# EVALUATING BIRD COMMUNITIES OF WESTERN GHATS TO PLAN FOR A BIODIVERSITY FRIENDLY DEVELOPMENT

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**Abstract**

Reconciling development with conservation of biological diversity has emerged as a significant concern in recent years. This has been primarily attempted through establishment of protected areas taken out of mainstream development, and through regulating impacts of major development projects with the help of environmental impact assessment exercises. We believe that these two instruments need to be complemented, by continually providing inputs into the biodiversity implications of ongoing development processes (and accompanying habitat transformations) at the landscape and regional level.

It is desirable that such assessment of biodiversity implications is based on a transparent, objective methodology which could be used by a wide range of practitioners working with the emerging decentralised processes of development planning. In this paper we outline such a methodology focussing on birds. This involves assigning a conservation value to bird species based on readily available information on their geographical range, habitat preference, endangerment and taxonomic distinctiveness. This may then be translated into a mean composite conservation value for bird assemblages characteristic of different habitat types. By combining this information with that on ongoing processes of habitat transformations, we can provide an assessment of how development processes are affecting biodiversity values. We illustrate this methodology by assessing the conservation value of 586 bird species of Western Ghats, and a sample of bird assemblages of seven major habitat types of the region. We conclude that the most serious loss of biodiversity value arises in the transformation of montane evergreen shola forests high altitude grasslands into monoculture plantations.

Key words: Conservation assessment, Western Ghats, Birds, Landscape transformation, Regional planning

## Introduction

Planning for environmentally sound and biodiversity friendly development has in recent years emerged as an important concern. Minimising the loss of biodiversity is one of the key objectives in planning for such sustainable development[1, 2]. Conservation or protection of biodiversity is critically dependent on the kinds of habitat transformations that are ongoing in any area. The habitat transformations in turn depend on land use and hence are intimately connected to the overall development[3]. Therefore we cannot consider conservation and development as two watertight compartments. Till now the efforts to reconcile them have primarily taken two forms; creation of additional protected areas taken out of the mainstream of development and assertion of control over the way major development projects are executed on the basis of environmental impact assessment exercises [4]. Both these approaches have led to positive gains, yet both have their own limitations. The protected areas approach is particularly appropriate when the focus of conservation is on one or more flagship species like the tiger or the Siberian crane. But it is inadequate when the focus shifts to conservation of the entire spectrum of diversity of life, including genetic diversity. Thus many elements of conservation interest, such as wild relatives of cultivated plants like yams occur in highly disturbed habitats such as road verges; others occur as weeds in field; yet others are restricted to climax communities such as wet evergreen forests. Multiple populations of the entire diversity of these wild relatives of cultivated plants can then only be conserved through prudent management of a whole variety of habitat types, both within and outside protected areas [5]. The environmental impact assessment exercises too are inadequate in their approach as well as in practice[6, 4]. They are invoked only in case of major development projects like dams, and leave out of consideration most continual, smaller scale changes. Their treatment of biodiversity is very superficial, often limited to partial listing of major species of larger wildlife or migratory birds. They do not incorporate a proper method to assess the biodiversity loss due to landscape transformations. The environmental impact assessment procedures currently prevalent in India provide no scope for public participations [7]. They are also conducted as one time exercises and do not involve continual monitoring. Given these various limitations in the end they have only a limited positive impact[1]. Apart from the knowledge of environmental impact of major developmental projects, the impact of various kinds of landuse practices on biodiversity is necessary to initiate an ecologically prudent management of natural resources. For such broad based developmental planning we need inputs and instruments additional to networks of protected areas and the one time environmental impact assessments.

To be effective such inputs to development planning must deal with all of the country's landscape and waterscape and be continual since the processes of erosion of biodiversity are going on everywhere all the time. Such broad-based monitoring of biodiversity cannot be the sole responsibility of any one centralised agency; after all the ratio of scientists in the Botanical and Zoological Surveys of to India the land area of the country is 1:1 million hectares. It should instead be organised as a decentralised effort involving local organizations such as educational institutions and NGOs familiar and concerned with their own localities. Such a large scale effort will have to focus on a subset of living organisms that represent the entire taxonomic diversity and inhabit the whole range of habitats, yet are easily accessible and can be identified with some reliability. Such a subset could, for instance, comprise relatively better documented groups like birds, butterflies, ants, dragonflies, earthworms, crabs, leeches, fish, mushrooms, lichens and flowering plants. The levels of diversity in some such set of taxonomic groups should then be monitored in the full range of ecosystems or habitat types of any region; as an ongoing exercise, preferably on an annual basis.

