Bird Conservation International (2002) 12:335–351. © BirdLife International 2002
DOI: 10.1017/S0959270902002216 Printed in the United Kingdom

Status and habitat preference of White-bellied Shortwing *Brachypteryx major* in the Western Ghats (Kerala and Tamilnadu), India

V. V. ROBIN and R. SUKUMAR

Abstract

White-bellied Shortwing is a globally threatened species found in the Western Ghats of India. There have been few records of this species over the past 119 years and its population is thought to have fallen due to habitat loss and fragmentation. The present study was conducted to assess the habitat preferences and distribution of this species in the Western Ghats of Kerala and Tamilnadu states as a prelude to a long-term study on the biology and causes of decline of this species. Several areas across varying vegetation type and altitude were surveyed after an intensive reconnaissance. There were 214 sightings from evergreen and *shola* forests during the study. They were found to prefer *shola* forests to other vegetation types. The species was also found in pine, wattle and tea plantations near *shola* forests. Although it was found to prefer an altitude above 1,500 m, it was also found in *shola* forests between 1,000 and 1,500 m elevations. White-bellied Shortwing was found to occupy an elevation range from 1,000 m to 2,200 m. Encounter rates in *shola* forests fragmented by human interference were four times higher than those in natural *shola* forests. Most encounters of shortwings were near streams that were wet (running or damp). Emphasis is laid on the need for long-term studies to unravel the basic biology of the species in order to aid active conservation efforts.

Introduction

Five species of shortwings (genus *Brachypteryx*, subfamily Turdinae) exist; four of which are found in the Himalayas. The fifth, the endemic White-bellied Shortwing *Brachypteryx major*, is the only shortwing found in the Western Ghats, South India and has two subspecies: *B. m. major* and *B. m. albiventris*. It has been described as ''a shy and retiring species, affecting deep shades, found singly or in pairs in the undergrowth, rarely above three metres'' (Ali and Ripley 1987). It is known only poorly, with just 78 records from 1881 to 2000, inclusive of both sightings and collections (20 from Kerala and 58 from Tamilnadu). There are also 113 ringing records for four years between 1970 and 1991 (Appendix 1). Although it was reported to be fairly common by Ali and Ripley (1987), there are very few recent records and the species has been listed as Vulnerable (+2a,b,c,d,e; BirdLife International 2001).

Of the various factors that may cause population decline, hunting and direct toxicological effects can be ruled out, as White-bellied Shortwing is neither a

game bird nor one that is found in the proximity of industrialized areas. The most likely cause of the population decline of this species is habitat loss, fragmentation or degradation. BirdLife International (2001) states that the ''species has a small, severely fragmented, declining range owing to destruction and fragmentation of its evergreen and semi-evergreen forest habitat''. Before undertaking a detailed, long-term study to understand the biology and decline of the species, it was thought imperative to know its habitat preferences and abundance in different areas across the Western Ghats. This study therefore aimed to look at: (i) habitat preferences with reference to (a) altitude and (b) forest type; and (ii) abundance in different areas, with particular attention to areas of high local abundance, if any. The study covered the parts of the Western Ghats in Kerala and Tamilnadu as the first phase of a survey to cover the entire Western Ghats.

Methods

The study period consisted of four months of fieldwork, from 25 January to 20 May 2001. Areas with recent, frequent sightings of White-bellied Shortwing were identified from available literature and personal communications with various field biologists (Appendix 1). Two such areas, namely Rajamalai in Munnar, Kerala and Cairnhill Reserve forest in Ooty, Tamilnadu were visited to familiarize the authors with both subspecies of White-bellied Shortwing. For this purpose, observations were conducted from 05h00 to 18h00 every day (logistics permitting) for one week at each site. Once a bird was located and identified, it was followed for as long as possible. The calls were recorded (Sony WM- D6C recorder with Sony microphone) and motion as well as still pictures were taken (Pentax SF7 camera with Zigma 300 mm zoom lens, Sharp video camera). Peak activity time was noted as the time when most shortwings were singing. The survey commenced only after obtaining confidence that the bird could be identified by sight or call without confusion.

For the full surveys, several forest areas in Kerala and Tamilnadu were chosen, representing different habitats at different elevational gradients (Appendix 2). Trails inside forests were walked in the morning (07h00 to 12h00) and afternoon (14h00 to 18h00) while looking and listening for shortwings. The habitats sampled were categorized into tropical wet evergreen forest (evergreen forest), montane temperate forest (*shola* forest), tropical moist-deciduous forest, or plantations, based on Champion and Seth (1968). The montane temperate forests have been better described as montane evergreen forests (Mehr-Homji 1984, Shanker and Sukumar 1999) and are locally known as ''*shola* forests'' (hereafter referred to as *shola* forests). Altitude (using an altimeter) and habitat type were recorded every 0.5 km, and distance walked measured with a pedometer. Once a sighting (visual or audio) was made, the pedometer reading from the starting point was noted. Altitude and GPS location were also noted for every sighting (whenever possible). The bird was recorded by call only when it could be identified with confidence. While recording the number of individuals using just calls, only the number of individuals heard at the same time were recorded in order to avoid duplication or over counting.

Many species of Turdinae are associated with streams and to quantify this for the shortwing, the distance to the nearest stream from the point of sighting was

recorded. The stream, when present was classified into wet (running or damp) or dry.

