

Golden Eagle Breeding Returns to the West Bank, Palestine: Offspring Mortality in Both Attempts

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Abstract

The Golden Eagle *Aquila chrysaetos*, a globally distributed apex raptor, has long been rare in Palestine. This study reports the first documented breeding attempts in the West Bank in more than four decades. Bi-weekly surveys in Wadi Sa'ir and Al-Kanub Nature Reserve (October 2021–June 2023) revealed one active nest at each site, each containing a single chick that was banded. Both nesting areas were dominated by open grassland. Human disturbance was substantially greater in Wadi Sa'ir, largely driven by nearby human-modified land. Both attempts ultimately failed: the 2022 nestling was illegally taken from its nest, and the 2023 fledgling died after electrocution. Fieldwork in 2024–2025 was halted due to regional instability. We summarize nesting ecology, prey composition, threats, and conservation implications, highlighting the urgent need to protect nest sites and reduce human-related risks to support Golden Eagle persistence in the West Bank.

Keywords: Accipitridae, anthropogenic threats, electrocution, Middle East, poaching, remote sensing

INTRODUCTION

The Golden Eagle *Aquila chrysaetos* is one of the most powerful raptors in the Northern Hemisphere, known for its preference for mountainous landscapes, open terrains, and rocky cliffs (Watson, 2010). Its range spans across North America, Europe, North Africa, and large parts of Asia, with fragmented populations in the Mediterranean basin and the Middle East (Ferguson-Lees & Christie, 2001; Bautista, 2024). Golden Eagles usually breed on cliffs and in remote regions, requiring minimal human disturbance and an abundant prey base, which typically includes medium-sized mammals and birds (Watson, 2010; Katzner et al., 2003).

Across the Mediterranean, population trends vary. In the western Mediterranean, Golden Eagle populations are generally increasing due to habitat protection and targeted conservation measures, while in the eastern Mediterranean, populations are largely stable but locally threatened by human activities (Shirihai, 1996; Iñigo et al., 2008; Mayrose & Hatzofe, 2024). In smaller, fragmented regions such as Lebanon, Jordan, and Palestine, populations are under substantial pressure from habitat loss, human disturbance, poaching, and power line electrocutions. These threats are further compounded by limited availability of suitable nesting cliffs and prey, which restricts reproductive success and territory stability (Shirihai, 1996; Handal et al., 2021).

Several successful conservation initiatives in Europe have demonstrated prac-

tical measures to reduce Golden Eagle and other raptor mortality from anthropogenic threats. In Spain, the electricity company Endesa has insulated over 5,600 high-risk transmission towers to prevent electrocution of large birds (Endesa, 2025). Similarly, the LIFE Bonelli EastMed project in Cyprus has implemented insulation of power infrastructure in key raptor territories, significantly reducing mortality rates of Bonelli's Eagle and other raptors (Cyprus-mail, 2021).

In Israel, breeding records date back to the mid-20th century, with documented nests in the Judean Desert and central mountains (Leshem, 1979; Shirihai, 1996). In the Palestinian territories (West Bank), however, records have been sparse. Although two fledglings were reported to be illegally offered for sale in 2014 and 2017 (Handal et al., 2021), no systematic surveys were conducted in the West Bank during that period, and no confirmed nests were documented; therefore, these records cannot be considered verified local breeding events. The last confirmed breeding in the West Bank was in 1972 and 1979 (Brodetsky, 1972; Leshem, 1979), with no further evidence reported until this study. The species is considered Critically Endangered (CR) in Israel (Meiri et al., 2019). Although formal conservation programs in the West Bank are limited, local wildlife rangers and NGOs have begun monitoring raptor nests and promoting public awareness to reduce poaching and electrocution risks.

To reveal breeding status of Golden Eagle in Palestinian territory, we conducted

a systematic survey across high-potential raptor habitats in the central and southern West Bank. We also maintained close contact with residents, wildlife rangers, and personnel from the electricity company to understand the fate of chicks and assess potential threats. Although no formal interviews were conducted, informal interactions provided key contextual insights. We also used global geospatial datasets to remotely find Golden Eagle breeding habitat. This study thus provides crucial baseline data to inform conservation strategies in the region and guide potential mitigation actions for human-induced threats.

