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Roosting site selection by Indian House Crow (*Corvus splendens*)

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Abstract
Roosting is a typical bird behaviour where a group of individuals congregate in an area for a few hours effected by an environmental signals and return to the same site with the reappearance of these signals. Present study was planned to know the selection criteria for roosting sites in House crows (*Corvus splendens*). To test the roosting site characteristics seventeen parameters were assumed which had covered the broad aspects such as roost site characteristics, land use around sampling sites and anthropogenic pressure. Roost trees significantly tended to be taller by 25.39% more in tree height (t Stat=3.0182>t Crit, 0.01>P value) and 36.45% more in canopy height (t Stat=5.470>t Crit, 0.01>P-value) compare to non-roost trees. While comparing the distance from feeding sites with non-roost sites, the roost sites were observed to be selected near to feeding sites as nearest feeding sites were 1379.5m significantly nearer than non-roost sites (t Test=3.619>t Crit, 0.01>P value). The distance of nearest tree (average distance of trees from four direction) from the roost sites was 33.34±26m which was 100.67 m nearer than non-roost sites (t=4.356>t crit, 0.01> P-value). Larger trees with greater canopy, nearby human habitation which provide them shelter and safety along with anthropogenic feeding opportunities and moderate vegetation patches near the roosting places were the characteristics preferred for roosting purpose by house crows.

Keywords: Roosting Sites, Junagadh, Rajkot and House crow (*Corvus splendens*).

Introduction
Roosting is a typical animal behaviour where a group of individuals congregate in an area for a few hours effected by an environmental signals and return to the same site with the reappearance of these signals (Finkbeiner *et al.* 2012, Richner *et al.* 1996) [6, 13]. Roosting behaviour is also observed in bats, primates, and insects but it is most common among birds (Beauchamp and Guy 1999) [1] which could be in thousands to millions of individuals in one roost (Pérez-García 2012) [12]. Belonging to corvidae family, house crows (*Corvus splendens*) are known to form larger communal roosts which contain a few hundred to over thousands of individuals (Ian 1977, Coombs 1961) [8, 2]. A study in Singapore found that house crows are very common near human habitations and often busy streets and preferred to roost in area with human activities and presence of human settlements (Kelvin *et al.* 2002) [9]. They also prefer to roost close to feeding opportunities and in taller trees with dense crowns which is enclosed by tall-buildings (Kelvin *et al.* 2002) [9]. The present study was intended to identify the roosting site selection characteristics for the house crows (*Corvus splendens*). The survey was done by studying roosting site of house crows at Junagadh and Rajkot cities of Gujarat.

Methodology
To test the roosting site selection criteria seventeen parameters listed in Table 1 were assumed which had covered the broad aspects such as roost site characteristics, land use around sampling sites and anthropogenic pressure. From total twelve roost sites, seven regular roost sites (3 roost sites from Rajkot and 4 roost sites from Junagadh) were selected to test the parameters. Further these parameters were compared with non-roost sites which were selected randomly in the study area which had the structure of cluster of trees same as roost sites.

Roost site characteristics
Tree measurements i.e. tree height, GBH, canopy height, canopy width, canopy density were measured and numbers of trees occupied were counted. If a roost site comprised ≥ 2 roost trees, average of all tree measurements was taken to be consider. Distance between roosting trees forming one roosting site was measured.

The distance from the base of the selected tree trunk to the nearest adjacent tree (average distance of trees from four direction), nearest road and nearest street lamp. Distance from the base of the trunk to surrounding buildings was the mean distance to the nearest buildings in 4 cardinal directions. The distance of nearest building from tree trunk as well as the area (length × width) of building was calculated that faced the roost tree. The average distance of three nearest feeding opportunity from roost trees was measured.