Data analysis

Encounter rate (ER) was calculated as the number of individuals seen per km walked. The sightings were classified into three elevation classes: <1,000 m, 1,000–1,500 m and >1,500 m. The vegetation was categorized into four broad types: evergreen forest, moist-deciduous forest, *shola* forest and plantations. The three plantation types, pine, wattle and tea were pooled together as ''plantations'' for the analyses. Mann–Whitney *U*-tests were used to test for significant differences in encounter rates across various categories of elevation and vegetation. For applying the Mann–Whitney U-test, the data recorded for each category (elevation/vegetation type) were subdivided into sampling units of 0.5 km. To assess the proximity of streams to shortwing sightings, all sightings were classified under the following categories of distance to the nearest stream: (i) under 20 m , (ii) between 20 and 50 m and (iii) over 50 m. The null hypothesis of no difference between the categories was tested for every pair of categories using Chi-square tests. Preference for wet or dry streams was also examined using Chi-squared tests. All analyses were done using Statistica kernel release 5.5 and Microsoft Excel.

Mapping

The Survey of India maps of 1:100,000 were used as base maps. Areas with an elevation of 900 m and 1,500 m were generated from this. The forest cover in different areas was mapped based on Gaussen *et al*. (1961). MapInfo Professional version 5.0 and Arc View GIS version 3.0 were used for handling the maps.

Results

A total distance of 436.5 km was surveyed across the four broad habitat types: evergreen forest, moist-deciduous forest, *shola* forest and plantations, covering an elevational range of 60 m to 2,400 m. Four National Parks, seven Wildlife Sanctuaries, two Tiger Reserves and nine Forest Reserves were covered across Kerala and Tamilnadu during the study period (Appendix 2). A total of 214 sightings of the shortwing were obtained during the study.

Vegetation types

The sampling effort in different vegetation types was not equal as the focus was on covering as much forest as possible in different parts of the two states (Figure 1). Only 39 White-bellied Shortwing sightings (18% of the total) were in evergreen forests, even though the highest sampling effort was made here (307 km, or 70% of the total). Contrastingly, the maximum number of sightings (171, 79.5% of the total) were from 72.5 km (17%) of *shola* forests. Thus, sightings per unit effort were significantly higher in *shola* forests than in evergreen forests (Mann–Whitney *U*-test: $n = 614, 145$; $Z = -17.91$; $P < 0.01$). There were no sightings in

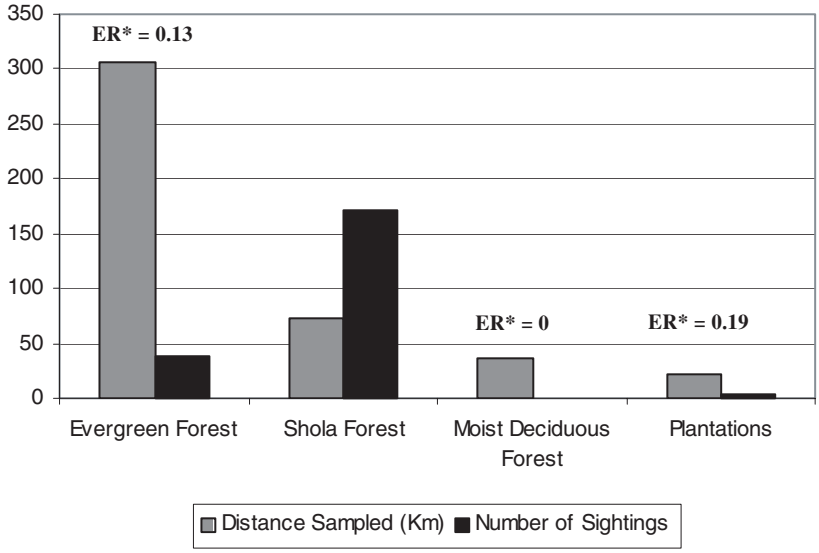

Figure 1. Sightings and sampling effort of White-bellied Shortwing in different vegetation types in Kerala and Tamilnadu (January 2001 to May 2001). ER, encounter rate (number of sightings per km).

moist-deciduous forest and there were only four sightings from all plantation types pooled together.

Elevational gradient

A considerable range in elevation across different vegetation types was surveyed. Evergreen forest was surveyed from 60 m and 1,550 m, *shola* forest from 1,200 m to 2,400 m, moist-deciduous forest from 600 m to 900 m and plantations from 1,680 to 2,000 m. Sightings of White-bellied Shortwing were grouped into different elevation categories (Figures 2 and 3). There were no sightings in forests up to 1,000 m although the highest sampling effort (303.5 km, 69.5%) was in this region. In forests between 1,000 m and 1,500 m 14 sightings (6.5% of the total) resulted from 37 km of survey (8.5%). In forests above 1,500 m, 200 sightings were made from 96 km (i.e. 93% of all sightings were from 22% of the sampling effort). A significantly greater number of sightings were made in forests above 1,500 m than in forests between 1,000 m and 1,500 m (Mann–Whitney *U*-test: $n = 74, 192$; $Z = -7.67$; $P < 0.01$). White-bellied Shortwing was found to occupy an elevation range from 1,200 to 2,200 m. The highest point in the survey area was 2,695 m (Anaimudi peak) and the highest elevation sampled was 2,400 m.

Habitat

Sightings of White-bellied Shortwing were segregated further according to both vegetation type and altitude in order to examine the effect of habitat (Table 1).

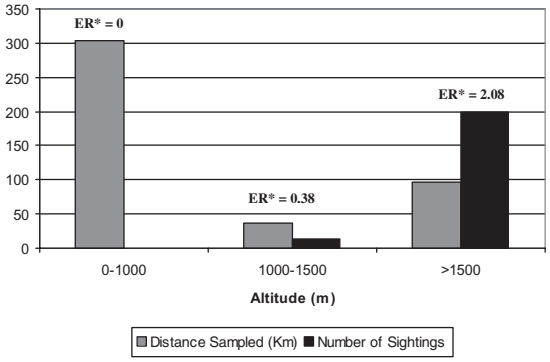

Figure 2. Sightings and sampling effort of White-bellied Shortwing in different altitudinal ranges in Kerala and Tamilnadu (January 2001 to May 2001). ER, encounter rate (number of sightings per km).

