

## IMPACTS OF VEGETATION STRUCTURE AND FIRE ON THE AVIAN POPULATIONS OF MUDUMALAI WILDLIFE SANCTUARY

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### ABSTRACT

The impacts of vegetation characteristics and occurrence of fire on avian populations of Mudumalai Wildlife Sanctuary are documented in this paper. Vegetation characteristics such as canopy volume, species richness and flowering tree density and diversity entered as significant factors in the multiple regression equation predicting the bird density across the habitats studied. Fire also entered as a significant factor in the multiple regression equation for predicting avian populations presumably by its effects resulting in higher productivity of food supplies to the bird communities.

**KEYWORDS:** Avian population, Occurrence of fire and Vegetation characteristics.

### INTRODUCTION

The Mudumalai wildlife sanctuary is an offshoot of the Nilgiri Biosphere Reserve (NBR) of the Western Ghats of India. The extent of this sanctuary is 321 Sq km and the average elevation ranges between 900 m and 1250 m above MSL. The vegetation of the sanctuary is classified into a broad spectrum of thorn forest, dry deciduous, moist deciduous and semi-evergreen forests. The sanctuary is known for its variety of avifauna that includes many species of chloropsis, barbets, nuthatches, tree-pie, flower peckers, drongos, minivets, parakeets, sunbirds, raptors, pigeons, doves, mynas, woodpeckers, babblers *etc.* Earlier research reports on its avifauna are by Johnson (1975), Kahn (1978), Gregory-Smith (1989), Sathyanarayana and Veeramani (1993), Gokula and Vijayan (1997), Gokula (1998), Andheria (1999) and Balasubramanian and Maheswaran (1999).

A factor that could affect the stability and composition of vegetation in a forest is fire. Fires often occur as a natural phenomenon, a part of the dynamics of forest regeneration and succession. However in India a large number of accidental, human-caused fires are reported from forests areas, often as a result of carelessness, a cigarette or "bidi" thrown in the canopy, small deliberate fire spreading over a large area. Fire had been reported to affect the nutrient status of the soil, diversity and richness and cause changes in species composition in flora in an area (Laurie, 1978; Rodgers, 1986; Karunakaran *et al.*, 1998). In general fire had been considered an enemy, a destroyer of wilderness resources

and values including animals, vegetation and scenery and the elimination of fire had been considered essential to the protection of a park. This traditional view of fire, as a force to be eliminated from wild land ecosystems has been largely replaced with recognition of the important role of natural fire in sustaining healthy native ecosystems. In addition to recognizing fire as a natural force in wilderness, it is also regarded that burning may be prescribed in few cases to restore, maintain, protect or preserve the wilderness resources and values.

Fire may have its own impacts on avifauna also as for example the burned coniferous forests in the Sierra Nevada supported a few more species than unburned forests, presumably because of higher productivity of bird food supplies (Bock and Lynch, 1970).

So, it is essential to understand the role of fire in an ecosystem and analyzing its impact on avian density and diversity in a habitat and this paper documents the effect of forest fire on the bird communities of Mudumalai Wildlife Sanctuary, India.

### Study Area

The Mudumalai Wildlife Sanctuary (Fig.1) is an offshoot of the Nilgiri Biosphere Reserve (NBR) of the Western Ghats. This sanctuary lies between latitudes 11° 32' and 11° 42' North and longitudes 76° 20' and 76° 40' East and situated at the confluence of three southern states *viz.*, Tamil Nadu, Kerala and Karnataka. Bandipur Tiger Reserve in the north, Sigur Reserved forest in the east

and Wyanad Wildlife Sanctuary in the west encompasses the sanctuary. The extent of this sanctuary is 321 sq. km.

