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Owls (Strigiformes) in Parque Nacional Peneda-Gerês (PNPG) – Portugal

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Abstract

Aguiar, A., Lopes, A. L., Pimenta, M. & Luís, A. (2010). Owls (Strigiformes) in Parque Nacional Peneda-Gerês (PNPG) – Portugal. *Nova Acta Científica Compostelana (Bioloxía)*, **19**: 83-92

Owls (Strigiformes) are particularly difficult to study and the existing information is still scarce. In PNPG area there are records of the seven species present in Portugal; the Long-eared Owl and the Short-eared Owl are here occasional species. This work aims to determine the distribution, density and abundance of Strigiformes in PNPG (Northwest of Portugal). Between December 2007 and June 2008, 106 passive hearing point counts of 15 minutes each were done in the centre of each of 106 squares (2x2 km). Distribution maps for each species were obtained. Therefore, we recorded a total of 98 contacts for Tawny Owl and 67 contacts for Scops Owl. We also obtained 7 contacts of Little Owl, 2 contacts of Barn Owl and one of Eagle Owl. The habitat selection by Scops Owl and Tawny Owl was also studied. Scops Owls seems to avoid low shrub and preferred forested areas. Tawny Owls also avoid low shrub areas, preferring forested areas, and were found in urban areas. The populations of these two species in PNPG show a considerable expansion, while the other ones reveal a marked decline regarding the previous situation. The implementation of monitoring and conservation measures is suggested to stop the decline of these three species.

Keywords: Strigiformes, distribution, Owls, habitat preferences, census, Portugal.

Resumen

Aguiar, A., Lopes, A. L., Pimenta, M. & Luís, A. (2010). Rapaces Nocturnas (Strigiformes) en el Parque Nacional de Peneda-Gerês (PNPG) – Portugal. *Nova Acta Científica Compostelana (Bioloxía)*, **19**: 83-92

Las rapaces nocturnas (Estrigiformes) son aves particularmente difíciles de estudiar y para las que hay escasa información disponible. En el PNPG se han registrado las siete especies presentes en Portugal, dos de ellas, Búho chico y Búho campestre, de presencia ocasional aquí. El objetivo de este trabajo es determinar la distribución, densidad y abundancia de las rapaces nocturnas en el PNPG (NW de Portugal). Entre diciembre de 2007 y junio de 2008 se realizaron 106 estaciones de escucha pasiva, de 15 min cada una, en el centro de 106 cuadrículas (2x2 km). Se obtuvieron así los mapas de distribución para cada una de las especies. Se obtuvieron además un total de 98 contactos de Cárabo europeo, 67 de Autillo europeo, 7 de Mochuelo común, 2 de Lechuza común y uno de Búho real. También se estudió la selección de hábitat de Autillo europeo y Cárabo europeo. El Autillo europeo parece evitar las zonas de matorral bajo seleccionando áreas boscosas. El Cárabo común mostró un comportamiento similar y fue además registrado en zonas urbanas. Las poblaciones de estas dos especies en el PNPG mostraron una considerable expansión, mientras que las otras mostraron un marcado descenso respecto a

la situación previa. Se sugiere la puesta en práctica de un seguimiento y ejecución de medidas de conservación para frenar la disminución de estas especies.

Palabras clave: Strigiformes, distribución, Rapaces Nocturnas, preferencias de hábitat, censos, Portugal.

INTRODUCTION

Owls (Birds, Strigiformes) are one of the groups of birds most difficult to study due to their discrete and mainly nocturnal habits (Proudfoot & Beasom, 1996) but, in late years, efforts were made to improve the knowledge about these species and to establish their conservation status. In Portugal, the information regarding this group is still scarce, despite the efforts made by researchers. The first works done in Portugal were based on the study of the Barn Owl's diet *Tyto alba (*Scopoli, 1769) with the aim of studying and counting small mammals. The Barn Owl's diet was also an integrate part of other studies carried out on the species (Roque, 2007). The remaining works concern census and local atlas (Pimenta & Santarém, 1996; Elias *et al.,* 1998; Lourenço *et al.,* 2002), the national atlas (Equipa Atlas, 2008) and studies on the ecology of some species: Barn Owl (Fernandes, 1991; Tomé, 1994; Santos, 1998; Tomé & Valkama, 2001; Álvaro, 2002; Roque, 2003); Eagle Owl *Bubo bubo* (Linnaeus, 1758) (Lourenço, 2000; Santos, 1998; Pinheiro *et al.,* 2003); Short-eared Owl *Asio flammeus* (Pontoppidan, 1763) (Tomé *et al.,* 1994); and Little Owl *Athene noctua* (Scopoli, 1769) (Bloise, 1999; Chumbinho, 1999; Tomé *et al.,* 2004; Tomé *et al.,* 2005). In Portugal there are seven species of Strigiformes, of which two are migratory and five are resident. The Short-eared Owl is the only one that does not breed in the national territory and it is only present during the winter, while the Scops Owl *Otus scops* (Linnaeus, 1758) pass the winter in Africa. In the area of Parque Nacional da Peneda-Gerês (PNPG) there are records of all the seven species present in Portugal, the Tawny Owl *Strix aluco* (Linnaeus, 1758) being the most common and the Long-eared Owl *Asio otus* (Linnaeus, 1758) and the Short-eared Owl being occasional species.

