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Griffon Vulture *Gyps fulvus* monitoring in Spain: current research and conservation projects

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ABSTRACT

Spain holds the most important Griffon Vulture *Gyps fulvus* population in the Western Palearctic (more than 17,000 breeding pairs in 1999). A review of current research and conservation measures in the country is provided. The breeding population is still increasing. However, some density-dependent regulation is possibly taking place in some areas, where breeding success seems to be decreasing. In contrast, food availability does not seem to constrain the population and does not determine the Griffon Vulture's distribution in Spain. A common and illegal practice of leaving carcasses in the field or at traditional feeding sites called *muladares* has supplemented the birds' dietary requirements. Some old regulations established by the Government in the 1950s were mostly overlooked by shepherds. Since 1973 *ca.* 5,000 Griffon Vultures have been ringed with metal rings and *ca.* 1,000 have been ringed with Darvic plastic rings. Resightings and recoveries of ringed birds have provided some information about the migratory routes of Griffon Vultures within Spain and Africa. However, the migratory movements are still not well known and the wintering areas in Africa and Spain still need to be identified. The use of satellite-transmitters is urgently needed in order to highlight many aspects of the species' ecology. Human-induced threats (e.g. egg collecting, disturbance at breeding colonies, shooting and poisoning) have been reduced through the implementation of national legislation and the protection of colonies. Most of the birds admitted to rehabilitation centres are malnourished and weak. A high percentage of them are released. A serious resurgence of poison incidents has been noticed since 2000, as compared with the preceding ten-year-period. New threats have arisen in recent years, including the impact of windfarms and attacks by vultures on livestock. Serious studies regarding the impact of windfarms on avian populations are lacking. Attacks on livestock occur as the animals are generally too weak to protect themselves.

INTRODUCTION

The Griffon Vulture *Gyps fulvus* is considered a rare species (Tucker & Heath 1994) under Category 3 of Species of European Conservation Concern (SPEC): species whose global populations are not concentrated in Europe but have an unfavourable conservation status on the continent. The causes of decline have been attributed to the use of poisons, and changes in land use and livestock-rearing practices which result in reduced food availability. The gregarious behaviour of the species has also contributed to its demise, due to several mass poisoning events (Hernández 2000). In marked contrast to the situation in most of Europe, the populations in France, Spain and Portugal are increasing (Sarrazin *et al.* 2000; Del Moral & Martí 2001).

In 1979 the Spanish Ornithological Society (SEO 1981) carried out the First National Census of Griffon Vultures in Spain. The majority of the breeding sites were located and censused; 200 colonies, 2,300 occupied nests and 3,200 breeding pairs were estimated. Subsequently, second and third surveys have taken place (Arroyo *et al.* 1990; Del Moral & Martí 2001). The two latter surveys revealed a marked increase in the number of vultures, even though there was better coverage and more experienced people participated. Thus, in contrast to other wild animals in Spain, there is extensive knowledge about the country's Griffon Vulture population and distribution. Protection of breeding colonies, limited direct persecution (shooting) and a reduction of the use of poisons have assisted the species' recovery (Arroyo *et al.* 1990; Hernández 2000; Del Moral & Martí 2001). This would not have been possible without the availability of livestock carcasses, abundant in Spain, and legislation which does not insist on the carcasses being buried or burnt.

Since the early 1990s, although numerous papers and reports have been published (mainly in Spanish), no publication (besides Donázar 1993) has collated all the information about Eurasian Griffons in Spain. The aim of this paper is to present an overview of the monitoring programmes and current research on Griffon Vulture populations in Spain. Information was obtained from various sources: published literature; personal unpublished observations; and observations by members of the Iberian Raptors Group of the Spanish Ornithological Society (SEO/BirdLife).

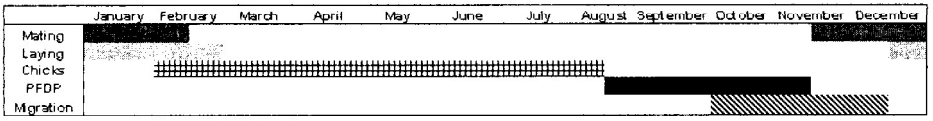
STUDY POPULATION

Status and trend of the Griffon Vulture population

Many vertebrate species gather periodically to breed in colonies (Tellería 1986), a phenomenon common among marine birds and mammals.. When concentrating in particular places the species can be censused with relative ease. These counts may not, however, provide the absolute number of birds in the population, as only a portion of the population may be breeding (Harris *et al.* 1983), not all birds may be visible, and some birds may be foraging and therefore not present at the breeding site (Birkhead 1978). Other methodological problems can also occur (for a review see Caughley 1977; Tellería 1986).

Three Griffon Vulture National Censuses have been carried out in Spain, starting in 1979 (SEO 1981; Arroyo *et al.* 1990; Del Moral & Martí 2001) . In 1999, 17,337-18,070 Griffon Vultures were counted and a population comprising 22,455 breeding pairs was estimated (Del Moral & Martí 2001). Despite these main surveys, other smaller scale censuses have been conducted on a more frequent basis (see references in Arroyo *et al.* 1990; Del Moral & Martí 2001). As an example, despite the national surveys, only for La Rioja (a 5,000 km^2 area) another six different counts were carried out (Lopo & Ceballos 1985; Lopo *et al.* 1986; Ceña *et al.* 1994; Camiña 2001b, 2003). The results of all of them clearly demonstrate the great recovery rate of the species in the Iberian Peninsula, without food, breeding and persecution constraints.

Figure 1. Breeding cycle of the Griffon Vulture (*Gyps fulvus*) in Spain (modified from Donázar 1993).



Griffon Vultures breed from January to July, commencing in December (Figure 1). Occasionally birds start breeding earlier and copulation has been recorded in early-November at the Montejo Raptors Refuge or La Rioja (F. J. Fernández and J. Prieto pers. comm., pers. obs.) and during October in the Cádiz province (Del Junco & Barcell 1997). Thus, the breeding season extends over a long period and the colonies are occupied most of the year.

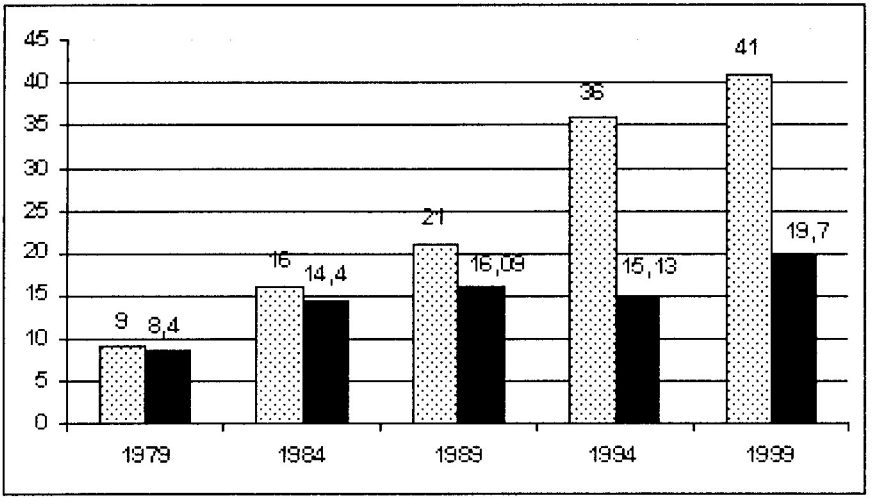
In Spain censuses are carried out from late-February until mid-July. Three visits per year have been recommended (Martínez *et al.* 1996); however, after all the colonies have been mapped, two visits per season is adequate to determine reproductive success and to determine population trends. Methodological problems during the surveys, such as distances to the colonies and unfavourable weather conditions, have been discussed by Del Junco & Barcell (1997). With this aim, a national survey on a ten-year-basis has been considered sufficient to monitor the country's breeding population.