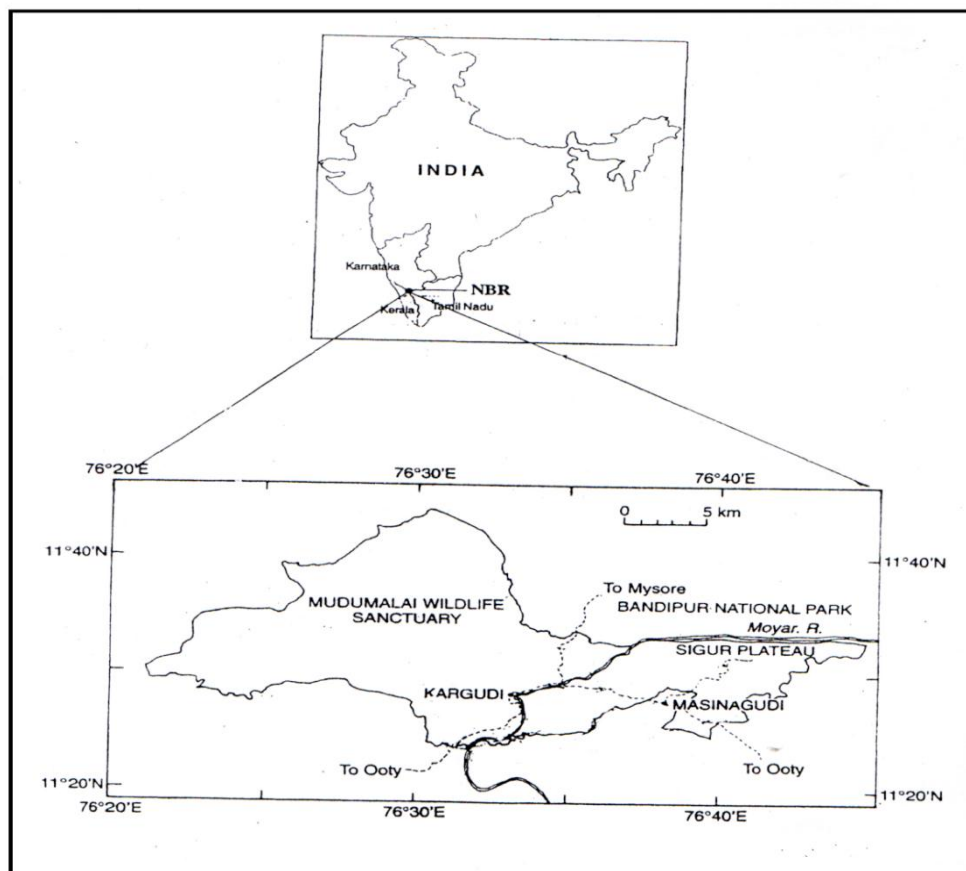


Fig. 1: Location map of Mudumalai wildlife sanctuary.

## MATERIAL AND METHODS

### Vegetation Studies

Data on species composition of plants (trees, shrubs, herbs and grasses) were gathered from a total of 80, one hectare plots. In each plots two corners were selected and in each corner one 25m x 25m quadrat was laid for tree enumeration. Shrub species density was assessed in two 5m x 5m quadrates which were laid at the opposite corners within each plot that were laid for trees. For the assessment of herb and grass cover two 1m x 1m plots that were laid within each plot for shrub enumeration.

Out of 80 one hectare plots 25 plots were laid in Dry Deciduous habitat, 21 plots in Moist Deciduous habitat, 10 plots in Scrub Jungle habitat, 12 plots in Ecotone between Dry Deciduous and Moist Deciduous Forests, 8 plots in Ecotone between Dry Deciduous Forest and Scrub Jungle and 4 plots in Revrine habitat of the study area. The number of the plots were decided based on the relative extents of different habitats and the location of the plots were by following the stratified random sampling (Muller-Dombois and Ellenberg, 1972).

### Tress Species and Density

Tress with >15 cm girth at breast height (1.3 m) were considered as matured trees and measured for girth at breast height, tree height and canopy volume (two diameters of the canopy at right angles and the canopy height were used to estimate canopy volume) as suggested by Mueller-Dombois and Ellenberg (1972). Density of a tree species was calculated as number per hectare.

