

# First confirmation of inland nesting for the Sooty Falcon (*Falco concolor*) in the AIUla region, Saudi Arabia: A new population revealed

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**Abstract** This work provides the first confirmed evidence of successful inland breeding of the Sooty Falcon (*Falco concolor*) in the AIUla region of northwestern Saudi Arabia, significantly expanding the known breeding range and population size of this globally threatened (“Vulnerable”) species. Surveys conducted across six nature reserves and six areas rich in biodiversity between 2023 and 2024 documented at least 38 breeding pairs, primarily concentrated in the Sharaan National Park, with additional pairs observed in Gharameel Nature Reserve and Wadi Nakhlah Nature Reserve. Breeding behaviours, including courtship, copulation, territorial nest defence, hunting, and the successful fledging of juveniles, were predominantly observed either on top of small inselbergs or on steep sandstone cliffs and rocky escarpments, highlighting the suitability of these habitats, which are widespread throughout the AIUla region. This newly identified population represents nearly 2% of the estimated global breeding population of the species, underscoring the conservation significance of this discovery. The findings demonstrate the ecological adaptability of the Sooty Falcon to arid inland environments and emphasize the critical role of conservation areas, such as those established by the Royal Commission for AIUla, in safeguarding and enhancing core habitats and protecting populations of threatened raptors. Further research and long-term monitoring are essential to refine population estimates, understand species ecology, habitat suitability, and inform adaptive conservation strategies.

**Keywords:** Arabian Peninsula, breeding ecology, breeding population, conservation areas, Falconiformes, nesting habitat

**Összefoglalás** A kutatás elsőként szolgál hiteles bizonyítékkal a hamvas sólyom (*Falco concolor*) sikeres, szárazföldi (nem tengerparti jellegű) költéséről Szaúd-Arábia északnyugati részén, AIUla térségében. Ez a felfedezés jelentősen növeli a világszinten veszélyeztetett, „Sérülékeny” besorolású faj ismert költési elterjedését és állomány-nagyságát. A 2023 és 2024 között hat természetmegőrzési területen és hat magas biodiverzitású térségben végzett felmérések legalább 38 költő párt dokumentáltak. A párok többsége a Sharaan Nemzeti Parkban fészkel, további párokat a Gharameel Természetvédelmi Területen és a Wadi Nakhlah Természetvédelmi Területen figyeltek meg. Költésre utaló viselkedést – udvarlás, pázás, területvédelmi magatartás a fészkek körül, vadászat, valamint a fiatalok sikeres kirepülése – leggyakrabban kis szigetegyeken, illetve meredek homokkő-sziklafalakon és sziklaperemeken figyeltek meg. A megfigyelések mutatják ezen – az AIUla-szerte sokfelé előforduló – élőhelyek alkalmasságát. Az újonnan azonosított állomány a faj becsült globális költőállományának csaknem 2%-át képviseli, ami kiemeli a felfedezés természetvédelmi jelentőségét. Az eredmények azt is bizonyítják, hogy a hamvas sólyom ökológiai értelemben véve rugalmas, és képes alkalmazkodni a száraz, kontinentális környezethez. Rámutatnak továbbá arra, hogy a természetvédelmi területeknek – különösen az AIUla Királyi Bizottság által létrehozott oltalmi területeknek – kulcs-

szerepük van az élőhelyek védelmében, és a veszélyeztetett ragadozómadarak populációinak megőrzésében. Az állomány pontosabb becsléséhez, a faj ökológiájának és élőhelyigényeinek mélyebb megértéséhez, valamint az adaptív természetvédelmi stratégiák kialakításához további kutatás és hosszú távú monitoring szükséges.

Kulcsszavak: Arab-félsziget, költésbiológia, fészkelőállomány, természetvédelmi területek, Falconiformes, fészkelőhely

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## Introduction

The Sooty Falcon (*Falco concolor*) is a medium-sized migratory raptor currently listed as globally vulnerable, with an estimated population of 2,800 to 4,000 mature individuals, believed to be gradually declining due to anthropogenic pressures (BirdLife International 2021). The species breeds across parts of North Africa, the Middle East, and the western fringes of the Indian subcontinent, with wintering grounds extending from Madagascar to the coastal regions of East Africa (Orta *et al.* 2020). Notable for its unusual breeding strategy (April to October), which begins in late spring and extends through late summer and early autumn, the Sooty Falcon is adapted to hot, arid environments and typically nests on rocky islands, coastal cliffs, and steep desert mountains (Frumkin & Pinshow 1983, Orta *et al.* 2020). This delayed breeding strategy coincides with the seasonal migration of passerines, which represent a key component of its diet (Clapham 1964, Frumkin & Pinshow 1983), highlighting the species' reliance on specific ecological and phenological patterns. The breeding behaviour of the Sooty Falcon is closely tied to isolated, predator-free habitats, which have historically been better documented on islands and coastal areas (Clapham 1964, Gaucher *et al.* 1995, Kavanaugh & King 2008, McGrady *et al.* 2017). However, significant knowledge gaps persist regarding its inland nesting populations, posing challenges to conservation efforts and emphasizing the need for targeted studies and research initiatives.

