Eagle Owls in Doñana: a conservation dilemma or not?

Vincenzo Penteriani, Rui Lourenço and Maria del Mar Delgado

Abstract The recent increase in the numbers of Eagle Owls *Bubo bubo* in Britain has led to widespread concern about the potential impact of this top predator on populations of other birds and mammals. We present data on the recent colonisation by Eagle Owls of the Doñana protected area, in southern Spain. The preliminary results provide a relevant case study for analysing the increasing Eagle Owl population in Britain. We describe population density and distribution, breeding biology, diet, home-range behaviour and natal dispersal of the species. Four years of research have highlighted the complexity of the situation in Doñana, and suggest that decision-makers should act with extreme caution when contemplating population control.

Introduction

The increasing population of Eagle Owls *Bubo bubo* in Britain has generated much debate over the potential conflicts that might arise from the presence of this large predator among the communities of British birds and mammals (e.g. Melling *et al.* 2008, Toms 2010). In terms of the origin of British Eagle Owls, several lines of evidence point to human involvement, particularly through the escape of individuals from falconers (as happened with Northern Goshawks *Accipiter gentilis* in the twentieth century; Anon. 1989). Even if it is not possible to discount natural colonisation completely, the captive origin of this population (or part of it) seems plausible, given the long history of captive Eagle Owls in Britain (reviewed by Melling *et al.* 2008).

The concerns and fears about Eagle Owls in Britain have provoked animated debate among and within conservation groups, leading some to lobby for a cull of the species. In late 2010, the UK Environment Minister decided not to take any action other than continued monitoring of the situation, highlighting the need to obtain more detailed information on population status and potential impacts on native wildlife (e.g. *Brit. Birds* 104: 49–50). On the basis of the available literature, it seems that good data are lacking on the number and spacing of breeding pairs, diet, reproductive success and natal dispersal; all of these, but the last in particular, are central to understanding and predicting the future spread of an Eagle Owl population, and the impact on other wildlife.

With the aim of providing information on some of the potential scenarios that may occur in Britain in relation to increasing numbers of Eagle Owls, we present data on a colonising population of Eagle Owls in southern Spain. Although local conditions are clearly different from those in Britain, we believe that the preliminary results of our research provide a useful case study.

Recent colonisation of Doñana by Eagle Owls

In the late 1990s, the Eagle Owl was recorded for the first time as a breeding species in the Doñana National Park (hereafter simply

Doñana), in Andalusia, southern Spain. Although high-density populations of Eagle Owls occur in the nearby hills, less than 100 km from Doñana, the species had never been recorded within the protected area, despite the many research projects undertaken since the 1960s. Although molecular research on the origins of those individuals that colonised Doñana is ongoing, some evidence supports the possibility of a human component in the process. Following the opening of the Rescue Centre of Bolín in 1975, at least 12 Eagle Owls from the hilly areas of Huelva, Seville and León were admitted. That centre closed in 1988 and was replaced by the Rescue Centre of Acebuche (situated within the national park), which received increasing numbers of Eagle Owls until 2006. Most of these were subsequently released far from Doñana, but some individuals escaped from the facility in the early 1980s, and these may have been the first Eagle Owls to be observed in Doñana (during 1982–85). The greatest number of escapes occurred in 1990 and, from 1996, the number of Eagle Owls observed in the protected area increased, and breeding was first recorded.

Human involvement in the Eagle Owl colonisation of Doñana is supported by the natal dispersal patterns we recorded in a neighbouring population, in which individuals dispersed only a few kilometres from their natal area and never the distance necessary to reach Doñana (Delgado & Penteriani 2008; Delgado *et al.* 2010; Penteriani & Delgado 2011). Moreover, it is difficult to understand why the Eagle Owl, a predator that in southern Spain relies mainly on Rabbits *Oryctolagus cuniculus* (Delibes & Hiraldo 1981; Penteriani *et al.* 2008), began to appear in Doñana immediately following a population crash of Rabbits in the area.

A major concern of those involved in the management of this protected area was the potential (negative) impact of Eagle Owls on the communities of birds and mammals of Doñana. It was clear that an understanding of the characteristics and dynamics of this new population was a necessary prerequisite to any decisions on human intervention. Consequently, in 2005, the Doñana Natural Park and the Estación Biológica de Doñana (Spanish Council for Scientific Research (CSIC)), with financial support from the Consejería de Medio Ambiente of the Junta de Andalucía, began a preliminary four-year study on the density and distribution, breeding biology, diet, home-range behaviour and natal dispersal of the species.

