

Spanish Imperial Eagles and other eagles found electrocuted in Morocco and proposition of correction measures

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Resumé:

L'Aigle impérial ibérique (*Aquila adalberti*) est un rapace rare et à répartition restreinte qui a niché au nord du Maroc dans le 20^{ème} siècle, mais actuellement il est entièrement limité à la péninsule Ibérique. Il est classé comme Vulnérable dans la Liste Rouge de l'UICN, mais toujours classé légalement 'En danger d'extinction' en Espagne comme en Andalousie en raison de sa petite taille de la population.

Dans la région de l'Andalousie, sud de l'Espagne, il existe un programme de réintroduction en cours visant à rétablir l'espèce dans la province de Cadix, d'où il était éteint comme nicheur depuis des décennies, et aussi pour renforcer d'autres populations dans cette communauté autonome. Dans le cadre de ce programme, les poussins sauvés originaires des populations sauvages de la région sont réintroduits dans La Junda (Cadix), et ont jusqu'ici réintroduit 83 poussins. En 2015, six aigles ont été sauvés, équipés de transmetteurs, puis libérés. Le 22 octobre, un de ces 6 aigles (avec bague 6M) est trouvé mort (électrocuté) avec deux autres Aigles impériaux ibériques, un Aigle royal (*Aquila chrysaetos*) et un Aigle de Bonelli (*Aquila fasciata*) dans la région de Guelmim, sud du Maroc. Le 7 novembre, quatre autres Aigles de Bonelli ont été trouvés électrocutés au pied des pylônes situés sur la même ligne électrique. Le 5 décembre, Ali Irizi a visité à nouveau la région où il a trouvé deux autres Aigles de Bonelli électrocutés au pied d'un pylône situé sur la même ligne électrique.

Malgré la forte tendance philopatryque de l'Aigle impérial ibérique, quelques bonnes indications dans la Péninsule ibérique (l'ensemble de la population espagnole et surtout celle de l'Andalousie est en augmentation, la recolonisation récente du Portugal) ont données de nouveaux espoirs que l'espèce peut s'installer et recoloniser ses anciennes zones de reproduction au nord du Maroc dans le futur. Malheureusement toutefois, les incidents d'électrocution à Guelmim ne montrent pas seulement que la mortalité non naturelle au Maroc est un facteur limitant pour la conservation de l'espèce en Espagne, mais il montre aussi que cela peut compromettre les chances possibles de recolonisation du Maroc dans le futur. En outre, ces électrocutions peuvent mettre en danger la population marocaine de l'Aigle de Bonelli, qui hiverne dans cette région en grand nombre.

Nous recommandons la correction des lignes électriques dangereuses, et de former une collaboration étroite entre les deux pays par des actions de conservation conjointes pour le bénéfice de l'Aigle impérial ibérique et d'autres rapaces.

Introduction

1) The species

The Spanish Imperial Eagle (*Aquila adalberti*) is a long-lived Mediterranean raptor that was until recently considered one of the most endangered raptors in the world. Although its breeding areas in most Spanish sub-populations has increased recently (González et al. 2008), and its population size has increased to about 450 pairs (MAGRAMA, 2014), it is still considered as Vulnerable in the IUCN Red List (BirdLife International 2015), and still legally classified as Endangered in Spain and Andalusia (González & Oria 2004, CMAyOT de la Junta de Andalucía 2015a).

The original breeding range of the species included the Iberian Peninsula and northern Morocco. In Spain, the species breeds in the centre, west and south of the country (González & Oria 2004). The species is currently increasing both in Spain and in Andalusia (CMAyOT de la Junta de Andalucía 2015b). In Portugal, where the species has just returned as a breeder after nearly 30 years of absence, breeds in the vicinity of Spanish border in the south and centre (Palma 2012). In Morocco, the species had bred in the north up until the first half of the 20th century (Thévenot et al. 2003), but since then there has been very few breeding records. In 1991, a potential breeding pair at Chefchaouen (Rif Mountains) was located, but its nesting was not verified and there was no further news about it (Fouarge 1992). And in 1995, there was another breeding record reported in the Spanish magazine *Quercus* 113, page 48 (in Thévenot et al. 2003). It was also cited as a breeder in Algeria in the 19th century.