This would generate a wealth of valuable data relevant for detailed planning of ecological management of particular ecosystems. But development planning has to proceed at a hierarchy of levels involving larger and larger spatial scales. The detailed locality specific information therefore needs to be summarised properly to provide effective inputs at higher levels. Such a process would necessarily lead to loss of some information; any priorities set on the basis of such abstraction could be open to question in specific instances. Ecologists therefore hesitate to accept such abstractions. But it is clear that development processes will go on, modifying ecosystems, further eroding biodiversity, and the best option before ecologists is to provide as much information as possible at the appropriate levels to try and influence these processes onto a biodiversity friendly course. Since information must be digested before it reaches higher levels, we must work out ways of doing so most effectively. This paper suggests one possible methodology for summarising information generated through biodiversity monitoring as a possible input to the process of development planning[3]. The proposal of course, has a number of weaknesses. It is nevertheless presented here in the hope that it would stimulate debate and catalyse further progress.

Development interventions primarily affect biodiversity through transformations of habitats. Thus while direct overharvests for forest based industry have led to local elimination of a few species, such as Dipterocarpus indicus in demand for manufacture of plywood, the indirect impacts such as through large scale clear felling of evergreen forests for raising eucalyptus plantations or planting of wattle on high altitude grasslands are likely to be of greater significance [8]. It is also far more feasible to keep track of transformations at the habitat level, especially given the availability of satellite imagery and information management systems like G.I.S; than to keep track of changes in populations of tens of thousands of biological species. It is therefore most efficient to organise monitoring biodiversity as a two-step process of monitoring habitat transformations and evaluating different forms of habitat transformations in terms of their implications for biodiversity [9]. Such a programme involves arriving at (1) a system of classification of habitat types (2) monitoring ongoing transformations in habitat types, (3) censuing different types of habitats in terms of the elements of biodiversity that they harbour, (4) assigning values to these elements of biodiversity and (5) assessing habitat transformations in terms of how they affect biodiversity values. The final, and the most difficult step is of course (6) ensuring that information is given appropriate weightage in arriving at and implementing development priorities.

We are a part of a network, the Western Ghats Biodiversity (WGBN) that is engaged in a co-operative research programme that aims at developing and putting into practice such a methodology[10]. In this paper we wish to present a case study to illustrate steps (4) and (5) of this methodology namely evaluating elements of biodiversity and assessing habitat transformations in terms of how they affect biodiversity values. We will, however, supplement this discussion with some material relating to the other steps in this methodology. Their fuller details are being published elsewhere.

**Background of the study**

Our case study is situated in the hill chain of Western Ghats, running parallel to the west coast of India for over 1600 km from 8$^o$ N to 21$^o$ N latitude. In width the hill chain averages 100 km; its highest peaks are around 1500 m to the north and 2600 m in the south. The rainfall ranges from 3000 mm on the coast to 7500 mm on the crestline, declining rapidly to the east. The Western Ghats constitute a substantial tract of tropical humid vegetation separated by over 1800 km from the larger contiguous tract of humid forest of Eastern Himalayas and Southeast Asia[11]. In consequence this tract of high levels of diversity is also characterized by high levels of endemicity. Originally covered by tropical wet evergreen, moist deciduous and dry deciduous forests, the vegetation of Western Ghats has been profoundly modified through human interventions, so that it is now an intricate mosaic of various degradations stages of the natural forest types along with plantations of rubber, eucalyptus, wattle, casuarina, betelnut, fields of paddy and gardens associated with habitation.