In La Rioja and Castellón provinces, where all the occupied cliffs have been located and regularly monitored, the number of colonies has increased over the last twenty years (J. Jiménez pers. comm.). However, the average number of breeding pairs per colony has remained almost stable during this 20-year-period (Figure 2.a and 2.b). The same trend was detected in Badajoz province (Extremadura region) between 1979-1999 (Traverso 2003).

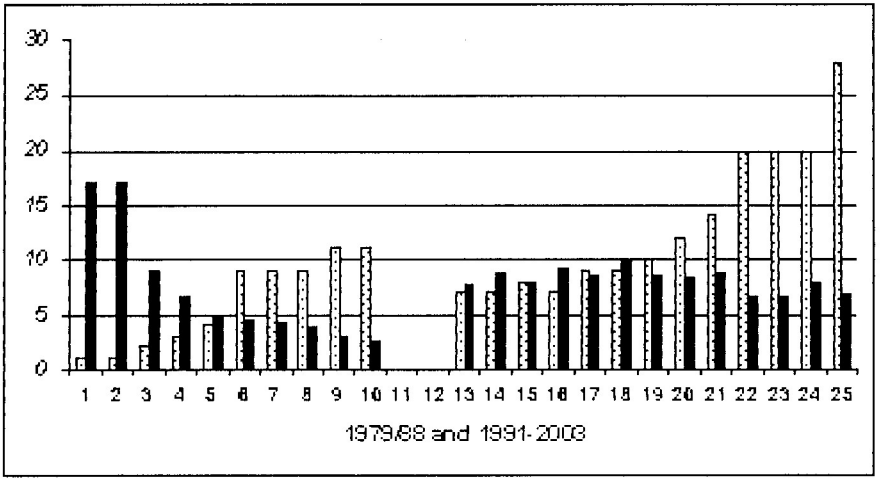
Two reintroduction programmes have been underway in Murcia, Almería and Alicante provinces. The two former sites have a very small number of breeding pairs (14 in 1999), while in Alicante no breeding population has yet been established (reintroduction activities started in 2001). The reintroduction sites are located on the eastern Spain migration route (Garrido *et al.* 2001) and it is anticipated that migrating birds will be attracted to feeding stations in these areas (pers. obs.).

Figure 2a and 2b. Trends in the number of colonies and breeding pairs per colony at La Rioja (Camiña 2002) and Castellón (1973-1988, Errando *et al.* (1988); 1990-2003, C.R.F. Forn del Vidre unpubl. data). Dotted bars: number of colonies, black bars: breeding pairs per colony.

a.



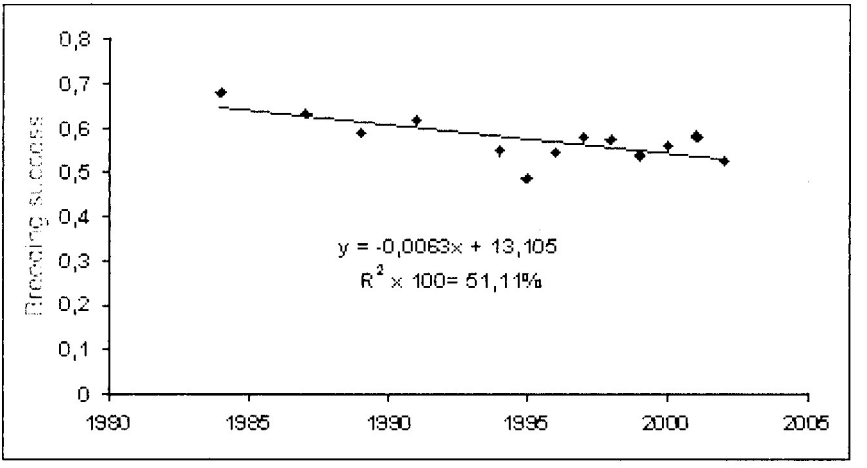
b.



In some provinces, such as Navarra, it has been suggested that the environment is reaching its carrying capacity, unable therefore to accommodate more vultures (Fernández *et al.* 1998). As a result there has been an apparent decrease in productivity at some sites, despite the regional population increase. Recent data, from Montejo Raptor Refuge and Castellón province (ADENA /WWF and Juan Jiménez unpubl. obs.), reveal a decrease in breeding success since 1980 and 1994 (Figure 3.a and 3.b) ($r=-0.71$ and $p<0.01$ for Montejo, $r=-0.82$ and $p<0.01$ for Castellón). However, no such effect has yet been noticed in other high density areas, such as Cádiz (Del Junco & Barcell 1997) or La Rioja (Camiña 2001b, 2002).

Figure 3a and 3b. Change of breeding success of two Griffon Vulture populations from 1980 to 2002 (a: Castellón) and 1994-2002 (b: Montejo Raptor Refuge).

a.



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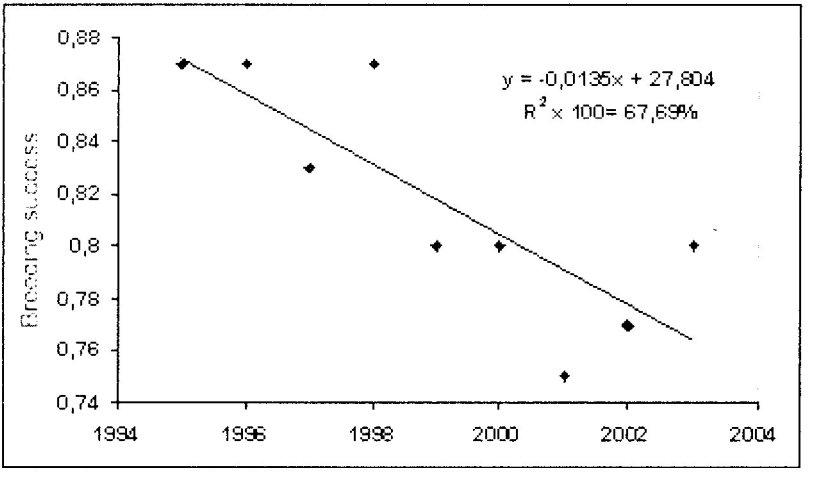


