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Distribution, ecology and conservation of the White-bellied Woodpecker *Dryocopus javensis* in the Western Ghats, India

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Twenty-nine sites in the Western Ghats, India, between Surat Dangs (Gujarat) and Kalakkad-Mundanturai (Tamil Nadu) were surveyed in 1995–1996 for White-bellied Woodpecker *Dryocopus javensis*. A total of 26 sightings of 47 birds were recorded at 15 sites. There were more sightings from moist deciduous forests (including plantations) than from evergreen/semi-evergreen forests. Sites with White-bellied Woodpeckers had significantly taller and broader trees than sites where the species was absent. Although 81% of sightings were in protected areas, only 31% of these were from sites relatively free from human disturbance. A total of 11 nest-trees were found, averaging 18.5 (± 4.2) m tall, and 59.1 (± 14.5) cm diameter at breast height. Nest cavities were 11.7 (± 2.3) m high, and the diameter at nest height was 37.6 (± 11.5) cm. Survey results plus information from naturalists, forest officials, and tribal people indicate that the White-bellied Woodpecker is fairly uniformly distributed from Goa to the southern tip of the Western Ghats, but there are no recent authentic reports from Maharashtra. In addition, a small population remains in the highly fragmented forests of Surat Dangs (Gujarat). The mean population density was 0.24 birds/km^2, from which a population of c.4,800 individuals is estimated for the Western Ghats. Dead or dying trees are essential for the survival of this species, and large areas of forest need to be protected if it is to be conserved.

INTRODUCTION

The White-bellied Woodpecker is resident in peninsular India and South-East Asia, east to the Philippines, and south to the Greater Sundas, with an isolated population in Korea (Winkler and Christie 2002). In India, it occurs chiefly in the humid hill tracts of Western Ghats, in south-west India (Short 1982, Ali and Ripley 1983). Elsewhere, it has been reported from south-east Madhya Pradesh and the northern part of the Eastern Ghats (Ali and Ripley 1983, Ripley *et al*. 1987). Very little is known about the current status of this woodpecker and there are no detailed studies on it. As a large woodpecker, having specialised foraging and nesting requirements (large dead trees in mature forest) and large territories (Short 1973), it is likely to be particularly sensitive to large-scale degradation of its habitat. Therefore, a survey of this species was carried out in the Western Ghats to

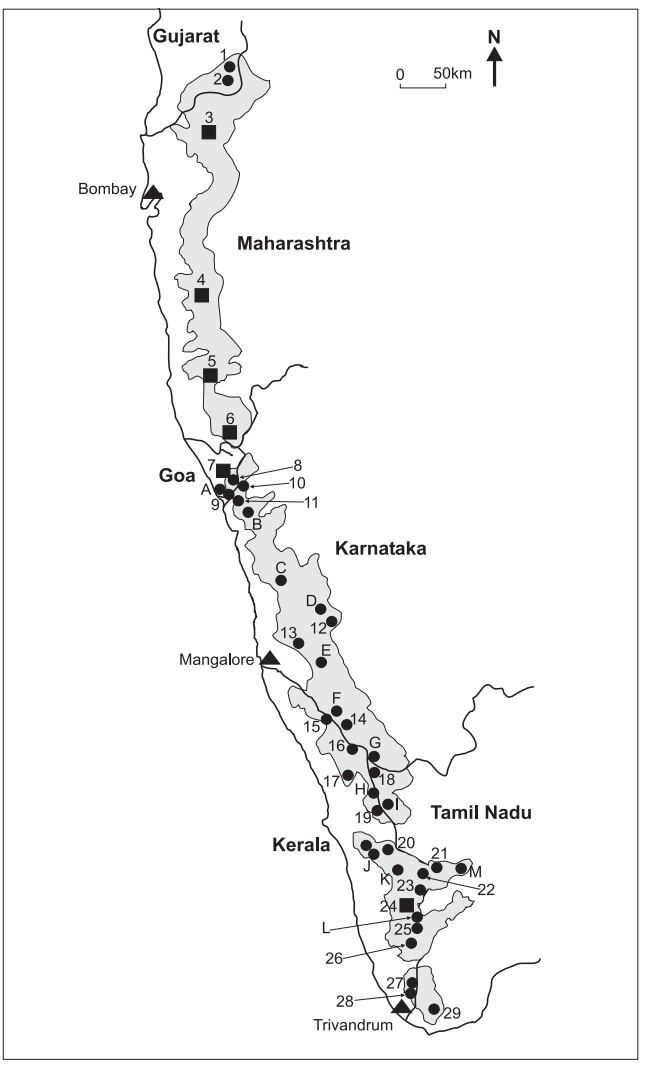

Figure 1. Location of survey sites. Circles indicate sites where White-bellied Woodpeckers were recorded; squares indicate sites where woodpeckers were not recorded; numbers correspond to sites 1–29 in Table 1; letters refer to following sites where the species has been recorded by other observers (Santharam 1995b): A: Cancona RF (GO) 15°01´N 74°01´E; B: various sites in north Kanara district (KN) 14°31´N 74°54´E; C: Sharavati WLS (KN) 14°18´N 74°55´E; D: Shimoga/Gudavi (KN) 13°56´N 75°38´E; E: Kudremukh WLS (KN) 13°10´N 75°15´E; F: Dubari RF (Coorg) (KN) 12°26´N 75°47´E; G: Bandipur NP (KN) 11°41´N 76°34´E; H: Silent Valley NP (KL) 11°08´N 76°25´E; I: Siruvani RF (TN) 11°00´N 76°58´E; J: Peechi Vazhani WLS (KL) 10°35´N 76°22´E; K: Chimmoni WLS (KL) 10°25´N 76°30´E; L: Munnar Area (KL) 10°06´N 77°04´E; M: Palani Hills (TN) 10°18´N 77°10´E (abbreviations follow Table 1).

