

Results of the pilot survey on the Lanner Falcon (*Falco biarmicus feldeggii*) in Thessaly Prefecture, Greece.

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Abstract

Lanner Falcon (*Falco biarmicus feldeggii*) is classified as endangered in Greece. Its breeding population is considered stable, with a patchy distribution on the mainland and the islands. Thessaly is considered one of the species' strongholds due to its arid climate, connecting the subpopulations of western and northern Greece to those in the south. This is the first dedicated pilot survey for the species in Greece. Historical and citizen-science data were compiled, and the prefecture was divided into seven sectors. Favourable areas were classified based on the abundance of past and recent observations, as well as the species' probability of presence. A total of 6,052 km was covered, with 107 field days and 480 monitoring hours invested from viewpoints during the breeding season. The species was recorded fifteen times, and eight territories were verified. Based on historical data, in four of the seven sectors, the species shows 59% decline. No fledglings or reproductive activity were recorded during 2024.

Keywords: Bird of prey, Endangered species, breeding season, monitoring efforts, territory verification, population decline, conservation

INTRODUCTION

The Lanner Falcon (*Falco biarmicus feldeggii*) is among the least-studied falcons in Greece, and its detailed population and distribution are still unknown in the country (Leonardi 2001; Alivizatos et al. 2021). The species has an extensive yet fragmented distribution, occurring across all thirteen Greek prefectures (Fig. 1A). Previous estimates of its population in Greece came from surveys of Important Bird Areas (IBAs) and Special Protected Areas (SPAs; Fig. 1B). The overall distribution includes 30 SPAs with one-third of the population living in medium-sized or large islands (10 SPAs), while the rest is on the mainland (Fig. 1B; Dimalexis et al. 2009). Ranging from 40 to 55 pairs in these assessments, this falcon was considered stable or locally declining (excluding potential pairs outside SPAs; Alivizatos et al. 2021).

Lanner Falcons in Greece can be found from sea level up to 2,300 m. Most territories are at moderate altitudes between 500 and 1000 m. In Crete, they are usually seen in rocky slopes between 400 and 1600 m. Nests have been found twice overlooking pine forests (Handrinos & Akriotis 1997) and one in a corvid nest on a plain (authors own data). In Thessaly, they were recorded near Lake Karla (Magnesia and Larissa) with one juvenile and two adults observed in 2022-2023 (authors own data). These observations, along with observations by citizen science network were the incentive of the current pilot survey in the Prefecture of Thessaly, Greece.

At the national level, the species is classified as “Endangered” (BirdLife International 1999; 2024). Its main threats include habitat loss, large photovoltaic parks, wildfires, flooding, poisoning from agrochemicals, and competition with the Peregrine Falcon (*Falco peregrinus*) (Birdlife International 1999). Other risks, such as egg collection and/or illegal shooting, are also possible (BirdLife International 1999; 2024). A major threat is also natural afforestation caused by land abandonment (e.g., the decline of traditional animal husbandry) which reduces the required open hunting grounds essential for the species (Alivizatos et al. 2021).

This is the first focused survey to document the species’ presence in the country. The goal is for the data acquired to serve as a basis for future studies on breeding parameters, habitat preferences, timing of reproduction, and population growth, comparable to other areas occupied by the subspecies *feldeggii* in the Mediterranean basin (Sarà 2014, Amato et al. 2014, 2021, Mascara & Nardo 2018, Sarà et al. 2022, Leonardi et al. 2024).

MATERIALS AND METHODS

Study area

The core study area was the Thessaly Plain in the Thessaly Prefecture, covering 14,036.64 km² (Fig. 1C, D). It lies in the central and eastern parts of the prefecture and is surrounded by Olympus

Mountain to the northeast, Ossa Mountain Mayrovouni and Pelion Mountains to the east, Othrys Mountain to the south, Chasia and Kamvounia Mountains to the northwest and Koziakas Mountain to the west (Fig. 1D).

