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Population Density and Habitat of Indian Peafowl (*Pavo cristatus)* in Navsari Agricultural University, Navsari, Gujarat

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Abstract: The Indian Peafowl (*Pavo cristatus*) plays various ecological roles, including seed dispersal, controlling venomous snake populations, and indirectly protecting human communities. This study estimated the population density and habitat use of Indian Peafowl at Navsari Agricultural University (NAU), Gujarat. Systematic line transects with distance sampling were conducted from March to May 2022, using seven transects ranging from 0.66 to 1.3 km in length, totalling 46.80 km. The estimated population density was 0.34 individuals per hectare (34 individuals/km²), with group densities of 0.18 and an average group size of 1.87. The best detection model was a uniform function with a simple polynomial adjustment, with an AIC of 289.55. Habitat-specific data showed that 79.41% of sightings occurred in farmed areas, 15.18% in mango orchards, and 7.59% in mixed habitats, indicating a preference for agricultural environments, likely due to greater food availability and suitable roosting sites. These results provide valuable baseline data for future research and conservation efforts.

Keywords: Indian peafowl, Population density, Habitat use, Agroecosystems

The Indian Peafowl (*Pavo cristatus*), an iconic species of the Indian subcontinent, is deeply embedded in India's ecological and cultural fabric. Celebrated for its dazzling iridescent feathers, complex courtship displays, and high ecological adaptability, the species holds a special position at the intersection of biodiversity and human cultural identity (Ramesh et al., 2009, Gurjar et al., 2013). As India's national bird, the Indian Peafowl represents both aesthetic beauty and spiritual significance, frequently appearing in religious art, classical literature, and folklore. It is also strongly linked to seasonal phenomena, such as the monsoon (Ramesh and McGowan 2009).

Ecologically, *P. cristatus* is widespread across India, inhabiting a variety of environments including dry deciduous forests, scrublands, agricultural fields, temple grounds, and urban parks (Yasmin et al., 1996, Thaker 1963). The species exhibits impressive behavioral flexibility, enabling it to survive in human-dominated areas while fulfilling key ecological functions, such as insect predation and seed dispersal (Johansingh et al., 1980,Sathyanarayana, 2005). Its omnivorous diet of grains, seeds, insects, and small animals helps it adapt to different food conditions. However, living near farms sometimes results in conflicts over crop damage (Gurjar et al., 2013). Additionally, behaviours such as dust-bathing in open soil are essential for controlling parasites and maintaining healthy feathers.

Males (peacocks) are highly showy, with large, iridescent trains made of elongated tail coverts decorated with eye spots (ocelli), mainly used during courtship. Females (peahens), on the other hand, have cryptic plumage for effective camouflage during nesting (Sathyanarayana 2004). Vocal calls are crucial for group communication and predator detection, with loud calls often serving as early warning signals in diverse landscapes. Despite being widely distributed and culturally protected, the Indian Peafowl faces increasing threats from habitat loss, pesticide exposure, illegal hunting, and expanding human development (Divya and Sarita 2013). Although listed in Schedule I of the Indian Wildlife (Protection) Act, 1972, and in Appendix I of CITES, conservation efforts are often reactive rather than data-driven, mainly due to the lack of baseline ecological information in many areas (MoEFCC 2020). Gaining a deeper understanding of habitat preferences and population ecology is crucial for effective conservation, particularly in rapidly expanding urban areas. University campuses, which often feature semi-natural habitats and controlled human activity, can serve as vital refuges for wildlife and as models for studying species in human-altered environments.

This study examines the population density and habitat use of the Indian Peafowl on the Navsari Agricultural University (NAU) campus in South Gujarat. By providing basic ecological data, this research aims to enhance the understanding of *P. cristatus* ecology in semi-urban settings and offer practical insights for its conservation in human-modified landscapes.

MATERIAL AND METHODS

Study area: The study was conducted at Navsari Agricultural University (NAU), situated in the Navsari district of South Gujarat, India, within the biogeographic zone (Western

Ghats plains), at an elevation of 11.83 meters above sea level. NAU encompasses an expansive 400 hectares, accommodating faculties for Forestry, Agriculture, Horticulture, Veterinary Sciences, Animal Husbandry, Agribusiness Management, and Fisheries Science. The campus features a diverse range of habitats, including sugarcane fields, a Rice Research Centre, a Livestock Research Centre, mango and sapota orchards, woodlands, shrublands (Arboretum and Biodiversity Conservation Centre), a Floriculture farm, a KVK (Krishi Vigyan Kendra), nurseries, staff quarters, and student hostels. Navsari is characterized by substantial rainfall and experiences three distinct seasons: Summer (March-June), Monsoon (July-November), and Winter (December-February).