Table 1. Sites surveyed (abbreviations: WLS = Wildlife Sanctuary; RF = Reserve Forest NP = National Park; GU = Gujarat; MH = Maharashtra; GO = Goa; KN = Karnataka; KL = Kerala, TN = Tamil Nadu).

No.	Site name and coordinates	State	Area (km^2)	Area surveyed	Survey effort (hours)	Habitats
1	Purna WLS 21°0′N 73°50′E	GU	160	4.0	23.5	Moist deciduous, teak
2	Bansda NP 20°45′N 73°28′E	GU	25	2.5	16.0	Moist deciduous, teak
3	Tansa WLS 19°34′N 73°15′E	MH	305	5.0	14.0	Dry deciduous; teak
4	Koyna WLS 17°24′N 73°48′E	MH	424	4.0	19.0	Semi-evergreen
5	Radhanagari WLS 16°23′N 74°00′E	MH	372	3.5	4.5	Semi-evergreen
6	Sawantwadi RF 15°54′N 73°52′E	MH	5	2.5	10.5	Moist deciduous, semi-evergreen
7	Bondla WLS 15°35′N 74°00′E	GO	8	3.0	8.0	Moist deciduous, semi-evergreen
8	Mollem WLS 15°20′N 74°00′E	GO	240	6.5	19.25	Moist deciduous, semi-evergreen
9	Cotigao WLS 15°02′N 74°05′E	GO	105	4.0	12.0	Moist deciduous, semi-evergreen
10	Dandeli WLS 15°24′N 74°36′E	KN	834	7.0	31.0	Moist deciduous, semi-evergreen; teak
11	Anshi NP 15°01′N 74°22′E	KN	250	3.0	10.0	Moist deciduous, semi-evergreen
12	Bhadra WLS 13°18′N 75°45′E	KN	492	3.5	18.0	Moist deciduous; teak
13	Someshwara WLS 12°20′N 75°00′E	KN	88	3.5	13.0	Moist deciduous; semi-evergreen
14	Nagarhole NP 12°01′N 76°05′E	KN	572	1.0	7.5	Moist deciduous; teak
15	Brahmagiris RF 12°02′N 75°42′E	KL	100+	4.0	9.75	Semi-evergreen
16	Wynaad WLS 11°38′N 76°24′E	KL	344	6.0	18.0	Moist deciduous; teak; semi-evergreen
17	Nilambur (S) RF 11°20′N 76°30′E	KL	225	3.0	17.75	Moist deciduous; teak; semi-evergreen
18	Mudumalai WLS 11°32′N 76°38′E	TN	321	2.0	12.25	Moist and dry deciduous
19	Siruvani RF 10°50′N 76°38′E	KL	50+	3.5	32.0	Semi-evergreen
20	Nelliampathies RF 10°30′N 76°47′E	KL	50+	2.0	12.0	Moist deciduous
21	Indira Gandhi WLS 10°18′N 77°00′E	TN	840	2.5	9.25	Moist deciduous; semi-evergreen
22	Parambikulam WLS 10°25′N 76°40′E	KL	285	3.0	18.0	Teak; moist deciduous
23	Sholayar RF 10°20′N 76°45′E	KL	70+	4.5	18.5	Semi-evergreen; evergreen
24	Idukki WLS 9°54′N 77°00′E	KL	70	3.0	12.0	Semi-evergreen
25	Periyar Tiger Reserve 9°26′N 77°00′E	KL	777	4.5	17.0	Moist deciduous; semi-evergreen
26	Ranni RF 9°20′N 77°10′E	KL	500+	5.0	21.0	Moist deciduous; semi-evergreen
27	Arippa/Ponmudi RF 8°45′N 77°10′E	KL	100+	5.0	18.0	Moist deciduous; semi-evergreen
28	Peppara WL S8°38′N 77°12′E	KL	53	1.5	5.5	Moist deciduous
29	Kalakkad-Mundanturai Tiger Reserve 8°30′N 77°23′E	TN	791	5.0	13.5	Moist deciduous; evergreen

determine its present distribution, status, and habitat requirements in order to help in developing management strategies for its conservation.

The Western Ghats, which run along the western coast of India, extend 1,500 km from 22°N to 8°N, and cover an area of 160,000 km^2. The hills extend from the coast, rise to an average elevation of 900–1,500 m above sea level, and descend to the dry Deccan plateau to the east. Apart from the 30 km Palghat Gap in Kerala, the hill ranges are continuous (Rodgers and Panwar 1988, Nair 1991). The topography and the rainfall gradient produce a wide range of forest habitats including evergreen, semi-evergreen, moist deciduous, dry deciduous and thorn forests, as well as grasslands and shola (montane evergreen) forest at higher altitudes. The Western Ghats have been recognised as a biodiversity hotspot (Myers 1988) and an Endemic Bird Area (Stattersfield *et. al*. 1998). However, human activities have caused severe loss and degradation of habitats. The region supports a population of over 35 million people, and it is a major area of cash-crop cultivation. The rate of deforestation may be as high as 0.5–1.14% per annum (Chattopadhyay 1985, Menon 1986). Presently, the protected area network covers nearly 10% of total land area of the Western Ghats, and includes several sanctuaries and national parks (Rodgers and Panwar 1988).

