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Original article

Roost tree characteristics of Egyptian vulture (*Neophron percnopterus*) in the Chitwan-Annapurna Landscape, Nepal

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A R T I C L E I N F O

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A B S T R A C T

Conservation of the endangered Egyptian vulture (*Neophron percnopterus)* in Nepal would benefit from more information on its specific habitat needs. This study investigated the characteristics of roost trees, including the number of Egyptian Vultures present, from December 2024 to March 2025, at 13 sites across the Chitwan–Annapurna Landscape (CHAL), where the species was known to occur. A total of 152 trees of 13 different species were identified as the roost trees of Egyptian vultures based on the presence of the birds or their droppings and feathers underneath. *Bombax ceiba* was the most common species used. Egyptian vulture roost trees were relatively large (mean diameter at breast height: 57.8 ± 17.22 cm, height: 17.9 ± 3.93 m and crown width: 10.90 ± 3.05 m), compared to nearby unused control trees (34.81 ± 7.31 cm, 11.71 ± 3.10 m, 5.73 ± 1.64 m). Most roost trees were located on the northeast (49%) and northwest (21%) aspects, with an average slope of 14.4°, although other slope and aspect features were available in all study sites. Distance to food sources and water bodies were significant predictors of the number of Egyptian vultures using the roost trees. When summed among sites, the peak count of Egyptian vultures totalled 566, with the peak number at different roost sites ranging from < 10 (7 of the sites) to 378 (Dovilla) individuals. Crown width, height of tree, distance to water bodies, and slope were significant predictors of the number of vultures at roost sites. These findings provide baseline information for planning conservation efforts to save the roost trees of Egyptian vulture and minimize threats to them.

INTRODUCTION

Globally, there are 23 vulture species. Nepal is home to all nine vulture species in the family Accipitridae, including Egyptian Vulture (*Neophron percnopterus*), found in the Indian subcontinent (Inskipp et al., 2016; DNPWC and DoFSC, 2023). Vultures perform a crucial ecological role, consuming animal carcasses (Ogada et al., 2012; Navarro and Castillo-Contreras, 2025) and controlling diseases like rabies, distemper and canine parvovirus (Pain et al., 2003). Despite such importance, vultures are one of the most threatened groups of birds globally (Buechley and Sekercioglu, 2016), with severe population declines in all but some New World vulture species (Ogada et al., 2012). Vultures are communal roosters, a common trait of many bird species, during at least a part of their annual cycle (Ceballos and Donázar, 1990; Beauchamp, 1999).

Egyptian vultures are relatively small and long-lived scavengers native to Asia, Africa and Europe (BirdLife International 2021)). There are three recognized subspecies. *N. p. percnopterus* is widespread in Europe, Africa and Western Asia. *N. p. majorensis* is endemic to the Canary Islands in Spain, and *N. p. ginginianus* is found in India and Nepal (Mishra, 2018).

Across their range, Egyptian vulture live in diverse habitats from an elevation range of 123 m to 2,050 m in Nepal (Shah et al., 2019), with occasional excursions to 3,800 m during summer (Grimmett et al., 2016). They selectively choose their roost sites close to essential and reliable food sources, like abundant livestock

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(Mateo-Tomas and Olea, 2015) and prefer big dead trees (Ceballos and Donazar, 1990). In the absence of trees, the Egyptian vulture sometimes select electricity pylons (Mishra et al., 2020) and cliffs in mountainous habitats (Ceballos and Donazar, 1989; Gurung et al., 2023) for building nests (Angelov et al., 2013; Mishra et al., 2020). The International Union for Conservation of Nature (IUCN) has categorized Egyptian vulture as Endangered and listed it in CITES Appendix II due to decline in its population (BirdLife International, 2021). Global declines are estimated at 50–79% over the past three generations (BirdLife International, 2021).