The purpose of this study is to determine the distribution of the Strigiformes species found in PNPG, complementing and updating the work carried out by Pimenta & Santarém (1996) and also studying how these species select their habitat, in order to contribute to the knowledge on the owls present in the study area and in Portugal.

METHODS

Study area

The study area matches with the PNPG area (approximately 72.000 ha) and is located in the northern limit of Portugal (Fig. 1). From the geological point of view it is dominated by a rocky substrate of granitic origin and includes in its geomorphology glacier structures at low altitude, namely erratic blocks, moraines and glacial circuses (Pimenta & Santarém, 1996). It is under Atlantic, Mediterranean and continental weather influences, showing a great variety of microclimates in its slopes. The annual average rainfall varies between 1600 and 3500 mm, winter snowfall is regular in the highest areas of PNPG (up to 1500 m), and annual average temperatures vary between 7.5 and 12 ºC, but can reach –12ºC, (Pimenta & Santarém, 1996). PNPG is one of the few areas of Portugal where pristine ecosystems can be found with forests dominated by oak-groves, although there are spots of resinous trees and mixed forests of resinous trees and deciduous trees. Shrubby areas are dominated by heather-gorses, *Genista* species and heathers. From the conservation point of view, the existence of peat-bogs and water courses with remarkable riparian vegetation and rocky crags is also very important. The existing villages are small and markedly rural, where the traditional agriculture and livestock management still subsist (Pimenta & Santarém, 1996).

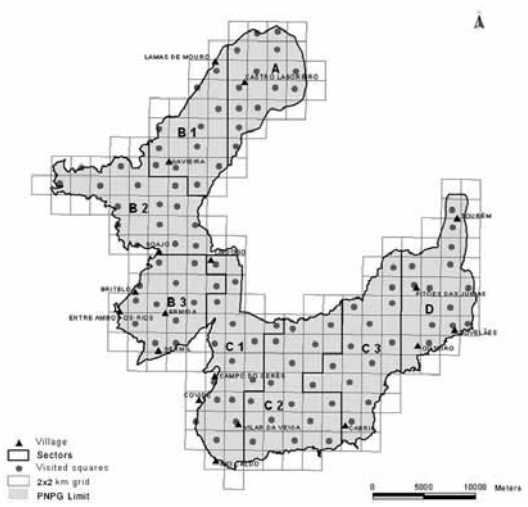

Fig. 1. Location of the sampling points (n=106) in the study area, PNPG. The sectors are: A, Castro Laboreiro; B1, Serra da Peneda; B2, Serra do Soajo; B3, Serra Amarela; C1, Serra do Gerês Ocidental; C2, Serra do Gerês Central; C3, Serra do Gerês Oriental; and D, Planalto da Mourela.

Census Methods

Between December 2007 and June 2008, that is, the period of the year recommended by Escandell (2005), hearing point counts lasting 15 minutes each where done, starting 15 minutes after sunset, in the centre of each of 106 squares (2x2 km UTM squares) (Bibby *et al.,* 2000; Escandell, 2005; BTO, 2005). The amount of squares studied represents about 48.4% of the total number of squares in the PNPG area (219 squares of 2x2 km) (Fig. 1). Each point was only visited once. The squares were distributed having in mind the following criteria: homogeneous coverage of the PNPG area, accessibilities, presence of water (puddles, ponds, etc.) in less than 50% of the square's total area, and habitats more favourable to the occurrence of Strigiformes. The PNPG area was further subdivided in 8 sectors reflecting the different areas of the PNPG (Fig. 1), with the purpose of carrying out censuses in an alternating and randomly way across the whole study area. The following variables were also registered for each point: altitude, moon phase, cloud cover, mist, temperature and wind. The time of sunset, moonrise and sunrise were obtained from the tables published by Observatório Astronómico de Lisboa (2007; 2008). Breeding evidences methodology according to Equipa Atlas (2008).

