STUDY ON ECOLOGICAL AND BREEDING BEHAVIOUR OF AN INDIAN EAGLE OWL *BUBO BENGALENSIS* (A CASE STUDY OF INDIAN EAGLE OWL IN CAMPUS TREE PLANTATION OF BJ CAMPUS IUB)

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ABSTRACT

Owls, as nocturnal avian predators, are important in maintaining ecosystem balance by controlling their populations. Pakistan being an agricultural country, rural population in large number possess small landholdings. But a considerable part of their agricultural produce is lost annually to vertebrate pest that can be solved by using owls. But due to anthropogenic activities, the habitat of owls is losing and their population is decreasing day by day. To conserve and manage their population for getting agricultural benefits, the study of Indian eagle owl in campus tree plantation of Bj campus was conducted. Six sites (DVA, Staff colony, CIDS, OAE, HEF, FMT) was selected to investigate the ecological, breeding parameters and feeding parameters of Indian eagle owl. The duration of the study was about seven months, in which sites were visited to monitor their activity pattern, vegetation covers around all selected sites and habitat preference of the Indian eagle owl was observed. After intervals of two weeks, sites were visited to monitor their nesting characteristics, courtship behaviour, clutch size, and fledging success. Their feeding behaviour was monitored by collecting their pellets and prey preferences were examined. All these observations were made through binocular cameras and were documented. The vegetation cover was observed by the vegetation survey method.Significant variations were observed between all parameters across different sites. All data was collected, measured and recorded on MS Excel and their average of parameters in comparison to six sites with their standard error was documented. Results revealed that in sites (IAE, DVA, and staff colony) near human associations and dense vegetative area, their feeding behaviour was found maximum as compared to other sites. While sites (CIDS, HEF and FMT) near dense vegetative areas, desert shrublands, and out of human reach, their breeding behavior was found maximum as compared to other sites.

INTRODUCTION

Owls, belonging to the order Strigiformes Grewal et al., 2016), are fascinating birds with over 200 species found in a variety of habitats worldwide, from deserts and coniferous forests to the Arctic tundra (Deane Lewis,1999). The Indian Eagle Owl (Bubo bengalensis), , is native to the Indian subcontinent also called as the Bengal Eagle Owl and Indian Great Horned Owl. Initially considered a subspecies of the Eurasian eagle owl, but now it is recognized as a distinct species.

Owls, though not known for their proficiency in nest building, occupy diverse habitats and vary greatly in size and appearance. (Deane Lewis, 1999). In the West Himalayas, Pakistan, India, Kashmir, and Nepal, most owls, except the burrowing owl, nests are typically low, exposed patches of ground, typically located on rocky outcrops, riverbanks, or indentations in cliffs inside ravines but Indian Eagle Owls inhabit rocky hills, wooded ravines, and semi-deserts, often near human settlements (Muthusamy et al., 2023). They have dusky black claws, fulvous feathered legs and toes with bare greenish-slate outer toe joints, a white chin and throat. Their length is 50–56 cm, and the males have 358–433 mm for wings and 185-227 mm for tails(Ali and Ripley, 1983). These owls fly mainly at night, beating their wings slowly and deliberately, alternating between glides. Typically flying low to the ground, they may employ diversionary strategies, such as pretending to have a wing injury, to protect their young (Grewal et al., 2016). Their silent flight, nocturnal calls during the breeding season, and enigmatic behavior have captivated human interest for centuries. To attract mates and defend their territory, Indian eagle owls (Bubo bengalensis) become extremely noisy during the breeding season (Garcia de la Chica et al., 2020). For courting and territory defense, these vocalizations and visual displays are crucial (Vrezec & Garcia, 2018). Owls are skilled hunters thanks to unique adaptations like binocular vision and binaural hearing (Soni, 2022; Espíndola et al., 2020). Their resonant, powerful sounds at dawn and dusk are essential for managing rodent populations.

The male Indian eagle owl's characteristic "bu-whooh," a strong, resonant double hoot, is repeated multiple times a second. The comparable song by the female has a slightly higher tone. When in the nest, both sexes may make a series of "huwoo-huwoo" sounds or cluck, with the female's calls being a little higher (Call, 1978). Usually hunting from perches or low-altitude foraging flights, they take down huge insects, reptiles, frogs, and even peafowls in addition to their primary prey, rats and mice. The Indian Eagle Owl, has unusual breeding habits with a wingspan of 100-140 cm. Their breeding season coincides with the best time to

find prey, so there's enough food to raise chicks. While the male supplies sustenance, the female incubates the eggs. Little owls are taught to hunt by their parents, beginning with insects and other small prey.

The Indian Eagle Owl is mostly a nocturnal, lone owl that builds its nests in tree hollows, natural cavities, and abandoned nests. Because of their insulating feathers, some species, like the great horned owl, can withstand harsh winter weather and start breeding in the winter (Tompkins, 1914). They usually fly close to the ground, their long glides broken up by slow, methodical wing beats. Adults frequently employ diversionary strategies, including pretending to have a wing injury, to protect their young (Grewal et al., 2016).

