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Griffon Vulture *Gyps fulvus* food shortages in the Ebro Valley (NE Spain) caused by regulations against Bovine Spongiform Encephalopathy (BSE)

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Abstract. Livestock farms in the mid-Ebro Valley were regularly monitored for carcass disposal and food availability before and after the carcass removal programme was established. At the same time Griffon Vulture censuses were carried out. During 2004 vultures fed almost exclusively on pigs. Since 2005 carcasses have not been available for vultures, but griffon numbers using the area have remained roughly the same. Most of the vultures previously present were non-breeding birds, which probably increased their chances of survival by feeding far from the breeding colonies. Since the inception of the carcass removal programme, the situation has reversed, with adults now outnumbering immature birds. The establishment of carcass removal programmes all over Spain could affect the stability and future evolution of Griffon Vulture populations. To ensure a proper conservation policy for vulture species, scientific research is urgently needed in other areas before management measures are implemented.

Key words: Griffon Vulture, *Gyps fulvus*, foraging, food, intensive farming, BSE

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INTRODUCTION

The Griffon Vulture is a large scavenger that in Spain, as well as other developed countries, feeds on large and medium-sized carcasses, mainly coming from domestic livestock (Del Hoyo et al. 1991, Mundy et al. 1992, Houston 1996). Its population has greatly increased over the last three decades (SEO 1981, Arroyo et al. 1990, Del Moral & Martí 2000). Causes of this have been the lack of persecution (poisoning, shooting and disturbance) together with the protection of colonies and abundant food (Donázar & Fernández 1990, Donázar 1993, Camiña 2004b).

In Spain, for a long time carcasses were put out for vultures at special feeding sites. These feeding sites, called *muladares* in Spanish, have been used illegally for decades by farmers for carcass disposal. This practice provided the vultures with food, and the farmers with an economical way to dispose of carcasses. According to existing legislation, corpses should have been buried but this regulation was constantly broken (Camiña 2004b). The appearance of the first cases of Bovine Spongiform Encephalopathy (BSE hereafter) both in Spain and Europe caused the implementation of the 1774/2002 regulation that required carcass removal programmes within the European Union (Official Journal of the European Union 2002). This measure was previously shown to reduce the food availability for carrion eating birds (Tella 2001). The disposal of carcasses must include transportation for incineration at processing plants. However, there are some Mediterranean countries such as Spain, France, Portugal, Italy and Greece where there are still viable carrion eating bird populations (BirdLife International 2004). To protect the feeding of vultures the 322/2003 Decision was enacted (Official Journal of the European Union 2003), but this proved to be unworkable, both from the economical and practical point of view (Camiña 2004a). Carcasses cannot be disposed until confirmation of negative

BSE test results has been obtained. A test lasts 48 hours on average and a shepherd should take care of corpses during this time. This Decision has remained unchanged until late 2005 (Official Journal of the European Union 2005) compromising the European vulture conservation.

In compliance with these regulations, in 2005 the Aragón Autonomous Government established a carcass removal programme in its territory (Boletín Oficial de Aragón 2005a). It started in early 2005 and should be implemented throughout the whole region by 2008 (Boletín Oficial de Aragón 2005b, 2005c and 2005d). Aragón extends over 47 682 sq km (around 10% of Spain) and hosted 4 383–4 455 Griffon Vulture breeding pairs in 1999, a 25% of the Spanish population (Del Moral & Martí 2000).

The aim of this study is to investigate the changes in food supply and presence of Griffon Vultures in an intensive farming area where the carcass removal programme is already operating. If overall food availability at farms has been reduced we predict: 1) Average number of vultures gathered at farms with available carrion should be higher after the removal programme was established than before, and 2) the percentage of not consumed carcasses at the farms should be lower after than before the programme.

Similar programmes are currently being planned or under way in other areas of Spain but their effects on vulture populations at local level have not yet been analysed (Camiña 2001). On the other hand, many environmental authorities have considered that vulture "restaurants" may be a helpful managing tool. However, these plans are not based on any scientific studies concerning the feeding ecology of vultures.

