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Human - Bird competition for plant resources in and around Masinangudi area, Mudumalai Wildlife Sanctuary, South India

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Abstract

Plants used by birds for foraging and nesting and their exploitation by local people for consumptive and commercial use in a part of Mudumalai Wildlife Sanctuary, India have been documented. Seventeen plant species that were crucial for various bird species to nest and forage have been cut for fuel wood and timber resulting in resource use competition between human and bird. Either a partial or a total substitution by alternative energy resources or establishment of a special harvesting place in the reserved forest zone adjacent to sanctuary can only minimize the human-bird resource competition since forest administrative policies do not permit resource exploitation within the sanctuary boundary.

Keywords : birds, competition, diversity, human, Mudumalai, plant resources

INTRODUCTION

Energy resources such as fuel wood is a limiting commodity for many tribal and non-tribal communities inhabiting in and around the protected areas in India. Since such communities are highly dependant upon wood as their primary energy source, removal of wood resources from the forest has been an age-old practice for those people. However, due to a rapid increase in human population size in recent years, this practice goes in an unsustainable mode and snowballs into a significant reduction of the resources available for animals in addition to alteration of forest structure. Hence, a systematic knowledge of human-animal resource competition would alone enable the manager to make realistic management plans for an area under severe human pressure. But, very few attempts have been made in this regard in India (e.g. Joshua and Johnsingh, 1994 and Ramakrishnan and Sivaganesan, 1997) eventhough majority of the protected areas in India are under severe human pressure. This paper deals with the impact of removal of wood resources by the local communities on foraging and nesting resources available for birds both in the breeding and non-breeding seasons of birds between 1994 and 1998 in Masinangudi area of Mudumalai Wildlife Sanctuary, Tamil Nadu, India.

STUDY AREA

The Mudumalai Wildlife Sanctuary located between 11°30' to 11°39' N and 76°27' and 76°43' E is situated at an average elevation of 1000 m in the Nilgiris district, Tamil Nadu. The climate is moderate, and temperatures vary from 14°-17°C during December-January to 29°-33°C during March-May. The annual rainfall varies from 600 mm to 2000 mm. The sanctuary is drained mainly by a perennial river *Moyar*. Corresponding to the rainfall, the vegetation varies from thorn forest in the east to semi-evergreen forest in the west. *Kurumbas*, *Nayakers*, *Paniyas* and *Chettys* are the major tribes inhabiting the sanctuary. They live in about 29 hamlets with a total population of about 1200. Apart from the tribal settlements, many villages are also present in and around the sanctuary. The present study was carried out in a part of Mudumalai Wildlife Sanctuary situated around the village Masinangudi, which harbours a human population of about 4,554. The study area being heterogeneous in nature supports a combination of tree species such as *Tectona grandis, Anogeissus latifolia, Acacia chundra, A. leucopholea, A.ferruginea, Ziziphus xylopyrus, Sapindus emarginatus, Phyllanthus emblica, Erythroxylum monogynum,* and *Cassia fistula.* Further details of the study area are given by Desai (1991).

METHODS

In Mudumalai Wildlife Sanctuary, the wood collection is usually severe from January to June (hot months) and low or none during the rainy months. I recognized two types of fuelwood harvesters *viz.,* consumptive user and commercial user.

Consumptive User: Collected all available dry wood on the forest floors and then went to break small dead branches from live or dead trees. Generally an individual or a group of five to six members were found and they were mainly females. They visited forest daily to collect the wood exclusively for their own use. The members often spread out and collected dry wood from various places and thus bundle of each member in this group differed from the other in their plant species composition. Hence, each member was treated as a separate entity. The members of this group often left the wood bundles and ran away if they see any intruder in their vicinity.

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Although many members of this type were encountered during the study, due to size and nature, identification of plant species in the wood bundles was restricted to a sample of 50 bundles belonging to 50 individuals.

