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## Brief report

# Status and population trend of Eleonora's Falcon *Falco eleonorae* in the Canary Islands

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## 1. Introduction

Eleonora's Falcon *Falco eleonorae* Gené, 1839 is a colonial, diurnal raptor whose distribution ranges from the Mediterranean region to the eastern coast of Morocco and the Canary Islands, where it has the westernmost and southernmost breeding colonies (Cramp & Simmons 1998, Snow & Perrins 1998). The species is highly migratory, gathering in breeding areas from mid-April to mid-October (Tucker & Heath 1994), its breeding period adapted to coincide with the postnuptial migration of small passerines (Cramp & Simmons 1998, Del Hoyo *et al.* 1994). After the application of proper census methods, as outlined in the International Action Plan for this species (BirdLife International 1999), its global breeding population has recently been estimated at more than 13,500 pairs (Dimalexis *et al*. 2008), although it could reach ca. 30,000 mature individuals (BirdLife International 2008). The Spanish breeding population consists of approximately 1,100 pairs distributed over the Balearic Islands (836 breeding pairs; Viada 2006), the Canary Islands (200; De León *et al*. 2007), and the Columbretes Islands (45; Viada 2006). The species is included in Annex I and II of the EC Birds Directive 79/409/EEC and constitutes a priority species for conservation. The International Species Action Plan recommended a coordinated international survey as urgent action to conserve the species (BirdLife International 1999), which was accomplished in some countries within the framework of the project "Conservation measures for *Falco eleonorae* in Greece" LIFE 03NAT/GR/000091.

In line with these recommendations, two aims are pursued in this paper: (1) to update census data of the breeding population of Eleonora's Falcon in the Canary Islands as a contribution to the above-mentioned global census project; and (2) to evaluate the population tendency of Eleonora's Falcon in the Canary Islands by using data from previous studies.

## 2. Material and methods

The Canary Islands (27º37'–29º25' N, 13º20'–18º19' W) are located 100 km off the Atlantic coast of northwest Africa (Fig. 1), consisting of seven main islands, and several islets and rocks. The breeding colonies of Eleonora's Falcon are located on the northernmost of these, known as the "Chinijo Archipelago" or "Los Islotes" (Martín & Lorenzo 2001). This archipelago is composed of

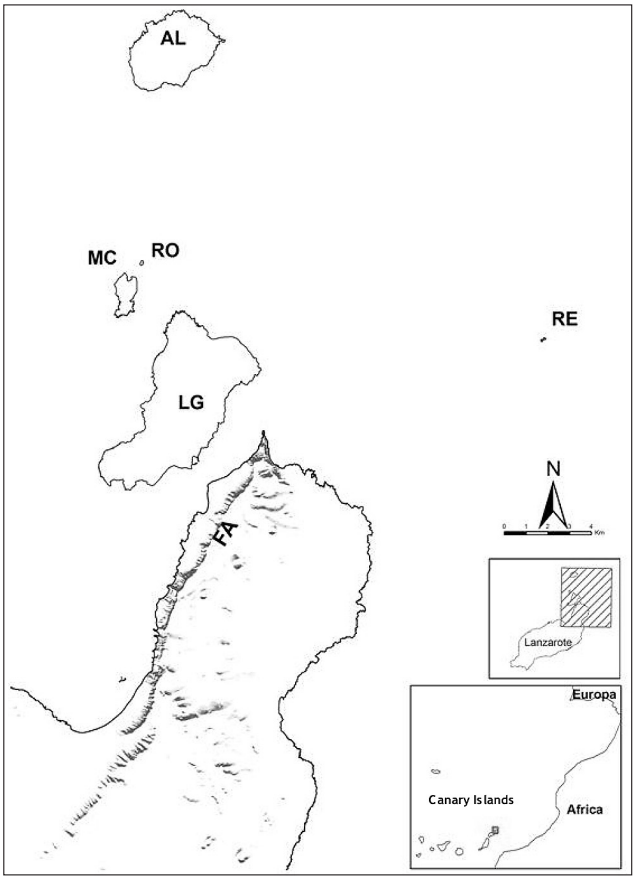


Fig. 1. Geographical location of the Canary Islands and Archipelago Chinijo. LG = La Graciosa, MC = Montaña Clara, AL = Alegranza, RE = Roque del Este, RO = Roque del Oeste, FA = Risco de Famara cliffs.

three islets and two rocks: La Graciosa (29.05 km$^2$; 266 m a.s.l), Montaña Clara (1.48 km$^2$; 256 m a.s.l), Alegranza (10.30 km$^2$; 289 m a.s.l), Roque del Este (0.06 km$^2$; 84 m a.s.l) and Roque del Oeste (0.016 km$^2$; 41 m a.s.l). The census was focused on those sites where breeding (1) was previously confirmed (Montaña Clara, Alegranza, Roque del Este and Roque del Oeste; Martín & Lorenzo 2001), and (2) was considered possible, such as La Graciosa and the cliffs of Risco de Famara (a 15-km long massif on Lanzarote, the nearest main island; Martín & Lorenzo 2001).

