

# Consequences of Bovine Spongiform Encephalopathy (BSE) on breeding success and food availability in Spanish Vulture populations

Alvaro Camiña

## ABSTRACT

The establishment of vulture restaurants has been considered a useful conservation tool for preserving vulture populations. Since Bovine Spongiform Encephalopathy or “mad-cow” disease (BSE) appeared in Spain (to date 277 cattle affected and increasing), leaving carcasses in the fields for vultures was strictly banned. During 2001-2002, the Spanish Government removed around 305,000 carcasses per year from the fields/farms (0.58% of the National Livestock census). Results of the *Surveillance Plan against BSE* have been unequal regionally. Only La Rioja Province has managed a good carcass removal programme that destroyed 48,025 and 31,277 carcasses in 2001 and 2002 respectively. However, even since BSE appeared vulture species in Spain have had enough food available. The effect of the carcass removal programme on the breeding success of vulture populations inhabiting large areas of Spain has been analysed. The study area accounted for 84% of Griffon, 50% of Cinereous, 51% of Egyptian and 100% of Bearded Vulture populations. The Bearded Vulture is the only species having a well-established - protected and managed - feeding programme. For the other species, although there are protected breeding areas, there is insufficient protection of feeding places. The National Royal Decree, approved in November 2002, and subsequent European regulations do not take into account extensive grazing management nor the use of ruminants for feeding vultures. Agreement between biologists and veterinarians is urgently needed in order to balance livestock rearing techniques and carcass availability for vultures.

## INTRODUCTION

The four vulture species inhabiting Spain have experienced different population trends in the last three decades: The Eurasian Griffon *Gyps fulvus* has largely recovered (SEO 1981; Arroyo *et al.* 1991; Del Moral & Martí 2001) while Cinereous *Aegypius monachus* and Bearded *Gypaetus barbatus* Vultures have slightly increased (Sánchez 2003; R. Heredia 2001 & pers. comm.); finally, the Egyptian Vulture *Neophron percnopterus* has suffered a 25% decline since the last First National Census in 1990 (Perea *et al.* 1991; Del Moral & Martí 2002). These trends are clearly due to protection of breeding areas and in some instances (e.g. the Eurasian Griffon) a superabundance of food and/or lack of human persecution by shooting or poisoning (Donázar & Fernández 1990; Camiña 2000). However, there has been a growth of poisoning incidents in recent years, especially for the Egyptian and Cinereous Vultures in certain areas (Antor 2003; Hernández 2000, 2003; Sánchez 2003).

Supplementary feeding has long been widely employed as a conservation tool for managing carrion-eating birds (Iribarren 1977; Terrasse 1985; Fernández 1988; Butchart 1988; Mundy *et al.* 1992; Vlachos *et al.* 1999). However in the 1970s and 80s only a few true feeding stations for Griffons operated in Spain, mostly managed by Non-Governmental Organizations (NGOs) and probably no more than ten (Iribarren 1977). In extensive grazing areas, carcasses remained in the field and vultures regularly fed on them. For many years only a few feeding points were used in the Pyrenees, where mainly sheep hooves and spinal columns were dropped in order to increase the survival of immature Bearded Vultures (Heredia & Heredia 1999). Other vulture restaurants were employed in the recovery of the Cinereous Vulture population, as in Mallorca (Tewes *et al.* 1998). However, to date, all the remaining so-called “feeding stations” were places where village people left livestock carcasses for vultures, known in Spanish as “*muladares*” and operating illegally. According to very old Spanish regulations all carcasses must be destroyed (buried or burnt) in order to prevent any effect on human health. However, both shepherds and authorities overlooked the problem of corpse disposal and left carcasses for vultures at these sites. From now on a clear distinction will be used between feeding stations and vulture restaurants. In Spain, the latter term is employed for legal feeding sites in accordance with the new regulations.

Since Bovine Spongiform Encephalopathy (BSE), and other diseases such as foot and mouth, appeared in Europe both livestock rearing techniques and movements within European Union territory have been peer supervised by the authorities. In Spain the first cases of BSE appeared in November 2000 and, up to May 2003, 277 cattle had been affected (Ministerio de Agricultura Pesca y Alimentación 2003). Shortly after, measures against BSE included carcass removal from farms to be destroyed by means of incineration. Nevertheless, carrion-eating birds directly affected by these measures were not taken into account (Camiña 2001a). Since then, some local regulations were published for preserving vulture populations (Boletín Oficial de La Rioja 2001; Boletín Oficial de la Comunidad Foral de Navarra 2001; Diario Oficial de la Generalitat Valenciana 2001). Finally, on 1 November 2002 the Spanish