Indian eagle owas are crucial indicators of ecosystem health, preying mainly on small rodents but occasionally on larger prey like juvenile deer, birds, and fish (Sergio et al., 2008). They inhabit various ecosystems, particularly forests, where they rely on trees for nesting. Over 83 owl species depend on old-growth forests, impacting forest management strategies in regions like the United States and Australia (Marcot, 1995; USDA Forest Service and USDI Bureau of Land Management, 1994). The Northern Spotted Owl, for instance, has significantly influenced ecological research and forest management practices in the U.S. (Forsman et al., 2011).

Culturally, Indian eagle owls symbolize knowledge, fear, wisdom, and spiritual beliefs across different societies. They are represented in flags, sculptures, and other cultural artifacts, underscoring their impact on cultural identity (Marcot and Johnson, 2003). In traditional practices in China and Korea, and even in witchcraft in some African regions, owls hold significant roles (Gore and Won, 1971; Austin, 1948; Cocker and Mikkola, 2001).

Protecting owl populations indirectly preserves other species in shared habitats, serving as a model for extensive habitat protection and biodiversity conservation (Cathcart, 2000). Owls are also significant bioindicators of ecological health and biodiversity. As evidenced by the eagle owl (Bubo bubo), high biodiversity levels are often associated with owl populations and appropriate habitats (Sergio et al., 2004). Furthermore, in agricultural areas like Malaysia's palm oil plantations (Duckett, 1976), Israel's grain fields (Meyrom et al., 2009), and rice paddies (Hafidzi and Mohd, 2003), barn owls (Tyto alba) are used in nest box programs as natural agents for regulating rodent infestations.

Owls play a crucial role as bio-control agents by managing rodent populations, reducing crop damage, and benefiting farmers economically. However, the population of Indian eagle owls is declining due to habitat loss due to deforestation, fragmentation of forests, and conversion of forests into agricultural land (Grande et al., 2018). Owl conservation efforts

are essential for preserving ecological diversity, preventing major crop losses, reducing chemical pest control, and promoting sustainable agricultural practices, where crop losses resulting from vertebrate pests are substantial (Beg et al., 2010). These roles and importance underscore the significant ecological, cultural, and agricultural contributions of owls to ecosystems and human societies. This research paper aims to investigate the ecological and breeding behaviors of the Indian Eagle Owl, highlighting its habitat preferences, nesting habits, and ecological significance. Understanding these aspects will enhance our knowledge of this species and inform conservation efforts to protect these majestic birds and their habitats.

MATERIALS AND METHODS

Experimental Site: A case study was conducted at Islamia University of Bahawalpur, Baghdad Campus, located in southern Punjab, Pakistan (28°30' N, 71°30' E), covering an area of 23928.22 km². The region has a subtropical continental climate with high temperatures, strong winds in summer, low and sporadic rainfall, and low humidity. Annual rainfall ranges between 90 to 200 mm, and temperatures range from -2°C to 50°C. The site includes diverse landscapes such as cultivated areas, administrative buildings, residential areas, recreational spaces, and agricultural experimental sites, interspersed with water bodies and human settlements. The adjacent Cholistan desert features farm trees, herbs, shrubs, and wild plants, providing a balanced ecosystem.

Study Duration and Methods: The study on the Indian Eagle Owl (Bubo bengalensis) was conducted fortnightly from March 2023 to September 2023, with field surveys occurring four times during this period. Surveys were conducted early in the morning to study ecological behavior and after sunrise to observe breeding behavior and vegetation cover. Data collection involved interviewing locals, direct observation with binoculars, and vegetation cover assessment using the quadrant method.

Sites Selected for the Study: Six distinct sites were selected for their potential to host eagle-owl nests:

- **Site 1**: Department of veterinary and animal sciences (DVA)
- **Site 2**: Staff colony
- **Site 3**: Cholistan Institue of Desert Sciences (CIDS)
- **Site 4**: Institute of Agriculture and Environment (IAE)
- **Site 5**: Horticulture experimental field (HEF)
- **Site 6**: Farm management turbine (FMT)

Vegetative Cover: The Vegetation Survey Method was used to document plant species and characteristics at each site, dividing vegetation into cultivated and wild species.

Nest Selection and Monitoring: Nests were randomly selected and monitored from March 2023. The breeding season began in late May. GPS coordinates, elevations, and vegetation

Figure 1: Six different sites selected for study of Indian eagle owl at Baghdad Campus Islamia University of Bahawalpur

types of all nests were recorded. Nest density was calculated using the nearest neighbor distance (NND) method. Nest characteristics, such as height, diameter, material, and occupancy status, were measured and documented.

