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Short communication

A retrospective study of mortality and morbidity factors for Common Buzzards *Buteo buteo* and Long-legged Buzzards *Buteo rufinus* in Greece: 1996–2005

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Introduction

The establishment of efficient conservation plans for birds requires extensive and reliable information on species' responses to human and natural disturbances (BirdLife International 2004). In this sense, the identification of potential threats to species diversity is of great interest to conservation biologists (Kuiken *et al.* 1999, Peres 2000; Janns and Ferrer 2001, Battaglia *et al.* 2005, Keane *et al.* 2005, Sergio *et al.* 2005). However, collecting adequate data on which to base conservation action for a variety of species over large areas requires deployment of considerable human and financial resources.

Bird species may occupy several habitats during the year and travel over large distances during migrations. Conducting accurate assessments across wide areas and over sufficiently long time periods is difficult. As a shortcut, the analysis of data collected from conservation bodies such as rehabilitation centres can provide a valuable additional strategy (Wendell *et al.* 2002, Martínez *et al.* 2006). Data collected recently at rehabilitation centres have been used to evaluate potential threats to wildlife (Morishita *et al.* 1998, Kwon *et al.* 2004, Wobeser *et al.* 2005). Based on the fact that injured animals admitted to rehabilitation centres may originate from a very wide area (compared to the spatial scales under which most monitoring programmes operate), and that data may have been collected over long time periods, such information could make a valuable contribution to establishment of conservation priorities and evaluation of ecological risks (International Wildlife Rehabilitation Council 2007).

The goal of this study was to investigate the main causes of mortality and morbidity in two raptor species, based on data collected from a rehabilitation centre in Greece. We used data for the Common Buzzard *Buteo buteo* and Long-legged Buzzard *Buteo rufinus*, a species included in the Greek national red list and in ANNEX I 79/409 of the EU Bird Directive, where it is considered a Species of European Conservation Concern (SPEC 3 - Species with unfavourable conservation status but not concentrated in Europe). The data, collected over a 10 year period, were used to explore patterns of bird admissions. We also investigated seasonal variation in the different types of injury and the association of type of injury and age class in the two species.

Methods

We compiled data from birds received at the Hellenic Wildlife Hospital (HWH) from 1996 to 2005. HWH came into operation in 1984, representing the first wildlife hospital within the wider

eastern Mediterranean region. The centre receives injured animals including birds, mammals, reptiles, and amphibians from all parts of Greece.

Once an individual is received, it is physically examined to determine body condition and identify any injuries. If an animal is diagnosed as wounded, weak or ataxic it undergoes a series of macroscopic and microscopic examinations and laboratory analysis to determine the source of trauma and to decide on the treatment process. The reason for admittance is recorded for every incident.

There are five main categories of trauma for bird species: gunshot, poisoning, illness, accident, and captivity. The category 'accident' includes electrocution, oil slicks, collision (with motor vehicles, fences, buildings, powerlines or other structures), lightning, hail storms or frost, and trapping. Birds which are illegally captured are recorded in the category 'captivity'. When possible, the age of individuals is determined using four age classes: fledgling, young, juvenile and adult. For every animal, the date of admission and its original location are also recorded.

We used locally weighted polynomial regressions (LOWESS) to graphically highlight any non-linear trend in recorded incidents and compare those trends (Cleveland 1993) for the two raptor species. LOWESS models were applied to log transformed numbers of birds. We used χ^2 tests to investigate possible interactions between the reasons for admittance and the years that the birds were received. We further compared the number of incidents recorded during the official hunting and non-hunting seasons. With the exception of some species, the hunting period in Greece lasts for about six months, from the end of August until the end of February; thus birds admitted between 1 September and 28 February were considered to have been received during the hunting season.

Results and Discussion

A total of 2,829 Common Buzzards and 82 Long-legged Buzzards were admitted to the centre during the 10 years of the study. Numbers of both species displayed large interannual variations (Figure 1). The estimated long-term trends in the annual numbers of birds received, as produced by LOWESS smoothing functions models, are shown in Figure 2. For Common Buzzards, the LOWESS smoothing model suggests a nonlinear functional form with a marked linear increase in the number of Common Buzzards received over the first seven years (1996–2002), followed by a marked linear decline from 2003 onwards. The LOWESS smoothing suggests a decline in the

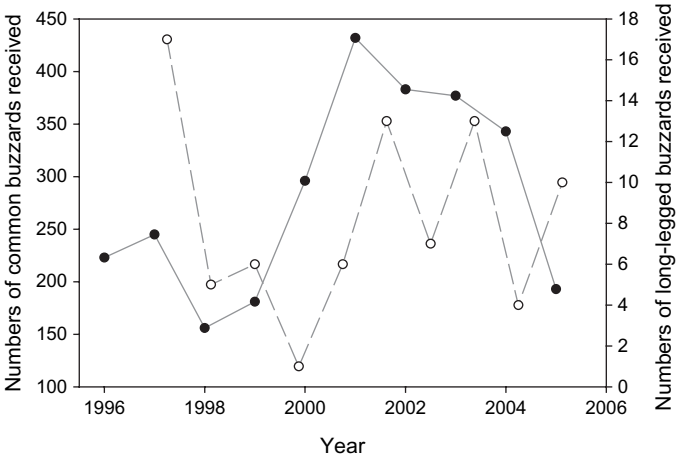

Figure 1. Annual numbers of birds received at the centre during the 10 years of the study. Dark circles represent Common Buzzards; open circles represent numbers of Long-legged Buzzards.

