance. The much-reduced frequency of *Irena puella* in secondary forest compared with mature forest is particularly noticeable in view of the apparent mobility of this species and the proximity of secondary forest to the adjacent mature forest. LAMBERT (1992) found that *Irena* was not greatly affected by logging, and occurred at similar frequency in both logged and unlogged plots. The great reduction in numbers of this species in secondary forest at Khao Nor Chuchi probably reflects the much higher level of disturbance of secondary forest there than in Lambert's logged plots and the consequent much-reduced availability of fruits.

This study contradicts JOHNS' (1986) suggestion that pittas *Pitta* spp. and wren-babblers *Napothera* spp., among other terrestrial insectivores, were absent from logged forest, but agrees with LAMBERT (1992) who found that pittas and Bornean Wren-Babbler *Ptilocichla leucogrammica* persisted in logged forests in Borneo, albeit often at reduced densities.

One of the species most clearly limited to mature forest was Fulvous-chested Flycatcher *Rhinomyias olivacea.* The closely related Grey-chested Flycatcher *R. umbratilis* was intolerant of habitat disturbance in Borneo (LAMBERT 1992), while wintering Brown-chested Flycatchers *R. brunneata* at Pasoh, Malaysia, inhabited only mature forest, and were never found in adjacent 20-year-old regrowth. (D.R. Wells, *in litt.*)

LAMBERT (1992) has commented that there is not always an exact correspondence in which species are present or absent in logged or disturbed forests compared with mature forest from place to place. Some species may be patchily distributed or restricted to particular microhabitats and their occurrence in particular study plots a matter of chance. Also, the persistence or otherwise of a species after logging may depend on its original abundance, or the distance of the study plot to other forest patches, and so on. In addition, faunal studies have seldom given objective or quantitative definition of "disturbed" or "logged." Measurements of comparative abundance among plots may be misleading, since the overwhelming predominance of a species such as *Pycnonotus atriceps* in secondary forest, will depress the percentage of sightings contributed by less common species, even though such species might be equally abundant in mature and secondary. A criticism of this study might be that the transects used were relatively short, and the number of visits inadequate, to sample the entire fauna. There may, perhaps, have been a tendency to over-record those species which had territories on, or adjacent to, the transect line, while missing other species further afield. Nonetheless, the study does reveal large, real differences in the relative frequency of the more abundant species.

These results also show the considerable conservation value of secondary forest. Notwithstanding the reduced abundance of some species, especially frugivores, a moderate diversity of insectivorous birds, including some which are lowland specialists and threatened or endangered in Thailand, such as *Pitta gurneyi, Napothera macrodactyla* and *Kenopia striata,* was found.

Such secondary forests have hitherto been much neglected. Thai national parks and wildlife sanctuaries are staffed usually not by biologists but by foresters, trained primarily to recognise timber trees. Noting the absence of large valuable hardwoods in secondary habitats, they refer to them as "degraded" forest, the implication being that such areas are of little conservation value and therefore suitable for allocation for settlement or cultivation. This is a major problem in Thailand: in spite of the very low proportion of the country covered by forest, the government is still pursuing policies which are leading to further loss of forest cover and biodiversity. As this study shows, secondary habitats may be a valuable conservation resource: they are the only near-natural woodlands now existing in the lowlands and, especially where they exist close to protected areas, offer a valuable option for conservation management. For example, away from Khao Nor Chuchi, there have been no sightings of *Pitta gurneyi* inside the boundary of any Thai protected area, and there are single sightings only of *Kenopia* and *N. macrodactyla* from one or two protected areas apiece. Yet all three species were still present, until at least 1992, in lowland forest patches outside the boundaries of one or two other protected areas.

Which bird species might be used as indicators of habitat quality when surveying secondary forest patches in southern Thailand for possible inclusion in protected areas? Such indicator species should be easily detected and identified by park managers and non-specialists. Most larger and conspicuous birds are not suitable since most will have already been trapped-out or greatly reduced due to habitat disturbance. Among the frugivores, Green Broadbill is one possible indicator species. While ground-feeding insectivores such as pittas and wren-babblers may be indicative of high-quality moist forest understorey, they are scarce and can be difficult to detect (though Large Wren-Babbler can more easily be detected by call). The *Malacopteron* babblers may offer a possible option since they are arboreal, rather vocal, and easily detected. While they are more abundant in mature forest, all three species found in this study were found in secondary forest too, though at reduced density, and it is therefore unlikely that they would persist in the most heavily degraded areas. Although it may be difficult for the naive observer to distinguish among *Malacopteron* species on either voice or plumage characters, specific identification may not be necessary since all species respond similarly to habitat disturbance. The generic features of *Malacopteron* songs (clear whistles in either an ascending or descending sequence) are easily recognizable with a little practice. Other relatively easily recognizable species which seemed to be indicative of better quality habitat were malkohas and woodpeckers.