Geographical Information System

The estimated localisation of each contact was transposed to a Geographical Information System (ArcView GIS 3.3) for the elaboration of distribution maps concerning each species. We have also used information prior to this work (Pimenta & Santarém, data PNPG 1996-2007). By overlaying information available in PNPG (highly detailed land cover maps) it was possible to determine the percentage of contacts considering soil occupation.

Statistic analysis for habitat selection

Habitat selection was studied for the Scops Owl and the Tawny Owl (the analysis of habitat selection by the remaining species was not carried out because there weren't enough data). We used the Savage's Selectivity Index $\omega i = Ui/pi$, where *Ui* is the proportion of observations in a specific habitat and *pi* is the proportion of this habitat within the total area. This index varies between 0 (maximum negative selection) and the infinite (maximum positive selection), where value 1 indicates selection according to availability. The value of $(\omega i-1)^2/(EP\omega i)^2$ was compared with the critical value of the Chi-square distribution (1 df), and the null hypothesis is that a certain species will use habitat types in the same proportion they are available. The Standard Error ($EP\omega i$) associated to the value of Savage's Selectivity Index was calculated through $\sqrt{[(1-pi)/(u \times pi)]}$, where *u* is the total number of registrations for a certain species. Bonferroni correction was applied to obtain the true statistical significance (Tella & Forero, 2000).

RESULTS

For all the studied species were obtained an overall of 175 contacts (TC), 96 of which (54.9%)

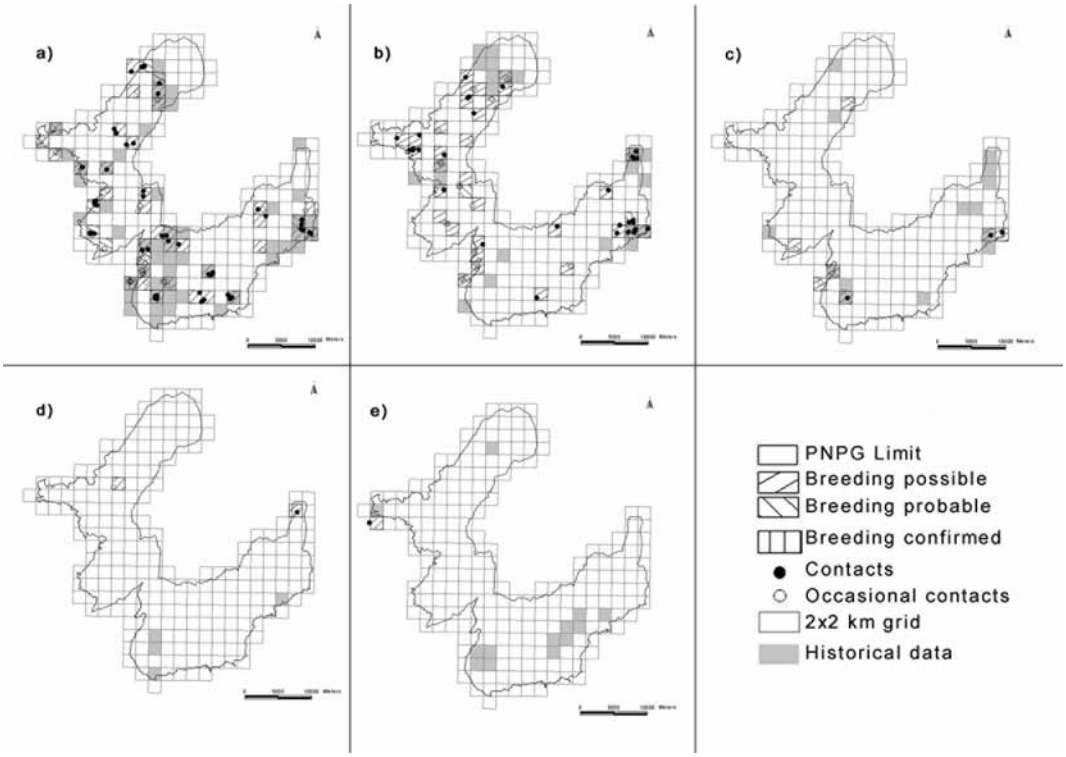

Fig. 2. Spatial distribution of Owls records in PNPG: a) Tawny Owl; b) Scops Owl; c) Little Owl; d) Barn Owl; e) Eagle Owl.

