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### Status and ecology of the Bonelli's Eagle, *Aquila fasciatus*, in the Pentadaktylos Mountain Range, Cyprus (Aves: Falconiformes)

Damla Beton <sup>a</sup>, Robin Snape <sup>b</sup> & Barış Saydam <sup>c</sup>

<sup>a</sup> The North Cyprus Society for the Protection of Birds and Nature (Kuşkor), Girne, Cyprus

<sup>b</sup> Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Devon, United Kingdom

<sup>c</sup> Independent researcher

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## Status and ecology of the Bonelli's Eagle, *Aquila fasciatus*, in the Pentadactylos Mountain Range, Cyprus (Aves: Falconiformes)

Damla Beton<sup>1\*</sup>, Robin Snape<sup>2</sup>, and Barış Saydam

*The North Cyprus Society for the Protection of Birds and Nature (Kuşkor), Girne, Cyprus.* <sup>2</sup>*Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Devon, United Kingdom.*

The Bonelli's Eagle is endangered in Europe, and the Cyprus population is estimated to be the 4<sup>th</sup> largest in Europe. During 2011 and 2012, ten active nests were confirmed in Pentadactylos Mountains with 8 additional sites meriting further investigation. Observations suggest a varied opportunistic diet largely based on Black Rat (*Rattus rattus*). Lowland wetland sites are confirmed as important foraging grounds. Bonelli's Eagle is under a variety of anthropogenic threats in Pentadactylos Mountains most significantly hunting and poisoning, evidence for which are discussed.

**Keywords:** Bonelli's Eagle, Pentadactylos Mountains, Cyprus, opportunistic feeder, Red List, threats.

### Introduction

The Bonelli's Eagle *Aquila fasciatus* (Vieillot, 1822) has a wide global distribution extending from Spain, through southern Europe and across central Asia into China (BirdLife International 2012a). Due to its large range it is evaluated as Least Concern by The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2012). At an estimated 1032–1223 pairs, the European population of the Bonelli's Eagle is relatively small (BirdLife International, 2010) and contributes to less than a quarter of its global population (BirdLife International, 2004). Over 80% of this population is concentrated in far western Europe (Spain and Portugal), with other small populations of less than 40 pairs distributed across other North Mediterranean countries. As a consequence of its small size and significant declines during the late 20<sup>th</sup> century, the European population in 2004 was evaluated as endangered (BirdLife International, 2004).

Considering the marked decline in the European Bonelli's Eagle population, which particularly affected its Spanish stronghold (Simó, 2007), the remaining smaller, isolated populations across the Mediterranean have become more valuable to the sustainability of the species globally. Islands such as Crete, Sicily and Cyprus in particular have a rather important role through the Mediterranean as they are likely to facilitate gene flow across the global population, supporting genetic connectivity between the Asian and Spanish strongholds. Extinction of these smaller populations would lead to increased disjunction between the western (Spain and Portugal) and eastern (Asian) populations which could undermine the potential recovery of the species throughout Europe. As Mebs and Schmidt (2006) pointed out “monitoring of all populations in Europe is important”.

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\*Corresponding author. Email: [damlabeton@gmail.com](mailto:damlabeton@gmail.com)