From old data, the crossing of the Strait of Gibraltar to Morocco by Spanish Imperial Eagles was considered at best accidental (González et al. 1989, Thévenot et al. 2003). But with the increase of the Iberian population and also bird migration monitoring at the Strait (e.g. 3 and 4 eagles were seen crossing in springs 2008 and 2009 respectively, and 9 eagles in autumn 2008: Ramírez 2009, Torralvo et al. 2011), and especially with the use of tracking technology we now know that the species do cross to Morocco and in increasing numbers over time.

2) Reintroduction project in Andalusia, southern Spain

In order to strengthen the Cadiz population of the species, originating from the successful Reintroduction Program carried out in close collaboration with the Biological Station of Doñana (EBD-CSIC), the priority of the Consejería de Medio Ambiente y Ordenación del Territorio (CMAyOT de la Junta de Andalucía) is to reintroduce the rescued chicks into the wild at La Janda following the same hacking methodology performed during the reintroduction program. In this context, 83 chicks have been released by hacking technique into the most suitable sites of La Janda. These chicks were originally rescued from the wild populations of the Sierra Morena during the period 2002-2011, from Doñana and Cadiz in 2013 (no individuals were released 2012) and from Sierra Morena and Doñana in 2015 (for the results of the project up to 2010, see Muriel et al. 2011).

Of the 77 chicks released until 2013, nine of which (11, 7%) have been found as breeders (five of them in the Cadiz nucleus, three in Doñana and one in Toledo). After the failed attempts in 2006 and 2007 by two individuals released in 2003, the settling of the population in the Cadiz nucleus started in 2009 with one pair in that year and in 2010, two in 2011 and five in 2012. In all cases, breeding occurred before the individuals acquired adult plumage.

In 2015, four territories exist in the Cadiz nucleus, of which three had bred successfully and resulted in the fledging of 5 chicks. Of these four pairs, one was made up of two individuals released by the hacking method, and the other three have an individual from the reintroduction program, demonstrating the success of this project. In addition to these, at least six released individuals have been incorporated into the breeding population in other areas of the Iberian Peninsula, 4 in Doñana between 2012 and 2015, one in Portugal in 2013 and another in Castilla-La Mancha in 2014 and 2015. These results indicate that the released individuals disperse and settle not only around of the release sites in Cadiz, but also in other areas of Andalusia, south of Castilla-La Mancha and Extremadura and southeast of Portugal, contributing to the conservation of the species throughout the Iberian territory.

In 2015 the eagles were fitted with transmitters provided by the EBD-CSIC which have been activated only at the moment the birds have begun to fly, providing essential information on their movements and places of dispersion. In late August, the eagles began to make exploratory flights outside the release sites, and in early October one of these birds (with ring 6M) found dead (electrocuted) along with two other Spanish Imperial Eagles, a Golden Eagle (*Aquila chrysaetos*) and a Bonelli's Eagle (*Aquila fasciata*) in the Guelmim region, Morocco (see details below).

3) Electrocution problems

Electrocution and collisions with power lines (along with poisoning) are among the main factors responsible for unnatural mortality of birds and especially large species (raptors, bustards, cranes, storks...). And this has been shown to be a major conservation problem for endangered raptors and other birds in many regions of the world (Ferrer et al. 1991, Janss & Ferrer 1998, 2000, 2001, Donázar et al. 2002, Boshoff et al. 2011, Angelov et al. 2013, Hernández-Matías et al. 2015).

Concerning the specific case of the Spanish Imperial Eagle, electrocution on power lines has been reported to be the main known cause of death for the species, accounting for 60% of mortality cases (Ferrer & Hiraldo 1992). Also, González et al. (2007) reported that electrocution was the main known cause of non-natural mortality for the species with 47.7% of the 267 cases in Spain between 1989 and 2004. Electrocution was again the main cause of death of this species in Andalusia accounting for nearly 40% of the 158 dead eagles recorded in the region between 1974 and 2009 (López-López et al. 2011). However, the latter study has showed a decrease in the number of electrocuted eagles since the approval in 1990 of the regulation aimed at reducing the impact of electrocution on birds by the Junta de Andalucía. And after mitigation measures were undertaken, bird electrocutions showed a 62% of reduction in the Andalusian population (López-López et al. 2011). This reduction in electrocution deaths is the main reason of the general increase in the population of Spanish Imperial Eagle in Andalucía (López-López et al. 2011).

