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## **Comparison of Species Composition in Three Forest Types: Towards Using Bird as Indicator of Forest Ecosystem Health**

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**Abstract:** Based on the study of understorey birds, this research examined the changes in species composition and abundance in three forest types namely primary forest, 5 and 10-year-old logged forest. Results indicated that the edge or secondary bird species, many of which belong to frugivore/insectivore and nectarivore/insectivore guilds, had increased in number in the logged forests. In contrast, the interior forest species, in particular insectivores decreased in the logged forests. This study suggested that the most resilient and adversely affected species due to logging activities are suitable to be used as indicators of forest ecosystem health.

**Key words:** Indicator, ecosystem health, logging, bird composition

### **INTRODUCTION**

The tropical rainforests are well known for its biodiversity and support rich wildlife communities. However, many of these forests have been extensively exploited and cleared for timber and other land uses over the last century. The loss of biodiversity especially at the ecosystem level is a great concern among scientists. An ecosystem such as the tropical rainforest is considered degraded or loss when the distinct habitats, species assemblages and natural processes are disrupted or diminished in quality and quantity. In the case of tropical forest birds that are highly dependent on the forest condition, the habitat loss and degradation as a result of logging would be a serious threat to their survival<sup>[1,2]</sup>. As forest industries continue, the size of undisturbed and pristine forest area will become smaller. As a result, the long-term survival of many forest birds and other wildlife will depend largely upon their ability to persist in human-altered habitats.

Despite the diversity of habitat types and bird communities in the tropics, the effects of forest exploitation on birds have been studied in relatively few areas or communities<sup>[3]</sup>. Nonetheless, previous studies indicated that although most bird species are adversely affected, some species have shown a significant increase in number when the forests are disturbed<sup>[3-8]</sup>. If the disappearance of certain bird species or groups from a given area occurs in response to disruptions in forest

structure, then their reappearance would be contingent upon a minimum level of forest regeneration. In addition, the degree of overlap in species composition of birds between the disturbed and undisturbed forests should further provide indication of the extent of forest as well as avifaunal regeneration in the disturbed habitat. In other words, there is a great potential of using birds as indicators of forest ecosystem health, which would further aid in effective management of forests.

This study intended to compare the composition and abundance of understorey bird species in three forest types, namely primary forest, 5 and 10-year-old logged forest. The main idea is to identify the potential bird species or groups that can be useful as indicators of forest ecosystem health.

### **MATERIALS AND METHODS**

The survey of understorey birds was carried out by mist-netting. The study site, Sungai Lalang Forest Reserve, which covers an area of about 50,000 ha, is located in southeastern part of the state of Selangor, Peninsular Malaysia. It is classified as a hill dipterocarp forest that has been selective logged for timber since the early 1970s. Approximately of 270 days of netting were involved in three compartments, i.e. a primary forest (Compartment 24) and two logged forests with 5-year (Compartment 18) and 10-year (Compartment 33) of recovery. All three sites chosen are similar in terms of

topography, which is basically undulating and cut by several small streams that form steep gullies. Birds were captured using 30 mist-nets (10×4 m) that had been set up from 0600 to 1730 h in each site. Birds captured were identified, measured and ringed before releasing at the same location where they were caught.

## RESULTS AND DISCUSSION

**Species composition and abundance:** From Table 1, results indicated that a total of 20 families were detected, which were represented by 58 species (271 individuals), 62 species (288 individuals) and 61 species (386 individuals) in the primary, 5 and 10-year-old logged forests, respectively. Basically, the number of understory species and individuals captured in primary forest were similar to that of the 5 and 10-year-old logged forests. However, the higher in number of birds captured in the 10-year-old logged forest suggested that the establishment of mature secondary growth might provide more food source and thus led to the increase in number of captures.

In terms of diversity indices (Table 2), results indicated that the total number of species was quite similar in all forest types based on the richness index  $R_1$ . For species evenness, the distribution of individuals among species was uneven in the 5-year-old ( $E = 0.54$ ) and 10-year-old logged forest ( $E = 0.45$ ) compared to primary forest ( $E = 0.69$ ). Based on Hill's diversity index, the number of abundant ( $N_1$ ) and very abundant species ( $N_2$ ) was higher for the primary forest than that of both logged forests. While the Shannon-Weaver diversity index further indicated that species composition was higher in primary forest ( $H = 3.55$ ), followed by in 5-year-old logged forest ( $H = 3.47$ ) and 10-year-old logged forest ( $H = 3.36$ ). This is similar to Wong<sup>[4]</sup>, which indicated that the bird communities overlapped heavily, but the logged forest site had lower species richness and fewer individuals.

