

details about the potential confusion with other species, such as Red-breasted Flycatcher *F. parva* or Kashmir Flycatcher or even a female Blue-throated Flycatcher *Cyornis rubeculoides*, were not provided in detail. This would also be the first record for India and has not been accepted by Praveen & Jayapal (2024) and hence not here as well.

Eurasian Tree Sparrow *Passer montanus*

Ward (1906b) listed the bird without any further details. Grimmett et al. (2011) mapped an independent record from the southern districts of Jammu, which remained untraced by us. Not accepted by other authorities and hence excluded from the list.

Meadow Pipit *Anthus pratensis*

Magrath (1921) reported a 'different' pipit among the Rosy Pipits *A. roseatus* near Gangabal Lake, believed to be a Meadow Pipit, but failed to collect a specimen or provide sufficient description.

Spot-winged Grosbeak *Mycerobas melanozanthos*

Ward (1906b) mentioned 'recorded this from various parts' and Lawrence (1895) listed the species as very rare in Kashmir forests. Neither provided details about specific records. These above two mentions are likely to be the sources of its doubtful status in Grimmett et al. (2011). There are no other references to specific records within in J & K.

Great Rosefinch *Carpodacus rubicilla*

Ward (1906b) mentioned a single specimen but doubted its locality to be from Kashmir proper. However, he says that the bird was found towards the Ladakh boundary. This is considered insufficient for acceptance.

Gold-naped Finch *Pyrhoplectes epauletta*

An egg deposited in NHMUK (NHMUK: ecatalogue:3819660) (Vertnet 2020) is the only evidence and hence not accepted here. 🚫

Grouping and home-range of the Vulnerable Great Slaty Woodpecker *Mulleripicus pulverulentus* in the western Himalaya

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Abstract

This study highlights the census, grouping and home-range size of the Great Slaty Woodpecker *Mulleripicus pulverulentus* in Sal *Shorea robusta* forests in Pawalgarh Conservation Reserve, Uttarakhand, India over two breeding and post-breeding seasons (2018–2020). The population is represented by 14 groups with a total of 63 individuals occurring in groups of 3–7 individuals. We mapped sightings (n=161; 11 groups) obtained during systematic transect walks to assess the distribution and abundance of the species within the study area and adjacent forest. Our observations were based on the repetitive encounters of individuals of all family groups, and we found that each group established and maintained the same territories in the successive years to meet their foraging and nesting needs. The mean home range of the species in the Sal forest was 1.87 ± 0.97 sq. km based on the minimum convex polygon method across the two seasons ranging from 0.77 to 4.08 sq. km. Each family group of Great Slaty Woodpeckers actively defended minimal overlapping territories throughout the years. Additionally, we observed an interesting intraspecific behaviour which we term as "Inflight Dance" with respect to territoriality wherein two-family groups with overlapping boundaries would engage in a circular flight movement during the breeding season. This study on the home range is a first attempt in the region and represents an important ecological baseline for this vulnerable species.

Introduction

Many bird species defend resource-based territories (Holmes et al. 1989; Winker et al. 1990). For example, a study on movement patterns of adult and juvenile 'Akohekohe' *Palmeria dolei*, an endangered Hawaiian honeycreeper revealed significant differences in the home ranges of adult and juvenile individuals, which in turn are attributed to the increased risk of malarial infection (Wang et al. 2020). The home range size and social interaction of the Black Woodpecker *Dryocopus martius* revealed significant variation among individuals (Bocca et al. 2007). Their analysis also pointed out that home ranges during the breeding period were more restricted than the post-breeding period. The overlap of home-ranges was prominent and broad in comparison

to the core area overlap with a high site-fidelity across all-year ranges. Similarly, a radio-telemetry study of the Australian owllet-nightjars *Aegotheles cristatus* in a *Eucalyptus* woodland coupled with GPS recordings revealed home range size requirements and site fidelity of this highly territorial bird did not differ seasonally and were not correlated with arthropod abundance (Doucette 2010). The movement ecology and other life history parameters such as home range (Franzreb 2006), reproductive success (Nappi & Drapeau 2009), and space use of foraging habitat (Walters et al. 2002) have been widely used as indicators for implementing suitable habitat management practices for woodpeckers such as the Red-cockaded Woodpecker *Dryobates borealis* and Black-backed Woodpecker *Picoides arcticus*. Data on movements

and foraging behaviour, important in any conservation and management programme are lacking for many species and may be effective in drawing conservation strategies both for resident and migrant birds (Bamford et al. 2007).