The mountains have canyons and rocky foothills, while the plain is marked by low, rocky hills with scattered across the grasslands. Grasslands are the main natural vegetation in both lowlands and hilly areas, along with scrublands and open forests. Agriculture mainly consists of non-irrigated cereal and cotton crops (Galanaki et al. 2017). The Prefecture experiences hot, dry summers with temperatures exceeding 35°C, typical of a Mediterranean Xeric type, and mild, more wet winters, especially in higher areas, characteristic of a Subhumid Mediterranean climate (Rivas-Martínez 1996). The climate ranges from Mesomediterranean in the lowlands to cooler, wetter conditions in the Supramediterranean mountains (Tselepidakis & Theoharatos 1989).

Located in the northwest part of the Thessaly plain, near the town of Kalambaka, the Meteora rock formation consists of towering sandstone pillars. Recognized as a UNESCO World Heritage site, it includes the SPA GR1440005 (Mount Antichasia and Meteora), an area that has historically hosted at least four pairs of Lanner Falcons. Half of the mainland Greek population is found in Central Greece (East of Pindos Mt, within 10 SPAs) in the Prefecture of Thessaly, making this area a potential stronghold area for the species (Fig. 1C).

Compilation of historical and recent data

Data for the species were compiled from the following sources: a) previously published ornithological assessments of IBA/SPA monitoring from 2001, 2009, 2016 and 2024; b) Greek and international literature research through scientific databases such as PubMed and Google scholar; c) data extracted from e-Bird, iNaturalist observation platforms; d) private reports from ornithological field trips; e) contributions from foreign ornithologists and the authors; and f) photographs of the species shared in Greek wildlife/bird photography Facebook management. Data were assessed for quality. Data from e-Bird and iNaturalist was included only if the report was accompanied by pictures of the species or detailed description. Historical nesting territory information was considered the most valuable, followed by observations of adult birds (pair or singles) during the breeding season (February-May), which were seen as potential territory-holders. Juvenile observations in May-June indicated breeding success and an active territory. Observations of juvenile in July-August and adults from July to January were excluded, as they likely indicated juvenile dispersal or adult winter movement.

Field survey methodology

Thessaly was divided into seven sample areas (Fig. 1D). Candidate areas were classified as high priority, medium pri-

ority, low priority, and uncharted/possible, based on historical data, recent observations (within the last 5 years), and habitat evaluation. In total, 13 high-priority, 8 medium-priority, 7 low-priority, and 17 uncharted/possible areas were identified. Researchers used fixed viewpoints in each area to observe suitable nesting cliffs from both distant and up close. Viewpoints were set up in corridors linking foraging and nesting habitats to improve encounter chances. Due to the extended habitat and limited time, the survey focused on high-priority areas, mainly in the east, northeast, northwest and north sectors. Only the northern part of the southern sector was surveyed, while the western and southwest sectors were not visited.

Fieldwork was conducted from March to July 2024 using binoculars (10x45), field scopes (25 – 65x) and DSLR cameras. Earlier start of fieldwork (e.g. January-February) was not possible due to lack of funding. The procedure followed the Lanner Falcon's breeding phenology in Sicily and southern Italy (Amato et al. 2021). Sites were visited 2-8 times, and each session lasted at least 4 hours, with extension if the species was observed. Cliffs were checked for nests, and photos of both active, inactive and possible nests were taken from distance. Local residents, such as hunters and shepherds, were discretely interviewed about raptors when

crossed paths with the field researchers. Territories were defined within an 8 km radius. Over 6,052 km were covered in the selected sectors. Five full-day expeditions (4 days each) took place from March to early July, covering the northwest (2), northeast (2), and parts of the north and south sectors. Tab 1 provides a detailed summary of the fieldwork effort carried out in Thessaly during 2024, including the number of fieldwork days, cumulative monitoring hours, and visits to areas of varying conservation priority.

RESULTS

Historical population and distribution of the Lanner Falcon in Greece and Thessaly

The population size and distribution of the Lanner Falcon in Greece remains unclear. Cross-verification of historical records, citizen-science data, and authors' historical data, suggest a cautious estimate of 60-80 historical territories. In Thessaly Prefecture, there may have been historically 17-22 territories, distributed as follows: 4 in the southern sector, 1-2 in the western sector, 4-6 in the northwest sector, 2 in the northern sector, 5 in the northeast sector, and 4 in the eastern sector (Fig. 1D).