Ecological and Breeding Behavior: Ecological behavior, activity patterns, and habitat preferences of the Indian eagle owls were observed. Breeding behavior was monitored from late May to the end of July across six nests at each site, recording nesting success, courtship behavior, clutch size, and fledging success. These parameters were monitored using cameras and other techniques, measuring egg dimensions and weight. Fledging Success was calculated using this formula:

- Hatching Success% = (Number of Hatched Eggs / Total Number of Laid Eggs) * 100
- Fledging Success% = (Number of Fledged Nestlings / Total Number of Laid Eggs) * 100

Feeding Behavior and Diet Composition: Feeding behavior was recorded through direct observation and pellet analysis. Pellets were collected, treated, and examined under a

microscope to identify prey species, including rodents, birds, reptiles, and insects. The relative abundance of different prey items was documented.

Data Analysis: Data were organized in Microsoft Excel, with each row representing a site and each column representing a nest reading. The mean value for each site was calculated using the `AVERAGE` function, and the standard deviation (SD) using the `STDEVA` function. Standard error (SE) was calculated as $SE = SD/\sqrt{n}$. Bar graphs with error bars representing the standard error were created to display mean values and variability.

RESULT

Morphology and general description: The Indian Eagle-Owl is a large bird with 50 to 60 cm in length and a wingspan of 125 to 140 cm and weighs about 1.1 to 2.5 kg. It has prominent ear tufts and bright orange or yellow eyes for excellent night vision. Its beak is robust and curved and is used for tearing into prey. Their feet are equipped with powerful talons for grasping prey with zygodactyl toes (two toes facing forward and two backward) that provide a strong grip.

Figure 2: Indian Eagle Owl

Activity patterns: In current experiment, activity pattern was observed in the early morning, between 5 am-8am and late evening 6pm-8pm, they showed their nocturnal activity at peak level near the Institute of Agriculture and Environment, department of Veterinary and Animal Sciences, horticulture experiment field and staff colony while their diurnal activity was found at peak level near CIDS site and farm management turbine as compared to other sites.

Vegetative Cover: The vegetation at Islamia University of Bahawalpur varied across different sites. The Department of Veterinary and Animal Sciences (DVA) had a blend of cultivated and wild flora dominated by safeeda and Khagal. Staff Colony had a mix of natural and cultivated

vegetation with prevalent Kikkar trees. The Cholistan Institute of Desert Sciences (CIDS) mainly had wild shrubs like mesquite. The Institute of Agriculture and Environment (IAE) focused on cultivated plants, with ber and neem trees as dominant species. The Horticulture Experimental Field (HEF) emphasized cultivated species, particularly date palm trees, while the Farm Management Turbine (FMT) area displayed a mix of cultivated and wild growth with poplar trees as the dominant species.

Habitat Preference: The nesting preferences of Indian eagle owls were studied across various sites. In CIDS, owls preferred Kikkar, Sheesham, and Mesquite due to the dense thickets providing cover and prey availability. Staff Colony and IAE favoured Kikar and Neem for their broad canopies, insect availability, and height conducive to nesting. FMT showed preferences for Bahan and Mesquite and Moringa trees for roosting and breeding, while HEF exhibited nesting on Date palm, Peepal, Bohar, and Jand. At IAE site, Neem and Ber was observed as preferred sites, and DVA showed the dominance of Eucalyptus camaldulensis and Safeeda. Kikar and Neem emerged as highly favored tree species for Indian eagle owls across these sites. Detailed documentation was made regarding nest locations, site attributes, occupancy rates, and nesting materials utilized.

Nesting Characteristics: In this experiment, random occupied nesting sites were noticed within campus trees, at all six sites having their different locations . The nests was observed active in all sites as shown in table. Almost similar structure was seen of all the nests with a minor difference. The shapes of nests was globular, cup shape and dome shape that was covered with thickets of dense vegetation.

Table 2: Nest Characteristics around different nest of Indian eagle owl at all six sites

Sites	Location (Longitude, Latitude)	Number of Nests	Vegetation Type	Material Used for Nesting	Occupancy status
DVA	71.6912E, 29.3545N	3	Eucalyptus Woodland	Twigs, leaves	Occupied
Staff Colony	71.6803E, 29.3652N	6	Residential Landscape	Twigs, grass	Occupied
CIDS	71.6708E, 29.3758N	8	Desert Shrubland	Twigs, leaves	Occupied
IAE	71.6603E, 29.3853N	7	Agricultural Fields	Twigs, grass	Occupied
HEF	71.6507E, 29.3957N	4	Experimental Gardens	Twigs, leaves	Occupied
FMT	71.6402E, 29.4052N	5	Mixed Vegetation	Twigs, grass	Occupied