During the two middle weeks of August 2007 we carried out a census in the study area, except for Alegranza which was prospected in the third week of August 2008. The species Action Plan recommends to begin counting nests on September (BirdLife International 1999). However, based on our long-term experience, these falcons are not disturbed considerably during short field visits earlier in the breeding season. Hence, we carried out the census in August to include attempted breeding pairs that fail and would thus not be counted in a census done in September. We also took the advantage of eggs being hatched and falcons still being in their nests in August, which enhances the likelihood of encountering birds.

In Montaña Clara, Alegranza, Roque del Este and Roque del Oeste, we prospected all accessible areas and visited active nests to assign their geographical coordinates using a hand-held GPS navigator. The field team consisted of 4 observers on the rocks, 5 on Alegranza and 8 on the rest of the study area, spending 1- to 6-day periods on each rock or islet. Moreover, we exhaustively prospected inaccessible areas of these islets and rocks using telescopes and binoculars until we could distinguish between a floater and a potential breeder that disappeared into a likely nest site. Such cases were added to the other nest counts.

Methods used on La Graciosa and Risco de Famara consisted of sight observations made at 4

Table 1. Number of Eleonora's Falcon breeding pairs during 2007–2008 (the number of visited nests are in brackets; the rest were inaccessible nests). Nest density, Kernel spatial density range (KSDR), minimum mean Euclidean distance between nests (MMD) and nest minimum distance range per islet (MDR) are also shown.

| Islet | Pairs | Nests/km$^2$ | KSDR (ha) | MMD (m) | MDR (m) |
|---|---|---|---|---|---|
| Montaña Clara | 115 (102) | 77.7 | 0–2.0 | 39.6 | 1–224.1 |
| Alegranza | 135 (124) | 13.1 | 0–5.1 | 65.5 | 1.4–391.8 |
| Roque del Este | 55 (48) | 916.7 | 2.2–6.5 | 7.2 | 0.7–33.4 |
| Roque del Oeste | 2 (2) | 0.13 | 0.1–0.3 | 74 | – |

and 20 observation points, respectively. We noted the number observed, their flight directions, and potential breeding behaviour simultaneously by 4 observers for 2.5 h at each point. Overlap of the observers' views was accounted by allocating birds to specific observers through radio contact.

To calculate nest density on each islet and rock, a Kernel density spatial analysis (250-m radius, 1-ha area unit, 1-m$^2$ resolution; Silverman 1986) was implemented in the ArcGIS 9.2 ESRI software, which was also used to geographically calculate distance ranges between nests. To calculate differences between the mean, minumum and maximum distances in nests among islets we ran one-way Anova and subsequent Bonferroni post hoc tests for all the comparisons. These analyses were implemented in Statistica (StatSoft 2003).

## 3. Results

We counted 307 breeding pairs for the Canary Islands Eleonora's Falcon population in 2007–2008. Their distribution was restricted to Montaña Clara ($n$ = 115), Alegranza ($n$ = 135), Roque del Este ($n$ = 55), and Roque del Oeste ($n$ = 2). We did not detect any breeding pairs on La Graciosa or Risco de Famara, but we observed a bird flux between Risco de Famara and the islets (typically 1.7 falcons/h). This flux, however, could vary with the season, time of day, and wind direction and strength. Breeding pair densities, and mean, minumum and maximum distances between nests significantly varied among islets ($p$ <0.001 for all comparisons). Roque del Este supported the highest densities and, as expected, the smallest distances between nests (Table 1).

Prior to this study, four censuses had been carried out on the Canary Islands population of Eleonora's Falcon during the last 40 years: the studies of Lovegrove (1971), Hernández *et al*. (1985), Trujillo *et al.* (1994) and De León *et al*. (2007) (Table 2). The 2007–2008 population was approximately 100 breeding pairs larger than the 2000–2001 population (De León *et al*. 2007), but the nesting range did not cover new islets. At islets, the populations had increased by 30 breeding pairs on Montaña Clara (35%), by 76 on Alegranza (129%), and by 18 on Roque del Este (49%). No change was found for Roque del Oeste with only 2 pairs, but with limiting availability of space, a considerable increase would hardly be expected. The