Evergreen forest Of the 307 km of evergreen forests surveyed, 87% (268 km) were between 0 and 1,000 m. This formed 88% of all habitats sampled between 0 and 1,000 m. There were no sightings in this region. Between 1,000 and 1,500 m there were 11 sightings (27% of all sightings in evergreen forest across different elevations), forming 79% of all sightings in this elevation range across different vegetation types. There were 28 sightings in evergreen forests greater than 1,500 m, which formed 70% of all sightings in evergreen forest but only 14% of all sightings across different habitats in this elevation. Encounter rates were highest in this region of evergreen forests: the number of sightings in evergreen forests above 1,500 m elevation was significantly greater than that between 1,000 and 1,500 m (Mann–Whitney *U*-test: $n = 19, 60$; $Z = -6.06$; $P < 0.01$).

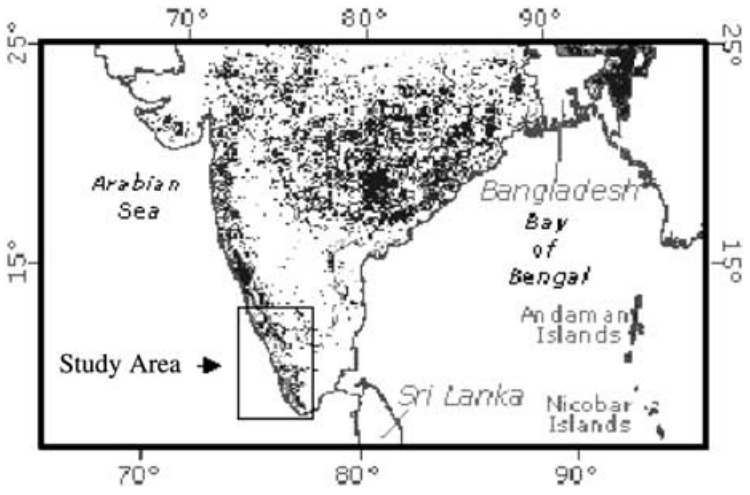

Figure 3(a). Study area location.

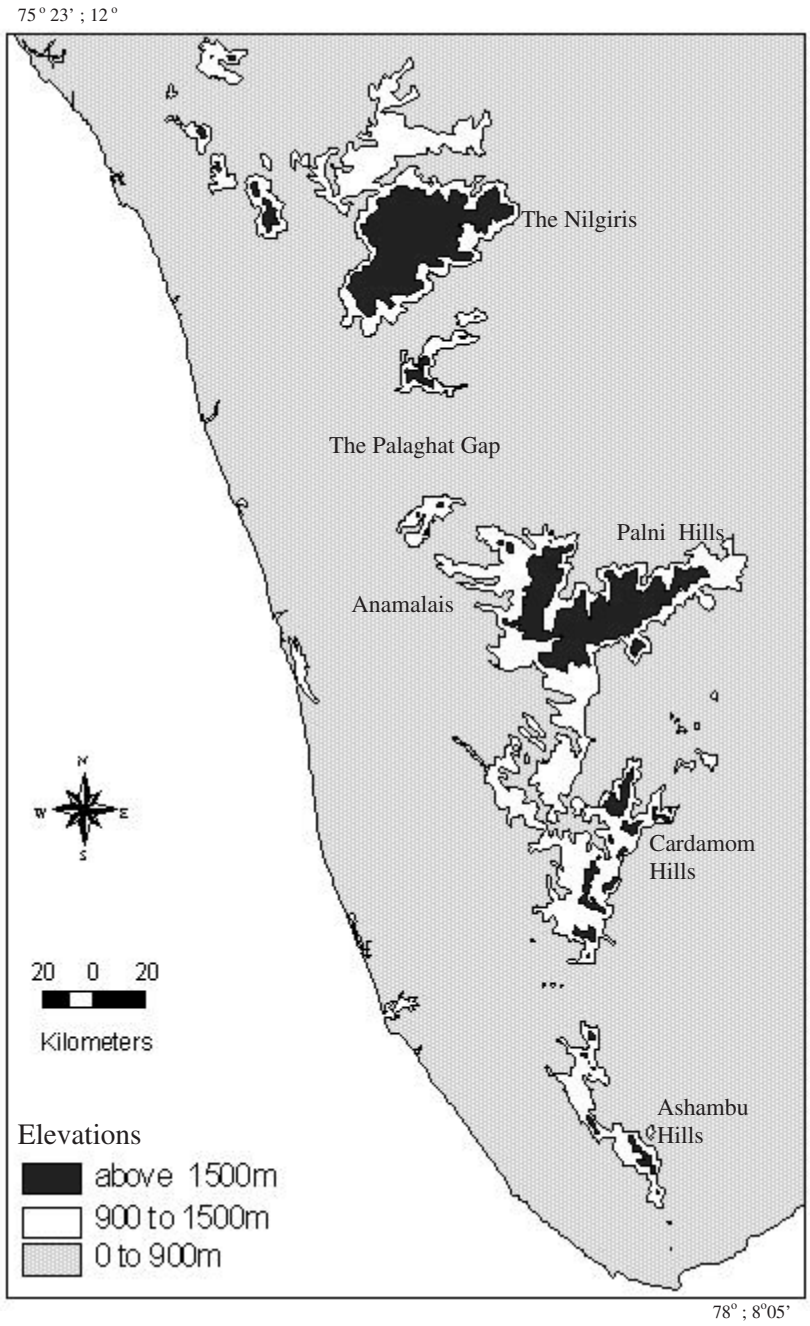

Figure 3(b) Elevation regimes of the Western Ghats of Kerala and Tamilnadu.