Egyptian vulture is a resident breeder in Nepal (Ghimire et al., 2020), and estimated a population of 300–1,000 individuals (Inskipp et al., 2016). In Nepal, Egyptian vulture has been classified as vulnerable due to its declining population, caused by poisoning, habitat loss, persecution and human-induced disturbances (Inskipp et al., 2016; Dhakal et al., 2022).

Adult Egyptian vulture is dispersed at nest site territories from March to May (Gurung et al. 2023); however, after breeding, they congregate and use selected trees for roosting (Ceballos & Donazar 1990). The characteristics of the roost trees of the Egyptian Vulture have been studied elsewhere (eg Wright et al., 1986; Ceballos and Donázar, 1990; Donazar et al., 1996; Mishra et al., 2020). There also are a few studies of Egyptian vulture in Nepal, including on its breeding success (Gautam and Baral, 2009; Subedi and DeCandido, 2014), roost site selection (K.C. et al., 2019) and breeding biology (Baral, 2024), but there has been a paucity of research on the characteristics of the roost trees. Understanding communal roosting dynamics is crucial in reducing human–vulture conflicts (Novaes and Cintra, 2013). Furthermore, research at congregation sites aids in early identification of threats and the implementation of conservation measures (Arkumarev et al., 2014), particularly for forest management, including harvesting timber without harming the vulture populations (Yamac, 2007). This is particularly important in CHAL because of rapid deforestation across its entire landscape (WWF, 2013). Therefore, this research aimed to provide the data needed on roost trees to help guide conservation. Indeed, protection of roost sites has become a priority for this globally threatened species (Mishra et al., 2020).

MATERIALS AND METHODS

Study area

The research site, CHAL (Figure 1), covers an area of 32,090 sq km, with elevations ranging from 100 m to 8,091 m above mean sea level (masl). CHAL is recognized as a major biodiversity hotspot in central Nepal and is part of the Greater Himalayan Landscape, envisioned as a potential north–south biological corridor (WWF, 2013; Basnet et al., 2000). The major river systems within CHAL are Kali Gandaki, Seti, Marsyangdi, Daraundi, Budhi Gandaki, Trishuli and Narayani/East Rapti. CHAL encompasses six protected areas, including three national parks (Langtang, Chitwan and Shivapuri–Nagarjun), along with one wildlife reserve (Parsa) as well as two conservation areas (Annapurna and Manaslu). The ecology of the area has been well described (eg Adhikari et al., 2024; Bastola et al., 2025), confirming its importance for biodiversity, including vultures. All nine species of vultures in Nepal have been reported within the study region (Dhakal et al., 2022), and Pokhara Valley is known to be an important area, particularly for Egyptian Vulture (Inskipp et al., 2016; Ghimire et al., 2020).

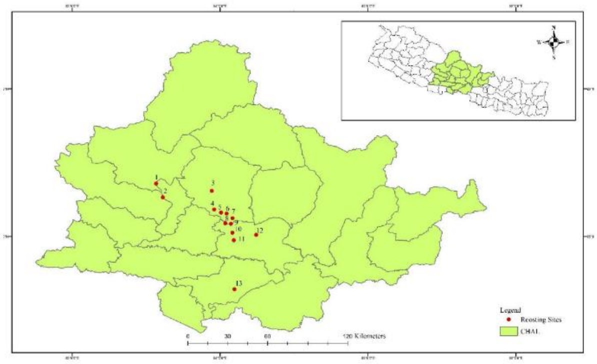

Figure 1. Study area (1 Myagdi, 2 Parbat, 3,4,5,6,7 Kaski, 8,9,10, 11,12 Tanahun, and 13 Nawalpur district)