Table 2. Number of Eleonora's Falcon breeding pairs per colony and study year (the number of visited nests are in brackets; the rest were inaccessible nests). RF = Risco de Famara, LG = La Graciosa, MC = Montaña Clara, AL = Alegranza, RE = Roque del Este and RO = Roque del Oeste.

| Date | RF | LG | MC | AL | RE | RO | Total | Reference |
|---|---|---|---|---|---|---|---|---|
| Aug 1970 | – | 1 (0) | 10 (2) | 25 (9) | 25 (13) | – | 61 (24) | Lovegrove 1971 |
| Aug 1983 | – | – | 21 (5) | 22 (3) | 21 (0) | – | 64 (8) | Hernández *et al.* 1985 |
| Aug 1987 | – | – | 30 (7) | 24 (12) | 12 (8) | – | 66 (27) | Trujillo *et al.* 1994 |
| Aug–Sep 2000–2001 | – | – | (85) | (59) | (37) | (2) | 200 (183) | De León *et al.* 2007 |
| Aug 2007–2008 | – | – | 115 (102) | 135 (124) | 55 (48) | 2 (2) | 307 (276) | Present study |

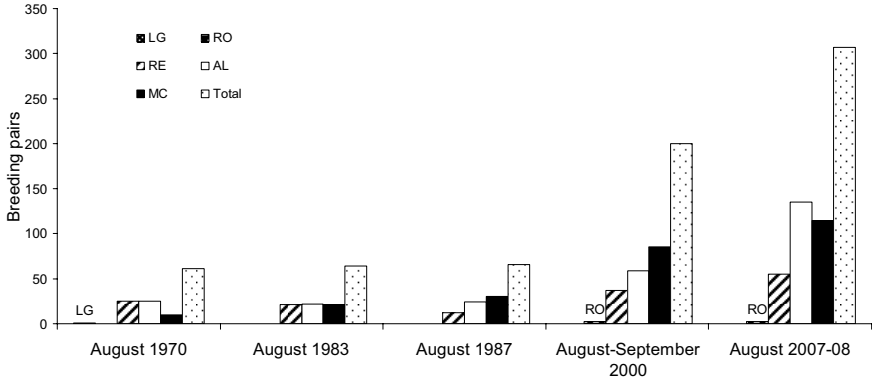


Fig. 2. Total number of breeding pairs of the Eleonora's Falcon in the Canary Islands according to Lovegrove (1971), Hernández *et al.* (1985), Trujillo *et al.* (1994), De León *et al.* (2007), and the present study. LG = La Graciosa, MC = Montaña Clara, AL = Alegranza, RE = Roque del Este, RO = Roque del Oeste.

population trend was positive over the last 40 years, but more substantial from late 1980s onwards (Fig. 2). This tendency was detectable for every islet except for the very small Roque del Oeste.

## 4. Discussion

The census of the Canary Island colony of Eleonora's Falcon showed a rapid breeding-population increase, with an average of 12 breeding pairs per year, assuming linear annual growth and a relatively stable population until the 1980s (Fig. 2). This increase was particularly noticeable in Alegranza, where the population had increased from ca. 60 to over 130 pairs between 2000/2001 and 2007–2008 (Table 2). The whole population increase may have begun in the end of 1980s: the population appears remarkably larger in the recent, i.e., the present and De León *et al*. (2007) than in older data (Lovegrove 1971, Hernández *et al*. 1985, Trujillo *et al*. 1994).

The potential causes for this abrupt change in the Canary Islands are unclear. This species has been intensively studied in the Mediterranean region. However, reasons for population changes in the Mediterranean colonies may not be applicable to the Canary Islands for three reasons: changes reported there have been considerably smaller, no unambiguous mechanisms for increases there have been suggested, and the accuracy of reported numbers varies between studies. Regarding the latter, small colonies have often been precisely inventoried, but larger colonies – that would really determine the population trend – may have been underestimated in numbers (BirdLife International 1999). Recently Dimalexis *et al.* (2008) accurately assessed Mediterranean population size using modern census techniques for the first time. However, population trends cannot be reliably derived using their data together with (less accurate) older data. Hence, we are restricted to focus on the local population trend and local conditions.

In 1986, coinciding with the beginning of the positive trend, the Archipielago Chinijo was protected by the Law 89/1986 and declared Parque Natural de los Islotes del Norte de Lanzarote y los Riscos de Famara. This protection strengtened in succesive years through the Spanish Law 12/1994 and the European Directive 79/409/EEC. Although these measurements did not entail an effective and constant wardening of the area, they decreased human activities such as illegal hunting or nest plundering and controlled the use of the area, i.e., disembarkation or navigation in areas close to breeding-colony islands such as Montaña Clara or Roque del Este became forbidden. These protection measures may have had positive consequences for the Eleonora's Falcon population, although lack of accurate data prevent from quantifying this effect.