The Sooty Falcon population in Saudi Arabia is generally considered to be one of the largest within its global range, yet it exhibits a patchy distribution, occurring predominantly on the Red Sea islands and, less frequently, on coastal cliffs and in inland areas (Jennings 2010, BirdLife International 2021). Despite its size and importance, the population estimates for the country are sparse, and the breeding behaviour of the species in inland regions remains poorly understood. While occasional inland sightings may suggest the possible occurrence of isolated breeding pairs (Jennings 2010), the available observations provide limited insight into the breeding distribution and ecology of the species. Addressing this knowledge gap is essential, as inland populations could represent previously unrecognized components of the species' ecology and contribute to a more comprehensive understanding of its conservation needs.

The AIUla region, located in northwestern Saudi Arabia, is characterized by arid and hyper-arid desert landscapes, including steep cliffs, rocky plateaus, and isolated wadis (dry riverbeds). These natural features create a variety of microhabitats that support different raptor species, including the Sooty Falcon (Sousa *et al.* 2024). The remoteness of the region and the absence of previous ornithological surveys suggested that its potential as a breeding habitat for several raptor species had been largely overlooked. Given the unique geographical and ecological attributes of AIUla, targeted surveys are therefore crucial to assess breeding raptor populations and to understand their habitat preferences within this inland desert environment.

This study aims to document the presence of the Sooty Falcon in the AIUla region and to assess the dynamics of its breeding population. It thus provides essential baseline data on the species' phenology, confirmation of breeding, distribution of breeding pairs, and nesting habitat characteristics to support effective conservation efforts.

## Material and Methods

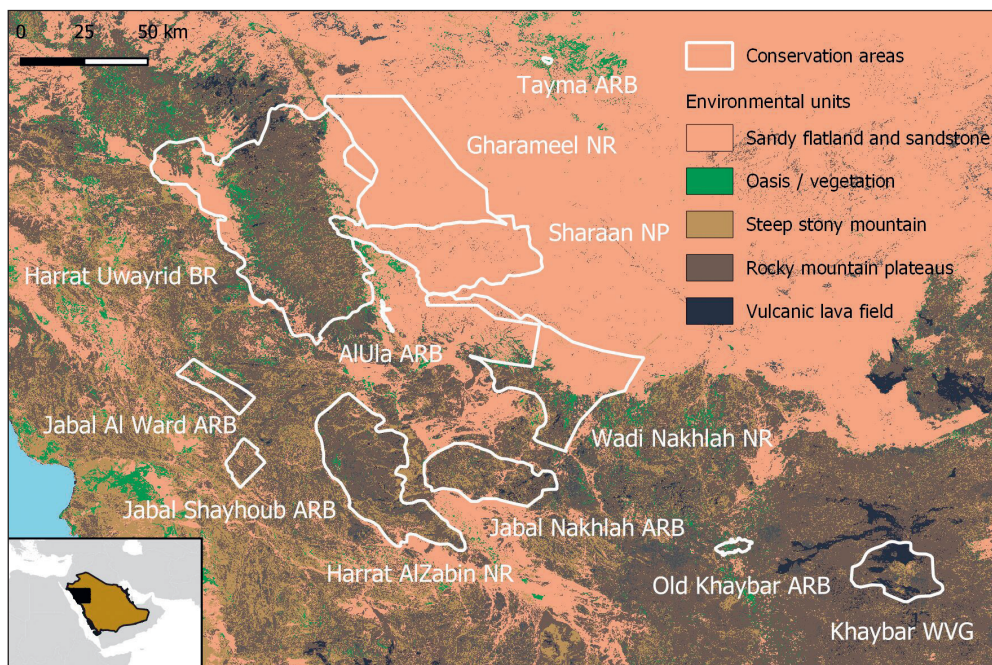
### Study area

The study focused on the conservation area network in the AIUla region of Saudi Arabia, which includes a National Park (NP), three Nature Reserves (NR), a Biosphere Reserve (BR), a White Volcano Geopark (WVG), and six Areas Rich in Biodiversity (ARB) (*Figure 1*). Established in 2020 by the Royal Commission for AIUla, this network covers approximately 13,600 km<sup>2</sup> and aims to safeguard the natural values and diverse habitats of the region. AIUla County is one of the most arid regions of the Arabian Peninsula, with a relatively stable climate throughout the year characterized by long, sweltering, arid, and clear summers (Obaid *et al.* 2020). The hot season extends over four months, from May to September, with daily maximum temperatures exceeding 35 °C, peaking in August and September with a maximum of around 38 °C and a minimum between 20–22 °C (climate-data.org).