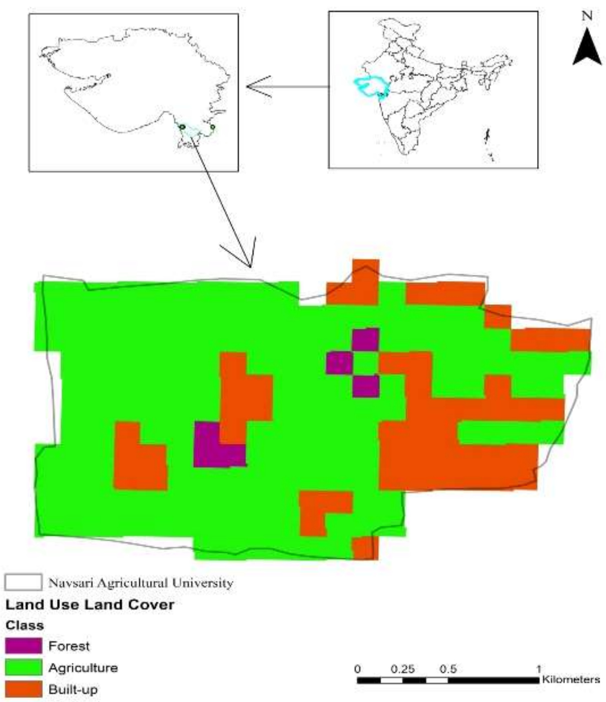

Fig. 1. Study area

Distance sampling involves a sophisticated set of techniques widely used to estimate the density or abundance of biological populations (Buckland et al., 2004). The primary methods within this framework are line transects and point transects. These approaches have proven effective across a variety of organisms, including trees, shrubs, herbs, insects, amphibians, reptiles, birds, fish, and both marine and terrestrial mammals. The core principle behind these methods remains consistently applicable. Our study aimed to estimate the population density of Indian peafowl within the NAU campus, and we used line transect sampling. In this method, an observer moves along a series of straight paths, known as track lines. We chose a walking transect approach within the distance sampling framework to assess the Indian peafowl population.

The NAU campus features a diverse range of habitats, leading us to conduct seven transect walks to evaluate the density and abundance of Indian peafowl. These transects were performed during the morning (8:30 to 9:30 AM) and evening (5:15 to 6:15 PM). Two observers carefully monitored each transect from both sides, systematically recording data on group size, perpendicular distance from the path, GPS coordinates of the groups, habitat features, and any additional behaviors exhibited by the species during the study period (21).

Statistical analysis: The analysis of distance sampling data was performed using DISTANCE software version 7.2 (Thomas et al., 2010), following standard procedures for

Table 1. List of transects monitored to assess Indian peafowl abundance at NAU

Transect No.	Transect name	Transect length (Km)	Replicates	Total length (Km)	Latitude	Longitude
1.	Rice Research Center – Farm No.3 – Livestock Research Center	1.3	7	9.1	20°92'723"	72°90'030"
2.	Regional Horticulture Research Station- Arboretum main road	1.2	7	8.4	20°92'425"	72°89'282"
3.	Research Farm of Genetics & Plant Breeding – Krishi Vigyan Kendra	1.1	7	7.7	20°93'057"	72°89'417"
4.	Bakery–Vice Chancellor Bungalow road–Agribusiness Management College- College of Forestry- Biodiversity –Bamboo Resource Center	1.1	7	7.7	20°92'697"	72°90'941"
5.	Canteen – Soil Management Unit – University Bhavan- Temple	0.633	5	3.1	20°92'411"	72°90'652"
6.	ASPEE College of Horticulture- Swami Vivekanand Boys Hostel – Gymnasium –Veterinary College – Agroforestry Farm	1.2	4	4.8	20°92'327"	72°90'585"
7.	Type D-1 Quarters – Mango Orchard – Helipad	1.0	6	6	20°92'812"	72°90'968"
Total				46.80		

estimating bird abundance and density. Initially, perpendicular distances of observations from transect lines were stratified into finer distance intervals. This stratification was intended to minimize detection bias due to evasive animal movement or increased detectability near roads (Buckland et al., 2001).