WGBN has initiated studies of the landscape of the Western Ghats, the distribution of biodiversity over this landscape and the ongoing transformations of the landscape in 20 localities spanning the entire geographical spread of the hill chain [10]. An area of about 25 km$^2$ has been mapped in each of these localities with reference to habitats defined in terms of vegetation structure and composition as discernible on spatial scales of a hectare or more. We distinguish in an order of 45 habitat or landscape element types 9 over the 20 localities; each locality has between 8 to 15 of these. The local people are very familiar with how this landscape has been changing over the last 10 to 20 years, what kinds of landscape elements are being transformed into what other kinds and what social and, economic forces are driving these changes. We thus have accounts of ongoing landscape transformations for all localities based on oral history as well as official documents and maps. We have also surveyed to varying degree of completeness occurrences of species of birds, flowering plants, butterflies, freshwater molluscs, fresh water insects, freshwater fishes and caecilians in representative samples of elements of various habitat types in all the localities. Of these the bird surveys are relatively complete and constitute the basis of this case study. The companion paper [12] in this issue provide further details.

**Habitat Transformations**

For the purpose of this case study we have aggregated some of the landscape element types into fewer categories, for instance merging secondary scrub and tree savanna derived from degradation of evergreen forest as also a variety of tree monocultures such as rubber, eucalyptus, wattle and betelnut. Using the resultant seven categories, **Table 1** summarises the broad picture of ongoing transformations of the landscape in 15 of 20 study localities. The seven habitat types are arranged roughly in order of departure from primary, natural to more and more human impacted types. The most evident tendency is for maintenance of the same type so that the diagonal elements are all shown as 'frequent' in **Table 1**. The only other frequent element is the conversion of scrub into monoculture tree plantations of species like Acacia auriculiformes. The elements above the diagonal indicate progression back to more natural types; these are largely absent or rare. The elements below the diagonal indicate conversions to more human impacted or fully managed types, these occur at a greater rate.

A variety of development interventions lead to these transformations and our objective is to appraise them in terms of biodiversity values. As argued above such appraisal may with profit be organized as a decentralised, participatory exercise. Birds, being attractive and readily identifiable down to species are in many ways amongst the most suitable groups of organisms for this purpose. They are however highly mobile and therefore more likely to use a wider range of habitats and often disperse into less preferred habitats from neighbouring more preferred ones. Bird communities are therefore likely to be less sensitive to habitat changes and should not be used as the only basis of appraising the implications of habitat transformations for biodiversity values. Nevertheless, they are an appropriate choice as one of the components of such an exercise.

The next step in evaluating implications of habitat transformations is identification of the bird species pools characteristic of different habitat types. We have attempted to do so on the basis of 132 one hour transects distributed over the seven major aggregated habitat types of the Western

Ghats[12]. A total of 212 species were encountered in the course of these transects. These do not provide information on the total species pools, but are only samples of the pools from each habitat type. Nevertheless these are a reasonable starting point for our further analysis.

**Valuing Bird Taxa**

We need to evaluate the bird species pools characterising the various habitat types. This is best based on an evaluation of the individual member species of the pool. This would be an exercise of quantifying the effort that the society might be willing to devote to ensure continued persistence of any given species. This would depend on a variety of attributes of the species. They belong to three major categories; rarity, extent of threat of extinction and utility[13]. In general, rarer the species, the more threatened the species, the greater the utility of the species, the greater the effort that would be merited to ensure its continued persistence.

We may then assign to any particular species a conservation value reflecting this effort, such that the value would increase with rarity, extent of threat and utility. The actual values could either be ranks along a scale or a specific number. We propose to leave out attempts to quantify utility of bird species and assign quantitative values ranging between 0 and 1 on the basis of 7 attributes relating to rarity and extent of threat. Four of these values relate to the geographical range: G1, over the entire world divided into 6 zoogeographic regions; G2 over the oriental region divided into 9 subregions; G3 over the Indian subregion divided into 8 provinces; and G4 over the Malabar (Western Ghats plus West coast) province divided into 4 sections. The conservation value for a taxon by geographic range is given as:

$$G = (N-a)/(N-1)$$

where <u>N</u> is the number of subdivisions at a given level and <u>a</u> is the number of subdivisions from which the taxon is known. This ensures that the more restricted the range on any of these scales, the greater would the conservation value be. The conservation value of each taxon by habitat preference was computed as

