UNIVERSITI PUTRA MALAYSIA

EDGE-INTERIOR GRADIENT EFFECTS ON THE UNDERSTOREY BIRD COMMUNITY IN AN ISOLATED AYER HITAM FOREST RESERVE, MALAYSIA

HOSSEIN VARASTEH MORADI

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By

HOSSEIN VARASTEH MORADI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

June 2009

DEDICATION

Specially dedicated to:

My beloved family

Parisa and Ayda

My mother and my late father

Your love has made me a better and stronger person.

You are always in my heart.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Faculty: Forestry

The fact that the world is losing its biodiversity due to human activities, particularly around the tropical forest region, has been widely known. One of the biggest threats to biodiversity is the edge effects, especially in isolated and fragmented habitats. Thus, to investigate the edge effects on the community of understorey birds, an isolated tropical rainforest of Malaysia was chosen. The objectives of this study were: (1) to examine the species composition, richness, abundance, and density changes across edge-interior gradient; (2) to detect any distinct bird communities associated with certain habitat types and the factors affecting the association (3) to distinguish the interior and edge specialist species and guilds. The point-count sampling method was used in a 1248-ha lowland rainforest patch of Ayer Hitam Forest Reserve to carry out a survey on the individual understorey bird and species, at each of the 93 survey points, between December 2006 and July 2008.

Birds and environmental variables were recorded within a 25 m radius of each point. A total of 2263 observations, 72 species, representing 19 families were recorded in this study. The species composition, density, abundance, and diversity of birds showed some significant differences across the edge-interior gradient at the guild and species levels. Based on the bird-habitat association, along the edge-interior gradient, two groups were distinguished. These were the edge-specialist group which was positively correlated with ground cover, light intensity, shrub cover, temperature, and percentage of shrub cover between 0.5 and 2 m in height; meanwhile the interior-specialist group was highly sensitive to the forest edge and could indicate good habitat quality of forest interior with high humidity, dense canopy cover, high number of dead trees, high percentage of litter cover, and deep litter layer. At the guild level, the results showed that the terrestrial insectivores and sallying insectivores are sensitive to edge and have positive correlation with distance from the edge, leaf litter depth, canopy cover, and the number of tall trees (>10 m). The presence of some species such as the Yellow-vented Bulbul, Cream-vented Bulbul, and Plaintive Cuckoo was associated with high light intensity and shrub cover, which are the best indicators of the edge. Meanwhile, the presence of Short-tailed Babbler, Moustached Babbler, and Black-caped Babbler was associated with high relative humidity and leaf litter cover, which are the best indicators of forest interior.

Changes in the micro-environment at the edge are a key factor to indicate the understorey avian responses to the edge-interior gradient. As edge

specialists can be widely found in the matrix surrounding the patch, they require less conservation against being declined or endangered; i.e. they can be well managed in the matrix surrounding the forest patches. Interior-specialists, on the other hand, especially terrestrial insectivores, should be given the most attention in conservation of forest areas. From the conservation viewpoint, the forest remnants in the lowlands of Peninsular Malaysia are of considerable concern. Due to the characteristics including thick leaf litter layer, dense canopy cover, high number of dead trees, and high relative humidity, these remnants have the capability of supporting the understorey bird species sensitive to edge effects.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN GRADIEN PINGGIR-DALAM HUTAN TERHADAP KOMUNITY BURUNG DI PERINGKAT BAWAH HUTAN DI HUTAN SIMPAN TERPENCIL AYER HITAM, MALAYSIA

Oleh

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Dunia sedang mengalami kehilangan kepelbagaian biodiversitinya disebabkan aktiviti-akitiviti yang dijalankan oleh manusia terutamanya di kawasan hutan tropika. Salah satu ancaman yang besar kepada biodiversiti adalah kesan peminggiran terutamanya di habitat yang terpencil dan terasing. Sebuah hutan hujan tropika yang terpencil di Malaysia iaitu Hutan Simpan Ayer Hitam telah dipilih untuk mengkaji kesan peminggiran ke atas komuniti burung di bahagian bawah hutan. Objektif kajian ini adalah untuk: (1) mengkaji komposisi, kekayaan, limpahan, dan perubahan kepadatan spesies burung di sepanjang gradien pinggir hutan ke bahagian dalam hutan (2) mengesan sebarang perbezaan komuniti burung berkaitan dengan jenis habitat dan faktor-faktor yang menyebabkan perkaitan tersebut (3) membezakan spesies khusus dan 'guild' di bahagian dalam dan di pinggir hutan. Kaedah pensampelan 'point-count' digunakan untuk survei individu