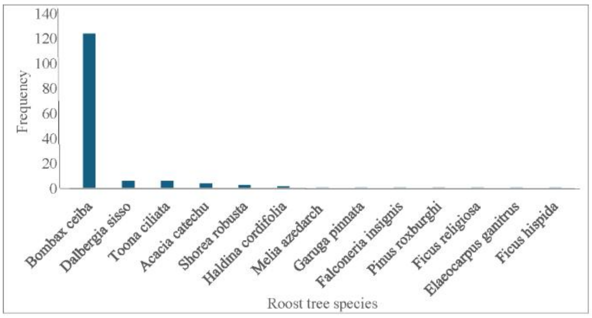

Figure 2. Species of trees chosen by EV for roosting

Data collection

In each of the 13 known roost sites (identified based on field observations, literature review and expert inputs; Figure 1), individual trees were identified as roost trees during initial field surveys based on the presence of roosting Egyptian Vulture or evidence of birds using the tree for roosting, such as accumulation of bird droppings and/or feathers underneath (Yamac, 2007; Yadav and Kanaujia, 2023). If there was a large tree within 20 m of a roost tree, it was identified as a control tree based on the absence of evidence of use by vultures. Every roost and control tree was identified with GPS and given a unique code. We measured the characteristics of the roost and control trees such as diameter at breast height (DBH), total height and crown width (Ceballos and Donazar, 1990).

Besides tree characteristics, environmental features such as slope, aspect, elevation and distance from the nearest food sources, water bodies, road, human settlement and agricultural fields were measured with GPS, GIS and Google Earth Engine for roost tree, as well as paired control trees, because these parameters are known to be important for roost site selection by Egyptian Vulture (Ahmad et al., 2021; K.C. et al., 2019).

The roost sites were visited once each month between December 2024 and March 2025, and the number of

Egyptian vulture in each roost tree was counted in the early morning before their departure for feeding sites and/or in the evening after they had returned to the tree. The observations were made using high-resolution binoculars (Nikon 8 x 42) and a DSLR camera. Birds were classified as adult or immature based on their plumage and facial coloration (Clark and Schmitt, 1998).

Data analysis

We used ArcMap for spatial mapping and excel for storing and summarizing data on vulture count and measurement of trees and site characteristics. A binomial Poisson log link was used for pair-wise comparison of characteristics of roost and control trees, using the Generalized Linear Model (GLM) framework in RStudio. Negative binomial regression analysis was used to test significant variables for predicting the number of Egyptian vultures in roost trees with the following model:

Maximum Number of Vultures ~ Diameter Breast Height + Crown Width + Height + Distance to Water Body + Distance to Agriculture Field + Distance to Human Settlement + Distance to Public Road + Distance to Food Source + Slope + Aspect + Elevation.

RESULTS

Characteristics of roost trees and roost sites

A total of 152 roost trees were found and measured in the study area. Among the 12 different species used, *Bombax ceiba* was the most dominant species (Figure 2). Only 101 of the roost trees had comparable control trees. A pairwise comparison of this sample of paired roost and control trees revealed that the roost trees were significantly larger than the control trees (Table 1, Figure 3).

Table 1. Average values and differences between roost trees and control trees (n=101)

Variable	Roost	Mean	Range	Std. Error Mean	Difference
DBH (cm)	Roost	57.8	23–130	1.76	R > C, p < 0.05
	Control	34.8	18–56	0.72	
Height (m)	Roost	17.9	6–28.6	0.40	R > C, p < 0.05
	Control	11.7	5.2–23	0.30	
Crown Width (m)	Roost	10.9	3–16	0.29	R > C, p < 0.05
	Control	5.7	3–10	0.16	