The volume of the crown was estimated as that geometric shape that most closely approximated its shape, usually a sphere or hemisphere. Suitable adjustments/corrections were employed for those tree canopies that deviated from the assumed spherical or hemispherical shape (Eisenberg, 1981). Crown diameters were determined by pacing the distance and the volume of the spherical or hemispherical canopies were calculated from the formula.

$$V = 4/3\pi (D/2)^3$$

Where V = volume of spherical canopy;

D = Diameter of the crown

Shannon-Wiener index (Shannon and Wiener, 1949) was calculated using the following

The diversity index is

$$H' = - \sum_{i=1}^S (p_i)(\log_{10} p_i)$$

Where S = number of species

$p_i$  = proportion of individuals of a given species

### Recording of Fire Occurrences

Compartment-wise occurrence and extent of fire were recorded during 2000 and 2001. The data on the occurrence of fire in the previous years was also obtained from earlier records in the forest department for comparison.

## OBSERVATION AND RESULTS

### Bird species compositions of different habitats of Mudumalai wildlife sanctuary

A total number of 167 species of bird belonging to 13 orders cover second in different habitats of Mudumalai wildlife sanctuary during the study period table 1. The scrub jungle had the highest no of species (115) followed by dry deciduous forest (103) moist deciduous forest (99) ecotone between dry deciduous and moist deciduous forest (93) reverine forest (88) and the ecotone between dry deciduous forest and scrub jungle (84).

**Table 1: List of bird species recorded in Mudumalai wildlife sanctuary during the study period.**

S#	Common Name	Scientific Name	Order	Ecological Group
1	Indian pond heron	<i>Ardeola grayii</i>	Ciconiformes	Waterbird
2	Bonellis eagle	<i>Hieraetus fasciatus</i>	Falconiformes	Raptor
3	Booted eagle	<i>Hieraetus pennatus</i>	Falconiformes	Raptor
4	Brahminy kite	<i>Haliastur indus</i>	Falconiformes	Raptor
5	Changeable hawk eagle	<i>Spizaetus cirrhatus</i>	Falconiformes	Raptor
6	Crested serpent eagle	<i>Spilornis cheela</i>	Falconiformes	Raptor
7	Eurasian sparrowhawk	<i>Accipiter nisus</i>	Falconiformes	Raptor
8	Oriental hobby	<i>Falco severus</i>	Falconiformes	Raptor
9	Black kite	<i>Milvus migrans</i>	Falconiformes	Raptor
10	Shikra	<i>Accipiter badius</i>	Falconiformes	Raptor
11	Indian white backed vulture	<i>Gyps bengalensis</i>	Falconiformes	Raptor
12	Grey francolin	<i>Francolinus pondichianus</i>	Galliformes	Granivore
13	Grey jungle fowl	<i>Gallus sonneratti</i>	Galliformes	Omnivore
14	Indian peafowl	<i>Pavo cristatus</i>	Galliformes	Omnivore
15	Jungle bush quail	<i>Pardicula asiatica</i>	Galliformes	Granivore
16	Red spur fowl	<i>Galloperdix spadicea</i>	Galliformes	Granivore
17	Red wattled lapwing	<i>Vanellus indicus</i>	Charadriiformes	Vermivore
18	Yellow wattled lapwing	<i>Vanellus malabaricus</i>	Charadriiformes	Vermivore
19	Emerald dove	<i>Chalcophaps indica</i>	Columbiformes	Granivore
20	Eurasian collard dove	<i>Streptopelia decaocto</i>	Columbiformes	Granivore
21	Green imperial pigeon	<i>Ducula aenea</i>	Columbiformes	Frugivore
22	Nilgiri wood pigeon	<i>Columba elphinstoni</i>	Columbiformes	Frugivore
23	Pompadour green pigeon	<i>Treron pompadora</i>	Columbiformes	Frugivore
24	Orange breasted green pigeon	<i>Treron bicincta</i>	Columbiformes	Frugivore
25	Oriental turtle dove	<i>Streptopelia orientalis</i>	Columbiformes	Granivore
26	Spotted dove	<i>Streptopelia chinensis</i>	Columbiformes	Granivore
27	Yellow legged green pigeon	<i>Treron phoenicoptera</i>	Columbiformes	Frugivore
28	Alexandrine parakeet	<i>Psittacula eupatria</i>	Psittaciformes	Frugivore
29	Blosm headed parakeet	<i>Psittacula roseate</i>	Psittaciformes	Frugivore
30	Blue winged parakeet	<i>Psittacula columboides</i>	Psittaciformes	Frugivore
31	Indian hanging parrot	<i>Loriculus vernalis</i>	Psittaciformes	Frugivore
32	Rose ringed parakeet	<i>Psittacula krameri</i>	Psittaciformes	Frugivore
33	Asian koel	<i>Eudynamis scolopacea</i>	Cuculiformes	Frugivore
34	Brainfever bird	<i>Hierococcyx varius</i>	Cuculiformes	Frugivore
35	Greater coucal	<i>Centropus sinensis</i>	Cuculiformes	Omnivore
36	Indian cuckoo	<i>Cuculus micropterus</i>	Cuculiformes	Frugivore
37	Lesser coucal	<i>Centropus bengalensis</i>	Cuculiformes	Insectivore
38	Pied crested cuckoo	<i>Clamator jacobinus</i>	Cuculiformes	Omnivore
39	Sirkeer malkoha	<i>Phaenicophaeus leschenaultia</i>	Cuculiformes	Frugivore
40	Small green billed malkoha	<i>Phaenicophaeus viridirostris</i>	Cuculiformes	Omnivore
41	Eurasian eagle owl	<i>Bubo bubo</i>	Strigiformes	Raptor