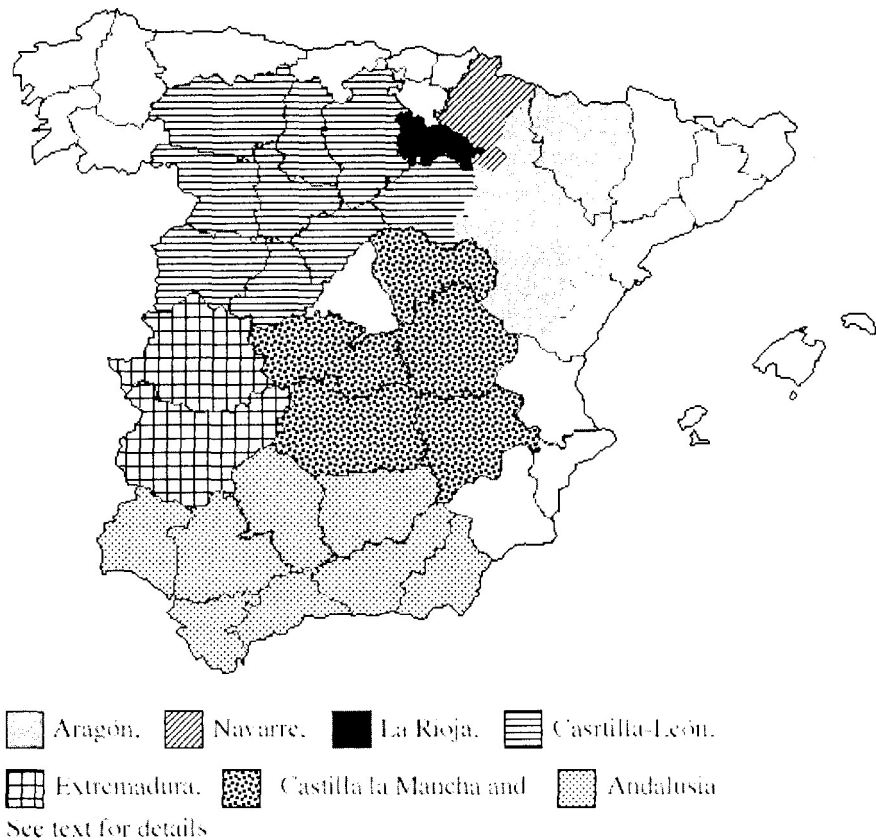
Government published a Royal Decree (Boletín Oficial del Estado 2002) that permits the disposal of carcasses for carrion-eating birds. Only recently the European Union approved a regulation concerning the use of carcasses for vultures in those countries where these species breed (Diario Oficial de la Unión Europea 2003). The aims of this paper are 1) to assess the efficiency of the carcass removal programme in terms of the extent of BSE in Spain. As soon as BSE appeared an immediate change in food availability was presumed. 2) to review the breeding success of the four vulture species breeding in Spain before 2000 and after the appearance of BSE (2001 breeding seasons). 3) to evaluate the application of the 1098/2002 Spanish National Royal Decree, the local regulations mentioned above and the EU 322/2003 Decision (Diario Oficial de la Unión Europea, 2003) together with the current situation of existing "*muladares*" and legal vulture restaurants in Spain.

## METHODS

The study was carried out in a vast area of Spain accounting for 72.4% of Eurasian Griffon, 96% of Cinereous, 80% of Egyptian and 100% of Bearded Vulture populations (Del Moral & Martí 2001, 2002; Sánchez, 2003; R. Heredia 2001 & pers. comm.). The area includes the Local Governments of Aragon (three provinces: Zaragoza, Huesca and Teruel accounting for 47,682 km<sup>2</sup>), Navarra (one province, 10,421 km<sup>2</sup>), La Rioja (one province 5,033 km<sup>2</sup>), Castilla la Mancha (five provinces: Guadalajara, Albacete, Ciudad Real, Cuenca and Toledo, 79,255 km<sup>2</sup>), Castilla-León (eight provinces: Burgos, Palencia, León, Zamora, Salamanca, Avila, Segovia and Valladolid, 94,010 km<sup>2</sup>), Extremadura (two provinces: Cáceres and Badajoz, 41,602 km<sup>2</sup>) and Andalusia (eight provinces: Huelva, Sevilla, Cádiz, Córdoba, Jaén, Málaga, Granada and Almería, 87,267 km<sup>2</sup>), in all accounting for 365,270 km<sup>2</sup>. See Figure 1.

The numbers of carcasses removed yearly from the fields or farms were taken from the Agriculture and Livestock Ministry for 2001 and from Consejería de Agricultura Gobierno de La Rioja for 2001 and 2002 (all unpublished data from the Action Plan Against BSE). Thus, clear data on the number of carcasses of different types removed in the latter region are being collected (F. J. Puértolas, pers. comm.). In addition, a special surveillance programme regarding the impact of the "Plan against BSE" on carrion-eating birds was started in 2001 (Camiña 2001b, 2003a, 2003b; Camiña & Luján 2002). Livestock censuses were taken from Local Government statistics (Junta de Extremadura 1998; Junta de Castilla León 1999; Gobierno de La Rioja 2001; Comunidad Foral de Navarra 2002; Gobierno de Aragón 2002; Junta de Andalucía, 2003 and Junta de Comunidades de Castilla La Mancha 2003). With this information it was possible to estimate minimum mortality rates for the different types of livestock in 2001.