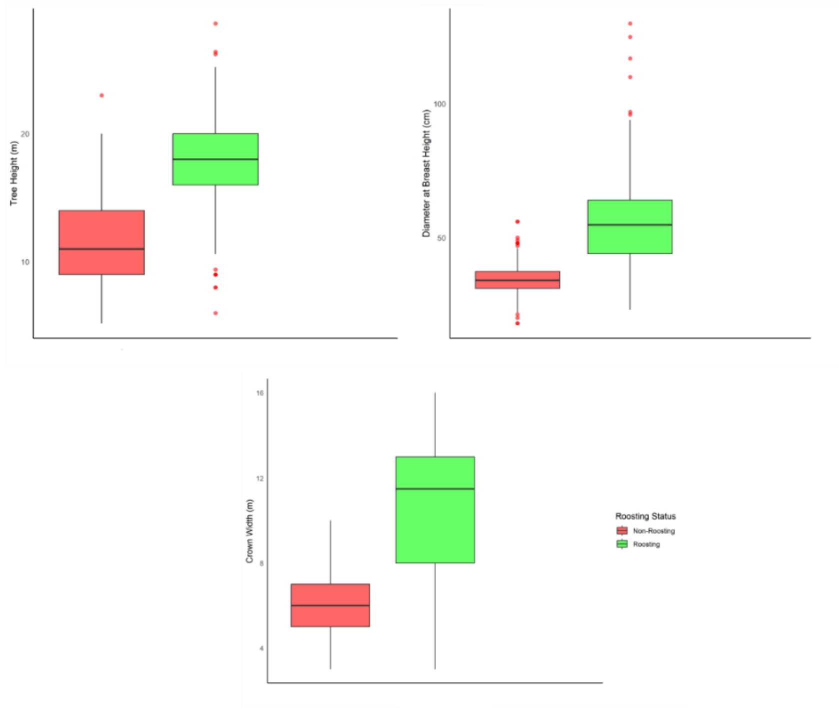

Figure 3. Comparisons of height, diameter breast height, and crown width of roost trees and control (non-roost) trees.

Average distance of roost trees to various identified features in the surrounding landscape was typically less than 300 m, but there was high variability (Table 2). The average distance to obvious feeding sites was almost 800 m, but there was high variation (Table 2).

Table 2. Distance of roost trees from different physical features of sites where roost trees occurred

Feature	Average (m)	Range (m)
Water body	143	18–688
Human settlement	279	11–670
Road	289	7–840
Agriculture field	156	4–648
Obvious food source	773	7–3000

The average slope of the roost trees was 14.36°, but they ranged from nearly flat to 37°. We found roost trees at elevations from 206 m to 873 m, but the average elevation was 660 m. Roost trees were primarily located in the northeast (50%) and northwest (22%) aspects.

Congregations of Egyptian Vultures

Egyptian Vulture populations using roost trees varied across the four survey months (Figure 4). The maximum number occurred in January, and the sum of the peaks at each site provided an estimate of 566 Egyptian Vultures at roost sites in that month. Peak counts at individual roosting areas varied greatly across sites, with Dovilla having most birds (Figure 4). Across the four survey months, the variation was mostly in adults with an obvious departure after January, while the number of juveniles remained somewhat stable (Figure 5). Significant predictors of the maximum number of vultures at roost trees were crown width, height, distance to water and slope. The aspect was marginally significant (Table 3).

Table 3. Regression coefficients for potential predictors of the number of vultures at roost trees

Characteristics	Coefficient	Descriptions of characteristics
DBH	B = –0.0103 P = 0.1439	NS
Crown width*	β = 0.1347 p = 0.0011	An increase in height increases the number of Egyptian Vulture
Height*	β = 0.0641 p = 0.024	An increase in crown width increases the number of Egyptian Vulture
DWB*	β = –0.0025 p = 0.015	An increase in distance from water bodies decreases the number of Egyptian Vulture
DAF	β = 0.001 p = 0.359	NS
DHS	β = –0.001 p = 0.4403	NS
DPR	B = 0.0003 p = 0.7664	NS
DFS	β = –0.0002 p = 0.3962	NS
Slope*	β = 0.0259 p = 0.0416	An increase in slope increases the number of Egyptian Vulture
Elevation	β = 0.0003 p = 0.7363	NS
Aspect*	β = –0.0016 p = 0.0562	Marginal significance

*** Indicates significance**

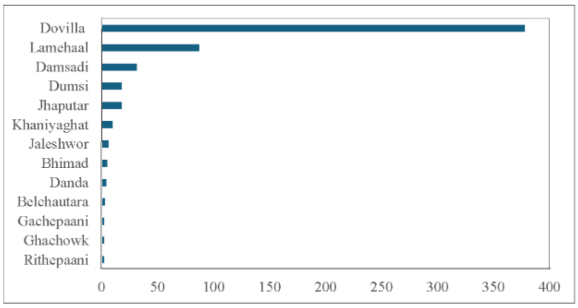

Figure 4. Peak counts of EV across Kaski, Tanahun, Parbat, Myagdi, and Nawalpur districts.