Commercial User: These people select a particular tree, cut it down completely into small stems, and made bundles. They were largely males. They visited twice or thrice in a week to collect wood largely for commercial use as firewood or construction materials for hotels, restaurant, and houses. Identification of this user was easier as this group was bolder than the consumptive user and targeted largely live trees. The targeted tree was cut and wood was shared among the members. The bundles of all the members in this group had the same plant species. Since a single bundle represented the whole group, one bundle and one person were selected for each species for inspection and interview.

Vegetation was sampled to estimate the density and diversity of plant species in 50 X 20 m plots established at every 100 m interval. In total, 70 plots were laid and all the trees and shrubs present within the plots were identified to species level. Number of individuals of each tree and shrub species was counted and density was enumerated. One-time sampling was done for trees while sampling was repeated every year for shrubs and herbs. Diversity was calculated using Shannon Weaver index (1949) $H' = -\Sigma p_i \log p_i$ (where H'= diversity and *pi* = the proportion of observation in the subset *i*). Plant species with cut / chopping / lopping signs were identified to species level and counted.

Foraging records of birds were collected within the first four hours after sunrise and for each foraging attempt substrate used, species of plant used, and foraging method used were recorded. Further details about the methods are given by Gokula (2001a). Searches were made on foot for nest structures by examining the trees and shrubs. An active nest was corroborated if adults were seen performing breeding activities (nest-building or renovation, incubation, feeding the young, etc.,) in or adjacent to the nest. The plant species on which the nest was constructed was identified to species level.

To quantify the biotic pressure, and to assess qualitatively their perceptions of preferred firewood species, informal interviews were conducted with individuals collecting firewood within the study area. There was no set questionnaire, nor was a sampling strategy adopted since wood collection is prohibited inside the sanctuary and getting the opinion about the preferred species from the people and inspecting the firewood bundle were difficult. The size class and species were determined for stems within the bundle of wood that had been collected only from wood cutters from whom information could be gathered. In total, 103 members from both groups were interviewed on various months and seasons during the entire study period of four years and their wood bundles were inspected. As their opinion on the preferred species did not deviate much, no extra effort was taken to increase the sample size. All the information was compiled and plants exploited by then were listed.

Based on the availability and utilization data, preference was calculated using Jacobs index of preference

$$D = \frac{r - p}{r + p - 2rp}$$

where *D*= preference index, *r*= proportion of a particular class / category in the usage and *p*=proportion in the population.

The index varies from –1 to +1, with -1 being total avoidance, 0 being no preference and +1 being absolute preference (Jacobs, 1974).

RESULTS

In total, 313 nests of 31 bird species were found (Table 1). Birds used 12 tree and nine shrub species for nesting (Table 1). As identification was not possible for some snags, it was considered as a plant substrate regardless of species. Of the 21 plants, the diversity of nests was greater on *Anogeissus latifolia* (2.0). Species such as *Lantana camara, Erythroxylum monogynum, Ziziphus mauritiana, Randia dumetorum* and *Acacia chundra* were the next group that supported more or less the same diversity of nests. Birds were found to be selective as they used some plant species more frequently than others as nesting substrates (Table 1). Birds even preferred *Lantana camara* for nesting which is referred often as a disturbing component to local plant communities and *Opuntia dillenii* to place / construct the nests.

In total, 23,398 foraging activities made by 36 species of birds were recorded and of which 19,873 were performed on 25 species of plants (Table 2). Among the plant species, birds were seen eating fruits largely in *Ficus* sp., *Lantana camara* and *Erythroxylon monogynum,* eating seeds largely in *Anageissus latifolia, Diospyrus montana, Tectona grandis, Terminalia bellirica,* and drinking nectars in *Butea monosperma, Cassia fistula, Loranthus* sp*, Tectona grandis* and *Syzygium cumini.* Birds used almost all the plant species either as a platform to perform the foraging maneuvers or a substrate from which food items are chosen.

