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Research Article

Analysis of Artificial Nest Inhabitancy and Factors Affecting Their Inhabitation of Different Avian Species in Uvas C-Block Pattoki Pakistan

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Abstract

Artificial nesting is considered as a common experimental practice throughout the world. Artificial nest boxes offer a convenient way for carrying out experiments, identifying birds and capturing birds for research and conservation. Studies on the effects of urbanization on birds has revealed that species richness is negatively impacted by urbanization and fragmentation which decreases bird diversity while increasing bird density. This study was designated to determine the inhabitancy of birds inside artificial nests as well as enlists the factors which affect the inhabitation of birds in such nests. The experiment was conducted at the University of Veterinary and Animal Sciences, C-Block, Ravi Campus, Pattoki. Google Earth Pro (a software) was used to take the satellite image of experimental site. Further, geo-referencing and digitization of image were done by using ArcGIS *version 10.1*. This digitized image was categorized into four classes as roads, barren, buildings, ponds and agricultural land for quantification of land use of experimental site. Ten types of artificial nests varied by nests shapes, size and material were installed at five selected sites named as building site, barren site, pond site, road site and agriculture land site. Total sixty (n=60) artificial nests were installed at five nest sites, hence each site possessed twelve nests supported with iron wire and nails. All of these nests were installed approximately among 4 and 5m above ground. A measuring tape (40 feet) was used to measure the height of each tree by the yardstick measuring method. The area obtained after the digitization of the boundary of (UVAS) C-Block was 46.03 hectares. The findings indicated that throughout the trial's last three months (January, February, and March), twelve nests out of sixty were occupied at the ponds site, H.S-1, and botanical garden whereas others were remained unoccupied. The overall rate of occupancy was 20%. Further, eight nests were those where in birds' activities were observed. It is concluded that inhabitancy of birds inside artificial nests is influenced by both natural and anthropogenic factors including the presence of water, food sources, human activities nesting sites and predators. This study will contribute to provide information that helpful that will be helpful for the future conservation of birds and wildlife management.

Keywords: Artificial nest, inhabitancy, anthropogenic factors, occupied

1. Introduction

he artificial nest boxes provide an easy way for experimental observation, manipulation of eggs, identification of birds, and capturing the birds for experiments and conservation. The extensive use of artificial nest boxes has contributed to remarkable progress in our knowledge of physiology, behavior, and ecology. The nest boxes are widely used by cavity-nesting birds', especially small passerines [1].

Bird's visitation towards trees could be practiced to increase by adding artificial nest boxes at the native trees. The large trees

have significant importance and provide unique natural hollows to birds for breeding [2]. Natural nest sites provide significant habitat for birds to breed in terms of population dynamics especially in forest systems where harvesting or urbanization destroy nests. The nest boxes usually have a long life. These nest strategies can be reused again and again across several breeding seasons by breeding pairs [3]. Occupancy of artificial nest boxes could be increased by using the nest boxes with different entrance sizes for different hollow nesting species. Targeting occupancy depends upon landscape context. It is not majorly affected by tree size [4].

Understanding the factors that affect the features of birds communities that using urban parks at both the patch and landscape-level is significant to affective management towards to focus management attempt towards increasing bird's diversity [5]. Urban communities of birds are greatly affected by urbanization causing reduce in birds' species richness and diversity but an increase enhances overall birds' diversity [6]. The species richness and diversity of different feeding guilds are affected by the total area being the most impacted groups. Thus, an increase in the total area would be more favourable to insectivores and granivores compared with feeding guilds [7].

The impact of urbanization on birds found that as an area becomes more urbanized, the diversity of birds' decreases but the density of birds population increase [8]. The design of nests is also influenced by the risk of predation above the ground. The important determinant of reproductive success is the selection of a safe nesting site. Some birds have been appeared to select a site for nesting in those places where there the risk of predation is reduced [9].

Light has a remarkable effect on a bird's biology, behaviour, and physiology. The fitness of offspring is greatly affected by illumination. It also includes the process of acceleration of embryo development, stimulation of skeleton growth, and regulation of the sleep-wake cycle [10]. The availability of insects as a food source is a key factor controlling the dispersal pattern of insectivores. So, this proves beneficial to improve bird's diversity through targeted management actions [11]. Birds use temperature as a signal of seasonal development to adjust this breeding cycle, which proves useful nesting health [12]. Avoidance behavior could minimize the influence of nest predation risk. For example, nesting activities near the habitat boundaries may increase exposure nests towards the predator. The exposed nests are more predated. Increased level of predation of artificial nest boxes examined near to the habitat boundaries in forest patches [13] in open grasslands habitat and for artificial and the nests in marshlands [14].

