

Impacts of the Changing Housing Patterns on The Populations of House Sparrow *Passer domesticus* (Passeriformes: Passeridae) in the Rural Hills of Uttarakhand: A Case Study

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ABSTRACT

The present study was aimed to assess the impacts of the changing housing patterns on the populations of House Sparrow in the rural areas of the hills of the Pithoragarh region in Uttarakhand. The sampling sites were chosen in such a manner to include the traditional stone masonry, mixed (partially concrete), and modern concrete houses. We recorded the density of House Sparrow (using point count method), density of nest, and sex ratios in the different categories of houses at different time durations of the day. In this study (i) the traditional stone masonry houses recorded the highest density of House Sparrow and nests, (ii) changing housing patterns did not affect the sex ratio in House Sparrow and, (iii) the changing housing patterns in the rural areas of the hills of Uttarakhand appeared to be one of the causes of population decline in House Sparrow. The conservation measures we have outlined here include a comprehensive public awareness and education programmes, installation of artificial nest boxes in the houses and gardens, and protection of House Sparrow under the rules of Wildlife (Protection) Act (1972), Government of India.

Key words: Impact, Housing pattern, House sparrow, Threats, Conservation

Introduction

House Sparrow, *Passer domesticus* (Linnaeus, 1758) is one of the most widely distributed species inhabiting all the continents and subcontinents of the world. Vaurie (1949) and Summers-Smith (1988) described two major groups of *Passer domesticus* i.e., Palaearctic (Spanish) and Oriental (Indian) groups. Each group represents 6 sub-specie (Summers-Smith, 1988). House Sparrow is the most human-friendly and commensal species, linked to the human habitations from time immemorial. Once

House Sparrow was so common and abundant that farmers in the different parts of the world considered it a pest and enemy because they believed that a large number of House Sparrow was damaging the agricultural crops. The rapid urbanization and changing land use/land cover seem to lead to an adverse impact on the population of House Sparrow (Khera *et al.*, 2010; Lakhera, 2015). The populations of House Sparrow have been declining since the early 1980s from different parts of the world including European countries (Crick *et al.*, 2002; Summers-Smith, 2000; De Laet, 2004).

Except a few reports like SoIB (2020), majority of the researches observed a gradual decline in the populations of House Sparrow over the past few decades in India (Modak, 2017). Also, many other non-scientific organizations have been raising their voices for the conservation of House Sparrow. The factors like agricultural intensification, high transportation, urbanization, loss of nesting opportunities, electromagnetic radiations, competition for food, use of pesticides, air pollution, climate change, etc. were attributed to the major threats to House Sparrow (De Laet and Summers-Smith, 2007; Khera *et al.*, 2010; Dandapat *et al.*, 2010; Lakhera, 2015; Modak, 2017; Roshnath *et al.* 2018; Aslan *et al.*, 2018; Nath *et al.* 2019; Choudhary *et al.*, 2019). The majority of such impacts were, however, reported from the urban ecosystems, which are negligible in the hilly areas of Uttarakhand due to varied climatic, geophysical, and demographic conditions (Lakhera, 2015; Modak, 2017; Roshnath *et al.*, 2018).

Despite the slow pace of development in the hilly areas of Uttarakhand, a factor that attracts the attention is the rapid changes in the housing pattern. The traditional houses do not have many basic facilities, like ventilation, sanitation, in-house water supply, etc. and they are not even earthquake resistant. In order to find such facilities, people in hilly areas have been giving priority to the modern concrete houses for the past few decades (Negi *et al.*, 2017). Like other factors, modern housing patterns were also reported as one of the causes to affect the populations of House Sparrow significantly (Moudra *et al.*, 2018; Nath *et al.*, 2019; Choudhary *et al.*, 2019). A few studies infer that the concrete houses in urban areas have badly affected the house sparrow. However, we did not find a case study on the impact of housing patterns on the population of House Sparrow in hills of Uttarakhand. Given that, the present contribution was aimed to investigate the impacts of changing housing patterns on the populations of House Sparrow in hilly areas of Uttarakhand.