42	Forest eagle owl	<i>Bubo nipalensis</i>	Strigiformes	Raptor
43	Jugle owlet	<i>Glaucidium radiatum</i>	Strigiformes	Raptor
44	Spotted owlet	<i>Athene brama</i>	Strigiformes	Raptor
45	Crested tree swift	<i>Hemiprogne coronate</i>	Apodiformes	Insectivore
46	Malabar trogon	<i>Harpactus fasciatus</i>	Trogoniformes	Omnivore
47	Small bee-eater	<i>Merops orientalis</i>	Coraciformes	Insectivore
48	Blue bearded bee-eater	<i>Nyctornis athertoni</i>	Coraciformes	Insectivore
49	Chestnut headed bee-eater	<i>Merops leschenaulti</i>	Coraciformes	Insectivore
50	Common hoopoe	<i>Upupa epops</i>	Coraciformes	Insectivore
51	Indian roller	<i>Coracias benghalensis</i>	Coraciformes	Insectivore
52	Lesser pied kingfisher	<i>Ceryle rudis</i>	Coraciformes	Waterbird
53	Malabar grey hornbill	<i>Ocyrceros griseus</i>	Coraciformes	Frugivore
54	Oriental dwarf kingfisher	<i>Ceyx erithacus</i>	Coraciformes	Waterbird
55	Small blue kingfisher	<i>Alcedo atthis</i>	Coraciformes	Waterbird
56	Blue eared kingfisher	<i>Alcedo meninting</i>	Coraciformes	Waterbird
57	Stork billed kingfisher	<i>Halcyon capensis</i>	Coraciformes	Waterbird
58	White breasted kingfisher	<i>Halcyon smyrnensis</i>	Coraciformes	Waterbird
59	Black shouldered woodpecker	<i>Chrysocolaptes festivus</i>	Piciformes	Insectivore
60	Brown capped pygmy woodpecker	<i>Dendrocopos nanus</i>	Piciformes	Insectivore
61	Brown headed barbet	<i>Megalaima zeylonica</i>	Piciformes	Frugivore
62	Coppersmith barbet	<i>Megalaima haemacephala</i>	Piciformes	Frugivore
63	Crimson throated barbet	<i>Megalaima rubricapilla</i>	Piciformes	Frugivore
64	Great black woodpecker	<i>Dryocopus javensis</i>	Piciformes	Insectivore
65	Greater golden backed woodpecker	<i>Chrysocolaptes lucidus</i>	Piciformes	Insectivore
66	Heart spotted woodpecker	<i>Hemicircus canenete</i>	Piciformes	Insectivore
67	Lesser golden backed woodpecker	<i>Dinopium benghalensis</i>	Piciformes	Insectivore
68	Scaly bellied green woodpecker	<i>Picus xanthopygaeus</i>	Piciformes	Insectivore
69	Rufous woodpecker	<i>Celeus brachyurus</i>	Piciformes	Insectivore
70	Small yellow naped woodpecker	<i>Picus chlorolophus</i>	Piciformes	Insectivore