However, there are two distinct and different aspects of habitat disturbance, namely habitat degradation, such as that studied here, and habitat fragmentation, and their effects upon the avifauna might be expected to differ. FORD & DAVISON (1995) found that malkohas and woodpeckers persisted relatively well in 500–800 ha fragmented patches of mature forest in Malaysia, though they noted a marked reduction in babblers and some other understorey species. Among those persisting in secondary forest here, which they failed to note, were *Trichastoma bicolor, Napothera macrodactyla* and *Kenopia striata.* The small number of babblers represented on land-bridge islands (WELLS, 1976) suggests that babblers possess poor dispersal capabilities, would be unlikely to persist in more heavily disturbed or fragmented situations and so may be generally suited as indicators of better quality, less fragmented habitats. On the other hand, all three of the *Malacopteron* recorded at Khao Nor Chuchi also persisted in the forest patches studied by FORD & DAVISON (1995).

The secondary forest at Khao Nor Chuchi undoubtedly owed its relative richness to the fact that it was still contiguous with tall forest, and probably also to the presence of some moist gullies which remained damp year-round. This may not be typical of secondary forest patches in more isolated situations elsewhere. Smaller, more isolated patches would be expected to be much drier and support fewer species of birds. Further work to study the attributes of such areas is needed.

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Appendix. Bird species censused in disturbed mature forest, secondary forest and clearing at Khao Nor Chuchi May 1991 – July 1992. Figures are numbers of sightings. Feeding guild data chiefly follow Johns (1986): R, raptor; P, piscivore; AF , arboreal frugivore; TF, terrestrial frugivore; AIF, arboreal insectivore/frugivore; TIF, terrestrial insectivore/frugivore; TI, terrestrial insectivore; FGI, foliage-gleaning insectivore; BGI, bark-gleaning insectivore; SwI, sweeping insectivore; SaI, sallying insectivore; FF, arboreal faunivore/frugivore: IN, insectivore/nectarivore. A few species listed as frugivores *(e.g., Lonchura spp.)* are granivores rather than consumers of soft fruits.

Status codes: R, resident; M, passage migrant, non-breeding visitor or breeding visitor.

Species	Guild	Status	Tall forest		Sec. forest		Clearing
Transect/Trail Code			**T3**	**B**	**T2**	**N**	**T1**
Spilornis cheela	R	R	8	9	2	2	2
Accipiter trivirgatus	R	R					1
Accipiter sp.	R					1	
Spizaetus alboniger	R	R					1
Gallus gallus	TIF	R			1	7	2
Turnix suscitator	TIF	R				1	
Treron curvirostra	AF	R	3	2	1		
Ptilinopus jambu	AF	R	1	3			
Chalcophaps indica	TF	R	17	10	5	5	
Loriculus vernalis	AF	R	12	19	3	9	6
Cuculus vagans	FGI	R			2	4	2
Cuculus fugax	FGI	R	10	3			
Cuculus micropterus	FGI	R	3	3	1	1	
Cacomantis sonneratii	FGI	R		2			
Cacomantis merulinus	FGI	R			2	2	4
Chrysococcyx xanthorhynchus	FGI	R	1	3		1	1
Surniculus lugubris	FGI	R	2	1		2	2
Phaenicophaeus sumatranus	FGI	R				1	
Phaenicophaeus chlorophaeus	FGI	R	1	5			
Phaenicophaeus javanicus	FGI	R	2	2			
Phaenicophaeus curvirostris	FGI	R	1	3		4	
Phaenicophaeus sp.	FGI	R		2	1	1	
Centropus sinensis	TI	R				1	5
Ketupa ketupu	R	R	1				
Caprimulgus macrurus	SwI	R				3	
Aerodramus fuciphagus	SwI	R	3	8	2	15	19
Rhaphidura leucopygialis	SwI	R		1			
Hemiprocne longipennis	SwI	R				1	9
Harpactes diardii	FGI	R	5	14			
Harpactes orrhophaeus	FGI	R		1			
Harpactes duvaucelii	FGI	R	5	3		1	