The genus *Mulleripicus* is represented by four species varying in size from 29 cm to 50 cm (Winkler et al. 2020). However, little information is available for the three island species: the Southern Sooty Woodpecker *M. fuliginosus*, Northern Sooty Woodpecker *M. funebris*, and Ashy Woodpecker *M. fulvus*. Relatively more is known about the Great Slaty Woodpecker *M. pulverulentus*, a species of conservation concern (Lammertink et al. 2009). It is the largest woodpecker in India and is listed as Vulnerable in the IUCN Red List (BirdLife International 2023). The distributional range of the species in India extends between 600 m and 2,000 m in the Himalayan and sub-Himalayan forests within various protected areas (Ali & Ripley 1970; Winkler et al. 2020). The species is strongly associated with mature, old-growth dipterocarp forests, particularly *Sal Shorea robusta*, where they forage primarily on beetle larvae (Ali & Ripley 1970). The Great Slaty Woodpecker (hereinafter GSW) is a logging-sensitive species and in recent years, a decline in its population can be associated with the loss of favourable habitat due to selective logging of large trees (Lammertink, 2004; Lammertink et al. 2009). We need more information on various aspect of their biology such as their home range size, habitat use, availability of food to better inform habitat management for their conservation.

In this paper, we attempt to infer the variation in home-range size among various family groups of GSW in and around a small protected area in the western Himalaya of Uttarakhand, India. We followed groups of GSW and assessed the ranging behavior for each group based on foraging, nesting, and roosting observations during two breeding and post-breeding seasons. Our objectives were (a) to study the variation in group size, and (b) to determine the variation in the home-range size and spatial overlap between groups.

Study area

This study was conducted in the 57.73 sq. km Pawalgarh Conservation Reserve (hereafter PCR) and an additional 29.47 sq. km outside the PA (Figure 1). PCR supports a small population of GSW and is comprised of managed natural old growth and young *Sal* forests (Kumar et al. 2011). The tree canopy is dominated by *Sal* (80–90%) with principal associates such as *Terminalia tomentosa*, *Lannea coromandelica*, *Terminalia bellirica*, *Adina cordifolia*, *Syzygium cumini*, *Garuga pinnata*, and *Lagerstroemia parviflora* with *Anogeissus latifolia* found on hill slopes. The middle and lower storeys consist mainly of *Ougeinia oojeinensis*, *Mallotus philippensis*, *Cassia fistula*, *Ehretia laevis*, and *Phyllanthus emblica*. The river *Dabka* bisects the landscape into eastern and western parts.

Methods

Distribution of transects

The study region was surveyed along 52 transects. Each transect traversed various habitat patches like *Sal* and miscellaneous forest stands, perennial and seasonal riverbeds, Teak *Tectona grandis* plantations, grasslands, roads, and village boundaries. Although each transect varied in length (2 km – 9 km), we ensured these transects had an open canopy up to 100 m on both sides to

ease the detection of GSWs. The detectability of GSWs is rather challenging in the absence of aural cues and consequently we walked each transect with a fixed speed covering 500 m/hr to ensure detection. The 7 km, 8 km and 9 km transects were covered on two consecutive days owing to their length.

Sampling

The data collection was primarily based on locating each group and recording the number of individuals and their sex from 2018 to 2020. We carried out the transect walk from 0530–0930 h during the summer season (April to June) and 0700–1100 h during the winter season (October to March). During evening surveys, we followed each family group from 1600–1830 h during the summer season (April to June) and 1500–1730 h during the winter season (October to March). We recorded the GPS locations of the first encounter and then followed the family groups intensively to assess the variations in group sizes (if any) during both the seasons. Furthermore, while following the group we recorded the second GPS coordinates which corresponded to losing the group (the group flew very far or a barrier in proceeding like a steep ridge, river, presence of tiger and elephants). We actively followed each group, and the groups were given a unique identification code based on their multiple sightings from the same area. We were able to differentiate each group and individuals based on morphological characters of all or some individuals in that group based on multiple sightings from the area in use. The field identification with notable differences in each group is summarised in Table 1 that helped us demarcate the home range boundaries [273, 274].