In total, 28 species of trees and 34 species of shrubs were recorded in the study area and of which only a very few species *viz., Anogeissus latifolia* (63.35 / ha)*, Tectona grandis* (33.5 / ha)*, Acacia chundra* (9.9 / ha) and *Erythroxylum monogynum* (8.5 / ha) were abundant (Table 3). Woodcutting signs were observed on 67 individuals of 12 species of plants and signs were frequent on species such as *Acacia catechu, Anogeissus latifolia and Tectona*

Table 1. Number of nests constructed by different species of birds in various plant species found in and around Masinangudi area of the Mudumalai Wildlife Sanctuary, Tamilnadu between 1994 and 1998

Bird Species	Plant species*																						
	A.ch	*A.ca*	*A.l*	*C.*sp	*E.g*	*E.m*	*E.*sp	*F.b*	*G.m*	L.c	*O.d*	*P.e*	*P.m*	*R.d*	*S.p*	*T.g*	*T.b*	*T.a*	*Z.x*	S	U.sh	Gr.	No. of plants used	Total no. of nests
Spotted Dove *Streptopelia chinensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Blossomheaded Parakeet *Psittacula roseate*	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	11	0	0	3	22
Large Green Barbet *Megalaima zeylanica*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Lesser Goldenbacked Woodpecker *Dinopium benghalense*	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	5
Yellowfronted Pied Woodpecker *Dendrocopos mahrattensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Yellownaped Woodpecker *Picus chlorolophus*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Common Myna *Acridotheres tristis*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2
Grey Tit *Parus major*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Indian Robin *Saxicoloides fulicata*	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8	0	18	4	28
Magpie Robin *Copsychus saularis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Chestnutbellied Nuthatch *Sitta castanea*	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Purple Sunbird *Nectarina asiatica*	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	3	0	0	0	2	10
Baybacked Shrike *Lanius vittatus*	3	0	1	0	0	5	3	0	3	0	0	1	3	0	0	0	0	5	0	0	0	0	8	24

contd.,

Table 1 contd.,

Bird Species	Plant species*																							
	A.ch	*A.ca*	*A.l*	*C.*sp	*E.g*	*E.m*	*E.*sp	*F.b*	*G.m*	L.c	*O.d*	*P.e*	*P.m*	*R.d*	*S.p*	*T.g*	*T.b*	*T.a*	*Z.x*	S	U.sh	Gr.	No. of plants used	Total No. of Nests
Blackheaded Oriole *Oriolus xanthomus*	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2
Whitebellied Drongo *Dicrurus caerulescens*	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Blackheaded Cuckooshrike *Coracina melanoptera*	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Scarlet Minivet *Pericrocotus flammeus*	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Whitebellied Minivet *Pericrocotus erythropygius*	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	3
Woodshrike *Tephrodornis pondicerianus*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Redwhiskered Bulbul *Pycnonotus jocosus*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Redvented Bulbul *Pycnonotus cafer*	2	0	0	1	0	1	0	0	0	10	0	0	0	5	0	0	0	3	3	0	0	0	7	25
Whiteheaded Babbler *Turdoides affinis*	4	4	1	0	0	3	0	0	4	11	1	0	0	3	2	0	0	3	4	0	0	0	11	40
Whitebrowed Fantail Flycatcher *Rhipidura aureola*	0	0	20	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	24
Paradise flycatcher *Terpsiphone paradisi*	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	2	11
White-eye *Zosterops palpebrosus*	0	0	4	0	0	1	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	4	9
Rufousbellied Babbler *Dumetia hyperythra*	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	2
Spotted Munia *Lonchura punctulata*	12	0	1	0	0	0	0	0	18	0	0	0	0	0	0	0	0	30	2	0	0	0	5	63
Whitethroated Munia *Lonchura malabarica*	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	3	5
Redwattled Lapwing *Vanellus indicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1

