

with an abnormal yellow plumage. Deane (1876) lists a xanthochoid specimen of the Bluebird (*Sialia sialis*).

Xanthochroism is of more frequent occurrence in parrots, a group in which it supplants albinism, Lawrence (1889). Caged birds of various species often acquire a yellow coloring which has been correlated with certain kinds of food eaten or to some pathological condition.

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AVIAN BIONOMICS OF MALAYA 2. THE EFFECT OF FOREST DESTRUCTION UPON A LOCAL POPULATION

By H. ELLIOTT McCLURE* and HUSSEIN BIN OTHMAN

INTRODUCTION

As in many parts of the world where expanding populations and economics demand more land and resources, much of the tropical rain forest of Malaya is rapidly being reduced to ashes or parkland.

This is an attempt to evaluate the effect of forest removal upon existing and adjacent bird populations. The biologist is rarely informed before a habitat is to be destroyed. Usually he can make studies only following the destruction and draw conclusions as to its effect from reference to and study of adjacent areas. Brandenburg and Campbell (1935) report that cleanup work in a secondary forest in Swan Creek Valley, Ohio, reduced the bird nesting by 87% in three years. Warbach (1958) noted that farm improvement involving the removal of brush from old fields during a five-year period brought a reduction of 40% in nesting pairs. The effect of tree removal in tropical rain forest does not appear to have been reported.

SUBANG STUDY AREA

The Subang Forest Reserve lies west of and adjacent to the village of Subang and the International Airport about 10 miles northwest of Kuala Lumpur in the State of Selangor. It is a secondary lowland forest of *Shorea*, *Dyera*, *Palaquium*, and *Endospermum* species from 25 to 30 years old with a closed canopy 50 to 80 feet high. Original felling occurred from 1937 to 1941 and natural regeneration has returned the forest to its present state (Fig. 1). The primary forest was *Shorea*, *Canarium*, *Palaquium*, and *Dyera* with a 150 to 200 foot canopy.

Avifaunal studies began in January 1962 and netting areas were set up as shown in Fig 2. Selective cutting in Areas B, C and D began in April and by July these three areas had been felled, burned,

*Work was accomplished while the authors were with the U. S. Army Medical Research Unit, Kuala Lumpur, Malaysia.



Fig. 1. Secondary swamp forest at Subang, Malaya.

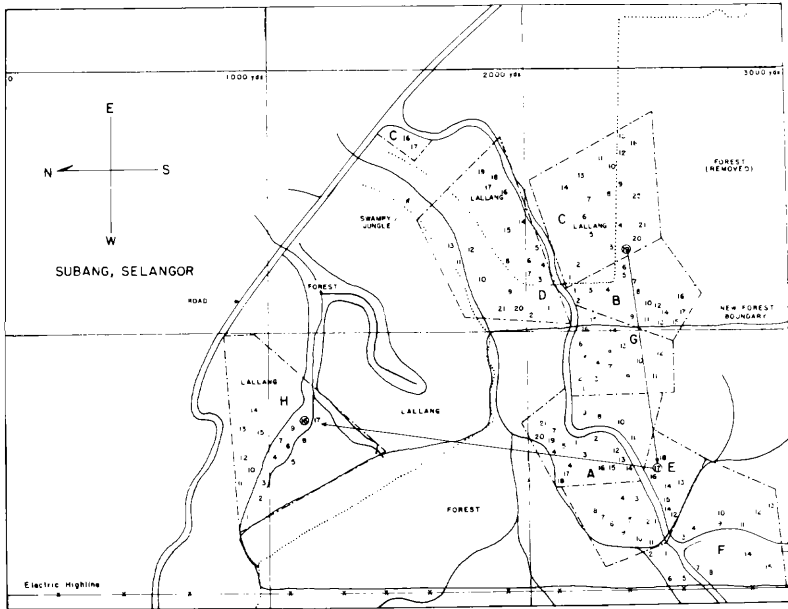


Fig. 2. Map of Subang area showing the locations of nets and netting areas. Also shown is the range of one Little Spiderhunter.

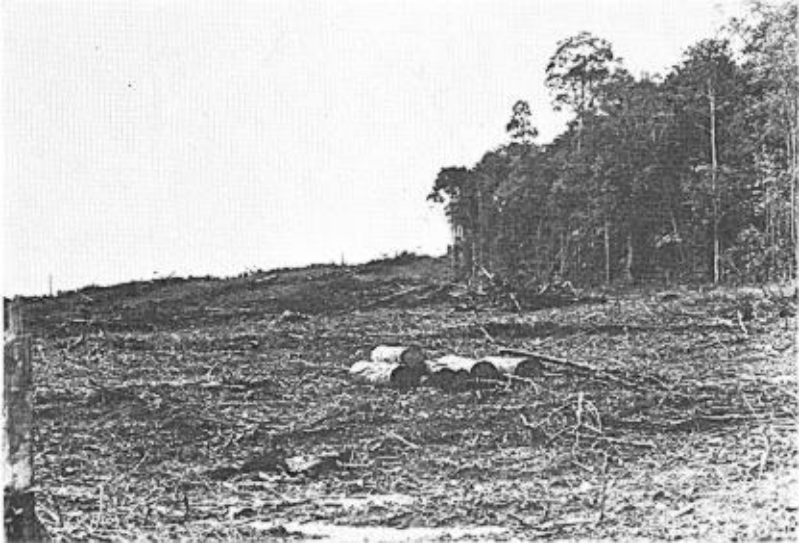


Fig. 3. Appearance of forested area after B and C had been cut over.