Table 1. Summary of fieldwork effort, monitoring hours, and site visit priorities by month in Thessaly during 2024.

Month	Fieldwork Days	Monitoring Hours	High-Priority Area Visits (all months)	Medium-Priority Area Visits (all months)	Low/Possible-Priority Area Visits (all months)
March	15	50	-	-	-
April	24	135	-	-	-
May	13	68	-	-	-
June	25	178	92	10	10
July	15	45	-	-	-
Total	107	480	92	10	10

Survey results

The Lanner Falcon was recorded 15 times: 12 times in high-priority areas and 3 times in uncharted areas in the southern sector. There were also 3 unverified sightings. Based on these, we confirmed 8 territories (3 in the northeast, 2 in the northwest, 2 in the east, and 1 in the south), with two more (1 in the south and 1 in the northwest) likely (Fig. 1D). Of the 10 territories, 8 were in high-priority areas with historical presence of the species, while two might be newly discovered areas.

Most observations (6) involved male adults mobbing other species (*Corvus corone* and *Falco tinnunculus*) or hunting and eating. In one case, a pair was seen, and in another, a female. In five cases, the sex was not identified. No juvenile birds or reproductive activity were recorded. The species was photographed three times. Three suspected nesting locations were found in cliffs where birds were roosting, and two abandoned historical

nests have been located. In other areas, no nests were found due to abundance of suitable cliffs, some with limited visibility.

DISCUSSION

Thessaly population estimation/trend

This pilot survey confirmed the presence of the species in Thessaly, mainly within historical territories. The southern, south-western and the western sectors were not surveyed meticulously, and therefore were excluded from the calculations. In the other sectors, the northwest shows a 50-66% decline (2 territories), the north a 100% decline (zero territories), the northeast a 40% decline (3 territories), and the east shows a 50% decline (2 territories). The average decline across the four sectors is calculated to 59% (17 historical vs 7 current; Fig. 1D).

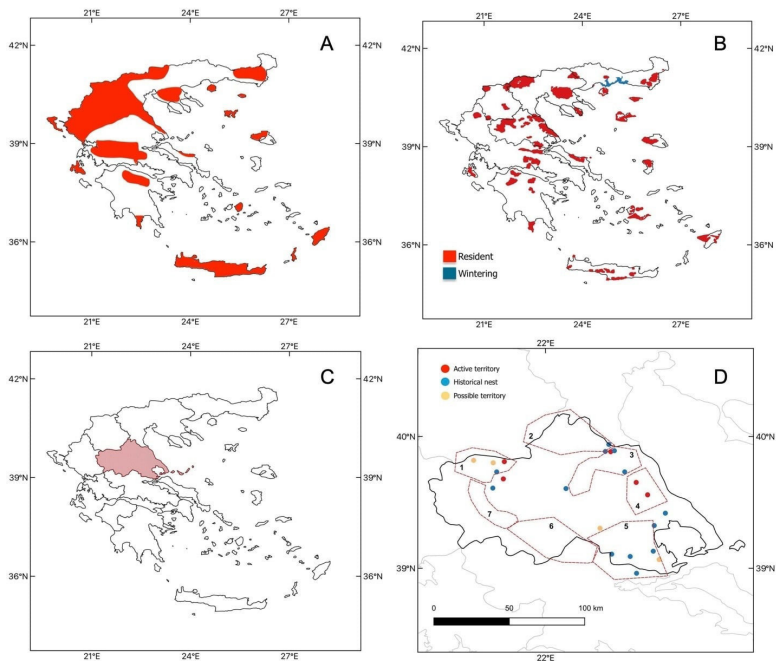


Figure 1. A - Lanner Falcon distribution in Greece (Alivizatos et al. 2021), B - Lanner Falcon in Greek Special Protection Areas (SPAs), C - Thessaly Prefecture, D - The seven research sectors of Thessaly Prefecture and historical, current and possible Lanner Falcon territories in Thessaly a – Sectors 1 = North West, 2 = North, 3 = Northeast, 4 = East, 5 = South, 6 = Southwest, 7 = West.

