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Research Article

# Seasonal habitat selection by house sparrows across the urbanization matrix in Delhi, India

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## Abstract

House sparrows are associated with rural and urban regions and are a common species of any urban ecosystem. previous studies confirm that urbanizationand industrialization are two major factors causing the loss of suitable foraging and nesting space in urban areas for house sparrows, contributing to their rapid population decline. In this context, we studied habitat selection by sparrows and influence of season and urbanization on it. Totally 58 transects were traversed from August 2017 to July 2018 to locate house sparrows across five seasons and five urbanization types. Habitat variables for each occupied site and systematically selected sites was quantified. We found that suburban and high-density urban areas were mostly used by the species. Habitat variables like the presence of residential areas, old buildings, vegetation, water, grocery shops, food provision, small eateries, open drainage system and open household waste dump influenced the habitat selection by house sparrows. In order to conserve sparrows in Delhi, it is very important to conserve its habitat or artificially create it by the installation of artificial nest boxes and by providing food and water for them.

**Keywords:** Conservation, east delhi, habitat selection, house sparrow, urbanization.

## Introduction

Urbanization and anthropogenic activities are rapidly changing the ecological conditions of urban areas leading to a change in the distribution and population status of urban birds. In the last few decades, rapid urbanization had caused a devastating influence on biodiversity across the globe. It has both direct and indirect effects on the native bird population structure and composition (Marzluff 2001), by impacting their habitat, food availability, predator diversity, disease outbreaks, competitors etc. As a major consequence of this, common and abundant species has now shown drastic declines in their population to such an extent that their sightings are rare now. House sparrow (*Passer domesticus*) is one such urban bird that has suffered extensively, leading to a massive decline in its population not only in India but throughout the world (Balmori and Hallberg 2007, Dandapat *et al*. 2010).

The house sparrow (*Passer domesticus*) is one of the most widely spread and abundant birds in the world (Shaw *et al*. 2008), having a historical relationship with man (Vincent 2005). It is native to Europe, North Africa, parts of Asia and the Indian subcontinent (Fig. 1). From these parts of the world, it was introduced to the rest of the word either intentionally or accidentally by humans (Hussain *et al*. 2014). In the Indian subcontinent, they are commonly found in India, Pakistan, Bangladesh, Sri Lanka and Maldives (Ali and Ripley 1987).

It being a “Least Concern” as per IUCN Red List, in recent decades, a decline in the sparrow

population has been reported from many countries, with varying rates across rural-urban gradients (Chamberlain *et al*. 2005, Robinson *et al.* 2005, Erskine 2006). Many plausible hypotheses like lack of nesting sites, non-availability of food, electromagnetic radiation, pollution, competition, predation, intensification of agriculture etc. had been put by many scientists. Summer-Smith (2003) reported that the two most important factors likely to have affected the house sparrow population were the lack of availability of the food and the lack of suitable nesting sites. Shaw (2009) conferment the above finding and stated that the major cause of this decline is the small-scale change in its habitat leading to a reduction in suitable foraging and nesting sites.

How a species as common as sparrow could go extinct from many urban centres of the word? It is not only a matter of grave concern but is an ugly reflection of the impacts of urbanization. For any successful conservation programme, it is very important to have critical knowledge of the needs and preferences of a species. In this backdrop, we undertook this study to find out the main habitat variables that lead to the selection of a particular habitat by house sparrows. By conserving such areas or by creating such habitats we can not only conserve sparrows in Delhi but can re-establish its population in areas from where they have become extinct. The main aim of this study was to find out the preferred habitat of sparrow and to see any variation in selection across seasons and urbanization matrix.