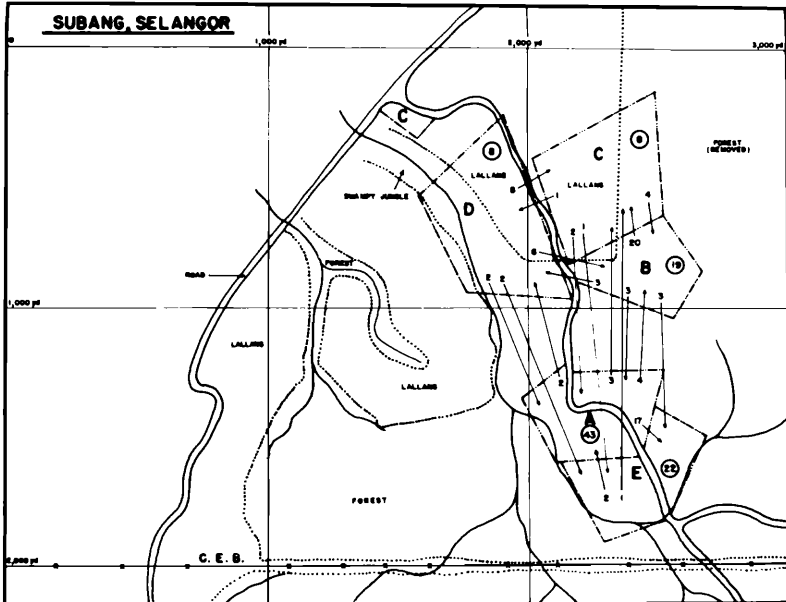


Fig. 4. The exchange of birds between netting areas during the period January 1 and July 31, 1962.

and bulldozed to make room for resettlement of villagers displaced by the construction of the airport. Approximately 400 acres of forest were removed (Fig. 3).

The authors were unaware that the area was to be felled and the avifaunal studies were designed to make representative collections of the avian ectoparasites. Therefore the selection of study plots had not been made to explore the effects of the forest destruction.

About 20 net lanes were cleared in each of four plots so as to touch upon the slight variations in the forest structure. Area A, Figs 1 and 2, was deep enough in the forest (about 500 yards) to avoid the edge effects and to take forest species. It was traversed by a stream and swamp that became flooded during rains of May and November. Area B, Fig 3, was along a gentle slope that rose 50 to 100 feet above the stream. Area C included forest edge and the adjoining lallang grass slope and Area D was in a much disturbed *Pandanus* swamp spur forest along the creek. It included edge and brush lallang.

After B, C, and D had been deforested new net lanes were cleared in G and E within the forest. F was a forest edge area which was disturbed by linemen clearing for a Central Electricity Board high-line and it was abandoned. One thousand yards east Area H encompassing some cut over forest, streamside, and lallang was established. The approximate locations of net lanes are shown in Fig. 2.

Netting and observations were made each week alternating from A through D. Fifteen nets were put up each Monday and remained until Friday afternoon. Two men serviced the nets at hourly intervals each day and removed the captured birds. Following the destruction of B, C, and D the procedure was continued at A, E, G, and H.

Each captured bird was banded, dusted lightly with the commercial silicon dioxide insecticide Dri-Die 67 and the stupefied extoparasites were shaken from its feathers.

Twice each week between the hours of 0800 and 1000 a tally of birds seen or heard calling was made along a transect through A and B. These tallies were discontinued during June and July when McClure was on leave, but netting activities continued. In later months tallies were made only in A.

THE AVIFAUNA

So that the complexity of the avifauna in this secondary forest can be understood, all species tallied or netted are summarized in Table 1 and listed in Table 2. Table 2 includes only the birds within the forest not listing aerial species or those species of the lallang. In this small plot of about a half square mile 115 species were either seen, heard, or netted. A total of 2,865 birds including 89 species were tallied and 1,446 including 85 species were netted. There were 1,069 birds banded and 377 recaptures.

The forest canopy was so dense that seeing birds was difficult, but the accuracy and extent of the weekly tallies increased as songs were associated with species. In common with many forests, species were netted which were never seen. Twenty-six species were netted

TABLE 1. SUMMARY OF THE FIELD OPERATIONS AT SUBANG FOREST. T = TALLY, N = NETTED

	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Number of Tallies	T 9	12	11	6	8	—	—	2	4	7	4	4	67
Number of Net-Days	N 200	200	150	150	300	200	200	200	200	200	200	150	2350
Number of Species	T 40	50	44	44	40	—	—	29	33	32	32	31	89
Number of Species	N 39	36	33	31	40	36	40	37	40	31	36	30	85
Total Species Recorded	T+N 57	64	58	57	56	36	40	55	54	51	58	51	115
Total Birds	T 500	576	599	214	287	—	—	93	160	131	137	168	2865
Total Birds	N 115	118	125	85	182	154	127	126	136	93	113	72	1446
New Birds Netted	N 112	103	108	57	151	108	74	86	99	64	67	40	1069
Number Birds Recaptured	N 3	15	17	28	31	46	53	40	37	29	46	32	377
Average No. Birds per Tally	T 5.5	4.8	5.4	3.6	3.6	—	—	4.6	4.0	1.9	3.4	4.2	4.3
Average No. Birds per 100 Net-Days	N 5.7	5.9	8.3	5.6	6.1	7.7	6.3	6.3	6.8	4.6	5.6	4.8	6.1

	Month												Total
	J	F	M	A	M	J	J	A	S	O	N	D	
17. Lesser Green-billed Malkoha <i>Phaenocphaga diardi</i>					2	—	—	2					4
18. Rufous-bellied Malkoha <i>Phaenocphaga sumatranus</i>						—	—	—				7	7
19. Chestnut-breasted Malkoha <i>Phaenocphaga curvirostris</i>	5	1			1	—	—	—	2	1	2	12	0
20. Scops Owl <i>Otus scops</i>	2	4				—	—	—		8	9	23	0
21. Collared Scops Owl <i>Otus bakkamoena</i>	2		3			—	—	2	6	1	3	23	0
22. Bay Owl <i>Phodilus badius</i>	1	1				—	—	1	—			3	1
23. Gould's Frogmouth <i>Batrachostomus stellatus</i>	1	1			2	—	—	—	1			5	0
24. Malaysian Eared Nighthjar <i>Eurostopodus temmincki</i>						—	—	—	—	0		2	0
25. Diards Trogon <i>Harpactes diardi</i>		1				—	—	—	4	1		6	0
26. Red-rumped Trogon <i>Harpactes diwaaceli</i>	5	12	4	11	5	—	—	1	1			39	0
27. Cinnamon-rumped Trogon <i>Harpactes orrhophaeus</i>	1	3			1	5	2	1	3			16	0
28. Banded Kingfisher <i>Lacedo pulchella</i>			1			—	—	—	2	1		3	0
29. Chestnut-collared Kingfisher <i>Halcyon concreta</i>	1			2	2	4	—	—	3	1	1	17	0
30. Ruddy Kingfisher <i>Halcyon coronanda</i>						—	—	—	1		3	4	6
31. White-breasted Kingfisher <i>Halcyon smyrnensis</i>		1		1	1	1	—	—	1		2	7	0
32. Deep-blue Kingfisher <i>Alcedo meninting</i>						2	3	—	1	1	1	8	0
33. Red-backed Kingfisher <i>Ceyx rufidorsus</i>	2		2	1		—	—	4	1			10	0