Table 1: Vegetation Cover across different sites within Bj Iub campus

Sites	Species type	Scientific name	Common name	Growth form	Prenial/ annual
DVA	Cultivated	*Foeniculum vulgare*	Saunf	Herb	Annual
	Cultivated	*Phoenix dactylifera*	Khajor	Tree	Perennial
	Wild	*Achyranthes aspera*	Phut kanda	shrub	Annual
	Wild	*Eucalyptus camaldulensis*	safeeda	Tree	Perennial
	Wild	*Tamarix aphylla*	Khagal	Tree	Perennial
	Wild	*Sesuvium sesuvioides*		Herb	Annual
	Cultivated	*Eucalyptus camaldulensis Dehnh.*	Safeeda	Tree	Perennial
STAFF COLONY	Cultivated	*Mangifera indica*	Aam	Tree	Prennial
	Cultivated	*Carissa carandas*	Karanjwa	Shrub	Perennial
	Cultivated	*Eucalyptus citriodora Hook.*	Safeeda	Tree	Perennial
	Wild	*Acacia nilotica(Linn.) Delile*	Australian Kikar	Tree	Perennial
	Cultivated	*Azadirachta indica*	(Neem)	Tree	Perennial
	Wild	*Tamarix aphylla*	Khagal	Tree	Perennial
	Wild	*Aerva javanica*	Bui	Shrub	Perennial
	Wild	*Trianthema portulacastrum*	Lal itsit	Herb	Annual
CIDS	Wild	*Prosopis cineraria*	Jand	Shrub	Perennial
	Wild	*Leptadenia phyrotchnica*	Khip	Shrub	Perennial
	Wild	*Carthamus ocycantha*	Poli	Herb	Annual
	Wild	*Prosopis juliflora*	Mesquite	Shrub	Perennial
	Cultivated	*Bambusa glaucescens (Willd.) Sieb. Ex Munro*	Bans	Grass	
	Wild	*Dalbergia sissoo Roxb.*	Sheesham	Tree	Perennial
	Wild	*Tamarix aphylla*	Khagal	Tree	Perennial
	Wild	*Acacia ampliceps Maslin*	Australian Kikar	Tree	Perennial

IAE	Cultivated	*Citrullus lanatus*	Tarbooz	Herb	Annual
	Cultivated	*Cucumis sativus*	Kheera	Herb	Annual
	Cultivated	*Concorpus erectus*		Shrub	Prennial
	wild	*Acacia farnesiana (Linn.) Willd.*	Australian Kikar	Tree	Prennial
	Cultivated	*Azadirachta indica*	Neem	Tree	Perennial
	Cultivated	*Ziziphus mauritiana*	Ber	shrub	Perennial
	Wild	*Tamarix aphylla*	Khagal	Tree	Perennial
	Wild	*Acacia nilotica(Linn.) Delile*	Australian Kikar	Tree	Perennial
	wild	*Acacia victoriae Benth.*	Australian Kikar	Tree	Perennial
	wild	*Acacia jacquemontiiBenth.*	Australian Kikar	Tree	Perennial
HEF	Cultivated	*Helianthus annus*	Soraj mukhi	shrub	Annual
	Cultivated	*Bougainvillea glabra*		shrub	Perennial
	Wild	*Gisekia pharnaceoides L*		Herb	Annual
	Wild	*Rianthema portulacastrum L*	Lal itsit	Herb	Annual
	Cultivate	*Phoenix dactylifera*	Date Palm	Tree	Perennial
	Wild	*Prosopis cineraria*	Jand	Shrub	Perennial
	Wild	*Aerva javanica(Burm. F.) Juss. Ex J.A. Schultes*	Bui	Shrub	Perennial
	Wild	*Farsetia hamiltonii Royle*	Fareed buti	Herb	Perennial
FMT	Cultivated	*Ocimum basilicum*	Niazbo	Herb	Perennial
	Cultivated	*Triticum aestivum*	Wheat	Grass	Annual
	Cultivated	*Ficus bengalensis L.*	Bohar	Tree	Perennial
	Cultivated	*Ficus religiosa L.*	Peepal	Tree	Perennial
	Cultivate	*Populus euphratica*	Bahan/popular	Tree	Perennial
	Wild	*Prosopis juliflora*	Mesquite	Shrubs	Perennial
	Cultivated	*Moringa oleifera Lam.*	Sohanjna	Tree	Perennial
	Wild	*Cenchrus ciliaris*	Dhaman	Grass	Perennial
	Wild	*Desmostachya bipinnata*	Dhabb	Grass	Perennial

Nest measurement: In this experimental investigation, notable variations were observed in the nesting parameters among the surveyed sites. Notably, the maximum nest height was recorded at the Staff Colony site (refer to Figure 4.2 and 4.4), possibly to avoid human disturbances. Conversely, the minimum nest height was documented at the FMT site (Figure 4.4), while the lowest elevation was noted at the DVA site (Figure 4.2), indicating a tendency to avoid human proximity and exhibiting a preference for diverse vegetation types for nesting purposes. The largest nest diameter was observed at the HEF site due to its dense vegetation cover, while the smallest diameter was found at the DVA site (Figure 4.5). Across all surveyed locations, the average nest elevation and distance to water were calculated as 151±2.30 and 45.53±3.23, respectively, demonstrating consistent nest placement patterns. Furthermore, the average nest height and diameter were estimated at approximately 53.37±2.52 and 208.9±4.37, respectively, reflecting typical nest dimensions across the investigated sites.