To meet the assumptions of conventional distance sampling, specifically, that detectability decreases with increasing distance from the line, perpendicular distances were subsequently binned into broader intervals, including the road shoulder zone, thereby accommodating detection heterogeneity. The appropriateness of distance class intervals was evaluated using Chi-square goodness of fit tests as proposed by Buckland and Turnock (1992).

Detection functions for species were modeled using a combination of main functions: Half-normal (HN), Hazard-rate (HR), and Uniform (UN). The HN function was combined with adjustment terms like cosine, simple polynomial, and Hermite polynomial functions to improve model flexibility. The best detection function was chosen based on the lowest Akaike Information Criterion (AIC), with the model having the lowest AIC being deemed the most parsimonious (Burnham et al., 2011).

RESULTS AND DISCUSSION

Seven transects were systematically laid across the NAU campus, with lengths ranging between 0.66 and 1.3 km, covering a total survey distance of 46.80 km. Transects included agricultural farms (sugarcane, rice, and crop research fields), orchards (mango and sapota), woodland patches (arboretum, bamboo resource centre, and biodiversity plots), shrublands, grass-dominated areas, and built-up zones (staff quarters, student hostels, academic blocks, and common areas). Latter stated transect distribution ensured adequate coverage of both natural and human-modified habitats to capture variation in Indian Peafowl detection and habitat use.

During the transect surveys, a total of 79 Indian peafowls were observed, yielding an encounter rate of 1.68 individuals/kilometer (Table 2). The majority of peafowl sightings (79.41%) occurred in agriculture habitats, followed by mango orchards (15.18%), mixed-use areas comprising agricultural and residential zones (7.59%), and areas in close proximity to human habitation (3.79%).

Distance sampling analysis indicated that the uniform model with a simple polynomial key provided the best fit and was therefore selected for density estimation (Table 2). Based on this model, the density of Indian peafowls in the NAU campus was estimated to be 0.34±0.16 (S.E.) individuals/hectare. The average group size of peafowl was 1.87±0.12, corresponding to a group density of 0.18±0.08 groups per hectare. The effective strip width (ESW) for the survey was estimated to be 46.27 meters, with a coefficient of variation (CV) of 48.01% (Table 2). The abundance of Indian peafowls in the NAU campus was estimated to be 136 ± 64 individuals.The Indian peafowl is renowned for its remarkable adaptability, a trait that underpins its enduring and treasured relationship with the people of India. The diverse cultures and religions of India have esteemed the sheer charisma of this unparalleled and exquisite avian species. The conservation of the Indian national bird is of paramount ecological and ethical significance.

The species' historical presence in urban environments, alongside human habitation, coupled with previous research conducted in this context, renders the Indian peafowl an exemplary subject for studies on population density and habitat at Navsari Agricultural University, Navsari, Gujarat. The line transect method proved to be the most effective, as the majority of birds were detected in proximity to the line, thereby facilitating detection and enumeration. Previous

Table 2. Different models run at different distances to assess the Indian Peafowl density

Model name	AIC	ΔAIC	Mean GS	GD	Densities ± SE	ESW	%CV
UN + SP	289.55	0.00	1.87 ± 0.12	0.18 ± 0.08	0.34 ± 0.16	46.27 ± 2.30	48.01
HN + SP	291.69	2.14	1.87 ± 0.12	0.18 ± 0.08	0.34 ± 0.16	45.95 ± 4.96	48.96
UN + COS	292.64	3.09	1.88 ± 0.13	0.19 ± 0.09	0.37 ± 0.18	42.31 ± 3.28	48.38
UN + HP	292.64	3.09	1.88 ± 0.13	0.19 ± 0.09	0.37 ± 0.18	42.31 ± 3.28	48.38
HR + HP	293.01	3.46	1.90 ± 0.13	0.20 ± 0.10	0.39 ± 0.20	40.99 ± 9.00	52.60
HR + COS	293.17	3.62	1.92 ± 0.13	0.20 ± 0.10	0.40 ± 0.20	40.32 ± 5.98	50.02
HR + HP	293.47	3.92	1.87 ± 0.12	0.18 ± 0.08	0.34 ± 0.16	45.99 ± 3.86	48.49
HN + COS	293.50	3.95	1.90 ± 0.13	0.21 ± 0.10	0.40 ± 0.19	40.11 ± 3.59	48.59
HN+ HP	293.90	3.95	1.90 ± 0.13	0.21 ± 0.10	0.40 ± 0.19	40.11 ± 3.59	48.59