	T	J	F	M	A	M	J	J	A	S	O	N	D	Total
68. Yellow-vented Bulbul	129	132	214	8	23	—	—	—	—	5	—	—	—	511
<i>Pycnonotus goiavier</i>	11	35	14	4	5	—	—	—	4	4	—	—	—	94
69. Large Olive Bulbul	—	4	2	2	2	—	—	—	—	1	—	—	—	22
<i>Pycnonotus plumosus</i>	—	5	5	—	—	—	—	—	4	6	—	—	—	30
70. Red-eyed Brown Bulbul	2	3	3	—	2	—	—	—	—	2	—	—	—	10
<i>Pycnonotus brunneus</i>	3	3	3	1	2	—	—	—	1	2	—	—	—	35
71. White-eyed Brown Bulbul	3	4	7	13	8	—	—	—	4	6	—	—	—	54
<i>Pycnonotus simplex</i>	—	4	5	2	2	—	—	—	7	1	—	—	—	75
72. Lesser Brown Bulbul	—	—	—	—	—	—	—	—	—	—	—	—	—	4
<i>Pycnonotus erythrophthalmus</i>	—	—	—	—	—	—	—	—	1	—	—	—	—	1
73. Scrub Bulbul	5	2	1	5	4	—	—	—	2	2	—	—	—	26
<i>Criniger bres</i>	4	3	6	3	6	—	—	—	6	2	—	—	—	34
74. White-throated Bulbul	16	12	24	6	4	—	—	—	2	3	—	—	—	70
<i>Criniger phaeocephalus</i>	12	5	11	7	11	—	—	—	10	9	—	—	—	98
75. Finsch's Bulbul	—	—	—	—	—	—	—	—	6	9	—	—	—	0
<i>Criniger finschi</i>	—	—	—	—	—	—	—	—	1	—	—	—	—	1
76. Hairy-backed Bulbul	3	3	5	7	5	—	—	—	1	7	—	—	—	29
<i>Hypsipetes criniger</i>	3	2	1	2	5	—	—	—	5	3	—	—	—	32
77. Green Iora	—	—	—	—	—	—	—	—	8	2	—	—	—	22
<i>Aegithina viridissima</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	0
78. Lesser Green Leafbird	—	—	—	—	—	—	—	—	4	2	—	—	—	13
<i>Chloropsis cyanopogon</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	9
79. Greater Green Leafbird	—	5	—	—	—	—	—	—	—	—	—	—	—	2
<i>Chloropsis sonnerati</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	1
80. Yellow-headed Green Leafbird	—	5	—	—	4	—	—	—	—	2	—	—	—	15
<i>Chloropsis cochinchinensis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	0
81. Fairy Bluebird	—	—	—	—	—	—	—	—	1	—	—	—	—	1
<i>Irena puella</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	0
82. Black-capped Babbler	—	—	—	—	—	—	—	—	—	—	—	—	—	0
<i>Pellorneum capistratum</i>	—	—	—	—	—	—	—	—	—	1	—	—	—	3
83. Short-tailed Babbler	—	—	—	—	—	—	—	—	—	—	—	—	—	2
<i>Trichastoma malaccensis</i>	—	2	1	3	4	—	—	—	2	2	—	—	—	22
84. Blyth's Jungle Babbler	—	—	—	—	—	—	—	—	6	10	—	—	—	42
<i>Trichastoma rostrata</i>	2	1	5	1	8	—	—	—	10	2	—	—	—	55

	Month												D	Total		
	J	F	M	A	M	J	J	A	S	O	N	D				
85. Ferruginous Babbler	9	2	3	2	9	—	—	—	—	—	—	—	—	—	—	11
<i>Trichastoma bicolor</i>	1	—	—	1	—	4	1	5	—	—	—	—	—	—	—	28
86. Abbott's Jungle Babbler																0
<i>Trichastoma abbotti</i>	8	4	—	—	15	—	—	6	1	—	—	—	—	—	—	1
87. Greater Red-headed Tree Babbler	2	—	6	3	3	1	3	1	1	2	—	—	—	—	—	34
<i>Malacopteron magnum</i>		2	2	2	3	1	1	1	3	28	—	—	—	—	—	22
88. Lesser Red-headed Tree Babbler	2	2	4	2	3	1	1	1	3	4	1	2	—	—	—	35
<i>Malacopteron cinereum</i>	2	2	2	2	6	—	—	1	7	—	—	—	—	—	—	21
89. Plain Babbler	1	2	1	2	2	3	—	2	1	1	1	1	—	—	—	25
<i>Malacopteron affine</i>																15
90. White-throated Babbler				1	1	—	—	—	—	—	—	—	—	—	—	0
<i>Malacopteron albobogalare</i>				1	3	—	—	—	—	—	—	—	—	—	—	2
91. Striped Tit-babbler	20	3	4	1	3	—	—	—	—	—	—	—	—	—	—	37
<i>Macronus gutaris</i>																0
92. Fluffy-backed Babbler	1	4	2	2	7	—	—	—	—	—	—	—	—	—	—	8
<i>Macronus pilosus</i>	4	4	3	2	2	5	2	2	2	3	—	—	—	—	—	36
93. Black-necked Tree Babbler	14	26	30	22	33	—	—	6	13	20	2	2	—	—	—	171
<i>Stachyris nigricollis</i>	2	1	3	3	6	3	7	9	2	7	1	5	—	—	—	48
94. Red-rumped Tree Babbler	24	35	11	3	17	—	—	4	14	10	18	17	—	—	—	153
<i>Stachyris maculata</i>	7	4	1	2	3	3	3	4	4	2	7	1	—	—	—	41
95. Red-winged Tree Babbler																21
<i>Stachyris erythroptera</i>																14
96. Narcissus Flycatcher			1	—	3	—	—	—	—	—	—	—	—	—	—	1
<i>Muscicapa narcissina</i>																0
97. White-throated Jungle Flycatcher																0
<i>Rhinomyias umbratilis</i>																10
98. Chestnut-winged Flycatcher	1	3	—	2	4	—	—	—	—	9	1	1	—	—	—	7
<i>Philetoma pyrrhoptera</i>	3	—	—	2	—	2	3	—	—	—	—	—	—	—	—	16
99. Black-naped Blue Flycatcher	2	4	3	2	—	—	—	—	—	—	—	—	—	—	—	12
<i>Hypothymis azurea</i>																4
100. Paradise Flycatcher	4	2	1	1	—	—	—	—	—	—	2	1	—	—	—	9
<i>Terpsiphone paradisi</i>	4	1	1	1	—	—	—	2	4	1	3	1	—	—	—	19

