

# The Wildlife (Protection) Act and conservation prioritization of butterflies of the Western Ghats, southwestern India

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*Various schedules of the Wildlife (Protection) Act, 1972 (henceforth WPA), dictate the level of legal protection given to species of Indian animals. Shortcomings of the schedules of the WPA with respect to insects have been pointed out, but no solutions have been suggested. Here I have used butterflies of the Western Ghats as a case study, analysed their conservation values with multiple species attributes and then compared my findings with the species listed under the WPA. Analysis shows that a large proportion of species with high conservation values, many of them narrowly endemic and endangered, are not listed under the WPA, indicating the need to expand the listings. This methodology can be used to objectively assess conservation values of other animals and their inclusion in the WPA.*

**Keywords:** Biodiversity hotspots, environmental law, insect diversity, Wildlife Protection Act.

THE most important legal system for protection of endangered animals in India is the Wildlife (Protection) Act, 1972 (ref. 1), henceforth WPA. The more recent Biological Diversity Act and Biological Diversity Rules<sup>2</sup> govern the use and protection of biodiversity, but both rely on the schedules of the WPA as a guideline for protecting species. WPA was a laudable legal measure for its time and it has proven valuable in the past several decades, especially with respect to conservation of large mammals and other vertebrates. The effectiveness of WPA in the conservation of invertebrates, however, is less clear. Several limitations of invertebrate lists under the schedules of the WPA have been highlighted in the past, particularly: (a) taxonomic inconsistencies and inaccuracies<sup>3</sup>, (b) lack of objectivity<sup>3,4</sup>, and (c) inadequacy of the listings of the schedules<sup>4</sup>. Of potentially dire consequence is the exclusion from the WPA schedules of many species that are narrowly endemic to small geographic areas within the confines of the country, are highly endangered and do not have any special legal protection.

The butterfly fauna of the Western Ghats (Table 1)<sup>5,6</sup>, which is one of the global biodiversity hotspots and an important conservation area, exemplifies the problems posed by current listings under the six WPA schedules. According to the WPA, taxa listed under Schedule I have the highest level of legal protection, Schedule II offers the second highest level of protection and so on down to

Schedule IV. Schedule V lists vermin and pests, and Schedule VI lists six plants. Among the first four schedules, butterflies are listed under Schedules I, II and IV, but many of the Western Ghats endemics and rare species have not been included<sup>4</sup>. There seem to be no data available in peer-reviewed literature describing the conservation importance of Indian butterfly species and subspecies. The rationale behind assigning taxa to specific WPA schedules has also not been published in any publicly available government documents. This has prevented objective assessment of the current listings and any future opportunities to improve them.

One way to remedy this situation is to analyse conservation values of butterfly species, which can then be used as a guide to the listing of species under WPA schedules. Conservation values based on multiple species attributes were computed earlier for birds of the Uttara Kannada District, southwestern India, by scoring their distributional ranges, habitats and taxonomic distinctiveness<sup>7</sup>. A similar scoring system was employed to assign conservation values to all the bird species and their habitats in the Western Ghats, to highlight conservation strategies in the face of ongoing habitat conversion and biodiversity loss<sup>8</sup>. Species parameters have also been used recently in assessing extinction proneness in tropical butterflies<sup>9</sup>, and should be useful in the present context. Here I present an analysis of butterfly fauna of the Western Ghats, using multiple species parameters in assigning conservation values to all species. The results are compared with the WPA schedules and I also discuss how the approach presented here can be instrumental in improving the WPA schedules to ade-

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**Table 1.** Family-wise breakdown of butterfly diversity and endemism in the Western Ghats

Family	Genera	Species	WG endemics <sup>a</sup>	WG + SL endemics <sup>b</sup>	Total endemics
Papilionidae	4	19	5	0	5
Pieridae	14	34	3	1	4
Nymphalidae	45	97	12	4	16
Riodinidae	1	1	0	0	0
Lycaenidae	54	100	3	3	6
Hesperiidae	46	82	10	0	10
Total	164	333	33	8	41

<sup>a</sup>WG, Species endemic to the Western Ghats; <sup>b</sup>WG + SL, Endemics shared with Sri Lanka.

quately protect species that need legal protection for their long-term conservation.