Land use around roost sites

Because selection of roost trees could be based on land use surrounding a site, the percentage of area covered by different types of land use around roost and noon-roost trees was determined. For assessment, all roost trees and non-roost trees were placed on google earth map and circle with a 1000 m radius was drawn, centred on the position of each tree. From the detailed map of google earth the percentage of different types of land use was estimated within the circle. A concrete environment was considered as built area. Open space consisted of cleared land, roads, play grounds and waste lands. Vegetation comprised areas covered by unmanaged vegetation, parks and over grown wastelands. Water included areas of rivers, lake, ponds and canals.

Human-activity indices

A human-activity index (Gorenzel and Salmon 1992) was composed of multiple components, each given a score based on potential human activity near roosting birds; the higher the score (range=1 to 480), the greater the potential human activity. Components consisted of distance to the nearest building (1=>30m, 2=> 2=30m, 3=>15-20m, 4=>7-15m, 5=0-7m); distance to nearest railroad track (1=>150m, 2=0-150m); night time traffic on the nearest road 1=0-10 vehicles per 10 m, 2=> 10 pedestrians per 10 m). The number of vehicles on the nearest road, number of pedestrian were obtained through ten min surveys conducted at 2000. Individual components of human-activity index were rated for all roost and non-roost sites. The human-activity index was derived by multiplying the scores of each individual component.

Table 1: House crow roost site characteristics of seven house crow roost sites and non-roost sites.

No.	Roost site Characteristics	Roost Sites	Non-roost Sites
1	Tree height	18.67±9m	13.2±21m
2	Canopy height	11.8±10m	9.4±21m
3	Diameter at breast height	2.45±5.2m	1.12±3.2m
4	Canopy density	91.5±10	73.6±21
5	Canopy cover	98.4±14m	43.54±3.5m
6	Distance from nearest tree	33.3±12m	67.5±34.2m
7	Distance from nearest road	49.1±28m	82.3±54m
8	Distance from nearest feeding site	293.9±128m	1673.55±213.2m
9	Distance from nearest street lamp	30.7±10m	612.3±32m
10	Distance between roost trees	7.45±3m	25.65±10.2m
11	Average distance to surrounding building	62.1±9m	109.4±2.3m
12	Dimension of nearest building	1342.5±28m^2	967±103m^2
13	Built environment	65±32%	45±21%
14	Open space	22.7±12%	30±24%
15	Vegetation	18.4±16.2%	10±11.2
16	Water	1.8±1.4%	5.9±11
17	Human Activity index	71.4±34	45.7±86

Result

Roost site selection

Roost trees significantly tended to be taller by 25.39% more in tree height (t Stat=3.0182>t Crit, 0.01>P value) and 36.45% more in canopy height (t Stat=5.470>t Crit, 0.01>P-value) compare to non-roost trees (Fig. 1.1). Further roost sites had larger DBH by 69.38 % (Fig. 1.1) and denser crowns by 17.9% more than non-roost sites. However significant difference was not observed. Thus the greater DBH and higher canopy density were not required for roosting as crows were also observed to roost in moderate canopy density.

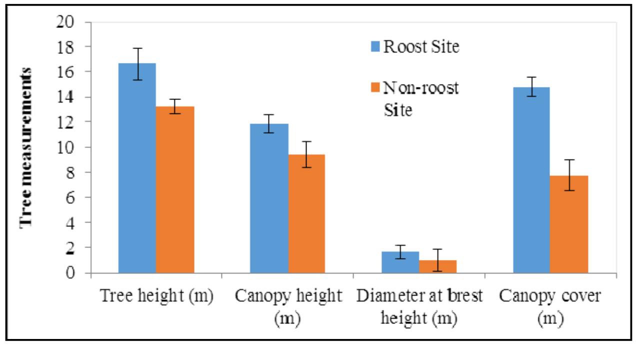

Fig 1: Tree measurements of roost and non-roost site

Canopy cover was 91.54% significantly larger than of non-roost sites (t=5.145>t crit, 0.01>P-value). Therefore by comparing the roost site characteristic with non-roost sites; the tree height, canopy cover and canopy height were found to be selection standards for roosting among all tree characteristics. The distance of nearest tree (average distance of trees from four direction) from the roost sites was 33.34±26m which was 100.67 m nearer than non-roost sites (t=4.356>t crit, 0.01> P-value) (Fig. 1.2). This states that they prefer to roost in area nearby the high vegetation comparatively.