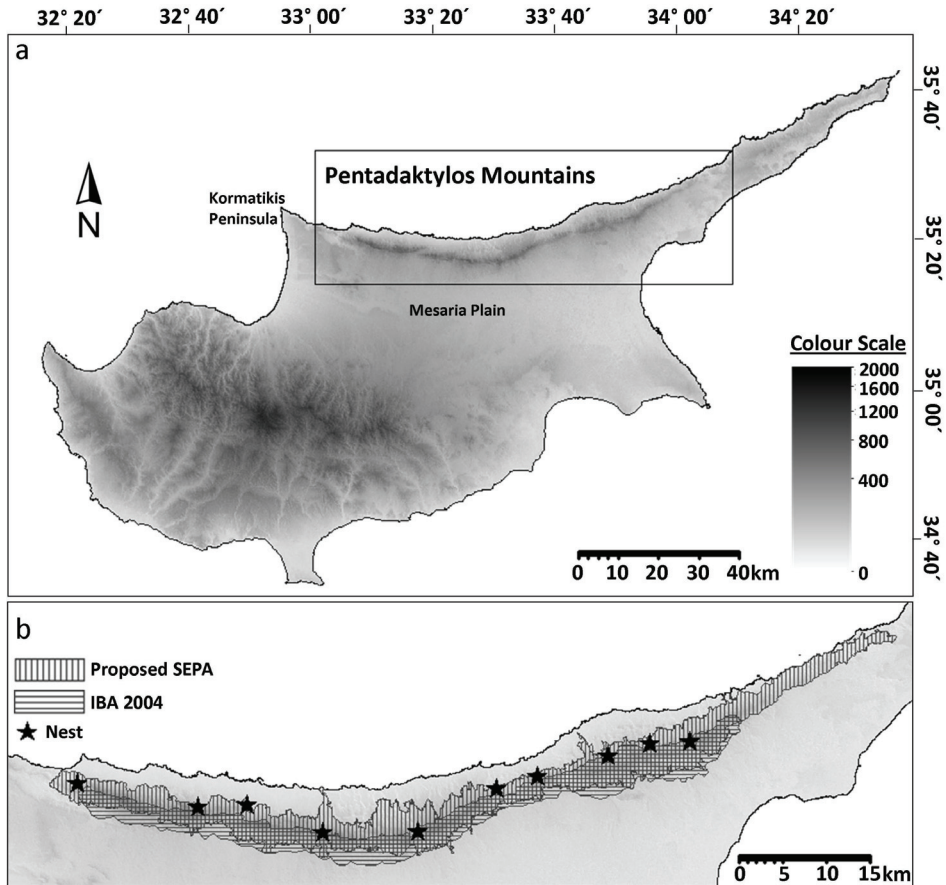


Figure 1. a. Elevation map of Cyprus (based on data downloaded from [www.worldclim.org](http://www.worldclim.org)). b. Distribution of Bonelli's Eagle nests vs. proposed Pentadaktylos Mountains SEPA (Seffer et al., 2011) and current declared IBA (Iezekiel et al., 2004a).

The Cyprus population was estimated to hold more than 50 pairs during the late 1950s (Flint & Steward, 1992). By the early 1990s its population declined to less than 20 pairs (BirdLife International & European Bird Census Council, 2000). A recent study, however, estimates the Cypriot population at 31–39 pairs (Kassinis, 2010), making it the fourth largest in Europe. Yet, this recent study does not include the Pentadaktylos Mountains (Kassinis, 2010), where Bonelli's Eagles are known to occur (Flint 1999–2003; Iezekiel, Makris, & Antoniou, 2004a).

The Pentadaktylos Mountains were identified as an Important Bird Area (IBA) in 2004 under the BirdLife International scheme, due to the likely significant occurrence of eight species including the Bonelli's Eagle (Figure 1) (BirdLife International, 2012b). It was estimated then to harbour 2–3 pairs (Iezekiel et al., 2004a), yet this estimation was not confirmed by any specific field studies. The most recent report which details observations of Bonelli's Eagles in the region indicates that there was at least one pair breeding in 2001 (Flint, 2003). The aim of our current study was to clarify the status of the Pentadaktylos Mountains population whilst providing first insights into phenology, reproductive success, diet and distribution of nesting birds and key foraging sites.

### Study Area

Our study area, the Pentadaktylos Mountain range, parallels the north coast of Cyprus reaching a maximum altitude of 1024 m (Figure 1). The northern slopes are very rugged and steep and separated from the coast by narrow lowlands that are 5 km at their widest. In contrast, its southern slopes meet with the broad Mesaria Plain, the most agriculturally active area in Cyprus, which also contains wetland sites and waterways. Annual rainfall varies between the northern and the southern slopes, which on average receive 480 mm and 340 mm of rain respectively (Seffer, Emirzade, Özden, Fuller, & Sefferova, 2011).