contd.,

Table 1 contd.,

Bird Species	Plant species*																							
	A.ch	*A.ca*	*A.I*	*C.*sp	*E.g*	*E.m*	*E.*sp	*F.b*	*G.m*	L.c	*O.d*	*P.e*	*P.m*	*R.d*	*S.p*	*T.g*	*T.b*	*T.a*	*Z.x*	S	U.sh	Gr.	No. of plants used	Total No. of Nests
Tailorbird *Orthotomus sutorius*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Brahminy Kite *Haliaster indus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	2	10
Crested Hawk Eagle *Spizaetus cirrhatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	2
No. of bird species used	5	1	15	1	3	5	1	1	3	5	2	3	1	4	1	3	2	7	4	7	2	2	32	
Total No. of nests	24	4	53	1	6	17	3	1	32	25	3	4	4	9	2	15	6	48	12	23	2	19		313
Percentage of nests	7.7	1.3	16.9	0.3	1.9	5.4	1.0	0.3	10.2	8.0	1.0	1.3	1.3	2.9	0.6	4.8	1.9	15.3	3.8	7.3	0.6	6.1		
Nest diversity (H')	1.32	0	2.06	0	0.82	1.30	0	0	0.73	1.20	0.01	1.01	0	1.42	0	0.52	0.01	1.22	1.30	1.60	0.60	0.20		

**A.ch = Acacia chundra*; *A.ca = Acacia catechu*; *A.I. = Anogeissus latifolia*; *C.* sp. = *Cordia* sp; *E.g = Elaeodendron glaucum*; *E.m = Erythroxylum monogynum*; *E.*sp = *Eucalyptus* sp*; F.b = Ficus benghalensis*; *G.m = Gymnosporia montana*; *L.c = Lantana camara; O.d = Opuntia dillenii*; *P.e = Phyllanthus emblica*; *P.m = Pterocarpus marsupium; R.d = Randia dumetorum*; *S.p = Strychnos potatorum; T.g = Tectona grandis*; *T.b = Terminalia bellirica; T.a = Toddalia asiatica; Z.x = Ziziphus xylopyrus*; S = Snag; U.sh = Unidentified shrub; Gr. = Ground

Table 2. Number of foraging visits made by different species of birds on various plants for food collection in and around Masinankudi area of the Mudumalai Wildlife Sanctuary, Tamilnadu between 1994 and 1998

Bird species	Plant Species*																										
	A.ca	*A.ch*	*A.i*	*A.l*	*B.c*	*B.m*	*C.f*	*D.m*	*D.p*	*E.g*	*E.m*	*E.*sp	*F.*sp	*G.m*	*L.c*	*L.p*	*L.*sp	*P.e*	*R.d*	*R.x*	*T.a*	*T.b*	*T.g*	*Z.c*	*Z.x*	S	No. of species used	Total foraging visits
Lorikeet *Loriculus vernalin*	0	0	0	0	0	131	116	0	0	0	0	130	122	0	0	181	0	122	0	116	0	0	0	0	0	0	7	918
Large Green Barbet *Megalaima zeylanica*	0	0	0	123	0	0	0	115	0	0	0	0	142	0	0	0	0	0	0	0	0	0	113	0	0	0	4	493
Lesser Goldenbacked Woodpecker *Dinopium benghalense*	0	0	0	122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	117	0	0	127	4	491
Yellowfronted Pied Woodpecker *Dendrocopos mahrattensis*	0	0	0	127	113	0	0	0	0	0	126	0	0	0	0	0	0	0	0	0	0	0	125	0	0	129	5	620
Yellownaped Woodpecker *Picus chlorolophus*	126	113	0	133	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	122	115	0	0	116	7	845
Heartspotted Woodpecker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	0	0	0	0	0	126	126	0	0	0	3	368
Brahminy Myna *Acridotheres*	0	0	0	0	0	0	0	120	0	0	0	0	118	0	132	0	0	114	0	0	126	0	0	0	0	0	5	610
Grey Tit *Parus major*	114	0	0	120	0	0	0	0	0	0	126	0	0	0	113	0	0	0	0	0	118	0	0	0	0	122	6	713
Chestnutbellied Nuthatch *Sitta castanea*	0	0	0	128	0	0	0	0	0	120	140	0	0	0	0	0	0	0	0	0	114	164	123	0	0	128	7	917
Blackheaded Oriole *Oriolus xanthomus*	0	0	0	120	0	0	0	0	0	113	0	0	125	0	0	0	0	0	0	0	0	0	0	0	0	0	3	358
Scarlet Minivet *Pericrocotus flammeus*	0	0	0	0	0	0	0	0	0	0	121	0	123	117	0	0	0	0	0	0	0	0	154	0	0	0	4	515
Greater Rackettailed Drongo *Dicrurus caerulescens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	0	0	0	0	0	118	135	0	0	0	3	368