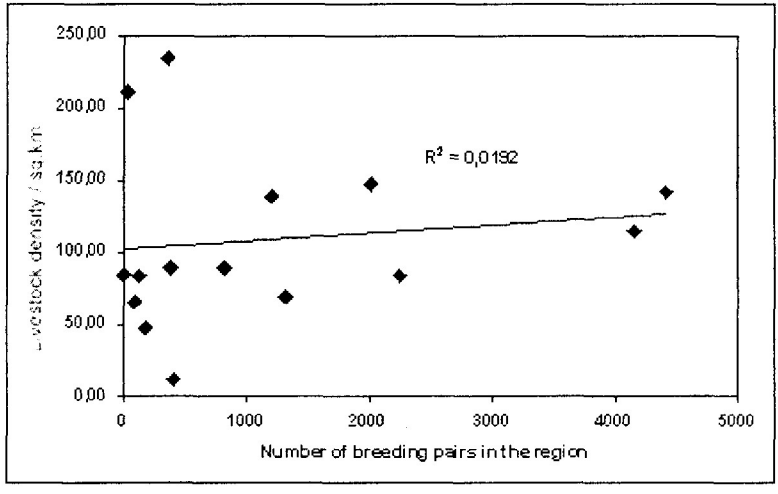
The III[rd] National Survey of Griffon Vultures in Spain (Del Moral & Martí 2001) was supported with updated results on the number of breeding colonies/pairs located in the Important Bird Areas (IBAs) network. At present 80.5-83.9% of the breeding pairs are located in IBAs, or in regionally or nationally protected areas.

Food and feeding

The numbers of livestock in Spain have increased over the past few decades. Despite this, no relationship between livestock density and breeding pairs of griffons per province has been detected for 1979 (De Juana & De Juana 1984) and 1999, respectively (r=-0.070, p=0.65, n=44 provinces; r=-0.0045, p=0.97 and n=47 provinces). Relationship among these variables for

1999 has been drawn in Figure 4. The reason for this is not known, but it could be related to different livestock rearing practices (intensive versus extensive grazing) which cause differences in food availability (i.e. livestock mortality) and/or breeding constraints (i.e. presence of suitable cliffs) that force vultures to breed at specific sites. De Juana & De Juana (1984) considered all livestock types together in one "prey category" which they defined as "livestock units". Because they did not consider the role of pigs as a potential food source, we preferred livestock densities in both years for comparisons.

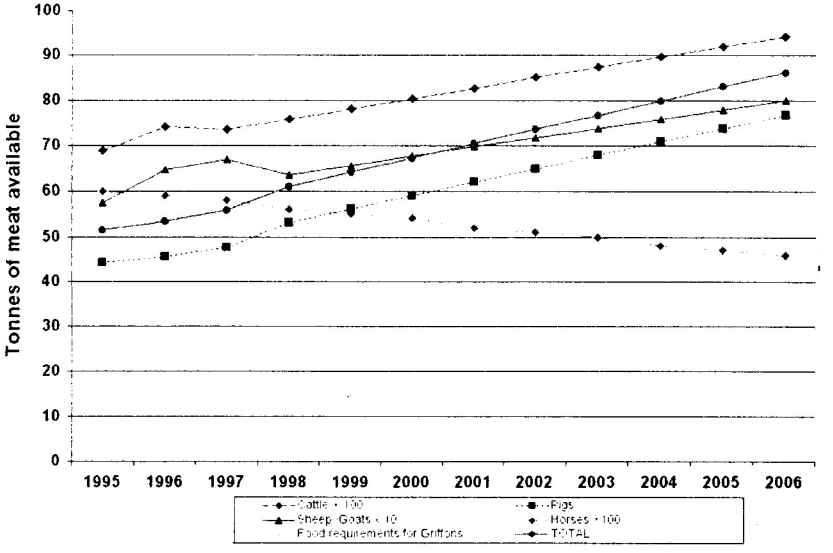
Figure 4. Relationship between total livestock density and the number breeding pairs of Griffon Vultures in each Autonomous Region (n =15) in 1999.



In 2000 the Spanish Government established a new programme for the removal of carcasses of animals in an attempt to prevent possible outbreaks of disease, such as BSE (Boletín Oficial del Estado 2000). Previously, the only regulation enforced in Spain was the burial of carcasses with a lime cover. This was usually not done by farmers. Instead, as a cheaper and easier method, livestock carcasses were dropped close to Griffon Vulture foraging areas at traditional places called *muladares*. As a consequence of European Union regulations on waste disposal, the Ministry for the Environment made some calculations on the availability of carcasses (estimated in tons of meat) for Spain. Figure 4 shows the trend and forecast for 1995 up to 2006. Arroyo *et al.* (1990), using data from Mundy (1985), estimated that the entire Spanish Griffon Vulture population would require 5,300 tons of meat per year. Ten years later, using population estimates from the IIIrd National Census, Camiña (2001a,b) estimated that Spanish vultures needed 15,000 tonnes of meat/year. The national government's calculation was significantly higher, around 64,000 tons of dead livestock per annum. If we consider that Griffon Vultures require *ca.*. 600 g/day (based on data from Komen 1992 for the Cape Griffon *Gyps coprotheres*), the vultures in Spain would only consume about 23% of the weight of all food available (Figure 5). These calculations do not consider the weight of the skin and bones, which are not consumed, and those carcasses that

are not located by vultures. What these simple calculations suggest, however, is that food supply is not a serious constraint for vultures in Spain. Del Junco & Barcell (1997) estimated that in Cádiz province the vultures required only 14-29% of the available carcasses. This was similarly the case in Alava province, where the vultures required only 50% of the livestock carcasses which became available (Arambarri *et al.* 1996). In previous studies, some authors (De Juana 1981, De Juana & De Juana 1984) took into account only livestock farmed on an extensive basis, i.e. not pigs, which provide a significant proportion of the vultures' diet (Fernández 1988; Sampietro & Pelayo 1995; Camiña 1996, this volume). In certain areas, large amounts of food other than pigs and extensively-farmed livestock are also placed at *muladares*.

Figure 5. Amount of meat (in tons) available in Spain, on an annual basis, between 1995 and 2000 and forecasts until 2006 (Source: Ministry for the Environment, Management Plan Project for Animal Corpse Disposal 2000). The triangle represents the estimated food requirements for the entire Spanish Griffon Vulture population in 1999.



The first studies at *muladares* were in Navarra (Fernández 1988), with the main aim of monitoring their relevance for vultures and other carrion-eating birds. Later, research on this subject has been conducted by Arambarri *et al.* (1996), Camiña (1996, 1997, 1998, 2002) and Fernández y Fernández-Arroyo (2002). In these studies food availability and the consumption of carcasses by vultures was determined at two different levels: extensive livestock grazing areas where vultures rely on finding carcasses in a natural way, as they do in large parts of Africa (Houston 1974) and in areas where less 'natural' food is available and where vultures are more dependent on *muladares*.