**Figure 1. Map of Spain showing the seven regions (Local Governments and provinces that they comprise) considered in this study.**



Estimates of breeding success of the four vulture species have been collated at a regional level from published material and from many scientists regularly monitoring regional vulture populations. Data from Local Governments were provided by authorities as well (pers. comm. of unpubl. data). Juan José Sánchez Artés from the Black Vulture Conservation Fund (BVCF) and Rafael Heredia, National Adviser for the Bearded Vulture, from the Spanish Government, provided us with the latest National Censuses for both Cinereous and Bearded Vultures respectively. After BSE appeared a yearly monitoring programme was proposed to assess the evolution of breeding parameters. At least for colonial species (Eurasian Griffon and Cinereous Vulture) censuses should be taken at most of the breeding colonies and not just single sites as was sometimes previously done (Arroyo *et al.* 1991; Del Moral & Martí, 2001). The aim was to avoid focusing on colonies under specific threats because this could bias the results. The breeding season starts as early as December (Eurasian Griffon and Bearded Vulture) and lasts until August, i.e. Egyptian Vulture (Cramp & Simmons 1978; Del Hoyo *et al.* 1994). Thus the effect of measures against BSE was tested in the 2001 breeding season. Only for La Rioja were data on 2001 and 2002 breeding seasons largely available. Data of breeding success and productivity were gathered and are used here as in



Cheyland (1981): Breeding success: number of fledglings/number of pairs that laid eggs. Productivity: number of fledglings/total number of breeding pairs.

Finally, on 1 November 2002 the Spanish Government approved the National regulation on disposal of carcasses for carrion-eating birds (Boletín Oficial del Estado 2002). Previously, in March, April and June 2001, La Rioja, Navarra and Valencia Local Governments established specific regulations for their territories (Boletín Oficial de La Rioja, 2001; Boletín Oficial de la Comunidad Foral de Navarra, 2001; Boletín Oficial de la Generalitat Valenciana, 2001). In La Rioja three feeding stations were legally established and the number of carcasses dropped there regularly monitored.

Firstly, requirements of carcass disposal regulations in Spain are compared and, secondly, food requirements of vultures assessed. Finally, the most recently approved regulations from the EU are considered.

## RESULTS

### Removal of carcasses.

Table 1 shows the Livestock Censuses (1998-2001) for the regions included in this study together with the percentage they account for in Spain as a whole. A total of at least 52,172,715 horses, goats, pigs, sheep and cattle were registered in 2000 (Ministerio de Agricultura Pesca y Alimentación 2003). The data for horses are too imprecise for consideration.

**Table 1. – National Livestock Censuses for the six regions considered in this study, totals for the whole Spain and % that these regions represent on the overall census (n. a. means not available).**

Region (year of census)	Horses	Goats	Pigs	Sheep	Cattle
Andalusia (1998)	213,355	1,375,649	2,249,117	2,765,505	504,261
Aragon (2000)	n. a.	18,124	3,559,535	2,530,817	359,301
Castilla & Leon (1999)	n. a.	209,951	3,027,081	6,360,827	4,645,566
Castilla la Mancha	n. a.	383,485	1,293,212	3,475,941	211,156
Extremadura (1998)	n. a.	248,721	117,593	3,074,377	377,943
Navarra (2000)	n. a.	with sheep	473,959	904,951	115,664
La Rioja (2001)	5,636	15,013	118,165	252,460	51,900
<b>TOTAL</b>	218,991	2,249,943	10,838;662	19,364,878	6,265,791
<b>SPAIN</b>	n. a.	2,743,149	22,079,591	20,989,148	6,360,827
<b>Percentage</b>	n. a.	81.99	49.08	92.26	98.51

Table 2 shows the number of carcasses removed in each region during 2001. Results are also expressed as a percentage of their respective total regional livestock censuses.

From these data it can be calculated that the average annual removal rate (carcasses removed/livestock census) for the whole of Spain is on average only 0.58% (range 0.03-10.97%). Clearly, the highest value is for La Rioja (i.e. 10.97%), the remainder are all less than 2% (Table 2). This table also reveals

that all regions collected cattle and, to some extent, sheep carcasses but no pigs or horses. The results for La Rioja, where data for 2002 are also available, can be examined in detail. Table 3 shows the total numbers of carcasses removed, carcasses per day and percentage they represent of the regional livestock census.

**Table 2. Numbers of each type of carcasses removed to be destroyed in 2001. \***  
**For Castilla la Mancha and Navarra all were classified as cattle according to**  
**Gobierno de Navarra (2000) and Junta de Castilla la Mancha (2003).**

Region	Horses	Goats	Pigs	Sheep	Cattle	% over census
Andalusia	0	16,017	0	31,964	21,478	0.97
Aragon	51	44	309	19,331	17,221	1.26
Castilla & Leon	0	with sheep	0	38,205	21,551	0.41
Castilla la Mancha*	0	0	0	0	5,913	0.03
Extremadura	0	0	0	4	2,277	0.16
Navarra *	0	0	0	0	4,663	0.31
La Rioja	202	1,087	14,913	29,352	2,471	10.97
<b>TOTAL</b>	<b>253</b>	<b>with sheep</b>	<b>15,222</b>	<b>149,203</b>	<b>129,342</b>	

**Table 3.- Number of carcasses removed from field in La Rioja for 2001 and 2002, carcasses per day and % they account over the regional Livestock census (Gobierno de La Rioja 2001). For Chicken and Rabbits results are in tons (n. a., not available).**