contd.,

Table 2 contd.,

Bird species	Plant Species*																										
	A.ca	*A.ch*	*A.i*	*A.l*	*B.c*	*B.m*	*C.f*	*D.m*	*D.p*	*E.g*	*E.m*	*E.*sp	*F.*sp	*G.m*	*L.c*	*L.p*	*L.*sp	*P.e*	*R.d*	*R.x*	*T.a*	*T.b*	*T.g*	*Z.c*	*Z.x*	S	No. of species used	Total foraging visits
Whitebellied Drongo *Dicrurus caerulescens*	0	0	0	129	0	0	0	0	0	0	124	0	0	114	0	0	0	0	0	0	114	119	0	0	0	0	5	600
Indian Robin *Saxicotoides fulicata*	0	231	0	119	0	0	0	0	0	0	121	0	0	113	127	0	0	0	0	0	0	0	124	0	0	117	7	952
Paradise Flycatcher *Terpsiphone paradisi*	89	0	0		0	0	0	0	0	0	123	0		116	145	0	0	0	0	0	114	0	0	0	0	0	5	587
Small Minivet *Pericrocotus cinnamomeus*	0	114	0	121	0	0	0	0	0	123	117	0	118	114	0	0	0	0	0	0	0	0	143	0	0	0	7	850
Whitebellied Minivet *Pericrocotus erythropygius*	0	0	0	0	0	0	0	0	0	0	114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	114
Redvented Bulbul *Pycnonotus cafer*	0	0	0	0	0	119	0	113	0	0	117	0	127	129	166	0	0	0	0	0	122	0	0	0	0	0	7	893
Whiteheaded Babbler *Turdoides affinis*	0	0	0	116	0	0	0	0	0	0	117	0	0	0	113	0	0	0	0	0	0	0	0	0	0	0	3	346
Whitebrowed Fantaill Flycatcher *Rhipidura aureola*	0	117	113	119	0	0	0	0	0	0	0	0	115	0	116	0	0	114	0	0	115	0	124	0	115	0	9	1048
Baybacked Shrike *Lanius vittatus*	0	117	0	126	0	0	0	0	0	0	123	113	0	0	114	0	0	113	113	0	115	0	0	0	0	116	9	1050
White-eye *Zosterops palpebrosus*	0	124	0	131	0	124	114	118	0	0	117	118	122	0	130	0	0	0	0	0	0	0	123	0	0	0	10	1221
Tailorbird *Orthotomus sutorius*	96	115	0	116	0	0	0	0	0	0	125	0	0	137	121	0	0	0	0	0	114	0	115	0	0	0	8	939
Common Iora *Aegithina tiphia*	0	0	0	129	0	0	0	114	121	0	123	0	0	0	0	0	0	0	0	0	116	115	133	0	0	0	7	851
Dull Green Leaf Warbler *Phylloscopus trochiloides*	0	0	0	120	0	0	0	0	0	116	0	0	130	0	0	0	0	0	0	0	0	143	133	0	0	0	5	642
Yellow Throated Sparrow *Petronia xanthocollis*	0	0	0	124	0	121	0	0	0	0	0	0	0	0	114	0	0	0	0	0	0	0	120	0	0	0	4	479