$$H = (N-a)/(N-1)$$

where <u>N</u>, is the total number of bird habitat types over the Western Ghats region and <u>a</u> the number of habitats favoured by a given taxon. This ensures that the more limited the habitat range of a species, the greater would the value be. The conservation value of a taxon reflecting its taxonomic distinctness was calculated as :

$$T = 1/(a \times b)$$

where a is the number of species known in the family to which the taxon belongs and b is the number of races under the species. Rarity is thus sought to be captured in terms of narrowness of geographical range, narrowness of habitat preference and limitations on number of related taxa. The conservation value by degree of endangerment was assigned as

$E = p$

where p is the proportion of endangered taxa in the family to which the taxon belongs. This methodology has been discussed earlier in some detail by Daniels et.al[14].

Admittedly these attempts to capture rarity and endangerment in terms of broad patterns of geographical distribution, habitat preferences, taxonomic position and number of related taxa recorded as threatened are crude. Nevertheless they are based on information which is available for all bird species of Western Ghats, indeed of the whole country, and therefore permit of an evaluation exercise which is reasonably objective and accessible for verification by all who may be interested [15,16,17]. This overcomes problems which plague other more subjective exercises, including the listing of threatened species in IUCN sponsored red data books. Thus the peafowl (Pavo cristatus), the Nigiri Wood Pigeon (Columba eliphistonii), lesser adjutant stork Leptoptilos javanicus and the redfaced malkoha Phaenicophaeus pyrrhocepahlus are the 4 Western Ghats species included in the list of endangered species[17]. However of these four the peafowl is widely distributed in India with many pockets of local abundance thanks to religious beliefs and the lesser adjutant stork is locally quite common in its appropriate habitat.

## Distribution of Conservation Values

The 212 species encountered by us over the 132 transects are a subset of the 586 species of the Western Ghats[18]. We have computed for the set of 586 species of Western Ghats conservation values for each of these 7 parameters, and a composite conservation value (CCV) as the sum of four values, namely the mean of the four values derived from geographical distribution and the other three values related to habitat preference, taxonomic uniqueness and degree of endangerment. As **Fig. 1** shows this the CCV ranges between 0.66 for the Indian jungle crow, widespread, habitat generalist, a member of a speciose family with many races and of a family in little danger of extinction to 2.77 for crab plover, a wader with a restricted geographical distribution, narrow habitat preferences, and the only species in the family Dromadidae. The cumulative frequency distribution rises rapidly at either end, between 0.66 to 1.11 and between 1.94 to 2.77, with about 520 species in the middle accounting for the values between 1.11 to 1.94. The bottom 22 and top

21 species with composite values substantially higher or lower than the majority are then of special interest. Fifteen out of these are birds of aquatic habitats, egrets, cormorants, cranes or skuas. Since our focus is on terrestrial habitats. We may take a closer look at the other species **Table 2**. The species with highest conservation value include thrushes, babblers, woodpeckers, trogon, characteristic of forest habitats with narrow ranges at least at the subspecies level; and gallinaceous birds (quails, junglefowls etc.) that are extensively hunted and thereby threatened. The species with the lowest conservation values include passerines, swallows, hawks and falcons with a broad range of habitat tolerance and a wide geographical distribution, many of whom have adapted to human presence.

It is also of interest to examine the distribution of the composite conservation value amongst the broader groups of birds at family/subfamily level. **Table 3** provides this information for six groups for which the group values are significantly lower or greater than for the rest in the pool of 583 Western Ghats species. Two groups of water birds herons and curlews, and one group of terrestrial birds hawks and vultures have significantly low composite conservation values. These have all very broad geographical distributions. Although the hawks and vultures have a significantly higher value in terms of endangerment, and curlews and sandpipers significantly higher value because of their more limited habitat preference, their CCVs are still significantly lower than the general population.