	2001			2002			Census
	2001	car./day	Car./census	2002	car./day	Car./census	
Sheep	29,352	80.41	11.62%	10,644	29.16	4.21%	252,460
Cattle	2,471	6.77	4.76%	2,443	6.69	4.71%	51,900
Goats	1,087	2.97	7.24%	1,232	3.37	8.21%	15,013
Pigs	14,913	40.85	12.62%	16,765	45.93	14.18%	118,165
Horses	202	0.55	3.58%	193	0.53	3.42%	5,636
Chicken (T)	200*	0.54	n.a	251,7*	0.67	n.a.	2,815,550
Rabbits (T)	54*	0.14	n.a	53,5*	0.14	n.a.	21,488
<b>Total of carcasses</b>	<b>48,025</b>	<b>132.23</b>		<b>31,277</b>	<b>86.49</b>		<b>3,280,212</b>

From 2001 to 2002 the total number of sheep collected diminished while pigs were now included, with the remaining categories little changed. Average removal rate for 2001-2002 in La Rioja was higher as compared with the average removal rate for the rest of Spain in 2001: average ( $\pm$  standard error) for La Rioja  $9.01\% \pm 1.95$  and  $n = 2$  and average of  $0.52\% \pm 0.19$  for "Spain" and  $n = 6$  (t -Test,  $t = -7.77$  and  $p < 0.001$ ). However, there is a decrease of carcass removal rate in La Rioja in 2002 (7.05% of the regional census as compared with 10.97% the previous year) probably caused by a "relaxation" in the sheep removal process resulting in fewer carcasses collected. The high

potential availability of carcasses in the region is noteworthy as compared with the estimated Eurasian Griffon population and the food requirements for the species there (Camiña 2000). Results do not reveal great seasonal changes in mortality, probably because they are gross numbers for six-month periods.

2) Breeding success before and after BSE:

Bearded Vulture

The total number of occupied territories for 2002 was 93; being the highest value ever recorded. The population was comprised of 80 pairs that bred and 30 fledglings, (Heredia, pers. comm.). However, the breeding success is still decreasing Causes of this will be mentioned later.

Eurasian Griffon

Breeding success data from La Rioja, Navarra, Castilla-León and certain colonies from Extremadura have been collated (Donázar *et al.* 1998; Camiña 2001b, 2003a, 2003b; A. Senosiain pers. comm.; ADENA/WWF pers. comm.).

Table 4. Breeding success before and after the BSE disease. N = number of colonies controlled.

N = Number of colonies considered.

	Before	After	t-test	Sig. Level
NAVARRA B. Success N	0.75±0.15 5	0.66±0.17 7	0.92	0.37
LA RIOJA B. Success N	0.77±0.10 8	0.80±0.22 23	- 0.002	0.98
CASTILLA-LEON B. Success N	0.57±0.05 28	0.55±0.04 30	0.529	0.60

Table 4 compares the average breeding success before and after BSE and no differences were found. Colonies “after” included the same colonies controlled for breeding success “before” plus more colonies within their respective areas. All breeding pairs on the same cliff were considered as a “colony” (not as Arroyo *et al.* 1991 and Del Moral & Martí 2001 precluded; considering as a “colony” all the cliffs within a radius of 1,000m). Furthermore, some data referring to Cáceres Province in Extremadura ( Prieta 2003 & pers. comm.) revealed a 17% increase in 2001 as compared with the III National Census (Del Moral & Martí 2001). At that time, breeding success was reported to be 0.68. Data on productivity are quite similar to those for breeding success but are not so abundant for pre-BSE. Thus, no information on this subject has been included here.

### *Cinereous Vulture*

Only breeding success for two colonies from Extremadura region (Monfragüe and Sierra de San Pedro, both in Cáceres Province) can be compared. The Spanish Cinereous Vulture population is monitored each year, and is steadily increasing; However, many human-induced threats other than food availability (mainly poisoning or tree felling) are affecting many colonies (Sánchez 2003). Thus, values of breeding success are highly biased by those threats when making comparisons on the impact of BSE only. Monfragüe Natural Park, the largest colony in Spain, had 228 breeding pairs in 2001 and breeding success was 0.76 in both 1998 and in 2001). At Sierra de San Pedro colony there were 220 pairs and breeding success was on average  $0.70 \pm 0.14$  for the period 1998-2000 as compared with 0.76 in 2001. Other data for Castilla La Mancha region showed that for the period 1989-2000 the number of breeding pairs increased from 196 to 243, and breeding success from 0.80 to over 0.90. In 2001 there were 267 breeding pairs with a breeding success similar to the previous period. In addition, outside the regions considered in the present study, another colony in central Spain has also increased and reached a higher breeding success in 2002 as compared with the last four years (SEO 1999; Del Moral pers. comm.). Breeding success was on average  $0.71 \pm 0.02$  for 1997-1999.

### *Egyptian Vulture*

The only information available for this species (Table 5) is from Andalusia (Benítez *et al.* 2003). Estimates of productivity and fledging success were made from different sample sizes and anyway no clear trend on breeding parameters was found between years.