273. A male showing white/silver forecrown representing two different family groups.



274. A female with a tiny black spot on the right upper portion of the chin.

We identified territory boundaries based on behavioural observations i.e., foraging, roosting, boundary disputes and calling perches, thereby delineating area for each group. The display also includes loud calls, and each performed territorial display was marked and considered as an independent fix to evaluate the home-range size for each family group. Similarly, to locate the nesting and roosting cavities, we conducted systematic nest searches across all sites with an average effort of 28 observer hours per week during the morning and 12–15 observer hours per week during the evening survey. We also carried out intensive surveys in the marked territory of each group to locate the nest cavities along transects. The nesting cavities were located by listening to the continuous excavating sounds by the individuals of the species. All observations were aided by binoculars (8x42 and 12x50) or a spotting scope (45x) from a distance causing no disturbance. We did not use the call playback method for any group to define their respective territories. We mapped the territories and digitized them using ArcGIS 10.5 (ESRI 2016) for geospatial analysis using the Spatial Analyst tool. Territories were delineated as non-overlapping maximum defended areas based on standard territory-mapping techniques, using the behavioural attribute data of bird locations for interpretation.

Statistical Analyses

A total of 161 GPS locations for 11 groups were used to map the space use for each group. The locations recorded for each group of GSWs were a categorical representation of one family group and defines a particular activity as being in flight or perched in a tree (foraging, vocalising, nesting, roosting, and even territorial displays). In case of both nesting and roosting, the locations used by the groups were included as one data point in the analysis, irrespective of the number of times we recorded the birds using

that particular active roost or nest. Of the 14 family groups we surveyed, we only estimated the home range of 11 groups due to insufficient locations of the others. We estimated territory size with the minimum convex polygon (MCP) method where a polygon around the outermost locations is used to determine home range. We also ran a simple linear regression using the home range as the dependent variable and number of fixes (n) and group size as independent variables. This test was performed to determine whether the home range size is dependent on the number of fixes or the group size of various family groups.

Results Grouping

In 2019, we recorded a total of 41 individuals (17 males and 24 females) belonging to 11 family groups (Table 1). Seven groups were located inside the conservation reserve and four were mapped outside the protected area. 45% of the groups consisted of three individuals, 36% of the groups had four individuals and remaining 18% consisted of five individuals.

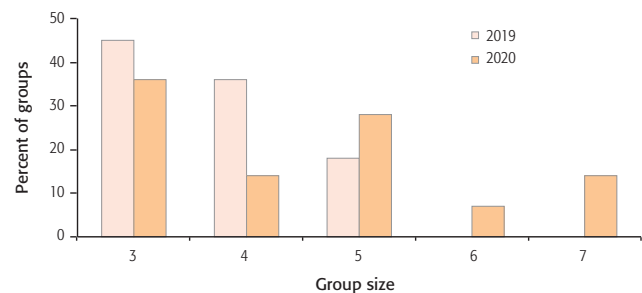


Fig. 1: Frequency of group size in the Great Slaty Woodpecker in 2019 and 2020

Table 1. Summary of group size and number of individuals in each group of Great Slaty Woodpecker within the Pawalgarh Conservation Reserve and the area surveyed outside.