The anthropogenic pressure over any territory is due to a lack of space. The lack of space, especially through built-up area expansion is at the expense of agricultural land and changes. This kind of pressure negatively affects the quality of life, through pollution and congestion [15]. It is estimated that 2.9 billion birds of almost all biomass in North America have been lost due to the urbanization fragmentation, climate change and other landscape factors [16]. The urbanization and fragmentation have a negative impact on species richness. Individual species response is varied [17,18]. These declines have greatly been moved by land drainage and intensification of agriculture management resources required for nesting and chick-rearing [19, 20, 21].

Biodiversity strategies sometimes look to compensate for the loss of habitual hollow-bearing trees removed during the development of road and housing construction by adding the nest boxes on the smaller trees as replacement space for hollow using fauna [22].This study examines the occupancy dynamics of artificial nests and identifies key factors influencing birds' habitat selection and nesting behavior with a focus on understanding the complex interactions between environmental variables, nest characteristics, and bird community composition.

2. Materials and Methods

2.1. Quantification of land use of (UVAS) C block, Pattoki

Quantification of land means giving numbers to describe different features of a piece of land. This includes measuring how big the land is, like calculating its size in square meters, acres, or hectares by using advanced techniques.

2.2. Experimental site

The experiment was conducted at the University of Veterinary and Animal Sciences, C-Block, Ravi Campus, Pattoki. Ravi campus is situated in Pattoki which is a city in the Kasur District of the Punjab province of Pakistan. In June 2002, on the upgraded of the college of Veterinary Sciences to the status of the University, Punjab Government allotted about 1000 Acres at Pattoki for the establishment of the sub-campus for the education and research work activities. Ravi campus Pattoki has four blocks named as A-Block, B-Block, C-Block, and D-Block.

2.3. Materials

Google Earth Pro was used to search about UVAS C-block. First, we observed all images (including historical and latest) of C-block. A KML (The KML file is a Keyhole Markup Language file commonly used for geographic visualization in applications like Google Earth) file (Coordinates information) was developed and four points were marked, and the image was saved. The overview of the satellite image of (UVAS) C Block, Ravi campus is shown in Figure 1.

2.4. Google Earth Pro

Google Earth is a computer program that renders a 3D representation of Earth-based primarily on satellite imagery [23]. The program maps the Earth by covering up satellite images, aerial photography, and GIS data onto a 3D globe, allowing users to see cities and landscapes from various angles. Users can explore the globe by entering addresses and coordinates, or by using a keyboard or mouse. The core technology behind Google Earth was originally developed at Intrinsic Graphics in the late 1990s. At the time, the company was developing 3D gaming software libraries. Google Earth now covers more than 98 percent of the world and has captured 10 million miles of Street View imagery, a distance that could circle the globe more than 400 times.

2.4.1. Procedure

By using Google Earth Pro, UVAS C-block was searched. First, we observed all images (including historical and latest) of C-block. A KML file (Coordinates information) was developed and four points were marked, and the image was saved.

2.5. Geo-referencing

Geo-referencing means associating something with locations in physical space. The term is commonly used in the GIS field to describe the process of associating a physical map or raster image of a map with spatial locations. Geo-referencing may be applied to any kind of object or structure that can be related to a geographical location such as point of interest, roads, places, bridges, or buildings.

2.5.1. Procedure

In the procedure ArcGIS (10.1) software was used and selected WGS 1984 as the geographic coordinate system [24]. The raster image of C- Block UVAS which we took from Google earth pro was added. The image was geo-referenced.

Figure 1. The overview of the satellite image of (UVAS) C Block, Ravi campus.

2.6. Digitization

The result is the representation of an object, image, sound, document, or signal by generating a series of numbers that describe a discrete set of points or samples. Digitization is of crucial important to data processing. The digital data can more

easily be stored and accessed and also migrated to new stable formats as needed this is why it is the favored way of presenting information for many organizations around the world. Editor Toolbar is used in digitization [25].