were recorded during the listening periods (C) in the 106 squares visited and 79 were designated as occasional contacts (OC) out of the listening time. Some OC were not considered because there is no assurance that did not correspond to individuals already registered. The sector with the highest number of contacts (C) and also with the greatest number of registered species (4 species) was **sector D** (Fig. 1), while in **sector C3** only Tawny Owl was registered. The sector with less contacts during the listening time was **A**, with only 4 C, and the one with less contacts on the whole was **sector C2** with only 10 TC. Globally, in PNPG area, 37.1% of TC were obtained in deciduous forests, 14.9% in resinous forests and 12.0% in mixed forests of deciduous and resinous trees. The percentages of TC in agricultural areas (10.1%) and tall brushwood (9.1%) are similar, as were the percentages of contacts in urban areas and low shrub areas. It should be noted that the mixed forests of resinous and deciduous trees (excluding the uncultivated areas), has the lowest TC percentage (2.9%). The results obtained for each species can be found in Fig. 2 and Tables I-III.

DISCUSSION

The results obtained in this work showed that the Tawny Owl and the Scops Owl (Table I) are the most abundant owls in PNPG area, which is in line with the results obtained by Pimenta & Santarém (1996) for the same area. There are few records for Eagle Owl (Fig. 2.e), Little Owl (Fig. 2.c) and Barn Owl (Fig. 2.d); therefore, these species can be considered as scarce in PNPG which, again, matches the results from Pimenta & Santarém (1996). No contacts were obtained for Long-eared Owl and Short-eared

TABLE I. Results obtained for each species and percentage of individuals for each type of land use

	C	OC	TC	Use of soil (%)								
				DF	RF	MDRF	MRDF	TB	LS	Ag	Urb	Unc
S. aluco	56	42	98	46.9	16.3	8.2	4.1	8.2	2.0	9.2	4.1	1.0
O. scops	35	32	67	37.3	4.5	11.9	—	7.5	19.4	19.4	—	—
A. noctua	3	4	7	—	—	—	—	—	—	85.7	14.3	—
T. alba	1	1	2	—	—	—	—	—	—	50.0	50.0	—
B. bubo	1	—	1	—	—	—	—	100.0	—	—	—	
All species	96	79	175	37.1	14.9	12.0	2.9	9.1	6.3	10.3	6.9	0.6
Area of PNPG				8.6	3.8	1.7	2.1	9.2	29.7	5.9	0.8	35.7

Abbreviations: C, contacts during the listening time; OC, occasional contacts; TC, total of contacts; DF, Deciduous forest; RF, Resinous forest; MDRF, Mixed deciduous and resinous forest (more deciduous than resinous trees); MRDF, Mixed resinous and deciduous forest (more resinous than deciduous trees); TB, Tall brushwood; LS, low shrub; Ag, Agricultural land; Urb, Urban; Unc, Uncultivated.

TABLE II. Values of Savage's Selectivity Index (ω**i**) for each habitat used by the Tawny Owl, index standard error and corresponding value of χ^2. Statistical significance after Bonferroni correction ($P < 0.0056$; $\chi^2 > 7.6750$)

Habitat	ω**i**	**s.e. (wi)**	**Stat χ^2**
Agricultural Land	1.202	0.402	0.253
Deciduous Forest	**4.864**	0.329	**137.679**
Resinous Forest	**4.249**	0.505	**41.343**
Mixed Deciduous and Resinous Forest	**6.583**	0.767	**52.992**
Mixed Resinous and Deciduous Forest	1.907	0.683	1.763
Uncultivated	**0.029**	0.136	**51.320**
Urban	**6.177**	1.107	**21.873**
Tall brushwood	1.216	0.317	0.466
Low Shrub	**0.069**	0.155	**35.907**

TABLE III. Values of Savage's Selectivity Index (ω**i**) for each habitat used by the Scops Owl, index standard error and corresponding value of χ^2. Statistical significance after Bonferroni correction ($P < 0.0071$; $\chi^2 > 7.237$)

Habitat	ω**i**	**s.e. (wi)**	**Stat χ^2**
Agricultural Land	2.260	0.486	6.725
Deciduous Forest	**4.164**	0.398	**63.135**
Resinous Forest	**3.885**	0.611	**22.277**
Mixed Deciduous and Resinous Forest	**8.754**	0.928	**69.875**
Mixed Resinous and Deciduous Forest	0.697	0.826	0.134
Tall Brushwood	0.647	0.383	0.849
Low Shrub	**0.452**	0.188	**8.491**