Group ID	Notes	2019			2020		
		Group Size	N males	N females	Group Size	N males	N females
Group 1	A female with a darker right wing in comparison to the typical colouration of the left.	3	1	2	3	1	2
Group 2	A female individual showing presence of two white spots at the base of the beak and on the throat margin.	3	1	2	3	1	2
Group 3	Presence of two individuals (a male and a female) bearing diffused black colouration on the typical pale-yellow chin and throat (Kaur et al. 2023).	3	1	2	3	1	2
Group 4	A male individual with almost white/silver forecrown and lore region.	4	2	2	4	2	2
Group 5	No distinct character noted. However, Group 1 separates this group from Group 6.	5	2	3	5	2	3
Group 6	No overlap with Group 5 noted and no distinct character present in any individual.	-	-	-	5	3	2
Group 7	A female individual with a tiny black spot on the right upper portion of the chin.	4	2	2	5	3	2
Group 8	Group located outside PA and no noticeable character.	4	2	2	6	3	3
Group 9	A female individual with almost white/silver forecrown and lore region.	5	2	3	7	3	4
Group 10	A secluded group identified outside PA with no immediate groups present nearby.	3	1	2	3	1	2
Group 11	Only group with a single female individual.	3	2	1	3	2	1
Group 12	Not included in the analysis for home-range.	4	2	2	4	1	3
Group 13	Not included in the analysis for home-range.	-	-	-	5	2	3
Group 14	Not included in the analysis for home-range.	-	-	-	7	3	4
Total		41			63		

In 2020, a total of 63 individuals (28 males and 35 females) were recorded belonging to 14 family groups, each group comprising of 3-7 individuals (Table 1). Out of 14 groups, 36% had three individuals, 14% were represented by four individuals, 28% had five individuals, 7% had six individuals and 14% had seven individuals (Figure 1). We concluded the identity of each individual (the total number of males and females) for all group assemblages.

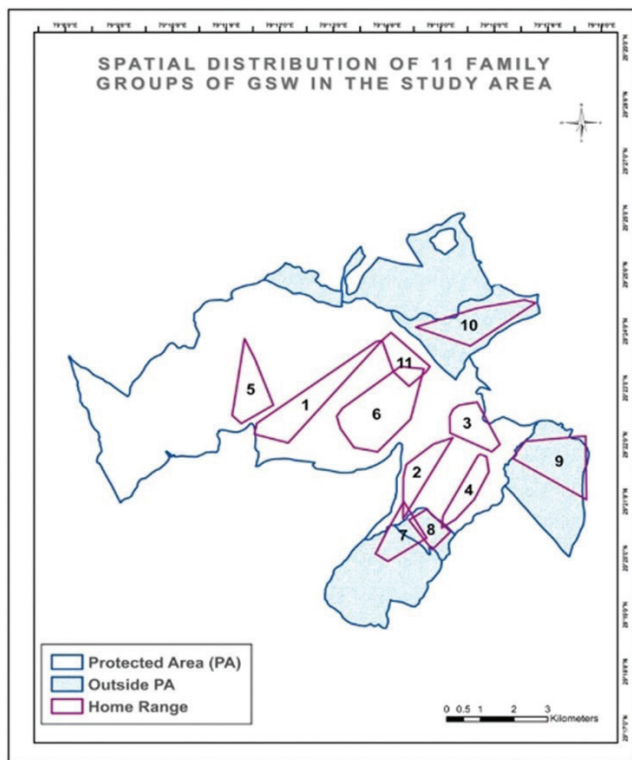


Fig 2. Distribution of family groups (n=11; MCP 100%) of the Great Slaty Woodpecker in and around Pawalgarh Conservation Reserve

Home-range size, “inflight dance”, and spatial overlap in home ranges

Eleven groups of GSW showed short-ranging movement (Figure 4), ranging over a combined total of 20.60 sq. km of the 87.20 sq. km (23.62%) surveyed woodland habitat. Group 6 and Group 8 represent the maximum and minimum home range covering an area of 4.08 sq. km and 0.77 sq. km respectively (Table 2). Neighbouring family groups displayed intraspecific territoriality with slight overlap and the only evident territorial interaction was detected during the breeding season. We found that six groups (Groups 2, 4, 5, 7, 8, and 11) of GSW show minimal overlap. The average overlap of 0.123 sq. km (± 0.15 sq. km) was recorded with only Group 8 showing overlap with two neighboring groups (Group 4 and Group 7) in the surveyed area. Additionally, we observed an interesting social interaction among the individuals of two different family groups sharing the same boundary and termed it as “inflight-dance”. This display behavior prior to the breeding season was observed four different times where the individuals would come together and perform the dance sequentially circling above the trees, vocalizing and chasing one another mid-flight and this lasted for 21.5 minutes (± 17 minutes)

followed by dispersal of both groups to their individual territories with individuals accounted each time in their respective family groups. Regression analyses showed that the home range size was not correlated to neither the group size ($R^2=0.02$, $P=0.20$) nor the number of independent fixes ($R^2=0.04$, $P=0.15$).