Three groups namely thrushes and chats, pheasants and quails and babblers and laughing thrushes have significantly higher CCVs. These they owe in all three cases to more restricted geographical distributions, and in the case of pheasants and quails also to significantly higher degree of endangerment. Three other groups of birds are notable for relatively high values along some of the dimensions of conservation value, though their CCV is not significantly higher. These include ducks and geese and pigeons and doves that have significantly high values in terms of endangerment, and woodpeckers that have significantly higher values in terms of restricted geographical distribution. Virakkala et.al[19] have suggested the use of woodpeckers as indicators of the health of forest habitats of Finland. For the terrestial habitats of Western Ghats the babblers would evidently be an appropriate choice as the group with the highest CCV.

**Valuing habitats**

Having thus quantified the conservation value at the species level, we can proceed to assign values to habitats on the basis of species they harbour. Most of the earlier exercises of this nature have primarily relied on species richness. An important advance in this context has been the use of taxonomic information as suggested Vane Wright and his co-workers[20]. Our concept of mean composite conservation value is another attempt in this direction. **Table 4** provides the mean composite conservation value for the nine habitat types. It is notable that the two habitat types with lowest mean CCV, gardens and scrub savanna are also richest in the number of species whereas more natural habitats like shola-grassland and evergreen forest harbour comparatively lower number of rarer species which have a high conservation importance. This is because the former habitats are highly heterogeneous spatially and are colonised by a large number of opportunistic species with wide geographical distributions and broad habitat tolerances. It then appears appropriate not to base conservation decisions on simple species richness, strengthening the case for using a measure such as the mean composite conservation value. The mean CCV for shola-grassland is significantly higher than all other values, that of evergreen and semi-evergreen forests significantly higher than that of scrub- savanna and habitation,and that of deciduous forests significantly higher than that of gardens (all statistically significant at $p < 0.05$). The differences between evergreen forests, semi-evergreen or deciduous forests and monoculture tree plantations are not significant. A caveat is however in order here. All the localities surveyed by us are a highly intricate mosaic of several of these habitat types. In particular, the monoculture tree plantations surveyed are of small extent and tend to abut on patches of evergreen and, deciduous forests. Their bird communities though often poorer in total number of species, are made up of many elements from neighbouring forest habitats. This may be the reason why their mean CCV is not significantly lower in comparison with evergreen and deciduous forest types.

**Appraising Transformations**

The next step is to combine the information on mean CCVs with that on ongoing habitat transformations and quantify their implications in terms of loss of biodiversity values. It is clear that the broad trend of transformations is from the primary, more natural types of higher mean CCV to secondary, more human impacted types of lower mean CCV. This is intuitively obvious and our analysis may be said to have added little to our understanding. However, this is not entirely so. The most frequent transformation is from scrub to tree monocultures, transformations which are often assumed to have adverse biodiversity consequences. Our analysis however suggests that this may not necessarily be the case; the mean CCV of monocultures is in fact slightly higher, though not significantly so. Another frequent transformation involves raising monocultures plantations in the shola-grassland systems. Forest managers argue that this transformation in fact enhances biodiversity values as it enhances the net biomass[21, 22]. Our analysis suggests otherwise, mean CCV for shola-grasslands being significantly higher than that for monoculture plantations.

This suggests that the analysis of the type presented here can indeed lead to non-obvious conclusions of relevance to management decisions, and therefore of value to development planning. Even if some of the other conclusions appear to be obvious, their being derived on the basis of an objective, verifiable methodology is still of value. However, we must emphasize that this is only a beginning and meant to demonstrate the significance of a possible methodology which in its present form has many undoubted shortcomings. The first most obvious shortcoming is the reliance on just one particular group of organisms - the birds. To enhance its usefulness the analysis should be extended to as many other taxa as possible favouring different broader adaptive zones available in that area. Secondly, our analysis leaves out of consideration the relative extent of different habitat types, at the local as well as regional scales. Thus not only may shola-grasslands be of considerable value because they harbour bird species with a high mean CCV, but also because this habitat type is of very limited distribution in higher reaches of the Western Ghats. Furthermore, its ongoing fragmentation may be a matter of serious conservation concern. It is necessary to elaborate specific methodologies to include these additional considerations.