The unique vegetation structure of the Pentadaktylos Mountain range has high ecological value for biodiversity conservation. It includes 14 different habitats (based on The European Nature Information System (EUNIS) classification), three of which are priority habitat types for conservation under the Habitats Directive (Dir 92/43/EEC) (Seffer et al., 2011). Within these habitats particularly well preserved are calcareous rocky slopes with chasmophytic vegetation, limestone pavements and Mediterranean pine forests with endemic Mesogean pines (Seffer et al., 2011). They also host various endemic species and subspecies of birds, plants and reptiles (Seffer et al., 2011). Consequently, in addition to its IBA status, the site is also proposed as a Special Environmental Protected Area (SEPA) in 2011 (Seffer et al., 2011) (Figure 1).

### Methods

All field work was undertaken by experienced local wildlife photographers during 2011 and 2012. Preliminary data were first gathered in order to establish target areas from which to initiate nest searches. Data from casual observations made by photographers since 2007 and images and information shared on social networking sites were first collated. Informal interviews were held with shepherds and resulting data were also used to target fieldwork. Searches were initiated in January of each study year. Where eagles were seen, repeat visits were made as soon as practically possible, with the first nest photographed on 13 February 2011. By noting the basic ecological and geographic characteristics of the first discovered nest site we were able to prioritise further searches to more specific habitats. This targeted field work continued through the 2011 and 2012 breeding seasons. Once nests were found further opportunistic visits were made until June, at which point young were fledged, to record additional information such as the number of young, success and diet using high resolution telephotographic equipment. Nests were deemed active if adult birds were seen tending them. At the same time, coincidental observations of individuals were recorded throughout the year in order to detail seasonal distributional patterns.

### Results

**Nesting numbers and distribution.** Ten active nests and one inactive nest were located. The first 4 active nests were located in 2011 and were subsequently monitored through 2012 when a further 6 separate nests were located (Table 1). An additional inactive nest was likely to be that of a Bonelli's Eagle. A further 8 sites were noted where pairs were repeatedly seen yet no nest was found. The nests were distributed fairly evenly across the mountain range from Mersinlik (Flamudi) at its eastern to Karşiyaka (Vasilia) at its western extent (Figure 1). The distance between two nests ranges between 3.15 and 10 km. All were located on north facing rocky slopes and found at altitudes between 300–800 m (Table 1). All of these nests are located within the proposed SEPA (Figure 1), but not all are within the current designated IBA.

**Diet.** Our dietary observations include higher rates (6 incidences) of rat – especially Black Rat, *Rattus rattus* – in combination with single incidences of Chukar, *Alectoris chukar cypriotes*, Wood Pigeon *Columba palumbus*, Jackdaw *Corvus monedula* and Teal, *Anas crecca*, predation (Figure 2). The species is clearly opportunistic and adaptable as even predation on Cyprus Wheatear *Oenanthe cypriaca* was observed. Scavenging of poisoned canine carcasses was also directly observed with one bird requiring rehabilitation after secondary consumption of the pesticide Lanate.

Table 1. Nest records of Bonelli's Eagle in the Pentadaktylos Mountain Range, Cyprus. Alt. = altitude in m a.s.l.