Five general habitat types can be identified in the region: (1) The northeastern barren of sandy flatland and sandstone, dominating Sharaan NP, Ghrameel NR, and the northern and eastern sectors of Wadi Nakhlah NR; (2) The vegetated areas along the oasis of AIUla ARB, Old Khaybar ARB, and Tayma ARB; (3) The southwestern steep stony mountainous areas, including Jabal Al Ward ARB, Jabal Shayhoub ARB, and parts of Jabal Nakhlah ARB; (4) The rocky mountain plateaus found in Harrat AlZabin NR, Harrat Uwayrid BR, and the southern sector of Wadi Nakhlah NR; and (5) The volcanic lava fields located in Khaybar White Volcano G (*Figure 1*).

### Data collection

The entire conservation area network in the AIUla region was extensively surveyed for raptors during seven field visits conducted between November 2022 and December 2024. Each visit lasted one to two months and involved two to four observers. These surveys aimed



*Figure 1.* Map showing the location of the conservation area network in the AIUla region, Saudi Arabia, including a National Park (NP), three Nature Reserves (NR), a Biosphere Reserve (BR), a White Volcano Geopark (WVG), and six Areas Rich in Biodiversity (ARB), designated for the protection of natural values and ecological heritage

*1. ábra* A szaúd-arábiai AIUla régió természetvédelmi területeit bemutató térkép, rajta a természeti értékek és ökológiai örökség védelmére kijelölt Nemzeti Park (NP), három Természeti Rezervátum (NR), egy Bioszféra Rezervátum (BR), a Fehér Vulkan Geopark (WVG), és hat Nagy Biodiverzitású Terület (ARB) elhelyezkedésével

to document raptor presence across all protected areas within the network and to identify potential breeding activity. Preliminary observations conducted in 2023 and early 2024 allowed the identification of areas where Sooty Falcons were repeatedly detected during the breeding season. Based on these observations, focused surveys were subsequently carried out in Sharaan NP, Ghrameel NR, and Wadi Nakhlah NR, which were the only areas where a consistent seasonal presence indicative of breeding activity was recorded.

To confirm breeding, document breeding pairs, and locate nesting sites, targeted surveys were conducted in September and October 2024, corresponding to the late nestling and fledging period of the species. These surveys covered 24 driving routes, each approximately 10 km long, distributed across the three areas (9 in Sharaan NP, 8 in Ghrameel NR, and 7 in Wadi Nakhlah NR). Routes were selected to ensure representative spatial coverage of available habitats while accounting for topographic variation, and were spaced to minimize repeated detections of the same individuals on different routes or survey days. Breeding pairs were identified when one or two individuals were observed exhibiting behaviours consistent with breeding, such as repeated use of the same cliff section, territorial defence, pair-bonding behaviour, or attendance at a nesting site. Observations recorded on the same or different

days were considered to represent different breeding pairs only when locations were at least 5 km apart (Orta *et al.* 2020), unless individuals could be clearly distinguished. Following the confirmation of breeding activity in Sharaan NP, an additional 45 fixed sampling points were established at complementary locations within this area to assess the presence of further breeding pairs and confirm nesting success. Sampling points were spaced at least 500 m apart. At each point, a 10-minute observation period was conducted, during which pairs were confirmed when at least one breeding adult or a juvenile was observed at or near a nesting site. Playback calls were used cautiously to aid detection during the late nestling and fledgling period, when adults frequently remain in the vicinity of nests and juveniles are often conspicuous, despite generally lower responsiveness to playback compared to earlier breeding stages. Observations were conducted during two daily time windows, in the morning (mostly between 08:00 and 10:00) and in the afternoon (mostly between 16:00 and 18:00), corresponding to periods of increased activity of adults and fledglings. Breeding territories were delineated by grouping confirmed pairs based on the spatial proximity of observations and nesting sites, resulting in a conservative estimate of the minimum number of breeding pairs present during the study period.

All observations were carried out using binoculars (Zeiss Conquest HD 10×42) and spotting scopes (Swarovski ATS 65/ATX 85). Nest heights were measured whenever possible using a laser rangefinder (Nikon Prostaff 1000). Photographic documentation was obtained using Canon Powershot SX70 HS and Nikon Coolpix P950 cameras. Playback calls were conducted using a portable speaker.