The only study carried out to date in an extensive grazing system was in La Rioja (northern Spain), a 500km^2 mountainous area, ranging in altitude from 900 to 2228m a.s.l. (Camiña 1996, in prep.). Here livestock graze freely and

there are no rubbish dumps, feeding stations or *muladares*. The vultures in this area mainly consumed the carcasses of sheep and cattle (Table 1). There, according to livestock rearing practices, two seasons ("summer" and "winter") were considered and the factors affecting the consumption of carcasses were described (Camiña 1998). It was determined that in these areas vultures were highly dependent on crows to find the carcasses.

Table 1. Diet of the Griffon Vulture in an extensive grazing area in La Rioja (northern Spain) after Camiña (1996, in prep.). Results are expressed in percentages as number of carcasses consumed as well as the weights these carcass types contribute to the diet Camiña (1998). "Summer" (n= 103 carcasses) and "winter"(n=54) refers to the different livestock rearing practices in these areas. Weights for each type of carcasses are after Camiña (1998).

	Carcasses		Biomass	
	Summer	Winter	Winter	Summer
Sheep	79.70%	67.30%	18.60%	28.63%
Cattle	16.60%	20.19%	55.77%	59.95%
Horses	04.90%	10.57%	25.03%	11.42%
Pigs	00.00%	00.00%	0.00%	00.00%
Wild Ungulates	00.00%	01.00%	0.60%	00.00%

Vultures relying on *muladares* forage elsewhere only when no food is provided at these feeding places (Donázar 1992; Camiña 1996); they are also less dependent on other species to locate their food and generally roost in the vicinity of the feeding places (Camiña 1996; Garrido & Sarasa 1998). As an example, at the Montejo Raptor Refuge there is a feeding station managed by ADENA/WWF. Carcasses are provided mainly by shepherds living in the villages surrounding the Refuge (Figure 6). The results from La Rioja, an area with intensive farming practices (Ebro River Valley), show similar percentages as Montejo (Camiña, in prep.). There, *muladares* were operational until 2000. The *muladares* in La Rioja and Navarra (Fernández 1988) demonstrate the contribution that pig farms can make to these feeding places (Figure 7).

Only one study attempted to relate the number of birds present at the *muladares* throughout the year with food availability. This research showed that the number of vultures at a feeding station was higher in September, just after the juveniles have left their nests (Figure 1), with lower numbers in March (Arambarri *et al.* 1996). 65-75% of the vultures at the *muladares* were adults.

Migration and foraging movements

The Griffon Vulture is a partial migrant, with first year birds in particular exhibiting long-distance movements (Bernis 1983; Griesinger 1996, 1998). Birds become more sedentary on reaching sexual maturity and some philopatry has been suggested (G. Doval, pers. comm.). As a preliminary analysis, we plotted the recovery of 43 vultures, all ringed as nestlings (Oficina de Anillamiento, Dirección General de Conservación de la Naturaleza) (Figure 8). Figure 8 plots the distance in kilometres between the natal site and the reported

recovery sites (both variables were log transformed prior to regression analysis, Camiña *et al.*, in prep.). Only birds ringed at the nest and older than one calendar year when recovered were used. Relationship between distance from nest and days until recovery (age) is inverse related and highly significant, i.e. older birds are recovered closer to the breeding sites than younger birds (kilometres from breeding site = 3.48-2.40 days since ringing; ANOVA on regression $F_{1,41}=27.15$, $p<0.001$, $r=-0.63$).

Figure 6. Percentage of carcasses by species delivered to the Montejo Raptor Refuge feeding station (Fernández y Fernández-Arroyo 2002). N = 6318 carcasses. "Others" category included 20 dogs and three cats. "Birds" comprised mainly of chickens, with only two turkeys and one duck being provided.

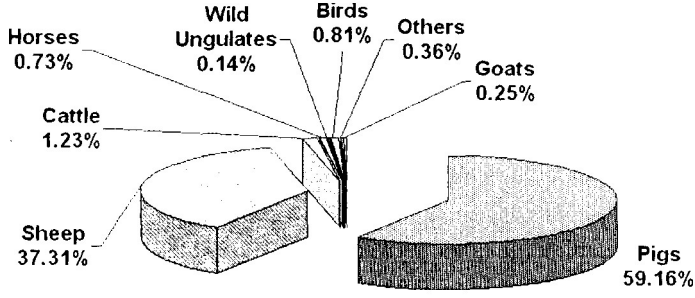


Figure 7. Percentage of each type of carcass found at *muladares* in an intensive farming area in La Rioja from 1996-1999 (after Camiña 1996).

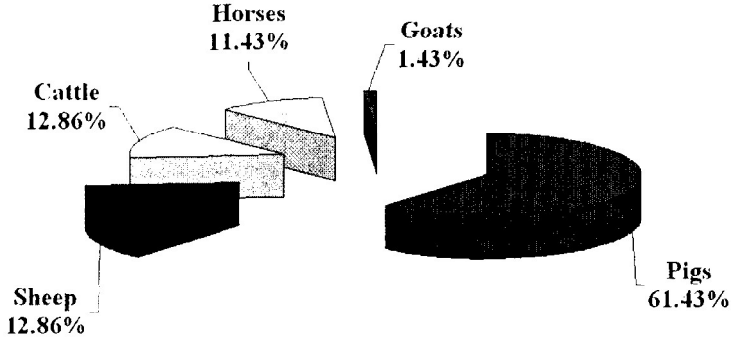
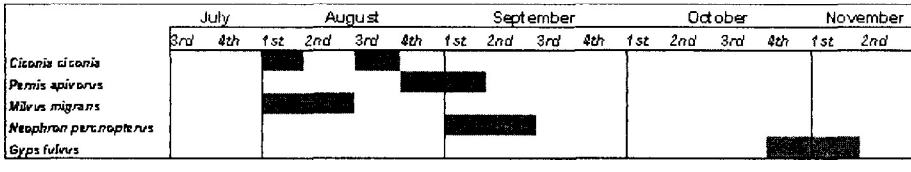
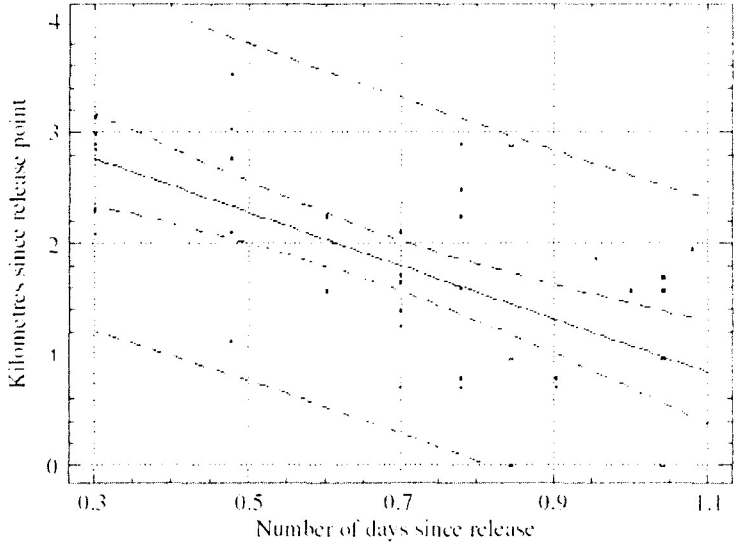


Figure 8. Autumn migration of three of the commonest species of soaring birds and two vultures at the Strait of Gibraltar, shown by week. The shaded area indicates the full migration period, black the peak of the migration passage (SEO/BirdLife 2000).