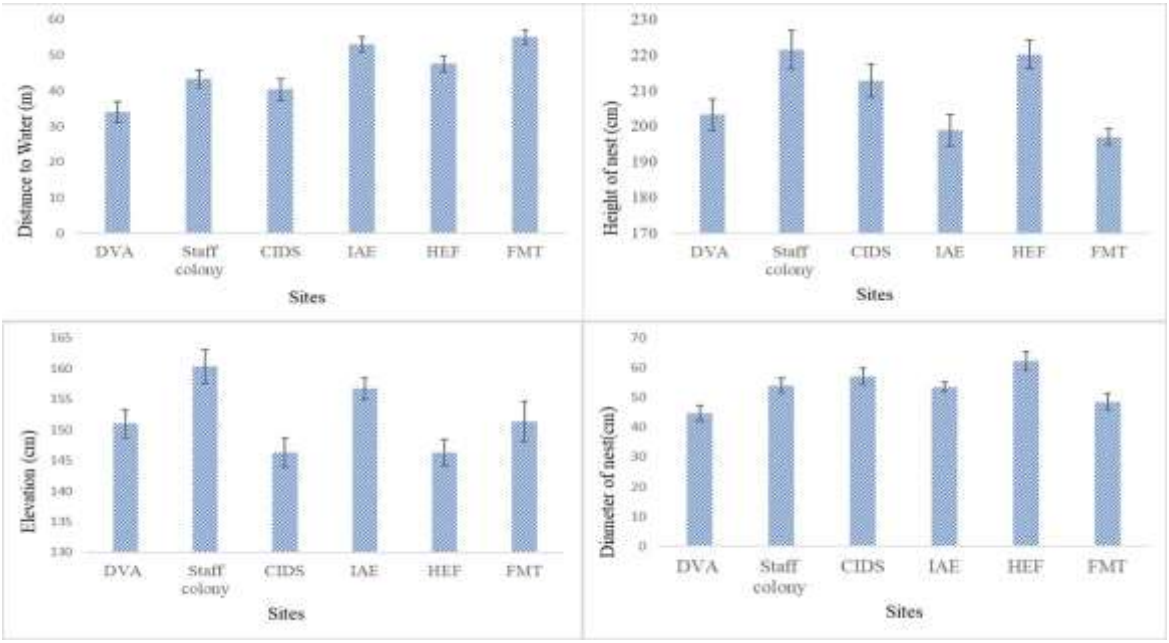

Figure 3: Measurement of the nest of Indian eagle owl to water(m) in comparison of six sites

Nest density: The nest density around each site varies based on the number of nests indicated that CIDS is the most preferred site for nesting, while IAE, HEF, and FMT are equally less preferred in comparison as shown in table 4.3. DVA and Staff Colony are moderately preferred.

Table 3: Nest density around each site varies based on the number of nests of Indian eagle owl

Sites	Nest Density
DVA	Less density during breeding and moderate for roosting and nesting
Staff Colony	Moderate density during feeding and nesting
CIDS	High density during feeding and breeding
IAE	High density during nesting and feeding
HEF	Less density during breeding and high for feeding and nesting
FMT	High density during roosting and breeding

Life span: The life span of Indian Eagle-Owls was found minimum at CIDS site due to their desert shrubland as compared to other sites while maximum life span was found at site IAE, HEF and staff colony due to their mixed vegetation, prey availability around residential area and experimental field.

Nesting Success: The nesting success rates varied across sites, with CIDS exhibiting the highest rate at approximately 85% due to optimal conditions like dense vegetation and prey availability. DVA recorded a moderate success rate of around 70% primarily in Eucalyptus trees. Staff Colony and IAE both had success rates of about 75%, benefiting from a mix of vegetation. HEF showed a minimum success rate of around 65%, while FMT recorded a 70% success rate.

Courtship Behaviour: Courtship behaviour was observed after establishing nesting territories, with plumage color changes and displays lasting about 10 minutes. The female leaned forward at a 25–30° angle during attachment, and mating occurred without vocalizations. The first egg was laid in early June 2023, with an average incubation period of 27 days and an egg-laying interval of about 3 days across sites. CIDS exhibited maximum courtship behaviour due to high population density and optimal habitat.

Egg Measurement: There were significant differences in egg size among Indian eagle owl eggs across sites. Eggs were larger on average near Staff Colony, IAE, and HEF, reflecting better nutritional status. The average egg length across sites was about 5.59±0.11, width was about 4.79±0.08, and weight was about 39.85±1.51 grams.