## Results

### Sooty Falcon phenology in the AIUla region

Sooty Falcons were recorded in three conservation areas within the AIUla region – Gharameel NR, Sharaan NP and Wadi Nakhlah NR – between April and October, while no confirmed seasonal presence was detected in other surveyed areas. Starting in late April and early May, both isolated individuals and small groups of three to four adult birds were observed across all three areas. By late May, Sooty Falcons exhibited evident territorial and breeding behaviours in Gharameel NR and Sharaan NP, including interspecific territorial interactions with Common Kestrels (*F. tinnunculus*). Most individuals were observed in breeding pairs, engaging in courtship displays or copulation, and frequently roosting near probable nesting sites. In September, multiple breeding pairs in Gharameel NR and Sharaan NP were observed hunting, defending territories, or perching near likely nest sites, indicating active nesting. Juveniles were confirmed in early October in Sharaan NP, often perched near nest entrances or taking their first flights under the supervision of adult birds, providing confirmation of successful breeding at this location. No juveniles were observed in Gharameel NR or Wadi Nakhlah NR, although adult birds seen near probable nesting sites suggested ongoing breeding activity. By late October, all birds appeared to have departed from the study areas.

### Sooty Falcon breeding confirmation and breeding pair distribution

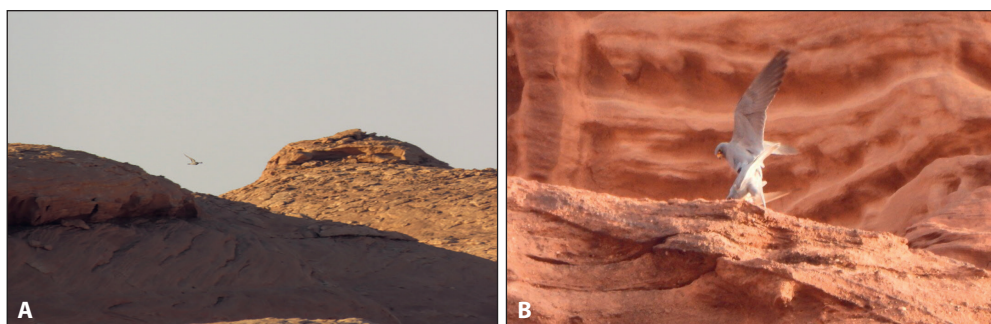
During a field visit to Gharameel NR on the 14<sup>th</sup> May 2023, one adult Sooty Falcon was observed in active flight over the bulky sand cliffs (*Table 1, Figure 2A*). Later, between the 24<sup>th</sup> and 27<sup>th</sup> of May 2023, up to 30 adult individuals were recorded, either alone, in pairs, or in small groups of three to four birds, within Sharaan NP, including the first record of copulation (*Table 1, Figure 2B*). Observations throughout this period were sporadic and dispersed across specific sites of the two conservation areas, several kilometres apart. However, it remained unclear whether these sightings represented birds passing through on their way to final breeding areas or individuals using these locations for nesting. A follow-up survey in early November 2023 at the same locations found no Sooty Falcons, leaving unresolved whether these areas were breeding sites or simply staging areas, rich in prey, where the falcons congregate before breeding (Leonardi *et al.* 2024).

The following year, on the 20<sup>th</sup> of April 2024, three adult individuals were observed in active flight over the steep

*Table 1.* Observations of Sooty Falcons in the conservation areas of the AIUla region during their spring arrival at breeding sites (April–May)

1. táblázat A hamvas sólyom megfigyelések időpontjai a fészkelőterületeken a tavaszi érkezés (április–május) környékén AIUla régióban

Date	Conservation area	Total number of adult individuals
14/05/2023	Gharameel NR	1
24/05/2023	Sharaan NP	12
25/05/2023		8
26/05/2023		7
27/05/2023		3
20/04/2024	Wadi Nakhlah NR	3
01/05/2024	Sharaan NP	16
02/05/2024		3
03/05/2024		4
04/05/2024		9
05/05/2024		1
14/05/2024		11
15/05/2024		2



*Figure 2.* A. Adult Sooty Falcon observed flying over the cliffs of Gharameel NR on 14 May 2023 (photo by Jaime Sousa); B. Breeding pair of Sooty Falcons copulating on a cliff in Sharaan NP on 26 May 2023 (Photo: Ana Pinto Coelho)

2. ábra A. Átrepülő öreg hamvas sólyom a Gharameel NR szikláinak felett, 2023. május 14-én (Fotó: Jaime Sousa); B. Párhozó hamvas sólyom pár a Sharaan NP egy szikláján, 2023. május 26-án (Fotó: Ana Pinto Coelho)