STUDY AREA AND METHODS

Study area

The study was carried out on an area of ca. 495 km^2 of Los Monegros (Leciñena-Alcubierre-Robres- Perdiguera, Ebro Valley NE Spain, 41°50´N, 0°31´W, Fig. 1). The climate is Mediterranean continental semiarid with 220–500 mm of rainfall concentrated in spring and autumn, maximum temperatures range between summer and winter (40°C to -10°C). The area has been mostly converted into an extensive cereal plain (pseudosteppe). Average altitude is 400 m.a.s.l., except a mountain ridge (Sierra de Alcubierre where mean altitude is 581 m, range 350–812) that crosses the study area from NW to SE. This area is occupied by some forests mainly comprised of *Pinus halepensis* and *Juniperus thurifera*. In addition to cultivated lands, there is also livestock, with 108 big farms of cattle (8 farms), sheep (28), pigs (70) and rabbits (2). Clearly, pigs outnumber other livestock types (83.08% of the total census), while only sheep are maintained in a semi-extensive condition under shepherd supervision. Livestock numbers in the area for 2003 included 86 598 pigs, 14 238 sheep, 2 428 rabbits and 974 cattle individuals (Departamento de Agricultura y Alimentación 2005). There are also chickens and a few horses but the numbers are not available from official statistics. Carcasses are usually produced inside or close to the farm and, as a result, they have to be removed for sanitary reasons.

Before the carcass removal programme came into operation, carcasses were placed in shallow pits close to the farms, where vultures could feed on them. From early 2005 on containers were provided for carcass disposal (Diario Oficial de Aragón 2005a). Corpses are placed inside, and the container is loaded on a truck, and moved to the incineration plant. Farmers must phone for carcasses to be removed within 24–48 hours. The containers are closed, and carcasses are not accessible to vultures.

Los Monegros area has been used by Griffon Vultures as a roosting site for a long time. They use pines for perching there. Breeding colonies are located at a mean distance (± SD) of 51.11± 9.69 km (mean colony size 69.14 ± 104.11 breeding pairs) to the north and 79.68 ± 6.94 to the south (mean colony size of 11.11 ± 12.71). Another vulture species breeding there is the Egyptian Vulture *Neophron percnopterus*. In addition, a floating population of immature and subadult birds also gather at communal roosts within the area (Donázar et al. 1996).

Food availability at farms

Livestock censuses provided the data on the number of farms in the area, and the types and numbers of livestock present there (see above). During June–July 2004, ninety three of all 108 intensive farms were visited and mapped by GPS. Of these 108 farms, 70 reared pigs, 11 sheep/goats, six cattle, five chickens and one horses. The method of carcass disposal was recorded, and the possible use of carcasses by vultures was quantified. On each visit, the number and type of carcasses was recorded, and the weight of food available for vultures was estimated. Only fresh car-