While electrocution and other power-lines related mortalities and the conservation problems they cause to endangered species is well documented and mitigation measures were applied in many countries (Janss & Ferrer 1999, Janss et al. 1999, Tintó et al. 2010, López-López et al. 2011, Ferrer 2012, Chevallier et al. 2015), this is not the case in Morocco or in the rest of Northwest Africa where there is almost total lack of data regarding this problem. A notable exception is the study of Alonso et al. (2005) who identified collision with power-lines as the second main threat (after poaching) for the endangered Moroccan population of Great Bustard (*Otis tarda*) with 7 out of 30 mortality cases (23%) registered between 1997 and 2003. Even general field notes are lacking except a few cases such as the observation of 21 White Storks (*Ciconia ciconia*) electrocuted in the Middle Atlas in July 2005 (Guillaume 2005).

Results: the electrocutions in the Guelmim region, Morocco

In mid-September 2015, CMAyOT de la Junta de Andalucía informed GREPOM that one tracked eagles that was located south-west of Guelmim does not seem to move, and suspected that something wrong has occurred (either the bird was dead or the transmitter was lost). A. Irizi volunteered to go to search for the eagle and found out what happened exactly to the bird. Coordination with the 'Service Provincial des Eaux et Forêts de Guelmim' (HCEFLCD) ensured that he got some logistical support (one more car) and two forestry technicians, A. Errati and H. Lorán, joined him.

On 22 October, the search team went to the location of the signal some 50 km south-west of Guelmim. After searching underneath and around 3 adjacent electricity pylons, they found the carcasses of five eagles: three Spanish Imperial Eagles (including the one with the transmitter), one Golden Eagle and one Bonelli's Eagle. The position and locations of the eagles were as follows (see figure 1):

1. A Bonelli's Eagle killed at bottom of the electricity pylon. It was the first eagle found and also the first victim of the five birds due to its advanced decomposition state.
2. A Spanish Imperial Eagle freshly killed, we can see some flies on the body of the bird (figure 2).
3. This is the tracked Spanish Imperial Eagle with ring '6M', the body still fresh but older than the eagle 2. We can see larvae on the back of the bird which was directed to earth when found.
4. A Golden Eagle killed at the bottom of the electricity pylon. It was killed earlier than both the eagles 2 and 3, as the body had already started to decompose.
5. A Spanish Imperial Eagle electrocuted and still trapped high in the electricity pylon, its body appears relatively fresh (figure 3).

Given the large number of eagles found dead in one small area (underneath 2 pylons about 300 m away from each other), several hypothesis have to be followed including shooting, poisoning and electrocution. The first two potential causes can be discarded because: 1) the eagles were not killed on the same date, 2) all dead eagles were found in or at the bottom of the pylons or in the immediate vicinity (these birds were dragged due to the

steep slope) and 3) at least the Golden Eagle showed burns from electrocution in its head. So we can say with confidence that the cause of death of these eagles is the electrocution.

On 7 November, Ali Irizi returned to the area and searched underneath the pylons of the same power line. He found four different Bonelli's Eagles electrocuted at the bottom of the pylons (2 electrocuted on the same pylon, while the others were electrocuted at two adjacent pylons some 5 km away). He also photographed a Spanish Imperial Eagle and different individuals of Bonelli's Eagle in the area¹. He also carried out some interviews with some people from the local villages who indicated that now and then they experienced power outage and the electricity company had to repair the lines after each problem. All the photographs of the electrocuted eagles are available at this link: <http://moroccanbirds.blogspot.com/2015/11/electrocuted-eagles-guelmim.html>