Vincenzo Penteriani

Vincenzo Penteriani

61 & 62. Typical breeding sites of Eagle Owls *Bubo bubo* in Doñana: small patches of Eucalyptus close to the marshes and areas of mature pine forest; March 2005.

Characteristics of the Eagle Owl population breeding in Doñana

Density and distribution of breeding pairs

Eagle Owl breeding sites were located using various census techniques. Taped calls were played at 1-km intervals along transects of the entire region, to obtain a general idea of breeding distribution as a baseline for more detailed surveys. These transects were supplemented by visits to listen (passively) for territorial males and females at sunset and sunrise from September to March during 2006–08, at a total of 275 listening points. In spring and early summer, those points were revisited to detect the calls of juveniles in their post-fledging dependent period (at 100–150 days old; Penteriani *et al.* 2005; Delgado & Penteriani 2007; Delgado *et al.* 2009). These sessions enabled detection of previously unknown breeding areas and an estimate of reproductive success in breeding areas where the location of the nest was unknown. Finally, potential nesting areas were visited with the aim of inspecting nest-sites.

As a result of preliminary searches, we established the location of 13 breeding sites and six potential reproduction areas (i.e. where either a calling male or a calling pair had been detected, even though we did not find the occupied nest), corresponding to a breeding population of at least 19 pairs. The mean distance (± SD) between neighbouring occupied nests was 3.9 ± 0.4 km, with a minimum distance between nests of 3.4 km. It is worth noting that the most difficult aspect of the work was verification; many reports that we investigated, of calling individuals, incubating females and prey remains/pellets, were found to concern Long-eared *Asio otus* or Tawny Owls *Strix aluco*. This suggested to us that the impression of a 'huge' Eagle Owl population in Doñana was incorrect, and that this impression had contributed to increased apprehension about the possible negative effects of this predator.

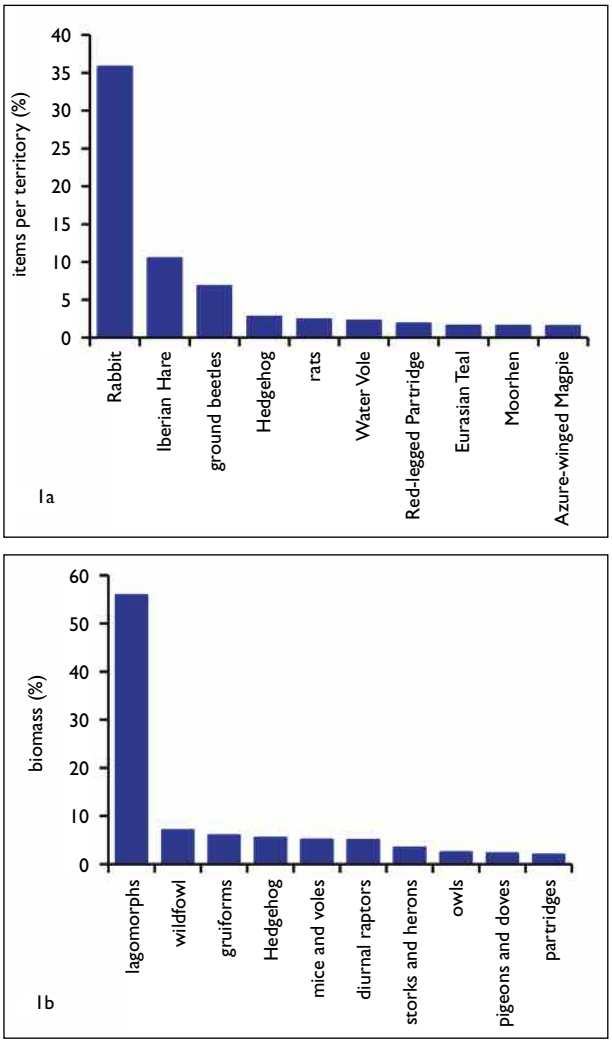

Fig. 1. Main features of the Eagle Owl *Bubo bubo* diet in Doñana. Fig. 1a shows frequency (% of items identified per territory) of the ten most frequent prey species (accounting for 67% of all prey items). Fig. 1b shows biomass contribution of the ten most frequent prey orders (94% of all prey).