Species	Guild	Status	Tall forest		Sec. forest		Clearing
Transect/Trail Code			**T3**	**B**	**T2**	**N**	**T1**
Harpactes oreskios	FGI	R	4	7	3	4	
Harpactes sp.	FGI	R	1				
Alcedo meninting	P	R			1		1
Ceyx erithacus	TI	R	3	3	2		
Lacedo pulchella	TI	R		6			
Merops leschenaulti	SaI	M				1	
Nyctyornis amictus	SaI	R	5	3			
Eurystomus orientalis	SaI	R			1		1
Berenicornis comatus	FF	R	1	4			
Anorrhinus galeritus	FF	R				7	
Rhyticeros undulatus	FF	R	4	1			4
Anthracoceros malayanus	FF	R				1	
Megalaima chrysopogon	AIF	R	3	2			
Megalaima rafflesii	AIF	R	4	5	1	1	
Megalaima mystacophanos	AIF	R	13	14	1	2	
Megalaima australis	AIF	R	5	5			1
Calorhamphus fuliginosus	AIF	R	4	1			
Sasia abnormis	BGI	R		1			
Celeus brachyurus	BGI	R		1			
Picus viridanus	BGI	R	1	1		5	1
Picus miniaceus	BGI	R		1			
Gecinulus viridis	BGI	R		3		1	
Meiglyptes tristis	BGI	R	2	2			
Meiglyptes tukki	BGI	R			4		
Blythipicus rubiginosus	BGI	R	5	1			
Woodpecker sp.	BGI			2			
Corydon sumatranus	FGI	R	1	4			
Eurylaimus javanicus	FGI	R	2	9			
Eurylaimus ochromalus	FGI	R	3	5	2	3	
Calyptomena viridis	AF	R	19	21	11	8	
Pitta caerulea	TI	R			1		
Pitta sordida	TI	M	3	3			
Pitta guajana	TI	R	1			1	
Pitta gurneyi	TI	R				2	
Hirundo rustica	SwI	M			1		
Hemipus picatus	SaI	R	2			2	2
Tephrodornis virgatus	FGI	R	5	3			
Coracina fimbriata	FGI	R	2	1			
Pericrocotus divaricatus	FGI	M			1		
Pericrocotus flammeus	FGI	R	3	8			7
Aegithina viridissima	FGI	R	3	12	3	13	1
Aegithina lafresnayei	FGI	R	4	3	6	6	

Species	Guild	Status	Tall forest		Sec. forest		Clearing
Transect/Trail Code			T3	B	T2	N	T1
Chloropsis cyanopogon	AIF	R			2		
Chloropsis sonnerati	AIF	R	1	8		1	2
Chloropsis sp.	AIF	R		9		12	
Irena puella	AF	R	30	33	11	16	6
Pycnonotus melanoleucos	AIF	R	1	3		2	
Pycnonotus atriceps	AIF	R	8	1	55	58	56
Pycnonotus melanicterus	AIF	R	6	11	23	14	8
Pycnonotus cyaniventris	AIF	R	1				
Pycnonotus eutilotus	AIF	R	1	1	7	4	2
Pycnonotus finlaysoni	AIF	R			11	40	52
Pycnonotus goiavier	AIF	R					1
Pycnonotus plumosus	AIF	R			7	14	50
P. finlaysoni/plumosus	AIF	R				2	6
Pycnonotus simplex	AIF	R	12	5	10	30	12
Pycnonotus brunneus	AIF	R	1			2	1
Pycnonotus erythropthalmos	AIF	R		4			8
Pycnonotus sp.	AIF	R	3	5	3	6	8
Criniger ochraceus	AIF	R	11	13	8	9	2
Criniger bres	AIF	R	1	1	7		
Cringer phaeocephalus	AIF	R	7	12	7	3	
Hypsipetes criniger	AIF	R	14	6	9	10	
Hypsipetes charlottae	AIF	R	7	13	8	11	1
Hypsipetes malaccensis	AIF	R	8	7	2	6	
Dicrurus leucophaeus	SaI	M	1	1			
Dicrurus annectans	FGI	M	4	2			
Dicrurus aeneus	SaI	R					6
Dicrurus paradiseus	FGI	R	2	1			
Oriolus xanthonotus	FGI	R	3	10		2	1
Oriolus chinensis	FGI	M			1		
Platysmurus leucopterus	FGI	R			1	4	
Melanochlora sultanea	FGI	R		2		3	
Pellorneum ruficeps	TI	R			27	31	30
Pellorneum capistratum	TI	R	7	15	8	5	
Trichastoma malaccense	TI	R	1	5	7	2	
Trichastoma bicolor	FGI	R	1	3	10		
Trichastoma abbotti	FGI	R			8	10	1
Malacopteron magnirostre	FGI	R	13	12	5		
Malacopteron cinereum	FGI	R	13	12			
Malacopteron magnum	FGI	R	2		2		
Pomatorhinus schisticeps	FGI	R					2
Kenopia striata	TI	R	7	5	2		
Napothera macrodactyla	TI	R	6	7		2	