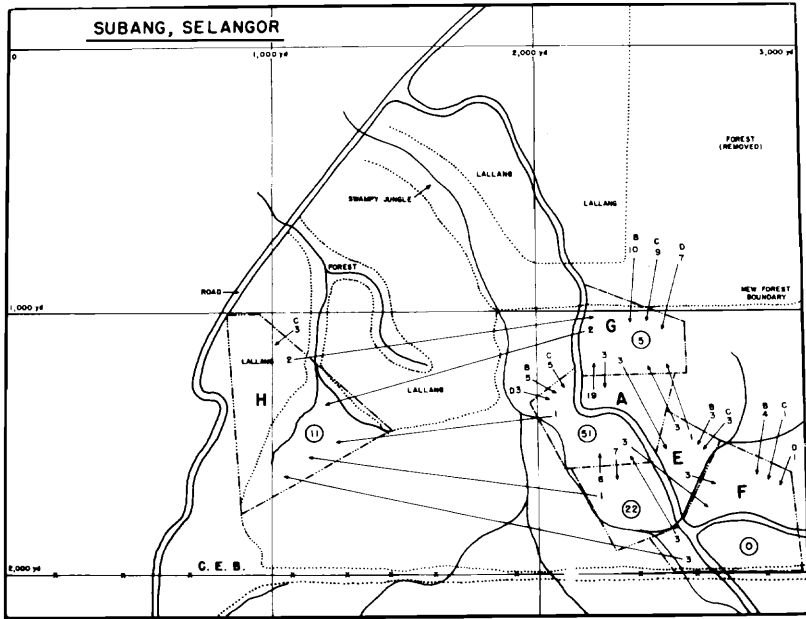


Fig. 5. The exchange of birds between netting areas during the period August 1, 1962, and April 30, 1963.

but were not seen while 29 species were seen or heard but were not captured.

This bird population was an extremely fluid one with constant exchange of individuals from area to area. Table 3 summarizes the results of the netting activities. Fig 4 illustrates the exchange of birds between January 1 and July 31 before cutting was complete and Fig 5 illustrates the exchange from August 1, 1962, to April 30, 1963. Fig 6 illustrates the sources of the birds recaptured in each area. These figures suggest that in each area the population was made up of residents, or at least birds which had not left the area when recaptured, and residents or non-residents which wandered over areas greater than the distance between the closest net lanes in adjoining areas. Because there was an interchange for at least a thousand yards it may be that the daily range of many species in this type of forest is great enough that plots 1000 yards square would be necessary to encompass the ranges.

At any given moment the population of an area was made up of local birds plus representatives of all other areas. Of the birds recaptured during the first half of the year 45.6% were taken in areas other than where they were banded.

Area A was the most stable area in which there was netting. It included lowland forest that was flooded during heavy rains, a small stream traversed it and the canopy was dense and complete. Thorn bamboo, Bertam Palms and *Pandanus* interlaced the hardwoods.

SOURCE OF RECAPTURED BIRDS

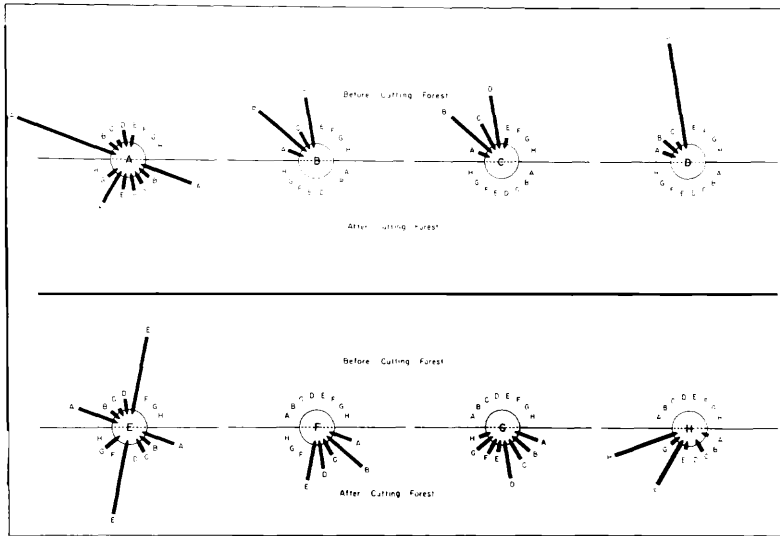


Fig. 6. The sources of recaptured birds.

The soil was spongy, covered with leaves, and shrub growth was dense where sunlight penetrated the canopy. No cutting or disturbance was made in this section of the forest during the study, therefore this station can probably be considered as the check or control.

