

S39-4 Human impacts on forest bird communities in the Western Ghats, India

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Abstract We studied bird communities along a gradient of disturbance levels in five major habitats in the Western Ghats during 1994–1997: the montane (shola) forests and grasslands, and wet evergreen, moist deciduous, dry deciduous, and thorn forests. Species richness of birds was higher with moderate disturbance, but species richness and abundance were very low in the most highly disturbed areas (plantations). Abundance was 35% lower in disturbed evergreen forest, and 23% lower in the montane (shola) forest, whereas abundance was higher in the moist deciduous forest, mainly due to more habitat specialists and endemics in the wet forests. The populations of the threatened endemic Nilgiri laughing thrush of the shola forest and the Nilgiri pipit, a grassland specialist and endemic, were discernibly lower in disturbed habitat. Breeding bird species and their nests were much less abundant in disturbed dry deciduous and thorn forests, particularly nests, demonstrating a negative correlation with intensity of grazing and firewood collection: the tree species most used for firewood are also those preferred for nesting. Some of the habitat specialists, such as the paradise flycatcher, white-browed fantail flycatcher, spotted munia and crested hawk-eagle, were affected by disturbance at nest sites.

Key words Forest birds, Habitat specialists, Human impacts, Western Ghats, India

1 Introduction

The Western Ghats in India, one of the Global Hotspots of Biodiversity and Endemic Bird Areas (Stattersfield et al., 1998), has experienced significant land-use change as a result of development programs. In Kerala in 1987, the National Remote Sensing Agency documented a 0.3% loss of forest during 1972–1985, and Prasad (1998) reported the same fall during 1961–1988. Menon and Bawa (1997) found a 0.5% loss between 1920 and 1990 over a larger area (Kerala, Karnataka and Maharashtra states); and Jha et al. (2000) reported a 1.16% loss for Kerala and Tamil Nadu between 1973 and 1995. Also notable is the 47% decline in evergreen forest in the southern Western Ghats (Prasad, 1998), which is the habitat for most of the regional habitat specialists and endemics (Vijayan and Gokula, 1999). Although some studies have been conducted on the bird communities in this region, they are mainly short-term surveys carried out in a limited area (Gokula and Vijayan, 1996; Daniels, 1996; Pramod et al., 1997; Prasad et al., 1998). Accordingly, we took up the study reported here to assess the impact of habitat changes on the bird communities in the major forest types in the Western Ghats.

2 Materials and methods

2.1 Study areas

The study areas were sited in the Nilgiri Hills in the Nilgiri Biosphere Reserve (10°45'–12°15'N and 76°–77°15'E)

in the Western Ghats, south India, and show remarkable topographic, climatic, and vegetational diversity (Vijayan et al., 1998). The habitats that we assessed were: (1) thorn forests on lowland plains, (2) dry deciduous forest on lower slopes, (3) moist deciduous forest in Mudumalai, at over 1 000 m altitude, (4) montane (shola) forest and grassland in and around Upper Bhavani at >2 000 m altitude in Tamil Nadu, and (5) wet evergreen forest in and around Silent Valley at 900–1 100 m altitude in Kerala State. Our approach was to study a gradient of disturbance levels in areas adjacent to intact stands of each of the habitats. Categories of disturbance level were (1) undisturbed (or least disturbed), disturbed, and highly disturbed (completely altered plantation habitat). For each habitat, study sites representing the three disturbance levels were chosen with the same physiognomic settings and altitudes as sites of intact habitat to reduce bias.

2.2 Methods

Disturbance factors such as distance from human settlement, movement of people, presence of cattle and their tracks, signs of grazing, and dung in 2-ha sampling areas were documented. Signs of tree cutting and pruning were also recorded to assess timber preferences in relation to impacts on nesting of birds in the dry deciduous and thorn forests, where human pressure was greater. We recorded the intensity of firewood collection, and the plant species and size class of stems within the bundles of collected wood. We interviewed 100 people to learn their preferred firewood

species.