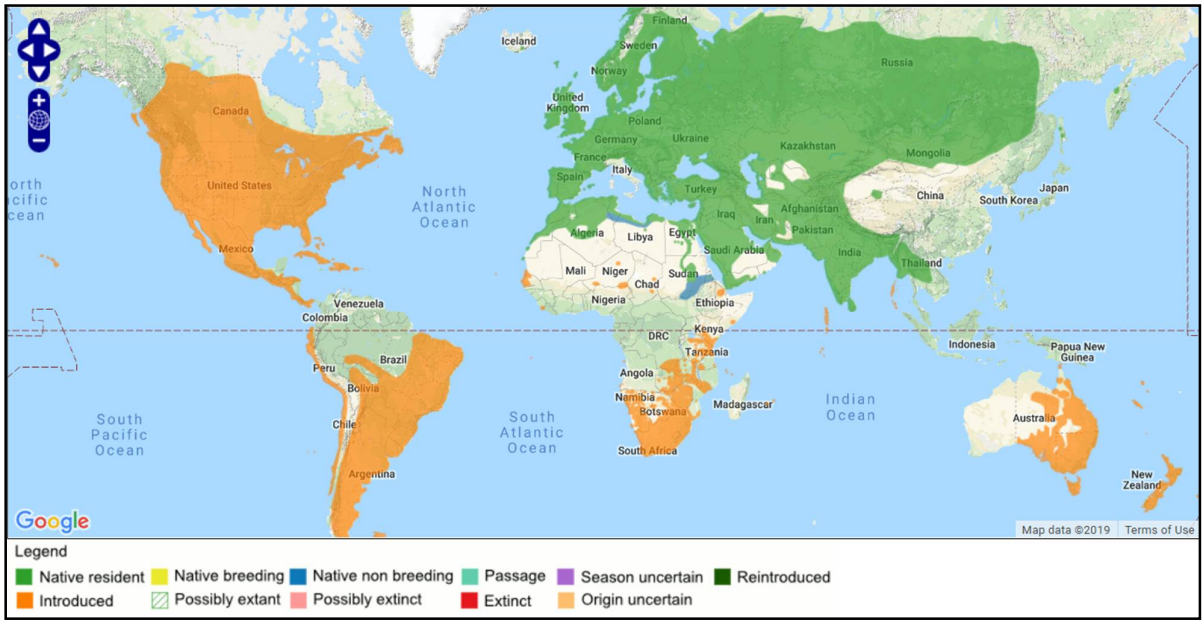


**Figure 1.** Distribution map of house sparrow (Birdlife International 2019)

## Material and method

### Study area

East Delhi (28°38'N, 77°17'E), with a total area of 64km$^2$, is sandwiched between River Yamuna in the West and Uttar Pradesh state in East and South. Though a relatively small administrative unit of Delhi, it has a variety of urbanization matrixes. For our study, we classified the study area into five urbanization types: agricultural area (AR), suburban area (SUA), high-density urban area (HDUA), medium-density urban area (MDUA) and low-density urban area (LDUA) based on the degree of urbanization (Fig. 2). As per 2011 census,

population of East Delhi is more than 16 million people (Census, 2011) where the density is more than 26500 people km$^2$. Based on the temperature and humidity, the study period was divided into five seasons: winter (November-January), pre-summer (February-March), summer (April - June), monsoon (July-August), post-monsoon (September-October).

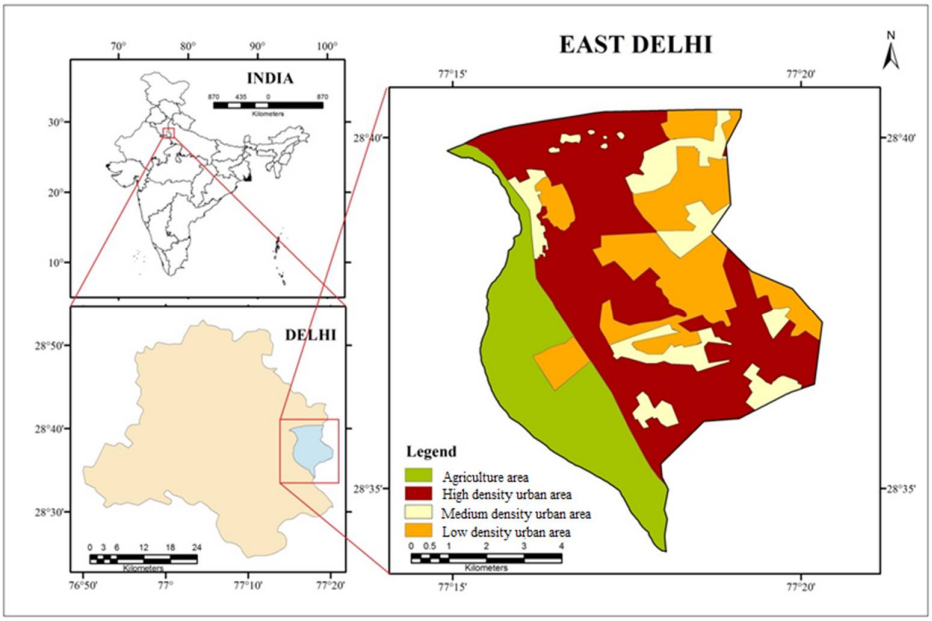


**Figure 2.** Study area and classification of different urbanization matrix

**Data collection**

The study area was divided into grids of one km$^2$ in order to maintain the homogeneity of habitat. In each grid, one transect of 500m long and 20m wide was laid. A total of 58 transects were walked monthly across different urbanization types (AR = 12 transect, SUA = 10, HDUA = 18, MDUA = 11 and LDUA = 7) to locate house sparrow during the study period (August 2017 to July 2018). The number of transects was in the proportion of area occupied by different urbanization types.