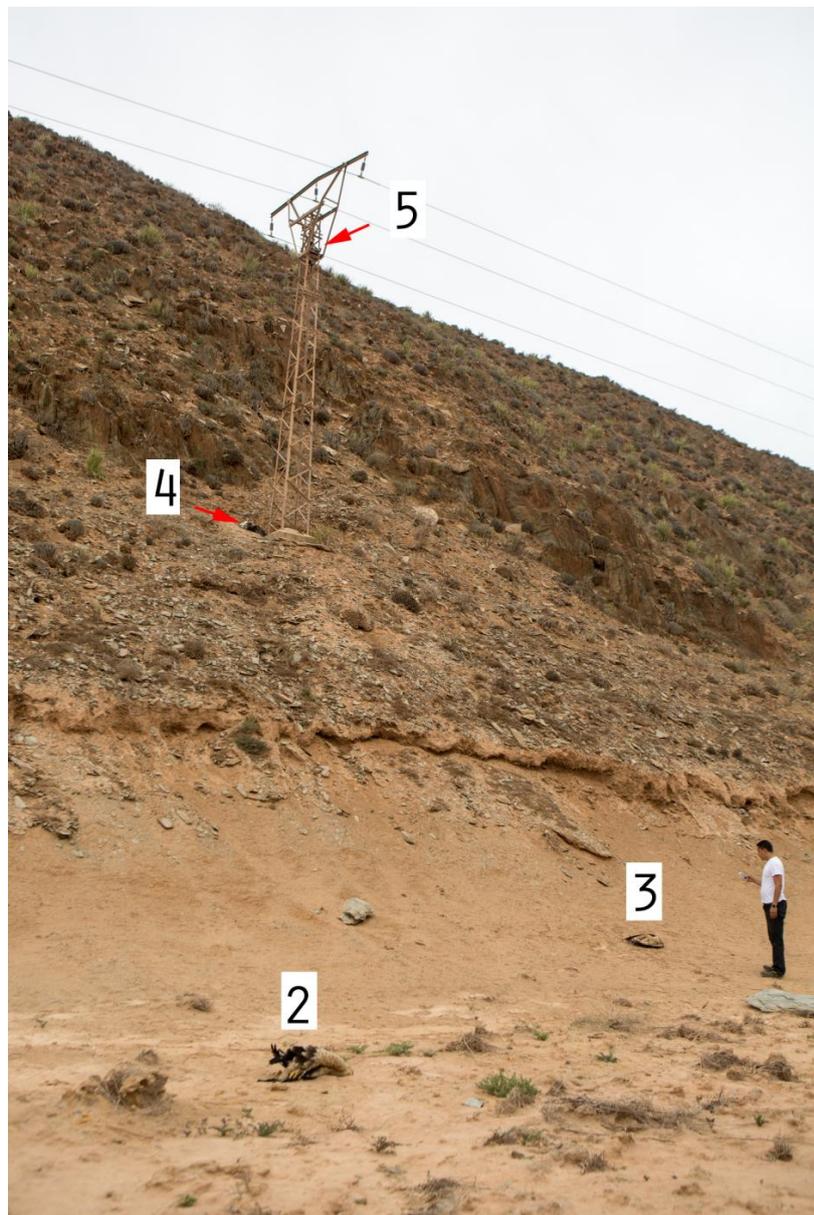


Figure 1: The position of the electrocuted eagles mentioned in the text: three Spanish Imperial Eagles and one Golden Eagle found at one pylon, Guelmim region, Morocco, 22 October 2015 (photo: Ali Irizi). The Bonelli's Eagle (No 1) was found at some 300 m to the east from this pylon.

¹ The photographs are at this link: <http://moroccanbirds.blogspot.com/2015/11/aquila-fasciata-guelmim.html>

On 5 December, Ali Irizi returned again to the region where he found two more Bonelli's Eagles electrocuted underneath one pylon situated on the same power line. The eagles' carcasses looked relatively fresh and could have been electrocuted a week or 10 days earlier. Photographs of these birds are available at this link: <http://moroccanbirds.blogspot.com/2015/12/aquila-fasciata-electrocuted.html>



Figure 2: Spanish Imperial Eagle freshly electrocuted, Guelmim region, Morocco, 22 October 2015 (photo: Ali Irizi).