2.6.1. Procedure

A software Arc GIS (10.1) was used to create a shape file and named as a C Block shape file and the polygons of different

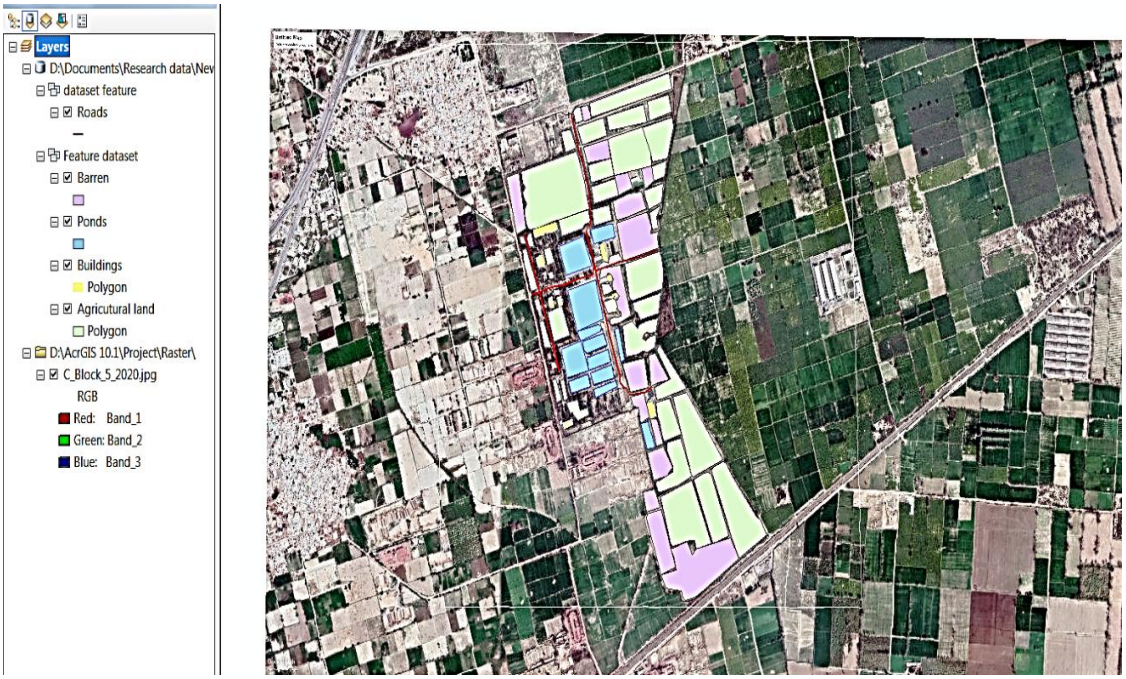

Figure 2. The shape file of (UVAS) C block, Ravi Campus, Pattoki.

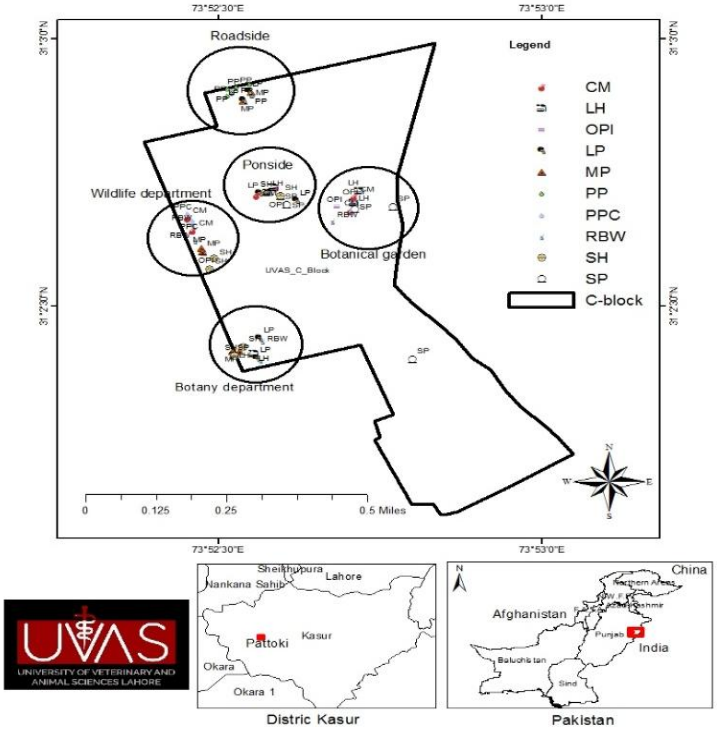

Figure 3. The digitized clases of experimental site .

types of areas like ponds, urban, barren, agricultural land, and road were made (Figure 2). Description of digitized classes is shown in table 1. We made an MXD file of A-Block Classification and named the polygons in the attribute table as (r)Roads, (b)Barren (b)Buildings (p)Ponds and (a) Agricultural land. Digitized classes of experimental site are shown in Figure 3.