METHODS

Field surveys were conducted during January–May 1995 and September 1995 to May 1996 at 29 sites (Table 1, Figure 1). The total area surveyed was calculated from the distance covered and the visibility at each site. All sightings of White-bellied Woodpecker were noted, and the number of individuals, forest type, level of disturbance, and protected status of the site were recorded. A disturbed site was defined as one situated <100 m from human habitation or roads, or one where there were signs of human activities such as tree-cutting or cattle-grazing etc.

When nest-holes were located, the following details were noted: maximum height of the tree, height at which the nest-hole was located (the lowest if there were several), diameter at breast height (DBH), diameter at nest height (DNH, estimated by comparison with the DBH), number of holes, condition of the tree and nest substrate (live or dead), location of hole (trunk/branch), orientation, estimated nest-hole diameter and shape, forest type, human disturbance, and distance to the nearest path or road.

To assess the availability of trees suitable for nesting, 30–50 trees were randomly selected along eighteen 0.5–2.5 km transects. For each tree, the height, DBH and condition (live, dead or live with dead limbs) were noted.

Table 2. Sightings of White-bellied Woodpecker during surveys. Abbreviations: M: moist deciduous forest; S: semi-evergreen forest; E: evergreen forest; T: Teak plantation; P: protected; N: not protected, D: disturbed; U: undisturbed.

Site	Date	Habitat	No. birds	Status	Disturbance	Comments
1. Purna WLS	27–31/10/95	M, T	2	P	D	Calls heard
2. Bansda NP	1–2/11/95	M	1	P	U	Calls heard
8. Mollem WLS	6/12/95	M	2	P	D	Seen near nest tree
9. Cotigao WLS	29/11/95	M	1	P	U	Calls heard
10. Dandeli WLS	29/1/96	T, M	1	N	D	
	31/1/96	M	1	P	D	Heard; old nest tree nearby
	2–3/2/96	S	1	P	D	Calls heard
	2/2/96	M	3	P	D	1 seen calling; 2 near nest tree
11. Anshi NP	1/2/96	S	2	P	U	
	1/2/96	S	1	P	U	Calls heard
12. Bhadra WLS	30/4/96 & 1/5/96	M	2	P	D	1 seen; 1 heard
	30/4/96	M, T	2	P	D	
	1/5/96	M	1	P	D	
13. Someshwara WLS	2/5/96	M, S	1	P	D	
16. Wynaad WLS	17/9/95	T, M	1	P	D	Calls heard
	9/5/96	M	1	P	D	Calls heard
	11/5/96	M	1	P	D	Calls heard
	12/5/96	M	1	P	D	Female
18. Mudumalai WLS	24/5/96	M	1	P	U	Calls heard
21. Indira Gandhi WLS	21/5/96	S	2	P	D	2 females (1 juv)
23. Sholayar RF	26–27/4/95	M, S	4	N	D	Pair with 2 juv
	19/3/96	E	2	N	U	1 seen; 1 heard
25. Periyar Tiger Reserve	14/3/96	S	2+1	P	U	1 heard calling
	16–17/3/96	S	4	P	D	2 adults + 2 juv
26. Ranni RF	6/4/95	M	3	N	D	Pair with juv
27. Arippa/Ponmudi RF	4/5/95	S	2+1	N	D	2 seen; 1 heard calling

Table 3. Tree characteristics at sites where White-bellied Woodpeckers were present/absent. The fourth and sixth columns indicate the percentage of trees that were sufficiently tall and broad to be potential nest-trees (thresholds derived from mean minus 1 SD dimensions of nest-trees).

Site	N	Mean ± SD height (m)	% Trees >14.3 m	Mean ± SD DBH (cm)	% Trees >44.6 cm
Present					
1. Purna WLS	70	11.4 ± 4.3	20	34.3 ± 17.6	23
2. Bansda NP	90	11.0 ± 4.0	21	27.1 ± 13.8	12
8. Mollem WLS	90	10.2 ± 3.3	11	23.5 ± 12.6	9
9. Cotigao WLS	40	11.4 ± 3.9	28	33.3 ± 15.8	28
12. Bhadra WLS	40	15.0 ± 5.8	58	39.1 ± 20.4	38
16. Wynaad WLS	80	14.0 ± 4.7	40	41.6 ± 18.6	38
21. Indira Gandhi WLS	80	13.1 ± 5.2	43	36.0 ± 23.0	30
25. Periyar TR	40	14.5 ± 5.5	55	35.5 ± 18.2	35
28. Peppara WLS	30	12.9 ± 5.4	37	29.4 ± 13.8	17
Mean:		12.6 ± 1.7	35	33.3 ± 5.8	26
Absent					
3. Tansa WLS	40	8.7 ± 2.8	3	26.8 ± 10.4	8
4. Koyna WLS	40	10.3 ± 3.6	13	27.4 ± 15.4	10
6. Sawantwadi RF	40	10.3 ± 3.2	8	25.7 ± 11.5	8
7. Bondla WLS	40	9.3 ± 2.3	0	19.3 ± 7.4	0
Mean:		9.7 ± 0.8	6	24.8 ± 3.7	7
Mann-Whitney Test	U	2	3	4	3
	P	0.01	0.02	0.02	0.02

Table 4. Records of nesting activity (year unknown when not specified).