71	Speckled piculet	<i>Picumnus innominatus</i>	Piciformes	Insectivore
72	White cheeked barbet	<i>Megalaima viridis</i>	Piciformes	Frugivore
73	Yellow fronted pied woodpecker	<i>Dendrocopos mahrattensis</i>	Piciformes	Insectivore
74	Ashy drongo	<i>Dicrurus leucophaeus</i>	Passeriformes	Insectivore
75	Ashy prinia	<i>Prinia socialis</i>	Passeriformes	Insectivore
76	Asian brown flycatcher	<i>Muscicapa dauurica</i>	Passeriformes	Insectivore
77	Asian fairy blue bird	<i>Irena puella</i>	Passeriformes	Vermivore
78	Asian paradise flycatcher	<i>Terpsiphone paradisi</i>	Passeriformes	Insectivore
79	Baya weaver	<i>Ploceus philippinus</i>	Passeriformes	Insectivore
80	Bay backed shrike	<i>Lanius vittatus</i>	Passeriformes	Insectivore
81	Bengal bush lark	<i>Mirafrassamica</i>	Passeriformes	Granivore
82	Black bulbul	<i>Hypsipetes leucocephalus</i>	Passeriformes	Frugivore
83	Black drongo	<i>Dicrurus macrocercus</i>	Passeriformes	Insectivore
84	Black and orange flycatcher	<i>Ficedula nigrorufa</i>	Passeriformes	Insectivore
85	Black napped flycatcher	<i>Hypsipetes azurea</i>	Passeriformes	Insectivore
86	Black headed cuckoo shrike	<i>Coracina melanoptera</i>	Passeriformes	Insectivore
87	Black headed munia	<i>Lonchura Malacca</i>	Passeriformes	Granivore
88	Black headed oriole	<i>Oriolus xanthornus</i>	Passeriformes	Omnivore
89	Black lored yellow tit	<i>Parusxanthogenys</i>	Passeriformes	Insectivore
90	Booted warbler	<i>Hippolaris caligata</i>	Passeriformes	Insectivore
91	Brahmini starling	<i>Sturnus pagodarum</i>	Passeriformes	Omnivore
92	Bronzed drongo	<i>Dicrurus aeneus</i>	Passeriformes	Insectivore
93	Brown shrike	<i>Lanius cristatus</i>	Passeriformes	Insectivore
94	Chestnut bellied nuthatch	<i>Sitta castanea</i>	Passeriformes	Insectivore
95	Common chiffchaff	<i>Phylloscopus collybita</i>	Passeriformes	Insectivore
96	Common crested lark	<i>Galerida cristata</i>	Passeriformes	Granivore
97	Common hill myna	<i>Gracula religiosa</i>	Passeriformes	Frugivore
98	Common iora	<i>Aegithina tiphia</i>	Passeriformes	Insectivore
99	Common lesser white throat	<i>Sylvia curruca</i>	Passeriformes	Insectivore