Table 1. Sightings of White-bellied Shortwing in different habitats (altitudinal ranges and vegetation types) in Kerala and Tamilnadu (January 2001 to May 2001)

Altitude classes (m)	Vegetation Types											
	Evergreen forest			*Shola* forest			Moist-deciduous forest			Plantations		
	Distance sampled (km)	Number of sightings	ER	Distance sampled (km)	Number of sightings	ER	Distance sampled (km)	Number of sightings	ER	Distance sampled (km)	Number of sightings	ER
0–1,000	268	0	0	–	–	–	36	0	0	–	–	–
1,000–1,500	30	11	0.4	7	3	0.4	–	–	–	–	–	–
>1,500	9.5	28	3	66	168	2.6	–	–	–	21	4	0.2

ER, encounter rate.

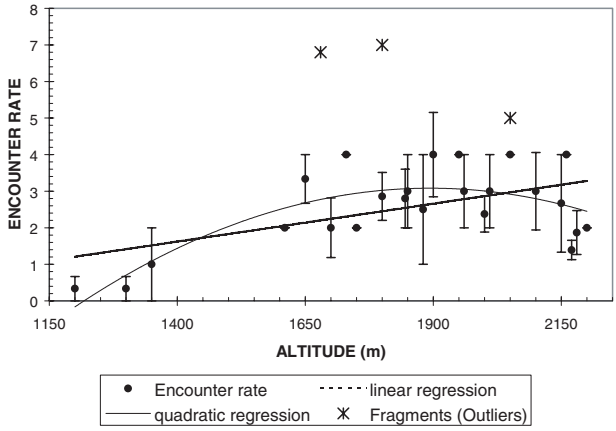

Figure 4. Encounter rate of White-bellied Shortwings in Sholas with respect to altitude in Kerala and Tamilnadu (January 2001 to May 2001). Encounter rate = a * (altitude (m))^2 + b * Altitude (m) + c ; where a = $-6.75*10^{-6}$, b = 0.02551, c = −21.111; R^2 = 0.57475.

Shola forest There were only three sightings in the *sholas* between 1,000 and 1,500 m, but most sightings (168), were in the *sholas* above 1,500 m. This formed 98% of all sightings in the *sholas*, 84% of all sightings in this elevation range, and 78% of all sightings. The number of sightings in the *sholas* above 1,500 m was significantly higher than that in *sholas* between 1,000 and 1,500 m (Mann–Whitney *U*-test; n = 132, 6; $Z = -0.35$; $P > 0.01$).

A comparison of encounter rates showed that in spite of the higher percentage of sightings in evergreen forests between 1,000 m and 1,500 m, *shola* forests had a marginally higher encounter rate, but this was not statistically significant (Mann–Whitney *U*-test: $Z = -0.985$, $P = 0.324$). The number of sightings in *sholas* above 1,500 m was also not significantly higher than that in evergreen forests above 1,500 m (Mann–Whitney *U*-test: $Z = -0.972$, $P > 0.2$).

Moist-deciduous forest and plantations There were no sightings of White-bellied Shortwing in moist-deciduous forests. All the moist-deciduous forest sampled was below 1,000 m. Plantations had four sightings, with one sighting each in tea plantation and pine plantation and two in wattle plantation. All sampling and sightings of White-bellied Shortwing in the plantations were above 1,500 m.

Polynomial regression The relationship between the shortwing sightings in *shola* forests and elevation was analysed using polynomial regression. The data are best described by a quadratic equation (Figure 4). All coefficients a, b and c (see Figure. 4) were significantly different from zero (*t*-test, $P < 0.01$, ANOVA, *F*-test, $P < 0.01$). The optimal elevation for shortwing sightings from the quadratic regression equation was 1,890 m. Four outliers were removed before fitting the curve. Three of these areas were isolated fragments of forests and one was a barren peak without forests above 2,200 m.

Table 2. Encounter rate of White-bellied Shortwing in large forests in Kerala and Tamilnadu (January 2001 to May 2001)

Areas	Distance sampled (km)	Number of sightings	ER	Mean ER
Munnar[a]	13	27	2.08	1.58 ± 1.26
Kodaikanal[a]	31.5	37	1.17	
Indira Gandhi Wildlife Sanctuary[a]	62.5	64	1.02	
Ooty[a]	3	11	3.67	
Upper Bhavani[a]	14	25	1.79	
Kothagiri[a]	6.5	18	2.77	
Kalakkad Mundanthurai Tiger Reserve[a]	42.5	1	0.02	
Peppara Wildlife Sanctuary[a]	16	2	0.13	
Rajamalai[b]	2.5	17	6.80	
Bombay Shola[b]	1	5	5.00	6.26 ± 1.1
Cairnhill Reserve Forest[b]	1	7	7.00	

[a]Large forests.
[b]Fragmented forests. ER, encounter rate.

Sightings of White-bellied Shortwing in different locations

Location-wise classification of sightings (Appendix 2) according to elevation ranges and habitats revealed that some areas, such as Parambikulam Wildlife Sanctuary and Indira Gandhi Wildlife Sanctuary (IGWS) had *shola* forests between 1,000 m and 1,500 m but there were no sightings in these regions. All the sightings of White-bellied Shortwing in evergreen forests were from one site, Akkamalai in IGWS. Three areas, namely Munnar, IGWS and Upper Bhavani had the highest number of sightings. These areas, along with three other areas, namely Kodaikanal, Ooty and Kothagiri contributed 207 of the 214 sightings.