The Alegranza population of Eleonora's Falcon experienced a substantial increase between 2000–2001 and 2007–2008, which may be a result of changes occurring on this island during the

1980s. Two of these may be particularly important. Firstly, the inhabitants of this island – the lighthouse keeper and his family – had husbandried goats at the island in the early 1980s, after which this activity soon ceased. Secondly, feral cats had been present in Alegranza probably since the first human setlement in the mid-19th century, but apparently the last individual was killed in 1998 (Martín *et al.* 2002). Regarding the rest of the islands, there are no indications of remarkable nest predation neither before nor after 1987. In Montaña Clara, the eradication of rabbits in 2000–2001 (Martín *et al.* 2002) might have promoted the slight increase detected for the last seven years, e.g. through enabling the sheltering vegetation recover at the falcon nesting sites. However, as rabbits still inhabit other areas with a similar Eleonora's Falcon increase, this factor may not generally be important.

The Canarian increase might be a surplus from Morocco, as a great population increase has been recorded at the nearest Moroccan colony following the introduction of conservation measures by state authorities (Aghnaj *et al.* 2002). However, the Moroccan increase started later than that of the Canary Islands. Moreover, Eleonora's Falcon is a philopatric species, with the longest distance reported between the natal and first-breeding sites being only 5 km, and breeders tend to stay in the same territory within a colony from year to year (BirdLife International 1999). The breeding population of the Canary Islands may thus appear closed, making an increment related to the Moroccan colony unlikely.

The population increase reported here might be partially influenced by an increase in the intensity of field work, compared to earlier reports. However, two reasons support the positive trend experienced by the Canarian population. Firstly, we found 107 breeding pairs more than in the previous 2000–2001 census (De León *et al.* 2007), using the same methods and effort. Secondly, population increases have recently been reported in Greece, Sardinia and Sicily (Dimalexis *et al.* 2008), and Morocco (Aghnaj *et al.* 2002). Also the Spanish Mediterranean population has generally increased over the past few decades, although there are indications of stabilization: the Balearic Islands population had changed from 254 breeding pairs in 1976 to 683 in 1991 and to 562 in 1994 (Mayol 1981, Muntaner 2003). Similar trends have been reported for small colonies, such as the Columbretes Islands: 17 (1964), 12–13 (1972–1974), 25 (1988), 30 (1989) and 34–35 (2001) (Bernis & Castroviejo 1966, Mayol 1977, Muntaner 2003).

The peak nest densities in the Canary Islands were found in the most rugged localities and on wind-protected slopes. The latter tendency is analogous to that shown for colonies in the Aegean Sea (Walter 1979, Wink *et al*. 1982), but it contrasts with observations from the Columbretes Islands and Mediterranean where falcons place their nests on sites with high wind exposure (Urios & Martínez-Abraín 2006, Viada 2006). Exposure to wind may aid in reducing the thermal stress of birds and facilitate rapid escape from the nest; also the prey flux could be related with wind direction and exposure (Urios & Martínez-Abraín 2006, Viada 2006). However, in the Canary Islands the constant trade winds during the breeding season may prevent falcons from placing their nests at windy slopes. The observed minimum distances between nests were similar to other colonies (Del Hoyo *et al.* 1994). Additionally, the colonies in the present study were on uninhabited islets, whereas no breeding pairs were located at the populated La Graciosa and Risco de Famara, a pattern similar to that suggested for the global population (Del Hoyo *et al.* 1994). Worryingly, the species has not been able to expand its range to the nearby islands, nor established new colonies away from the four known islets and rocks since the 1970s. Apparently some limiting factors prevent the range expansion, e.g. invasive species, such as rats, goats and cats, and human disturbance. We conclude that by protecting breeding colonies, restricting human activies, and removing predators may significantly improve the conservation status of the Eleonora's Falcon, measures that would be worth implementing elsewhere for the conservation of this falcon.

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## Kanarian Saarten välimerenhaukan *Falco eleonorae* kannankehitys

Työssä inventoitiin välimerenhaukan tunnetut pesimäpopulaatiot Kanarian Saarilla ja vertailtiin saatuja populaatiosuureita aiempiin, samalla alueella tehtyihin selvityksiin. Lajin populaatiokoko oli seitsemässä vuodessa noussut noin 200 parista yli 300 pariin. Laji ei kuitenkaan ollut tänä aikana asuttanut uusia alueita. Runsastumisen syyt saattavat liittyä pesäsaalistuksen ja häirinnän vähenemiseen.

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