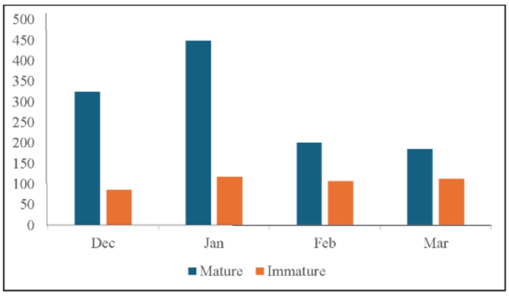

Figure 5. Monthly variation in counts of mature (adult) and immature EV

DISCUSSION

Our study was consistent with Subedi (2008) that *Bombax ceiba* was a favoured tree for roosting by vultures, including Egyptian vulture in Nepal. It was also a common tree used at one site in India (Mishra et al., 2020), but *Terminalia bellirica* was even more frequently used than *Bombax* at another site in India (Yadav and Kanaujia, 2023). In contrast, pine (*Pinus roxburghii*) was used exclusively in Pakistan (Ahmad et al., 2021), whereas pine and white poplar (*Populus alba*) were the most commonly used tree species by Egyptian Vulture in Spain (Ceballos and Donazar, 1990). The choice of tree species probably had more to do with characteristics than species.

For specific roost tree characteristics, we did not find comparable data in Nepal, but Ceballos and Donazar (1990) conducted a similar comparison between roost and control trees by Egyptian vulture in Spain. In contrast to our findings, roost trees were not consistently larger than control trees there. Yadav and Kanaujia (2023) evaluated roost trees for Gyps vultures in India and found that roost trees there tended to be larger in terms of DBH and height than those we measured in Nepal.

Like our study, K.C. et al. (2019), working in Rukum, Nepal, found that Egyptian Vulture roosted relatively near human settlements and water, attributing this to carcass disposal, often in rivers, that provided food for the bird. Dhakal et al. (2019) documented the importance of proximity of food for vultures, particularly around slaughterhouses and dumping sites in Pokhara Valley, Nepal. Also, in Bulgaria, Milchev et al. (2012) indicated vultures lived near human settlements. Different results were found in the studies of Egyptian vulture in Turkey (Sen et al., 2017) and India (Mishra et al., 2020), where the roost sites of Egyptian vulture were far from human settlements. While proximity to roads and settlements is probably related to food availability, disturbance from traffic and other human activities are also potentially negative influences on birds at roost sites (Ghimire et al., 2020).

During the annual International Vulture Awareness Day surveys between 2019 and 2024, overall counts in 34 locations in Nepal ranged from 357 to 511 birds (Bhusal, 2024). In 2024, Bhusal reported 388 Egyptian vultures in Pokhara Valley, similar to our peak count there.

We noted fluctuations in the number of vultures at individual roost trees and within roost sites among counts, and there was a seasonal build up and then decrease in mature birds over the four months of our study. Variation in the number of vultures at congregation areas has also been noted elsewhere, with reasons given including human disturbance, weather and food availability (Thomson et al., 1990; Donazar et al., 1996). Social interactions also affect numbers (Parker et al., 1995).

CONCLUSION

Egyptian vulture relies heavily on individual roost trees with specific characteristics that set them apart from other trees nearby, it is clearly important to preserve the individual trees which have now been identified in the CHAL. Additionally, planning for replacements well ahead is important before existing trees die or are otherwise lost. Information from this study provides a baseline for monitoring longevity of roost trees and variation in the number of vultures using specific trees in CHAL, which provides a majority of roosting habitat for the Egyptian vulture in Nepal.

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