The isolated fragments of forest with high encounter rates were all *shola* forests. Sightings in these forests were examined and the mean encounter rate was found to be 6.27 ± 1.1. This was significantly greater than that for large forests (1.58 ± 1, Mann–Whitney *U*-test: $n = 9, 378$; $Z = -3.965$; $P < 0.01$) (Table 2). Areas with White-bellied Shortwing sightings were mapped with elevation gradient and forest cover as the prime areas (Figure 5). The Cardamom Hills were not sampled because of logistical difficulties, however this area is known to support White-bellied Shortwings (A. Robertson, P. Padmanabhan pers comm.) though further information is not available.

Occurrence of the two subspecies of White-bellied Shortwing

Ali and Ripley (1987) mentioned that the two subspecies *B. m. major* and *B. m. albiventris* occupy different geographical zones. All sightings of *B. m. albiventris* were from the south of the Palakkad Gap while those of *B. m. major* were from north of it. The sightings were classified according to the geographical ranges. From the 65.5 km sampled in areas north of Palakkad Gap, 61 sightings of *B. m. major* were obtained while 153 sightings of *B. m. albiventris* were obtained from 371 km sampled south of Palakkad Gap.

Classification of these geographical regions by altitude and vegetation revealed

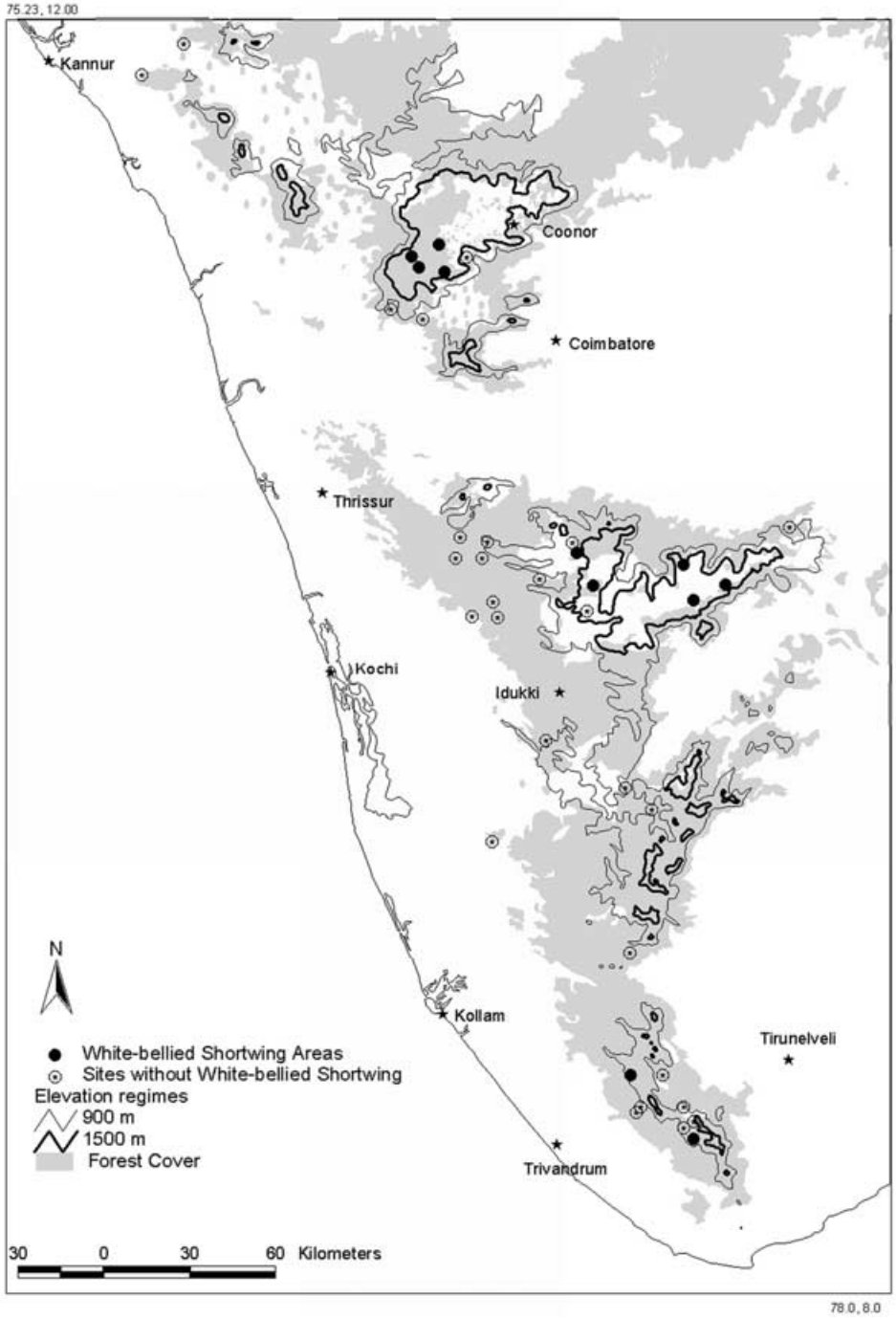

Figure 5. Prime white-bellied Shortwing areas in Kerala and Tamilnadu (January 2001–May 2001).

that most sightings of both the subspecies were from *shola* forests above 1,500 m in spite of larger sampling efforts in lower elevation forests. There was no disparity in trends between the two subspecies, except that there was no sampling between 1,000 and 1,500 m in the areas south of the Palakkad Gap (for details see Robin 2001). The mean encounter rate for *B. m. major* was 2.49 individuals per kilometre and 1.59 ± 1.38 for *B. m. albiventris* using only favourable habitats for shortwing in calculating encounter rates. A comparison of the encounter rates of the two subspecies revealed no significant difference (Mann–Whitney *U*-test; $n = 59, 175$; $Z = -2.041$, $P > 0.1$).