Clutch size and Incubation period: The largest clutch sizes was found at CIDS site, due to optimal nesting conditions while the minimum clutch size was found at DVA site as compared to other sites. while HEF and FMT show slightly larger clutch sizes due to better cover and food resources. Overall, the average clutch size of Indian eagle owl across all sites was about 2.31±021.

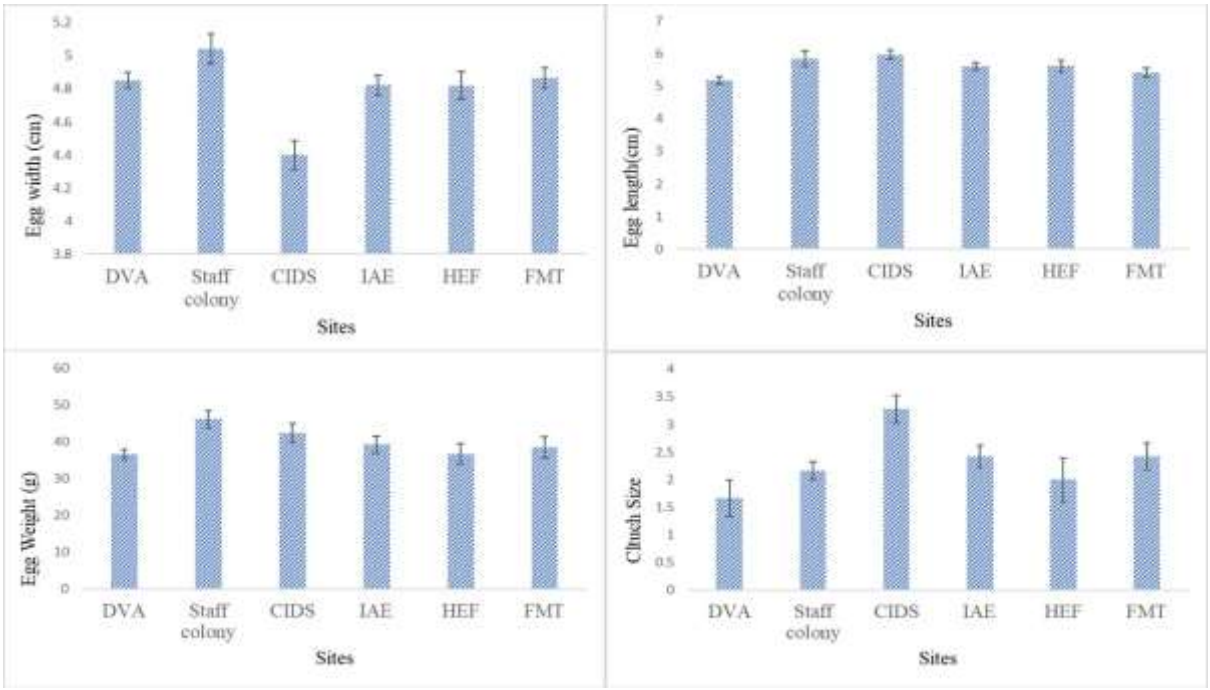

Figure 4: Measurement of egg length (cm), egg width(cm), egg weight(g) and clutch size of Indian eagle owl in comparison of six sites

Table 4: Measurement of clutch size, fledging success of Indian eagle owl chicks at six sites

Sites	Clutch size	Hatching Success%	Fledging Success%
DVA	1.66	75	65
Staff colony	2	80	70
CIDS	3.28	90	80
IAE	2.42	80	70
HEF	2	70	60
FMT	2.42	75	65

Fledging Success: Fledging success varied across sites, with CIDS showing the highest rate at 90%, attributed to safe nesting and ample food. Other sites had moderate success rates ranging from 60% to 75%, with Staff Colony and IAE performing better due to fewer human disturbances. DVA and HEF had lower success rates due to suboptimal nesting conditions.

Feeding Behaviour: The owl primarily perched on nearby structures during feeding, scanning for predators by bobbing its head. It alternated between perches and tree branches, diving to catch prey, mainly insects, either in flight or on the ground.

Diet Composition: Analysis of owl pellets revealed diverse prey items across sites. Pellet size was larger where vegetation was densest and human presence highest, particularly at IAE,

HEF, and Staff Colony. Pellets from these sites had greater length (4.88±0.18 cm), width (2.99±0.11 cm), and dry weight (6.38±0.34 grams) compared to other sites.