Date	Site	Activity	Source
29 Dec 1992	16. Wynaad WLS	Excavating	P. K. Uthaman (*in litt.* 1992)
Early Jan	F. Coorg	Excavating	Betts (1951)
24 Jan	20. Nelliampathies	Excavating	Kinloch (1921)
End of Jan	10. Nelliampathies	Egg-laying	Kinloch (1923)
Jan/Feb1994	25. Periyar TR	Incubating	Neelakantan (1975)
Jan–Feb 1994	16. Wynaad WLS	Nest with young	P. K. Uthaman (*in litt.* 1994)
Feb 1991	25. Downton Estate (near Periyar TR)	4 birds seen on a dead stump	A. Robertson (*in litt.* 1991)
26 Feb 1993	21. Indira Gandhi WLS	Nest with fairly old young	K. Kazmierczak (*in litt.* 1993)
7 Mar	20. Nelliampathies	Nest with 2 naked nestlings	Kinloch (1921)
16–17 Mar 1996	25. Periyar TR	2 young following adults, begging for food	Pers. obs.
27 Mar 1994	27. Arippa	Incubating?	C. Sushanth Kumar (*in litt.* 1994)
6 Apr 1995	26. Ranni RF	Female juv. foraging with adults	Pers. obs.
26-27 Apr 1995	23. Sholayar RF	Juv. with 2 adult birds; adult seen feeding regurgitated food	Pers. obs.
21 May 1996	21. Indira Gandhi WLS	Juv. female with adult female	Pers. obs.
May	25. Periyar TR	Nesting	Robertson and Jackson (1992)

In addition, I solicited information on this species from 150 naturalists, scientists, forest officials, tribal people and others, through correspondence or in person.

RESULTS

Sightings

I recorded 26 sightings of 47 birds from 15 of the 29 sites surveyed (Table 2). Nearly 70% of sightings were in moist deciduous forest (including teak plantations) and c.30% were in evergreen or semi-evergreen forest. A mean of 1.8 birds per sighting (range: 1–4) were recorded. Although 81% of sightings were in protected areas, only 31% were in areas relatively free from human disturbance. The total number of sightings (26) was divided by the total area surveyed (107.5 km^2) to give a mean density of 0.24 birds/km^2. Using the same approach, the density in semi-evergreen forest was 0.19 birds/km^2, and that in moist deciduous forest was 0.28 birds/km^2. White-bellied woodpeckers were significantly more likely to be recorded from sites with taller and broader trees (Table 3), although it should be noted that the sample size for sites without woodpeckers was small (four).

Nesting and nest-sites

Incorporating my own observations with published records, the breeding season appears to last from December to May, with the earliest chicks fledging by March (Table 4).

A total of 11 nest-trees were found during the survey, of which four were being actively used (Table 5). The mean ± SD nest-tree height was 18.5 (± 4.2) m and the

Table 5. Nest-tree and nest-hole characteristics. Condition: L = live; D = dead; L/D = live tree/dead branch; Position: T = trunk; B = branch; MB = main branch; Habitat: SEG = semi-evergreen; EG = evergreen; MD = moist deciduous; Disturbance: D = disturbed; U = undisturbed.

Site	Tree height (m)	DBH (cm)	Nest height (m)	DNH (cm)	Orient-ation	Con-dition	Posi-tion	No. holes	Habitat	Distance to path (m)	Disturb-ance
21. I.Gandhi WLS	15.2	50.6	12.2	25.4	S	D	T	1	SEG	50	D
16. Wynaad WLS	22.8	61.7	9.7	38.1	N	D	T	4	MD	30	D
16. Wynaad WLS	12.2	33.5	9.7	25.4	W	D	T	1	MD	12	D
27. Arippa	19.8	39.6	13.7	22.9	W	L/D	MB	1	SEG	15	D
8. Mollem WLS	18.2	62.2	12.2	30.5	SE	L/D	B	2	MD	40	D
10. Dandeli WLS	24.3	71.1	15.2	45.7	NW	D	T	4	MD	50	D
10. Dandeli WLS	15.2	50.8	12.2	33.0	NW	D	T	2	MD	75	D
25. Periyar TR	18.2	61.0	15.2	45.7	NE	D	T	1	SEG	50	U
23. Sholayar RF	13.7	63.5	10.6	38.1	E	D	T	2	EG	50	U
12. Bhadra WLS	19.8	74.9	8.5	58.4	NE	L	T	3	MD	5	D
16. Wynaad WLS	24.3	81.3	9.1	50.8	NE	L	MB	3	MD	25	D
Mean	18.5	59.1	11.7	37.6						36.5	
SD	4.2	14.5	2.3	11.5						21.1	
Range	12.2–24.3	33.5–81.3	8.5–15.2	22.9–58.4						5–75	