MATERIALS AND METHODS

Field Surveys

Between October 2021 and June 2023, bi-weekly surveys were carried out across mountainous and rocky areas of the central and southern West Bank, including Wadi Sa'ir (Hebron District), Al-Kanub Nature Reserve (Hebron District), the Bethlehem mountains (Bethlehem District), and the western margin of the Jordan Valley. Across these zones, 18–22 fixed vantage points were repeatedly monitored, covering cliffs, ridgelines, and valleys previously identified as suitable Golden Eagle habitat. Each survey cycle involved 42–55 km of linear coverage, combining vehicle-based routes with 8–12 km of foot transects per visit. Observation points were visited for 20–40 minutes

using binoculars (10×42) and a spotting scope (20–60×), with 1–3 km spacing to avoid overlapping detection areas. To avoid disturbance, nests were monitored exclusively from distant observation points. Data collected included nest locations, chick development, prey composition (inferred from prey remains), and human-related threats. GPS coordinates (accuracy <5 m) and photographs were recorded for all observations, and one fledgling was banded by wildlife rangers at approximately one month of age. All field data were archived in the Palestine Society for Environment and Sustainable Development (PSESD) database.

Spatial Data Preparation

Spatial analyses were performed in R (version 4.4.2). Nest coordinates were projected to UTM Zone 36N to ensure accurate distance measurements. Road networks and agricultural land layers were obtained from OpenStreetMap, and elevation and slope were derived from 90 m SRTM DEMs.

Land-Cover Analysis

We used the ESA WorldCover 2020 (10 m) dataset, reclassified into seven habitat categories including trees, shrubland, grassland, cropland, built-up areas, bare land, and water. Proportional composition was calculated within a 5-km buffer around each nest.

Human Disturbance Index (HDI)

To quantify human pressure around each Golden Eagle nesting site, we calculated a simplified Human Disturbance Index (HDI) based on three dominant anthropogenic features: paved roads, agricultural land, and residential zones. These variables were selected because they represent the main forms of land-use encroachment in the southern West Bank. For each nest, Euclidean distances to the nearest occurrence of these features were computed and transformed using an inverse-distance function ($1/\text{distance}$), following the assumption that proximity reflects higher disturbance potential (Güneralp & Seto, 2013). The full mathematical formulation of the HDI is presented here. Because HDI values can be scale-dependent, we additionally normalized all disturbance scores to a 0–1 range to allow direct comparison between the two nests.

$$HDI = \sum_{i=1}^n \frac{1}{\text{Distance to feature}_i} \quad \text{relative HDI} = \frac{HDI}{\text{max HDI}}$$

Prey Identification

Prey remains were identified based on bone, feather and shell morphology using Drewitt (2020).

RESULTS

Two active Golden Eagle nests were identified and monitored in the southern West Bank during the 2022 and 2023

breeding seasons (Fig. 1). It was not possible to determine whether both nests belonged to the same pair.

Breeding Attempt 1; 2021–2022

On 26 February 2022, a nest under construction was observed on a rocky cliff in Wadi Sa'ir, Hebron District (hereafter Nest 1) (Fig. 1AB). The nest, built by both adults using olive and pine branches transported from around 4 km away, was located inside a shallow cave at around 16 meters above ground. A single chick hatched on 3 March. However, by 11 March the chick and adults had disappeared.

Breeding Attempt 2; 2022–2023

On 19 December 2022, another nest was discovered ca. 4.2 km away from the previous site in Al-Kanub Nature Reserve (hereafter Nest 2) (Fig. 1CDE). By 8 February 2023, a chick approximately 3–4 days old was observed. Monitoring revealed that the female remained at the nest while the male provided food. The chick's plumage transitioned from white to brown by 9 March, offering camouflage within the nest. Wing flapping and vocal begging behavior began in early April, and the chick successfully fledged around 16 April 2023.

Habitat characteristics

Land cover analysis within 5 km buffers around the two Golden Eagle nests

showed that both sites were dominated by grassland. Grassland comprised approximately 71.9% of the area surrounding Nest 1 and 61.4 % around Nest 2, indicating that both nests were located in largely open landscapes. Other land cover types are presented in Fig. 2.

Topographic conditions differed markedly between the two nesting locations. Nest 1 was situated on a relatively flat terrain (slope = 4.9°) at an elevation of 514 m, whereas Nest 2 occupied a much steeper site (slope = 29.6°) at 656 m. This indicates that Nest 1 was established at a lower, gentler site, while Nest 2 was located higher and on a steeper slope.

Anthropogenic proximity and disturbance index

Nest 1 showed a disturbance index value of 102.38. This value was primarily influenced by its measured distance of 0.01 km from the nearest paved road (Fig. 3). Nest 2 had a disturbance index value of 10.00. After normalization of the HDI values, Nest 1 was set as the reference, and the normalized output positioned Nest 2 at approximately 0.10 relative to Nest 1. All calculated values are presented in Table 1.