For each occupied location following habitat variables were recorded: urbanization type (AR/SUA/HDUA/MDUA/LDUA), macro site (residential area / shops / open area / park / school / plant nursery / vegetable market etc.), type of buildings (old / new/ old and new / mud houses), distance to nearest vegetation patch (one plant/tree to a group of plants/trees), type of vegetation (herb & grasses / shrubs & creepers / tree), distance to water source, distance to grocery shop, distance to small eatery, distance to food provision, type of drainage system (open/ closed), type of household waste disposal system (open dump / no dump) and presence of other bird species. For habitat availability, the above habitat variables were recorded within 50m radius at every 100m on 58 transects.

**Statistical analysis**

For data analysis, SPSS *v.* 25 was used and Microsoft Excel was used for plotting graphs and tables. Data were segregated based on season and urbanization type. Continuous variables like distance to vegetation, water, grocery shop, small eatery and food provision were analysed using non-parametric Kruskal Wallis H test to check for any seasonal similarities or dissimilarities in distances of occupied sites from habitat variables across urbanization types. Phi coefficient matrix was computed for dichotonomous data like macro sites, type of vegetation and presence of other bird species to check for any degree of association across seasons and urbanization types. Pearson correlation was used to check

for any multicollinearity among different habitat variables like urbanization type, types of buildings, presence of vegetation, water, grocery shop, small eatery, food provisioning, the drainage system and household waste disposal type. Non-correlated variables were subsequently used for multinomial logistic regression to quantify how the habitat variables influence the habitat selection by house sparrow.

## Results

A total of 5143 locations of occupied habitat by house sparrows were recorded during the study period covering five seasons. The maximum number of locations was recorded from suburban areas (3052) while the least was recorded from low-density urban areas (Fig. 3). There was a significant difference in the seasonal sighting across urbanization types ($\chi^2 = 26.179$, df = 4, $p < 0.05$).

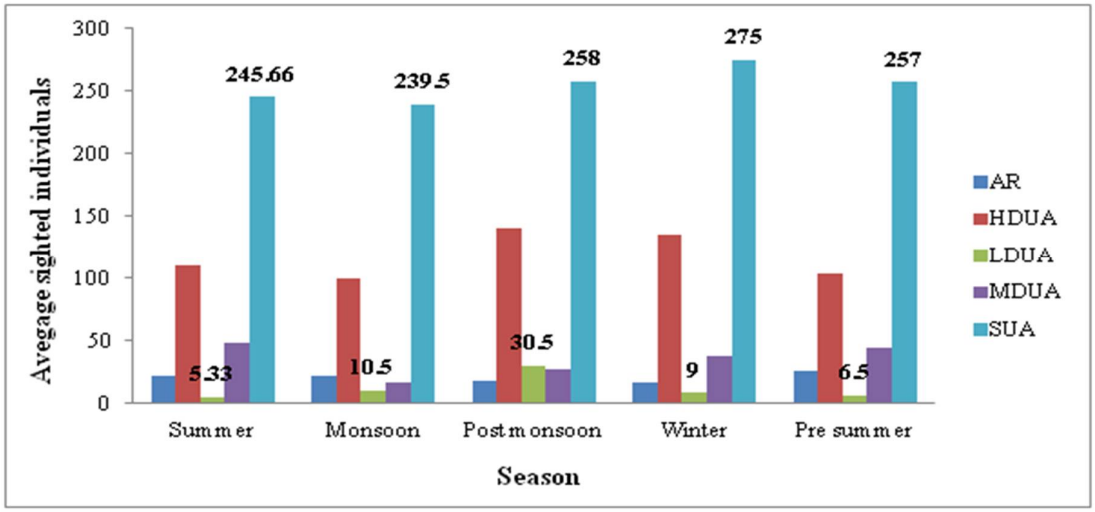


**Figure 3.** Average sighted individuals across different urbanization matrix in different seasons.

There was no significant difference in the distance to vegetation, water, grocery shop, small eatery and food provision for different seasons ($\chi^2 = 1.362$, df = 4, $p = 0.745$) but a significant difference was observed for different urbanization types. The distance to vegetation ($\chi^2 = 35.011$, df = 4, $p = 0.000$), water source ($\chi^2 = 18.757$, df = 4, $p = 0.001$) and food provisioning ($\chi^2 = 18.226$, df = 4, $p = 0.001$) varied significantly while distance to grocery shop ($\chi^2 = 0.131$, df = 2, $p = 0.936$) and small eatery ($\chi^2 = 5.490$, df = 4, $p = 0.241$) did not varied significantly across different urbanization types (Fig. 4). The average distance from different habitat variables from the occupied site is given in figure 5.