Study Area

The sampling was carried out in the months of January and March 2020 in a total of 5 hamlets of three revenue villages (Marsoli Bhat, Muna Kote, and Balakot). These villages are located in Pithoragarh sub-division (29°21'–29°35' N latitude and 80°02'–80°20' E longitude) of Pithoragarh district, Uttarakhand (Figure 1). We surveyed a total of 67 houses in Marsoli Bhat village (traditional stone



Fig. 1. The study was carried out in a few villages of sub-division Pithoragarh of district Pithoragarh in Uttarakhand

masonry houses -32, modern concrete houses -15, partially concrete houses - 20), 52 houses in MunaKote revenue village (traditional stone masonry houses -11, modern concrete houses -22, partially concrete houses - 19), and 61 houses in Balakote revenue villages (traditional stone masonry houses -17, modern concrete houses -23, partially concrete houses - 21) during the survey.

Materials and Methods

The houses were divided into three categories, viz. traditional stone masonry houses (hereafter *Kachcha* houses), modern concrete houses (hereafter *Pucca* houses), and partially concrete houses (hereafter partially *Pucca* houses). Each category comprised 60 houses in three villages. The houses were selected randomly; however, two contiguous houses were avoided for the sampling to reduce the chance of double counting. *Kachcha* houses had stone masonry walls, and slate roofing supported by small wooden logs. The concrete houses were considered as *Pucca* houses (modern houses). In partially *Pucca* houses, roofs were made either of slates or tins, whereas the stone masonry walls were cemented.

We followed the point count method in the survey (Richard *et al.*, 1986). A house along with its courtyard was considered as a sampling unit. In this study, a modified point was a circle with a radius of 10 m. While laying the point in a sampling unit, the care was taken to cover the building area and its courtyard. In hilly areas of Uttarakhand, houses are often built on small land terracing. The premise of a house includes a building and a courtyard. Gener-

ally, a premise is smaller and covered within a small-sized point. Therefore, the radius of a point was measured to be 10 m. All the individuals of House Sparrow sitting on the building, courtyard, and trees, if any within a point, were taken into account while the individuals of House Sparrow flying over the point were not counted for the analysis. While conducting the sampling, we found that the individuals of birds frequently moved around at a point in a short time of period, which increased the chances of double counting. Given this, the time for watching a point was reduced to 5 minutes in the month of January and 3 minutes in the month of March to avoid such types of errors. In order to enumerate the House Sparrow, we took three replicates at each point and recorded the average value at the site. The males and females were counted separately. The values of the months of January and March were averaged to calculate the density of House Sparrow for the final result. We recorded all the nest sites within a point during the months of January and March. We did not take replicates at point for the nests. The values of the months of January and March were averaged to calculate the density of nests for the final result.

After the calculation of averages along with standard deviations, the density of House Sparrow and nests were calculated as the number of individuals/point and the number of nests/point, respectively in *Kachcha*, *Pucca*, and partially *Pucca* houses. We analyzed the sex ratio in the populations of House Sparrow to observe the impacts of environmental conditions on males or females. Each sampling unit was sampled during the morning (0600 – 0800 hrs), afternoon (1200-1400 hrs), and evening (1600-1800 hrs). A sampling unit was surveyed twice (January and March) for each time of period of the day (morning, afternoon, and evening) during the surveys. Thus, a total of 6 sampling efforts were made for each sampling unit.

In order to confirm the impacts of changing housing patterns on the populations of House Sparrow, we performed one-way ANOVA to verify the significance of possible differences in the density of House Sparrow in *Kachcha*, partially *Pucca*, and *Pucca* houses among the different time durations of a day. The same exercise was performed to verify the significance of possible differences in the density of House Sparrow during morning, afternoon, and evening hours among different house categories. Similarly, one-way ANOVA was performed to

verify the significance of possible differences in the density of nests of House Sparrow among the different categories of Houses. We used Chi Square Test (X^2) to estimate the possible variations in the sex ratio of House Sparrow in the different categories of houses at different time durations of a day.