2.7. Inhabitation Inside artificial nests

2.7.1 Software use

Google Earth Pro 7.3.3.7699 (64-bit) and ArcGIS were used to

make the shape file of the experimental site and to locate the exact locations of nest sites (human settlement 1, human settlement 2, water bodies, roadside, and botany department) on the map. ArcGIS software (Aeronautical Reconnaissance Coverage Geographic Information system) was used which is a geographic information system for making the different maps of their study areas according to their spatial data. It was used for organizing geographical data in the form of maps and to peruse mapped information and their management in a database. The mobile application GPS essential (Global Positioning System) was used for taking x-y coordinates of different locations during the survey.

2.8. Nest types and shapes

We used ten different types of artificial nests include 1) Plastic pipe 2) Small pot 3) Medium pot 4) Large hut 5) Small hut 6) Large pot 7) Rectangular wooden box 8) Plastic box 9) Clay money box 10) Capped plastic pipe. Thirty nests were contained old nests material. The nests were made of clay, plastic material, and wooden material. Sixty nests (N=60) were classified into ten different types (N=10) and each type was represented six same nests. The shapes of nests were elongate, circular, and rectangular type. Description of nest types is listed in table 2.

2.9. Nest site selection

The experimental site was categorized into five different nest sites.

1- Human settlement 1 (Ground of Biological Sciences Department)

2- Human settlement 2 (Ground of Wildlife Department)

3- Pond site

4- Road-side

5- Botany department

2.10. Nest installation plan

Sixty artificial nests (N=60) were installed at five different nest sites. Each site was contained 12 artificial nests. It was installed with iron wire and nails. Twenty-two nests were hanged and the remaining thirty-eight were supported with branches. All nests were placed between 4 and 5 m above ground. A measuring tape (Length=40f) was used to measure the height of each tree by the yardstick measuring method. Description of nests installation sites is in table 3.

2.11. Analysis of Variables:

The height of trees was measured by the yardstick method in fieldwork. The temperature was measured by the thermometer. Agriculture land cover was analyzed with the help of ArcGIS software 10.1 version and nests entrance sizes were measured by measuring tape [24]. The level of human disturbance was measured during a random survey of the areas of roadside, human settlement 1, and human settlement 2. Directions of nests were noted by the mobile Compass App. The diameter of dominant trees was measured by measuring the diameter at breast height (DBH) of most of the dominant trees in the areas.

2.12. Monitoring of nests:

The nests were monitored two times a week during the random survey and each nest was observed for three minutes during each survey to record the nest occupancy. The nests were observed with the help of binoculars and a mobile camera. Ten feet wooden stick (Length=10f) was attached to a mobile holding stand which helps in nest observations.

Table 1. The description of digitized classes.

Class	Description
Buildings	Land cover by developmental areas (departments, labs, hostels etc.)
Barren	The land without any cover, unused land
Pond	The land cover by water
Road	The ways to convey peoples from one place to another
Agriculture land	The land cover by fields such as wheat, rice and maize etc.

Table 2. The description of each nest type.

Nest type	Abbreviation /Code	Description:
Plastic pipe	PP	PP is a plastic pipe and has an opening of about 4.5cm. It is sapphire-colored.
Small pot	SP	SP is a small-sized Brown colored pot. This pot is made up of clay material and has an opening of about 4cm.
Medium pot	MP	MP is a medium-sized pot with a hole opening of about 4.5cm. It is made up of clay material and has a sandy brown color.
Large hut	LH	LH is a large-sized hut built up of wood material. Its color is aquamarine. It has an opening of about 6.5cm towards the south.
Large pot	LP	LP is a large-sized pot, made up of clay material and has an opening size of about 6cm. It is completely rust-colored
Rectangular wooden box	RWB	RWB is a box of rectangular shape and has enough space for large birds. Its color is like natural wood obtained from trees. It has an opening size of about 5.7cm.
Plastic box	OPL	OPL is a plastic box painted with orange color. It has an opening of about 6cm and this hole is made by a saw. It is covered by a lid from the top surface.
Clay money box	CMB	CM is a money box made up of clay. it is used to collect money but we transformed it into an artificial nest by making a hole of about 5.5cm. It has wheatish color.
Capped plastic pipe	CPP	PPC is a plastic pipe with a cap that is made up of small plastic baskets. It has an opening of about 5cm as an entry spot for birds. It has a cobalt blue color.