Prey Preference: The study revealed diverse prey preferences among Indian eagle owls, influenced by local prey availability and hunting efficiency across six sites. Predation rates

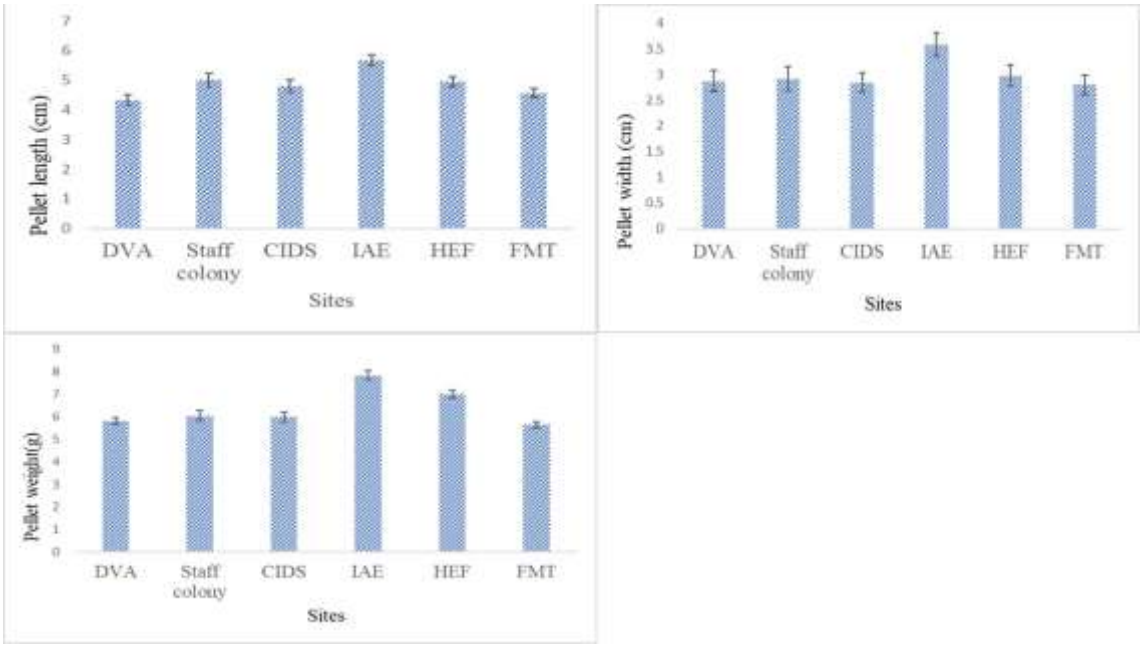

Figure 5: Measurement of length(cm), width(cm) and weight (g) of pellets (cm) of Indian eagle owl in comparison of six sites

were notably higher at IAE, Staff Colony, and HEF, targeting agricultural pests like insects, small mammals, and rodents, showcasing their adaptability and pest control role in different environments. Analysis of prey distribution and abundance indicated a range of prey types across sites, with Staff Colony, IAE, and CIDS showing higher diversity and numbers, especially in rodents and birds. Staff Colony had the highest prey numbers overall, particularly in rodents and birds, while IAE also had significant prey numbers in these categories. CIDS displayed notable diversity and prey abundance. HEF and FMT had moderate prey levels, including rodents and small mammals, whereas DVA exhibited the lowest relative prey abundance. Rodents were the most prevalent prey type across all sites, followed by birds and small mammals, with varying levels of abundance.

Table 5 Prey types across all sites

Prey Type	DVA	Staff Colony	CIDS	IAE	HEF	FMT	Total Number
Rodents	18	60	77	78	32	39	304
Birds	15	45	64	59	24	33	240
Small Mammals	15	30	64	39	16	33	197
Others	12	15	51	20	8	26	132

Table 6: Relative abundance of prey types at each site

Prey Type	DVA (%)	Staff Colony (%)	CIDS (%)	IAE (%)	HEF (%)	FMT (%)
Rodents	5.92	19.74	25.33	25.66	10.53	12.83
Birds	6.25	18.75	26.67	24.58	10	13.75
Small Mammals	7.61	15.23	32.49	19.8	8.12	16.75
Others	9.09	11.36	38.64	15.15	6.06	19.7

Table 7: Breeding frame of Indian eagle owl

Event	Duration
First owl leaves roost and arrives at nesting sites	3-4 weeks of February 2023
Spreading of a nesting territory	1-2 weeks of March 2023
Body color started changes, breeding plumage was appeared	3-4 weeks of March 2023
No breeding activity	1-2 weeks of April 2023
Courtship displays and birds pairing was observed	1-2 weeks of May 2023
Recommencement of nest building and mating	3-4 weeks of May 2023
Egg laying and incubation was started	1-2 weeks of June 2023
First egg laid	2 week ofs June 2023
Last egg laid	3-4 weeks of August 2023
First egg hatched	3-4 weeks of July 2023
Fledgling chicks were observed	3-4 weeks of August 2023
Conversion of breeding sites into roosting sites	1-2 week of September 2023

DISCUSSION

Bubo bengalensis exhibits a range of morphological and behavioral adaptations that make it a successful predator in its natural environment. The combination of its physical attributes and ecological behaviors underscores the species' ability to thrive across various habitats within the Indian subcontinent. In this experiment, the observed morphological features of the Indian Eagle-Owl (Bubo bengalensis) were consistent with descriptions in the literature. These owls are large, with lengths ranging from 50 to 60 cm, a wingspan of 125 to 140 cm, and a weight of 1.1 to 2.5 kg (Ali and Ripley, 1983). Their prominent ear tufts and bright orange or yellow eyes are adapted for excellent night vision, aiding in their nocturnal lifestyle (Grewal et al., 2016). The robust, curved beak and powerful talons equipped with zygodactyl toes (two toes facing forward and two backward) are essential adaptations for grasping and tearing prey (Rasmussen and Anderton, 2012).