We studied bird communities by the variable circular plot method (Reynolds et al., 1980), sampling 10 ha in each habitat. Censusing began half an hour after sunrise and lasted 10 minutes in each plot. We repeated the sampling over three seasons, namely the dry (December–March), first wet (June–August), and second wet (September–November) periods during 1994–1996. We analyzed populations of the two rare endemics in the montane shola forest and grassland to assess the impact of habitat changes on them.

We also laid one 5-ha plot each in undisturbed and disturbed dry deciduous and thorn forest during 1995 to study the impact of disturbance on nesting birds; in 1996–1997, we laid two 5-ha plots for detailed studies on nest-site selection by several habitat specialists (Martin and Roper, 1988). We observed nest-tree or substrate variables and nest-patch variables within a 0.07-ha circular plot centered on the nest tree. Variables included nest height, vegetation cover (canopy, shrub, and ground), and cover over the nest, and we compared these with those of randomly selected sites to test for selection. The SPSS software (Norusis, 1994) was used for analyzing the data.

3 Results

3.1 Human disturbance of habitat

Table 1 Disturbances in different habitats

Habitat	Number of cattle	No. of dung piles	Cattle tracks	% trees logged	% area burned
Undisturbed dry deciduous	-	-	-	0.7	1
Disturbed dry deciduous	21	36	9	3.7	3
Teak plantation	12	6	3	4.6	-
Undisturbed moist deciduous	-	-	-	1.2	1
Disturbed moist deciduous	11	6	6	3.5	-
Coffee and tea plantation	-	-	-	8.4	-
Undisturbed thorn	-	-	-	1.7	-
Disturbed thorn	137	89	12	21.2	1
Eucalyptus plantation	63	71	7	35.5	-
Undisturbed evergreen	-	-	-	-	-
Disturbed evergreen	-	-	-	3.8	-
Coffee plantation	-	-	-	7.5	-
Undisturbed shola	-	-	-	-	-
Disturbed shola and grasslands	-	-	-	4.0	3.5
Wattle plantation	-	-	-	3.8	3

Sample plots 2 ha each. Unless specified, all habitats are forest.

Pruning and cutting of trees, and cattle grazing, were the major disturbance factors other than seasonal fire. Greatest disturbance occurred in the thorn forest, followed by dry deciduous forest (Table 1). Detailed studies in thorn and dry deciduous forests showed that rates of exploitation were highest in thorn forest. Interviews revealed human preferences for seven species for firewood and a few for other purposes. Wood bundles comprised eleven species (Table 2).

3.2 Impact of disturbance on the bird communities in different habitats

Montane (shola) forest and grassland Bird species richness and abundance were greater in shola forest than in the grassland or an adjacent wattle plantation (Table 3). Although similar numbers of species were found in undisturbed and disturbed habitats, the abundance of birds was on average 23% lower in disturbed sites, and species richness was 38% lower, and abundance 59% lower, in the wattle plantation. Of all habitats studied, shola forest is richest in endemic species, namely the Nilgiri wood pigeon (*Columba elphinstonii*), Nilgiri laughing thrush (*Garrulax cachinnans*), rufous-bellied shortwing (*Brachypteryx major*), Nilgiri flycatcher (*Muscicapa (Eumyias) albicaudata*), and black-and-orange flycatcher (*Muscicapa nigrorufa*) (Ali and Ripley, 1987). The first three are globally threatened (BirdLife International, 2001). Of the 16 bird