Table 3. The description of nests installation.

Sites	Descriptions
Human settlement 1	Human settlement is the area of Department of Biological Sciences. Near this settlement, there are some houses of the workers. This site has great hustle and bustle of people including students, teachers, workers and children living in nearby houses. This site has an abundance of greenery and tall trees. A poultry shed is located in it and it also has a rush of people working there.
Human settlement 2	Human settlement is the area of Department of Wildlife and Ecology. Near this settlement there are some houses of faculty members and a girl's hostel. This site has also great hustle and bustle of people including students, teachers, workers and students living in hostel. This site has a library, IT lab, cafeteria, fish hatchery and Academic Block.
Botanical garden	Botanical Garden is located behind the Fish seed rearing unit. This garden is established in 2019 and many kinds of trees of commercial importance are planted in it. This is under the supervision of Head of Department of Biological Sciences. This garden is surrounded by crop fields.
Pond site	Pond site is the site where large water ponds are present. These water ponds are a part of project of Fisheries Department. A huge number of fishes are reared in these ponds. These water bodies are surrounded mostly by trees of Psidium guajava, Punica granatum, Mangifera indica and Grewia asiatica.
Road-side	Area on sides of road. This site has trees in a row. A large number of traffic vehicles visit this daily.

3. Results

3.1. Quantification of Land use of (UVAS) Ravi Campus

The area obtained after the digitization of the boundary of (UVAS) C-Block was 46.03 hectares. After the digitization of the UVAS C-Block satellite image, we have got the classes in the study area (see in the image) by their colors. The colors in the image represent a class. We have got five classes shown in Figure 4 in C Block named buildings, barren, agricultural land, ponds, and roads.

The comparison between different classes by their percentages

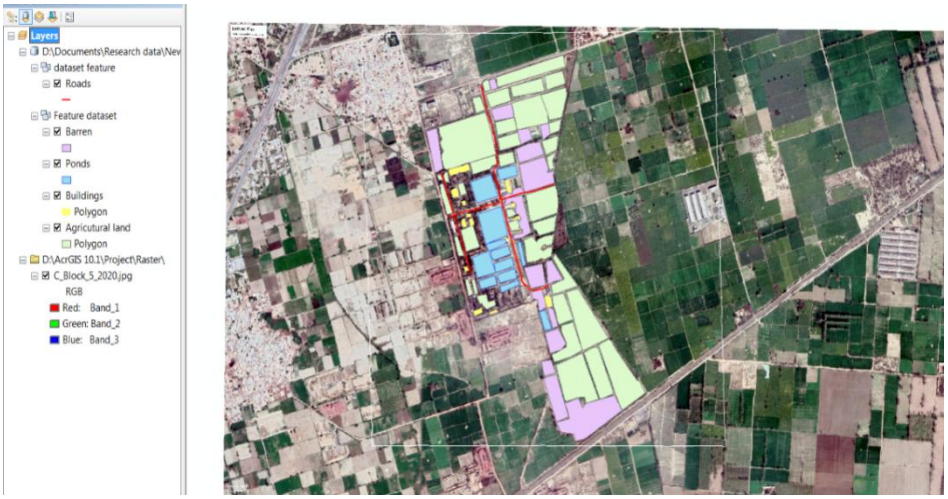

Figure 4. Digitized image of UVAS C Block (Buildings, Barren, Agriculture land, Ponds and Roads.