Prey Composition

Prey items recorded near the nests included spur-thighed tortoise *Testudo graeca*, rock hyrax *Procapra capensis*, Chukar Partridge *Alectoris chukar*, Sand Partridge *Ammoperdix heyi*, red fox *Vul-*

pes vulpes, domestic chicken *Gallus gallus domesticus*, and a lamb *Ovis aries domesticus*. Tortoises in particular were observed being dropped from height by adults to break the shell.

Offspring mortality

Interviews with residents revealed that the chick from Nest 1 was illegally taken from the nest by unknown people. On 29 June 2023, we received an eagle electrocution record on 161kV transmission tower. Examination of the carcass confirmed that it belonged to the same juvenile bird tagged at the nest earlier that year (i.e. Nest 2). The incident happened only 4.2 kilometers from the nest.

Besides chick theft and electrocution, we observed potential threats including habitat disturbance from hikers and herders.

DISCUSSION

The Golden Eagle remains one of the most emblematic yet endangered raptors in the Palestinian territory. The two documented breeding events show that Golden Eagles utilized the available microhabitats in the surveyed area despite measurable anthropogenic proximity. Although the species is typically associated with relatively undisturbed nesting sites (Watson 2010), the nests we monitored were situated within foraging distance of agricultural or semi-natural lands. Proximity to agriculture and roads may increase the risk of disturbance and ex-

posure to land-use change or infrastructure development, factors that could negatively affect nesting success or territory stability. The fate of the two fledglings in our study also supports this conclusion, as one was illegally removed and the other (a juvenile) died from electrocution, both reflecting strong local anthropogenic pressures.

Between the two surveyed sites we observed a marked difference in normalized HDI values, driven primarily by the proximity of Nest 1 to a paved road. While broader meta-analyses and case studies have documented relationships between roads/agriculture and raptor disturbance (González et al. 2006; Benítez-López et al. 2010), our dataset is limited to two sites and therefore cannot by itself establish causal links at the landscape scale. Nonetheless, the observed disparity suggests that localized infrastructure placement may influence disturbance exposure at nest sites, and this warrants further investigation with larger samples.

The environmental characteristics observed at the two Golden Eagle nests in the southern West Bank align with broad patterns reported elsewhere in the species' range. Watson (2010) notes that Golden Eagles typically prefer rugged, remote terrains with open visibility for hunting and cliff ledges for nesting. In the Mediterranean Basin, López-López et al. (2006) reported nesting sites in south-eastern Spain frequently located in dry grassland mosaics at elevations above 600 m and with comparable slope profiles. Similarly, the West Bank nest sites

were largely surrounded by grassland, indicating a preference for open, semi-arid landscapes. The proximity of both nests to agricultural fields (~0.5–3 km) and rural infrastructures (~0.2–1 km) suggests a higher degree of landscape fragmentation and human influence than in more northern or protected ranges. These results highlight both the ecological flexibility and the conservation sensitivity of Golden Eagles in human-influenced landscapes (Katzner et al., 2003). Maintaining open, transitional habitats and minimizing encroachment around nesting cliffs remain crucial for the species' local conservation (Watson, 2010).

Threats and conservation

Our investigation indicates that nestling survival is threatened by human-related factors, including habitat disturbance and electrocution from power lines. At the Al-Kanub Nature Reserve, the only juvenile was electrocuted shortly after fledging, highlighting risks from poorly insulated transmission (161 kV) and distribution lines (230 V–33 kV), especially when air gaps are spanned (Khammash, 2005; Kolnegari et al., 2020). Desertification may further increase the use of power structures as perches, elevating electrocution risk. Conservation efforts may benefit from public awareness, legal protection of nesting sites, installation of perching barriers and protective covers, and coordination with the Environmental Quality Authority (EQA) (Ferrer, 2012). Field observations in 2024 and 2025 were

limited due to political unrest, yet less explored mountainous areas likely host additional Golden Eagle pairs. Engaging local communities in nest monitoring and protection may enhance conservation outcomes, particularly in post-conflict areas, where Golden Eagles are a species of ecological and cultural significance (Bautista, 2024; Ellis et al., 2024; Hilario-Hussein et al., 2024).

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Table 1. Environmental and anthropogenic attributes of the two Golden Eagle nests in the southern West Bank. Distances (km) to nearest roads, agricultural land, and residential areas are shown, along with raw and normalized Human Disturbance Index (HDI) values.