Owl, similarly to what is referred by Pimenta & Santarém (1996), which indicates that the occurrence of these species in PNPG area would be occasional. We highlight the apparent increase in the numbers of Tawny Owls by almost 50%, as compared to the estimate made by Pimenta & Santarém (1996), as well as the increase by more than 50% of the Scops Owl population, in line with the positive trends observed in Spain in recent years (Escandell, 2005). As for the remaining Strigiformes there is an apparent reduction of about 50% in the populations of Barn Owls and Little Owls and a rather marked reduction in the population of Eagle Owls, as compared with the results presented by Pimenta & Santarém (1996). The distributions of the registered species correspond partially to the ones obtained by Pimenta & Santarém (1996) (Fig. 2). Except for Little Owls, these population trends are in agreement with the trends observed by Escandell (2005) in Spain. However the population trend for Little Owl in the last few years in Spain (SEO/BirdLife, 2010) is consistent with that observed in PNPG.

Data obtained for Tawny Owls (Table I and II) shows how important deciduous forests are for this species (Cramp, 1985; Pimenta & Santarém, 1996), whose distribution and abundance reflect the presence of this kind of vegetation and which present in these areas the highest densities observed in PNPG. The presence of the Tawny Owl in the neighbourhood of urban and agricultural areas is also common, and there may be relatively high densities there, similarly to what Sunde & Redpath (2006) observed, probably as a result of the prey availability and the low overlapping of intraspecific territories (Redpath, 1995). Considering this species' relatively high densities in the study area and the fact that immature Tawny Owls settle at short distance from their parents' territories (Cramp, 1985), it is possible that young Tawny Owls include in their territories rural and agricultural areas, adjacent to forests, using buildings, posts or isolated trees as hunting perches (Redpath, 1995). The occurrence of the species in resinous forests is, eventually, due to the remarkable adaptability of Tawny Owls in what concerns to their habitat (Cramp, 1985; Roque, 2007), but estimated densities are not as high as in deciduous forests (Pimenta & Santarém, 1996). On the other hand, the presence of Tawny Owls in areas of tall brushwood may be explained by the fact that these are normally adjacent to forests, serving as transition areas, normally rich in small mammals (Redpath, 1995). The above considerations are supported by the results of Savage's Selectivity Index (Table II), which indicates that Tawny Owls select forest areas (deciduous, resinous and a mixture of deciduous and resinous forests) and urban areas, avoiding low shrubs and uncultivated areas, probably because these are inadequate hunting and nesting habitats. The occurrence of a smaller number of contacts in some sectors is probably related with the lack of preferential habitat (Cramp, 1985), since in these sectors the species is concentrated in small, well demarcated areas (small patches of forest), that have an adequate habitat. In global terms and concerning the distribution within PNPG whole area, there is a decrease in the abundance of Tawny Owls at altitudes higher than 1000 m, which was also noticed by Pimenta & Santarém (1996). The number of contacts decreased over time, throughout the study period and in the breeding season, with the maximum values registered in December and January, the period when the birds establish and defend actively their territories and, consequently, they increase vocal activities (Cramp 1985).

Like the Tawny Owl, the Scops Owl (Table I and III) seems to be mainly associated to deciduous forests, where it finds resting-places and tree cavities suitable for nesting (Cramp, 1985; Marchesi & Sergio, 2005). Resinous forests and mixed resinous and deciduous forests seem to be also important, as well as agricultural land and low shrub areas, close to forested areas. Records obtained in woodland areas are mainly located in the forests' periphery, normally adjacent to agricultural and low shrub areas. As Cramp (1985), Galeotti & Sacchi (2001) and Marchesi & Sergio (2005) referred, this "mosaic" habitat seems to be the preferred one for the Scops

Owl in PNPG area. When compared with tall brushwood areas, low shrub areas seem to be much more important to the Little Owl, which could be due to a greater availability of food, according to Marchesi & Sergio (2005). The distribution and abundance of Scops Owls reflect the characteristics of the soil coverage, and the records gathered are similar to those obtained by Pimenta & Santarém (1996), which lead us to believe that Scops Owls populations show some fidelity to the areas they occupy in PNPG to breed. This territorial stability had also been noticed in a population in the north of Italy (Galeotti & Sacchi, 2001). Although they are present in agricultural and low shrub areas, according to the result of Savage's Selectivity Index, Scops Owls select only forested areas (deciduous, resinous and a mixture of deciduous and resinous forests) (Table III); this can be explained by the greater abundance of resting-places and also by the camouflage conditions these areas offer, and avoids tall brushwood areas, probably because of the lack of suitable nesting places. Besides, low shrub areas are widely distributed and can be found in abundance across the whole PNPG area. It is reasonable to admit that the presence of Scops Owls in this habitat may be dependent on the existence of areas with trees and/or adjacent agricultural areas, suggesting that low shrub areas by themselves do not offer all the conditions this species needs. The high number of contacts in sector D (Mourela's plateau) suggests that this should be the area within PNPG whose characteristics are more suitable for the Scops Owl, probably because it includes a great number of extensive agricultural areas and because it is, from a bio-climatic point of view, the only Supra-mediterranean Region in PNPG (Pimenta & Santarém, 1996; Zuberogoitia & Campos, 1997). The Scops Owl distributes evenly through all altitudes of the study area, although it is slightly more abundant in altitudes of about 1000 m, common in sector D. It was also the species found at the highest altitude (above 1400 m), as it so happens in Italian Alps (>1 500 m) (Cramp, 1985; Marchesi & Sergio, 2005). The first records were obtained in the beginning of February (probably early migrants, since according to Pimenta & Santarém (1996) the majority of the birds arrive at PNPG in April) and the peak of contacts was registered in the beginning of April, diminishing to about one third by the end of May.