No.	Alt.	Year	Found	No. of young	Revisits	Notes
1	440	2012	01.04.	2	14.04., 24.04.	Both adults and young around the nest. On 01.04 an adult observed feeding on a prey.
2	450	2011	13.05.	2	16.05.; 23, 25, 28.05.	Both young in flight and perched on the corner of the nest.
		2012		≥1	11, 14, 18, 29.01.; 29, 31.03.; 25.04.	Only one young observed while flying with adults. Possibly more young present.
3	420	2012	16.04.	≥1		As in military area, observed from a distance. More young might be present.
4	660	2011	07.05.	1	14.05.	About 5 weeks old young on 14.05.
		2012		2	14.01.; 15, 21.02.; 23.04.	–
5	760	2011	24.05.	none		Only edge of the nest seen.
		2012		2	27.04.	Adults with 2 young observed around the nest.
6	300	2012	22.04.	none	mid-May	Nest active, but young could not be seen due to its placement.
7	390	2012	23.04.	2	19.05.	Young half-grown on 19.05 (need 2–3 weeks more before flight).
8	420	2012	26.04.	2	27, 29.04.; 01.05.	One of the young left the nest between 29.04. and 01.05.
9	310	2012	23.04.	2	27.04.	2–3 weeks old young observed on 27.04.
10	450	2011	13.02.	2	10, 30.04.; 07., 14.05.	Adult observed flying to the nest carrying a rat on 13.02. On 10.04 3 rat and a chukar remains observed in the nest at the same time. Young undertaking attempts to fly on 14.05.
		2012		1	14, 26.02.; 27, 29.04.; 01.05.	Young still in the nest on 01.05.
11	500	2012	21.01.	0	08, 25.02.	Apparently old nest with no recent activity.

**Behaviour and foraging area.** Observations made during the current study (Table 2) as well as the available records of KUŞKOR (North Cyprus Society for Protection of Birds and Nature) show that post-breeding foraging grounds of this population include wetlands within lowlands on the Mesaria Plain and Kormakitis Peninsula (Figure 1), when these areas host wintering wildfowl. Two of these records were during the breeding season, of which one was a non-breeding juvenile, while the other was from a wetland proximal to its nesting site. In December 2012 a second-year immature was found at

Table 2. Records of the Bonelli's Eagle from various wetlands (Flint 1999–2003, recent observations by KUSKOR) (ind. = individual).

Year	Date	Place	Notes
1999	27.04.	Geçitköy Reservoir	1 pair, close to a nest site
	10.09.	Geçitköy Reservoir	1 juv. and 1 adult
2000	18.08.	Alagadı Reservoir	1 ind.: juvenile
2010	30.10.	Kalkanlı Reservoir	1 ind.
	20.11.	Kalkanlı Reservoir	1 ind.
	22.12.	Kalkanlı Reservoir	1 ind.
2011	17.08.	Kalkanlı Reservoir	1 juvenile feeding on a Black Rat
	12.10.	Kalkanlı Reservoir	1 ind.
	17.11.	Kalkanlı Reservoir	1 ind. feeding on a rat
	20.01.	Gönyeli Reservoir	1 ind.
	04.04.	Kalkanlı Reservoir	1 ind.: juvenile
2012	16.09.	Gönendere Reservoir	1 ind.
	02.10.	Demirhan Wetland	1 ind.
	12.10.	Haspolat Sewage Works	1 ind.
	17.–19.11.	Kalkanlı Reservoir	1 ind.
	24.12.	Kalkanlı Reservoir	1 juv. scavenging poisoned carcass
	11.01.	Kalkanlı Reservoir	1 ind.
	Jan.	Haspolat Sewage Works	1 ind.

Kalkanlı Reservoir, where it had consumed the carcass of a dog poisoned with the illegal pesticide Lanate. The bird was successfully rehabilitated, marked and released and was photographed one month later at the site.

## Discussion

Our study shows that at least 10 pairs of Bonelli's Eagle actively breed through Pentadactylos Mountains, making the site amongst the most important, if not the most important conservation area for this species in Cyprus. Furthermore, this count is likely to under represent the true number of nesting pairs for the following reasons. Firstly, our efforts were biased towards northern slopes. Secondly, all nests were located on north facing rocky slopes which is in contrast to those found in the rest of the island, where the majority of nests are constructed in trees (Kassinis, 2010). Consequently, some nests were likely overlooked. Thirdly, we believe that there are 8 additional sites outside those detailed here, where further investigation could yield additional nests. Further surveys are thus well merited.