## Methods

### *Study area and butterfly species*

The Western Ghats stretches along the western coast of peninsular India from Surat Dangs in southern Gujarat to southwestern Tamil Nadu (8–20°N), covering an area of ~160,000 sq. km and ranging in elevation from sea level to ~2700 m. The northern parts and extreme southern tip are less moist, while the central and southern Western Ghats receive heavy annual precipitation of up to 6000 mm, which supports dense evergreen forests rich in species diversity and endemism. The two most biodiverse areas of the Western Ghats, i.e. Coorg–Nilgiris and southern Western Ghats, are separated by the Palghat Gap (Figure 1), giving rise to local endemism and increasing overall diversity in the area. Most of the flora and fauna of the Western Ghats are derived from the Oriental region (Holloway<sup>10</sup> and references therein). Endemism varies from over 60% for amphibians and reptiles to 4% for birds, but the overall levels of diversity and endemism in the Western Ghats are high<sup>11</sup>, prompting their inclusion in the global biodiversity hotspots. A list of the Western Ghats butterflies was prepared from faunistic literature<sup>5,6,12–14</sup>.

### *Conservation scores*

Each butterfly species was given scores for four parameters (global distribution, local distribution, habitat preference and status) as discussed below. Values were assigned for various states of the parameters such that restricted global and local distributions, rarity and occurrence in threatened or very specialized habitats, each received the highest score. Widespread global and local distributions, commonness and occurrence in widespread, less threatened or diversity of habitats, each received a low score. Then a composite conservation value was calculated for each butterfly species by adding its four scores. Since scores were assigned from 1 to 10 for each of the four parameters, the highest possible conservation value for a species was 40 and the lowest value was 4.



**Figure 1.** Map of the Western Ghats showing the four zoo-geographic divisions.

Parameter values could be assigned in a number of ways and the method used here was arbitrary. What was critical for the present purpose was the relative rank of various states of the parameters. By extension, the relative conservation values (in this case out of 40) of different species were important, not absolute numbers computed for each species. In order to preserve and present my original data values were not normalized. The values can be normalized from my raw data for comparison with similar studies in other groups or areas. Given the limited space here, it is not feasible to give the complete list of butterflies of the Western Ghats with parameter values and conservation scores for each species. This dataset can be requested by e-mail. It will also be made available in a free public domain soon.

**Table 2.** Association between global distribution and status of butterflies of the Western Ghats

	RAPA <sup>a</sup>	RAWI	UNPA	UNWI	COPA	COWI	ABPA	ABWI	Total
NWG <sup>b</sup>	5		3	1	9	2			20
WG	1	1	2	1	4	4			13
WGSL	1	2	1		1	3			8
PI	1	1			1	7			10
IS	3		1	9	1	17			31
OR	17	14	7	21	4	71		1	135
OEH	2	3		5	1	22			33
OAU	2		1	7	1	26		3	40
OAF	2		2	1		13			18
OH					1	1			2
GL	2	1		1	1	17		1	23
Total	36	22	17	46	24	183	0	5	333

<sup>a</sup>Status within the Western Ghats – RA, Rare; UN, Uncommon; CO, Common; AB, Abundant; PA, Patchily distributed; WI, Widely distributed. Conservation scores – RAPA, 10; RAWI, 9; UNPA, 7; UNWI, 6; COPA, 4; COWI, 3 and ABWI, 1.

<sup>b</sup>Global distribution – NWG, Narrowly endemic to the Western Ghats (occur only in the southern and Coorg–Nilgiris regions; conservation score is 10); WG, Endemic to the Western Ghats, conservation score is 8; WGSL, Endemic to the Western Ghats–Sri Lanka biodiversity hotspot, conservation score is 6; PI, Restricted to Peninsular India, conservation score is 5; IS, Restricted to the Indian Subcontinent, conservation score is 4. The following distributions are over larger zoogeographic scales: OR, Oriental region, conservation score is 3; OEH, Oriental region and eastern Palaearctic (China, Japan, Korea, etc., conservation score is 2); OAU, Oriental and Australian regions, conservation score is 2; OAF, Oriental and African regions, conservation score is 2; OH, Oriental and Palaearctic, conservation score is 2, and GL, Distributed over three or more zoogeographic regions, or ‘global’, conservation score is 1.