**Table 5. Breeding parameters for Andalusia Egyptian vulture population (Benítez *et al.* 2003). Pr: productivity, F. s. fledging success. (N<sub>1</sub>, N<sub>2</sub> = number of pairs used for calculating productivity or fledging success).**

Year	N <sub>1</sub>	Pr.	N <sub>2</sub>	f.s.
2000	20	1	16	1.25
2001	23	0.73	14	1.21
2002	22	0.90	16	1.25

### **Management of feeding stations before and after BSE disease.**

As previously mentioned, “*muladares*” for vultures have been illegal for many decades. To date, there are four specific regulations governing the establishment of feeding stations in Spain. At the National level the Royal Decree 1098/2002 has been in force since 1 November 2002 (Boletín Oficial del Estado, 2002). Previously, La Rioja, Navarra and Valencia Local Governments in March, April and October 2001 respectively, established local laws to regulate the disposal of carcasses in their territories (Boletín Oficial de La Rioja 2001; Boletín Oficial de la Comunidad Foral de Navarra 2001; Boletín Oficial de la Generalitat Valenciana 2001). Table 6 summarises the main comparisons between regional and national regulations. The chief problems relating to their application have been underlined. It is also shown

that requirements for dropping carcasses differ within regions and with the national regulation. Six months before the Spanish Decree, on 1 May 2002, both the European Parliament and Commission published the 1774/2002 Regulation for all animal remains that are not used for human consumption (Diario Oficial de las Comunidades Europeas 2002) and this was put into practice on 1 May 2003. This regulation was finally reinforced by the 322/2003 Decision from the Commission published on 12 May 2003 (Diario Oficial de la Unión Europea 2003). Both documents try to balance BSE control with the preservation of carrion-eating birds within the European Union for five countries - Portugal, Spain, France, Italy and Greece - that host breeding populations of vultures and certain species of eagle and kite. Apart from recognising the different species breeding in each of these countries, the Decision accepts all types of carcass put out for vultures. Nevertheless, cattle, and sheep and goats older than 24 and 18 months respectively, must test negative for encephalopathies before being placed at a vulture restaurant.

Referring to the current management of feeding sites in the different regions in Spain, all the vulture species will be considered together, except for the Bearded Vulture because of its specialised food habits and restricted distribution. The number of vulture restaurants operating in Spain in 2002 for this species are shown in Table 7. They are the only feeding stations with a true legal framework. Twenty-eight, based in other regions outside the Pyrenees, as in La Rioja, sometimes provide food in suitable areas where some vagrant individuals have been recorded (Antor *et al.* 2000).

Food provision is made mainly with sheep hooves and spinal columns of pigs so that Bearded Vultures can obtain enough bones. This also seeks to avoid competition with Griffons. All food comes from slaughterhouses so has been supervised by veterinarians. As an example, the monthly average use of vulture restaurants by Bearded Vultures is shown in Figure 2. The abundance index (0 = lack of use of vulture restaurants, 3 = maximum use) was calculated by counting the number of days that birds were seen attending three feeding sites during provisioning activities (once per week since the mid 80s): 0= no birds recorded; 1= Bearded Vultures present on less than half of the provisioning days, 2 = vultures present on half of the days and 3: birds present on more than half of the days (Fondo de Amigos del Buitre 2001).

In addition to the existing restaurants for the Bearded Vulture the following are operating or planned in the Pyrenees region: Navarra established nine, and seven additional ones are planned. Previously, research was undertaken (Fernández 1988) to assess the importance of existing feeding sites (*muladares*). Thereafter, additional surveys of illegal sites were undertaken. Aragón has made two regional surveys (Sampietro & Pelay 1995; Fundación para la Conservación del Quebrantahuesos 2003). There were around 232 illegal feeding sites (*muladares*) in 1995. The second survey revealed a clear reduction in their number and many had been closed. Despite the difficulty of finding illegal feeding sites there is a clear reduction in the number of these places in Aragón region between 1995 and 2002 (only 116 recorded), see Table 8. This reduction was related to other European regulations referring to waste. BSE has increased the lack of such feeding areas.

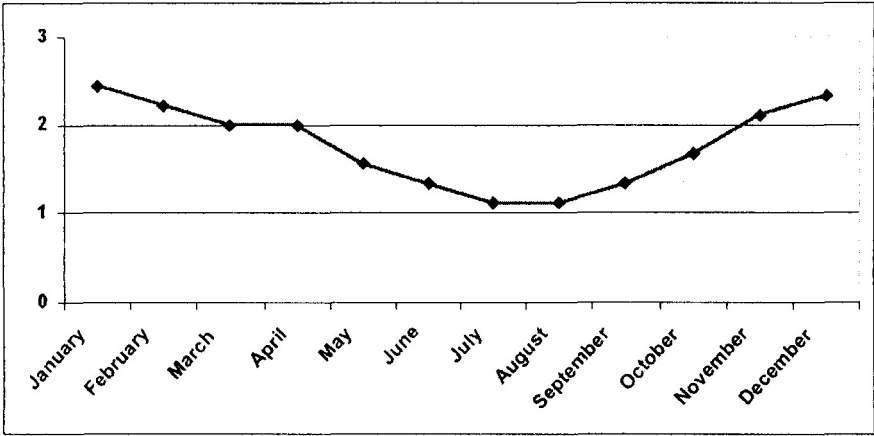
**Table 6. Main features of the different Local and National regulations on carcass disposal in Spain.**