contd.,

Table 2 contd.,

Bird species	Plant Species*																										
	A.ca	*A.ch*	*A.i*	*A.I*	*B.c*	*B.m*	*C.f*	*D.m*	*D.p*	*E.g*	*E.m*	*E.*sp	*F.*sp	*G.m*	*L.c*	*L.p*	*L.*sp	*P.e*	*R.d*	*R.x*	*T.a*	*T.b*	*T.g*	*Z.c*	*Z.x*	S	No. of species used	Total foraging visits
Rosefinch *Carpodacus eruthrinus*	0	0	0	149	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	149
Nilgiri Flowerpecker *Dicaeum concolor*	0	0	0	0	0	116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	116
Franklin's Wren Warbler *Prinia hodgsonii*	0	0	0	0	0	0	0	0	0	0	144	0	0	0	160	0	0	0	0	0	0	0	0	125	0	0	3	429
Yellow-eyed Babbler *Chrysomma sinense*	0	0	0	0	0	0	0	0	0	0	153	0	0	137	0	0	0	0	0	0	0	0	0	0	0	0	2	290
Small Green Bee-eater *Merops orientalis*	0	0	0	114	0	0	0	0	0	0	123	125	0	0	0	0	0	0	0	0	0	126	129	0	0	117	6	734
Plain Flowerpecker *Dicaeum concolor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	164	0	0	0	0	0	0	0	0	0	1	164
No. of bird species used	4	7	1	20	1	5	2	5	1	4	19	4	10	8	12	3	1	4	1	1	10	9	17	1	1	8	32	
Total foraging visits	425	931	113	2486	113	611	230	580	121	472	2374	486	1242	977	1551	412	164	463	113	116	1168	1158	2152	125	115	972		19670
Foraging bird diversity (H')	1.38	1.91	0.00	2.99	0.00	1.61	0.69	1.61	0.00	1.39	2.94	1.38	2.30	2.08	2.48	1.07	0.00	1.39	0.00	0.00	2.30	2.19	2.83	0.00	0.00	2.08		

**A.ca = Acacia catechu*; *A.ch = Acacia chundra*; *A.i = Acacia indica; A.I. = Anogeissus latifolia*; *B.c = Bombax ceiba*; *B.m = Butea monosperma; C.f. = Cassia fistula*; *D.m = Diospyros montana*; *D.p = Dalbergia paniculata*; *E.g = Elaeodendron glaucum*; *E.m = Erythroxylum monogynum*; *E.*sp = *Eucalyptus* sp*; F.*sp = *Ficus* sp; *G.m = Gymnosporia montana*; *L.c = Lantana camara; L.p = Lagerstroemia parviflora; L.*sp = *Loranthus sp; P.e = Phyllanthus emblica*; *R.d = Randia dumetorum*; *R.x = Radermachera xylocarpa*; *T.a = Toddalia asiatica; T.b = Terminalia bellirica; T.g = Tectona grandis*; *Z.c = Ziziphus cumini*; Z.x = *Zyzypus xylopyrus*; S = Snag.

grandis (Table 3). The preference index (D) values for all these three tree species (*Acacia catechu, Anogeissus latifolia* and *Tectona grandis*) were also high (Table 3).

In total, 50 bundles of consumptive group and 53 bundles of commercial group were inspected and interviewed. *Anogeissus latifolia, Acacia chundra, Erythroxylum monogynum*, and *Eucalyptus* constituted 66% of them. The other species recorded included and *Dalbergia latifolia*, *Diospyros montana*, *Acacia leucophloea*, *Pterocarpus marsupium* and *Phyllanthus emblica*. Interviews with the people revealed that the plant species were largely used as firewood. The local people listed seven preferred plant species for various purposes and of which *Anogeissus latifolia* and *Acacia chundra* were the most preferred. Although only leaves of *Erythroxylum monogynum* were said to be collected for the cattle, woodcutting of this species was also seen. Usage of this species for fencing was also observed. In total, based on informal interviews, inspections of wood bundles, and vegetation surveys, 17 plant species *viz., Acacia catechu, Acacia chundra, Acacia leucophloea, Anogeissus latifolia, Cassia fistula, Chloroxylon swietenia, Dalbergia latifolia, Diospyros montana, Erythroxylum monogynum, Eucalyptus* sp*., Phyllanthus emblica, Premna tomentosa, Pterocarpus marsupium, Randia dumetorum, Stereospermum colais, Tectona grandis* and *Ziziphus xylopyrus* were identified as extensively used by the local people for various purposes.