Results

In the present study, *Kachcha* Houses recorded a total of 734, 362, and 201 individuals of House Sparrow in the morning, afternoon, and evening hours, respectively (Figure 2). The sex ratios between males and females (M:F) for the corresponding periods were calculated to be 1:1.0, 1:1.3, and 1:1.5. Partially *pucca* houses recorded a total of 529, 274, and 150 individuals of House Sparrow in the morning, afternoon, and evening hours, respectively. The sex ratios for the corresponding periods were 1:0.82, 1:0.89, and 1:1.11. *Pucca* Houses recorded a total of 451, 219, and 149 individuals of House Sparrow in the morning, afternoon, and evening hours, respectively. The sex ratios for the corresponding periods were 1:0.84, 1.0:1.02, and 1:1.29. The overall sex ratio was calculated to be 1:1.024. *Kachcha* houses recorded high density of House Sparrow (12.23 ± 4.8 , 6.03 ± 2.9 , and 3.35 ± 1.7 individuals/point) in the morning, afternoon, and evening hours as compared to that of partially *Pucca* houses (8.81 ± 3.8 , 4.56 ± 2.2 , and 2.50 ± 1.2 individuals/point) and *Pucca* houses (7.51 ± 4.1 , 3.65 ± 2.2 , and 2.48 ± 1.9 individuals/point). The early morning hours seemed the most suitable time for the activities of House Sparrow (Table 1). The total number of nests recorded from *Kachcha*, partially *pucca*, and *Pucca* houses were 38, 11 and 7, respectively. The majority of nests was recorded in

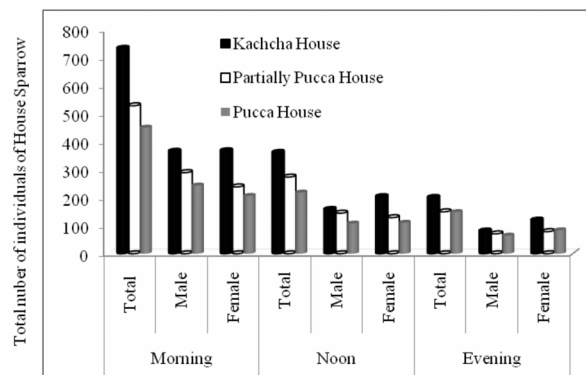


Fig. 2. Number of House Sparrow spotted at different times in different types of houses

Table 1. Density of House Sparrow and nests in different types of houses

Parameter	<i>Kachcha</i> House			Partially <i>Pucca</i> House			<i>Pucca</i> House		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Total number of individuals									
Morning hours	734	366	368	529	290	239	451	244	207
Noon hours	362	158	204	274	145	129	219	108	111
Evening hours	201	81	120	150	71	79	149	65	84
Average density of House sparrow (individuals/point)									
Morning hours	12.23±4.8	6.10±2.9	6.10±3.3	8.81±3.8	4.83±2.3	3.98±2.4	7.51±4.1	4.06±2.5	3.45±2.2
Noon hours	6.03±2.9	2.63±1.6	3.40±2.0	4.56±2.2	2.41±1.5	2.15±1.2	3.65±2.2	1.80±1.4	1.85±1.3
Evening hours	3.35±1.7	1.35±0.9	2.00±1.3	2.50±1.2	1.18±0.8	1.31±1.0	2.48±1.9	1.08±1.0	1.40±1.2
Average Sex ratio (male:female)									
Morning hours		1.00	1.00		1.00	0.82		1.00	0.84
After Noon hours		1.00	1.3		1.00	0.89		1.00	1.02
Evening hours		1.00	1.5		1.00	1.11		1.00	1.29
Average density of nests/point		0.633±0.90			0.183±0.39			0.116±0.32	
Total number of nests		38.0			11.0			7.0	

the month of March. *Kachcha* houses recorded high density of nests (0.633±0.90 number/point) as compared to that of partially *Pucca* houses (0.183±0.39 number/point) and *Pucca* houses (0.116±0.32 number/point) (Table 1).