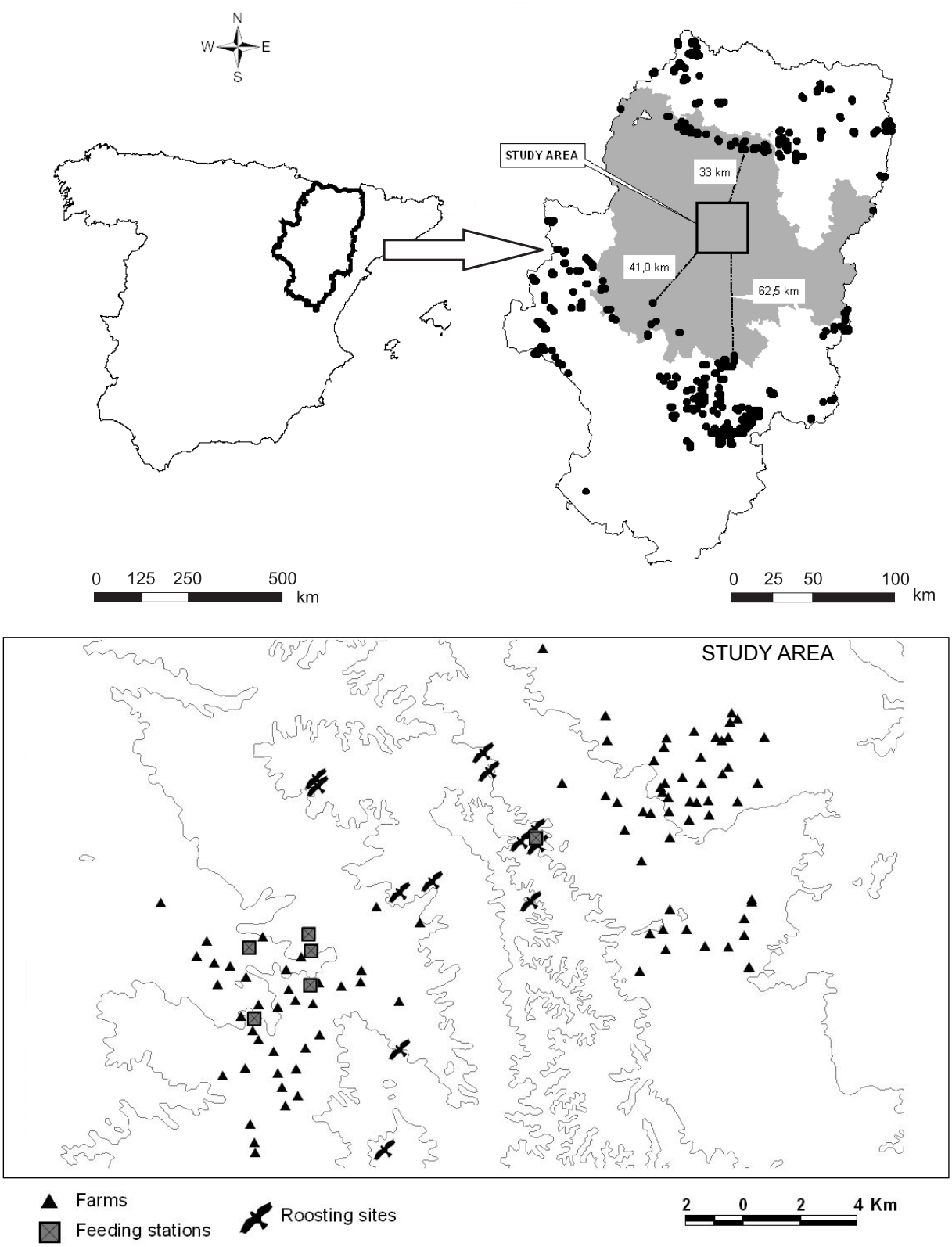

Fig. 1. Location of Aragón in Spain showing the distribution of Griffon Vulture colonies (black points) and areas where the carcass removal programme is already operating (dark grey). Distance from colonies to the study area is shown. Detailed view of the study area showing the location of intensive farms, feeding sites or muladares and Griffon Vulture communal roosts.

casses or blooded bone and skin remains were considered. Once vultures start feeding, they completely deplete the whole carcass, and only time required for eating can limit this. Pigs were assigned to one of the following size classes, according to rearing practices in the area: I — smaller ones up to 15 kg, II — average of 50 kg (range 40–60), III — average 90 (80–100) and finally IV — around 200 kg, while the remaining livestock were classified only to types. If vultures were seen feeding in a farm, total numbers and species present, feeding or not, were recorded. Griffon Vultures were aged according to Del Moral & Martí (2001) and Forsman (1999) as: juveniles (from fledging until the beginning of the second calendar year), immatures, subadults and adults. Differences between them were based on the colour and shape of ruff, bill and flight feathers, pattern of uppercoverts and the appearance of mantle. Eye colour could be determined in some cases, dark brown both in juvenile and immature vultures and yellowish brown in adult ones. Age was always assessed while vultures were on the ground. After the carcass removal programme started in April–May 2005 (Boletín Oficial de Aragón 2005b), the area was sampled again by the same procedure in June–July 2005 to compare for food availability and presence of vultures.

Data analysis

Statistical analyses were performed using the STATISTICA 6.0 package (Statsoft 1997). The following variables were considered: number of carcasses available per farm on each visit, type and estimated weight of food available. As vultures could feed on any of the farms, sampling started on different ones on each visit. Thus, they were randomly selected but always as many as possible were visited (mean of 11.3 ± 5.75 farms/day). Non-parametric tests were used for comparisons. In order to test whether the number of griffons present was related to the amount of food available, two further Spearman rank correlation analyses were performed, relating the number of vultures with the estimated amount of meat in the two years. For this purpose, the average weights of the above considered carcass categories were used. This was only possible for those days or farms when vultures were seen feeding.