Finally the all important question of how the insights derived from such an analysis are to be incorporated in specific management decisions such as in taking up specific plantations activities, or at a larger scale in the broader process of development planning remains open. We suggest that before any developmental projects or broader land use change are implemented these type of studies, both in short and long term, will help us in a more reasonable cost benefit analysis upon which to base decisions to steer development on to a more sustainable and environmentally friendly path. Hopefully we will move in this direction as a more decentralised process of development planning takes root in the country[23]. The fact that the methodology sketched above easily lends itself to an objective, participatory exercise should render it easier to incorporate it in such a decentralised process of planning.

**Legend to Figure: 1**

Distribution of composite conservation value in 586 species of birds in Western Ghats

**Table 1**. A schematic summary of ongoing changes in the landscape of the Western Ghats

**Table 2**. Conservation values of 28 selected species of birds from 586 species of Western Ghats

**Table 3**. Distribution of composite conservation values in some broader groups of birds

**Table 4**. Composite conservation value (CCV) of habitats

**REFERENCES**


1.Common, M. S. and Norton.T.W, in *Biodiversity Conservation*, Kluwer Academic Publishers, Netherlands.1995. pp. 87-110,

2.Lovejoy, T. E., in *Biodiversity Measurement and Estimation*, (ed. Hawksworth D.L), The Royal Society, Chapman & Hall Publishers, London.1995. pp. 81-87

3.Brandon K., in *Last Stand* (eds. Kramnes, Sehaik,C.V., J. Johnson), Oxford University Press, New York.1997 pp. 90-114.

4.Spellerberg, I.F., *Evaluation and Assessment for Conservation*. Chapman & Hall Publishers, London.1992. pp.260.

5.Gadgil, M., Singh, S.N.,Nagendra.H., and Chandran,M.D.S, *In- situ Conservation of Wild Relatives of Cultivated Plants: Guiding Principles and a Case Study*, Published by FAO and Indian Institute of Science.1996. pp.21

6.Ghosh, A. K. in *Taxonomy in Environment and Biology*, 1990. pp.281 - 290.

7. Gadgil, M. and Chandran, M.D.S. *Frontline*, March 26, 1993. pp. 62-73.

8.Daniels, R. J. R., Gadgil, M.,and Joshi, N.V., *Journal of Applied Ecology*, 1995. 32, 866-874.

9.Gadgil, M., *Curr. Sci*., 1994. 66, 401 - 406.

10.Gadgil, M., *Curr. Sci*., 1996. 70, 36- 44.

11.Daniels, R. J. R., Joshi,N.V., and Gadgil, M., *Proceedings of the National Academy of Science*, 1992, 89, 5311 - 5315.

12. Pramod, P., Joshi,N.V., Ghate,U., and Gadgil.M., On the Hospitality of Western Ghats Habitats for Bird Communities. 1997 *(Current Sci.)*

13.Reid, W. V. and Miller, K.R., *Keeping Options Alive: The Scientific Basis for Conserving Biodiversity*, World Resources Institute, Washington D.C.1989. pp.128.

14. Daniels,R.J.R., Hegde, M., Joshi, N.V. and Gadgil, M.,*Conservation Biology*, 1991. 5: 464 - 475.

15. Ali, S. and Ripley, S.D., *Handbook of the Birds of India and Pakistan*. Compact Edition, Oxford University Press, Bombay, India. 1983. pp.737.

16. Howard, R. & Moore, A., *A Complete Checklist of the Birds of the World*. Oxford University Press, Oxford, England.1980

17. World Conservation Monitoring Centre. India. *Conservation of Biological Diversity*, IUCN, Cambridge 1988

18. Daniels, R.J.R., *Birds of Southwestern India*, Oxford, New Delhi. 1997. pp.217

19. Virakkala, R., Rajasarkha, A., Vaisanner, R.A., Vikholm, M., and Virolainen, E., *Annual Zoological Fennici*.1994.31,pp.173-186.