Several pairs of Eagle Owls in Doñana bred on the ground but most used old nests of other species: raptors, storks and herons. In addition, since Eagle Owls breed earlier than many other raptors, particularly migrants such as Red Kites *Milvus milvus*, Black Kites *M. migrans* and Booted Eagles *Aquila pennata*, some raptors (re)used nests previously occupied by Eagle Owl pairs in the same season. Support for a relatively low density of Eagle Owl breeding pairs in Doñana is

provided by the frequent use of alternative nest-sites between years, which would have been more difficult in a more densely distributed population. At seven of 13 breeding sites observed, the same pair used an alternative nest-site in the following year up to a kilometre or more distant.

Breeding phenology and reproductive success

Laying dates ranged from mid December to the end of March, with variation evident between pairs, and also by pairs at the same site in different years. During 2001–08, the mean (± SD) productivity of the population was 1.5 ± 1.0 fledged young per breeding pair (range 1–3 young). Reproductive success was lower than in the surrounding hilly areas, where study pairs averaged more than two fledged young per attempt, range 1–4 (Penteriani & Delgado unpubl. data).

Diet

Periodic visits to 19 nest-sites throughout the year resulted in the collection of 1,752 prey items, which were analysed following Lourenço (2006); the results are summarised in fig. 1. The bulk of the diet, in terms of biomass contribution, was composed of lagomorphs, with Rabbits comprising 44.1% and Iberian Hares *Lepus granatensis* 11.7% of the total. Waterfowl were the second most frequent prey group (7.0% of consumed biomass), followed by gruiforms – Moorhen *Gallinula chloropus*, Purple Swamp-hen *Porphyrio porphyrio* and Common Coot *Fulica atra* – which comprised 5.9% of biomass.

Predators, both birds and mammals, were relatively rare in the diet of the Doñana Eagle Owls; we recorded seven species of diurnal and four species of nocturnal raptor in prey remains. The mean frequency of diurnal raptors in the diet was 2.7% (of the items identified), somewhat higher than the mean value recorded for Europe of 1.2% (Lourenço *et al.* 2011), which translated into a biomass contribution of 5.0%. The most commonly predated diurnal raptors were Black Kites, Red Kites and Common Buzzards *Buteo buteo* (2.6%, 0.9% and 0.5% of total biomass,

Vincenzo Penteriani

Vincenzo Penteriani

63 & 64. Most of the Doñana Eagle Owls *Bubo bubo* use stick nests built by other raptors (adult on nest here in May 2004) but ground-nesting pairs are not uncommon (two young at a nest in May 2007).

Vincenzo Penteriani

65. Breeding female Eagle Owl *Bubo bubo* close to a nest in Doñana, February 2007.

respectively). The mean frequency of owls in the diet was 2.5% (mean value for Europe 2.4%; Lourenço *et al.* 2011), corresponding to a biomass contribution of 2.4%. Barn *Tyto alba* and Tawny Owls each accounted for 0.9% of total biomass.

Among mammalian carnivores, we recorded only young animals (three Red Foxes *Vulpes vulpes*, a feral cat *Felis catus* and two unidentified canids, probably young Foxes), which formed 0.4% of items identified (and 0.8% of biomass), lower than the mean consumption of mammalian carnivores recorded for the Eagle Owl in Europe (0.8%; Lourenço *et al.* 2011).

In summary, the percentage of smaller avian predators in the diet of Eagle Owls in Doñana (5.2%) was slightly higher than the mean value for Europe (3.6%) but similar to that recorded in many European studies (Lourenço *et al.* 2011); the contribution of such smaller predators to the diet as a percentage of total biomass (7.4%) was minor; and predation of other raptors occurred mainly in those territories where the latter were particularly abundant (for example, the density of breeding Black Kites in Doñana is one of the highest in Europe).