dan spesies burung pada setiap 93 titik survei dari Disember 2006 hingga Julai 2008. Burung dan pembolehubah persekitaran dicatatkan dalam sekitar 25 m bagi setiap titik survei. Sejumlah 2263 pemerhatian yang terdiri daripada 72 spesies yang mewakili 19 famili burung dicatatkan. Komposisi, kepadatan, kelimpahan, dan kepelbagaian spesies burung menunjukkan beberapa perbezaan yang ketara di sepanjang gradien pinggir hutan dan bahagian dalam hutan pada peringkat 'guild' dan spesies burung. Dua kumpulan burung dapat dibezakan berdasarkan pada perkaitan habitat dan burung di sepanjang pinggir hutan dan bahagian dalam hutan. Kumpulan burung khusus di pinggir hutan berkait rapat secara positif dengan lapisan litupan tanah, intensiti cahaya, litupan pokok renek, suhu, dan peratusan litupan pokok renek yang berketinggian antara 0.5 hingga 2 m. Manakala kumpulan burung khusus di bahagian dalam hutan adalah sangat sensitif terhadap pinggir hutan dan boleh menjadi petunjuk kepada kualiti habitat yang baik di bahagian dalam hutan dengan kelembapan yang tinggi, kepadatan litupan kanopi, bilangan pokok mati yang banyak, dan peratusan litupan sampah yang tinggi dan lapisan yang tebal. Pada paras 'guild' burung, keputusan kajian menunjukkan insektivor terestrial dan insektivor 'sallying' adalah sensitif kepada pinggiran hutan dan mempunyai korelasi positif dengan jarak dari pinggir hutan, kedalaman daun sampah, litupan kanopi, dan bilangan pokok tinggi (>10 m). Kehadiran beberapa spesies burung seperti Merbah Kapur, Merbah Mata-putih dan Sewah Mati-anak yang berkait dengan intensiti cahaya dan litupan pokok renek adalah petunjuk kepada pinggir hutan yang baik. Manakala kehadiran Rimba Ekor-pendek,

Rimba Berjambang, dan Rimba Kopiah-hitam yang berkait dengan kelembapan relatif yang tinggi dan litupan daun sampah adalah petunjuk yang baik kepada bahagian dalam hutan.

Perubahan pada persekitaran mikro di pinggir hutan adalah faktor utama penyebab burung di bahagian bawah hutan respons kepada gradien pinggir ke dalam hutan. Kumpulan burung khusus di pinggir hutan merupakan spesies burung yang kebanyakannya wujud di kawasan matrix hutan pinggir. Oleh itu pemuliharaan mereka bukan menjadi perkara yang wajib dan jika beberapa spesies ini berkurangan atau terancam, mereka mungkin boleh diurus dengan lebih baik di kawasan sekitar matrix hutan pinggir. Manakala spesies khusus hutan dalam terutamanya insektivor terestrial, memerlukan perhatian yang tinggi bagi konservasi kawasan hutan. Dari perspektif pemuliharaan, saki baki hutan di kawasan tanah pamah di Semenanjung Malaysia yang mengandungi lapisan daun sampah yang tebal, litupan kanopi yang padat, bilangan pokok mati yang banyak, dan kelembapan relatif yang tinggi mempunyai nilai pemuliharaan yang tinggi kerana mereka boleh menampung spesies burung di peringkat bawah hutan yang sensitif kepada kesan pinggir hutan.

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I certify that a Thesis Examination Committee has met on 30 June 2009 to conduct the final examination of Hossein Varasteh Moradi on his thesis entitled "Edge-interior Gradient Effects on the Understorey Bird Community in an Isolated Ayer Hitam Forest Reserve, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1988. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

HOSSEIN VARASTEH MORADI

Date: 28 July 2009

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LIST OF ABBREVIATIONS AND SYMBOLS

%	Percent
˚C	Degree celsius
a.s.l	Above sea level
AFF	Arboreal foliage gleaning insectivore-frugivores
AFI	Arboreal foliage gleaning insectivores
A-g-in-f	Arboreal foliage gleaning insectivore-frufivore
AHFR	Ayer Hitam Forest Reserve
AL	Number of *Agrostistachys longifolia* trees
ANOSIM	Analysis of similarity
ANOVA	Analysis of variance
Arct-wbl	Arctic Warbler
Ar-g-in	Arboreal foliage gleaning insectivores
Asnb-fly	Asian Brown Flycatcher
Bark-gle	Bark gleaning insectivores
BCB	Black-caped Babbler
BDW	Banded Woodpecker
Bffv-bul	Buff-vented Bulbul
BGI	Bark gleaning insectivores
Blkc-ba	Black-caped Babbler
Blkh-bul	Black-headed Bulbul
Bnd-wod	Banded Woodpecker
BNW	Buff-necked Woodpecker
Brnz-drn	Bronzed Drongo
BSL	Basal area
CCA	Canonical correspondence analysis
CCV	Canopy cover
Chkr-wod	Checker-throated Woodpecker
Chstw-ba	Chestnut-winged Babbler
Cm	Centimeter
Cmn-tlr	Common Tailorbird
Crmv-bul	Cream-vented Bulbul
CTB	Common Tailorbird
CTW	Checker-throated Woodpecker
CVB	Cream-vented Bulbul
CWB	Chestnut-winged Babbler
dbh	Diameter in breast height
DA	Discriminant analysis
DCCA	Detrended canonical correspondence analysis
DDT	dbh of dead trees
DEI	Depth of edge influence
DIS	Distance from the forest edge
Drkth-or	Dark-throated Oriole
Dsk-brdb	Dusky Broadbill
E	East
E(Sn)	Expected number of species
E´	Camergo's index of evenness