RESULTS

None of the farms visited fed vultures with sheep or cattle, as these types of food were no longer available. Sheep were found but all of them were old carcasses, prior to this study. They accounted for only 1.72% of all carcasses in the area. During summer 2004, only 3 (5.66%) of the farms on the northern slope of Sierra de Alcubierre disposed of carcasses in a manner that made them available for vultures. In contrast, on the southern slope 23 farms (58.97%) had pits that were both accessible and used by griffons. In addition, four *muladares* (well established and fenced feeding sites) were found: one was closed in March 2003 in the northern area while the three remaining in the southern area were still operating and supplied with rabbits (1) and chickens (2).

In summer 2005 all farms had containers for carcass removal.

In accordance with types of carcasses available, vultures almost exclusively fed on pigs, although rabbits or chickens could not be properly quantified at the *muladares*. They were seen feeding on the last two species only in 2005. Pig carcasses were consumed in a proportion to their availability with no clear preferences for carcass size (Fig. 2). Only slight changes in size of available car-

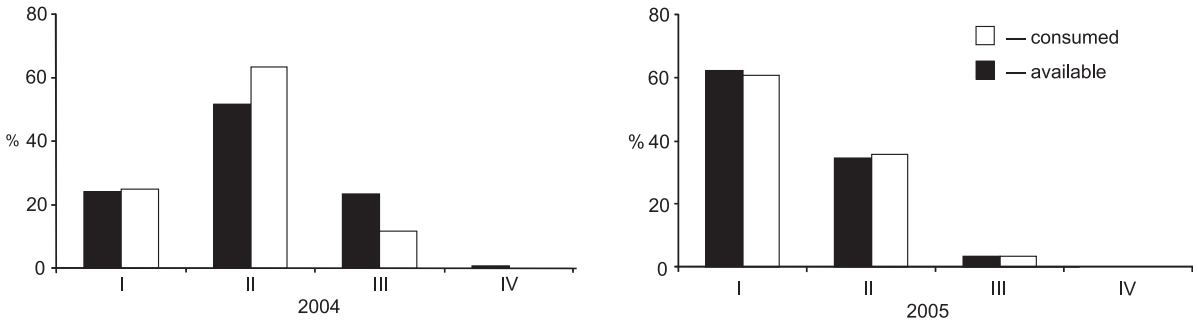

Fig. 2. Percentages of carcasses available and consumed before (2004) and after (2005) the carcass removal programme was implemented. Carcass size classes: I — < 15 kg, II — 40–60 kg, III — 80–100 kg, IV — ca 200 kg.

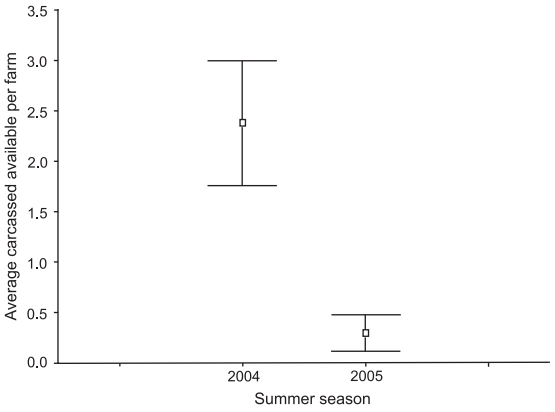

Fig. 3. Carcasses available for vultures per farm (Mean ± 0.95 Conf. Interval) for the two consecutive summer seasons June-July 2004–2005.