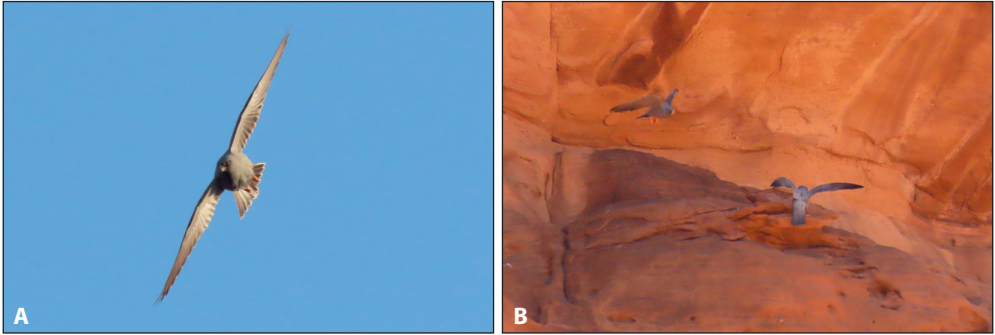


Figure 3. A. Adult Sooty Falcon flying over the cliffs of Wadi Nakhlah on 20 April 2024 (Photo: Paulo Alves); B. Breeding pair of Sooty Falcon engaging in courtship and perching near probable nest cavities in Sharaan NP on 1 May 2024 (Photo: Paulo Alves)

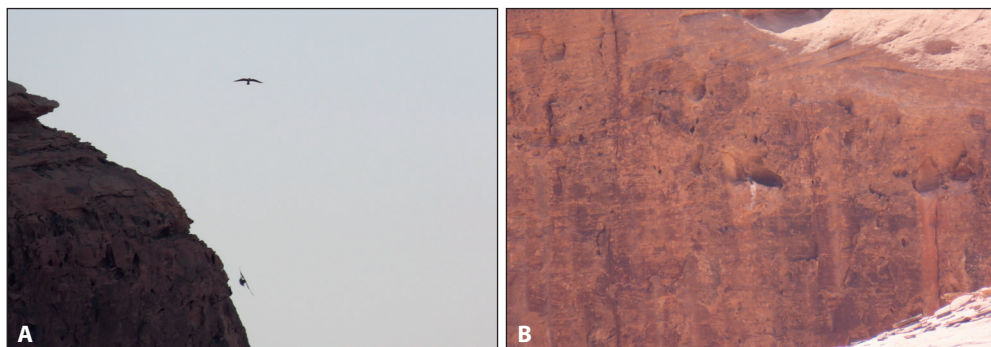
3. ábra A. Átrepülő öreg hamvas sólyom a Wadi Nakhlah szikláinak felett, 2024. április 20-án (fotó: Paulo Alves); B. Násztevékenységet folytató, illetve a sziklán, a feltételezett fészkek mellett ülő hamvas sólyom pár a Sharaan NP-ban, 2024. május 1-én (Fotó: Paulo Alves)

cliffs of Wadi Nakhlah NR (Table 1, Figure 3A). A few days later, between the 1<sup>st</sup> and 5<sup>th</sup> May 2024, up to 33 adult individuals were again observed singly or in small groups of up to four individuals within Sharaan NP, with an additional 13 individuals recorded between the 14<sup>th</sup> and 15<sup>th</sup> of May 2024 (Table 1). These observations were scattered across different locations within the conservation area, strongly suggesting the involvement of different breeding pairs. Although most individuals were observed in isolated breeding pairs engaging in courtship

Table 2. Observations of Sooty Falcons during systematic surveys conducted in the autumn nestling and fledgling period (September-October) across the three conservation areas of the AIUla region where the species was previously recorded

2. táblázat Hamvas sólyom megfigyelések az őszi fiókás periódusban és a kirepülés időszakában (szeptember-október) az AIUla régió három természetvédelmi területén, ahol a fajt korábban megfigyelték

Date	Conservation area	Total number of adult individuals	Total number of juvenile individuals	Total number of confirmed nests	Estimated breeding pairs	
18/09/2024	Sharaan NP	7	0	1	13	35
19/09/2024		12	0	0		
20/09/2024		3	0	0		
03/10/2024		16	5	2	22	
05/10/2024		6	7	2		
06/10/2024		2	4	1		
14/10/2024		6	4	2		
21/10/2024		4	3	2		
25/09/2024	Gharameel NR	1	0	0	2	
26/09/2024		1	0	0		
13/10/2024	Wadi Nakhlah	1	0	0	1	



*Figure 4.* A. Breeding pair of Sooty Falcon hunting over the sandy cliffs of Sharaan NP on 18 September 2024 (Photo by Paulo Alves); B. Adult Sooty Falcon perched at the entrance of a nest in Sharaan NP on 19 September 2024 (Photo: Bruno Herlander Martins)

4. ábra A. Sharaan NP szikláin felett vadászó hamvas sólyom pár, 2024. szeptember 18-án (Fotó: Paulo Alves); B. Öreg hamvas sólyom a fészek bejáratánál a Sharaan NP-ban, 2024. szeptember 19-én (Fotó: Bruno Herlander Martins)

displays and perching near suitable nest cavities (*Figure 3B*), supporting the hypothesis of reproduction in the area, direct evidence of breeding was still lacking. Therefore, additional targeted surveys were conducted in September and October 2024 to confirm the reproductive activity at these sites and estimate the number of breeding pairs.