### Global distributions

Global distributions were assigned to species in terms of zoogeographic regions following Cox<sup>15</sup>: (1) Oriental region (India east- and southeast-ward up to Indonesia, the Philippines and Taiwan), (2) Australian region (New Guinea–Irian Jaya, Australia, New Zealand and associated Pacific Islands), (3) African region (including parts of the Middle East), (4) Palaearctic region (northern Eurasia), (5) Nearctic region (North America, including parts of Central Mexico), and (6) Neotropical region (southern North America, Central and South America). I classified the more restricted Oriental distributions into Indian subcontinent (Pakistan to northern Myanmar and the Himalayas to Sri Lanka), and Peninsular India and Sri Lanka–Western Ghats biodiversity hotspot (for narrower endemics, see the next section). Several faunistic works were consulted for global distribution of species<sup>5,16–24</sup>. Values for each of these distributional categories and other parameters are given in Tables 2 and 3.

### Local distribution (within the Western Ghats)

The Western Ghats was subdivided in the following four natural zoogeographic sections<sup>7</sup>: (1) northern – southeastern Gujarat to Goa, (2) central – Goa to Coorg, (3) Coorg and Nilgiris, and (4) southern – south of the Palghat Gap to the southern tip of the Western Ghats (Figure 1). Local distribution of species was extracted from a variety of sources<sup>4–6,13</sup> and unpublished observations.

### Habitat preferences

The major butterfly habitats were classified in broad categories reflecting the precipitation gradient, altitude and vegetation types, as follows:

- (1) Low and mid-elevation evergreen and semi-evergreen forests (sea level up to 1500 m): This is one of the most endangered habitats in India; hence species inhabiting this habitat received the highest conservation score.
- (2) Montane evergreen forests (>1800 msl) known as ‘shola’ forests: Species found in this habitat are highly specialized on montane forests and some of them are narrow endemics. This and the next habitat are highly endangered due to tea, coffee and wattle plantations and associated human disturbance; hence their inhabitants also received the highest score.
- (3) Montane grasslands and edges of shola forests above 1800 m: as above.
- (4) Moist forests: Including evergreen, semi-evergreen and dense riparian moist deciduous forests. Evergreen forests are thus a subset of moist forests, the evergreen forest species being more habitat-specialized. Species assigned to this category usually do not venture into drier and more exposed parts of the deciduous forests. This habitat is increasingly threatened from damming of forest rivers, extensive human use and various development activities.

**Table 3.** Association between global distribution and habitat preference of butterflies of the Western Ghats

	EVS <sup>a</sup>	SHO	MSG	MOI	DEC	DDS	WOO	GRS	SSA	DIV	Total
NWG <sup>b</sup>	11	2	7								20
WG	11			2							13
WGS	5	1		2							8
PI				3	3	2		1		1	10
IS	8			4	8	2	3	4	1	1	31
OR	53	1	2	34	22	3	12	3	2	3	135
OEH	11		1	8	4		5			4	33
OAU	10			12	3	1	9	2		3	40
OAF				1		3		13		1	18
OH			1							1	2
GL	3		1		1		7	6	1	4	23
Total	112	4	12	66	41	11	36	29	4	18	333

<sup>a</sup>Butterfly habitats – EVS, Low and mid-elevation evergreen and semi-evergreen forests, conservation score is 10; SHO, Montane evergreen ('shola') forests, conservation score is 10; MSG, Montane shola-grassland mosaics, conservation score is 10; MOI, Moist forests (evergreen, semi-evergreen and riparian moist deciduous forests, conservation score is 8); DEC, Deciduous forests, conservation score is 6; DDS, Dry deciduous and scrub forests, conservation score is 4; WOO, Generalist woodland species (evergreen, deciduous and scrub forests, conservation score is 3); GRS, Low and mid-elevation dry grasslands and savannahs, conservation score is 2; SSA, Streams, swamps and other open freshwater habitats, conservation score is 2 and DIV, Diverse habitat types (generalist spp.), conservation score is 1.

<sup>b</sup>Global distribution as in Table 2.

- (5) Moist deciduous forests: This habitat is more secure than the above-mentioned habitats, but suffers from felling, burning and intensive human use.
- (6) Dry deciduous forests and scrublands: Most of these are highly disturbed deciduous forests that have been thinned and converted to dry habitats due to intense use by humans and livestock.
- (7) Woodlands: Species assigned to this category inhabit a wide range of woodland habitats, from openings in evergreen forests to wooded areas in urban settings. These are woodland generalists.
- (8) Low and mid-elevation dry grasslands and savannahs: These are usually maintained as grazing land for livestock by human-induced fires.
- (9) Non-forest streams, swamps and other open freshwater habitats: Although this habitat is important for migratory birds, fish and other animals, it is not so important for butterflies since few habitat generalist species use it non-exclusively.

Habitat information on butterfly species was gathered from various sources<sup>4,13,25–26</sup> and unpublished observations.