mean nest-tree DBH was 59.1 (±14.5) cm. Nest-holes were located at a mean height of 11.7 (±2.3) m and the mean diameter at nest height (DNH) was 37.6 (±11.5) cm. Of the 11 nests, seven (64%) were on dead trees, two (18%) were on dead branches of live trees, and two (18%) were on live trees. However, even these apparently live trees had broken branches and trunks, indicating they may have been affected by heart-rot. Eight (73%) nests were located on tree trunks, and three (27%) were located on branches. Nest-holes were round in shape and averaged 12.4 (±1.2) cm in diameter. There was no clear pattern in their orientation. Nest-trees had 2.2 (±1.2, range 1–4) nest-holes. Seven (64%) nest-trees were located in moist deciduous forest, and four (36%) were in evergreen/semi-evergreen forest. Nine nests (82%) were located in disturbed sites. Three nests each had two young, and at four other sites 1–2 young were seen accompanying adult birds.

DISCUSSION

Distribution

The White-bellied Woodpecker is fairly uniformly distributed in the southern half of the Western Ghats, from c.15ºN (Goa) to the southern tip at 8ºN. This may be because the humid forest cover is fairly contiguous. In contrast, this species's distribution is more discontinuous in the northern part of the Western Ghats, in Maharashtra, where the semi-evergreen forest is highly fragmented and degraded, often occurring in isolated stands that lack tall trees (Gadgil and Meher-Homji 1990).

Abdulali (1941, *in litt*. 1995) recorded this species at Suriamal, Nasik district, Maharashtra, in June 1941, June 1950 and March 1953. This area now falls in the Tansa Wildlife Sanctuary. Although still forested, it lacks large, tall trees suitable for nesting of the White-bellied Woodpecker. Enquiries with local villagers, tribal people and forest officials did not yield any positive recent records.

In Gujarat, I recorded the species in the Purna Wildlife Sanctuary and Bansda National Park in the Surat Dangs (the northernmost part of the Western Ghats). The species has also been recorded by: Abdulali (1975): three specimens from Surat Dangs and one from Songadh, Navsari District; Ali and Ripley (1983); Worah (1991); Snehal Patel (*in litt*. 1994, 1995); Barucha (verbally 1995) and Suresh Kumar (verbally 1995).

Elsewhere, the woodpecker has been reported from: Melghat, Maharashtra (Akhtar 1994); Bastar region, Madhya Pradesh (Salim Ali 1951, Hewetson 1956); Udanti Wildlife Sanctuary (Bharos 1992); near Allapalli, Ghadchiroli district, in eastern Maharastra along the Madhya Pradesh border (Maslekar verbally); Kawal Wildlife Sanctuary, Andhra Pradesh (Srinivasulu *et al*. 2001) and in the Eastern Ghats near Vishakapatnam, Andhra Pradesh (Ripley *et al*. 1987). In the absence of authentic records between Goa and Tansa (a distance of >400 km), it is possible that the population of south Gujarat and north Maharashtra (if still extant) is isolated from that of the southern Western Ghats. As the distance between the Surat Dangs and Melghat, the nearest of the eastern population, is about 350 km, these too may be isolated.

Status, density and estimated population size

Ali and Ripley (1983) described this species as 'not common, but very local ... thinly distributed, rare or sporadic'. Several recent studies (Sugathan and Varghese 1996, Lainer 1999, Zacharias and Gaston 1999), including the present one, have confirmed this statement. The species was not found in good numbers at any of the sites. The only sites where birds were seen relatively commonly were Dandeli WLS and Anshi NP (Maharashtra), Wynaad WLS (Kerala) and Bhadra WLS (Karnataka).

A mean density of 0.24 birds/km^2 was estimated. This compares with 0.66 birds/km^2 for Korean and 4.0 birds/km^2 for Malaysian studies of this species (Short 1978, Ryol 1987). Density estimates for congeners include 0.14–0.54 birds/km^2 for Black Woodpecker *Dryocopus martius* (Isenmann and Schmitt 1967, Scherizinger 1990) and 0.09–1.88 birds/km^2 for Pileated Woodpecker *Dryocopus pileatus* (Renken and Wiggers 1989, Mellen *et al*. 1992).

Table 6. Nest-site characteristics of larger woodpeckers *Dryocopus* spp.

Nest-tree height (m)	Nest-tree DBH (cm)	Nest height (m)	DNH (cm)	Location	Source
White-bellied Woodpecker (197–347 g)					
25	80	24		Philippines	Peterson *et al*. 1995
		6.2		Korea	Ryol 1987
		9–15		Western Ghats	Kinloch 1923
		20		Western Ghats	Neelakantan 1975
18.5	59.1	11.7	37.6	Western Ghats	this study
Black Woodpecker (285–378 g)					
18.0	8.0	48.8	36.3	Norway	Hagvar *et al*. 1990
7.3	45.5			Sweden	Johnsson 1993
16				Poland	Weslowski and Tomialojc 1986
Pileated Woodpecker (240–341 g)					
28.0	84.0	15.0	60	Oregon	Bull 1987
20.3	54.6	13.6	37.9	Virginia (forest)	Conner *et al*. 1975
9.8	47.5	7.5	33.0	Virginia (non-forest)	Conner *et al*. 1975

Using this density it is possible to generate an approximate population estimate for the White-bellied Woodpecker in the Western Ghats. The total forest area of the Western Ghats is c.50,000 km^2 (Rodgers and Panwar 1988). Of this, it is estimated that around 60% of forest area may consist of grasslands, montane shola forest, open areas, reservoirs, forest plantations, degraded and stunted scrub forests. Hence there may be c.20,000 km^2 of habitat suitable for White-bellied Woodpeckers. This is a maximum estimate as intact forest cover may be as low as 25% of the total forest area (Nair 1991). At a density of 0.24 birds/km^2, this produces an estimate of c.4,800 White-bellied Woodpeckers in the Western Ghats.