	<b>LA RIOJA</b> Orden 7/2001, 8th March 2001. BOR 30, 10 <sup>th</sup> March 2002.	<b>VALENCIA</b> Orden 1st October 2001. DOGV 4108, 17 <sup>th</sup> October 2001.	<b>NAVARRA</b> Orden Foral 30 <sup>th</sup> April 2001	<b>SPAIN</b> (RD 1098/2002) BOE 262 1 <sup>st</sup> November 2002
<i>Type of carcasses that can be used</i>	All carcasses (pigs, chicken, rabbits, horses) except from ruminant species (sheep, goats and cattle).	All carcasses except from ruminant species (sheep, goats and cattle).	All carcasses except cattle, including ruminant species (sheep, goats) if they have not neurological symptoms.	All carcasses, including ruminant ones if both <u>SRM have been previously removed and animals are negative to encephalopathies tests.</u>
<i>Who decides that there is food lacking for carrion eating birds?</i>	Environmental authorities	Environmental authorities	Does not explain this.	Environmental authorities on each Local Government.
<i>Requisites for leaving carcasses at feeding stations</i>	<ul style="list-style-type: none"> <li>• Veterinarian certificate that the farm is free of diseases.</li> <li>• Authorisation for the farm.</li> <li>• Close to the feeding point.</li> <li>• Register of species, number of carcasses, identification, vehicle employed and route to the feeding point.</li> <li>• Only non ruminant farms.</li> </ul>	<ul style="list-style-type: none"> <li>• Veterinarian certificate that the farm is free of diseases.</li> <li>• Authorisation for the farm.</li> <li>• Close to the feeding point.</li> <li>• Register of species, number of carcasses, identification, vehicle employed and route to the feeding point.</li> </ul>	<ul style="list-style-type: none"> <li>• Be registered for carrying carcasses.</li> <li>• Register of species, number of carcasses, identification, vehicle employed and route to the feeding point.</li> </ul>	<ul style="list-style-type: none"> <li>• Authorisation for EACH carcass.</li> <li>• Close to the feeding point.</li> <li>• Register of species, number of carcasses, identification, vehicle employed and route to the feeding point.</li> <li>• Certificate of being free for encephalopathies.</li> </ul>
<i>Characteristics of the feeding point</i>	<ul style="list-style-type: none"> <li>• Fenced:</li> <li>• 1.75 metres height.</li> <li>• 0.5 metres deep.</li> <li>• Far from human settlements.</li> </ul>	<ul style="list-style-type: none"> <li>• Fenced:</li> <li>• 2 metres height.</li> <li>• 0.5 metres deep.</li> <li>• Far from human settlements.</li> </ul>	<ul style="list-style-type: none"> <li>• No details provided.</li> </ul>	<ul style="list-style-type: none"> <li>• Fenced.</li> <li>• Far from human settlements.</li> </ul>
<i>Who carry and drop carcasses at feeding points?</i>	The shepherd himself.	The shepherd himself.	The shepherd himself.	The shepherd himself.

**Table 7. Number of legal feeding stations working in Spain for Bearded Vultures (whole Spain).**

Region	Number
Guipúzcoa Province (Basque country)	2
Navarra	3
Aragón	12
Catalonia	11

**Figure 2. Average monthly use of three vultures restaurants by Bearded Vultures (all ages) throughout the year: Abundance index of Bearded Vultures was estimated by counting the number of days that birds were seen attending feeding sites (see text for explanations).**



**Table 8. Results on the second survey (2002) on traditional illegal feeding areas (muladares) for vultures in Aragón (Fundación para la Conservación del Quebrantahuesos, FCQ, 2003).**

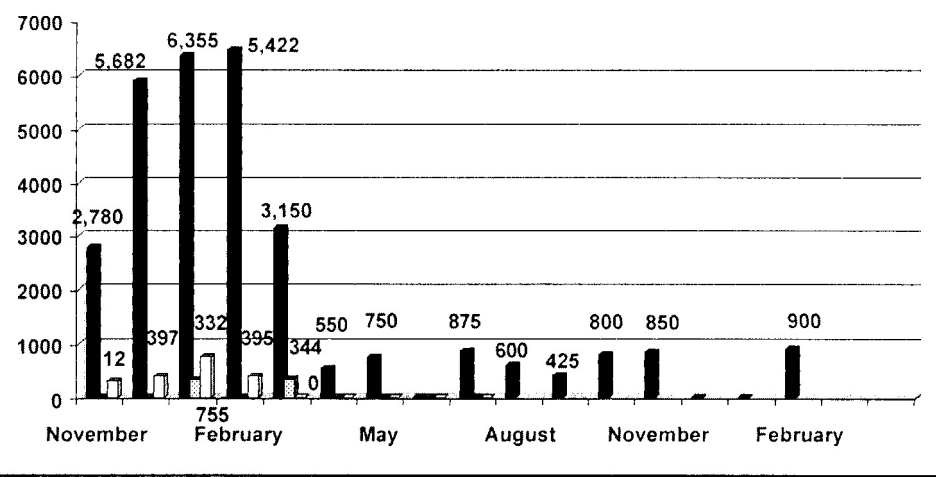
Type	ACTIVE	LESS ACTIVE	CLOSED
Feeding sites	79	10	8
Feeding sites/ Rubbish dump	7	1	2
Rubbish dump/ Feeding site	5	5	3
Rubbish dump	9	0	4
<b>TOTAL</b>	<b>100</b>	<b>16</b>	<b>17</b>

Feeding sites were places where only carcasses and meat and bone remains are dropped, at feeding sites/rubbish dumps also wastes were disposed. The use of 'feeding site' or 'rubbish dump' reflects the main food source provided at such places.