Out of 12 roost sites, 8 roost sites were observed to roost near to active roads and street lamps. The distance of roost site from nearest road and street lamp were nearer by 33.18m (t Stat=5.590>t crit, 0.01> P value) and 581.55m (t Stat=6.953>t crit, 0.01> P-value) respectively than non-roost sites (Fig. 1.2). Average distance to surrounding building was 47.29 m near than the non-roost sites (Fig. 1.2).

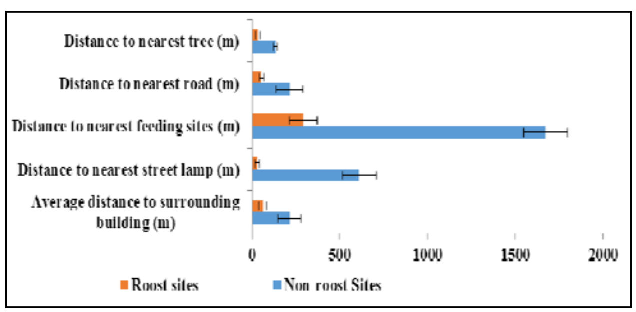

Fig 2: Distance of various anthropogenic features from roost and non-roost sites.

The building that faced roost trees also tended to have greater area than non-roost trees by 38.83%. Thus they prefer to roost near existence of human activates. Human-activity index was found to be 56.26 % significantly higher (t Test=4.739>t crit, 0.05> P value) than non-roost sites (Fig. 1.3).

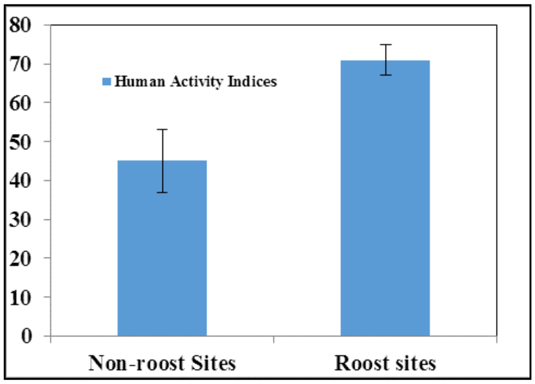

Fig 3: Human activity indices of roost and non-roost sites.

While comparing the distance from feeding sites with non-roost sites, the roost sites were observed to be selected near to feeding sites as nearest feeding sites were 1379.5m significantly nearer than non-roost sites (t Test=3.619>t Crit, 0.01>P value).

Most stable roost sites were observed to roost near the human habitats which was enclosed by settlements which may provide them protection from predation as well as receiving advantage to acquire warmness during low temperature. The widespread and repeated plantation of tall trees was a specific characteristic of roost trees. The distance between the roost trees was from 7.45±3 meter and it was 18.11 meters lesser than non-roost sites. Therefore the distance between roost trees was also very important factor for selecting roost sites. These clusters of trees with less distance make merged crows of all trees and may be helpful to effectively scan for potential predators and which also provide uniform and compact vertical arrangement of perch sites.

Compare to non-roost sites, areas around roost sites had significantly 28.30% more built area (t Stat=8.338>t Crit, 0.01>P-value) (Fig. 1.4). Vegetation cover was found to be 97% more around roost site compare to non-roost sites (Fig. 1.4) which was also significantly high (t Stat=5.922>t Crit, 0.01> P-value) than non-roost site (Table 5.17). Open space around roost site was 17% lesser than non-roost site (Fig. 1.4).

