

# IMPACT OF HUMAN INTERFERENCE ON THE PLANT AND BIRD COMMUNITIES IN THE NILGIRI BIOSPHERE RESERVE



**Sálim Ali Centre for Ornithology & Natural History  
Coimbatore 641 108**



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## **FINAL REPORT**

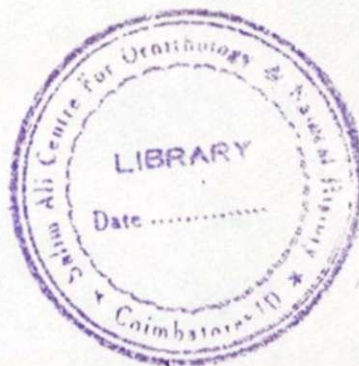
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## **I. EXECUTIVE SUMMARY AND RECOMMENDATIONS**

Community ecology dealing with the spatial and temporal assemblages of species, populations and the factors influencing them, though complex has been studied more in birds. Bird communities vary at macro and micro geographical scales and are believed to have direct relation with the structure of habitat. Although tropical regions are very rich in species, very little information is available, especially from the wet evergreen forests where censusing of bird densities is extremely difficult. It is essential to study quantitatively various communities that are nearly natural or protected and in disturbed or destroyed conditions, in order to suggest which of the communities are most vulnerable and to decide the strategies for conservation and management.

The Nilgiri Biosphere Reserve has a long history of human interference through the "development" projects such as hydroelectric dams, introduction of monoculture, expansion of agriculture and horticulture which have brought in substantial changes in the ecological scenario of the area. Such changes in the landscape of the Nilgiris during the 19th and 20th centuries have been depicted through mapping and discussed their implications on the ecology of the area. Habitat alterations lead to resource variations which have direct impact on populations. The few studies conducted in India have not brought out clearly the impact of changes in the environment on the plant and bird communities. Since birds are identified as indicators of environmental changes mainly with the changes in the vegetation and for monitoring human impacts on ecosystems, this project was taken up with the following objectives:

1. To study the structure and function of bird and vegetation communities in different habitats and to assess the impact of disturbance on them in the Nilgiri Biosphere Reserve.
2. To bring out the relation between bird-species diversity and habitat diversity.
3. To determine the status of endemic and rare species in different habitats of the Nilgiri Biosphere Reserve and suggest conservation strategies.

### **Study area and Methods**

The study was conducted during 1993-97 in the Nilgiri Biosphere Reserve (10°45'-12°15' N latitude and 76° - 77°15' E longitude) extending over 5520 km<sup>2</sup> with a remarkable topographic and vegetation diversity.

The intensive study areas were selected in the following six habitats in and around Upper Bhavani, Mudumalai and Silent valley: 1) wet evergreen forest, 2) shola forests and grasslands, 3) moist deciduous forest, 4) dry deciduous forest, and 5) scrub (thorn) forests.

### **Human disturbances**

Disturbance factors such as distance from human settlements to the sampling area and movement of people, cattle head and tracts, grazing signs, and dung in the sampling area, cutting and lopping signs were recorded.

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### Vegetation

Vegetation sampling was done by using plot method in five major vegetation types of NBR. Two hectares were sampled each in the undisturbed and disturbed sites and forest plantations adjoining each of the major vegetation types.

Vertical distribution of the foliage was sampled along 1 Km transect in the thorn and dry deciduous forests following the method of MacArthur and Horn. A total of 260 points (13 points/ plot) were made for the vegetation profile. The percentage of foliage thickness at each stratum was determined.

### Bird community

All the bird species sighted during the surveys were recorded. Apart from this, any published and unpublished information available on birds of NBR were also included in order to prepare a detailed checklist as well as database on birds of NBR.

Studies on the bird communities were conducted in the same study areas sampled for plant communities. The variable width circular - plot method was followed to estimate the bird population sampling about 10 ha area in each habitat. Bird species diversity was calculated at each vertical stratum (every metre) for correlating with the foliage height diversity. Total diversity was calculated to study the community structure and compare with different habitats.

To identify the impact of disturbance on bird community, a rapid assessment was done in the scrub (thorn) and dry deciduous habitats in Mudumalai. A three kilometre transect was laid from the forest periphery abutting villages towards the interior of the forest to represent the gradient of various human disturbances. Bird counts were done using fixed width line transect.