100	Common myna	<i>Acridotheres tristis</i>	Passeriformes	Omnivore
101	Common rose finch	<i>Carpodacuserythrinus</i>	Passeriformes	Granivore
102	Common tailor bird	<i>Orthotomus sutorius</i>	Passeriformes	Insectivore
103	Common woodshrike	<i>Tephrodornis pondicerianus</i>	Passeriformes	Insectivore
104	Eurasian black bird	<i>Turdus merula</i>	Passeriformes	Insectivore
105	Eurasian golden oriole	<i>Oriolus oriolus</i>	Passeriformes	Omnivore
106	Fire throat	<i>Luciia pectardes</i>	Passeriformes	Insectivore
107	Flower pecker	<i>Dicaeum spp.</i>	Passeriformes	Nectarivore
108	Forest wagtail	<i>Dendronanthus indicus</i>	Passeriformes	Insectivore
109	Golden fronted chloropsis	<i>Chloropsis aurifrons</i>	Passeriformes	Omnivore
110	Grass warbler	<i>Schoenicola platyura</i>	Passeriformes	Insectivore
111	Great tit	<i>Parus major</i>	Passeriformes	Insectivore
112	Greater rocket tailed drongo	<i>Dicrurus paradiseus</i>	Passeriformes	Insectivore
113	Greenish leaf warbler	<i>Phylloscopus trochiloides</i>	Passeriformes	Insectivore
114	Grey headed flycatcher	<i>Culicicapa ceylonensis</i>	Passeriformes	Insectivore
115	Grey wagtail	<i>Motacilla cinerea</i>	Passeriformes	Insectivore
116	Grey headed bulbul	<i>Pycnotus priocephalus</i>	Passeriformes	Omnivore
117	Grey headed starling	<i>Sturnus malabaricus</i>	Passeriformes	Omnivore
118	Indian pitta	<i>Pitta brachyyura</i>	Passeriformes	Insectivore
119	Indian robin	<i>Saxicola fulicata</i>	Passeriformes	Insectivore
120	Indian scimigar babler	<i>Pomatorhinus horsfieldii</i>	Passeriformes	Omnivore
121	Indian treepie	<i>Dendrocitta vagabunda</i>	Passeriformes	Omnivore
122	Jerdons chloropsis	<i>Chloropsis cochinchinensis</i>	Passeriformes	Omnivore
123	Jungle babbler	<i>Turdoides striatus</i>	Passeriformes	Omnivore
124	Jungle crow	<i>Corvus macrorhynchos</i>	Passeriformes	Omnivore
125	Jungle myna	<i>Acridotheres fuscus</i>	Passeriformes	Omnivore
126	Jungle prinia	<i>Prinia sylvatica</i>	Passeriformes	Insectivore
127	Large cuckoo shrike	<i>Coracina macei</i>	Passeriformes	Insectivore
128	Large pied wagtail	<i>Motacilla maderaspatensis</i>	Passeriformes	Insectivore
129	Large woodshrike	<i>Tephrodornis gularis</i>	Passeriformes	Insectivore
130	Lesser grey shrike	<i>Lanius minor</i>	Passeriformes	Insectivore
131	Little spider hunter	<i>Arachnothera longirostra</i>	Passeriformes	Insectivore
132	Lotens sunbird	<i>Nectarinia lotenia</i>	Passeriformes	Nectarivore
133	Malabar whistling thrush	<i>Myiophonus horsfieldii</i>	Passeriformes	Vermivore
134	Nilgiri flycatcher	<i>Eumyias albicaudata</i>	Passeriformes	Insectivore
135	Orange headed thrush	<i>Zoothera citrine</i>	Passeriformes	Vermivore
136	Oriental magpie robin	<i>Copsychus saularis</i>	Passeriformes	Insectivore
137	Oriental white eye	<i>Zosterops palpebrosus</i>	Passeriformes	Insectivore
138	Orphan warbler	<i>Sylvia hortensis</i>	Passeriformes	Insectivore
139	Pied bush chat	<i>Saxicola caprata</i>	Passeriformes	Insectivore
140	Pied flycatcher shrike	<i>Hemipus picatus</i>	Passeriformes	Insectivore
141	Purple sunbird	<i>Nectarinia asiatica</i>	Passeriformes	Nectarivore
142	Purple rumped sunbird	<i>Nectarinia zeylonica</i>	Passeriformes	Nectarivore
143	Red-vented bulbul	<i>Pycnonotus cafer</i>	Passeriformes	Omnivore
144	Redwhiskered bulbul	<i>Pycnonotus jocosus</i>	Passeriformes	Omnivore
145	Rosy starling	<i>Sturnus roseus</i>	Passeriformes	Frugivore
146	Rufous backed shrike	<i>Lanius schach</i>	Passeriformes	Insectivore
147	Rufous bellied babbler	<i>Dumetia hyperythra</i>	Passeriformes	Insectivore
148	Scarlet minivet	<i>Pericrocotus flammeus</i>	Passeriformes	Insectivore
149	Small minivet	<i>Pericrocotus cinnamomeus</i>	Passeriformes	Insectivore
150	Small sunbird	<i>Nectarinia minima</i>	Passeriformes	Nectarivore
151	Spongeled drongo	<i>Dicrurus hottentottus</i>	Passeriformes	Granivore
152	Spotted munia	<i>Lonchura punctulata</i>	Passeriformes	Granivore
153	Streaked fantail warbler	<i>Cisticola juncidis</i>	Passeriformes	Insectivore
154	Tickells blue flycatcher	<i>Cyornis tickelliae</i>	Passeriformes	Insectivore
155	Tree pipit	<i>Anthus hodgsoni</i>	Passeriformes	Insectivore
156	Velvet fronted nuthatch	<i>Sitta frontalis</i>	Passeriformes	Insectivore
157	Verdit flycatcer	<i>Eumyias thalassina</i>	Passeriformes	Insectivore