Table 2 Plant species used by birds for nesting and by people for firewood

Species	Dry deciduous	Thorn forest	% used by people
	Percentage of nests		
<i>Acacia chundra</i>	13.3	6.5	17
<i>Tectona grandis</i> (A)	7.8	0.0	-
<i>Anogeissus latifolia</i> (A)	27.8	10.5	23
<i>Anogeissus latifolia</i> (S)	6.7	0.0	-
<i>Lantana camara</i>	14.4	8.5	-
<i>Randia dumetorum</i>	5.6	3.5	-
<i>Acacia catechu</i>	2.2	1.0	-
<i>Phyllanthus emblica</i>	3.3	0.5	1
<i>Pterocarpus marsupium</i>	1.1	0.0	4
<i>Elaeodendron glaucum</i>	2.2	2.0	-
<i>Erythroxylum monogynum</i>	-	8.5	16
<i>Toddalia asiatica</i>	-	25.0	-
<i>Gymnosporia montana</i>	-	11.0	-
<i>Eucalyptus</i> sp.	-	1.5	10
<i>Zyziphus mauritiana</i>	-	6.0	-
Others	-	2.0	-
Unidentified species	-	-	13
Unidentified snag	7.8	1.5	16
Total number of nests	90	200	

A = alive, S = snag, - = not recorded

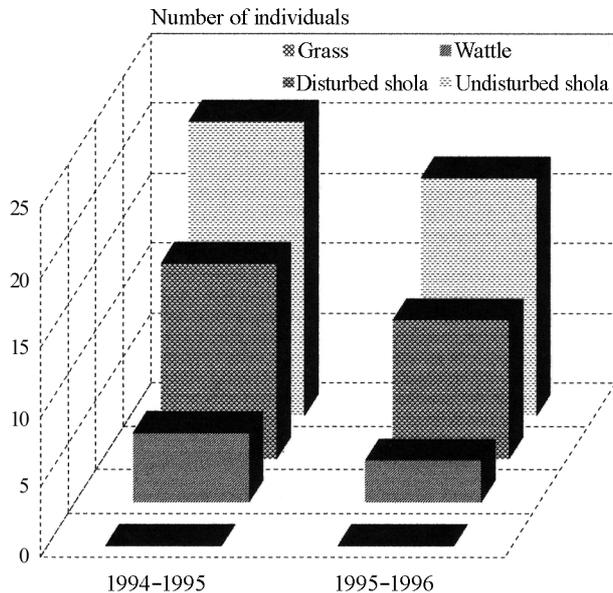


Fig. 1 Status of the Nilgiri laughing thrush in different habitats

species endemic to the Western Ghats, the Nilgiri laughing thrush is the only one that prefers shola forests > 2 000 m in altitude (Vijayan et al., 2001). The population density of this species was one pair/ha in undisturbed areas, and was 37% lower in disturbed forest and 79% lower in the wattle plantation (Fig. 1).

Grassland harbored a few species of birds: pipits, bulbuls, and chats. On grassland that had been converted to wattle plantation, the numbers of species and individuals were higher, but those of grassland specialists were lower. The Nilgiri pipit (*Anthus nilghiriensis*), endemic to the Western Ghats and globally near-threatened, is one such grassland specialist (BirdLife International, 2001). Its numbers were about 60% lower in the wattle plantation than on grassland (Fig. 2).

Evergreen forest Species richness was higher in disturbed forest, whereas abundance of birds was greater in the undisturbed forest (Table 3). In moderately disturbed areas, the number of species was 19% higher and the number of birds was 35% lower. A highly disturbed coffee plantation nearby supported 59% fewer species and 72% fewer individuals than did the undisturbed area. Even in disturbed forest, the abundance of habitat specialists and endemics, such as the white-bellied blue flycatcher (*Muscicapa (Ficedula) pallipes*) and Nilgiri flycatcher, was much lower.