On the other hand, in 2001 La Rioja established three vulture restaurants, one still operating. A second one was closed down because of a food superabundance in its vicinity; and the third is starting to drop carcasses just

now. Figure 3 shows the amount of food provided at two feeding stations since November 2001. Fourteen farms from five neighbouring villages provided food there by themselves. Average distance from farms to the vulture restaurants was less than 10km. A monthly sheet must be given to authorities with the numbers and kilograms of carcasses disposed. Castilla León region planned 27 vulture restaurants and one province of Castilla la Mancha (Ciudad Real) a minimum of three. Extremadura has had one feeding station for a long time but, till now, there are no plans to establish more vulture restaurants. Finally, in Andalusia 25 are currently being set up and another 12, specifically for Cinereous Vultures, are being considered. The latter are mobile feeding stations, to avoid competition with Griffons. They are baited with rabbits and planned to change location as soon as interspecific competition is noticed. In Andalusia Local Government officers will be in charge of carrying and dropping carcasses at vulture restaurants (V. Talavera, pers. comm.).

**Figure 3. Kilograms of meat provided at two vulture restaurants in La Rioja from November 2001 until February 2003. Black bars: Pigs, white bars: Rabbits, dotted bars: Chicken. The arrow means ceasing activities at one of the vulture restaurants.**



## DISCUSSION

Removal of carcasses has provided, for the first time in Spain, reasonable estimates of the amount of carrion generated annually. Results have also revealed that the success of the “Surveillance Plan against BSE” has varied regionally. Only La Rioja has reached the highest rates of removal with an annual budget of 1.82 million Euros for this purpose. A different situation exists in Extremadura and Castilla la Mancha, where the use of extensive rearing practices all year round makes the shepherds rely on vultures to locate dead livestock. All the carcasses taken into account in this paper came from both intensive and extensive farming activities. Only remains from slaughterhouses were not considered in these calculations. If the results from La Rioja are applied to the whole of Spain, then it can be estimated that the



number of available carcasses is much higher. The removal programme should have to remove around 3,725,132--5,723,347 carcasses annually; however, only 305,249 were collected in 2001. Secondly, percentages from Table 3 could be considered as "*minimal annual mortality rates*" for each type of carcass. Even for La Rioja, carcasses dropped at existing vulture restaurants were not included. Annual mortality rates here (Table 4) are slightly higher than those supported by De Juana & De Juana (1984), Fernández (1988) and Donázar and Fernández (1990), where annual mortalities for sheep (6.4%) and cattle/horses (2%) were reported.

Results support the idea that, to date, vulture populations have not been affected as a whole by measures against BSE. Furthermore, many of the traditional illegal feeding sites ("*muladares*") remain operative with provision of carcasses other than ruminants and one feeding station in La Rioja has ceased food provisioning. The regulations have done very little to remove carcasses and the existing vulture restaurants were insignificant in terms of food supply; see Figure 3 for La Rioja where the Eurasian Griffon population is comprised of 819 breeding pairs (Del Moral & Martí 2001; Camiña 2000). If we estimate a daily food requirement for a Griffon Vulture of 500 grams of meat (Donázar 1993), and only for the breeding population there, then the monthly food required (819 birds X 2 birds/pair X 30 days/month X 0,5 kgr./day) would reach 24,570 kgr. As an example, if the 7,442kgr. of carcasses provided in January 2002 are considered, and assuming that the entire carcass could be consumed (skeleton and skins not discounted), then only 30.29% of the breeding population could feed there that month. For the Bearded Vulture, despite the significant population increase since 1986, lower breeding success seems to be related to causes other than food shortages (Heredia & Margalida 2001). The number of vulture restaurants has also increased since 1990 (Heredia & Heredia 1999, data gathered for this paper) and food has been provided on a regular basis. In accordance with the Royal Decree 1098/2002 and old regulations food provisioning is ensured and enhanced by legality. Nevertheless, Hernández (2003), as revealed from radio-tracked birds, found that poisoning is the main threat for the species on both sides of the Pyrenees. Vulture restaurants for the Bearded Vulture have provided non-poisoned food for the non-breeding population (juveniles and immatures) during adverse weather conditions (Heredia & Heredia 1999). Provision of safe food for the non-breeding populations of vultures should be one of the main reasons for establishing feeding stations. The Eurasian Griffon relies exclusively on carcasses (Camiña 2000, 2001a) and breeding parameters remain at the same level as recorded before 2000. Changes in breeding success for the Cinereous Vulture have been associated with poisoning of breeding adults in many of the Spanish colonies (Sánchez 2003). Immature birds then mated and made breeding attempts that usually failed (Costillo *et al* 2001; E. Costillo & A. Godino pers. comm.). Furthermore, sheep carcasses range from 43-83% of the diet of the Cinereous Vulture (Corbacho *et al.* 2001) and the lack of such would be a serious problem if most were removed. For the Egyptian Vulture up to 25.1% of its food has been considered to come from sheep/goat carcasses (Donázar 1993; Donázar *et al.* 1996). Thus, it must be aware of changes in the surveillance plan against BSE. Without doubt, the great success of Spanish vulture populations has not been the result of establishing vulture restaurants in the past but of the abundance of food together with measures to protect colonies

from human persecution (Donázar & Fernández 1990). Vultures have been well adapted to the human landscape for a long time (Donázar 1992; Houston 1996) and it is other hazards that make their populations so highly threatened.