### Foraging of birds

Foraging records were collected at the study site during January to April (dry spell) in 1995 and 1996. For each foraging attempt the following parameters were recorded:

### Nesting of birds

A 10 ha plot was laid for the nest-site selection studies. Searches were made on foot for nest structures by observing substrate suitable for nesting. The nest-site selection dealt with variables at three levels, nest (height, length, width, depth, orientation, concealment), nest-tree or substrate (tree species, height, Gbh) and nest-patch (0.07 ha circular plot centered at nest tree with canopy cover, ground cover, shrub cover, distance to water, settlement and road, and microhabitat). To test for selection, nest - site characters were compared with similar measurements at randomly selected sites.

A few species were selected for ecological studies as envisaged in the objectives of the project since they are habitat specialists and poorly studied. Moreover, some species are rare and endemic to the Western Ghats.

## Executive Summary & Recommendations

Statistical analyses: Various parametric and non-parametric tests, species diversity and overlap, Twinspan Analysis, Principal Component Analysis, and Discriminant Function Analysis were conducted.

## Results and discussion

### Vegetation

A total of 750 plant species belonging to 97 families were encountered during this study although about 3200 species were recorded earlier from NBR. Poaceae represented by 60 species formed the most dominant family in NBR. Tree flora was dominated by Lauraceae, shrub flora by Rubiaceae and herbaceous flora by Poaceae. Lopping or cutting of trees for various purposes and cattle grazing were the major disturbances besides seasonal fire. Present study indicates that the preference of people towards select species for firewood caused major disturbance to the tree community in the dry forests in Mudumalai Wildlife Sanctuary.

Maximum tree diversity (3.43) was recorded in the undisturbed evergreen forests and minimum (0.20) in the wattle plantation as expected. In the disturbed evergreen forests the number of tree species recorded was 36.7% lower than in the undisturbed site, while the density was 35% less in the disturbed site, whereas the coffee plantation showed a decrease of 63% of the tree species and 77% of the trees as compared to the undisturbed site. The shola forests had the maximum tree density. The disturbed sites had a decrease in tree species and individuals, 10 and 31% respectively when compared to the undisturbed sites. In the moist deciduous and dry deciduous forests, disturbed sites recorded relatively more species and in the scrub jungle there was no difference. Compared to the natural habitats, forest plantations recorded low values for species richness, density and diversity for trees and shrubs. Many plantations were rich in herbaceous vegetation, mainly due to the invasion of weeds, particularly the exotics. The adverse impacts of human interference on plant communities observed in the present study are similar to that of the results obtained by studies from other parts of India including the Western Ghats.

Human induced biotic pressures affecting the regeneration of tree species was evident from this study. For example, in the disturbed evergreen forests a loss of 49% of seedlings was recorded and the completely affected evergreen forests (coffee plantations) showed a loss of 100% of the seedlings. Species richness and density of recruitment class were found low in the disturbed sites and very low or nil in the forest plantations.

Forty six endemic plant species including 24 trees, 13 shrubs and 9 herbs were encountered in NBR during this study. Highest number of endemics were recorded in the shola forests (n=26) followed by evergreen forests (n=19). Population of endemic trees and shrubs showed a reduction in density values in the disturbed sites and very low densities in the forest plantations. However, as far as herbs are concerned, disturbed sites have recorded relatively higher density values. Of the six species of exotic weeds, two species, namely *Lantana camara* and *Chromolaena odorata* spread out extensively in most of the habitats, particularly the disturbed sites and forest plantations.



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The TWINSpan analysis of data on trees could be profitably used in discerning the human impacted biomes in the dry deciduous, moist deciduous and evergreen forests. In the scrub, however, it was found to be inadequate in discerning the impacts. It would be interesting to examine similar patterns are exhibited by shrub and herb species and overall vegetation combining the three components.

### Avifauna of the Nilgiri Biosphere Reserve

In total 413 species and subspecies of birds have been hitherto reported from the Nilgiri Biosphere Reserve, based on our survey and from other reports. These include 81% landbirds and 19% aquatic birds. There are 74% resident species, 21% migrants and the rest (5%) of unknown status. Status of these birds with respect to their abundance is not clearly known for about 22% while 7% are rare and others common or uncommon according to Ali & Ripley (1983). This brings out the need for collecting information on the abundance of many species. The global conservation status according to the IUCN criteria shows three of these species to be threatened, 28 near-threatened, and the rest safe. This list is being revised for the Red Data Book for the Birds of Asia.