20. Vane-Wright,R.I, Humphries, C.J.and Williams, P.H.,*Biological Conservation*, 1991. 55, pp.235-254

21. Prabhakar.R., *Resource use, culture and ecological change: A case study of the Nilgiri hills of southern India*. Ph.D.Thesis, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, 1994, p.297

22. Kunhikrishnan.E, (pers. comm.)

23. Rao,P.R. S. & Gadgil.M.,*Economic and Political Weekly*,1995. pp.2501-2511.

Table 2. Conservation Values of 28 selected species of birds from 586 species of Western Ghats

| HB No | Species | Rank | CCV | G1 | G2 | G3 | G4 | H | T | E |
|---|---|---|---|---|---|---|---|---|---|---|
| 1063 | Grey Hypocolius | 2 | 2.28 | 0.80 | 0.00 | 1.00 | 1.00 | 1.00 | 0.33 | 0.00 |
| 260 | Rock Bush Quail | 4 | 2.08 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.00 | 0.11 |
| 277 | Red Spurfowl | 5 | 2.07 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.00 | 0.11 |
| 1638 | Whitebellied Shortwing | 7 | 2.02 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.02 |
| 1637 | Rufousbellied Shortwing | 7 | 2.02 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.02 |
| 299 | Indian Red Junglefowl | 11 | 1.99 | 1.00 | 1.00 | 0.85 | 1.00 | 0.91 | 0.00 | 0.11 |
| 599 | Redfaced Malkoha | 12 | 1.99 | 1.00 | 0.87 | 1.00 | 1.00 | 1.00 | 0.01 | 0.01 |
| 1220 | Mount Abu W.T. Babbler | 13 | 1.99 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.00 | 0.02 |
| 710 | Trogon | 14 | 1.98 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.01 | 0.01 |
| 1135 | Yellowthroated Bulbul | 15 | 1.97 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.01 | 0.00 |
| 1756 | Bourdillon's Blackbird | 16 | 1.97 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.02 |
| 853 | Pigmy Woodpecker | 19 | 1.95 | 1.00 | 1.00 | 1.00 | 0.66 | 1.00 | 0.00 | 0.03 |
| 614 | Striated Scops Owl | 20 | 1.94 | 0.80 | 1.00 | 0.85 | 1.00 | 1.00 | 0.01 | 0.02 |
| 1874 | Forest Wagtail | 542 | 1.09 | 0.80 | 0.37 | 0.14 | 0.00 | 0.73 | 0.02 | 0.00 |
| 135 | Brahminy Kite | 543 | 1.09 | 0.80 | 0.25 | 0.00 | 0.00 | 0.78 | 0.00 | 0.04 |
| 953 | Indian Golden Oriole | 545 | 1.08 | 0.60 | 0.62 | 0.42 | 0.00 | 0.65 | 0.02 | 0.00 |
| 748 | Bluetailed Bee-eater | 547 | 1.07 | 1.00 | 0.00 | 0.28 | 0.00 | 0.74 | 0.01 | 0.00 |
| 130 | Crested Honey Buzzard | 549 | 1.04 | 0.80 | 0.25 | 0.00 | 0.00 | 0.74 | 0.00 | 0.04 |
| 750 | Small Green Bee-eater | 553 | 1.00 | 0.60 | 0.87 | 0.42 | 0.00 | 0.52 | 0.00 | 0.00 |
| 209 | Peregrine Falcon | 554 | 0.99 | 0.00 | 0.37 | 0.00 | 0.00 | 0.87 | 0.00 | 0.03 |
| 124 | Blackwinged Kite | 555 | 0.99 | 0.40 | 0.12 | 0.14 | 0.00 | 0.78 | 0.00 | 0.04 |
| 1884 | Grey Wagtail | 556 | 0.98 | 0.60 | 0.00 | 0.00 | 0.00 | 0.83 | 0.00 | 0.00 |
| 1006 | Indian Myna | 557 | 0.93 | 0.20 | 0.50 | 0.14 | 0.00 | 0.70 | 0.00 | 0.02 |
| 1407 | Brown Flycatcher | 558 | 0.90 | 0.80 | 0.00 | 0.28 | 0.00 | 0.61 | 0.00 | 0.02 |
| 917 | Eastern Swallow | 560 | 0.86 | 0.00 | 0.12 | 0.00 | 0.00 | 0.83 | 0.00 | 0.00 |
| 965 | Indian Grey Drongo | 561 | 0.85 | 0.80 | 0.75 | 0.42 | 0.00 | 0.35 | 0.00 | 0.00 |
| 736 | W.B.Kingfisher | 562 | 0.73 | 0.80 | 0.62 | 0.57 | 0.00 | 0.22 | 0.00 | 0.01 |
| 1057 | Indian Jungle Crow | 563 | 0.66 | 0.80 | 0.87 | 0.71 | 0.00 | 0.04 | 0.00 | 0.02 |