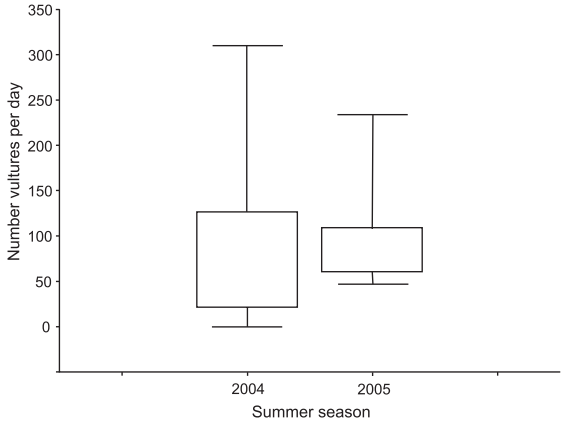

Fig. 4. Mean minimum and maximum numbers of Griffon Vultures recorded feeding at pig farms for summer 2004 and 2005 for those days/farms where vultures were recorded.

casses were found between years. In 2004 bigger carcasses (III and IV classes) were less consumed, while all classes were consumed according to their availability in 2005.

Comparison of carcasses available for vultures before and after the anti BSE programme was established revealed that food availability (average carcasses available per farm) greatly diminished between the two consecutive summer seasons 2004–2005 (Mann Whitney U-test, $Z = 4.29$, $p = 0.001$, Fig. 3).

On the other hand, the mean Griffon Vulture number recorded per day did not decrease, and even increased slightly, although the differences were not significant (Mann Whitney U-test, $Z = -0.43$, $p = 0.66$, Fig. 4). The number of griffons foraging was not related with the amount of meat available (Spearman´s rank correlation for 2004: $r_s = -0.28$, $p = 0.33$ and 2005: $r_s = -0.18$, $p = 0.60$).

Finally, during 2004 (n = 225), immature and subadult age classes clearly outnumbered adults (Fisher exact test, $p = 0.001$). However, percentages changed in 2005 (n = 625) with adults outnumbering younger birds (Fisher exact test, $p < 0.001$). There were great differences in the distribution of age classes between the two consecutive summers ($\chi^2 = 76.44$, $p < 0.001$). No juvenile Griffon Vultures were seen in the summers of 2004 or 2005 (Fig. 5).

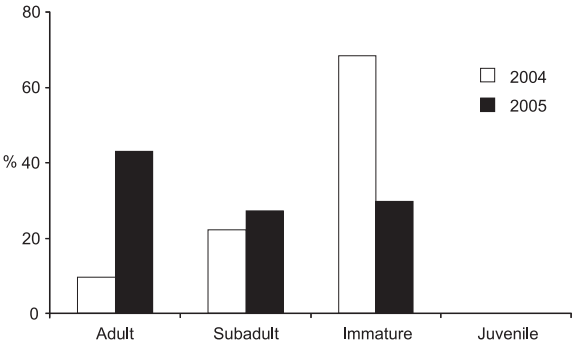

Fig. 5. Distribution of Griffon Vulture age classes recorded in 2004 and 2005.

DISCUSSION

The results clearly demonstrate that a great reduction in food available for griffons, mean number of carcasses, occurred in 2005 when 93.75% of farms had containers for carcass disposal. The decrease in food availability first started on the northern slope of Sierra de Alcubierre in early 2003 when the most important *muladar* that gathered up to 1 000 griffons was closed in order to mitigate vulture mortality at a neighbouring windfarm area (Lekuona 2002). Before that, pigs provided with the bulk of carcasses for vultures and they were consumed according to their availability.

Based on the data for 2004, it is known that Sierra de Alcubierre served immature and non breeding vultures as a roosting site (Lekuona 2002, Authors' own obs.). They could improve their survival by reducing competition with adults. Then, immatures outnumbered adults, and breeding birds could probably forage closer to the colonies. However, during 2005 the situation reversed, with adults being the most numerous group. It is noteworthy that no griffon juveniles were recorded in either the 2004 or 2005 surveys. Probably it is too early in the year for this age class to be present at this feeding area, owing to the dis-

tance of Los Monegros it is far from the breeding colonies. At this time juveniles tend to remain at the nest or in the vicinity of colonies (Authors' own obs.).

Despite the food shortage after the establishment of the carcass removal programme, the number of griffons has not changed as much as the food available. As it was predicted, a slight but not significant increase in the average number of griffons at farms was detected. A reason for this could be the presence of extensive sheep herds in the area where dead animals are left in situ and consumed by vultures. Vultures could move for finding food to areas that have not been considered in this study. Secondly, a delayed behavioural and population response of a long-lived species like the Griffon Vulture would be expected, causing a lack of immediate reduction in vulture numbers. On the other hand, no change was detected in the percentage of non-consumed carcasses before and after the programme was established. Vultures usually act as opportunistic scavengers consuming all carcasses available (Authors' unpub. data). Once a carcass is disposed at an accessible pit, vultures feed until finishing all the meat. Finally, changes in the proportions of carcasses available from 2004 to 2005 could also be related with changes in pig rearing practices.