The family of pycnonotidae, nectariniidae and timaliidae formed considerable proportion (>50%) of the total species captured in three sites. Nonetheless, results indicated that the pycnonotidae and nectariniidae, which mostly comprised of secondary or colonizing species such as bulbuls and spiderhunters increased in number while the primary forest babbler species of Timaliidae decreased when condition shifted from primary to logged forests. As supported by Zakaria and Francis<sup>[3]</sup>, most studies also found similar results in which some changes occurred in species composition after logging, with

Table 1: Number of species and individuals (in parenthesis) by family

Family	Logged forest		
	5-year-old	10-year-old	Primary forest
Pycnonotidae	11 (86)	10 (94)	7 (53)
Timaliidae	8 (28)	16 (79)	13 (64)
Muscicapidae	11 (18)	5 (15)	8 (28)
Nectariniidae	5 (59)	3 (102)	3 (46)
Turdidae	5 (22)	3 (23)	4 (23)
Picidae	5 (18)	5 (21)	5 (13)
Alcedinidae	4 (7)	4 (17)	4 (16)
Eurylaimidae	2 (5)	2 (7)	1 (5)
Cuculidae	2 (9)	0 (0)	3 (3)
Strigiformes	2 (6)	0 (0)	2 (2)
Dicruridae	1 (9)	1 (4)	2 (6)
Laniidae	1 (16)	1 (2)	1 (5)
Columbidae	1 (3)	1 (6)	1 (3)
Trogonidae	1 (1)	1 (1)	0 (0)
Oriolidae	1 (2)	0 (0)	0 (0)
Campephagidae	1 (1)	0 (0)	0 (0)
Sylviidae	0 (0)	1 (2)	1 (1)
Ploceidae	0 (0)	1 (2)	1 (1)
Meropidae	0 (0)	1 (5)	0 (0)
Corvidae	0 (0)	1 (1)	0 (0)
Pittidae	0 (0)	0 (0)	1 (1)

Table 2: Diversity indices of bird species in primary, 5 and 10-year-old logged forests

Indices	Logged forest		
	5-year-old	10-year-old	Primary forest
Species richness			
No.	62	61	58
$R_1$	10.75	10.07	10.17
Species diversity			
H	3.47	3.36	3.55
$N_1$	32.11	28.66	34.66
$N_2$	17.92	13.48	24.12
Species evenness			
E	0.54	0.45	0.69

No. = Total number of species;  $R_1$  = Margalef index; H = Shannon index;  $N_1$  = Measures the number of abundant species present;  $N_2$  = Measures the number of very abundant species; E = Evenness indices

retention of many of the original species and reductions or losses of others. At the same time, secondary or colonizing and edge species often increased. As a result, total diversity or number of species was often similar.

There were several families that were represented by only single species or individual including meropidae, pittidae, ploceidae, oriolidae and campephagidae. These groups were either belonged to the migratory species or middle and upperstorey species, which were not susceptible to capture by mist-net. Another explanation for this might be due to unlikelihood of capturing certain habitat specialists or scarce species that are low in density in the study sites owing to sample size.

**Trophic structures and feeding guilds:** Following this, all birds captured were further classified according to trophic structures and feeding guilds (Table 3). Results indicated that insectivore guild, which includes sallying insectivore, terrestrial insectivore, foliage-gleaning insectivore and

Table 3: Distribution of birds captured by guild in three compartments

% of individuals	Logged forest				Primary forest	
	5-year-old		10-year-old			
	No. of birds	(%)	No. of birds	(%)	No. of birds	(%)
Sallying insectivore	27	9.38	25	6.48	35	12.92
Terrestrial insectivore	11	3.82	25	6.48	6	2.21
Foliage-gleaning insectivore	37	12.85	79	20.47	77	28.41
Bark-gleaning insectivore	18	6.25	19	4.92	13	4.80
Nectarivore/insectivore/frugivore	59	20.49	104	26.94	46	16.97
Arboreal frugivore	6	2.08	6	1.55	5	1.85
Arboreal frugivore/insectivore	89	30.90	97	25.13	58	21.40
Terrestrial frugivore/insectivore	3	1.04	9	2.33	5	1.85
Carnivore/insectivore	9	3.13	1	0.26	3	1.11
Carnivore	29	10.07	21	5.44	23	8.49
Total	288	100.00	386	100.00	271	100.00