Migration of large soaring birds through the Straits of Gibraltar has long been investigated (e.g. Bernis 1983; Griesinger 1996, 1998). Franchimont & Moumni (1996), Bernis (1983) and Griesinger (1996) conducted the first surveys, but only observed the migrating birds for short periods. By the end of the 1990s the Spanish Ornithological Society (SEO/BirdLife) and the local Government in Andalucía (Junta de Andalucía) started a new project *Programa Migres*, with the aim of counting birds during the autumn migration at Gibraltar. During 1997 counts were made during a short period (mid-July to mid-October) (SEO/BirdLife 1998). Subsequently raptor counts have been conducted every day from July to November. Figure 9 shows the migration phenology for four of the most common raptor species (SEO/BirdLife 2000). Peaks of passage change slightly between years. Griffon Vultures migrate much later in the year compared to other raptor species (SEO/BirdLife, 1998). Later counts for Griffon Vultures were developed from 2000 onwards (19 October - 20 November). It is possible that more griffons migrate over the Straits after 20 November (G. Doval pers. comm.), but unfortunately funding is not available to extend the survey period.

Figure 9. Relationship between the age of vultures and the distance of recovery (in kms) (both variables log transformed) from the ringing place (metal rings and birds ringed at nests), 95 and 99% confidence intervals for mean are also showed (see text for explanations).



Vultures only cross the Straits when weather conditions are favourable, occasionally remaining in the area for long periods, even wintering there without attempting the crossing (Garrido & Sarasa, 1998). In addition, the area supports sufficient food. Favourable days have medium force W-NW winds (Bernis 1983; Griesinger 1996). The fact that Cádiz province has one of the largest Griffon Vulture populations in Spain (Del Moral & Martí 2001) makes it difficult for inexperienced observers to ascertain whether a group of vultures is migrant or resident.

The total numbers of griffons crossing during the 1997-2000 period have been 4,597, 1,633, 2,649 and 4,816, respectively. With a current total population of Griffon Vultures in Spain numbering *ca.* 22,455 pairs (Del Moral & Martí 2001) and productivity of 65% being reported for the last two censuses (Arroyo *et al.* 1990; Del Moral & Martí 2001) an estimated 14,596 juveniles are produced each year. This means that only between 11% and 33% of the fledglings migrate to Africa each year. Even if one considers that juvenile mortality is high, it is possible that up to 10,000 juvenile griffons would remain wandering around Spain. Besides this, from the mid-late 1990s onwards, increasing numbers of ringed juvenile Griffon Vultures from Spain have been recorded in southern France (M. Terrasse pers. comm.). The migration pattern clearly reveals that during the time when the birds are departing for Africa, a new breeding season is already commencing in the Iberian Peninsula.

It is not clear where in Africa the Griffon Vultures 'over-winter', despite a few recoveries from Gambia and Senegal (Alonso 1984) and Chad (Susic 2000). Recent data from the former two countries provided two and three ring recoveries, respectively (Oficina de Anillamiento DGCN, unpublished reports), Other people (T. Watcher and C. Barlow pers. comm.) have reported up to 26 unringed birds in The Gambia.

Not all the griffons cross into Africa. Garrido & Sarasa (1998) and Garrido *et al.* (2001) have reported that increasing numbers remain on the Spanish side of the Straits of Gibraltar area. There they remain roosting and feeding at highly predictable food sources, taking food even from plastic bags containing domestic waste (Garrido & Sarasa 1998). This wintering area could extend over large areas of the entire Andalucía, Extremadura and southern Castilla-La Mancha regions (Camiña *et al.* 2002, pers. obs.). More than 90% of the vultures at certain localities are immatures and juveniles (Garrido & Sarasa 1998; A. Godino, pers. comm., pers. obs.). It is possible that the vultures remain there because of the mild conditions and high food availability, i..e. compared with northern Spain.

Ringing programmes are currently undertaken using metal rings from the Spanish Ringing Office. For the 1973-2000 period, a total of 3,559 griffons were ringed (Hernández-Carrasquilla & Gómez-Manzaneque 2001). Only 192 have been recovered (5.4%), 40 of these being from birds no farther away than 10km from the ringing site. These rates are similar to those reported by Piper (2000) for the similar Cape Griffon *Gyps coprotheres*. Other marking programmes have involved the use of Darvic plastic rings (yellow rings using black alphanumeric codes). These programmes are cò-ordinated by the Doñana Biological Station. Up to September 2000, a total of 955 griffons were ringed with these rings and 813 have never been re-sighted, with 142 (14.9%) being recorded on more than one occasion. Total sightings numbered 237 but included birds recorded more than once (Charo Cañas pers. comm.).

Radio-tracking has not been widely employed on Griffon Vultures as these birds range widely. However, it can be a useful tool to determine the movement patterns of breeding birds, such as the study at the Hoces del Duratón colony (Arroyo & Garza) and, to some extent, for recording the movements of juvenile birds (Griesinger 1996, 1998). The total ranges of Griffon Vultures

during the period January to August varied from 934 to 8,695 km^2 (Arroyo & Garza, 1996). Unfortunately, no further fieldwork has been conducted in Spain to compare the distribution of food resources and the foraging ranges of different colonies of Griffon Vultures.

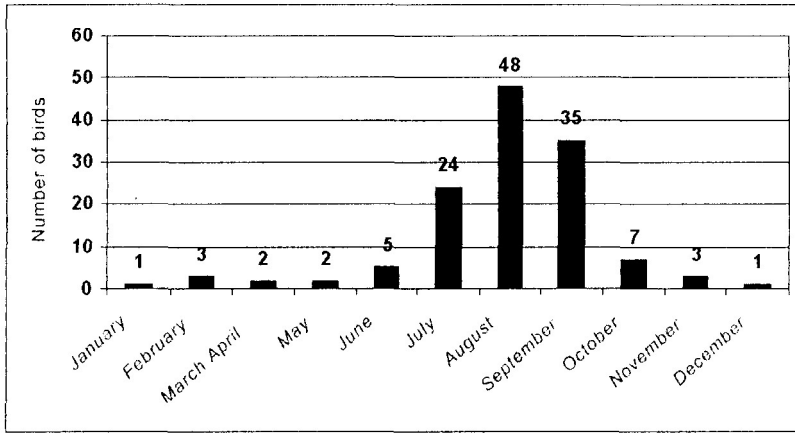
Knowledge about migration and the movements of Griffon Vultures has been improved by ringing and radio-tracking programmes. Unfortunately, to date, only one griffon has been fitted with a PTT satellite transmitter (Berthold *et al.* 1991). However, the transmitter failed after only two months. Further such studies have not been conducted for financial reasons. The species has a favourable population status in Spain. There are others with more serious conservation problems, even within the vulture group (Black, Egyptian or Bearded Vultures). However, until the movements of Griffon Vultures are tracked using suitable methods, many aspects of the bird's biology will remain unknown.