Nest-sites

White-bellied Woodpeckers predominantly selected dead trees for nesting, in contrast to eight sympatric smaller woodpecker species, for which only one in 63 nests (<2%) was found in a dead tree (although dead wood substrates were favoured for 46% of nest sites: Santharam 1995a). The Black and the Pileated Woodpeckers also predominantly nest in dead trees (Conner *et al.* 1975, Bull 1987, Hagvar *et al.* 1990).

The presence of more than one hole in 64% of nest-trees indicated that such trees were used repeatedly for nesting and/or roosting. Re-using old nest-sites may be disadvantageous, as these may be known to predators or competitors (Nilsson *et al.* 1991), and several species of woodpeckers use new nests to avoid this (Short 1979, Sonerud 1985). However, old nests maybe enlarged and re-used by large woodpeckers (Short 1982, Nilsson *et al.* 1991), perhaps particularly in areas where suitable nest-trees are scarce, due to intense forest management.

Table 6 compares nest-site characteristics with those for two congeners. The data are broadly similar, except for the larger dimensions of trees chosen for nesting by Pileated Woodpeckers in Oregon, which may relate to the greater availability of large trees.

Habitat use

White-bellied Woodpeckers cannot survive in habitats where large dead or dying trees are absent, as these are essential for nesting. However, foraging individuals were seen using live, small-sized trees. This is also the case for large woodpeckers in Europe (Spitznagel 1990) and North America (Mellen *et al.* 1992). This means that individuals cannot breed, in managed forests and in cardamom plantations and coffee estates, unless large, dead trees are left standing. There are several records of White-bellied Woodpeckers occurring in cardamom plantations: e.g. 'common' in cardamom plantations in the Cardamom hills, Kerala (Fergusson and Bourdillon 1903); Downton cardamom estate, near Periyar Tiger Reserve, Kerala (A. Robertson *in litt.* 1991); and a recently abandoned cardamom estate near Munnar, Kerala (M. S. Koshy *in litt*. 1994). It has also been reported from coffee estates bordering forests in Coorg (Karnataka) by Betts (1951) and more recently by C. S. Machaiah (*per* C. M. Cariappa *in litt.* 1995), and in Wynaad, Kerala (V. J. Zacharias verbally 1995). However it is not certain if the birds breed at all these sites.

The preponderance of sightings and nests of the White-bellied Woodpecker in moist deciduous forests suggests a preference for this habitat. However, most of these sightings were close to evergreen/semi-evergreen or riverine forest patches, so it is possible that birds use such patches within their territories, and are simply more detectable in the moist deciduous habitat.

Individuals were also recorded in fragmented forest patches in Bansda National Park, Gujarat (25 km^2) and at Arippa, Kerala (8.9 ha), where nesting was noted. This latter site is surrounded by plantations and human settlements and may be separated from the nearest natural forest patch by at least 10–20 km. The Black Woodpecker is known to occur and breed in the highly fragmented forests of south-central Sweden and in Finland. Tjernberg *et al.* (1993) suggested they could breed successfully in such patches provided the tree composition and food supply were suitable. However, it remains to be seen how long the White-bellied Woodpecker can survive in such small forest patches in the Western Ghats. Further work is required to determine nesting success in small forest patches compared to larger areas of contiguous habitat.

It has been suggested by several authors that the White-bellied Woodpecker is very shy and intolerant of human disturbance, particularly at the nest, and that it may not be found in disturbed habitats (Kinloch 1923, Betts 1951, Ali and Ripley 1983, Ryol 1987). However, my observations do not support this claim: nearly 70% of sightings were from disturbed areas. Furthermore, 82% of nests were located in disturbed sites or areas regularly frequented by people. The mean distance of nests from the nearest path/road was 36.5 m (range: 5–75 m). Neelakantan (1975) also found a nest 'hardly a stone's throw from the road' in the tourist zone of Periyar Tiger Reserve where 'human activity and noises were no less than at a lumbering camp'. The species may not be as sensitive to human activities as previously supposed.

Conservation implications

The Western Ghats south of Goa appear to be the major stronghold of the White-bellied Woodpecker, having populations suitable for long-term conservation. By contrast, in the Surat Dangs of Gujarat, less than 50% of the land constitutes reserved forest (Worah 1991) and this comprises mostly patches of secondary forests. Most natural forest has been replaced by teak and bamboo. Currently there are only two protected areas in the Dangs region, which are 160 km^2 and 25 km^2 in extent. Even these are under heavy pressure from humans and require intensive management. Trees above 40 cm DBH are almost entirely absent outside protected areas (Worah 1991) and this may seriously limit the survival prospects of the White-bellied Woodpecker. Hunting of birds by a large population of tribal people is prevalent in the Dangs. Furthermore, the White-bellied Woodpecker population in this area appears to be isolated from the southern and eastern populations. Hence the prospects for their conservation in this area are not encouraging.