A comparison of data on wood cutting signs on various tree species and their use by birds for nesting and foraging has been given in table 3. *Anogeissus latifolia, Tectona grandis, Erythroxylum monogynum, Acacia chundra* and *Eucalyptus* sp. were the trees which have been the source of severe competition between human and bird at the study area as they bore most wood cutting signs and also formed the primary source for nesting and foraging by birds.

DISCUSSION

During the pre-colonial period, the Mudumalai was sparsely populated with only tribal communities (*Kurumbas* and *Irulas*), living on a subsistence mode of resource use with an intricate exchange of relationship between them and forests. In 1800, the cold and damp environment of Nilgiris attracted Europeans to settle here and only after 1853 the area might have ecologically flipped due to changes in the land use pattern through cultivation of food crops and plantation of coffee, tea, and rubber by the migrants. The expansion in cultivation and plantation needed large labour inputs which resulted in an increase in the human population. After a latent period in 1990s a drastic increase in the human population has occurred when the execution of a hydroelectric project was started (Prabhakar and Gadgil, 1994). Many of them who came in as labourers in the projects settled in and the demand for the resources started increasing. The greater demand for firewood and building material resulted in reckless felling of teak and other wood during 1860-82. During that period, the population of Masinangudi village was about 1,291 (Francis, 1908) and now, the hydroelectric project and development of tourism has resulted a drastic increase in the population, which is now about 4,500. However, like earlier, still more than one third of the human population settled inside the sanctuary depends on any one or more of the forest resources such as firewood, honey, fruits, soil and timber for various purposes. Manual labour is one of the main occupations for about 50 % of the total families and 65% families had no regular income in Masinangudi. As a result, wood has become a primary energy and income source for the local communities of this area. Although the forest department has banned this exploitation, unfortunately, the regulations do not keep abreast with reality. This was much evident when people, in the interview, suggested that plant species are largely preferred for firewood either for own or commercial use. Silori and Mishra (1995) estimated that villagers have removed 1,800 tons of fuelwood in their study period in Mudumalai Wildlife Sanctuary. However, this might have considerably increased now with the increase in population. Positive selection of particular species was confirmed as 17 plant species were identified as used extensively by the local people for various purposes. The local people preferred even *Acacia catechu* that was sparsely distributed. On the other hand Ramakrishnan and Sivaganesan (1997) recorded a minimum of seven to a maximum of 25 plant species being used by the people for various purposes in the eastern portion of the Nilgiri hills. This difference in the number could be attributed to the availability of preferred plant species in different habitats. Similarity in the heavy utilization of some plant species (e.g., *Cassia fistula, Chloroxylon swietenia, Erythroxylum monogynum,* and *Randia dumetorum*) in both the areas (Mudumalai and eastern portion of Nilgiri Hills) showed the importance of those species to local people.

Conversely, the behavioural data proved the ecological importance of those plant species in this area. Almost all nests were found on common plant species in the study area. To avoid predation, birds build their nests more on common plant species than rare ones, as finding rare species in an area would be time consuming for a predator (Martin and Roper, 1988). However, all the common and abundant species present in the study area were not extensively used for nesting. For example, *Tectona grandis* and *Opuntia dillenii* although common, could support only a few nests. Similarly, plant species such as *Randia dumetorum, Acacia cateachu* were in low density, but could support more number of nests. Kozma and Mathews (1997) studied 24 plant species used as nest-plants by various bird species in Chihuahuan desert and inferred that

Table 3. Comparison of data on plant species with woodcutting signs with their use by birds for nesting and foraging in and around Masinangudi area of Mudumalai Wildlife Sanctuary, Tamilnadu