DIRECT PERSECUTION AND CONFLICTS WITH MAN

Rehabilitation Centres

There is at least one wildlife rehabilitation centre in most Spanish provinces. In addition to many species of birds, mammals and other wildlife, many Griffon Vultures are treated at these centres. The number treated in La Rioja from 1985-2000 is presented in Figure 10. Most were recently fledged vultures suffering from malnutrition. They probably fledge in good condition, but have a struggle to find food (P.J. Mundy, pers. comm.). Their deteriorated body condition allows bacteria, lice or a host of parasites and diseases to flourish. Nevertheless, some veterinarians suggest that the weakness and malnutrition could be a secondary symptom for birds already suffering from some kind of disease (J.M. Blanco pers. comm.). Anyway, rehabilitation centres can play a crucial role in investigations of other aspects of Griffon Vulture biology, such as ptilochronology analyses (Camiña & Yosef 2001, 2003).

Figure 10. Number of Griffon Vultures taken to the La Fombera Rehabilitation Centre in La Rioja (1985-2000) (n=131 (Source: Gobierno de La Rioja).



The peak supply of malnourished birds to rehabilitation centres is at fledging time (see Figure 1). However, in southern Spanish latitudes more vultures are treated from September to October (Castellón) and October to November (Málaga) (Garrido *et al.* 2001; Camiña *et al.* in prep.). This could be indicative of the southern autumn migration. The peak is in November at the Straits of Gibraltar and Málaga and is clearly related to the vultures crossing into Africa at these localities (SEO/BirdLife 1997, 1998, 2000).

Figures 11 and 12 show the causes of admissions of Griffon Vultures to rehabilitation centres and the treatment results. Although most birds are released (72.8%), no data are available on their subsequent survival.. In fact, Atencia & Moreno (in Del Junco & Barcell 1997), based on ringing and re-sightings, suggest that only about 9% of birds readapt completely to the wild.

Figure 11. Reasons for Griffon Vultures being admitted to La Fombera Rehabilitation Centre (1985-2000) (n=120 (Source: Gobierno de La Rioja).

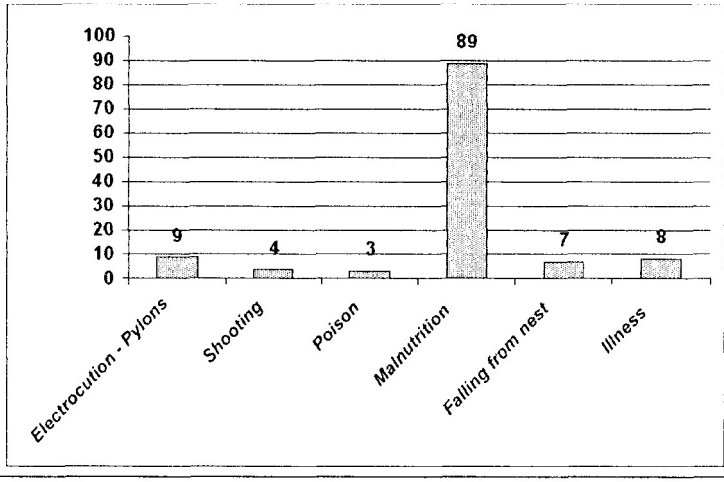
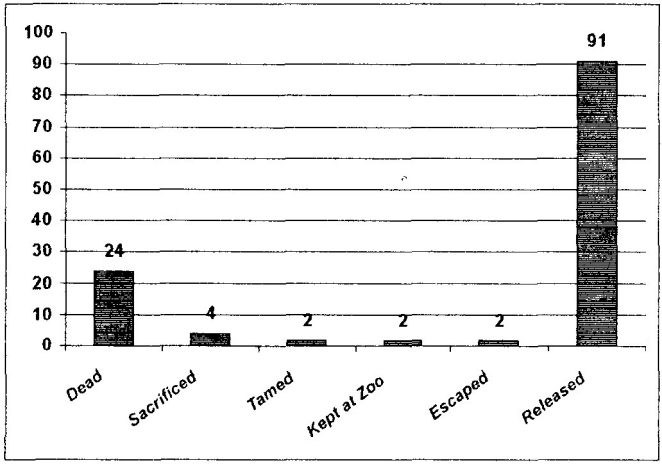


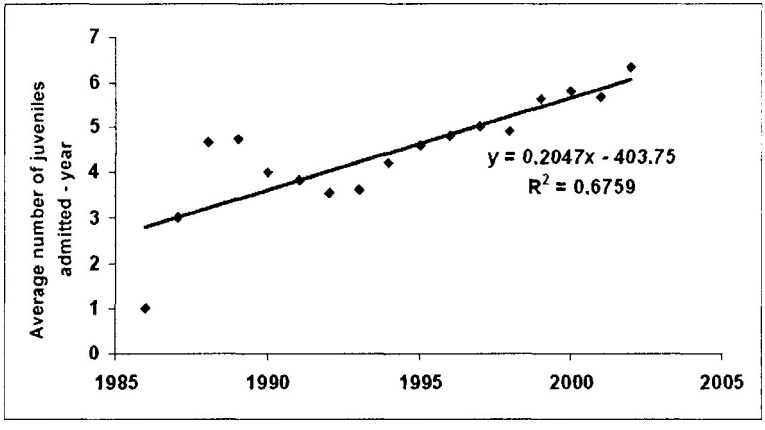
Figure 12. Results of the treatment provided to Griffon Vultures at La Fombera Rehabilitation Centre (1985-2000) (n=125) (Source: Gobierno de La Rioja).



At Jerez Zoo (Cádiz province), between 1989 and 1996, it was found that 72% of treated Griffon Vultures (n=53) suffered from malnutrition (86% being juveniles) (Del Junco & Barcell 1997). At this zoo, 88% of the birds were released (93% of the juveniles).

In La Rioja there has been a continual increase of admitted, malnourished fledglings to the rehabilitation centre since 1986 ($r=0.79$; $p<0.001$) (Figure 13). There is a positive, but not significant ($r=0.67$; $p=0.52$), relationship between the number of Griffon Vulture breeding pairs and the number of admitted fledglings. Unfortunately no data are available from other areas of Spain.

Figure 13. Trend of the average number of Griffon Vultures admitted to the La Fombera Rehabilitation Centre from 1985 to 2002 (Source: Gobierno de La Rioja).