In the southern Western Ghats, the White-bellied Woodpecker has a reasonable chance of survival, provided its habitat is well-managed. Tree-felling carried out without proper planning may reduce the availablity of large dead trees. Although selected tree-felling has been abandoned in many states such as Kerala, dead and windfallen trees are still collected by the forest

department (Chundamannil 1993). In the moist deciduous forests of Peechi-Vazhani Wildlife Sanctuary, Kerala, the proportion of dead trees is as low as 1.2%, and the White-bellied Woodpecker was never seen during a 2-year study period (Santharam 1995a).

Using the density estimates generated by this study, forest areas of 1,000–1,500 km^2 would be needed to conserve a minimum viable population of 500 individuals. There are now only five large, contiguous, forested areas in the Western Ghats suitable for long-term conservation of the White-bellied Woodpecker: (1) Goa and north Karnataka; (2) central Karnataka (including the moist deciduous forest patches of Bhadra, Shettyhalli and the evergreen forest patches of Kudremukh and Someshwara); (3) the lower Nilgiris (Tamil Nadu), Wynaad (Kerala) and parts of Coorg (Karnataka); (4) the Anaimalai hills (Kerala), including Anaimudi, Chimmoni, Sholayar and Parambikulam; and (5) Periyar/Varushanad (Kerala). Creating protected area networks with appropriate management policies and techniques will take considerable effort and coordination, because most of these forest patches cover two or more adjacent states. However, such initiatives are required to ensure the long-term survival of the White-bellied Woodpecker.

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REFERENCES

Abdulali, H. (1941) The Great Black Woodpecker in the neighbourhood of Bombay *J. Bombay Nat. Hist. Soc*. 42: 933–934.

Abdulali, H. (1975) A catalogue of the birds in the collection of the Bombay Natural History Society Pt. 17. *J. Bombay Nat. Hist. Soc*. 72: 112–131.

Akhtar, A. (1994) Melghat Tiger Reserve. *Hornbill* 2: 25.

Ali, S. (1951) Discovery of the so-named 'Malabar' Black Woodpecker (*Dryocopus javensis hodgsoni* (Jerdon)) in Bastar (East Madhya Pradesh) *J. Bombay Nat. Hist. Soc*. 49: 787–788.

Ali, S. and Ripley, S. D. (1983) *Handbook of birds of India and Pakistan*. Compact edition. Bombay: Oxford University Press.

Betts, F. N. (1951) The birds of Coorg, Pt. II. *J. Bombay Nat. Hist. Soc*. 50: 224–263.

Bharos, A. M. K. (1992) Occurrence of the Indian Great Black Woodpecker *Dryocopus javensis* (Horsfield). *J. Bombay Nat. Hist. Soc.* 89: 255.

Bull, E. L. (1987) Ecology of the Pileated Woodpecker in Northeastern Oregon. *J. Wildl. Manage*. 51: 472–481.

Chattopadhyay, S. (1985) Deforestation in parts of Western Ghats region (Kerala), India. *J. Env. Manage*. 20: 219–230.

Chundamannil, M. (1993) *History of forest management in Kerala*. Peechi: Kerala Forest Research Inst. Rep. No. 89.

Conner, R. N., Hooper, R. G., Crawford, H. S. and Mosby, H. S. (1975) Woodpecker nesting habitat in cut and uncut woodlands in Virginia. *J. Wildl. Manage*. 39: 144–150.

Fergusson, H. S. and Bourdillon, T. F. (1903) The birds of Travancore with notes on their nidification. Part I. *J. Bombay Nat. Hist. Soc*. 15: 249–264.

Gadgil, M. and Meher-Homji, V. M. (1990) Ecological diversity. Pp. 175–198 in J. C. Daniel and J. S. Serrao, eds. *Conservation in developing countries: problems and prospects*. Bombay: Bombay Natural History Society and Oxford University Press.

Hagvar, S., Hagvar, G. and Monness, E. (1990) Nest site selection in Norwegian Woodpeckers. *Hol. Ecol.* 13: 156–165.

Hewetson, C. E. (1956) Observations on the birdlife of Madhya Pradesh. *J. Bombay Nat. Hist. Soc.* 53: 595–645.

Johnsson, K. (1993) *The Black Woodpecker* Dryocopus martius *as a keystone species in forest*. Uppsala: University of Agricultural Sciences. Report 24.

Kinloch, A. P. (1921) Rough notes on the avifauna of the Nelliampathy Hills. *J. Bombay Nat. Hist. Soc.* 27: 939–944.

Kinloch, A. P. (1923) The nidification of the Malabar Great Black Woodpecker. *J. Bombay Nat. Hist. Soc.* 29: 561.

Lainer, H. (1999) The birds of Goa (Part II) *J. Bombay Nat. Hist. Soc*. 96: 405–423.

Mellen, T. K., Meslow, E. C. and Mannan, R. W. (1992) Summertime home range and habitat use of Pileated Woodpeckers in western Oregon. *J. Wildl. Manage*. 56: 96–103.

Menon, A. R. R. (1986) *Forest denudation in Kerala: a case study of Trichur forest division: proceedings of seminar on ecodevelopment of Western Ghats*. Peechi: Kerala Forest Research Inst.