158	White browed babbler	<i>Alcippe vinipectus</i>	Passeriformes	Insectivore
159	White bellied drongo	<i>Dicrurus caerulescens</i>	Passeriformes	Insectivore
160	White bellied minivet	<i>Pericrocotus erythropgyus</i>	Passeriformes	Insectivore
161	White browed fantail flycatcher	<i>Rhipidura aureola</i>	Passeriformes	Insectivore
162	White throated fantail flycatcher	<i>Rhipidura albicollis</i>	Passeriformes	Insectivore
163	White headed babbler	<i>Turdoides affinis</i>	Passeriformes	Omnivore
164	Yellow wagtail	<i>Motacilla flava</i>	Passeriformes	Insectivore
165	Yellow throated sparrow	<i>Petronia dantocollis</i>	Passeriformes	Granivore
166	Yellow eyed babbler	<i>Chrysomma sinese</i>	Passeriformes	Insectivore
167	Yellow browed bulbul	<i>Iole indica</i>	Passeriformes	Omnivore

**Fire occurrence**

Data Occurrence of fire in the Mudumalai sanctuary during 2000 and 2001 has been given in tables 2 and 3

and the vegetation characteristics of fire affected compartments in table 4.

**Table 2: Occurrence of fire in Mudumalai wildlife sanctuary during 2000.**

Serial number	Compartment number	Habitat type	Percentage of fire	Approximate area affected in hectare
1	1	Dry deciduous	100	600
2	2	Moist deciduous	80	600
3	3	..	20	240
4	4	..	60	600
5	5	..	20	90
6	6	..	5	50
7	7	Dry deciduous	60	450
8	8	..	100	700
9	9	..	100	600
10	10	..	100	600
11	11	..	100	600
12	12	..	80	1200
13	13	..	90	1800
14	14	..	100	2000
15	15	..	10	200
16	16	..	100	800
17	17	..	100	800
18	18	..	20	120
19	19	Moist deciduous	50	400
20	24	..	2	20
21	27	..	50	500
22	28	..	2	40
23	29	..	30	200
24	30	..	5	50
25	31	..	5	50
26	32	..	5	50
27	33	..	5	50
28	37	..	2	20
29	38	..	17	10
30	40	..	60	6000

**Table 3: Occurrence of fire in Mudumalai wildlife sanctuary during 2001.**

Serial number	Compartment number	Habitat type	Percentage of fire	Approximate area affected in hectare
1	7	Dry deciduous	5	50
2	8	..	10	100
3	9	..	100	600
4	10	..	10	50
5	15	..	8	125

6	16	„	5	50
7	27	Moist deciduous	2	50
8	28	„	1	100
9	40	Dry deciduous	10	1030

**Table 4: vegetation characteristics of fire affected compartments of Mudumalai wildlife sanctuary.**

Compartment number	Tree density (No./ha)	Mean tree height (m)	Mean DBH (cm)	Mean canopy volume (m <sup>3</sup> /ka)	% of grass cover	Herb density (No./ha)	Shrub density (No./ha)
7	232.0	11.6	24.2	1444.6	74.8	48750.0	5200
8	344.0	9.0	16.5	4075.2	42.0	25000.0	6200
9	240.0	12.2	26.5	6581.5	56.0	38750.0	7600
10	168.0	12.8	36.5	10545.5	50.8	47500.0	4700
15	360.0	10.8	27.5	12071.9	95.3	86250.0	1500
16	208.0	9.6	23.1	14018.6	63.3	83750.0	4300
27	200.0	16.1	46.2	15631.0	99.3	7500.0	800
28	272.0	15.8	39.0	43837.2	98.9	12120.0	400
40	267.0	9.9	25.9	5841.8	75.2	37900.0	5500

Totally 30 compartments were affected by fire during 2000, 5 in most deciduous forests and 25 Dry deciduous forest compartments 1, 8, 9, 10 and 11 were early affected during 2000 (Table 2).