Table 4. Classes' areas and number of polygons in a digitized image

Sr. No.	Class	No. of Polygon	Area (hectors)
1.	Ponds	12	5.6
2.	Barren	17	15.8
3.	Agriculture land	31	23.5
4.	Road	6	0.19
5.	Buildings	15	0.94

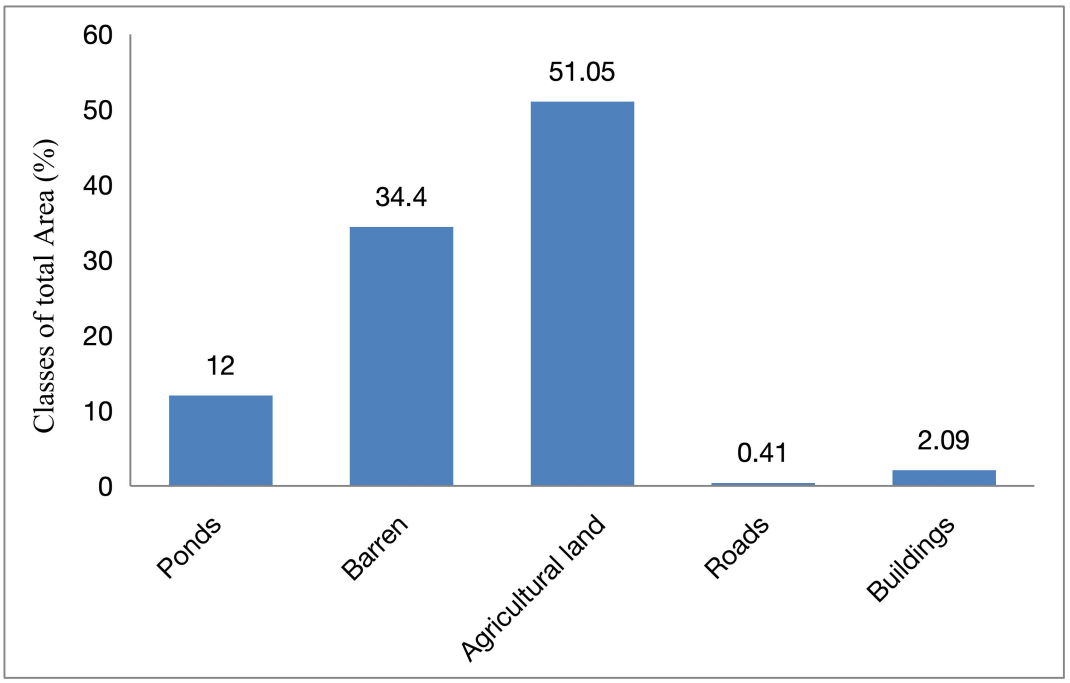

Figure 5. Comparison between different land use classes.

of total area of (UVAS) C Block is shown below in Figure 5. After the measurement of areas, we have compared them by the chart. We have observed that the ponds occupied 12%, barren land was 34.4%, agricultural land was 51.05%, roads were 0.41 and buildings occupied 2.09% of the total area. The detail of polygon and area (in hector) for chosen classes is in table 4.

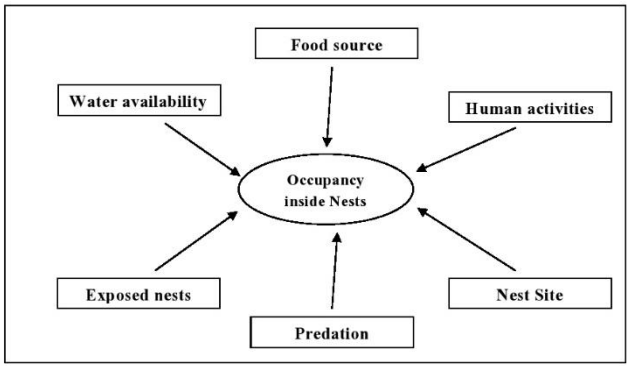

Figure 6. The inhabitation rate during months.

3.2. Inhabitation of Birds inside Artificial Nests:

The results show that twelve (N=12) were occupied in the last three months (January, February, and March) of the trial. The Inhabitation rate was zero in the first trial. Twelve nests were occupied out of sixty in a botanical garden, H.S_1, and ponds site. The overall inhabitation rate was 20%. Total sixty nests (N=60) were placed in five different sites. Twelve nests (12) were occupied (Table 5) in the three sites (H.S_1, ponds site, and botanical garden). Twenty-five (N=25) nests were unoccupied out of sixty nests and fifteen nests (N=15) were dropped at five sites due to wind, rain, and bird activities.