As previous population estimates for the Bonelli's Eagle at the Pentadactylos Mountain range were just 2–3 pairs (Iezekiel et al., 2004a), this relatively large population was unexpected. An apparent population growth might be as a result of a combination of factors such as lack of competitors and increase in food availability for example rodents and well stocked game birds. Since the extinction of the Eastern Imperial Eagle, *Aquila heliaca*, in Cyprus during the 1980s, any inter-specific competition or territorial pressure might have been eliminated. Other potential competitors are Griffon Vulture,



Figure 2. Top: Nestling of Bonelli's Eagle feeding on a rat (photograph: Barış Saydam). Bottom: Immature Bonelli's Eagle feeding on a rat (photograph: Birtan Gökeri).



*Gyps fulvus*, and Long-legged Buzzard, *Buteo rufinus*. The former is now also extinct through Pentadactylos Mountain range (Iezekiel et al., 2004b) and although Long-legged Buzzard is noted as a considerable competitor in some areas (Kassinis, 2009), records of migratory individuals in Pentadactylos Mountains are few. Kassinis (2010) believes that the availability of Hare and Chukar is the main reason for the relatively large population size in Cyprus as such prey are easily predated through landscapes with low or little vegetation, such as garigue, dry grasslands and rocky hills of the Pentadactylos Mountains. Coverage of these vegetation types through the mountain range increased significantly following the extensive forest fire in 1995 and sporadic fire events since. Flint (1999) suggests that this event expanded the hunting ground for the species. Also, the local hunters' federation (KKTC Avcılık Federasyonu: AVFED) is captive breeding and releasing thousands of Chukar to the wild each year prior to the game hunting season, which begins at the end of October. For example, in 2012 approximately 20,000 Chukar were released (www.avfed.com). Breeding success may thus be linked to game management.

Mebs and Schmidt (2006) and Caro, Ontiveros, and Pleguezuelos (2011) included rabbits and Red-legged Partridge *Alectoris rufa*, along with a variety of birds such as pigeons, crows, ducks, gulls and others up to the size of herons as common prey items. As there are no rabbits or Red-legged Partridge in Cyprus, we would expect Hare *Lepus europaeus cyprius* and Chukar to replace this part of the diet. Even though our observations correspond largely with their results, we have not observed any incidence of hare predation so far. Actually longer term dietary studies should be continued to monitor annual variation in prey choice in response to ecological changes of the region such as game population management and vermin control. It may be that this adaptability has enabled the species to prosper in the Pentadactylos Mountains where others have failed.

Still, it can not be concluded with certainty that the Bonelli's Eagle population has increased in Pentadactylos Mountains, as no reliable data exist on the long term demography of the species. However, if the population is in recovery, it may have experienced a genetic bottleneck in its recent history, in which case it could be subject deleterious effects of this. Yet, it is very possible that there may be interactions between the Pentadactylos Mountains and other Cypriot or even wider regional populations, which may be a relieving factor for total population viability. Telemetry and mark-recapture studies may be useful in determining this. The combined impacts of hunting and poisoning drove the Griffon and Cinereous Vultures *Aegypius monachus* and the Imperial Eagle to extinction in Pentadactylos Mountains (Flint & Stewart, 1992) and although Bonelli's Eagle have persisted well for two further decades these threats remain unmitigated. Northern Cyprus holds a great number of hunters –12.1% of the total population are active hunters (KKTC Avcılık Federasyonu, 2011) – and poisoning is a very common practice used by shepherds against foxes and abandoned hunting dogs throughout the Pentadactylos Mountains (Kyrenia Animal Rescue, 2012), coastal lowlands and Mesaria Plain (KUŞKOR, pers. comm.), all of which are foraging grounds of this species.

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