In *Kachcha*, partially *Pucca*, and *Pucca* houses, the density of House Sparrow differed significantly between the different time durations ($F_{2,177}=104.965$, $P\leq 0.005$; $F_{2,177}=87.235$, $P\leq 0.005$; $F_{2,177}=47.446$, $P\leq 0.005$, respectively). In the morning, afternoon, and evening hours, the density of House Sparrow varied significantly between the different categories of Houses also ($F_{2,177}=19.247$, $P\leq 0.005$; $F_{2,177}=13.627$, $P\leq 0.005$; $F_{2,177}=5.059$, $P\leq 0.01$, respectively). The density of nests varied significantly between the different house categories ($F_{2,177}=13.292$, $P\leq 0.005$).

There was no pattern in the sex ratios in the populations of House Sparrow. The sex ratio differed significantly in the *Kachcha* house category during the afternoon ($X^2=5.845$, $P\leq 0.05$) and evening hours ($X^2=7.567$, $P\leq 0.01$). In partially *Pucca* house category sex ratio differed significantly in morning hours ($X^2=4.916$, $P\leq 0.05$). In other cases, there were no significant variations in the sex ratios.

Discussion

There are certain reasons why we had chosen only the changing housing patterns as a driver of declining populations of House sparrow in this contribution. The undulating topography, rich natural resources, and widely scattered habitats are the special features of the hilly region of Uttarakhand. These typical characteristics limit the developmental

activities in the rural area of Uttarakhand, therefore, a few factors (road transport, cell phone towers, vehicular movement, etc.), which are considered to be responsible for the declining populations of House Sparrow are in poor conditions in the rural areas. These factors were negligible at the studied sites, observed during the field surveys. Due to such reasons, it cannot be attributed to the decreasing populations of house sparrow in the hilly region. Other factors, like agriculture intensification and its ancillary activities, especially in the rural areas, are badly affected by the outmigration in Uttarakhand (Mamgain, 2015). There has been a continuous decrease in its share, and a sizable part of the agricultural land has been abandoned (Mamgain, 2015; Joshi, 2018). Considering this scenario, the agricultural intensification and the use of pesticides can also not be related to the dwindling populations of House Sparrow in hilly areas. One prominent change that can be observed in the rural areas of Uttarakhand is the change in housing patterns for a few decades. In order to avail the more facilities, people have been switching over to modern construction technologies in the rural areas (Sharma, 2015).

Our results revealed that the morning hours and traditional *Kachcha* houses favoured the populations of House Sparrow. *Kachcha* houses were highly conducive for House Sparrow populations and were also preferred for the nest sites. We agreed with the inferences of Rajashekar and Venkatesha (2008) that the abundance of House Sparrow depends largely on the availability of the nest sites. House Sparrow nests in the crevices of roofs, ventilation holes, poles

having boxes, holes available in the house walls, etc. (Vincent, 2005). The traditional *kachcha* houses in Uttarakhand having small wooden logs supported sloping roof, intricate wooden carvings on the doors and the windows, are facilitated with such types of structures and which are suitable for nesting. Whereas modern buildings made of concrete and steel are devoid of holes and crevices (Husby *et al.*, 2006). Nath *et al.* (2019) concluded that the complex 'urbanization gradient' is a limiting factor for the abundance of House Sparrow. Their study at micro habitat level found negative impacts of increasing magnitude of urbanization on House Sparrow. In this study also, the modern concrete buildings were found to be non-conducive for the nesting sites and were anticipated as major threat to House Sparrow in the future. In addition, a study of WII also reported the negative impacts of modern housing pattern on the populations of House Sparrow in the rural areas of Uttarakhand (Rajashekar and Venkatesha, 2008).

Our results revealed that overall sex ratio in House Sparrow was very close to 1, indicating that changing housing patterns did not affect the sex ratio as predictions were made by various authors (Westneat *et al.*, 2002). In the present study, evening hours recorded high density of females as compared to that of males. But due to the absence of a regular pattern of significant variation in the sex ratio, we could not confirm this finding. We suggest more researches on such behavior of House Sparrow.