Fifty-nine species totaling 307 birds were netted. Thirty-four of these species were recaptured 128 times bringing the total birds handled to 435. These 34 species made up 57.6% of the species taken and included 86.5% of the birds handled. Of the 128 recaptures in Area A, 94 (73.4%) were birds from A, 8 (6.2%) from B, 7 (5.4%) from C, 5 (3.9%) from D, 8 (6.2%) from E, 3 (2.3%) from F, and 3 (2.3%) from G. However, in addition to the 94 recaptures of birds in A, there were 66 recaptures of A birds in other areas (Fig. 6).

Against this complex of multiple species and multiple movements, what effect did the habitat destruction have on the population? During the destruction of B, C, and D the forest was filled with wandering birds, both those being displaced and those in undamaged areas, but made restless by the disturbance. This is illustrated by the following percentages:

30.4% of new birds caught in A during Jan.-July were recaptured during Jan.-July.

28.7% of new birds caught in A during Jan.-July were recaptured during Aug.-April.

43.3% of A birds recaptured in Jan.-July were also recaptured Aug.-April.

TABLE 3. THE NUMBERS OF BIRDS MARKED AND RETRAPPED AND THEIR DISPERSION WITHIN THE SUBANG STUDY AREAS

Orig. Trap Line	Number Marked	Retrapped Birds Came From								H Total	Marked Birds Went To								H Total
		A	B	C	D	E	F	G	H		A	B	C	D	E	F	G	H	
A	146	43	3	2	2	2	2	—	—	52	43	4	3	2	17	—	—	—	69
B	139	4	19	4	6	—	—	—	—	33	3	19	20	3	3	—	—	—	48
C	124	3	20	8	8	1	—	—	—	40	2	4	8	1	1	—	—	—	16
D	55	2	3	1	8	—	—	—	—	14	2	6	8	8	2	—	—	—	26
E	90	17	3	1	2	22	—	—	—	45	2	—	1	—	22	—	—	—	25
F	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
H	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	554	69	48	16	26	25	—	—	—	184	52	33	40	14	45	—	—	—	184
January 1 to July 31, 1962																			
A	100	51	5	5	3	6	3	3	—	76	51	—	—	—	17	3	19	1	40
B	—	—	—	—	—	—	—	—	—	—	5	—	—	—	3	4	10	—	22
C	—	—	—	—	—	—	—	—	—	—	5	—	—	—	3	1	9	3	21
D	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	1	7	—	11
E	40	17	3	3	—	22	—	3	—	48	6	—	—	—	22	3	3	1	35
F	22	3	4	1	1	3	0	—	—	12	3	—	—	—	—	—	0	1	3
G	86	19	10	9	7	3	1	5	2	56	3	—	—	—	—	—	—	5	2
H	61	1	—	3	—	1	3	2	11	21	—	—	—	—	—	—	—	2	11
Total	306	91	22	21	11	35	7	13	13	201	76	—	—	—	48	12	56	21	201
August 1, 1962 to April 30, 1963																			

TABLE 4. A COMPARISON OF THE AMOUNT OF MOVEMENT OF BIRDS IN THE SUBANG FOREST DURING JANUARY THROUGH JULY 1962 AND DURING AUGUST 1962 THROUGH APRIL 1963

Species	Movement Jan.-Jul.	Movement Aug.-Apr.
Collared Scops Owl	1 B to C	3 A to G, 1 G to A
Scops Owl	1 C to D, 1 D to C	1 C to H
Red-rumped Trogon	1 B to A, 1 B to E	1 A to E, 1 F to A
Deep Blue Kingfisher	—	1 C to G to A, 1 E to A
Chestnut-collared Kingfisher	1 B to A	1 A to F, 1 A to E, 1 A to G, 1 B to A to G
Buff-necked Woodpecker	1 A to B, 1 D to C to B	1 B to F, 1 B to G, 1 D to G
Banded Red Woodpecker	—	1 A to G
Green Broadbill	2 A to E	—
Large Racquet-tailed Drongo	1 B to C	—
Crested Jay	1 C to B, 1 B to E	—
Crested Brown Bulbul	2 B to C, 2 D to C	2 B to G, 1 C to E
Large Olive Bulbul	1 B to C, 2 D to C	1 D to G, 1 B to F
Red-eyed Brown Bulbul	1 B to C, 1 D to B	—
White-eyed Brown Bulbul	1 B to C, 1 C to B	1 A to G, 1 C to F, 1 E to A, 1 F to A
Scrub Bulbul	1 D to B, 1 B to C	—
White-throated Bulbul	1 A to D, 1 B to A, 6 A to E, 1 B to D	1 C to A, 1 C to G, 1 E to G, 3 D to G, 2 H to G, 6A to E, 1B to F, 2 B to A, 4B to G, 3 B to E
Hairy-backed Bulbul	—	1 A to E, 1 A to G, 1 C to E
Short-tailed Babbler	—	2 E to A
Blyth's Jungle Babbler	1 B to C, 1 B to A, 1 D to E	1 B to E, 2 E to F, 1 E to G
Ferruginous Babbler	1 A to B, 1 C to A, 1 E to C	1 D to A, 1 E to F, 1 B to A
Greater Red-headed Tree Babbler	1 A to E, 1 E to A	1 B to G
Lesser Red-headed Tree Babbler	—	1 A to G, 1 G to E
Plain Babbler	—	1 A to E
Fluffy-backed Tit Babbler	—	1 F to G, 1 A to G
Black-necked Tree Babbler	2 A to E, 1 B to C, 1 E to A	1 A to E, 1 A to F, 1 C to G, 1 G to E
Red-rumped Tree Babbler	1 D to A	1 A to E, 1 A to G, 1E to G
Red-winged Tree Babbler	—	1 A to G
Chestnut-winged Flycatcher	1 A to E, 1 C to B	1 A to E, 1 A to G 3 A to G, 1 G to A
Siberian Blue Robin	—	1 C to E, 1 D to A, 1 D to G
Common Shama	1 A to E, 3 B to C, 1 D to E, 1 D to C	—
Little Spiderhunter	2 A to D, 3 A to C, 2 A to E, 1 A to B, 4 B to C, 3 B to D, 1 B to E, 1 C to A, 1 C to E, 1 D to C, 1D to B	1 A to F, 1 A to H, 1 A to G, 3 C to A, 5 C to G, 1 C to H, 1 D to F, 1 D to G, 3 F to H, 1 G to H, 1 D to A, 1 E to F, 1 E to H, 1 E to A

TABLE 4 (continued)

Species	Movement Jan.-Jul.	Movement Aug.-Apr.
Grey-breasted Spiderhunter	—	1 A to G, 1 G to A
Purple-naped Sunbird	—	1 G to H
33 Species	76 Records	110 Records

22% of new birds caught in A during Aug.-April were recaptured during Aug.-April.