### Status

Status, i.e. frequency of occurrence and patchiness of geographical distribution, was assigned to butterfly species in the Western Ghats from the literature as well as unpublished observations. Common species received lower scores than rare species, and species with patchy populations received higher scores than those with more widespread populations (Table 2).

Previous analyses have frequently used taxonomic distinctiveness in computing conservation values<sup>7,8,27,28</sup>. This component could feature prominently in future studies on Indian butterflies when we have a better understanding of phylogenetic relationships between various species groups and when species arrangements in some important genera have stabilized further. Several taxonomic efforts are currently under way to resolve these issues<sup>29–31</sup>, and it should be possible to use the resulting information in near future.

The present analysis should be considered with two important caveats in mind. First, the scoring scheme used here is open to some arbitrariness. Secondly, different sets of species attributes may be important while calculating conservation scores for different groups of organisms. Thus, in a more inclusive effort in future, a multi-criterion analysis should be performed followed by sensitivity analysis for the various species attributes, so that these two issues can be addressed in more detail.

### Results

Thirty-three of the 333 butterfly species found in the Western Ghats are endemic, and an additional eight endemics are shared between the Western Ghats and Sri Lanka biodiversity hotspots, making the total number of endemic and narrowly endemic species as 41 or 12.31% of the Western Ghats butterfly fauna (Table 1). The mean conservation value of all the 333 species was  $20.1 \pm 7.13$  (range 9–40). The mean conservation value of non-endemic species was  $18.51 \pm 5.85$  (range 9–33; 292 spp.), that of the species endemic to the Western Ghats and Sri Lanka was  $31.37 \pm 4.93$  (range 21–40; 41 spp.). The difference between the distribution of conservation values of

endemic and non-endemic species was significant (Kolmogorov–Smirnov test:  $D = 0.7445$ ,  $P < 0.0001$ ). However, the ranges of their conservation values overlapped to a large extent (Figure 2), indicating that endemism alone was not a good correlate of overall conservation values.

Table 2 gives a breakdown of species according to their global distribution and status within the Western Ghats. The proportion of rare and patchily distributed species was highest among narrow endemics, i.e. those occurring only in Coorg–Nilgiris and southern Western Ghats (five out of 20 species, or 25%), followed by other endemics, including those shared with Sri Lanka (seven out of 41 species, or 17%) and non-endemic species (29 out of 292 species, or 10%). Table 3 gives a breakdown of species according to their global distribution and habitat preference within the Western Ghats. An unusually high proportion of narrowly endemic species occupied three highly endangered habitats: evergreen forests (11 species, or 55% of the narrow endemics) and montane shola–grassland mosaics (9 species, or 45%). Thus, endemism, rarity, patchy distributions and preference for endangered habitats were generally associated. Note in Table 3 the marked absence of endemic species in dry, open habitats such as deciduous forests and scrub/savannahs, which are mostly a result of recent human-caused alterations in the Western Ghats.

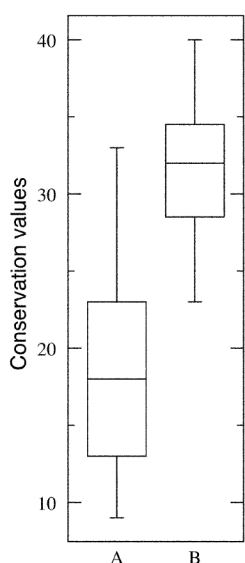
Table 4 gives a family and WPA schedule-wise breakdown of Indian butterflies. It also includes a family-wise breakdown of 82 out of the total 333 butterfly species of the Western Ghats, with conservation values in the top quartile of the analysis. Although the schedules consider all the Indian taxa while the present study analyses conservation values of only the Western Ghats butterflies,

the comparison bares important issues. The most striking result from this comparison is the taxonomic bias against family HesperIIDae as listed in the WPA schedules, whereas many hesperiids have high conservation values. Nymphalidae, Lycaenidae and HesperIIDae are the most diverse families both in India and in the Western Ghats<sup>5,6</sup>, and their endemism levels in the Western Ghats are similar (Table 1). Diversity, endemism and resulting conservation values of the three families were accurately represented in the present analysis: the three families had comparable number of species in the top quartile of conservation values. In contrast, the WPA schedules covered a mere 3% of species under HesperIIDae (Table 4). Moreover, only a minor proportion of the species having the highest conservation values is included in any WPA schedule, highlighting the inadequacies of the listings of the WPA schedules and the need to expand them.