The observed variation in age distribution of vultures could be caused by the carcass removal programme in Aragón. If food availability in the vicinity of breeding colonies was reduced (see Fig. 1), adult birds would be forced to forage further away. During 2005, increasing mean numbers of vultures are being recorded at other feeding sites of carcass disposal in Spain (Authors' own obs.). It appears that the same number of vultures have fewer feeding sites available. Further research and monitoring of these *muladares* and carcasses is urgently required to quantify this trend. The effect of diminishing food available and closing of the existing feeding sites in the Ebro Valley has already been highlighted for the Egyptian Vulture by Tella (1991, 1993), Donázar et al. (1996) and Grande et al. (2005) but little conservation work has so far been done (J. M. Grande pers. comm.). The present situation could also affect Egyptian Vultures owing to competition with griffons for supplies of chickens and rabbits (Authors' own obs.).

Livestock census statistics alone are not sufficient to reveal the impact of food availability on vulture populations, and further field data are needed on the actual disposal of carcasses. Illegal carcass disposal in the past was clearly one of the reasons for the vulture population recovery in Spain, and the introduction of carcass removal programmes can seriously threaten vultures in the future. As a general rule, both Agriculture and Livestock Departments and Environmental authorities are not cooperating, resulting in an inappropriate vulture management. Studies on the foraging ecology of vultures are scarce (Carrete & Donázar 2005) and decisions on feeding stations are not usually scientifically based (see Carrete et al. in press, for the case of the Bearded Vulture *Gypaetus barbatus*).

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STRESZCZENIE

[Wpływ regulacji unijnych związanych z zapobieganiem rozprzestrzeniania się gąbczastego zwyrodnienia mózgu (BSE) na dostępność pokarmu sępów płowych w Ebro Valley (północnowschodnia Hiszpania)]

W ostatnich trzydziestu latach liczebność sępów płowych w Hiszpanii znacząco wzrosła w wyniku zaprzestania odstrzału, a także ochrony kolonii i zwiększeniu dostępności pokarmu. Dzięki istnieniu wydzielonych miejsc, zwanych muladares, gdzie nielegalnie składowano padłe zwierzęta hodowlane, sępy miały stały dostęp do znacznych ilości pokarmu. Wskutek pojawienia się pierwszych przypadków BSE w Europie, także w Hiszpanii wprowadzono przepisy nakazujące usuwanie padłych zwierząt i ich utylizację z wykorzystaniem kontenerów niedostępnych dla padlinożerców. Podczas badań prowadzono ciągły monitorng dystrybucji padłych zwierząt na 108 dużych farmach w środkowej części regionu Ebro Valley (ok. 495 km^2, Hiszpania, Fig. 1). Objęto nimi zarówno okres przed (2004), jak i po (2005) wprowadzeniu przepisów obligujących do usuwania padliny. Prowadzono także liczenia sępów. W 2004 drapieżniki żerowały niemal wyłącznie na padlinie świń, bez wyraźnej preferencji wielkości ciała padłych zwierząt (Fig. 2). Od 2005 padlina przestała być dostępna dla sępów, mimo to liczba sępów na badanym obszarze nie zmieniła się (Fig. 4). W latach poprzedzających usuwanie padliny większość populacji stanowiły osobniki nielęgowe (młode), które zwiększały swe szanse na przeżycie żerując z dala od kolonii lęgowych. Po wprowadzeniu zakazu wykładania padliny sytuacja uległa odwróceniu i obecnie większość osobników stanowią ptaki dojrzałe (Fig. 5). Wyniki badań wskazują, że wprowadzenie zakazu wykładania padliny na terenie Hiszpanii może doprowadzić do zachwiania stabilności populacji sępów płowych. Aby wypracować model przyszłej ochrony gatunku, konieczne są pilne badania poprzedzające regulacje prawne.

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