The presence of Little Owls was never registered above 1000 m and all contacts were obtained in agricultural areas (except for one contact in an urban-rural area) (Table I), which shows this species' dependence for humanized habitats, namely areas of extensive agriculture (Cramp, 1985; Schaub *et al*., 2006). In general, its distribution is similar to the one obtained by Pimenta & Santarém (1996). Nevertheless, and opposed to what was reported by other authors (Zuberogoitia & Campos, 1997; Zuberogoitia, 2002, Roque, 2007) Little Owls contacts were all registered in areas near to the ones where Tawny Owls are present. Since it was not possible to study the hypothesis of overlapping territories, it is reasonable to admit the possibility that the expansion of Tawny Owls referred to by some authors may be, even indirectly by habitat changes, related with the reduction of the Little Owl population (Zuberogoitia, 2002).

Regarding Barn Owls (Table I) only two contacts were finally obtained, both at lower altitudes than 850 m and in humanized areas (rural and agricultural). As in the Little Owl's case, the expansion of the Tawny Owl to humanized areas may be related with habitat changes that lead to the decrease of the Barn Owl's population within PNPG area, as was documented by authors such as Muntaner & Mayol (1994) e Zuberogoitia (2002). Nevertheless, the decline of this population may also be related with the abandonment of traditional agricultural practices in PNPG area (PNPG, 1995) since, despite the territorial fidelity, these birds may leave their territories when the abundance of prey decreases (Shawyer & Shawyer, 1995; Fajardo, 2001; Salvati *et al*., 2002; Bond *et al*., 2004), similarly to what Little Owl and the Scops Owl may do.

As opposed to the European positive trend (Tucker & Heath, 1994) and the trend observed in Spain in recent years (SEO/BirdLife,

2010), the Eagle Owl population experienced a rather marked decrease in the study area, and became a very rare and almost extinct in PNPG, despite the great availability of suitable nesting and hunting habitat in the study area. The only record obtained is partly overlapped with one registered by Pimenta & Santarém (1996) (Fig. 2.e), and possibly it refers to the same bird (or the same couple), and/or the same territory. However, according to PNPG data, there were two other territories, before the beginning of this work, which were apparently left empty in the meantime. This decrease may be related with electrocution in power lines, referred by Sergio *et al*. (2004) but mainly with the shortage of Rabbits (*Oryctolagus cuniculus*), which are the main prey of the species in a great part of the Iberian Peninsula (Serrano, 1998; Martínez e Zuberogoitia, 2001), among other causes.

Globally, and according to our results, the populations of Tawny and Scops Owls show a favourable situation in PNPG area; the same does not happen to Little, Barn and Eagle Owls, all of them declining. The interpretation of the results and the cross-referencing with the previous information (Pimenta & Santarém, 1996) suggest that most causes for the observed decreases can be avoided or at least reduced. To do so, we may implement measures such as to raise the awareness of the local populations to the importance of the nocturnal birds of prey in the control of plagues that strike agriculture (inclusively promoting the setting of nest boxes), the incentive to traditional/biological agricultural practices that avoid the use of pesticides, and the environmental education at schools, communities and hunters' associations. At the national level, it seems necessary to carry out more work on the biology of these birds and the situation of the populations, whose fluctuations should be regularly monitored.

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REFERENCES

Álvaro, M. C. (2002). *Ecologia e conservação da Coruja-das-torres (Tyto alba Scopoli, 1769) no Nordeste Algarvio e Sudeste Alentejano*. Unpublished Report. FCUL, Lisboa.