Presence of stream

The effect of the presence of a stream on the distribution of White-bellied Shortwing was investigated by grouping sightings into classes based on the proximity to streams. The number of sightings within 20 m of a stream (98, or 63.2%) was significantly greater than would be expected by chance compared with sightings within 20–50 m of a stream (33 sightings, 21.3%; $df = 1$; $\chi^2 = 32.25$; $P < 0.001$), and compared with sightings greater than 50 m from a stream (24 sightings, 15.48%; $df = 1$; $\chi^2 = 44.89$, $P < 0.001$). The number of sightings within 20–50 m was not significantly different from what would be expected by chance compared with 20–50 m from a stream ($df = 1$; $\chi^2 = 1.42$; $P > 0.05$). Of all sightings, 146 (83.43%) were near streams that were wet, significantly more than would be expected by chance compared with sightings near dry streams (29 sightings, 16.57%: $df = 1$; $\chi^2 = 78.22$; $P < 0.001$).

Discussion

The number of sightings of White-bellied Shortwing from this study (214), compared with previously documented records (78 sightings and specimens from 1881 to 2000 and 113 ringing records from four years between 1970 and 1991), shows that this species has largely escaped the attention of previous studies. It may be noted, however, that the previous records mentioned above do not include Dr Salim Ali's records, who described this species to be ''fairly common'' (Ali and Ripley 1987).

There is considerable ambiguity and contradiction in comments by various authors on the status of the species (BirdLife International 2001), with confusion compounded by ambiguous descriptions of the bird's behaviour. Betham (1902 in BirdLife International 2001), for example, described the call of the male White-bellied Shortwing as a ''pretty low song, which is not very easily heard''. In this study, however, the call was found to be audible even at distances of 50–70 m inside the forest, while in *shola* patches it could be heard on grassland up to 100–120 m away. As the current study was conducted only in one season, it is not known if the song is prevalent in all seasons.

Although the maximum sampling effort was in forests of lower elevations, there were no sightings in this habitat. White-bellied Shortwing seemed to prefer altitudes above 1,500 m although it was also found in forests between 1,000 m and 1,500 m. There have been reports of White-bellied Shortwing from elevations as low as 250 m from Pooyankutty and 950 m at Thekkady (BirdLife International

2001). Although these areas were also covered in the present study, no sightings were obtained. Zacharias and Gaston (1999 in BirdLife International 2001) listed White-bellied Shortwing as 'rare' at Thekkady, and it might be possible that there are sporadic altitudinal movements from forests at higher elevation adjoining these areas.

White-bellied Shortwing showed a preference for *shola* forests and evergreen forests above 1,500 m, and no sightings were made in moist-deciduous forest, plantations or evergreen forest below 1,000 m. Although it is evident that most habitats above 1,500 m support White-Bellied Shortwing, very few sightings were made in plantations in this elevation range. The only sightings in plantations were from areas close to *sholas*. All sightings of White-Bellied Shortwing in evergreen forests were from one location, Akkamalai, where *shola* forest is contiguous with it.

The polynomial regression showed that there was an increase in the number of sightings with an increase in elevation. The quadratic regression indicated that the encounter rate of the shortwings increased with altitude reaching a peak at 1,890 m before decreasing. This could have been because there were fewer patches of forest and more grassland in the forest–grassland mosaic of *shola* forest with an increase in elevation (especially above 2,100 m). Most areas above 2,100 m were barren grassland peaks without forests. However there was site-specific variation for such factors. The shortwing was found to occupy an elevation range of 1,000 m (1,200 m to 2,200 m). Terborgh (1971) mentions that species found in higher elevations tend to occupy a wider elevation range. Although this might be true considering the records from 250 m at Pooyankutty, Kerala (Aziz *et al.* 1999 in BirdLife International 2001) to 2,200 m, the preference is for *shola* forests above 1,500 m.

The comparison of sightings in different locations showed that no sightings came from *sholas* and evergreen forest between 1,000 and 1,500 m in Varagaliar, IGWS and Parambikulam Wildlife Sanctuary. These areas were hilltops with naturally isolated small *shola* patches. The foothills of these areas were around 600 m with moist-deciduous forest and evergreen forest. This suggests that not all *sholas* between 1,000 and 1,500 m had White-Bellied Shortwing and there might be a requirement of a minimum contiguous area of *shola*. MacArthur (1972) indicated, with an example from the study of Diamond (1970), that a species of flower pecker, *Melanocharis longicauda* was absent from small isolated mountains while it was present in large mountain ranges. However, this was cited as an example of congeneric competition. White-bellied Shortwing does not have any congeners in the Western Ghats.

Contrary to the absence of White-bellied Shortwing from naturally isolated forests, patches of forests isolated by human impacts like the Bombay Shola in Kodaikanal, Cairnhill Forest in Ooty and Rajamalai in Munnar, had very high encounter rates. This is probably due to the lack of opportunity for dispersal from the isolated fragments. Although natural *shola* forests occur as a mosaic of forest patches and grassland, White-Bellied Shortwings were observed moving between these patches. This dispersal would have been restricted by human impact and hence the higher encounter rates in isolated, fragmented *shola* forests. It must be noted that this information is subjective and should be investigated by studying marked individuals to draw stronger conclusions.