All the 17 species including two subspecies of birds endemic to the Western Ghats (Ali & Ripley 1983) are observed in the Nilgiri Biosphere Reserve and of which only one species, the Nilgiri Laughing Thrush *Garrulax cachinnans* is endemic to the NBR. Although the NBR harbours 79% of the avifauna of Southwestern India, it does not conform to the avian pattern of Southwestern India, but complies with that of India and the world since there are >50% of passerines in the NBR. Major guild was of insectivores.

### Bird communities

#### 1. Evergreen forest

Among the habitats selected in the Silent Valley and nearby areas with disturbed and rather undisturbed evergreen forests and coffee plantation, species richness and diversity were more in the disturbed evergreen habitat while abundance of birds were more in the undisturbed. With moderate disturbance, the number of species increased by 19% while the number of birds decreased by 35%. The plantation could support very few species and individuals of birds; 59% of species and 72% of individuals of birds less than in the undisturbed forest. Even in the disturbed forest, the abundance of the habitat specialists and endemics such as the Malabar Trogon, Whitebellied Blue Flycatcher, Nilgiri Flycatcher were comparatively much less.

#### 2. Shola forest and grassland

Species richness, abundance, and diversity were more in the shola than in the grassland and plantation. Among the habitats, grassland seemed to be poor in terms of harbouring variety of birds. However, the Nilgiri Pipit endemic to Western Ghats was seen very often in this habitat and was a specialist. The shola forest is the habitat of four other endemic species, namely the Nilgiri Laughing Thrush, Rufousbellied Shortwing, Nilgiri Flycatcher, and Black-and-orange Flycatcher, the former two being globally threatened. Although the number of species were more or less similar in the disturbed and undisturbed habitats, the abundance of birds was reduced by 23% by disturbance while in the wattle plantation species richness was reduced by 38% and the number of birds by 59%.

### **3. Moist deciduous forest**

Among these habitats, species richness, abundance and diversity of birds were more in the disturbed moist deciduous forest followed by the undisturbed moist deciduous and coffee/tea plantation regardless of seasons and years. The average number of species in the disturbed area was 29% more than in the undisturbed area. This is mainly because of partial disturbance, whereas when the habitat was completely altered (plantation), there was a reduction in the number of species by 41%. In the case of the number of individuals of birds, there was about 30% increase by the disturbance whereas it was 46% reduction in the plantation.

### **4. Dry deciduous forest**

Species richness, abundance, diversity and evenness were high in the more disturbed dry deciduous forest regardless of seasons and years. The average number of species in the Teak plantation was almost equal to that of the disturbed site but with less number of birds.

### **5. Thorn forest**

Among the undisturbed and disturbed scrub and eucalyptus plantation, undisturbed scrub forest showed the highest species richness, diversity, and abundance of birds. Impact of the changes in the habitat was seen in all aspects of the bird community. The number of species of birds decreased by an average of about 13% in the disturbed in comparison with the undisturbed, whereas it was 22% in completely altered habitat or plantation. In the case of the number of individuals of birds, decrease in the plantation was of about 44 to 45% on average.

### **6. Bird communities along a gradient of disturbance**

The rapid survey along a four kilometer transect along a gradient of disturbance from human settlement to the interior forest in the scrub and dry deciduous forests showed considerable reduction in the abundance of birds because of human disturbance. The number of individuals and species of birds increased with the distance from settlements. The number of species and individuals of habitat specialists were more largely in the less-disturbed site. Human disturbances such as lopping of trees and cattle grazing have resulted in the changes in the composition of the vegetation which has in turn influenced the changes in the bird communities in a corresponding manner.

### **7. Bird species diversity and foliage height diversity**

Foliage diversity in different strata of the forests had significant difference between the two forest types and it had significant correlation with bird diversity (foraging birds) ( $r_s=0.874$ ) in the scrub and ( $r_s=0.814$ ) in the dry deciduous forest as found in many earlier studies. However, when the general bird count data was used, there was no significant correlation in many cases showing the importance of the functional relationship between foliage structure and foraging of birds

### **Foraging pattern of birds**

Besides understanding the species composition of the assemblages, it is essential to find out how they utilize the resources available by partitioning these effectively in order to reduce competition and co-exist peacefully (Cody 1974).

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Detailed observations were made on the foraging behaviour of the major species of birds in the thorn and dry deciduous forests in Mudumalai. 2562 observations were made on 35 bird species, 33 in the thorn forest and 30 in the dry deciduous forest.

In general, four substrates such as air, ground, wood (twigs and trunk/main branches), foliage, and Nectar/seed/fruit were recognized as used by the birds for foraging in the thorn and dry deciduous forests. In the dry deciduous forest, wood (twigs, trunk/main branches) was utilized by more number of birds, because more trees were available here.