	Location	Distance to road (km)	Distance to cropland (km)	Distance to residential area (km)	HDI (raw)	Normalized HDI
Nest 1	Wadi Sa'ir	0.01	3	0.96	102.38	1
Nest 2	Al-Kanub Nature Reserve	0.27	0.58	0.28	10.00	0.098

Fig. 1. Map of the West Bank with Golden Eagle nests (red dots) documented between 2021–2023. Panels (A)–(B) correspond to nesting sites in the Wadi Sa'ir mountains during the 2021–2022 breeding season, while panels (C)–(E) show nests from the Al-Kanub Nature Reserve during the 2022–2023 breeding season.

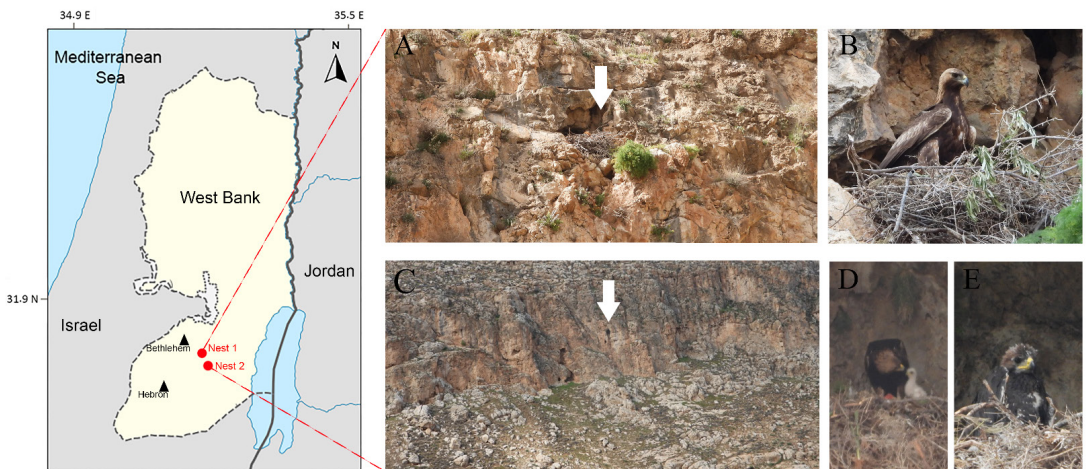


Fig. 2. Land-cover composition in the West Bank: (A) Land-cover map showing the two Golden Eagles nests recorded during the study period (red dots); (B) Proportion of each land-cover type within 5 km buffers around the two nests.

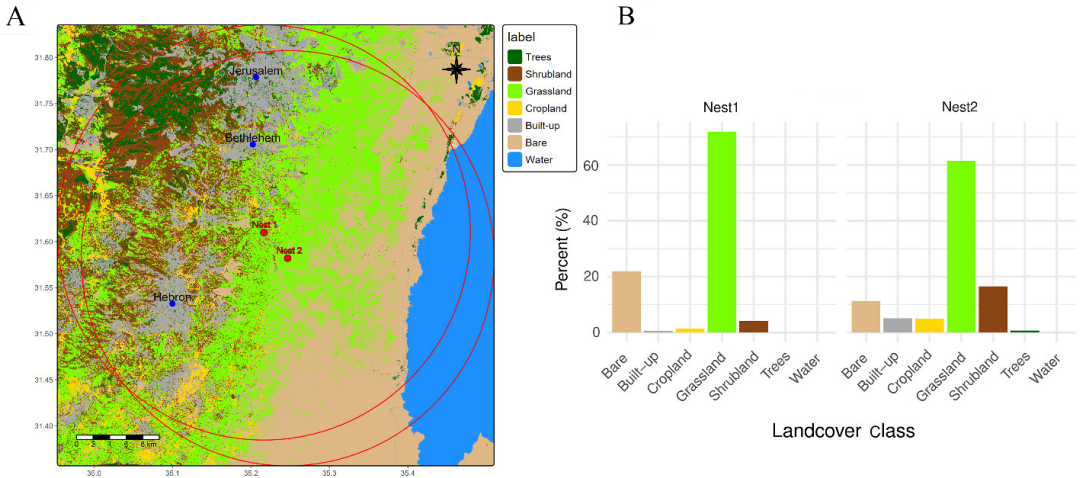


Fig. 3. Spatial distribution of Golden Eagle nests in the West Bank, showing surrounding road networks and agricultural land within a 10-km buffer.