Moist deciduous forest Bird species richness and abundance were both higher in disturbed than undisturbed forest, which in turn supported higher numbers than an adjacent tea and coffee plantation (Table 3). The average number of species in the disturbed area was 29% higher than in undisturbed forest (Mann-Whitney U-test, $U = 3$, $P = 0.01$), whereas in the plantation it was 41% lower ($U = 0$, $P = 0.002$). Numbers of individuals were also about 30% higher in disturbed than undisturbed forest ($U = 6$, $P = 0.05$), and

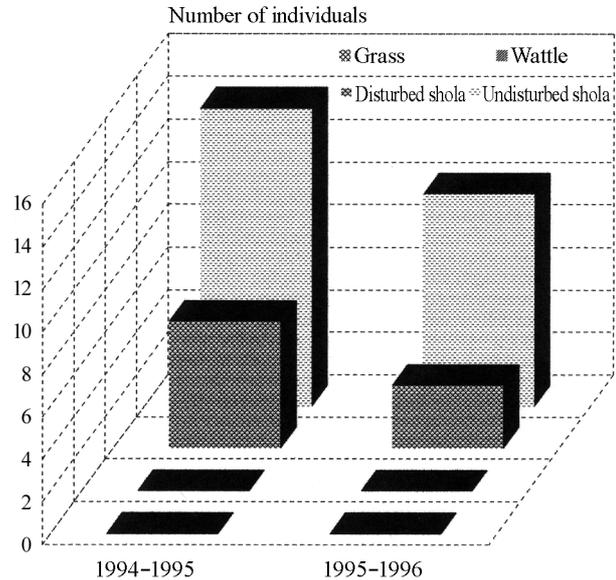


Fig. 2 Status of the Nilgiri pipit in different habitats

again lower by 46% in the plantation ($U = 1$, $P = 0.004$).

Dry deciduous forest Species richness and abundance were again both higher in disturbed than undisturbed forest (Table 3), species richness significantly so ($U = 0.0$, $P = 0.002$). The average number of species in an adjacent highly disturbed teak plantation was almost equal to that in the disturbed area, but abundance was lower ($U = 4.0$, $P = 0.02$). In general, however, dry deciduous forest is structurally simple and near-monospecific in tree species, being dominated naturally by teak (*Tectona grandis*) much as in the plantation.

Thorn forest In the thorn forest in and around Mudumalai, bird species richness and abundance was highest in undisturbed forest (Table 3). The number of species of birds was on average 13% lower in moderately disturbed and 22% lower in highly disturbed habitat. Individual numbers were slightly higher in moderately disturbed forest but 44% lower in a highly disturbed eucalypt plantation.

3.3 Impact of disturbance on breeding birds

Monitoring of breeding in the dry deciduous and thorn forests showed that birds use mainly 17 species of trees and shrubs for nest sites (Table 2), many of which are also preferred for firewood. Thus the collection of firewood impacts on the breeding bird community. In comparisons of both the disturbed and undisturbed (or, rather, less disturbed) 5 ha plots in these forests, we found a higher number of species and nests in less-disturbed areas. In the thorn forest, 19 nests of 10 species were recorded in the undisturbed site, as opposed to 12 nests of 6 species in the disturbed. Coordinate comparisons in dry deciduous forest were 9 nests of 4 species to 6 nests of 4 species. Nest-site-selection studies of several habitat specialists (paradise flycatcher, *Terpsiphone paradisi*; white-browed fantail,

Rhipidura aureola; spotted munia, *Lonchura punctulata*; crested hawk eagle, *Spizaetus cirrhatus*), showed that disturbance at the nest site had a significantly negative impact (PCA and stepwise DCA). The paradise flycatcher nested in shrubs in thorn forest of high shrub density; the white-browed fantail used small trees at sites with high tree density and ground cover; the spotted munia preferred thorny and straggler species, constructing nests in the lower canopy with more shade for concealment; and the crested hawk eagle preferred larger trees in undisturbed dry deciduous forest at least 3–4 km from human settlement, reflecting sensitivity to human disturbance.

4 Discussion

Habitat changes in the Western Ghats (Prasad, 1998; Menon and Bawa, 1997; Jha et al., 2000), particularly the 47% reduction in evergreen forests in the southern Nilgiri sectors, have caused great concern for biodiversity conservation (Prasad et al., 1998). Logging, firewood collection and grazing are the major disturbances (Desai and Baskaran, 1996; Ramakrishnan and Sivaganesan, 1997). The changes have contributed to the decline of many forest birds, especially endemic species (Stattersfield et al., 1998; BirdLife International, 2001).