Bibby, C. J., Burgess, N. D., Hill, D. A. & Mustoe, S. H. (2000). *Bird Census Techniques*. Second Edition. Academic Press, London.

Bloise, C. P. (1999). *O Mocho-galego (Athene noctua) em dois tipos de habitat mediterrânicos: efeito de variáveis ambientais sobre as populações e selecção de locais de nidificação*. Unpublished Report. FCUL, Lisboa.

Bond, G., Burnside, N. G., Metcalfe, D. J., Scott, D. M. & Blamire, J. (2004). The effects of land-use and landscape structure on barn owl (*Tyto alba*) breeding success in southern England, U.K.. *Landscape Ecology,* **20**: 555-566.

BTO (2005). *Tawny Owl Survey 2005*. BTO Surveys, UK.

Chumbinho, A. C. (1999). *Uso do espaço e comportamento de caça do Mocho-galego (Athene noctua) em habitats mediterrânicos*. Unpublished Report. FCUL, Lisboa.

Cramp, S. (Ed.) (1985). *Handbook of the Birds of Europe the Middle East and North Africa. The Birds of the Western Palearctic Vol. IV, Terns to Woodpeckers*. Oxford University Press, Oxford.

Elias, G. L., Reino, L. M., Silva, T., Tomé, R. & Geraldes, P. (Coords) (1998). *Atlas das Aves Invernantes do Baixo Alentejo*. SPEA, Lisboa.

Equipa Atlas (2008). *Atlas das Aves Nidificantes em Portugal (1999-2005)*. Instituto da Conservação e da Biodiversidade, Sociedade Portuguesa para o Estudo das Aves, Parque

Natural da Madeira e Secretaria Regional do Ambiente e do Mar. Assírio e Alvim, Lisboa.

Escandell, V. (2005). *Seguimiento de Aves Nocturnas en España. Programa NOCTUA. Informe 2003-2004. Análisis y establecimiento de una nueva metodología.* SEO/BirdLife, Madrid.

Fajardo, I. (2001). Monitoring non-natural mortality in the barn owl (*Tyto alba*), as an indicator of land use and social awareness in Spain. *Biological Conservation,* **97**: 143-149.

Fernandes, C. (1991). *Alguns aspectos da biologia da Coruja-das-torres (Tyto alba*) na região de Aveiro. Undergraduate Thesis. Universidade de Aveiro.

Galeotti, P. & Sacchi, R. (2001). Turnover of territorial Scops Owls *Otus scops* as estimated by spectrographic analyses of male hoots. *Journal of Avian Biology,* **32**: 256-262.

Lourenço, R. F. (2000). *Distribuição, situação populacional e ecologia trófica do Bufo-real (Bubo bubo Linnaeus, 1758) no Nordeste Algarvio*. Unpublished Report. FCUL, Lisboa.

Lourenço, R. F., Basto, M. P., Cangarato, R., Álvaro, M. C., Oliveira, V. A., Coelho, S. & Pais, M. C. (2002). The Owl (Order Strigiformes) Assemblage in the North-eastern Algarve. *Airo*, **12**: 25-33.

Marchesi, L. & Sergio, F. (2005). Distribution, density, diet and productivity of the Scops Owl *Otus scops* in the Italian Alps. *Ibis*, **147**: 176-187.

Martínez, J. A. & Zuberogoitia, I. (2001). The response of the Eagle Owl (*Bubo bubo*) to na outbreak of the rabbit haemorrhagic disease. *J. Ornithol*., **142**: 204-211.

Muntaner, J. & Mayol, J. (Eds.) (1994). Biología y conservación de las rapaces Mediterráneas. *Actas del VI Congresso de Biología y Consevación de las Rapaces Mediterráneas*. SEO/BirdLife Monografía n.º 4, Palma de Mallorca.

Observatório Astronómico de Lisboa. (2007). Almanaque 2007. FCUL, Lisboa.

Observatório Astronómico de Lisboa. (2008). Almanaque 2008. FCUL, Lisboa.

Pimenta, M. & Santarém, M. L. (1996). *Atlas das Aves do Parque Nacional da Peneda-Gerês*. Instituto de Conservação da Natureza - Parque Nacional da Peneda-Gerês, Braga.

Pinheiro, A., Onofre, N., & Carrapato, C. (2003). Primeira abordagem à selecção de habitat pelo Bufo-real (*Bubo bubo*) na área de regolfo de Alqueva. *Actas do IV Congresso de Ornitologia da SPEA e II Jornadas Ibéricas de Ornitologia*, p. 53, Aveiro.