The methods used by birds to obtain food are more specialized in each species notwithstanding the habitat structure. As foliage height diversity (FHD) differed between habitats, foraging patterns in the thorn and dry deciduous forests are largely separated by the foraging height even within the species. As the availability of short trees were less in dry deciduous habitat, the shrub layer could be distinctly separated from the trees and hence a typical shrub guild emerged in the dry deciduous habitat which was not so in the thorn forest.

Resource partitioning reduces the effect of competition by decreasing the amount of overlap between the competing species. All the birds in these habitats overlapped with others (mean overlap), but only to a smaller extent, below 50%. In all three dimensions (foraging height, foraging method and foraging substrate) highest mean niche overlap was found in the use of foraging height followed by foraging substrate and the least in the foraging method. Of the three, foraging methods and substrates may be constrained by morphology and thus it showed low niche overlap value because of higher degree of specialization in particular species.

This was evident when foraging behaviour of 28 bird species were compared between habitats; 20 species showed changes in their foraging heights between habitats when only 7 of 28 species showed changes in the proportions of prey attack manoeuvre used between habitats. The availability of diverse food items may vary between habitats and hence, birds that feed on variety of foods (eg., insects, nectar, fruit) may change their manoeuvre according to the habitat.

The most important factor dividing the bird community into foraging guilds relate to the physical structure of the habitat as found in the results of the multivariate analysis. First, height and height-related characteristics separate the ground foragers from all other species. Then, the locations of foraging and method of foraging separate the species into minor guilds. There are, therefore, two distinct foraging environments (forest floor and plant surface) in the thorn forest, whereas there are four (forest floor, air, shrub, and trees) in dry deciduous forest.

## Nesting of birds

Although 53 species of birds were observed breeding in different habitats of NBR, detailed studies were conducted only in two habitats in Mudumalai, namely the dry deciduous and thorn forests and tried to assess the habitat requirements and the impact of human disturbances on some of them. Breeding of the two of the birds endemic to the Western Ghats, the Nilgiri Laughing Thrush and Nilgiri Pipit were also studied at Upper Bhavani in order to analyze the impact of habitat alteration on them.



## Executive Summary & Recommendations

A total of 302 nests of 30 species of birds were observed during 1995 and 1996; 200 nests of 22 species in the thorn forest and 102 nests of 20 species in the dry deciduous forest. Cup-nests were more in number than other type of nests. Hole-nests were abundant (35%) in the dry deciduous forest than in the thorn forest (2%) while the dome-nests were more (30%) in the thorn forest. In total, 26 plant species were used for nesting; the diversity of nests was greater on *Anogeissus latifolia* (2.0) followed by Snags (1.6). Species such as *Lantana camara*, *Erythroxylum monogynum*, *Ziziphus mauritiana*, *Catunaregam spinosa* and *Acacia chundra* were the next group which supported more or less the same diversity of nests. Tree species such as *Anogeissus latifolia*, *Acacia chundra*, *Erythroxylum monogynum* and snags were collected by the local people in large quantities which were the preferred species for nesting of birds. Density of snags was lower in the scrub than in the dry deciduous forest, mainly because of firewood collection. Availability of snags had direct positive correlation with the number of hole-nests.

Breeding bird community in the scrub and dry deciduous habitats of 5 ha. each in disturbed and rather undisturbed areas showed higher number of species and nests with less disturbance; in the scrub 19 nests of 10 species in the undisturbed against 12 of 6 in the disturbed while in the dry deciduous, these were 9 of 4 and 6 of 4 respectively. Fire destroyed 19 nests of 6 species in a 5 ha plot in the dry deciduous forest in 1995. Species composition also changed, habitat specialists showing preference for undisturbed areas. The number of nests decreased with proximity to settlements.

Nine bird species with >10 nests were selected for detailed analysis. Some species such as the Whiteheaded Babbler and Baybacked Shrike used more species for nesting while Spotted Munia, Paradise Flycatcher and Purple Sunbird used only a few. The nest-site characteristics of the major species were identified. Many of them, except the Baybacked shrike, were sensitive to disturbance. Paradise Flycatcher nested on shrubs or saplings in a nulla (microhabitat) with more shrub cover and less tree density. Whitebrowed Fantail Flycatcher nests were on twigs on the outer edge of the lower canopy of trees and largely on *Anogeissus latifolia*. The Crested Hawk-Eagle preferred larger trees, namely *Terminalia bellirica* and *Dalbergia latifolia*. The nest sites were with less canopy, closer to water source and farther from human settlement.