Reproductive performance/dynamics

It was even more concerning that no breeding behaviour or juvenile Lanner Falcons were observed in 2024. In 2022-2023, however, at least one juvenile was photographed in the east sector of Thessaly, indicating an active territory. Unfortunately, other territories were not regularly monitored before this pilot survey. During the current survey, a pair was seen only once in suitable cliffs in June, and no copulation was observed. The low number of pairs detected during this pi-

lot study may have been influenced by specific constraints, even with the time invested. For instance, the allocation and less conspicuous nature of vocal activity during courtship behaviour could have hindered the detection of occupied territories (Leonardi et al. 2013). In addition, population fragmentation and the low number of active pairs mean that unpaired individuals (floaters) are not closely involved in maintaining a suitable territory (Leonardi et al. 2025). The absence of juvenile bird observations could be attributed to a decline in productivity,

consistent with the recent trends seen in Italian populations (Amato et al. 2021; Sarà et al. 2022). February rainfall was the main environmental factor affecting Lanner Falcon breeding (Amato et al. 2021; Sarà et al. 2022). While moderate rain encouraged breeding, heavy rainfall delayed egg-laying, leading to nest failures and fewer fledglings (Amato et al. 2021; Sarà et al. 2022). Human-induced pressures, alongside climate change, further intensify the negative impacts and must be taken into account (Leonardi 2001; Sarà et al. 2022).

Threats and future research and conservation actions

Various threats have been recognized as direct or indirect risk factors impacting the viability of the *feldeggii* subspecies of the Lanner Falcon population in Europe (Leonardi 2001; Gustin et al. 2002; Andreotti & Leonardi 2007). Among the various threats, one of the most pervasive is land abandonment, combined with the gradual discontinuation of traditional agricultural practices, particularly in arable lowland areas (Sarà 2014). The impact on the Lanner Falcon can occur on multiple levels, affecting not only the composition and abundance of its preferred prey in foraging areas, but also the suitability of its nesting territories (Sarà 2014). Habitat degradation, driven by the abandonment of traditional land uses, is currently occurring in the north, northwest, and northeast sectors, making negative impacts on this falcon a likely outcome (Kairis et

al. 2022; Bouillet 2024). Preliminary observations indicate that competition with the Peregrine Falcon does not represent a significant threat, a finding consistent with existing quantitative studies (Amato et al. 2014; Sarà et al. 2016). No direct illegal persecution was detected or suspected through the fieldwork or interviews. Disturbance caused by climbers, hikers or tourists was observed in the northwest sector (Meteora area). Expansion and establishment of medium-sized photovoltaic parks has been observed across all Thessaly and close to some Lanner Falcon territories. Their possible impact needs further investigation.

Future efforts in the Prefecture should focus on finding new territories in the south, southwest, and west sectors. Surveys should start in February, when nuptial flights occur. The main priority is to monitor the eight existing territories in the northwest, northeast, and east sectors, assess breeding activity, and check productivity and fledgling numbers. Satellite telemetry, following the established protocols for the species, can offer valuable insights into various aspects of their behaviour (Stephenson 2001; Sarà et al. 2019). For adults, it aids in understanding foraging habits, nest locations, dispersal patterns, and habitat use (Stephenson 2001). For juveniles, it plays a crucial role in monitoring survival rates and tracking dispersal from the natal site (Sarà et al. 2019). Pellet analysis and nest camera (if applicable) could provide information on diet, prey selection, breeding performance and reproductive behaviour,

allowing comparisons with the Italian population (Grenci & Di Vittorio 2004). Finally, dissemination the results with local authorities (Forestry Department, NECCA - Natural Environment & Climate Change Agency and Administration) would help secure funding for actions to boost the population and reduce further decline in the Prefecture.

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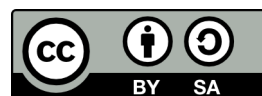
Competing interests

The authors have no competing interests to declare that are relevant to the content of this article

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