EI	Edge influences
EMD	Emerald Dove
Emrd-dov	Emerald Dove
E_{var}	Smith and Wilson index of evenness
FCB	Finsch's Bulbul
Flffb-ba	Fluffy-backed Tit-babbler
Fnch-bul	Finsch's Bulbul
FTB	Fluffy-backed Tit-babbler
GCV	Ground cover
GLM	General linear models
GRD	Greater Racket-tailed Drongo
Grt-drng	Greater Racket-tailed Drongo
Gryh-bab	Grey-headed Babbler
GYN	Greater Yellownape
h	Hour
H'	Shannon heterogeneity index
ha	Hectare
HUM	Humidity
Indn-cuk	Indian Cuckoo
Km	Kilometer
Km^2	Square kilometer
K-W	Kruskal-Wallis
LDP	Leaf litter depth
LPC	Leaf litter cover
LSH	Little Spiderhunter
LUX	Light intensity
m	Meter
m/s	Meter per second
m^3/ha	Cubic meter per hectare
Mgp-rbn	Magpie Robin
min	Minute
mm	Millimeter
MM	Number of *Melastoma malabathricum* shrubs
MPR	Magpie Robin
MRW	Maroon Woodpecker
Mstch-ba	Moustached Babbler
N	North
n	Number of observations
N_0	Total number of species
N_1	Number of abundant species in a sample
N_2	Simpson reciprocal index
NDT	Number of dead trees
Ne-in-fr	Nectarivore-insectivore-frugivore
NFT	Number of fruiting trees
NIF	Nectarivore-insectivore-frugivores
NPT	Number of palm trees
NT<2	Number of tree saplings with dbh of less than 2 cm
NT<6	Number of trees less than 6 m in height
NT>10	Number of trees higher than 10 m in height

NT10	Number of trees with dbh of 10-20 cm
NT2	Number of trees with dbh of 2-5 cm
NT20	Number of trees with dbh of 20-30 cm
NT30	Number of trees with dbh of 30-50 cm
NT5	Number of trees with dbh of 5-10 cm
NT50	Number of trees with dbh of more than 50 cm
NT6	Number of trees 6-10 m in height
NTI	Number of tree individuals
NTS	Number of tree species
OBF	Orange-bellied Flowerpecker
Olvb-wod	Olive-backed Woodpecker
Orngb-fl	Orange-bellied Flowerpecker
Orntl-wh	Oriental White-eye
OWB	Olive-winged Bulbul
PCA	Principal component analysis
Pffb-bul	Puff-backed Bulbul
PLC	Plaintive cuckoo
Pln-snbr	Plain Sunbird
Plnv-cuk	Plaintive Cuckoo
PNS	Purple-naped Sunbird
PSH2	Percentage of shrub cover between 0.5 and 2 m in height
PSH6	Percentage of shrub cover between 2 and 6 m in height
R^2	Coefficient of determination
RDA	Constrained redundancy ordination
Rdey-bul	Red-eyed Bulbul
REB	Red-eyed Bulbul
Rfsc-bab	Rufous-crowned Babbler
Rfs-tlr	Rufous-tailed Tailorbird
Sally-in	Sallying insectivores
SD	Standard deviation
SE	Standard error
SHB	Short-tailed Babbler
SHC	Understorey shrub cover
Shrtt-ba	Short-tailed Babbler
SIMPER	Similarity percentage analysis
SIN	Sallying insectivores
SLO	Slope
SPB	Spectacled Bulbul
Spct-bul	Spectacled Bulbul
Spct-spd	Spectacled Spiderhunter
Spt-dov	Spotted Dove
STB	Striped Tit-babbler
Strpt-ba	Striped Tit-babbler
TEM	Temperature
Ter-in-f	Terrestrial insectivore-frugivores
Ter-inse	Terrestrial Insectivores
TIF	Terrestrial insectivore-frugivores
TIN	Terrestrial insectivores
UPM	Universiti Putra Malaysia