Species	Guild	Status	Tall forest		Sec. forest		Clearing
Transect/Trail Code			**T3**	**B**	**T2**	**N**	**T1**
Stachyris rufifrons	FGI	R					8
Stachyris nigriceps	FGI	R		1			
Stachyris poliocephala	FGI	R	1				
Stachyris maculata	FGI	R	2	8	3	2	
Stachyris nigricollis	FGI	R					2
Stachyris erythroptera	FGI	R	1	2	6	7	10
Macronous gularis	FGI	R	5	10	12	20	74
Luscinia cyane	TI	M	8	7	15	10	6
Copsychus saularis	FGI	R					3
Copsychus malabaricus	FGI	R	25	22	10	34	17
Enicurus leschenaultii	TI	R	1				
Zoothera interpres	TIF	R				2	
Zoothera citrina	TIF	M	2			1	
Turdus obscurus	TIF	M				1	
Gerygone sulphurea	FGI	R		2			
Abroscopus superciliaris	FGI	R	33	21		4	1
Phylloscopus inornatus	FGI	M	4	9		4	
Phylloscopus borealis	FGI	M		2	1	2	
Phylloscopus plumbeitarsus	FGI	M		1	1		
Phylloscopus tenellipes	FGI	M	1	2	5	2	
Phylloscopus coronatus	FGI	M		1	1		
Locustella lanceolata	FGI	M					1
Orthotomus sutorius	FGI	R			3		3
Orthotomus atrogularis	FGI	R	18	21	47	46	55
Orthotomus sericeus	FGI	R					2
Prinia rufescens	FGI	R					7
Prinia flaviventris	FGI	R				1	28
Rhinomyias olivacea	SaI	R	14	11			
Ficedula zanthopygia	SaI	M				3	
Cyornis tickelliae	SaI	R	1		12	41	2
Culicicapa ceylonensis	SaI	R	1	1			
Hypothymis azurea	SaI	R	17	14	31	27	1
Philentoma pyrhopterum	SaI	R	11	14	6	5	
Terpsiphone paradisi	SaI	R	21	25	24	21	2
Dendronanthus indicus	TI	R				1	
Anthreptes simplex	IN						4
Anthreptes malacensis	IN	R				1	
Anthreptes rhodolaema	IN	R					1
Anthreptes singalensis	IN	R	1	1	4	1	6
Hypogramma hypogrammicum	IN	R	12	14	4	6	5
Nectarina sperata	IN	R			1	11	
Sunbird sp.	IN				1	1	3

Species	Guild	Status	Tall forest		Sec. forest		Clearing
Transect/Trail Code			**T3**	**B**	**T2**	**N**	**T1**
Arachnothera longirostra	IN	R	28	22	31	31	26
Arachnothera crassirostris	IN					1	
Arachnothera flavigaster	IN					1	
Arachnothera chrysogenys	IN	R		5	4	2	
Arachnothera affinis	IN	R		1			1
Arachnothera sp.	IN	R	1	3	2	3	
Prionochilus thoracicus	AF	R				1	
Prionochilus maculatus	AF	R	13	18	16	16	13
Dicaeum agile	AF	R			1	1	
Dicaeum chrysorrheum	AF	R				1	1
Dicaeum trigonostigma	AF	R		2	2	14	1
Dicaeum cruentatum	AF	R	2	1	13	38	7
Dicaeum sp.						2	
Sunbird/Flowerpecker sp.	IN/AF					1	
Lonchura striata	AF	R					11
Lonchura leucogastra	AF	R		3	2	1	2