(UN- Uniform, HN-Half Normal, SP- Simple Polynomial, COS- Cosine, HR- Hazard Rate, HP- Hermite Polynomial, AIC- Akaike Information Criterion, GS- Group Size, GD- Group Density, ESW- Effective Strip Width, CV%- Coefficient of Variation).

investigations have indicated that line transects yield more precise density estimates for bird species compared to point counts (Jarvinen, 1978, Verner 1985, Raman 2003). This method was previously employed to estimate the abundance of peafowl in Gir National Park (Trivedi 1993, Sankar et al., 2004). The current density findings align closely with those of other Indian peafowl populations. In Gir, the density was recorded at 39.6 ± 3.8 (mean ± S.E.) peafowl per km². The half-normal and cosine key models emerged as the most effective, with an effective strip width of 36.08 meters for Gir. The highest densities were observed in the eastern region of Gir, at 65.32 ±10 peafowl per km, followed by the central region at 42.60 ±7.6, and the western region at 31.06 ±3.5 peafowl per kilometer (Table 2).

We employed the line transect method to estimate the density of Indian peafowl (*Pavo cristatus*) at Navsari Agricultural University, Navsari, Gujarat, from March to May 2022. The present study reveals that the majority of peafowl were encountered in agricultural areas, with 79.41% within the NAU campus, followed by orchards (15.18%), mixed-use areas (7.59%), and human habitation (3.79%). This indicates a pronounced preference for agricultural fields within the campus. The elevated abundance of peafowl in these farm areas can be attributed to the availability of food and roosting sites. The observed low densities of peafowl may be discussed in the context of habitat unavailability and the myriad threats they face. Indian peafowl are omnivorous, consuming seeds, fruits, insects, worms, small rodents, and reptiles (including snakes and lizards). Their predation on snakes serves to mitigate the presence of these venomous creatures within human communities. Indian peafowl can pose both advantages and disadvantages to crops. On the one hand, they act as bio-control agents by preying on harmful pests.

On the other hand, they can become pests themselves. They have developed a reliance on the local human population for sustenance and protection, bolstered by various cultural and religious sentiments. Their preferred habitat consists of open meadows amidst scrub, mango, and coconut orchards. According to Bergmann (1980) and Johansgard (1986), Indian peafowl have been observed roosting in tall trees and nesting beneath dense bushes, with adjacent open areas serving as feeding grounds. It is imperative to protect these roosting trees and promote their plantation. The veracity of peafowl populations is threatened by habitat loss and destruction due to urban sprawl, which diminishes their natural environments. The university's substantial population of stray dogs poses an additional threat to peafowl populations, as these canines hunt adult peafowl residing near human settlements. Chicks, being more vulnerable, face a heightened risk of predation compared to adult birds. The Krishi Vigyan Kendra and its neighboring agricultural zones exhibited low populations of these birds, mainly due to the predation risk posed by stray dogs. NAU represents an area of significant agricultural potential, consequently increasing pressure on fallow lands to be cultivated. It has been documented that during mass roosting, peafowl disperse into smaller groups in the morning, with males forming harems of three to five females. After vacating the roosting sites, the birds forage in cultivated fields or other areas during the early morning. By midday, they seek refuge under shady trees, often near water sources, where they drink and preen extensively (Anwar et al., 2015). It has been observed that male peafowl frequent open areas for dust bathing, displaying, and feeding during early morning and late evening, rendering them more easily sighted. In the late afternoon, they forage once more and return for another drink at dusk before retiring to roost.

Brickle (2002) noted that areas adjacent to human habitation do not support substantial populations of peafowl. Furthermore, he stated that water sources are crucial for the species and significantly influence their population density. Dodia (2011) suggested that high tree density enhances the survival rate of Indian Peafowl, as roosting in trees with dense canopies mitigates the risk from predators such as cats, dogs, and mongooses. Anwar documented a decline in the population of Indian peafowl in cultivated areas, which is likely attributable to human activities and disturbances from livestock grazing, a phenomenon corroborated by our study. The conservation of Indian peafowl is intrinsically linked to their reliance on roosting trees; therefore, understanding their roost selection is vital for addressing their conservation requirements. The judicious selection of roosting sites enhances avian survival by reducing heat loss, facilitating information exchange, bolstering population accountability, and providing superior protection from predators. The current study investigates the population dynamics of Indian peafowl at Navsari Agricultural University, Navsari. It is recommended that long-term studies are essential for elucidating various impacts on wildlife.

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