Myers, N. (1988) Threatened biotas: "hot spots" in tropical forests. *Environmentalist* 8: 187–208.

Nair, S. C. (1991) *The Southern Western Ghats - a biodiversity conservation plan*. New Delhi: INTACH.

Neelakantan, K. K. (1975) A day at a nest of the Great Black Woodpecker (*Dryocopus javensis*). *J. Bombay Nat. Hist. Soc.* 72: 544–548.

Nilsson, S. G., Johnsson, K., and Tjernberg, M. (1991) Is avoidance by Black Woodpeckers of old nest holes due to predators? *Anim. Behav*. 41: 439–441.

Peterson, A. T., Ingle, N. and Fernandez, R. (1995) Notes on the nesting behaviour of the White-bellied Woodpecker. *Wilson Bull*. 107: 182–184.

Renken, R. B. and Wiggers, E. P. (1989) Forest characteristics related to Pileated Woodpecker territory size in Missouri. *Condor* 91: 642–652.

Ripley, S. D., Beehler, B. M. and Krishna Raju, K. S. R. (1987) Birds of the Visakhapatnam Ghats, Andhra Pradesh, Pt.I. *J. Bombay Nat. Hist. Soc.* 84: 540–559.

Robertson, A. and Jackson, M. C. A. (1992) *Birds of Periyar - an aid to birdwatching in the Periyar sanctuary.* Jaipur: Tourism and Wildlife Society of India.

Rodgers, W. A. and Panwar, H. S. (1988) *Planning a wildlife protected area network in India*, Vol.1, Field document No.7. Dehra Dun: Wildlife Inst. of India.

Ryol, C. J. (1987) *Endangered bird species in the Korean peninsula*: *the Whitebellied Black Woodpecker* Dryocopus javensis richardsi. Tokyo: Tristram Museum of Korean Nature.

Santharam, V. (1995a) Ecology of sympatric woodpecker species of Western Ghats, India. Unpublished dissertation, Pondicherry University, India.

Santharam, V. (1995b) A note on the preliminary findings on the distribution of the Great Black Woodpecker in the Western Ghats. *Newsletter for Birdwatchers* 35(4): 68–69.

Scherizinger, W. (1990) Is competition by the Great-spotted Woodpecker the cause for White-backed Woodpecker's rarity in Bavarian Forest National park? Pp. 81–91 in A. Carlson and G. Aulen, eds. *Conservation and management of woodpecker populations*. Uppsala: Swedish University of Agricultural Sciences. Report 17.

Short, L. L. (1973) Habits of some Asian woodpeckers (Aves, Picidae). *Bull. Am. Mus. Nat. Hist.* 152: 255–364.

Short, L. L. (1978) Sympatry in woodpeckers of lowland Malayan forest. *Biotropica* 10: 122–133.

Short, L. L. (1979) Burdens of the picid hole-excavation habit. *Wilson Bull.* 91: 16–28.

Short, L. L. (1982) *Woodpeckers of the world*. Greenville, Delaware: Delaware Museum of Natural History.

Sonerud, G. A. (1985) Nest hole shift in Tengmalm's owl *Aegolius funereus* as defence against nest predation involving long term memory in the predator. *J. Anim. Ecol.* 54: 179–192.

Spitznagel, A. (1990) The influence of forest management on woodpecker density and habitat use in floodplain forests of the Upper Rhine valley. Pp.117–145 in A. Carlson and G. Aulen, eds. *Conservation and management of woodpecker populations*. Uppsala: University of Agricultural Sciences.

Srinivasulu, C., Vasudeva Rao, V., Ravinder, G. and Nagulu, V. (2001) New site record of the Indian Great Black Woodpecker *Dryocopus javensis* (Horsfield) from Andhra Pradesh. *J. Bombay Nat. Hist. Soc.* 98(2): 280–281.

Stattersfield, A. J., Crosby, M. J., Long, A. J. and Wege, D. C. (1998) *Endemic bird areas of the world: priorities for biodiversity conservation*. BirdLife Conservation Series No. 7. Cambridge, U.K.: BirdLife International.

Sugathan, R. and Varghese, A. P. (1996) A review of the birds of Thattakad Bird Sanctuary, Kerala. *J. Bombay Nat. Hist. Soc.* 93(2): 487–506.

Tjernberg, M., Johnsson, K. and Nilsson, S. G. (1993) Density variation and breeding success of the Black Woodpecker *Dryocopus martius* in relation to forest fragmentation *Ornis Fennica*. 70: 155–162.

Weslowski, T. and Tomialojc, L. (1986) The breeding ecology of woodpeckers in a temperate primaeval forest. Preliminary data. *Acta. Ornithologica* 22: 1–21.

Winkler, H. and Christie, D. A. (2002) Family Picidae (Woodpeckers). Pp. 296–555 in J. del Hoyo, A. Elliott and J. Sargatal, eds. *Handbook of the birds of the world*. Vol. 7. Barcelona: Lynx Edicions

Worah, S. (1991) The ecology and management of a fragmented forest in South Gujarat, India: the Dangs. Unpublished dissertation, University of Poona, India.

Zacharias, V. J. and Gaston, A .J. (1999) The recent distribution of endemic, disjunct and globally uncommon birds in the forests of Kerala state, south-west India. *Bird Conser. Internat.* 9(3): 191–225.

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