Proudfoot, G. A. & Beasom, S. L. (1996). Responseviness of cactus ferrugineus pygmy-owls to broadcasted conspecific calls. *Wildlife Society Bulletim*, **24**: 294-297.

Redpath, S. M. (1995). Habitat fragmentation and the individual: tawny owls *Strix aluco* in woodland patches. *Journal of Animal Ecology,* **64**: 652-661

Roque, I. (2003). *A população de Coruja-das-torres Tyto alba (Scopoli, 1769) no concelho de Coruche: abundância e distribuição, selecção de habitat, biologia de reprodução, alimentação e mortalidade.* Undergraduate Thesis. Universidade de Évora, Évora.

Roque, I. (2007). *Conservação de Aves de Rapina Nocturnas (Strigiformes) em sistemas agro-silvo-pastoris mediterrânicos: aplicação ao Sítio de Interesse Comunitário de Monfurado (Rede Natura 200, Portugal)*. Master Thesis. Universidade de Évora, Évora.

Salvati, L., Manganaro, A. & Ranazzi, L. (2002). Aspects of the ecology of the Barn Owl *Tyto alba* breeding in a Mediterranean area. *Bird Study,* **49**: 186-189.

Santos, S. M. L. (1998). *Rapinas nocturnas (Aves, Strigiformes) do Parque Natural da Serra de São Mamede*. Undergraduate Thesis. FCUL, Lisboa.

Schaub, M., Ullrich, B., Knötzsch, G., Albrecht, P. & Meisser, C. (2006). Local population dynamics and the impact of scale and isolation: a study on different little owl populations. *Oikos*, **115**: 389-400.

SEO/BirdLife (2010). *Estado de conservación de las aves en España en 2010*. SEO/BirdLife. Madrid.

Sergio, F., Marchesi, L., Pedrini, P., Ferrer, M. & Penteriani, V. (2004). Electrocution alters the distribution and density of a top

predator, the eagle owl *Bubo bubo*. *Journal of Applied Ecology*, **41**: 836-845.

Serrano, D. (1998). Diferencias interhábitat en la alimentácion del Búho Real (*Bubo bubo*) en el valle medio del Ebro (NE de España): effecto de la disponibilidad de conejo (*Oryctolagus cuniculus*). *Ardeola,* **45**: 47-53.

Shawyer, C. R. & Shawyer, V. M. (1995). An Investigation of the Barn Owl Population Within the Arun and Western Rother Catchments. *Hawk and Owl Trust*, UK.

Sunde, P. & Redpath, S. M. (2006). Combining information from range use and habitat selection: sex-specific spatial responses to habitat fragmentation in tawny owls *Strix aluco*. *Ecography,* **29**: 152-158

Tella, J. L. & Forero, M. G. (2000). Farmland habitat selection of wintering lesser kestrels in a Spanish pseudosteppe: implications for conservation strategies. *Biodiversity and Conservation,* **9**: 433-441.

Tomé, R. (1994). *A coruja-das-torres (Tyto alba Scopoli, 1769) no estuário do Tejo: fenologia, dinâmica populacional, utilização do espaço e ecologia trófica*. Unpublished Report. FCUL, Lisboa.

Tomé, R. & Valkama, J. (2001). Seasonal variation in the abundance and habitat use of Barn Owl *Tyto alba* on lowland farmland. *Ornis Fennica*, **78**: 109-118.

Tomé, R., Bloise, C. & Kortimäki, E. (2004). Nest-site selection and nesting success of Little Owl *Athene noctua* in mediterranean woodland and open habitat. *Journal of Raptor Research*, **38** (1):53-46.

Tomé, R., Catry, P. & Costa, H. (1994). A invernada da Coruja-do-nabal *Asio flammeus* nos distritos de Lisboa e Setúbal. *Actas da I Conferência Nacional sobre Aves de Rapina*: 92-105. Parque Biológico Municipal de Vila Nova de Gaia.

Tomé, R., Santos, N., Cardia, P., Ferrand, N. & Korpimäki, E. (2005). Factors affecting the prevalence of blood parasites of Little Owls *Athene noctua* in southern Portugal. *Ornis Fennica*, **82**: 63-72.

Tucker, G. M. & Heath, M. F. (1994). *Birds in Europe: their conservation status*. Bird Life International. Bird Life Conservation Series nº 3, Cambridge.

Zuberogoitia, I. (2002). *Ecoetología de las Rapaces Nocturnas de Bizkaia*. PhD Thesis. Universidad del País Vasco.

Zuberogoitia, I. & Campos, L. F. 1(997). Intensive census of nocturnal raptors in Biscay. *Munibe,* **49**: 117-127.