Table 4: Species recorded only in primary forest

Species	Scientific name	Status	No. of birds
Asian brown flycatcher	<i>Muscicapa dauurica</i>	M and C	10
Rufous-tailed shama	<i>Trichixos pyrropyga</i>	R and U	8
Brown fulvetta	<i>Alcippe brunneicauda</i>	R and C	5
Bronzed drongo	<i>Dicrurus aeneus</i>	R and C	3
Buff-rumped woodpecker	<i>Meiglyptes tristis</i>	R and U	3
Crow-billed drongo	<i>Dicrurus amnectans</i>	M and U	3
Hill blue flycatcher	<i>Cyornis banyumas</i>	R/M and C	2
Hooded pitta	<i>Pitta sordida</i>	R/M and U	1
Hodgson's hawk cuckoo	<i>Hierococcys fugax</i>	R/M and C	1
Moustached hawk cuckoo	<i>Hierococcys vagans</i>	R and C	1
Chestnut-winged cuckoo	<i>Clamator coromachus</i>	M and U	1
Oriental scops owl	<i>Otus sunia</i>	M and U	1
White-necked babbler	<i>Stachyris leucotis</i>	R and U	1
Japanese paradise flycatcher	<i>Terpsiphone atrocaudata</i>	M and U	1
Brown-chested flycatcher	<i>Rhinomyias brunneata</i>	M and U	1
Inornate warbler	<i>Phylloscopus inornatus</i>	M and A	1
Banded woodpecker	<i>Picus miniaceus</i>	R and C	1
Hooded pitta	<i>Pitta sordida</i>	R/M and U	1

R = resident; M = passage migrant/winter visitor; C = common; U = uncommon; A = rare

bark-gleaning insectivore, represented the highest number of species captured. This followed by frugivore/insectivore, nectarivore/insectivore/frugivore, carnivore/insectivore and frugivore. More insectivorous species tend to be captured in primary forest compared to logged forest. They represent 48.34% of the total captured in the primary forest against 32.29 and 38.34% of 5 and 10-year-old logged forests. In contrast, more frugivore/insectivore species were captured in logged forests (30.90% in the 5-year-old and 25.13% in the 10-year-old logged forests) than in primary forest (21.40%).

As explained by Zakaria and Nordin<sup>[1]</sup>, in most primary forests, the frugivore/insectivore group is normally represented by fewer species and is replaced by the insectivore group. The higher number of frugivore/insectivore in logged forests is mainly contributed by the bulbul species of the pycnonotidae family. They are known as colonizing secondary species and prefer to inhabit logged forest. In addition, their ability to switch to an insectivorous diet provides advantage to tolerate seasonal variation in fruit

abundance in logged forests<sup>[3]</sup>. All these reasons have make them survive well in the logged forests.

**Potential Indicators:** Further analysis was done in order to identify species that experienced a drastic change in terms of number when forest condition shifted from logged to primary forest. Results indicated that red-eyed bulbul (*Pycnonotus brunneus*) and Grey-bellied Bulbul (*Pycnonotus cyaniventris*) had drastically decreased in number from logged forest to primary forest. On the other hand, the number of moustached babbler (*Malacopteron magnirostre*) had considerably increased from logged forest to primary forest. Thus, these species might be suitable indicators of forest condition due to their sensitivity to habitat disturbance. Besides that, as shown in Table 4, few residential species including the rufous-tailed shama (*Trichixos pyrropyga*) tend to have a high capture and were strictly confined to primary forest. Therefore, these species might also act as indicators of a mature forest. However, further in-depth studies are warranted, for instance with respect to their demography aspects.

Logging activities in the tropical rainforests are of great concern to conservationists. However, the information on logging effects and forest regeneration has not been fully understood. Although in cases where selective logging of large timber trees has been practiced, severe damages remain to the forest ecosystem. The non-timber species particularly fruit trees were damaged and destroyed. This would reduce the food sources for many frugivorous birds. Thus, regeneration may be delayed in the logged forest due to the decrease of specialized frugivores and dispersal of seeds<sup>[3]</sup>.

As indicated in the study, the differences in terms of species and guilds may implies that even after 10-year interval, the logged forest condition had yet to reached that of primary forest within which most bird community is found. In fact, the planned cutting cycle of 30 to 60 years may be insufficient for many forests to recover to their original structure and composition. As a result, such repeated logging is likely to further degrade the forest in such a way that many primary forest bird species that can presently use logged forest may be adversely affected<sup>[9]</sup>.

In general, the sensitivity of birds to the changes in the forest condition that they depend on may provide direct indication to the health of the forest ecosystem. In other words, the effectiveness at conserving the birds will also indicate the success in safeguarding ecosystem functions and biodiversity as a whole. However, it is still in its infancy of using understorey birds as indicators of forest ecosystem health. Further studies would need to be concentrated on factors or habitat requirements that influence the existence of a species in certain forest condition as well as their changing pattern over time.

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