Some people/institutions with little knowledge of vulture biology have suggested that if domestic livestock is not allowed for the feeding of scavenging birds, other species such as bulls from bullfighting or game could be employed. From the data gathered for this study only 2,924 bulls were removed in Madrid Province during 2001, being otherwise normally processed for human consumption. Because they would have to be transported to far distant feeding sites, costs cannot be borne for supplementary feeding.. On the other hand, game does not reach sufficiently high densities to be enough for vultures to feed exclusively on them. Andalusia is a region that hosts one of the highest densities of Red Deer *Cervus elaphus* in Spain, being on average 19.79-22.99 ind./km<sup>2</sup> (Junta de Andalucía 2003). Other species like the Spanish Ibex *Capra hispanica* in Cazorla, Segura and Las Villas and the Chamois *Rupicapra rupicapra* in Picos de Europa or the Pyrenees are confined to these mountain areas. Here, these food resources could play an important local role but are not a solution for all Spanish vulture populations (Lorente 1996). Furthermore, both Wild Boar *Sus scrofa* and deer are mainly restricted to forested areas (Purroy *et al.* 1986; Sáez-Royuela 1989; Camiña 2003c). There, vultures do not exploit food resources efficiently as a consequence of forest cover (Camiña in prep.). From Table 1 it can be estimated that an average livestock density of 123.36 individuals/km<sup>2</sup> (range 61.08-247.39) is up to 5-6 times higher than the game species in central-southern Spain.

It is necessary to investigate the use of vulture restaurants according to species present, their food requirements, different ages and season of the year. This can help to form a true management programme for feeding stations. Food provisioning ceased in one of the feeding stations in La Rioja because Griffons frequently flew outside the regional boundaries to feed, as they did before BSE appeared (Camiña 2001b). There, large amounts of pig were still available in an intensive farming area, so that food provisioning at the vulture restaurant was clearly unbalanced with the birds' requirements.. Further studies in Central Spain (Camiña 2001a; Benítez *et al.* 2003; Palomo & Camiña unpub. obs.; Donázar pers. comm.) have clearly demonstrated that vultures and other carrion-eating raptors extend beyond geographical regions when foraging and management plans cannot be restricted to political boundaries. On the other hand, vulture restaurants can help to reduce poisoning incidents in those areas where poisons pose a threat (Benítez *et al.* 2003). These authors consider that, for the Egyptian Vulture in Andalusia, high adult mortalities are probably due to poisoning incidents and are the main reason for the decline of the population there. Even for subadults and/or juvenile Egyptian Vultures poison is a threat because no concentrations at roosting sites, highly related to secure food sources, were found. Other breeding parameters or incidence of contamination remained at normal levels. Finally, foreign carrion-eating birds from other countries cannot be forgotten, as is the case with French Griffons that are vagrant in Spain (to date, 58 sighted throughout the territory, unpubs. obs.) or wintering Red Kites *Milvus milvus* (Viñuela *et al.* 1999).

Neither the National Royal Decree nor the European Decision takes into account the role of ruminant species in extensive grazing areas. There, carcasses from cattle and sheep are the only food available for vultures

(Lorente 1996; Margalida *et al.* 1997; Camiña 2000, 2001a). It is obvious that such carcasses are difficult to locate and remove. Even the National Strategy for the Bearded Vulture pointed out that extensive grazing had to be ensured (Dirección General de Conservación de la Naturaleza 2002). In addition, both regulations are impossible to fulfil from the technical point of view, being a very costly process. Before dropping carcasses at vulture restaurants they must test negative for encephalopathies. Some questions regarding the 322/2003 Decision remain unanswered. Who will conduct and fund these analyses? How can a shepherd wait for results with a corpse on the farm awaiting disposal? It must be pointed out that tests last from 24-48 hours and slaughterhouses cannot accept dead animals. There is an urgent need to determine whether carrion-eating birds process infected tissues/proteins and their role, if any, in spreading BSE or related diseases (CMIEET 2001). Some such data have already been collected (Joncour 1999). Currently, food availability for vultures in Spain – even without vulture restaurants- is a minor issue relative to poisoning. However, present regulations and food availability need to be evaluated carefully so that they do not seriously affect vultures in the near future. Surveillance of vulture populations must continue as well. Finally, some of the local regulations in Spain exceed national or EU regulations, being less restrictive. Nevertheless, because vultures breed normally and food is still sufficiently available, no further work has been carried out to establish an easily adapted framework regulating vulture restaurants.

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Alvaro Camiña  
 Apartado de Correos 339,  
 28220 Majadahonda, Madrid,  
 Spain  
 Email: [acamia@vodafone.es](mailto:acamia@vodafone.es)