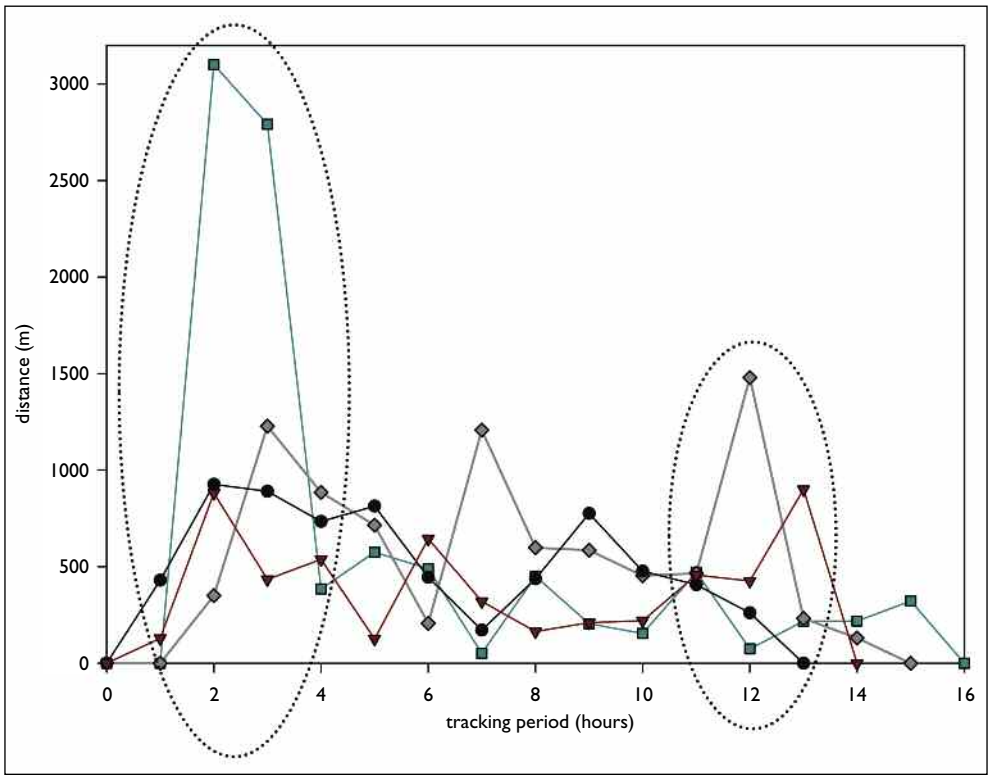

Fig. 2. Night-time movement patterns of four breeding Eagle Owls *Bubo bubo* in Doñana derived from radio-tracking. The two peaks of activity correspond to sunset and sunrise.

Home-range behaviour and movement patterns

During 2006–08, we radio-tagged five breeding Eagle Owls (three males, two females) from four different nest-sites. Tagged birds were followed continuously from one hour before sunset to one hour after sunrise and during the entire year, when we collected 55 nights of radio-tracking data (n=545 h of radio-tracking). For full details of this aspect of the study, see Penteriani *et al.* (2008) and Penteriani & Delgado (2011).

Breeding birds showed well-defined movement behaviour during the night and throughout the year. During the night, there were two peaks of activity, corresponding with sunset (mean ± SD, 1,464 ± 1,027 m), which probably reflected movements towards the hunting areas after vocal displays (Penteriani *et al.* 2008), and sunrise (351.3 ± 231.2 m), which included the return flight to the diurnal roost close to the nest (fig. 2). During the year, the owls moved relatively short distances (340.6 ± 214.8 m) during the pre-laying period, when most of the interactions between mates occurred in the proximity of the nest. Distance travelled decreased in males during the incubation period (240.7 ± 172.7 m). In contrast, during both the nestling and the fledging periods, when feeding and hunting activities increase, breeders of both sexes moved greater distances (nestling = 533.4 ± 428.3 m; fledging = 483.1 ± 252.3 m).