Plant species[a]	Density (No./ha)	Number of individual plants with woodcutting signs	Jacobs index of preference (D)	Number of nests	Nesting bird diversity (H′)	Number of bird species found nesting	Total foraging visits recorded	Number of bird species involved in foraging	Foraging bird diversity (H′)
Anogeissus latifolia	63.35	8	0.55	53	2.06	15	2486	20	2.99
Tectona grandis	33.50	9	0.53	15	0.52	3	2152	17	2.83
Eucalyptus sp.	18.50	10	0.31	3	0.00	1	486	4	1.38
Acacia chundra	9.90	3	-0.54	24	1.32	5	931	7	1.91
Erythroxylum monogynum	8.50	6	0.28	17	1.30	5	2374	19	2.94
Ziziphus xylopyrus	6.50	3	-0.43	12	1.30	4	115	1	0.00
Randia dumetorum	1.00	4	-0.03	9	1.42	4	113	1	0.00
Chloroxylon swietenia	0.85	1	-0.24	-	-	-	-	-	-
Acacia catechu	0.65	14	0.70	4	1.30	1	425	4	1.38
Premna tomentosa	0.62	1	-0.19	-	-	-	-	-	0.00
Cassia fistula	0.50	1	-0.15	-	-	-	230	2	0.69
Stereospermum colais	0.13	1	0.03	-	-	-	-	-	-
Anogeissus latifolia (snag)	*	3	*	23	1.60	2	972	8	2.08
Tectona grandis (snag)	*	3	*						

[a]Arranged based on highest density to lowest density
* D was not calculated as density was not enumerated

characteristics such as dense foliage, stiff branches, spinescent stems, and greater height of these plants might be the reason for the selection even when they are in low density. Hence, nest site selection could be attributed to the geometry and physical complexity of the plants rather than to their availability. As different plant species have different architecture, each plant species gives different opportunities for birds to perform their foraging activities and construct their nests (Gokula and Vijayan, 1996; Gokula, 2000; Gokula, 2001b,c; Gokula and Vijayan, 2003). *Anogeissus latifolia*, one of the preferred fuelwood species, supports more bird species both in terms of foraging as well as nesting. Above all, it was a nesting substrate for White-bellied Minivet *Pericrocotus erythropygius,* the globally near-threatened bird species.

In Mudumalai, majority of the birds breed during January to July (Gokula, 1999) and during that period, wood collection was observed severe. Even mere human presence was observed as hindrance to many birds for performing their breeding activities. I found often Paradise flycatcher *Terpsiphone paradisi* and Whitebrowed Fantail Flycatcher *Rhipidura aureola* deserting their nest construction due to first type harvesters described above. On the other hand, the second type harvesters were seen removing the entire tree where the hole-nesting birds occupied available holes on the tree. In an another case, they selected a tree next to the nest-tree of Crested Hawk Eagle *Spizaetus cirrhatus* for removal and due to their frequent visit and disturbance, the eagle abandoned the nest halfway. Above all, human activities have already reduced the availability of snags in the fringes of the Mudumalai Wildlife Sanctuary surrounding the Village Masinangudi and consequently reducing the density of hole-nesters inside the sanctuary (Gokula, 1999). Thus it is a matter of concern that the wood harvesters in general, not only reduce the resources available for the birds but also devastate the amount of energy invested by birds in their breeding activities.

As both human and birds showed remarkable preference towards the same plant species the local community need at present either a sustainable harvesting strategy or alternative fuel resources through with different purposes keeping the forest regulations abreast with reality. In the present case, sustainable harvesting may not be a solution as exploitation is totally banned inside the sanctuary. Strict vigilance or legislation, may not be fully effective since the harvesters will adopt different harvesting methods to circumvent both, as wood is the primary energy and income source for majority of the people. Hence, it is more likely that a partial or total substitution by alternative energy resources or establishment of harvesting place in the reserved forest zone can only minimize the human-bird resources competition in Mudumalai Wildlife Sanctuary.

CONCLUSION

Conservation tasks are more likely to be successful when the needs of the local people are considered. A realistic and ethical approach when their needs become a matter of conservation concern is to show an alternative to the local people. In the present case, a ban on fuelwood collection will no longer be effective unless an alternative arrangement for the fuelwood is made for the local people. Fuel substitution and efficiency may be promoted among public in Mudumalai Wildlife Sanctuary through construction of household biogas plants (village has a good cattle population), fuel-efficient stoves and solar energy.

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