69.5% of birds recaptured in A during Aug.-April were banded during Jan.-July.

18.8% of new birds banded in B during Jan.-July were recaptured during Jan.-July.

6.1% of B birds captured during Jan.-July were recaptured Aug.-April.

10.7% of new birds banded in C during Jan.-July were recaptured in Jan.-July.

7.7% of C birds captured in Jan.-July were recaptured in Aug.-April.

There were 76 records of birds moving from one area to another during Jan.-July and 110 records of their moving from area to area during Aug.-April. These records are shown by species in Table 4. (Netting at Subang was closed in December and repeated for only a week in April 1963.)

Having established that there was much movement and interchange of birds before and after the destruction of B, C, and D (but being unable to assess a value to the disturbance factor while B, C, and D were being cut) is it now possible to suggest what happened to the birds of B, C, and D? Table 4 and Figs 7 and 8 all show that B, C, D birds were in the undisturbed forest during Aug.-April.

The number of B, C, D birds recaptured during Jan.-July and again during Aug.-April should give an indication of the number of the original birds still in the forest. Table 5 lists this for 12 species, giving the number during Jan.-July and the number recaptured during the same period. By simple correlation those recaptured during Aug.-April suggest the numbers still present. The wide ranging species, White-throated Bulbul, Little Spiderhunter, and Buff-necked Woodpecker may have moved into the forest; or, because of their ranging habits, the removal of B, C, and D only curtailed their area but did not increase competition or decrease their chance for survival. Of the remaining more sedentary species, only about one-third were in the immediate vicinity of their original banding places.

Since Area A was the only area to be under constant observation for the whole year, a comparison by species of the recapture rate from B, C, D and from A might indicate the fate of the B, C, D population. Table 6 makes this comparison.

TABLE 5. BY CORRELATION THE NUMBER OF B, C, D, BIRDS THAT WERE MOVING ABOUT THE ADJACENT FOREST DURING SIX MONTHS FOLLOWING THE DESTRUCTION OF B, C, D.

Species	No. Banded During Jan.-Jul.	No. Recaptured During Jan.-Jul.	No. Recaptured During Aug.-Apr.	Number Birds Still in Forest
Scops Owl	4	2	1	2
Chestnut-collared Kingfisher	4	2	1	2
Buff-necked Woodpecker	7	2	3	10
White-throated Bulbul	15	10	15	23
White-eyed Brown Bulbul	39	5	1	8
Large Olive Bulbul	12	4	2	6
Crested Brown Bulbul	6	6	3	3
Blyth's Jungle Babbler	15	7	1	2
Black-necked Tree Babbler	6	5	1	1
Ferruginous Babbler	7	2	2	7
Common Shama	14	11	3	4
Little Spiderhunter	35	14	13	33

TABLE 6. A COMPARISON OF THE RECAPTURE RATE OF BIRDS ORIGINALLY TAKEN IN B, C, D, AREAS WITH THOSE CAPTURED IN A AREA

	Collared Scops Owl	Scops Owl	Diard's Trogon	Red Rumped Trogon	Cinnamon- rumped Trogon	Deep-Blue Kingfisher	Chestnut- collared Kingfisher
Total banded	15	17	8	12	2	6	11
No. recaptured	5	4	1	5	1	2	5
No. times recaptured	7	5	1	6	1	5	11
No. banded in B, C, D	3	4	1	4	0	3	4
No. B, C, D birds re- captured Jan.-Jul. outside B, C, D	0	0	0	1	0	0	1
No. B, C, D birds recaptured Aug.-Apr.	0	1	0	0	0	1	1
No. banded in A	5	1	5	6	2	1	4
No. A birds re- captured Jan.-Jul. outside A	0	0	0	0	0	0	0
No. A birds recaptured Aug.-Apr. outside A	3	0	0	1	0	0	3
Probable no. birds establishing new territories	0	1	0	1	0	1	0

	Buff-necked Woodpecker	Red-banded Woodpecker	Green Broadbill	Large Racquet- tailed Drongo	Crested Jay	Crested Brown Bullbul
Total banded	19	3	10	6	5	18
No. recaptured	9	2	4	3	2	10
No. times recaptured	12	2	5	3	3	17
No. banded in B, C, D	7	0	2	2	4	6
No. B, C, D birds re- captured Jan.-Jul. outside B, C, D	0	0	0	0	1	0
No. B, C, D birds recaptured Aug.-Apr.	3	0	0	0	0	3
No. banded in A	6	3	6	1	1	5
No. A birds recaptured Jan.-Jul. outside A	1	0	2	0	0	0
No. A birds recaptured Aug.-Apr. outside A	0	1	1	0	0	0
Probable no. birds establishing new territories	0	0	0	0	0	3

	Yellow-vented Bulbul	Large Olive Bulbul	Red-eyed Brown Bulbul	White-eyed Brown Bulbul	Serub Bulbul	White-throated Bulbul	Hairy-backed Bulbul	Short-tailed Babbler
Total banded	83	21	29	76	19	41	30	19
No. recaptured	2	6	4	12	8	24	7	3
No. times recaptured	2	9	5	13	17	68	8	3
No. banded in B, C, D	75	12	18	39	4	15	6	4
No. B, C, D birds recaptured Jan.-Jul. outside B, C, D	0	0	0	0	0	1	0	0
No. B, C, D birds recaptured Aug.-Apr.	0	2	0	1	0	13	1	0
No. banded in A	0	0	6	5	8	16	9	8
No. A birds recaptured Jan.-Jul. outside A	0	0	0	0	0	7	0	0
No. A birds recaptured Aug.-Apr. outside A	0	0	0	1	2	15	2	0
Probable no. birds establishing new territories	0	1	0	0	0	5?	0	0