Discussion and Recommendations

Based on the experience in Spain, immature eagles are more likely to die by electrocution in the dispersion areas than in breeding areas (González et al. 2007). Although until now, this limiting factor has not been known to occur in Morocco because of lack of surveys.

The wider region of Guelmim is one of the regions most frequented by dispersing/wintering Spanish Imperial Eagles in Morocco, and many immature birds were observed in this region during the last years. For example, a young eagle was photographed at NW of Tan-Tan in December 2006 and then again in February 2007 (several observers, *in* Bergier et al. 2011). In October 2010, a juvenile eagle was photographed at SW of the mouth of Oued Bou-Issafen (M. Roost & A. Reich *in* Bergier et al. 2013). In February 2012, a colour-ringed juvenile was photographed at some 78 km south of Guelmim (R. Jábek et al. *in* Bergier et al. 2014). And recently a juvenile was photographed on 7 November 2015 at Oued Bou-Issafen by A. Irizi². Given the number of birds electrocuted in the incidents reported here, it's most likely that several eagles have died here over the years since 2001 when the power line was built. It's important to note that this region seems to be an important dispersing/wintering area not only for the Spanish Imperial Eagles but also for non-adults Bonelli's Eagles (Luis García, pers. comm.). Other Spanish naturalist team working in this area has observed many young Bonelli's Eagles and found at least other three electrocuted birds of this species (Luis García, pers. comm.). This team have indicated that there is a high density of fat sand rats (*Psammomys obesus*), which has a similar size of young rabbits (*Oryctolagus cuniculus*), one of the main preys of Imperial, Bonelli's and Golden eagles. Similar observations were made by A. Irizi during his visits to the region. He particularly noted the high abundance of fat sand rat and also Barbary ground squirrel (*Atlantoxerus getulus*) and to a lesser extent Barbary Partridge (*Alectoris barbara*). All constitute potential prey for the wintering eagles.

² A photograph is at this link: <http://moroccanbirds.blogspot.com/2015/11/aquila-adalberti-guelmim.html>, and a short video at this link: <https://youtu.be/VOvFC-9d5WE>

Despite the strong philopatric tendency (i.e. return to the natal area to breed) of the Spanish Imperial Eagle, some good indications in the Iberian Peninsula (the whole Spanish population and especially the Andalusian one is increasing, recent recolonisation of Portugal) have given new hopes that the species may settle and recolonise its former breeding areas in northern Morocco in the future. Unfortunately however, the electrocution incidents at Guelmim not only shows that the unnatural mortality in Morocco is a limiting factor for the conservation of the species in the Iberian Peninsula, but also shows that this will have a negative effect on the possible recolonisation of Morocco in the future. On the other hand, although at present the trend of the Moroccan population of Bonelli's Eagle is not known but probably stable, and given that large number of immature birds frequenting this area in winter as discussed above, these dangerous electricity pylons may cause conservation concerns for this species in the future as well. Therefore we believe it's essential to conduct joint conservation actions for the benefit of the Spanish Imperial Eagle and other raptors as well. And for this aim, we present the following recommendations:

- The need to gather more information about the electrocution of large raptors in Morocco.
- Identification of dangerous electric lines or “death traps” in the wintering/dispersion areas (for Spanish Imperial and Bonelli's eagles) as well as in the breeding areas of other endangered raptors (Egyptian Vulture and Bonelli's Eagle). This could help inform the electricity company to built safer pylons in these regions in the future.
- After the identification of dangerous pylons already installed (as in the case at Guelmim reported here), the need to correct them with an adequate permanent insulation method, because the non-permanent corrections have been shown to deteriorate over the years (González et al. 2007, Martín et al. 2015). By correcting these dangerous pylons, the electricity company not only contributing to the conservation of the endangered raptors, but also saving the costs of the recurring maintenance after each power outage caused by bird electrocution.
- Develop close cooperation between both countries in terms of knowledge exchange about urgent conservation problems (e.g. electrocution, poisoning...) facing these endangered raptors (like organising workshops for the benefit of the Forestry technicians, people from the NGOs sector, staff of the electricity company...).



Figure 3: Electrocuted Spanish Imperial Eagle still on the pylon, Guelmim region, Morocco, 22 October 2015 (photo: Ali Irizi).

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