Between the 18<sup>th</sup> and 20<sup>th</sup> of September 2024, a total of 22 adult Sooty Falcons were observed in Sharaan NP along the nine driving routes. The observations included hunting flights, territorial nest defence, and perching at roosting sites, with one individual seen perched at the entrance of a nest (*Table 2, Figure 4A, B*). The estimated number of breeding pairs in the area covered by the first driving routes survey was at least 13 pairs (*Table 2*).

Moreover, between the 3<sup>rd</sup> and 21<sup>st</sup> of October 2024, as part of the ongoing survey in Sharaan NP, a total of 34 additional adult individuals were observed at 23 of the 45 sampling points, which were visited over five designated days (*Table 2*). During these days, a total of 23



*Figure 5.* A. Juvenile Sooty Falcons perched near their nest in Sharaan NP on 3 October 2024 (Photo: Borut Rubinić); B. Juvenile Sooty Falcon performing the first flights in Sharaan NP on 3 October 2024 (Photo: Borut Rubinić)

5. ábra A. Fiatal hamvas sólymok a fészkek mellett a Sharaan NP-ban, 2024. október 3-án (Fotó: Borut Rubinić); B. Fiatal hamvas sólyom első repüléseinek egyike a Sharaan NP-ban, 2024. október 3-án (Fotó: Borut Rubinić)

juveniles were also seen at the edges of their nests, with some fledglings already attempting their first flights under the supervision of adult birds (*Figure 5A, B*). This provided the first irrefutable evidence of successful Sooty Falcon reproduction at Sharaan NP. The estimated number of breeding pairs for the area covered by this second point sampling survey was at least 22 new pairs, bringing the total to a minimum of 35 pairs for Sharaan NP (*Table 2*).

Furthermore, between the 25<sup>th</sup> and 26<sup>th</sup> of September 2024, two adult individuals were observed in different parts of Gharameel NR along the eight driving routes. Given their spatial separation, the presence of suitable nesting habitat, and the timing of the observations within the active breeding period, these records were considered indicative of at least two probable breeding pairs (*Table 2*). Similarly, on the 13<sup>th</sup> of October 2024, a single adult was recorded in Wadi Nakhlah NR along the seven driving routes, suggesting the presence of at least one additional probable breeding pair in the area (*Table 2*).

Based on all observations, a minimum of 38 breeding pairs was estimated across the AIUla region. Of these, 10 breeding pairs were confirmed through direct evidence such as copulation, nest attendance, or the presence of juveniles, all recorded in Sharaan NP. The remaining breeding pairs were inferred from spatially distinct adult observations exhibiting behaviour consistent with breeding and occupying suitable nesting habitat during the breeding season in Sharaan NP, Gharameel NR, and Wadi Nakhlah NR. The core population was concentrated in Sharaan NP. These findings reveal a broad breeding distribution throughout the arid northeast of the sandy plain and sandstone general habitat type, primarily within the borders of Sharaan NP, but also extending to the Gharameel NR and Wadi Nakhlah NR (*Figure 6*).