As per the minimum adequacy model at 95% confidence level ($\Delta$ AIC =187.472, $\chi^2$ =215.436, df = 14, $P < 0.001$), habitat selection by house sparrow was a function of urbanization type (HDUA and SUA), old buildings and a mixture of old and new buildings, presence of vegetation, water source, grocery shop, small eatery and food provisioning, open drainage system and open household waste dumps (Table 1).

Based on the phi coefficient matrix (Table 2), habitat section by sparrow was positively related to residential area (r = 0.438, $p = 0.03$), grocery shop (r = 0.389, $p = 0.02$) and open areas (r = 0.247, $p = 0.002$). While the presence of park and agricultural area had a slightly negative correlation with habitat selection. The impact of school, vegetable market and offices were not significant. Among vegetation types, trees (r =0.402, $p = 0.000$) and shrubs and creepers (r = 0.553, $p = 0.002$) were positively correlated with habitat selection by house

sparrow (Table 2). *Lawsonia inermis* (mehendi), *Ziziphus mauritiana* (ber), *Prosopis spp, Combretum indicum* (Rangoon creepers) and *Bougainvillea glabra* (bougainvillea) were the most preferred shrubs and creepers. The presence of myna (r = -0.326, $p$ = 0.000) showed a negative correlation while crow and pigeon had no significant impact on house sparrow's habitat selection (Table 2).

**Table 1.** Results of multinomial logistic regression for the selection of habitat variables by house Sparrow

| HABITAT VARIABLE | B | SE | *P* |
|---|---|---|---|
| Intercept | -22.16 | 0.706 | 0 |
| **Urbanization gradient (HDUA)** | **-3.41** | **0.79** | **0.005** |
| Urbanization gradient (MDUA) | -1.73 | 0.92 | 0.071 |
| Urbanization gradient (LDUA) | -1.9 | 1.25 | 0.056 |
| **Urbanization gradient (SUA)** | **-3.83** | **0.776** | **0.008** |
| Urbanization gradient (AR) | 0[b] | - | - |
| **Type of building (old)** | **1.129** | **0.41** | **0.006** |
| Type of building (new) | -1.046 | 1107.54 | 0.988 |
| **Type of building (old & new)** | **2.468** | **1.613** | **0.017** |
| Type of building (mud houses) | 0[b] | - | - |
| **Vegetation (present)** | **12.472** | **0.396** | **0.003** |
| Vegetation (absent) | 11.49 | 0. 432 | 0.412 |
| **Water (present)** | **1.316** | **0.372** | **0.004** |
| Water (absent) | 0[b] | - | - |
| **Grocery shop (present)** | **2.274** | **0.416** | **0.001** |
| Grocery shop (absent) | 0[b] | - | - |
| **Small eateries (present)** | **-1.509** | **0.353** | **0.016** |
| Small eateries (absent) | 0[b] | - | - |
| **Food provision (present)** | **2.108** | **0.629** | **0.017** |
| Food provision (absent) | 0[b] | - | - |
| **Drainage system (open)** | **-1.123** | **0.482** | **0.045** |
| Drainage system (close) | 0[b] | - | - |
| **Household waste (open dump)** | **4.372** | **0.519** | **0.004** |
| Household waste (no dump) | 0[b] | - | - |

**Table 2.** Result of Phi coefficient showing the influence of different macro sites, type of vegetation and other birds species on the habitat selection by sparrow

| MACRO SITES | r | Sig. | VEGETATION TYPES | r | sig |
|---|---|---|---|---|---|
| Residential area | 0.438 | 0.03 | Trees | 0.402 | 0 |
| Shops | 0.397 | 0 | Shrubs and creepers | 0.353 | 0 |
| School | 0.022 | 0.794 | Herbs and grasses | 0.08 | 0.044 |
| Park | -0.117 | 0.005 | Other avian species | r | Sig |
| Vegetable market | 0.075 | 0.057 | Pigeon | 0.024 | 0.558 |
| Open area | 0.247 | 0.002 | Crow | 0.063 | 0.132 |
| Agriculture area | -0.198 | 0 | Myna | -0.326 | 0 |
| Plant nursery | -0.098 | 0.018 | | | |
| Offices | -0.081 | 0.053 | | | |