## Discussion

Here I have attempted to compute conservation values of butterflies of the Western Ghats. Conservation values have been used to further assess the adequacy of butterfly listings under the WPA schedules. The present analysis indicates that the WPA does not protect many endemic and non-endemic species with high conservation values. For example, the WPA schedules do not list the following Western Ghats species with highest conservation values: *Eurema nilgiriensis*, *Mycalis igilia*, *M. davisoni*, *M. orcha*, *Thoressa evershedii* and *T. sitala* (all with conservation values in the range 34–40, out of 40). On the other hand, narrowly endemic, patchily distributed and taxonomically the most distinctive butterfly in the Western Ghats, *Parantirrhoea marshallii* (conservation value 38), and other highly restricted Western Ghats endemics such as *Zipaetis saitii*, *Papilio buddha* and *Appias wardii* are all listed under Schedule II. These deserve to be listed under Schedule I. Thus, the WPA schedules should be expanded to include high conservation priority species currently missing from the schedules altogether, and species listed under various WPA schedules need reshuffling in order to grant a more appropriate level of protection to them according to their conservation values.

The finding that narrow endemics generally have higher conservation values is not surprising. However, particular attention should be paid to the fact that some rare and sparsely distributed non-endemics also have high conservation values. This is important because the Western Ghats populations of these more widespread species represent either subspecies or long-isolated populations that contain unique intraspecific genetic diversity and possess evolutionary potential, which is an important component of overall species diversity of the Western Ghats. In contrast, given their abundance in a variety of habitats, including urban landscapes, species endemic to the Indian subcontinent (e.g. *Pachliopta hector*) or the Western



**Figure 2.** Distribution of conservation values of non-endemic species (A) and species endemic to the Western Ghats and Sri Lanka (B).

**Table 4.** Family-wise comparison of taxa and their relative percentages (rounded-off to the nearest integer) listed under various schedules in the Wildlife (Protection) Act of India with taxa in the top quartile of conservation values in this study

	Schedules of the Wildlife (Protection) Act				This study
	I	II	IV	Total	
Papilionidae	14	21	0	35 (8%)	4 (5%)
Pieridae	6	21	4	31 (7%)	5 (6%)
Nymphalidae	61	141	5	211 (47%)	28 (34%)
Riodinidae	0	4	0	4 (1%)	0 (0%)
Lycaenidae	47	113	1	161 (36%)	21 (26%)
Hesperiidae	0	3	9	12 (3%)	24 (30%)
Total	128	303	19	450 (100%)	82 (100%)

Ghats (e.g. *Troides minos*) may not need legal protection under the WPA. For these reasons, I argue that endemism alone should not be used to list species in the WPA schedules; rather, a multi-parameter system similar to the one proposed here should be evolved and employed in future policy decisions and legal conservation efforts.

An analysis of conservation values of the birds of the Western Ghats has earlier shown that evergreen forests and montane shola–grassland mosaics support a high proportion of endemic and endangered bird species<sup>8</sup>; the present analysis shows that this is also true for the butterfly species. Hence, further attention is needed in offering better protection to these bird and butterfly habitats, since extinction of the species will follow widespread decline in their habitats even if the WPA protects them.

In summary, the analysis presented here offers a rationale, viz. conservation values of species based on multiple species attributes, for including species in the WPA schedules and providing them legal protection. This analysis can be extended to the flora and fauna of the entire country, particularly flowering plants, vertebrates and invertebrates on which similar information is available, such as butterflies and odonates (dragonflies and damselflies). As conservation biologists assess the status of various species and organismal groups, rank species by their conservation values and make the information available in peer-reviewed, publicly available research journals, government bodies can use this information for designing and implementing conservation strategies, including placement of species in appropriate WPA schedules according to their conservation values. This kind of strategy calls for concerted efforts of and regular interaction between researchers, conservation planning and decision-making bodies, and forest officials. The government approach to conservation also needs to be more dynamic, unlike the current static approach that lacks any schemes for periodic revisions and reassessments of important policy frameworks such as the WPA. This is crucial since conservation concerns are not unchanging even for apparently unthreatened species, as the alarming decline in vulture populations recently painfully demonstrated<sup>32</sup>.

Thus, periodic assessments of the WPA listings, particularly of those taxa on which new information is continuously being generated, will better equip us in dealing with the changing conservation scene. This is more likely to succeed in protecting India's biodiversity wealth in the long term.

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