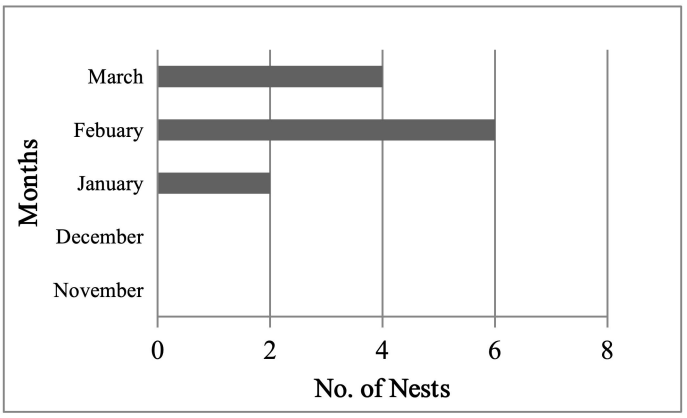

Figure 7. The factors which affect the nest occupancy of nests.

There were eight nests (N=8) in which birds' activities were observed. We have observed that the inhabitation of birds inside artificial was affected by environmental and anthropogenic factors such as water availability, nearby food source, human activities, nest site, and predation. Nests in human settlement 1, botanical garden, and ponds site were more occupied because they have sufficient water availability, food source, and less traffic noise as compared to the nests in human settlement 2 and roadside. Description of different factors such as availability of water, food source, traffic noise, exposed nests, and predation shown in Figure 7.

The results showed the Human settlement, ponds side, and botanical garden were rich in water and food sources. The occupied nests were usually in that area whereas human settlements 2 and roadside have greater disturbance and the nests were more exposed to predators.

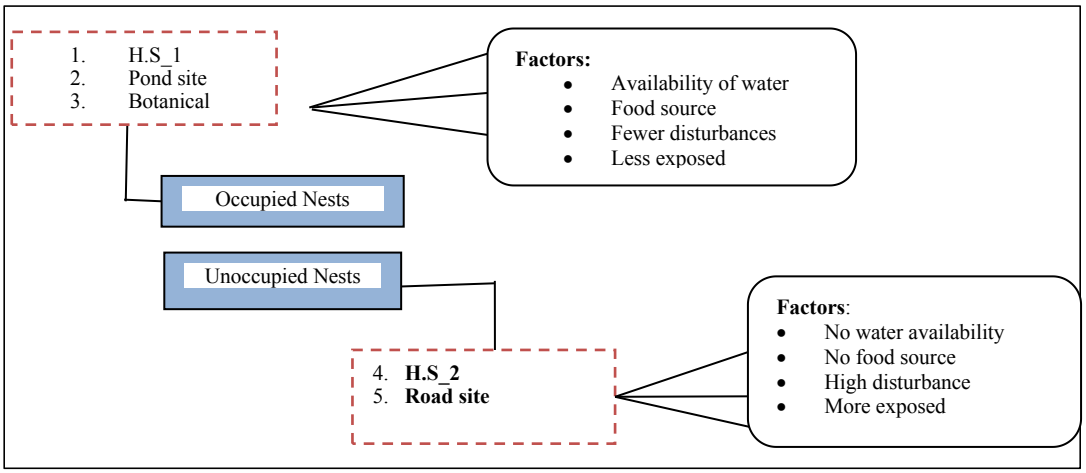

Figure 8. Flow chart of occupied and unoccupied nests.

Table 5. Description of different factors such as availability of water, food source, traffic noise, exposed nests, and predation

Sr. No.	Sites	Availability of Water	Food source	Traffic Noise	Predation	Exposed Nests
1.	Human settlement 1	√	√	fewer	×	less
2.	Human settlement 2	×	×	high	×	more
3.	Botanical garden	√	√	fewer	×	less
4.	Ponds site	√	√	fewer	×	less
5.	Road-site	×	×	high	×	more

4. Discussion

The quantification of the land use of the University of Veterinary and Animal Science, C Block, Ravi Campus, Pattoki was done [26]. The quantification of land showed that agricultural land covers 23.5 hectares area and the ponds cover 5.6 hectors area. Water and food availability provides a suitable site for nesting. The results showed the inhabitation rate was 20% [27]. In present study it was also observed that artificial nests near the human settlement 1, botanical garden, and ponds site are mostly occupied. The reason was that those sites were rich in water and food sources. These results are in line with [28].