Windfarms

A recent threat is the collision of birds with the blades of turbines at windfarms (*parques eólicos*). All the studies measuring the impact of wind turbines on raptors have been conducted by the same companies which promote the windfarm development. Thus their results are probably biased. Furthermore all remain unpublished (Consultora de Recursos Naturales 2001; Lekuona 2001, pers. obs.), with the data therefore being largely unavailable. One of the first places in Spain where vultures and other raptors were affected was at the Straits of Gibraltar (SEO/BirdLife 1995; Del Junco & Barcell 1997). There, all ages of vultures were equally affected (SEO/BirdLife 1995), namely 33 birds (seven juveniles, 16 immatures or subadults, and ten adults). In La Rioja, where the local government funded an investigation, no fatalities were found after the first two years, although the passage rate of vultures between the turbines was 0.09-2.10 vultures/hour (Camiña 2002b). No livestock graze in the area and this may be the reason for the low mortalities. The place is used for crossing and not as a feeding area. Four vultures (two adults) were, however, killed during 2003 (January-July) in a remote part of the windfarm, away from the main movement area. Similar observations have been reported for Navarra (Lekuona 2001) where different windfarms have reported different estimates of vulture mortality. The number of vulture corpses found within a

year varied from one to 53 birds at six different locations (Lekuona 2001). Here ages were skewed to adults (83 birds comprised 15 juveniles, four immatures or subadults, and 64 adults; $\chi^2_p = 73.93$; d.f. =2, $p<0.001$). In all cases Griffon Vultures were the most affected group of bird species.

Birds are affected not only by the blades. Power line collisions and electrocutions also occur at these sites. It should be considered that power lines are not a major threat for vultures (see Figure 11 where only 7.5% of admissions were caused by this threat). In this way, during the period September 2002 to July 2003, 24 birds were found at an important feeding and wintering/migration point in (Ciudad Real province, central Spain, pers. obs.). They had either collided with, or were electrocuted on, the power line crossing this area. Another 67 birds had previously been found at this site and the reduction in the number of mortalities may be due to correction measures being taken to reduce collisions and electrocutions. Thirty birds were found below a 300m long power line in Soria province during a two-year period (pers. obs.). If studies on the Griffon Vultures feeding and breeding/roosting sites were not undertaken in these areas, many of the injuries/mortalities would go undetected. Further details on the effect of power lines in vultures were supported by Alonso & Alonso (1999, and references therein) for different areas of Spain with varying abundances of griffons.

Poisoning

Use of *Veneno* (poison) was a great threat in the past, mainly when shepherds used strychnine to kill wolves (Hernández 2000). The same author found that 566 Griffon Vultures were poisoned between 1990 and 2000. However, in one single year (2000) 130 birds were poisoned. It is therefore possible that the problem may be increasing again in recent years Hernández 2003). The same study (Hernández 2000) found that the main poisons currently being used are aldicarb and carbofuran. Both cause a delayed death so that details concerning the origin/place of poisoning remain unclear and it is therefore difficult to find the person(s) responsible.

Attacks on livestock

In the early 1990s vultures were considered to be potential predators of livestock. However, this view was mostly based on sensational articles in the press and not scientific data. The only complete observation was of a Griffon Vulture attacking and killing a sheep too weak to protect itself (Camiña *et al.* 1995). Subsequently, attacks have been reported in Valencia and Huelva and possibly other provinces (J. Jiménez and I. Fajardo, pers. comm.),but the specific details of some incidents remain unclear. Three provinces have approved specific regulations concerning damage to livestock by vultures (Navarra, La Rioja and Alava). These regulations pay for the cost of the damaged animal. In order to be sure that the vultures were responsible for the mortalities, an agreement was signed between the Local Governments of both Navarra and La Rioja and the Veterinary University of Zaragoza. In the case of a suspected attack, veterinarians would conduct post-mortems. If the animal had been killed, haemorrhagic bleeding wounds would be visible. If the animal was already dead when the vultures started feeding on it, then bleeding would

not be visible. If the results of the analysis are negative, the shepherds must pay for the veterinary costs, but if positive the Local Governments will pay for these costs and compensate the farmer for the dead animal(s). The shepherds are generally happy with this arrangement and do not have a negative attitude towards vultures. Table 2 presents the "attacks" reported for La Rioja province for the last four years (2003 data only available for January-March).

Table 2. Number of attacks by vultures on livestock reported to the authorities, species of livestock affected, and costs paid by the Local Government of La Rioja.

Year	*Number of attacks*	*Species*	*Compensation (€)*
2000	3	Cattle	1, 045.76
2001	2	Cattle, Horse	480.81
2002	4	Cattle, Horse	2, 043.45
2003	2	Cattle	0.00

Eleven attacks were reported with a total cost of 3,570.02 € to the authorities. Only six of the 11 attacks were in fact considered to be caused by vultures, all of which concerned cows or mares giving birth. Data are not available for other provinces, so annual, regional and prey-type comparisons are not possible. In general, besides the few cases in Navarra, the problem remains unnoticed by the general public in Spain. In La Rioja the attacks only represent between 0.0034-0.0069% of the regional cattle and horse population (Gobierno de La Rioja 2001)

DISCUSSION

It is clear that the Spanish Griffon Vulture population has experienced a great increase over the last three decades. After some threats were drastically reduced (poison, shooting, egg-collecting, disturbance at breeding sites), the griffons started to increase in numbers, based on an abundant food supply, sufficient for the requirements of the increasing population (Donázar & Fernández 1990; Houston 1996). This fact is reinforced because vultures have no predators affecting them other than man. It seems evident that the vulture distribution in Spain is related to cliff (nest site) availability. Lack of relationship with livestock density should not be an ultimate factor. Different livestock rearing practices in different regions (extensive grazing, intensive farming) and the disposal of carcasses by shepherds can explain the different distribution patterns. The illegal practice of leaving livestock carcasses in the field instead of burning or burying them is the main factor leading to the vulture population increase. This practice and the use of *muladares* have fortunately been overlooked by authorities for a long time. The problem at the beginning of the 21st century is how to maintain such high vulture populations, especially in the light of the new Agricultural European framework and restrictive regulations after the foot and mouth and mad-cow disease outbreaks. Extensive information on the management of vulture feeding stations is available in another paper in these proceedings (Camiña 2004).

The second factor regulating raptor populations is the availability of nesting places (Newton 1979). It seems that a density-dependent mechanism is acting in some breeding areas, such as Navarra, Castellón and Montejo Raptor Refuge in Segovia (Fernández *et al.* 1998, ADENA/WWF pers. comm., Juan Jiménez pers. comm.).