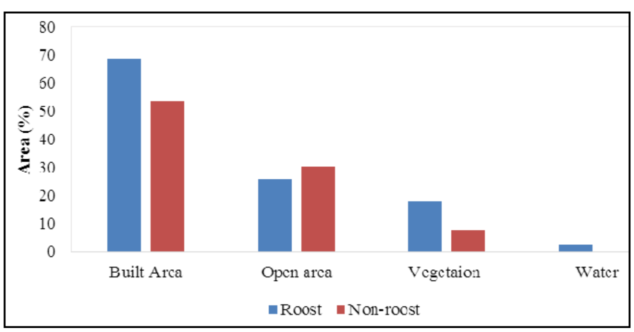

Fig 4: Area percentage of land use categories around Roost and Non-roost sites

However no significant difference was found. Thus crows were observed to roost in high anthropoid habitat with the belt of vegetation.

Discussion

Roost site selection

Larger trees with greater canopy, nearby human habitation which provide them shelter and safety along with anthropogenic feeding opportunities and moderate vegetation patches near the roosting places were the characteristics preferred for roosting purpose by house crows. Following conditions were particular for roost site selection by house crows.

Roosting near to availability of food

The primary requirement of the roosting birds is availability of plenty suitable roost trees in the proximity to suitable foraging sites. Studies on European starlings (*Sturnus vulgaris*), common grackles (*Quiscalus quiscula*) and American robins (*Turdus migratorius*) have revealed that roost sites were selected on the basis of their proximity to good foraging areas. Common ravens (*Corvus corax*) were observed to roost within 1 km of human-related food sources (Engle *et al.* 1992) [5].

Crows were observed to prefer roosting in areas where ample of food was available that can reduce commuting flight costs. Thus distance from foraging grounds from the roost (Vyas 1996) as well as propinquity to food sources was a very important factor in roost-site selection (Elsere 1984) [4].

Selection of trees with larger crowns and greater heights for roosting

The crows used a verity of trees which had greater height and larger canopy cover for roosting in the study area. Selection of large and dense crowns for roosting was because it may greatly reduce wind velocity and thus may provide protection against convection and heat loss (Walsberg 1986) [15]. These trees provide protection from ground predator with its slender and tall trunk which was difficult to climb. Very few predatory threads to the crows at roost sites were recorded during the study period with the presence of domestic dog (*Canis familiars*), domestic cat (*Felis catus*) and raptors found to roost around the roosts. By roosting in trees with greater trunk height, the crows achieved greater distance from the pedestrians below. However the selection of tall roosts against wind exposure appeared as a probable compromise between possible anti-predator advantages and energetics disadvantages (Draulans and Vessem 1986) [3].

Distance between roost trees

The distance between roost trees was also very important factor. The average distance between roost trees was 7.47 metre. Well-spaced roost trees but not more than 10 metre between in urban areas may provide protection, since crows may be able to effectively scan for potential predators such as human, snakes and cats. The widespread and repeated plantation of tall trees was most favourable roosting habitat. Live and unbroken canopy cover of the preferred trees provided uniform and compact vertical arrangement of perch sites. This suggests the foliage preference by the crows. It helps the birds in minimizing loss of the clear skies (Morse 1980) [10]. Roosting of the crows in several patches even within a roost sites was observed due to the availability of discrete patches of vegetation. Further, patchy vegetation at the roost sites probably provides clues to locate the roost from a distance.

Roosting near to human places

Urban areas may offer protection against native predators (Elserer 1984) [4] and therefore predator defence also may be one of the explanations for crows roosting in highly urbanised and less vegetated areas. Most stable roosting sites may be achieved by selecting trees that more closely surrounded by human settlements, possibly provided protection from predation. All the roost sites except two in study area were found to be ensuing at very anthropoid habitation. This was also because house crows roosting in urban areas appear to be more tolerant to people (Wee 1989) [16]. Other benefit was also that they got maximum amount of food from various anthropogenic opportunities within the cities, therefore not going far and roosting where the food was available which reducing their cost of flight.

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