There were significantly more sightings of shortwings near wet streams than away from them. The undergrowth and the presence of a wet stream seem to be the nuclear habitat for White-Bellied Shortwing. Perennial streams are also one of the characteristics of high-elevation forests whether it is evergreen or *shola* forest. This further supports the idea that White-bellied Shortwing prefers this habitat. This apparent preference could be driven by selection of insect prey found under such microclimatic conditions, or by the availability of nest material found there, or by both. Large amounts of moss were used as nesting materials in two nests that were observed during this study (Robin 2001), which might indicate that a specific microclimate is required for the species survival. The shortwing would hence prefer *sholas* but might occupy other secondary habitats when present next to the preferred habitats.

Need for conservation

Continuous habitat loss by alteration of forests for various purposes has brought about extensive damage and fragmentation of forests in the Western Ghats, with a loss of 25.6% of the forest cover in the last two decades (Jha *et al.* 2000). India has lost 30% of its forests in the last few decades (Kothari 1994) and continues to loose 0.28% of forest every year (Prasad 1998). There has been a loss of 50% of *shola* forests since 1850 (Sukumar *et al.* 1995). Understorey birds are known to be the most sensitive to disturbances in the forest structure as most are adapted to specific microhabitat conditions there (Wong 1985). White-bellied Shortwing, as a clear occupant of this niche, requires conservation attention for the same reasons. Bearing the current threatened status of White-bellied Shortwing in mind, it may also be noted that an incomplete understanding of the habitat ecology of a species can lead to erroneous conservation efforts (Fred *et al.* 2000).

Therefore, apart from a call for a comprehensive description and documentation of the basic biology of White-bellied Shortwing, there are a few specific issues that might require attention: (a) an investigation into whether they breed in the lower altitude (below 1,300 m) part of the range or whether these records represent movements from other areas; (b) the estimation and monitoring of White-bellied Shortwing populations in natural and isolated, fragmented forests; (c) a thorough study of the foraging and breeding behaviour of the species, establishing the specific microhabitat requirements; (d) an investigation of the altitudinal restriction of this and other members of the Turdinae, to understand if there is competition between species; (e) an investigation of depredation rates at nests; and (f) an assessment of ecological and behavioural changes, if any, when four congeneric species of shortwing occur together as in north-east India. The next immediate step proposed is to document the range of the shortwing in other parts of the Western Ghats (Karnataka and Goa) from where there have been only seven records in the past 119 years.

Acknowledgements

This study was carried out while the first author was a visitor at the Centre for Ecological Sciences, Indian Institute of Science, Bangalore. Both authors would like to thank Wildlife Conservation Society, India programme for funding the study and the forest Departments of Kerala and Tamilnadu for extending their support and cooperation towards this study. The first author would like to acknowledge: Centre for Wildlife Studies, where the first author was also a Research Associate, for providing institutional support during the course of the study. Dr N. V. Joshi, for a lot of his patience, time and help with the analysis, proof reading and at several other stages of the project; Dr P. K. Vijaykumar Nair for his kindness and help with the production of the maps; Dr Arun Venkataraman, Mr Bharath Sundaram and Mr Saandeep Kashyap for helping me with the maps and for their interest in the study; Dr Ullas Karanth, Mr T. R. Shankar Raman, Dr Stuart Pimm, Dr Lalitha Vijayan, Dr V.S. Vijayan, Mr N. Samba Kumar and Ms Nandini Rajamani for discussions, suggestions and help; everyone at CES for discussions, help and support in many ways; various field assistants for their help; several people (mentioned in Appendix 1), especially Mr Krys Kazmeirczak, Mr Andrew Robertson, Mr Clive Harris for parting with their sightings on Shortwings and providing valuable input.

Appendix 1: List of previous sightings of White-bellied Shortwing in Kerala and Tamilnadu.

Year	No.	Place	Comment	Reference
		KERALA		
1880–1998	20	Many locations	Sightings and specimens	BirdLife International, 2001
		TAMILNADU		
1881–1997	50	Many locations	Sightings and specimens	BirdLife International, 2001
1970, 1982, 1984, 1991	133	Palni Hills	Ringing records	BNHS (in BirdLife International, 2001)
Mar. 1983	1	High Wavies	Sighting	A. Robertson *in litt.*[a]
Jan. 1991	3	Ooty	Sighting	Kazmierczak, K.[a]
?	?	High Wavies	Sighting	Padmanabhan, P.[a]
Jan. 1991	3	Avalanche	Sighting	Kazmierczak, K.[a]
2000	?	Anamalai (IGWS)	Sighting	Raman, T.R.S.[a]
?	1	Sengaltheri (KMTR)	Sighting	Raman, T.R.S.[a]

[a]Pers comm. 2000.
IGWS, Indira Gandhi Wildlife Sanctuary; KMTR, Kalakkad Mundanthurai Tiger Reserve.

Appendix 2: Sightings and sampling effort of White-bellied Shortwing at different locations in Kerala and Tamilnadu (January 2001 to May 2001).