The observed activity patterns of Indian Eagle-Owls within the campus align with their known behavior of heightened nocturnal activity. Owls exhibited peak activity in the early morning (5 am-8 am) and late evening (6 pm-8 pm), particularly near areas like the Institute of Agriculture and Environment and the Department of Veterinary and Animal Sciences. This nocturnal activity pattern is typical for the species, reflecting their adaptation to hunting in low-

light conditions (Ramanujan, 2015; Penteriani and Delgado, 2008). Diurnal activity peaks near the CIDS site and farm management turbine suggest a degree of flexibility in their activity, likely influenced by prey availability and environmental conditions.

The vegetative cover at the study sites varied significantly, influencing the habitat preference of Indian Eagle-Owls. The mix of cultivated and wild species provided diverse nesting and roosting opportunities. Various dominant tree species such as Eucalyptus camaldulensis (safeeda) and Acacia nilotica (Kikkar) at various sites at different sites offered ample cover and food resources, aligning with findings from other studies (Pande et al., 2011; Ali, 2002; Muthusamy et al., 2023; Bird and Bildstein, 2007). Habitat preferences for Bubo bengalensis include rocky hills, forested ravines, and scrub-covered landscapes. The preference for specific habitats is strongly linked to the height and density of foliage, providing good roosting and nesting sites (Mehta et al., 2022; Brambilla et al., 2006; Martínez et al., 2003). Nesting sites varied across the study sites, with CIDS having the highest number of nests, indicating that the dense vegetation and optimal conditions at CIDS provide the best environment for nesting success (Newton, 2002). The variation in nest density across sites highlights the importance of habitat quality and availability of resources (Pande et al., 2011).

The life span of Indian Eagle-Owls, ranging from 15 to 20 years in the wild, was mentioned to be extended up to 25 years in captivity. The highest nesting success rate of 85% was observed at CIDS, reflecting the importance of optimal nesting conditions (Snyder and Wiley, 1976; Steenhof and Newton, 2007).

Reproduction occurs between November and April, with 2 to 4 eggs per clutch that doesn't coincide with the results of present study. Courtship behaviors were most vibrant at CIDS, likely due to the high population density and optimal habitat conditions (Pande et al., 2011). The owl's vocalizations are deep, booming calls used for communication and territorial defense. Vocalizations, aerial displays, and mutual preening are typical courtship behaviors that facilitate pair bonding and reproductive success (Martínez et al., 2003). These behaviors were less intense at other sites, suggesting that environmental factors influence the intensity and frequency of courtship displays. Egg measurements and clutch sizes varied slightly across sites, reflecting differences in nutritional status and habitat quality. The largest clutch sizes at CIDS (2-4 eggs) correlate with abundant food supply and optimal nesting conditions, while smaller clutch sizes at other sites indicate less favorable conditions (Pande et al., 2011; Kumar et al., 2014; Penteriani and Delgado, 2008). The average incubation period of 30 days and the fledging success rate of 80% at CIDS highlight the site's suitability for breeding.

The feeding behavior of Indian Eagle-Owls, characterized by perching on light posts and diving to the ground to capture prey, is consistent with their hunting strategies. The diverse diet composition, including rodents, insects, and birds, reflects their opportunistic feeding habits and the availability of prey in different habitats (Siva et al., 2019; Martínez et al., 2003). Pellet analysis revealed that owls in IAE, staff colony and DVA areas had higher feeding frequencies, likely due to the abundance of agricultural pests, on small mammals, birds, reptiles, and insects. while those in CIDS site had a higher frequency of bird predation. The diet of this owl species primarily consists of small mammals such as rodents, but it also includes birds, reptiles, and insects. As an opportunistic hunter, the Indian Eagle-Owl relies on its exceptional night vision and silent flight to ambush prey (Paunikar et al., 2015).

CONCLUSION

Important new information on the ecological dynamics and breeding habits of Indian eagle owls on campus will be gained from this study. In future eeffective conservation efforts will require an understanding of their reproductive habits, environmental requirements, and nesting preferences. To secure the long-term survival of these amazing birds, future research should examine factors influencing owl populations, such as anthropogenic influences and habitat modifications.

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