Natal dispersal and juvenile movement patterns

Dispersal can be defined as a three-phase process, characterised by well-defined behavioural shifts (Adriaensen *et al.* 2002; Hanski & Gaggiotti 2004; Delgado & Penteriani 2008): (1) *start*, when individuals leave their natal area; (2) *wandering*, when dispersing individuals search for new areas before temporary settlement; and (3) *stop*, when individuals settle – occupying a region for a long period of time relative to the entire dispersal process, or a breeding territory. During 2006–08, we radio-tagged 33 juveniles (9 in 2006, 15 in 2007 and 9 in 2008) from 11 nests, when the birds were c. 35 days old; they were located every 7–10 days (for more details see Delgado *et al.* 2010 and Penteriani & Delgado 2011). Dispersal began in late August (mean date 21st August), when the mean age of juveniles was 170 days; similar dispersal ages have been recorded in a Spanish (Delgado *et al.* 2010) and a Swiss (Aebischer *et al.* 2010) population. Juveniles prospected throughout Doñana, although it was clear that certain areas were preferred during both the wandering and the settlement phases; the mean dispersal distance (± SD) was 13.1 ± 7.7 km (males = 12.5 ± 6.5 km; females = 17.7 ± 9.1 km). In the three study years: (a) only 8% of juveniles reached the stop phase and settled in a more fixed or permanent area; (b) 40% of dispersing owls died during the wandering phase; (c) 4% remained in the wandering phase; and (d) the remaining 48% moved outside the Doñana area.

Eagle Owls in Doñana: a real conservation dilemma or not?

The arrival of Eagle Owls in Doñana was considered a potentially difficult problem from the outset. Faced with various possible ways of approaching the issue, the Spanish authorities opted to assess the need for human intervention by evaluating the potential impacts of Eagle Owl colonisation as accurately as possible. Four years of research represents just the first step in understanding

Vincenzo Penteriani

66. A fledgling male Eagle Owl *Bubo bubo* wandering into the area around the nest for the first time, July 2005.

the basic features of this new population of Eagle Owls.

Some important points are highlighted by the preliminary data:

1. The mean distance between pairs (almost 4 km) and the population distribution within Doñana suggest a population that is smaller than was first imagined. The rather even distribution throughout Doñana and the misidentification of other owl species probably created the (erroneous) impression of a much higher density of birds. This emphasises the need for caution when estimating the potential size of a new population.

2. Knowledge of reproductive success and juvenile mortality is crucial to understanding the dynamics of colonisation. Despite the habitat heterogeneity of Doñana, and the existence of a Rabbit population (one of the most important prey species for Eagle Owls), we detected relatively low reproductive success and high juvenile mortality during dispersal, which translated into a relatively low rate of increase.

3. Although Doñana has one of the highest densities of raptors in Europe, predation of smaller raptors was within the range recorded for other European areas (and concerned only the most abundant species in the immediate vicinity of an Eagle Owl nest). Evidently: (a) although healthy populations of other raptors can coexist with Eagle Owls, small populations that are already limited by other factors may be more vulnerable; and (b) non-lethal effects (e.g. redistribution of raptor nests around Eagle Owl breeding sites or alterations in the use of space by smaller predators) may also occur. The estimation of these non-lethal effects will be one of the priority aims of our future research in Doñana.

4. The research has clearly shown that many elements have to be considered when a colonisation occurs, and that detailed analysis should be undertaken before any decision is made on the future of Eagle Owl populations.

Four years of research have highlighted the complexity of the colonisation of Doñana by Eagle Owls but any decisions, in terms of population control, remain difficult at present. However, so far we have been unable to detect any immediate negative effect that could justify intervention to regulate numbers and/or redistribute this predator in Doñana. In relation to Eagle Owl establishment in Britain, our experience suggests that a cautious approach is sensible, to avoid interventions that may have unexpected effects. Clearly, one of the main concerns about the establishment of a new breeding population of Eagle Owls is its potential for a negative impact on native fauna. Although further work is required, our initial research in Doñana suggests that such fears may not always be justified and that this species is quite capable of moving into a new area and living alongside healthy populations of predatory birds.

Vincenzo Penteriani

67. Lagomorphs represent the most important food resource for Eagle Owls *Bubo bubo* in Doñana; April 2005.

Acknowledgments

We thank Fernando Hiraldo, Director of the Estación Biológica de Doñana-CSIC, and Curro Quirós, Director of the Natural Park of Doñana, for promoting scientific research into the main characteristics of Eagle Owl colonisation before management/conservation decisions are made. We also thank Consejería de Medio Ambiente, of the Junta de Andalucía, for financially supporting our study (research project no. 700/2005/M/00./). We thank Rocío Astasio (EBD), Cristina Ramos (EBD) and Francisca Rocío Martínez Fara (PN Doñana) for their help in the many logistical tasks, and Enrique Alés, José

Luís del Valle, Héctor Garrido, Fernando Goytre, Olga Mora, Sayago, Manuel Solís and Vilches for their invaluable assistance with the fieldwork. Finally, we thank those that, at some point, helped us during this controversial study in Doñana, in particular Miguel Ángel Bravo, Juan Calderón, Olga Ceballos, Luís García, Fernando Ibáñez, Manolo Máñez, Isidro Román and Carlos Urdiales (for stimulating discussions).