After the recovery of the Griffon Vulture populations, most Autonomous Regions in Spain conduct no research or conservation efforts, apart from local censuses and the annual assessment of breeding success. At the national scale a ten-year-interval between major censuses is considered adequate. If the density dependent mechanism mentioned above is correct, a lower increase would be expected during the fourth national survey in 2009. Together with the population increase, breeding pairs comprising vultures that are not yet adults have been detected (Blanco & Martínez 1996; Blanco *et al.* 1997). This has been explained by the high food availability that would lead birds to commence breeding at an earlier age. However, the lower breeding success of such pairs could be influenced by their ages (Fernández *et al.* 1998), probably because the younger birds are those that occupy marginal sites at the colonies and would generally be inexperienced at breeding. As one would expect, an increase in the average number of vultures visiting and feeding on carcasses has also been detected (Camiña 2002). The increase of vultures admitted at rehabilitation centres and the slight decreases on breeding success in some colonies could support the notion that birds are suffering from increasing intraspecific competition that would decrease the amount of food available to individuals.

One aspect that remains unclear is the meaning of "colony". For some authors (Arroyo *et al.* 1990) this is the breeding place where at least two or more pairs normally breed. In this way (Arroyo *et al.* 1990; Del Junco & Barcell 1997; Del Moral & Martí 2001) assumed that different colonies are separated by a distance of more than 1,000m. Small cliffs at shorter distances could act as true colonies (clumps of nests) because foraging activities between cliffs could be related to local integration. The distance of 1,000m is arbitrary and could cause confusion when different people at different times are censusing nests in high density areas. Del Junco & Barcell (1997) suggested that roosting sites would also act as colonies, and this is true. To date, not much work has been devoted to determining the floating, non-breeding populations, although Garrido & Sarasa (1998), Garrido *et al.* (2001) and Camiña *et al.* (2002) have reported large concentrations of non-breeding birds in mountainous areas or places where food resources are predictable. Up to 600-1,500 birds gather to feed at such localities during the winter months (Camiña *et al.* 2002; J. Mottos pers. comm.; A. Godino pers. comm.) To date, winter counts have been conducted at Montejo Raptor Refuge (F. J. Fernández y Fernández-Arroyo, pers. comm.) and Madrid province (SEO-Montícola 2003). However, only those for Madrid should be considered as true wintering counts (December-January) because censuses in Montejo and the surrounding areas are carried out in the first week of November, when vultures are still crossing into Africa.

Griesinger (1998) estimated that 90% of juveniles left their breeding colonies around mid-October. The final destination of such birds remains unknown, suggesting that some migrate into Africa while others are vagrants in

Spain. Some winter counts (Camiña *et al.* in prep.) found that only 2.2-6% of vultures at the northern Spain breeding sites were juveniles. In contrast, a large proportion (up to 80-90%) of the birds ringed in the northern latitudes were recorded in central-southern Spain during winter, in areas with predictable food sources (Garrido *et al.* 2001; Camiña *et al.* in prep.). The warmer climate offers better foraging conditions and more food is available (Hiraldo & Donázar 1990). Within this framework, winter counts are considered to be a priority in order to obtain more information about the movements of first year vultures. The first censuses are planned for December 2003 and January 2004.

Nothing is known about the post-fledging dependence period (PFDP) of Eurasian Griffons, other than re-sightings of colour-ringed birds. If juveniles leave the nests in July (Figure 1) and the colony/breeding areas around October (Griesinger 1998), the PFDP could be shorter than other large vulture species (Mundy 1992; P. J. Mundy pers. comm.). This could in turn affect these birds' survival as they must then rely on their own abilities when searching for carcasses. The probability of finding food would however be enhanced by the group-living behaviour of the species. The effect of such a short PFDP on the survival of first year vultures is currently unknown. Some juveniles have been recorded at their breeding cliffs begging for food and fed by their parents in early November, at the beginning of the new breeding season (Fernández y Fernández-Arroyo pers. comm.). The migration of first year birds away from the natal area would reduce the PFDP. There are many unanswered questions, such as why so few birds migrate to Africa and whether the counts at the Straits of Gibraltar are accurate. An increased availability of food and recent climatic changes could have inclined birds to remain in Spain rather than migrate into unknown territories. However, the factors underlying the partial migration of the Griffon Vulture could be more complex than suggested here (Berthold 1999).

Much work remains to be done in order to manage the food for griffons and other vulture species (Camiña 2003). Many of the recommendations of the Working Group on carrion eating birds, a group of scientific organizations and NGOs in Spain (Camiña 2001), suggested that funds are required to plan the sighting of feeding places, study the population dynamics of vultures, and the location of colonies. Griffon Vultures seem to rely less on *muladares* and vulture restaurants during March (Arambarri *et al.* 1996, unpubl. data; J.A. Donázar pers. comm.), perhaps trying to find a better quality of food when rearing chicks. *Muladares* or feeding stations cannot be dustbins where shepherds conveniently dispose of all livestock carcasses. From the authorities' side, vulture restaurants must be designed taking into account the vultures' ecology, rather than political criteria.

Windfarms development is being carried out without comprehensive environmental impact assessment studies. The effect of several windfarms within the same area has never been considered (Del Junco & Barcell 1997, pers. obs.). Furthermore, the foraging movements of birds are not taken into account when sites are selected. Only recently, real estimates of such use have been requested by environmental authorities prior to an authorisation (see Langston & Pullan 2002 for a review of this problem at European level). A rigorous post-construction monitoring of mortalities should take place.

Regarding the Eurasian Griffon, the effect of windfarms has differed in different regions. It is clear that vultures are the most affected species of raptor, if not of all bird species, surely as a consequence of their behaviour. Nevertheless, carcasses of other protected raptors, such as Golden Eagles *Aquila chrysaetos*, Booted Eagles *Hieratus pennatus* and Honey Buzzards *Pernis apivorus* are found below the turbines by forest guards and personnel working at the windfarms. However, no further action is taken by environmental authorities, even when one considers that the killed birds are protected under the European Birds Directive. The funds invested by the companies in reducing bird collisions are ludicrously low in comparison to the investment during development of the windfarms.

Possible attacks by Griffon Vultures on livestock may result in retaliation by shepherds and this therefore poses a new threat. All observed "attacks" have, however, been on animals too weak to protect themselves. It has been suggested that greater numbers of vultures and new livestock rearing practices could be the reasons for this behaviour. Shepherds try to get maximum benefit from cattle; thus they are using larger breeds, which sometimes results in problems during birth. The quality of a shepherd's life is also better than in the past, resulting in less time devoted to care of their cattle. This in turn may result in confusion when watching vultures close to live cattle.

Conservation of the Eurasian Griffon Vulture in Spain will continue with the help of many small NGOs and enthusiastic people working at the local level. The effort of organizations like SEO/BirdLife conducting national censuses is commendable. Many species are protected by means of Zones for Special Protection of Birds (Grimmet & Jones 1989; Heath *et al.* 2000). However, the conservation of breeding sites will not ensure the conservation of species with large home ranges. Habitat loss is one of the most important threats to the Griffon Vulture (Stattersfield & Capper 2000). More funds must be allocated to the study and conservation of species which have movement patterns that exceed national and even international boundaries. This must involve the use of the latest techniques, such as marking with satellite-transmitters. International co-operation must occur for the same project. Only with a thorough knowledge of the Griffon Vulture's ecology can effective management practices be applied.

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