	Blyth's Jungle Babbler	Ferru- ginous Babbler	Greater Red- headed Tree Babbler	Lesser Red- headed Tree Babbler	Plain Babbler	Fluffy- backed Tit Babbler	Black- necked Tree Babbler
Total banded	44	17	14	20	14	30	29
No. recaptured	12	9	6	6	2	9	13
No. times recaptured	20	12	9	6	2	12	23
No. banded in B, C, D	15	7	5	4	2	10	6
No. B, C, D birds re- captured Jan.-Jul. outside B, C D	1	1	0	0	0	0	0
No. B, C, D birds recaptured Aug.-Apr.	1	2	0	0	0	0	1
No. banded in A	13	5	7	9	8	6	14
No. A birds recaptured Jan.-Jul. outside A	0	1	1	0	0	0	4
No. A birds recaptured Aug.-Apr. outside A	0	0	0	1	1	1	5
Probable no. birds establishing new territories	0	0	0	0	0	0	0

	Red-rumped Tree Babbler	Red-winged Tree Babbler	Chestnut-winged Flycatcher	Siberian Blue Robin	Common Shama	Little Spider-Hunter	Grey-breasted Spider-hunter
Total banded	29	10	12	33	33	97	5
No. recaptured	7	4	3	9	14	42	2
No. times recaptured	13	5	7	11	23	81	2
No. banded in B, C, D	4	0	5	3	14	36	0
No. B, C, D birds recaptured Jan.-Jul. outside B, C, D	1	0	0	0	1	3	0
No. B, C, D birds recaptured Aug.-Apr.	0	0	0	0	3	13	0
No. banded in A	15	4	6	19	6	21	1
No. A birds recaptured Jan.-Jul. outside A	0	0	1	0	1	8	0
No. A birds recaptured Aug.-Apr. outside A	2	1	2	3	0	3	1
Probable no. birds establishing new territories	0	0	0	0	2	4?	0

	Purple-naped Sunbird	TOTAL
Total banded	9	846
No. recaptured	2	259
No. times recaptured	2	431
No. banded in B, C, D	1	325
No. B, C, D birds re- captured Jan.-Jul. outside B, C, D	0	11
No. B, C, D birds recaptured Aug.-Apr.	0	46
No. banded in A	3	235
No. A birds re-captured Jan.-Jul. outside A	0	26
No. A birds recaptured Aug.-Apr. outside A	0	49
Probable no. birds establishing new territories	0	18

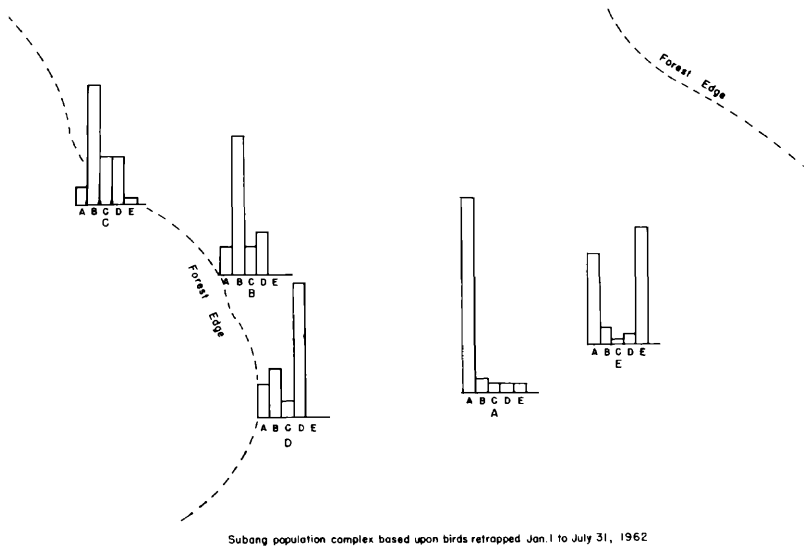
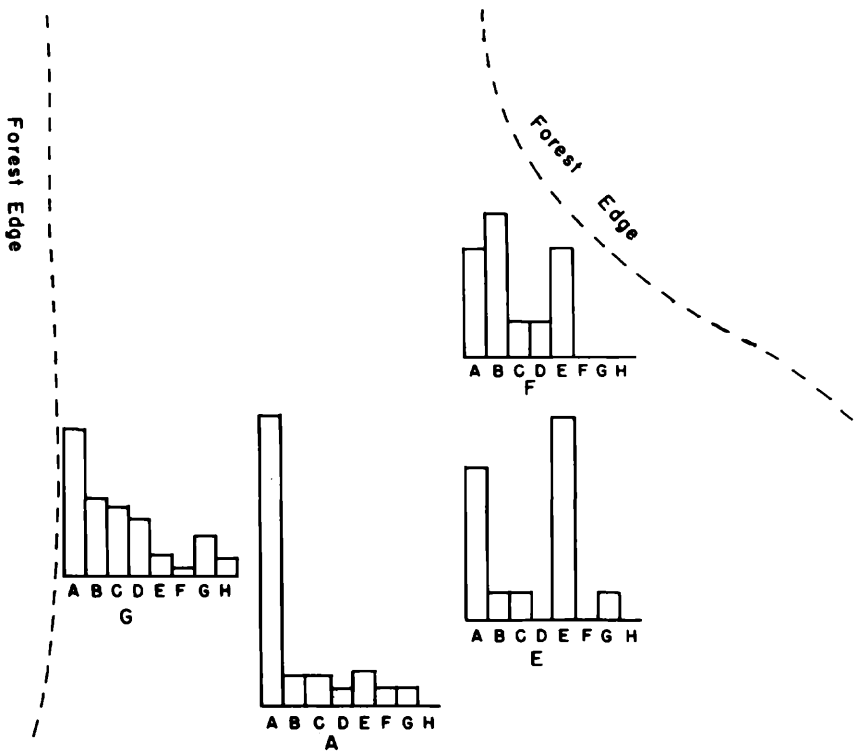


Fig. 7. Subang population complex based upon birds retrapped January 1 to July 31, 1962.