### Impact of disturbance on some habitat specialists and endemics

The Nilgiri Laughing Thrush (*Garrulax cachinnans*) is one of 17 species of birds endemic to the Western Ghats but the only bird endemic to the Nilgiris. It is globally threatened. There was remarkable decrease in the population, 37% with disturbance and 79% by completely altering the habitat into a monoculture plantation of wattle. It is a habitat specialist of the shola forest, does not use the grassland and avoids wattle plantation. The breeding population of this thrush was seven pairs in a disturbed forest of about four hectares while it was only one pair in a wattle plantation of about 20 ha in Upper Bhavani. The Nilgiri Pipit is a medium to high elevation grassland species endemic to the Western Ghats. Its population is reduced by about 60% when the grassland is converted into wattle plantation. The earlier concept of grassland as wasteland has created problem for this species as well as many endemic plant species in the montane grasslands of the upper Nilgiris. The nests were constructed on the ground and mostly under the grassroots. The nests were

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neatly built with the grass available near the site and hidden. Although this endemic species has a wider distribution than the Nilgiri Laughing Thrush, this is also a habitat specialist and its prime habitat, the open grasslands, has also been facing problems with the interference of man such as fire, overgrazing by cattle, conversion into plantations, reservoirs, agricultural fields, and so on. Hence, this species is also facing threat and needs protection of its habitat by way of stopping alteration of the existing habitat and restoration of some more areas (shola forest and grassland) as recommended for the Nilgiri Laughing Thrush.

Major species preferring specific habitats were affected by disturbance on the nesting tree or its vicinity as seen in the case of the species explained above, namely the Paradise Flycatcher, Whitebrowed Fantail Flycatcher, and Spotted Munia, and the Crested Hawk-Eagle.

### Observation on impacts of habitat alteration through Remote Sensing and GIS

Human impacts on the landscape could be observed in some of the study areas through satellite imageries. Probable impacts of the hydroelectric dam in Silent Valley was assessed through the studies on the imageries and ground data. Attempts were made to simulate the submergible areas of the proposed dam using digital terrain models with slope aspect and altitude. The extent of evergreen forest loss will be much more than that was predicted earlier and these areas of medium elevation is the richest area of biodiversity with regard to birds and plants. The impact of such disturbances on the system through fragmentation would have created problem for the rare endemic Lion-tailed Macaque and the migration of larger mammals. The construction of a series of dams and reservoirs in Upper Nilgiris have serious impacts on the system which is holding many rare and endemic species.

### Practical utility of this study

These findings would help in the management and conservation of plant and bird diversity. Urgent need for reducing human pressure which affect the habitat specific birds in the scrub forest in Mudumalai is highlighted to be taken up by the park managers for conservation management. Breeding requirements of some of the important bird species and the human impacts on them would help in formulating conservation programme for these species including some of the habitat specific and endemic species. Serious deleterious effect of converting forests into monoculture plantations, especially the shola forests and grasslands, on the endemic plants and birds brings out the immediate need for concerted conservation action. The exercise of simulating the submergible areas in Silent Valley using digital satellite data and predicting the environmental impacts is a valuable example for conservation planning.

### Recommendations

1. Immediate measures are to be taken to reduce pressure from grazing, firewood collection, and illegal felling of trees.
  - Coordination with animal Husbandry Department for supplying high milk-yielding stall-fed varieties of cattle and arrangement for providing / growing fodder.

#### Executive Summary & Recommendations

- Stop dung collection from the Mudumalai Wildlife Sanctuary area.
  - Firewood depots and biogas plants may be set up for providing fuel for cooking to the local people.
  - Ecodevelopment programmes may be initiated.
2. Proper regulation of extraction of Non-timber Forest Produces (NTFP) by locals/ tribals needs to be implemented.
  3. Participatory Management Techniques for wildlife habitat protection, restoration and use be initiated; also provide alternate livelihood for the local villagers who depend on the forests.
  4. Scrub forests of Sigur Reserve forest may be included in the Mudumalai sanctuary for better protection.
  5. No further expansion of plantations and restoration of grasslands and shola forests in the Upper Nilgiris; include more areas in the Mukurthi National Park.
  6. Long-term monitoring of vegetation and bird communities may be carried out along with intensive studies on the biology of rare and habitat specialist birds.
  7. GIS database needs to be set up with a variety of thematic details including information on flora and fauna. This would help the monitoring process.