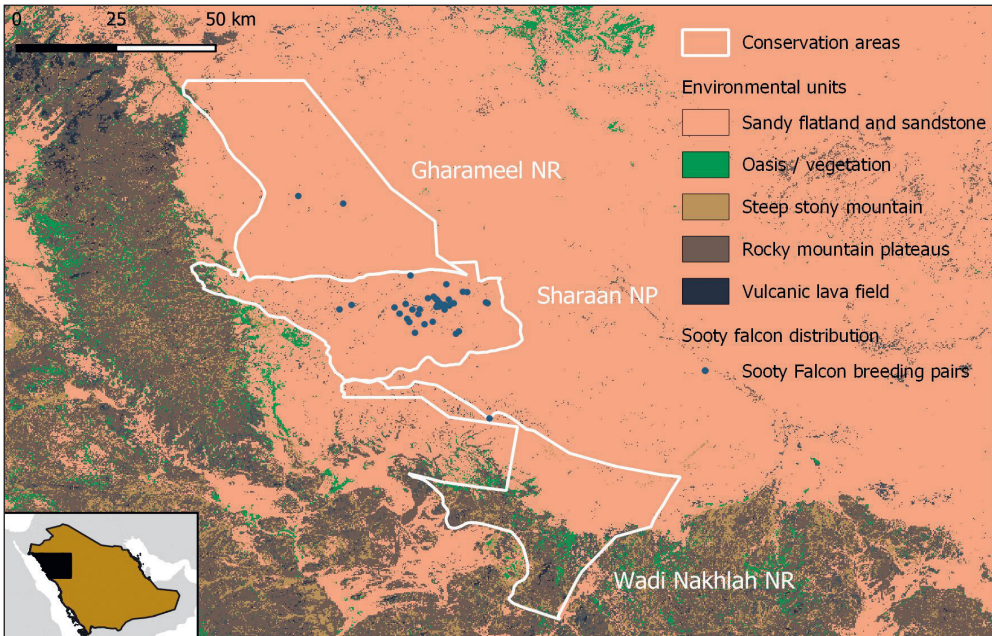
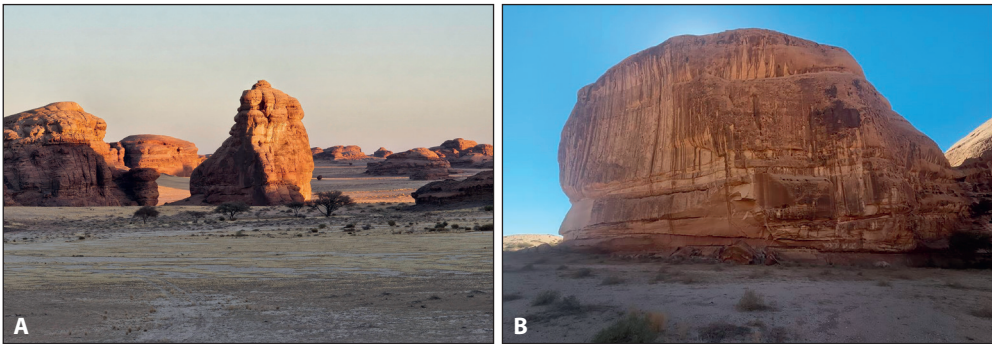


Figure 6. Map showing the distribution of Sooty Falcon breeding pairs recorded in the AIUla region  
6. ábra A megfigyelt hamvas sólyom fészkelőpárok területi eloszlása AIUla régióban

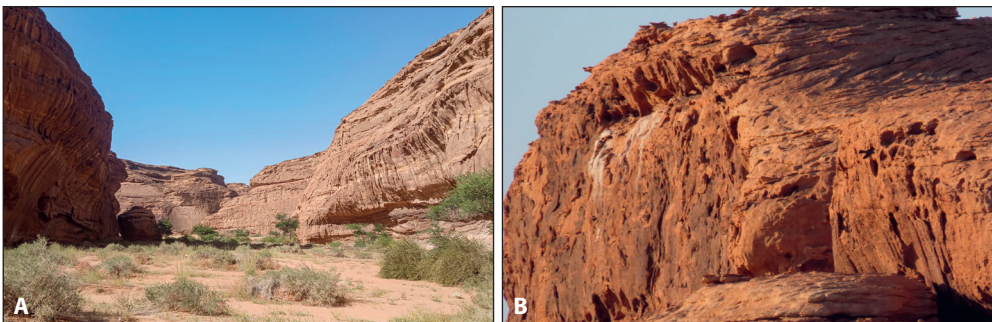
### Sooty Falcon nesting habitat characteristics

All observed nesting sites were located either on top of small inselbergs or on steep sandstone cliffs and rocky escarpments, at elevations ranging from 40 to 90 meters within Sharaan NP. In the Inselberg-type breeding sites, which consist of isolated hills, ridges, or small mountains that rise abruptly from the surrounding plains and resemble coastal islands and islets (*Figure 7A, B*), breeding pairs were relatively close to each other. The minimum distance between two breeding pairs was approximately 300 meters, while the maximum distance reached 1,000 meters. These sites typically featured cliffs ranging from 40 to 85 meters in height.