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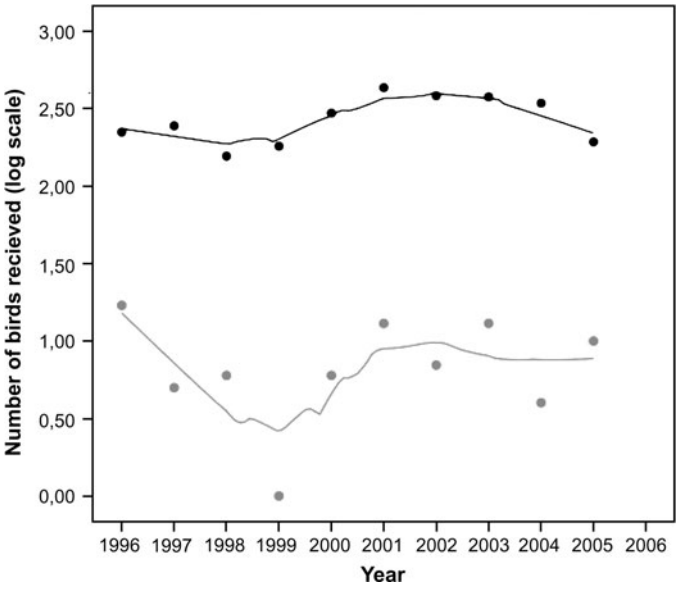

Figure 2. Trends in numbers of birds received produced by LOWESS models. Solid black curve shows the long term trend in log transformed numbers of Common Buzzards (dark circles); dashed grey curve shows the long term trend in log transformed numbers of Long-legged Buzzards (open circles).

number of Long-legged Buzzards received during the first year of the study, but the number of birds slightly increased from 1999 onwards following a nonlinear function form.

Causes of mortality

The results of the analysis showed significant interannual variations within the five main categories (i.e. shooting, accidents, poisoning, illness and captivity; $\chi^2_{36} = 265.7$, $P < 0.001$). More than 75% of Common Buzzards and 70% of Long-legged Buzzards received at the centre had been shot, indicating that persecution was the major cause of morbidity and mortality for both species in Greece (Figure 3). These percentages are among the highest recorded for raptor species in other regions (Clausen and Gudmundsson 1981, Deem *et al.* 1998, Real *et al.*, 2001, Wendell *et al.* 2002, Martínez *et al.* 2006, Margalida *et al.* 2008).

It has been suggested that law enforcement could have an effect on the number of birds recorded as victims of persecution (Mañosa 2002), reflecting a reluctance by people to report casualties from illegal causes. This attitude could result in an underestimation of the actual number of victims of persecution. In the present study we show a significant annual variation in the number of birds shot ($\chi^2_9 = 190.0$, $P < 0.001$), which reached a maximum in 2001, followed by a decreasing pattern in the remaining years (Figure 3). It is likely that the observed decrease between 2002 and 2005 is associated with deliberate concealment of shooting incidents, especially because during this period an EU project on selection and design of a protected areas network (under the EU NATURA 2000 framework) was undertaken throughout the country. In any case, there is clear evidence of persecution throughout the period of the study, indicating the ineffectiveness of the law in protecting raptor species.

It should be noted that shooting was recognized as the dominant cause of mortality and morbidity across different age classes for both species. We found that shooting was the cause of admittance in around 73% of young, 65% of juvenile and 84% of adult Common Buzzards.

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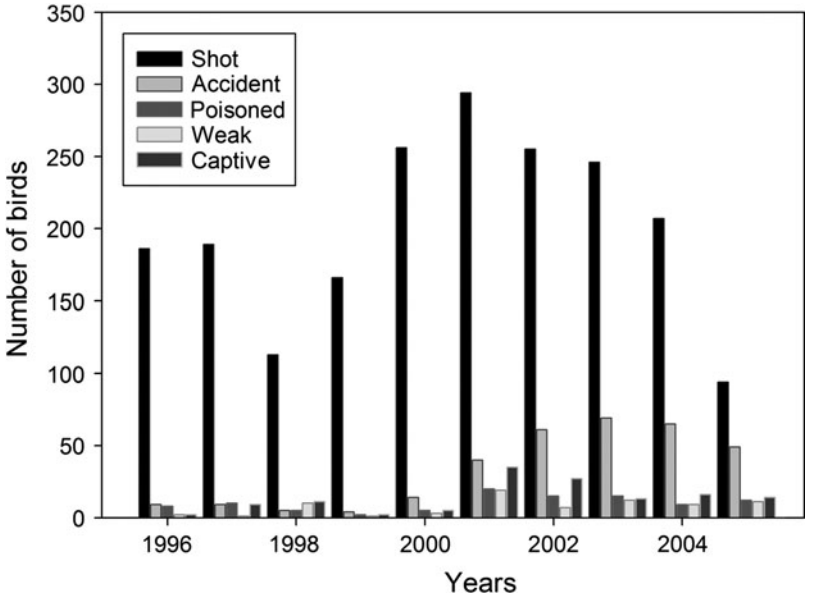

Figure 3. Numbers of buzzards admitted to the HWH over the period 1996–2005, categorized according to the reason for entry.