Table 2. Overlay of the home-range size by the different groups of Great Slaty Woodpecker

Group Id	Group Size	Total number of independent locations (n)	Home-range (sq. km)	Total area used (%) of the surveyed area
Group 1	3	11	2.75	3.15
Group 2	3	17	1.33	1.52
Group 3	3	19	1.41	1.61
Group 4	4	22	1.17	1.34
Group 5	5	9	1.70	1.94
Group 6	5	18	4.08	4.67
Group 7 [†]	5	15	1.35	1.54
Group 8 [†]	6	11	0.77	0.88
Group 9 [†]	7	11	2.68	3.07
Group 10 [†]	3	17	2.19	2.51
Group 11	3	11	1.17	1.34

[†]Groups located outside the PA

Discussion

We found home ranges have been evaluated for following species of Picids, Magellanic Woodpecker *Campephilus magellanicus* (Ojeda & Chazarreta 2014), Pileated Woodpecker *Dryocopus pileatus* (Mellen et al. 1992; Tomasevic & Marzluff 2018), Black Woodpecker *Dryocopus martius* (Bocca et al. 2007), Black-backed Woodpecker *Picoides arcticus* (Dudley & Saab 2007; Rota et al. 2014; Tingley et al. 2014), Red-cockaded Woodpecker *Dryobates borealis* (Porter & Labisky 1986; Franzreb 2006), White-headed Woodpecker *Dryobates albolarvatus* (Lorenz et al. 2015), and Lesser Spotted Woodpecker *Dryobates minor* (Wiktander et al. 2001) over the years. However, no such attempt was made for the genus *Mulleripicus* and despite the Vulnerable Status of the species; the movement and ranging pattern of this species have not been evaluated thus far. This is the first estimate of home-range and group size for a small population representing the westernmost distribution. It adds to the present knowledge of the species and may prove beneficial in preparing a much-needed management plan for its conservation. The Great Slaty Woodpecker is a cooperative breeder i.e., family groups are comprised of a dominant breeding pair and helpers (Lammertink 2004) and therefore, we hypothesised that the variation in the home-range size of each family group irrespective of the year or season can be attributed either to the differences in the total number of independent fixes or to the group size. However, we found no association between home range size and neither the number of fixes nor the group size.


Further, we observed that each family group maintains stable territories year-round with respect to the number of individuals and their identity, and this reasonable threshold value of habitat use forms the preliminary evaluation of minimum area required by one group of the GSW. The only change that we noticed in the

group structure (increase in the number of individuals) can be attributed to a successful nesting attempt and/or dispersal which was evident in and recorded for three groups during the next post-breeding and breeding seasons (Table 1). Home range overlap was minimal for the family groups. In order to understand the degree of territoriality, we must consider other methods of census in addition to territory mapping and study variation in territoriality in different seasons. Since, we were unable to acquire a large number of sightings (independent locations) for any family group, we did not use more robust methods for home range estimation and evaluated MCPs for each group as it estimates biologically meaningful home ranges even with few location samples (Wang et al. 2020). This study shows that the degree of overlap is minimal in terms of the MCPs and intraspecific territoriality can be suggested by 'Inflight Dance' involving the temporary association between two neighbouring family groups during the breeding season. The large territories maintained by the groups suggests that sizeable tracts of Sal forests are needed to maintain viable populations of GSWs. Long-term monitoring studies with ringing and radiotelemetry across multiple sites will further help outline an effective conservation strategy for this species.

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In Memoriam

HEM POU DAL
(1941 – JAN 31, 2024)

In Memoriam

DAVID FIELD ABBOTT
(DECEMBER 15, 1956 – FEBRUARY 20, 2024)