In the A, B, C, D areas a total of 36 species and 846 birds were banded, an average of 23.5 per species. Of these 259 or 30.6% were recaptured 431 times or an average capture rate of 2.7 times per bird. The birds captured in B, C, D areas are totaled because these areas were destroyed. Among the 325 birds taken here there was much exchange of individuals from area to area but only 11 or 3.4% were taken inside the forest away from these areas during the period January through July. Since most of the habitat was forest edge or adjacent to forest edge and most of the species taken here preferred forest edge, this lack of movement into the forest was to be expected. After the area was destroyed no further birds could be ringed, yet 46 (14.1%) were recaptured at other forest and forest edge locations during the period August through April.

A total of 235 birds were marked in A area, 146 of these between January 1 and July 31. Twenty-six of these 146 birds (17.8%) were recaptured in areas away from A during January-July. During the remainder of the period 49 birds were recaptured, 20.8% of the total (since the habitat was undisturbed all birds had an opportunity to remain in it). These data suggest that the disturbance in and adjacent to the forest was causing more bird movement even in undisturbed habitats, and that four times as many birds from the destroyed areas were moving in the forest than had done so previous to the cutting.

Little Spider Hunters and White-throated Bulbuls were the greatest wanderers through the forest and made up a large percentage of the recaptures. Based upon the assumption that B, C, D captured



Subang population complex based upon birds retrapped during Aug. 1, 1962 — Apr. 30, 1963

Fig. 8. Subang population complex based upon birds retrapped during August 1, 1962, and April 30, 1963.

birds which were repeatedly caught in an area within the forest during the August to April period were birds that had re-established in the new area, possibly 9 individuals of these two species had made this change. However, because of the wide ranging activities of these two species, it is not assured that they were residents exclusively of B, C, and D.

The birds that appeared to have made a successful or permanent change to another area were: one Scops owl from C to H, one Deep Blue Kingfisher from C to A, two Crested Brown Bulbuls from B to G and one from C to E, one Large Olive Bulbul from D to G, and two Common Shama from D to A and D to G respectively, a total of only 8 or 2.5% of the original birds present. Accepting a total of 18 birds (including a trogon moving from F to A) as having made a successful change of territory the percentage is 5.5. The suggestion

is that less than 5 of every 100 birds succeeded in establishing themselves in the vicinity of their original homes, the remainder either dying or becoming wanderers—displaced birds.

DISCUSSION

Although this was a secondary forest that was growing rapidly, it is possible that the avian population was stable for such a habitat. Most of the species associated with primary lowland forest (frog-mouths, broad-bills, babblers, trogons) were already established and possibly in numbers sufficient to saturate the habitat. There is no way to check this statement since population tallies had never before been made in Malayan forests and no undisturbed primary forest was accessible for comparison.

Much of the data presented here which appears confusing need not be. The fact that there appeared to be only one-third of B, C, D birds in the area following cutting, but that four times as many were present during Aug.-April as during Jan.-July points up the relatively small usage of the deeper forest when an irregular and extensive edge was available. Some of the B, C, D species were pushed into the forest and of these a few (if we accept the criterion of two recaptures in a new area as indicative of a change in territory) were succeeding in establishing a new home. Of these the Scops Owl, Red-rumped Trogon, Deep Blue Kingfisher, and Common Shama were species preferring deep forest. The forest edge species, excepting the White-throated Bulbul and Little Spiderhunter, did not fare so well. Of the 75 Yellow-vented Bulbul, 18 Red-eyed Brown Bulbul, 12 Large Olive Bulbul, 39 White-eyed Brown Bulbul, 15 Blyth's Jungle Babbler, all typically forest edge species, only 4 (2.5%) individuals were recaptured during August to April, an almost complete loss.

The effect of tree removal (to the point of total habitat destruction) upon the birds of a forest is as complex as the complexity of the original condition. McClure reported the effect of the removal of one tree upon Mourning Doves in Iowa demonstrating that the displaced birds nested in cavestroughs and other substitute sites because competition would not permit them to move into adjacent areas. He also reported on the nearly total destruction of a town site in Iowa by a July tornado. This was a more complex situation and surviving birds attempted to re-nest, but there was no influx into the void from surrounding areas because breeding birds already had territories. The subsequent rebuilding of the population could not be followed.

The situation at Subang was as much more complex compared to the townsite as the townsite was if compared to an individual tree. Since the forest is now adjacent to a village and an airport it is doubtful if it will stabilize again.

The observations reported here suggest that the destruction of the forest produces massive changes in the avifauna and that the remaining forest cannot and does not absorb the displaced species and individuals, first because it may not include niches favorable to them and secondly favorable niches may already be saturated. The

displaced birds become wanderers to find a niche or die. The finite existing bird population of land is reduced in total by each acre of original forest that is destroyed.

SUMMARY

During the period Jan.-July 1962, birds were netted and ringed at four locations in the Subang Forest Reserve near Kuala Lumpur. Between April and July three-quarters of the area was deforested to make room for a village. An additional three study areas were set up in adjacent forest and kept under observation until April 1963. A total of 318 birds had been marked before the area was destroyed and an additional 236 in the undisturbed forest. A comparison of the recapture rates of the birds from the deforested and forested area suggested that many species in the deforested area were completely eliminated or left the vicinity, that about one-third of the birds from the deforested area moved into adjacent forested area following the destruction, that the concentrations of these species which were mainly forest edge was four times what it had been before the disturbance, and that probably less than 5% of the birds from the destroyed areas were able to establish new territories in adjacent forest by the end of the study.

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