Similar results were obtained for Long-legged Buzzards, with more than 78% of young, 54% of juveniles and 78% of adult birds identified as victims of shooting. These results provide additional evidence to support the hypothesis of deliberate shooting of the two species.

Trauma caused by various types of accidents was the second most important cause of admission for both species - about 13% of Common and 18% of Long-legged Buzzards (Figure 3). A series of studies has demonstrated the importance of trauma-related mortality and morbidity on various raptor species in different areas (Bevanger, 1995, 1998, Morishita *et al.* 1998, Rubolini *et al.* 2001, 2006, Mañosa and Real 2001, Wendell *et al.* 2002, Sergio *et al.* 2004). Our study showed a relatively low contribution of trauma and a much higher level of persecution in birds admitted to the centre.

The other categories were less frequent causes of morbidity (for Common Buzzard: poisoned: 3.8%; ill: 2.8%; captivity: 5.1 %; for Long-legged Buzzard: poisoned: 1.5%; ill: 5.1%; captivity: 5.0%). Deaths of birds attributed to poisoning could be caused either by the intentional use of poison (Martínez *et al.* 2006) or the abuse of pesticides (Whitfield *et al.* 2003). The effects of deliberate abuse of pesticides on bird species have received considerable attention in the literature (Hill and Mendenball 1980, Henry *et al.* 1987, Scheuhammer and Norris 1996). In contrast, studies on intentional poisoning are rather rare since they require extensive analysis to detect specific substances (Martínez *et al.* 2006). Poisoned birds are also difficult to find in the field (Wendell *et al.* 2002), while diagnosis of pesticide poisoning can be difficult since the symptoms may not be recognized in some cases, even in dead animals (Kwon *et al.* 2004). As a result, pesticide poisoning of raptor species is often underestimated (Mineau *et al.* 1999).

Data collected at rehabilitation centres might be biased towards human-related sources of mortality (Spalding and Forrester 1993). To overcome potential biases and determine the degree of this observational error, comparative studies should be carried out in areas of both low and high human density (Brown and Sleeman 2002). Given the low significance of poisoning recognized here, we suggest that *in situ* observations should be conducted at sensitive sites such as agricultural areas where pesticide use is evident but also at popular human destinations.

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It is interesting to note that the total numbers of birds listed within the categories of trauma, poisoning, illness or captivity showed significant annual variations (accidents: $\chi^2_9 = 153$, $P < 0.001$; illness: $\chi^2_9 = 39.7$, $P < 0.001$; captivity $\chi^2_9 = 40.4$, $P < 0.001$). These interannual variations were clearest during the first years of the study, but the number of incidents increased from 2001 and thereafter. The increased contribution of injured birds is likely to reflect successful public education programmes and also increased public awareness and participation following the establishment of the NATURA 2000 network of protected areas undertaken across Greece.

Seasonal variation in the numbers of injured birds

For 58 incidents of Common Buzzard and five incidents of Long-legged Buzzards, information on the exact day of admission was not available. Given that in spring and summer (i.e. the non-hunting period) Greece is a mass tourism destination, leading to a significant increase in the number of people in the country, and that during these months weather conditions encourage movement to the countryside and access to more remote sites, it might be expected that the non-hunting period would result in a higher number of incidents. However, we found that a total of 2,191 (77%) Common Buzzards and 47 (57%) Long legged Buzzards arrived during the hunting period. Taking into account our previous findings that shooting was the main reason for admission, but also considering that most individuals shot were adults, thus clearly distinguishable birds, we conclude that there is considerable level of deliberate shooting of both species. This conclusion is further supported by the fact that more than 83% of Common Buzzards and 33% of Long-legged Buzzards received during the non-hunting season had been shot.

Implications for conservation

The findings of this study have several important implications. Most important, it is clear that direct action should be taken to minimize the number of birds subject to deliberate shooting (Mazaris *et al.* 2008). Shooting of buzzards is not necessarily associated with hunting. It is clear that shooting takes place throughout the year and throughout the country. We believe that the establishment of public awareness and educational programmes could have a positive effect in this direction. However, we should not underestimate the importance of shooting during hunting periods. In this latter case, the enforcement of existing laws and hunting regulations is necessary to minimize the negative effect on species diversity and distribution. It is also clear that losses due to human causes are similar for a common raptor species and one that is internationally protected. Thus, measures to counter lack of interest or ignorance regarding the relative importance of raptor species should be undertaken.

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