Birds reach their maximum abundance in undisturbed evergreen forest, as expected, because of the complexity of the habitat and its structure (Jayson and Mathew, 2000).

Table 3 Number of species and individuals of birds in different habitats

Habitat	Species	Individuals
Shola, wattle plantation, and grassland		
Undisturbed forest	16.3±4.0	105.3±12.3
Disturbed forest	16.8±2.4	90.5±48.1
Plantation	10.3±1.1	43.00±7.7
Grassland	7.3±5.4	18.67±7.4
Evergreen forest, and coffee plantation		
Undisturbed forest	21.3±4.4	162.8±34.8
Disturbed forest	25.0±4.1	106.3±50.0
Plantation	13.5±3.0	45.5±4.7
Moist deciduous, and coffee and tea plantations		
Undisturbed forest	16.7±2.1	73.7±20.2
Disturbed forest	21.2±2.0	95.7±16.5
Plantation	9.8±2.8	840.0±11.9
Dry deciduous, and teak plantation		
Undisturbed forest	11.5±1.4	70.2±8.8
Disturbed forest	17.5±2.1	90.2±17.9
Plantation	11.7±1.7	48.7±21.9
Thorn forest, and eucalyptus plantation		
Undisturbed forest	30.7±4.6	154.3±28.3
Disturbed forest	26.7±3.4	158.7±33.5
Plantation	23.8±4.8	86.8±23.2

Figures are means and standard deviations.

Species richness too is highest in undisturbed forest. The difference between undisturbed and disturbed areas in species richness and abundance increased with the species richness of the habitat, mainly because habitat specialists or forest interior species are more sensitive to disturbance (Canterbury et al., 2000; Pattanavibool and Dearden, 2002; Riley, 2002). In most other drier forest, habitats, species richness increased with moderate disturbance. This increase is due to the increase in generalists, as found also in the Eastern Ghats (Beehler et al., 1987) and elsewhere (Daniels et al., 1989).

In general, the bird communities of the plantations were impoverished. Khan (1978) concluded that few species can adapt to such habitats in the Nilgiris. In any case, the bird fauna of plantations is largely derived from natural forest sources in the vicinity (Daniels et al., 1989; Estades and Temple, 1999). Teak plantations probably support more birds than other plantations because of foliage layers and the presence of leaf- and wood-feeding insects, as in *Albizia* plantations in Malaysia (Mitra and Sheldon, 1993).

The montane shola forest and grassland habitat is a major center of endemism in the Western Ghats and therefore requires immediate conservation action (Sukumar et al., 1995; Pramod et al., 1997; Vijayan and Gokula, 1999; Robin and Sukumar, 2002). The Nilgiri laughing thrush, a rare endemic and specialist of shola forest (Islam, 1994; Vijayan and Gokula, 1999), is affected by habitat alteration (Vijayan et al., 2001), as is the Nilgiri pipit, a specialist of short grasslands at high altitudes. The earlier concept of grassland as wasteland has created problems for it (Vijayan et al., 1998).

Breeding in the thorn forest is affected by logging, firewood collection, and grazing. Sensitive to disturbance, species there build nests in the lower canopy and select sites with more shade for concealment (Gokula, 2001; Gokula and Vijayan, 2001). The crested hawk eagle prefers larger trees in undisturbed dry deciduous forest, thus demonstrating the importance of densely wooded areas especially along rivers and streams.

Recommendations have already been made to stop the expansion of monoculture plantations, to restore the shola forests and grasslands with the involvement of local communities, and to reduce human pressure by providing alternative sources of income (Vijayan et al., 1998; Vijayan and Gokula, 1999). A proper in-depth study of the endemics and habitat specialists is needed to elucidate their ecology and monitor population changes.

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