HBNo= Reference number of species as in Handbook (Ali and Ripley 1983)
CCV = Composite Conservation Value.
Rank= Rank of the species according to its CCV.
G1, G2, G3, G4, H, T, E as in the text.

Table 4. Composite Conservation value (CCV) of habitats

| Habitat | No Trans | Mean CCV | SD CCV | Max CCV | Min CCV | Med CCV |
|---|---|---|---|---|---|---|
| Shola/Grassland | 11 | 1.57 | 0.05 | 1.63 | 1.47 | 1.55 |
| Evergreen forest | 24 | 1.47 | 0.06 | 1.57 | 1.30 | 1.45 |
| Semievergreen fores | 13 | 1.49 | 0.05 | 1.56 | 1.40 | 1.47 |
| Deciduous forest | 23 | 1.44 | 0.05 | 1.58 | 1.32 | 1.44 |
| Scrub/Savanna | 17 | 1.40 | 0.10 | 1.59 | 1.20 | 1.41 |
| Secondary grassland | 3 | 1.39 | 0.08 | 1.48 | 1.30 | 1.39 |
| Monoculture plantation | 13 | 1.40 | 0.08 | 1.56 | 1.26 | 1.39 |
| Home Garden | 23 | 1.37 | 0.06 | 1.47 | 1.25 | 1.38 |
| Paddy fields | 5 | 1.30 | 0.05 | 1.36 | 1.23 | 1.32 |

Table 1. A schematic summary of ongoing changes in the landscape of the Western Ghats

| FROM TO | SH | EV | SE | DC | SC | MP | HB |
|---|---|---|---|---|---|---|---|
| SH | F | A | A | A | A | A | A |
| EV | A | F | O | R | A | A | A |
| SE | A | F | F | A | A | A | A |
| DC | A | O | O | F | R | R | A |
| SC | O | O | F | O | F | R | A |
| MP | O | O | O | O | F | F | A |
| HB | R | O | O | O | O | R | F |

F - Frequent  O - Occasional  R - Rare  A - Absent

SH Shola/grassland  SC Scrub/savanna
EV Evergreen forest  MP Monoculture plantation
SE Semievergreen forest  HB Gardens around habitation
DC Deciduous forest

Table 3. Distribution of Composite Conservation Values
in some broader groups of birds

| Group of birds | Nosp | Mg | Mr | SDg | SDr | t-val | p-val |
|---|---|---|---|---|---|---|---|
| Herons, Egrets, Bitterns | 15 | 1.22 | 1.56 | 0.24 | 0.23 | -5.35 | 0 |
| Hawks, Vultures, etc. | 40 | 1.45 | 1.55 | 0.25 | 0.24 | -2.48 | 0.01 |
| Pheasants, Patridges,- and Quails | 14 | 1.72 | 1.54 | 0.23 | 0.24 | 2.61 | 0.01 |
| Curlews, Sandpipers,- Snipes and Woodcocks | 26 | 1.39 | 1.55 | 0.13 | 0.24 | -3.28 | 0.00 |
| Babblers | 24 | 1.78 | 1.54 | 0.13 | 0.24 | 4.86 | 0 |
| Thrushes and Chats | 29 | 1.66 | 1.55 | 0.20 | 0.25 | 2.46 | 0.01 |

Nosp = Number of species of the respective group
Mg, Mr = Mean CCV of the group and the rest of the birds of Western Ghats
SDg, SDr = Standard Deviation of CCV of the group and the rest of birds
The t-test was used for detecting the statistical significance of the difference between mean values