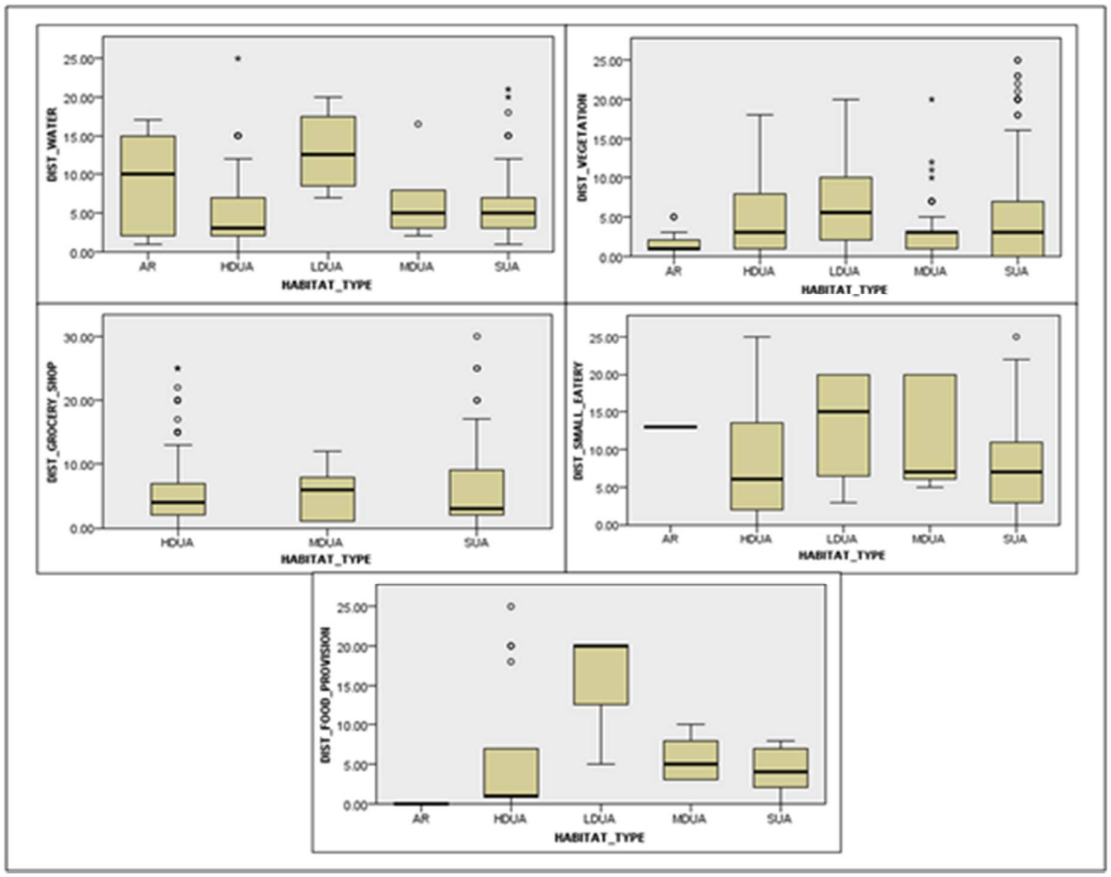


**Figure 4.** Distance (m) of different habitat variables from house sparrow location across urbanization matrix.

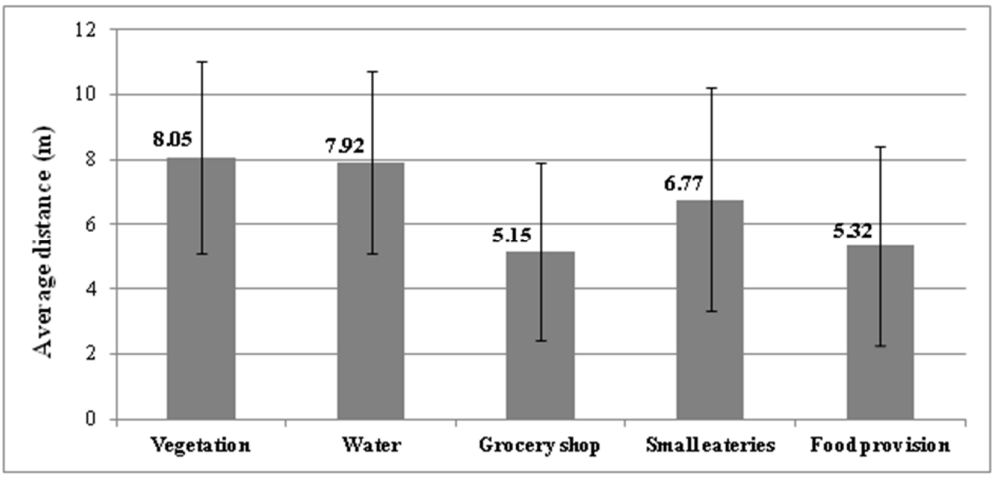


**Figure 5.** Average distance (m) of different habitat variables from house sparrow location

## Discussion

Birds have been one of the best bioindicators of any ongoing change in our environment (Bhattacharya *et al*. 2011). The changes in their population, community structure, behaviour patterns and reproductive ability have most often been used to assess the ecological status of any given ecosystem. The house sparrow is one such species, which is closely associated with humans (Chamberlain 2007) and thus serves as an excellent indicator for a given

ecosystem (Shaw *et al*. 2009). They are very sensitive to even a slight change in the environment. They have developed a commensal relationship with humans and therefore are associated mainly with human-dominated habitats including rural, urban and agricultural areas (Lowther and Cink 1992).

Habitat selection by house sparrows in the present study varied significantly across seasons and urbanization types. Habitats in suburban and high-density urban areas were extensively used, due to the availability of nesting sites and food for both adults and nestlings (Balaji *et al*. 2013). The least used habitats were from low-density urban areas and agricultural areas, might be because of non availability of nesting sites in modern buildings. Modak (2005) also recorded large number of sparrows from high-density urban areas and suburban areas compared to medium and low-density urban areas. Whereas Siriwardena *et al*. (2002) reported maximum sparrow sightings from suburban and rural areas compared to agricultural areas. The low socio-economic condition of people living in suburban and high-density urban areas created best-suited habitat for sparrows (Kanaujia *et al*. 2015). These areas being dominated by old buildings, had lots of conventional grocery stores, open drainage system and open household waste dumps which provides lots of nesting space and food to sparrows (Crick *et al*. 2002, Balakrishnan *et al*. 2011, Balaji *et al*. 2013, Sudhira and Gururaja 2013, Nath *et al*. 2015).