In recent years House Sparrow attracted the attention of conservationists, ecologists, and various other organizations however, a lot more needs to be done to conserve it. In the past few decades, the declining population of House Sparrow has alarmed not only the conservationists and the ecologists but bird lovers and civil societies. The Nature Forever Society of India (<https://www.natureforever.org/>) is a premier organization in India, which drew the attention of governmental agencies and scientific communities towards the conservation of House Sparrow. The society played a significant role in declaring the World Sparrow Day on 20 March. Various other organizations in India, like Citizen Sparrow Project (www.citizensparrow.in) in collaboration with other governmental and non-governmental organizations have been contributing significantly to the baseline data on, and conservation of House Sparrow, and its public awareness campaign. The baseline data on House Sparrow collected by

the 'Citizen Sparrow Project' from different parts of India indicated the gradual decline in the population of House Sparrow across the country.

The public participation and their cooperation will be inevitable steps towards the conservation of House Sparrow (Khera *et al.*, 2010). In order to conserve the House Sparrow, governmental agencies, non-governmental organizations and civil society groups need to run comprehensive awareness and education programmes (e.g. Bhatt and Pandit, 2019). The people can be encouraged to install the holes and the niches in under-construction new modern buildings. We witnessed a few sparrow lovers, which provided the nest sites in a modern concrete house and House Sparrow was found to accept such structures for nesting (Figure 3). Installation of artificial nest boxes in the modern houses and gardens were also considered to be useful, safe, and valuable



Fig. 3. Artificial nests - a). An artificial nest site was constructed in the modern concrete house by a sparrow lover. This picture was taken from other part of Uttarakhand, b). An artificial nest, installed at a modern house in the study area

measures to protect the House Sparrow (Nath *et al.*, 2019; Shah and Pandey, 2017). The nesting and laying eggs by House Sparrow in these artificial nest boxes were found satisfactory in different parts of the country (Jawale, 2012). The artificial nest boxes can be distributed in rural areas of Uttarakhand with the help of governmental agencies and civil society groups. It is important to mention that more studies are needed on the implications of artificial nest boxes and the responses of House Sparrow to artificial nest boxes. It was observed that the sparrow has different preferences for different types of nest boxes like mud pot box, wooden box, bamboo box, PVC piped box, etc. House Sparrow has the nest site plasticity, however, it is affected by the noise, shaded or non-shaded nesting sites, etc. (Balaji, 2014; Jayaraman *et al.*, 2017).

House Sparrow must also find a suitable place under the Wildlife (Protection) Act (1972) of India, so that people feel a sense of seriousness about its protection. The awareness programmes, mitigation measures mentioned above, and the protection of House Sparrow under the Wildlife (Protection) Act (1972) of India would be crucial for the future of House Sparrow in India.

Conclusion

The anthropogenic stresses on the House Sparrow have been reported from various parts of the world over the years. But its conservation has been overlooked for many years probably, because of its omnipresence status and non-sporting value. During the last 3-4 decades, many researchers, ornithologists, ecologists, and civil societies reported threats to its existence and worked for its conservation also. The researchers reported different types of man-induced factors, which were responsible for the decline of the populations of House Sparrow. The cumulative impacts of the outlined factors were considered as the drivers of dwindling populations of House Sparrow especially, in urban areas. These factors work together in urban areas, but the situation is not the same in rural areas, especially in hilly areas. We concluded that changing housing pattern (modern housing system) was one of the prominent factors in the rural areas of hills of Uttarakhand, which led to the stresses on the populations of House Sparrow. Traditional *Kachcha* house seemed more conducive for the populations of House Sparrow, however, it did not affect the sex ratio. We

opine that the conservation of House Sparrow does not require massive efforts and infrastructure as compared to other 'threatened' species. Given that, mitigation measures mentioned above, public participation, comprehensive awareness, and education programmes would play a significant role in its protection.

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