Totally 9 compartments, 7 in Dry deciduous habitat and 2 in Moist deciduous habitat were affected by fire during 2001 (Table 3). Compartment 9 was the most severely affected (100%). Totally 7% of the area was affected in the forest fire during the study period.

#### Relative importance of vegetation and fire on avian populations

The multiple regression analysis showed that the vegetation characteristics such as canopy volume, species richness and flowering tree density and diversity are having significant influence on the bird density across the habitats studied (Table 5).

Fire also entered as a significant factor in the multiple regression equation for predicting avian populations (Table 5).

**Table 5: Multiple regression equation of bird population density showing the relative importance of vegetation structure and fire in Mudumalai wildlife sanctuary.**

Parameter	Predictor	Coeff	St. Dev	t	P
Total bird density (log) F = 7.96 P < 0.01 N = 19 R <sup>2</sup> <sub>Adj</sub> = 76.7%	Constant	-27.454	6.277	-4.37	0.001
	Canopy volume/ha	0.00000003	0.00000001	-5.76	0.000
	Tree species richness	5.812	1.191	4.88	0.000
	Tree species richness <sup>2</sup>	-0.4705	0.1005	-4.68	0.000
	Tree species richness <sup>3</sup>	0.011931	0.002617	4.56	0.000
	Fire	0.40552	0.08258	4.91	0.000
	Flowering tree density	0.033713	0.008009	4.21	0.002
	Flowering tree density <sup>2</sup>	-0.00004695	0.00001107	-4.24	0.002
	Flowering tree diversity	6.006	1.409	4.26	0.002
	Flowering tree diversity <sup>2</sup>	-2.6210	0.6270	-4.18	0.002

## DISCUSSION

### Vegetation Characteristics and birds

The multiple regression analysis showed that the vegetation characteristics such as canopy volume, species richness and flowering tree density and diversity played an important role in influencing the avian density across the habitats studied (Table 5). Relationship between vegetation characteristics and avian diversity measures were reported earlier also (Mac Arthur and Mac Arthur, 1961; Mac Arthur *et al.*, 1962; Karr, 1971; James and Shuggart, 1973; Tomoff, 1974; Wilson, 1974; Terborgh, 1977). Gochfeld (1978) also found that *Mimus triurus* increased in density with vegetation

diversity. Influence of vegetation characteristics on bird occurrence had also been established by Sturman (1968) who found the chestnut backed chickades (*Parus refescens*) were found to select taller coniferous vegetation and Black capped chickades (*P. articapillus*) to select habitats where bushes and middle storey trees were common. Vegetation density was reported to be an important factor in habitat segregation among thrushes by Fischer (1980). According to Cody (1985) birds distinguish habitats on the basis of vegetation structure and structural aspects of habitats can be used to predict bird density and diversity as the number of species that pack into a habitat are directly related to structural diversity and in turn structural diversity is related to

either resource diversity or the number of ways in which resources can be partitioned by the birds.

### Fire and birds

Fire usually occurs in alternative years (if the fire is high in one year, in the immediate next year it usually will be less) due to various reasons. The prime reason is dry litter accumulation, which will stagnate in alternative years. Another reason is fire setters i.e., the poachers and some horn collection people, who set fire for ground clearance. The antler shedding will be in peak during November and December. If the forest is burned every year, the horn collection will be less and so they are setting fire every alternative years intensively. Fire seemed to have mainly depending upon the ground cover intensity, so that the tall grass and high weed areas are often getting burnt.

Fire occurrence were found to have a linear relationship with the overall density of birds (multi regression analysis; vide table 5) indicating that some bird species are attracted in large numbers to those areas. Bock and Lynch (1970) also found that burnt coniferous forests in the Sierra Nevada supported a few more species and larger species than unburned forests, presumably because of higher productivity of food supplies.

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