The nests in human settlements 2 and roadsides are more exposed to predators. The human activities were maximized around human settlement 2 and roadsides. Only one nest is occupied. We have observed that artificial nesting is influenced by certain environmental and anthropogenic factors. The anthropogenic activities are involved such as traffic noise, constructive equipment noise, human visitation, and grass and plants maintenance activities (cutting, sowing, and watering). Environmental factors which influence nesting are wind blowing, rain, predators, and water and food sources (Figure 8). These results of present study are in line with [29]. The present study showed that the favorable conditions of nesting for birds are water availability, food source, fewer human disturbances, and the nests are less exposed towards the predators. Human settlement 1, botanical garden and pond-side have enough water, food sources, fewer human disturbances, and nests were less exposed to predators. Therefore, nests are mostly occupied in those sites and human settlements 2 and roadside have fewer resources as compared to those sites as observed in [30]. The results showed that twelve nests (N=12) out of sixty are occupied. Three nests (N=3) are occupied in human settlement 1, only one nest (N=1) is occupied in human settlement 2. Three nests are occupied in the botanical garden and five nests are inhibited in the pond site. No nest is occupied on the roadside. Maximum nests are occupied on the pond side because the water is very important for birds especially for summer or warmer seasons. It has also great importance for birds to perform their physiological activities [31].

It was resulted that pond sides have more exposed nests towards predators and have higher traffic noise [32]. The traffic activities are much higher near the road site. It includes cars, loader vehicles, tractors, and passenger wagons. Birds have avoided this site for nesting. Human settlement 2 was a suitable site for nesting but the ratio of nesting in this nest was very low. The reason is human activities. Around the human settlement 2, there were academic blocks, grounds, human visitation, and human activities for maintaining plants and trees. Previous studies showed that birds are less utilized than those sites which have higher human visitation or anthropogenic activities. These results are parallel with [33]. According to results, the occupied nests are 20% and unoccupied nests are 41%. Twenty-five percent (25%) nests are dropped due to a strong wind blowing and damaged due to the rain. Fourteen percentage nests (14%) were those in which bird activities are observed. One important thing which was noticed during the survey was the nest boxes material [34]. As described above, ten types of nests were used during the experiment. Nests were made of plastic, mud,

wooden material with a specific diameter. During the whole survey, mostly wooden nests boxes are occupied with diameter in 5.5-6.0 diameters. Nests boxes with 4.4-7 diameters are not preferred by the bird species found in this area [35].

From November to December, no nest is occupied. The temperature was 11^0C to 15^0C in these months and humidity is also varied. Temperature is considered an important factor for birds for nesting. The temperature range in February and March was more suitable ranging between 16ºC to 26ºC. It has been observed that nests are mostly occupied between February and March and the observed humidity was about 58% to 90%. These results are similar to [36]. So, these conditions are proved to be favorable for nesting (Figure 6).

It was concluded from the experiment that the inhabitation of birds inside artificial nests boxes is influenced by water availability, food source, environmental and anthropogenic activities. Increased human activities decreased the inhabitation rate and have a bad effect on it. Next material, nest boxes types are also influenced inhabitation. One important factor is site selection. The site with all necessary sources is preferred by the birds. The outcomes of present study are supported by [37].

5. Conclusion

Inhabitation of birds inside artificial was affected by environmental and anthropogenic factors such as water availability, nearby food source, human activities, nest site, and predation. Nests in human settlement 1, botanical garden, and ponds site were more occupied because they have sufficient water availability, food source, and less traffic noise as compared to the nests in human settlement 2 and roadside. The results showed the human settlement, ponds side, and botanical garden were rich in water and food sources. The occupied nests were usually in that area. Whereas human settlements 2 and roadside have greater disturbance and the nests were more exposed to predators.

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Data Availability statement

The data used to support the outcomes of this study is available from the corresponding author on request.

Conflicts of Interest

All authors declare that they have no conflicts of interest.

Authors Contribution

Javeed Iqbal, conducted the research, collected, and analyzed the data, and wrote the manuscript. Naveed Akram, supervised, Wrote, edited, analyzed and reviewed. Arslan Riaz reviewed and edited. Wazir Ali and Muhammad Akram, reviewed. Sami Ullah reviewed, and edited.

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