		Vegetation						
		Evergreen forest			*Shola* forest		Moist-deciduous forest	Plantations
		Altitude			Altitude		Altitude	Altitude
		0–1,000 m Sum	1,000–1,500 m Sum	>1,500 m Sum	1,000–1,500 m Sum	>1,500 m Sum	0–1,000 m Sum	>1,500 m Sum
Munnar	Km[a]	.	.	.	.	15	.	5.5
	No.±	.	.	.	.	43	.	1
Kodaikanal	Km[a]	.	.	.	.	17	.	15.5
	No.±	.	.	.	.	39	.	3
Indira Gandhi Wildlife Sanctuary	Km	29.5	12.5	9.5	2	9	.	.
	No.±	0	11	28	0	25	.	.
Ooty	Km	.	.	.	.	4	.	.
	No.±	.	.	.	.	18	.	.
Upper Bhavani	Km	.	.	.	.	14	.	.
	No.±	.	.	.	.	25	.	.
Kothagiri	Km	.	.	.	.	6.5	.	.
	No.±	.	.	.	.	18	.	.
Kalakkad Mundanthurai Tiger Reserve	Km	24	17.5	.	1	.	.	.
	No.±	0	0	.	1	.	.	.
Achankoil	Km	15	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Aralam Wildlife Sanctuary	Km	4	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Chalakudy	Km	4	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
High Forest	Km	2	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Idukki	Km	19	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.

Appendix 2: *Continued*

		Vegetation						
		Evergreen forest			*Shola* forest		Moist-deciduous forest	Plantations
		Altitude			Altitude		Altitude	Altitude
		0–1,000 m Sum	1,000–1,500 m Sum	>1,500 m Sum	1,000–1,500 m Sum	>1,500 m Sum	0–1,000 m Sum	>1,500 m Sum
Neyyar Wildlife Sanctuary	Km	.	.	.	.	.	9	.
	No.±	.	.	.	.	.	0	.
Parambikulam Wildlife Sanctuary	Km	11	.	.	2	.	.	.
	No.±	0	.	.	0	.	.	.
Pooyankutti	Km	13	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Ranni	Km	25	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Shendurny	Km	10	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Sholayar	Km	26	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Silent Valley National Park	Km	28	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Thattekad Bird Sanctuary	Km	33	.	.	.	.	.	.
	No.±	0	.	.	.	.	.	.
Periyar Tiger Reserve	Km	10	.	.	.	.	18	.
	No.±	0	.	.	.	.	0	.
Wynad Wildlife Sanctuary	Km	.	.	.	.	.	9	.
	No.±	.	.	.	.	.	0	.
Peppara Wildlife Sanctuary	Km	14	.	.	2	.	.	.
	No.±	0	.	.	2	.	.	.

[a]Distance sampled.
[b]Number of sightings.

References

Ali,S. and Ripley, S. D. (1987) *Compact handbook of the birds of India and Pakistan.* Bombay and Oxford: Oxford University Press.

BirdLife International. (2001) *Threatened birds of Asia: the BirdLife International Red Data Book.* Cambridge, U.K.: BirdLife International.

Champion, H.G . and Seth, S. K. (1968) *A revised survey of the forest types of India.* Government of India.

Diamond, J. M. (1970) Ecological consequences of island colonization by southwest Pacific birds, I. Types of niche shifts. *Proc. Nat. Acad, of Sci. USA.* 67: 529–536.

Fred, S. G., Nina, M. K., Nolte, K. R. , Kuvlesky, W. P., Jr., DeStefano, S., Gall, S. A., Silvy, N. (2000). Comparative habitat ecology of Texas and Masked Bobwhites. *J. Wildl. Manag.* 64: 407–420.

Gaussen, H., Legris, P., Viart, M., Meher-Homji, V. M., Shankaranarayan, K. A., Dhabolkar, M. V. and Gupta, R. K. (1961) *International map of vegetation: Cape Comorin.* The Indian Council for Agricultural Research and The French Institute of Pondicherry.

Jha, C. S., Dutt, C. B. S. and Bawa. K.S. (2000) Deforestation and land use changes in the Western Ghats, India. *Curr. Sci.* 80: 378–388.

Kothari, A. (1994) People's participation in biodiversity conservation in India. Pp. 137–145 in A. F. Krattiger, J. A. McNeely, W. H. Lesser, K. R. Miller, Y. St. Hill and R. Senanayabe, eds. *Widening perspectives in biodiversity*. International Academy of the Environment and IUCN – The World Conservation Union.

MacArthur, R, H. (1972) *Geographical ecology. Patterns in distribution of species.* Princeton, NJ: Princeton University Press.

Mehr-Homji, V.M. (1984) Udhagamandalam (Ootacamund): A biogeographic perspective. *Ind. Geogr. J.*, 59: 205–213.

Prasad, S. N. (1998) Conservation planning for the Western Ghats of Kerala, II. Assessment of habitat loss and degradation. *Curr. Sci.*: 75: 228–235.

Robin, V.V. (2001). Status and habitat utilisation of the threatened White-bellied Shortwing in the Western Ghats (Kerala and Tamil Nadu). Technical Report submitted to the Wildlife Conservation Society, India Programme.

Shanker, K. and Sukumar, R. (1999) Synchrony in small mammal populations of montane forest patches in southern India. *J. Anim. Ecol.* 68: 50–59.

Sukumar, R., Suresh, S. H. and Ramesh, R. (1995) Climate change and its impact on tropical montane ecosystems in southern India. *J. Biogeogr.*. 22: 533–536.

Terborgh, J. (1971) Distribution on environmental gradients: theory and a preliminary interpretation of distributional patterns in the avifauna of the Cordilleria Vilcabamba, Peru. *Ecology* 52: 23–40.

Wong, M. (1985) In A. W. Diamond and T. E. Lovejoy, eds. *Conservation of tropical birds.* Cambridge, U.K.: International Council for Bird Preservation. (Tech. Publ. 4).

V. V. ROBIN and R. SUKUMAR
Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India. 560012,
E-mail: robinvvijayan@yahoo.com

Received 2 November 2001; revision accepted 24 July 2002