*Figure 7.* A. Overview of the inselbergs in Sharaan NP, appearing as isolated hills, ridges, or small mountains rising abruptly from the surrounding plains (Photo: Borut Rubinić); B. Detail of the steep rock formations providing shelter and nesting cavities for the Sooty Falcons (Photo: Paulo Alves)

7. ábra A. Szigethegyek a Sharaan NP-ban, amelyek különálló dombok, vonulatok, vagy kisebb hegyek formájában emelkednek ki az őket körülvevő síkságból (Fotó: Borut Rubinić); B. A meredek sziklaformáció részlete, amelyek védelmet és fészkelőüreget biztosít a hamvas sólymoknak (Fotó: Paulo Alves)



*Figure 8.* A. Overview of the steep sandstone cliffs in Sharaan NP, interspersed with narrow gorges and valleys (Photo: Bruno Herlander Martins); B. Detail of the extensive rock formations providing shelter and nesting cavities for the Sooty Falcons (Photo: Paulo Alves)

8. ábra Meredek homokkő sziklák a Sharaan NP-ban, közöttük kisebb-nagyobb völgyekkel (Fotó: Bruno Herlander Martins); B. Egy kiterjedt sziklaformáció részlete, amely védelmet és fészkelőüreget biztosít a hamvas sólymoknak (Fotó: Paulo Alves)

In contrast, in the cliff-type breeding sites, characterized by extensive sandstone plateaus interspersed with narrow gorges and valleys that contain eroded rock formations, caves, and crevices and resemble coastal cliffs (Figure 8A, B), breeding pairs were farther apart. The minimum distance between two pairs was around 1,150 meters, while the maximum distance reached 2,150 meters. The cliffs in these areas ranged from 60 to 95 meters in height.

These diverse nesting sites are shaped by the harsh environmental conditions of the region, with intermittent *wadis* running through the area, occasionally supporting sparse vegetation such as acacia trees, desert shrubs, and grasses. The aridity and intense heat further shape the flora and fauna that can thrive, creating a unique and challenging habitat for the Sooty Falcon.

## Discussion

This study presents the first confirmed evidence of inland breeding by Sooty Falcons in the AIUla region of Saudi Arabia, significantly extending the known breeding range of the species in this country, which has been previously documented primarily on islands and coastal cliffs (Jennings 2010). The discovery of at least 38 estimated breeding pairs, primarily concentrated within Sharaan NP, underscores the ecological importance of inland desert habitats, and specifically of protected areas within the AIUla County, for the global conservation of the species. Considering the current estimate of the world population of a maximum of 4,000 mature individuals (2,000 breeding pairs) (BirdLife International 2021), this newly identified population represents an increase of at least 2% in the global breeding population, highlighting its conservation significance.

While the breeding numbers and habitat traits of island populations of the Sooty Falcon are better documented (Gaucher *et al* 1995, McGrady *et al* 2017), this inland population exhibits distinct ecological characteristics. Nesting sites were located at elevations ranging from 40 to 90 meters, on both small inselbergs and steep sandstone cliffs and rocky escarpments within *wadis*, providing suitable nesting cavities with limited predator pressure. At inselberg breeding sites, breeding pairs were relatively close to one another, spaced around 300 to 1,000 meters apart, resembling the colonial spacing patterns documented in coastal and island populations (Gaucher *et al* 1995). In contrast, at large cliff breeding sites, pairs were more widely spaced, with inter nest distances ranging from around 1,150 to 2,150 meters, reflecting nesting patterns more similar to those observed in other steep desert mountain populations (Frumkin & Pinshow 1983). Observations of bird arrivals in late April, followed by courtship and territorial behaviours and culminating in the presence of fledglings by October, indicate that these inland cliff environments provide suitable breeding conditions throughout the species' known breeding period.

The resilience of the Sooty Falcon, demonstrated by its ability to thrive in diverse habitats, suggests the potential for other undiscovered inland populations elsewhere in the Arabian Peninsula and beyond. Thus, the confirmation of this inland breeding population has direct conservation implications. The establishment of the conservation area network

by the Royal Commission for AlUla is crucial to maintain a protected environment for this species. Nonetheless, these findings emphasize the need for continued habitat conservation and population monitoring, particularly in the face of global threats, such as climate change, habitat degradation, and human disturbance. The presence of breeding pairs in the Sharaan NP core, as well as in Gharameel NR and Wadi Nakhlah NR, further suggests that the distribution of the Sooty falcon in the AlUla region may be broader than this study has revealed. Conservation efforts should focus on safeguarding these key habitats, while promoting additional research to refine population estimates and distribution, and to gain deeper insights into the breeding patterns and movement behaviours of the species.

## **Conclusion**

The identification of a previously unrecognized breeding population of Sooty Falcons in the AlUla region significantly enhances our understanding of the ecological range of this globally vulnerable species. This discovery demonstrates the importance of targeted research and highlights the conservation value of this remote hyper-arid area. The relative inaccessibility and isolation of the AlUla region have left it largely undisturbed by human activities, creating a vital refuge for raptors such as the Sooty Falcon. These findings emphasize the critical role of protected areas in safeguarding vulnerable raptor populations and demonstrate the immense conservation potential of arid inland regions. Further surveys and long-term monitoring are essential to track population trends, assess habitat quality, and develop adaptive conservation strategies to ensure the persistence of this species in its newly identified range.

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