Proximity to resources is a major factor in habitat selection by birds as it maximises their efforts by reducing time and energy spent in foraging distant grounds. The study reported no significant seasonal difference in the distances of habitat variables from occupied sites. No seasonal difference indicated that house sparrow's needs and preferences remained same throughout the year, irrespective of breeding or non-breeding seasons. Distance to vegetation, water source and food provision was significantly different for different urbanization types, as, their availability was not constant and sparrows might had traded off the proximity for some other factor. Whereas distance to grocery shops and small eateries did not vary significantly across urbanization types, indicating their importance for house sparrows. Though their availability was not constant still if available their proximity mattered to sparrows, as grocery shops and small eateries provided food to them.

Macro sites like residential areas (Chamberlain *et al*. 2007), grocery shops (Balakrishnan *et al*. 2013) and open areas had a positive effect on habitat selection by sparrows. These areas provided nesting places, food for both adults and nestlings, roosting and foraging grounds. Presence of parks, agricultural areas and plant nursery had a negative impact due to the presence of predators or competitors (Kanaujia *et al*. 2015). Medium-sized bushy vegetation like *Lawsonia inermis* (mehendi), *Ziziphus mauritiana* (ber), *Prosopis spp, Combretum indicum* (Rangoon creepers) and *Bougainvillea glabra* (bougainvillea) were preferred by sparrows, used extensively for roosting, foraging and as escape cover (Dhanya and Azez 2010). Presence of competitors like myna was avoided by sparrows while selecting their habitat (Khera *et al*. 2010) .

## Conclusion

The current study elucidated the habitat selection across seasons and urbanization types. Maximum used habitat was reported from suburban areas and high-density urban areas while least were reported from low density and agricultural areas. There was no seasonal difference in habitat selection by sparrows. Presence of residential areas, old buildings, grocery shops, small eateries, the open drainage system and open household waste dumps plays an important role in habitat selection. By conserving areas providing the above habitat variables we can conserve house sparrows.

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