References

Adriaensen, F., Chardon, J. P., DeBlust, G., Swinnen, E., Villalba, S., Gulinck, H., & Matthysen, E. 2002. The application of 'least-cost' modelling as a functional landscape model. *Land. Urban Plan* 64: 233–247.

Aebischer, A., Nyffeler, P., & Arlettaz, R. 2010. Wide-range dispersal in juvenile Eagle Owls (*Bubo bubo*) across the European Alps calls for transnational conservation programmes. *J. Ornithol.* 151: 1–9.

Anonymous. 1989. Goshawk breeding habitat in lowland Britain. *Brit. Birds* 82: 56–67.

Delibes, M., & Hiraldo, F. 1981. The rabbit as prey in the Iberian Mediterranean ecosystem. In: Myers, K., & MacInnes, C. D. (eds.), *Proceedings of the World Lagomorph Conference*, pp. 614–622. Guelph University Press.

Delgado, M. M., & Penteriani, V. 2007. Vocal behaviour and neighbour spatial arrangement during vocal displays in Eagle Owl. *J. Zool.* 271: 3–10.

— & — 2008. Behavioral states help translate dispersal movements into spatial distribution patterns of floaters. *Am. Nat.* 172: 475–485.

—, —, & Nams, V. O. 2009. How fledglings explore surroundings from fledging to dispersal. A case study with Eagle Owls *Bubo bubo*. *Ardea* 97: 7–15.

—, —, Revilla, E., & Nams, V. O. 2010. The effect of phenotypic traits and external cues on natal dispersal movements. *J. Anim. Ecol.* 79: 620–632.

Hanski, I., & Gaggiotti, O. E. 2004. *Ecology, Genetics, and Evolution of Metapopulations*. Elsevier Academic Press, London.

Lourenço, R. 2006. The food habits of Eurasian Eagle Owls in Southern Portugal. *J. Raptor Res.* 10: 297–300.

—, Santos, S. M., Rabaça, J. E., & Penteriani, V. 2011. Superpredation patterns in four large European raptors. *Popul. Ecol.* 53: 175–185.

Melling, T., Dudley, S., & Doherty, P. 2008. The Eagle Owl in Britain. *Brit. Birds* 101: 478–490.

Penteriani, V., & Delgado, M. M. 2011. Birthplace-dependent dispersal: are directions of natal dispersal determined a priori? *Ecography* 34: 729–737.

—, —, Maggio, C., Aradis, A., & Sergio, F. 2005. Development of chicks and pre-dispersal behaviour of young in the Eagle Owl. *Ibis* 147: 155–168.

—, —, Bartolommei, P., Maggio, C., Alonso-Alvarez, C., & Holloway, G. J. 2008. Owls and rabbits: predation against substandard individuals of an easy prey. *J. Avian Biol.* 39: 215–221.

Toms, M. 2010. Eagle Owls in Great Britain: an assessment of potential impacts. BOU Proceedings – *The Impacts of Non-native Species*. BOU, Peterborough. See also www.bou.org.uk/bouproc-net/non-natives/toms20100531.pdf (accessed January 2012)

Vincenzo Penteriani[a], Rui Lourenço[b], Maria del Mar Delgado[c], *Department of Conservation Biology, Estación Biológica de Doñana, CSIC, c/Americo Vespucio s/n, 41092 Seville, Spain; e-mail:* penteriani@ebd.csic.es

[a] *Finnish Museum of Natural History, Zoological Museum, University of Helsinki, FI-00014 Helsinki, Finland*

[b] *LabOr – Laboratory of Ornithology and Institute of Mediterranean Agricultural and Environmental Sciences, University of Évora, 7002-554 Évora, Portugal*

[c] *Metapopulation Research Group, Department of Biosciences, FI-00014, University of Helsinki, Finland*

William OWLlace

Rui Lourenco