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Effect of human activities on Egyptian vulture breeding success

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Abstract

Habitat loss, electrocution on power poles and persecution by humans are the main threats to birds of prey. Nevertheless, the effects of human disturbance on endangered species are becoming notorious due to the increasing recreational use of the natural environment. We evaluated the effects of human disturbances on Egyptian vulture *Neophron percnopterus* breeding success and developed conservation measures based on minimum distance of effect and buffer areas in a high human density area of northern Spain. A total of 100 breeding attempts of 15 breeding pairs were monitored over 8 years. Human disturbances affected 42 of the breeding attempts. Those disturbances related to and originating in forestry work had the most severe effect on breeding success, being associated with the loss of 100% of 13 breeding attempts, while human disturbances related to free-time activities caused 44% failures in 25 breeding attempts by four pairs, two of them within Natural Parks. The breeding success was significantly less in territories affected by disturbances than in those free of disturbances. Some pairs affected by disturbances changed their nest site, increasing breeding success. Adults were prevented from entering the nest to feed chicks when anyone was detected at an average distance of 307 m, while an average distance of 837.5 m allowed them access. The maximum alert distance was estimated at 605 m and the buffer area was 57 ha. We discuss the application of our results for management schemes and conservation of this species.

Introduction

Habitat loss, electrocution on power poles and persecution by humans are the main threats to birds of prey in Europe (Tucker & Heath, 1994). Persecution of raptors can take many forms, including destruction of nests, deliberate disturbance of nesting birds and poisoning, shooting and trapping adults and immature individuals (e.g. Sarà & Di Vittorio, 2003; Whitfield *et al*., 2004; Martínez *et al*., 2006*a*). Moreover, disturbances affect some endangered species reducing the available breeding habitat (Sergio & Bogliani, 2000; Liberatori & Penteriani, 2001; Grande, 2006; Martínez, Pagán & Calvo, 2006*b*; Zuberogoitia *et al*., 2006) and are a cause of breeding failure (Arroyo & Razin, 2006; González *et al*., 2006). The causes of regression, breeding failure and distribution of hazards for species may show geographic variation, and causes absent in some areas may prevail in others. Because human recreational use of the natural environment is likely to increase in the future, the need to understand how wildlife responds to human activities is becoming increasingly important (Arroyo & Razin, 2006). Wildlife managers need appropriate tools to improve the protection of endangered species, demanding information about how, when or which types of human activity may be detrimental to wildlife in specific areas (Carney & Sydeman, 1999; Romin & Muck, 1999; Sitati, Walpole & Leader-Williams, 2005; Young *et al*., 2005; Preisler, Ager & Wisdom, 2006). Some authors suggest that spatial and temporal restrictions are needed to protect the breeding and foraging sites of endangered species (Sarà & Di Vittorio, 2003; Ontiveros *et al*., 2004; Carrete & Donazar, 2005; González *et al*., 2006).

The Egyptian vulture *Neophron percnopterus* is the smallest European vulture with a weight of about 2 kg, exploits carcasses of small and medium-sized animals and breeds in holes in cliffs located in open landscapes in arid and rugged regions (Cramp & Simmons, 1985; Donázar, 1993). The Egyptian vulture is a globally endangered species with about 27–37% of the estimated total European population in Spain (Birdlife International, 2004). The severe decline (25%) suffered in Spain during the last decade, was more obvious (50%) in those areas close to human villages, while those populations found in mountainous areas seemed to remain stable (Del Moral & Marti, 2002). The main cause of decline remains human persecution, especially shooting and poisoning, the latter being responsible for the species' disappearance from many Spanish regions (Donázar, 1993) and other countries (Liberatori & Penteriani, 2001; Sarà & Di Vittorio, 2003). These causes of death were more evident than the detection of activities causing breeding failure.

The study area population was stable and no evident decline was detected (Del Moral & Marti, 2002). These Egyptian vultures breed in mountainous areas, far from villages and cities, where extensive poultry farming and forest timber are the main activities. Poisoning has not been detected in our study area (only one documented case in 2000) and persecution focused on the species is almost non-existent. In the absence of these causes of mortality one would expect a population increase as is occurring in Castellón, Eastern Spain (García-Ripollés & López-López, 2006). Nevertheless, the effect of disturbances is acting and nowadays loss of territory due to vultures' response to human activities is threatening the population (Carrete *et al*., 2007), thus urging research on this specific threat, normally obscured by the two main causes of population decline (human persecution and habitat loss) and consequently undetected although often suspected.

The aims of this study were: (1) to measure the disturbance effect on breeding success of Egyptian vultures; (2) to develop and propose conservation measures based on minimum distance of effect and buffer zones.

Study area and vulture population

The study area covered the whole administrative area of Biscay (2384 km^2), a province in the Western Basque Country (northern Spain), between 43°10′ and 43°27′N and 3°27′ and 2°31′W. Its territory is hilly and densely populated with extensive urban and industrialized areas. The fact that hardly 50 km separate sea level from the highest point (1480 m a.s.l.) gives some idea of the steepness of the relief. More than 50% of the area is dedicated to forestry at the expense of traditional small-scale farming. Most of the wood produced comes from plantations of *Pinus radiata* and *Eucalyptus* spp., while the traditional patchwork of woodland, pasture and small-holdings has been greatly reduced.

There are two Natural Parks in the study area (Gorbeia 200.16 km^2 and Urkiola 57.68 km^2), whose information centres received 35 359 visitors in 2006 (www.parquesnaturales.consumer.es), and a third Natural Park (Armañón 35.19 km^2) has been approved recently. There are one, four and three territories of Egyptian vultures, respectively (42% of the total breeding population in Biscay). The main outdoor activities during the Egyptian vulture breeding season in these parks are hiking, mountain-biking, climbing and mushroom collecting. There are no restricted areas for hiking and there is only one area forbidden to climbers, in Urkiola Natural Park, which holds one Egyptian vulture pair.

The Egyptian vulture population was estimated to be 19, occupying territories in Biscay (Del Moral & Marti, 2002). The species breeds in cliffs, some of them easily accessible on foot. The diet is based mainly on sheep and goat carcasses, and small- or medium-sized animals, mainly road-killed mammals and passerines (Hidalgo *et al*., 2005). The main threats were suspected to be human disturbances associated with free-time activities and forest timber activities (Del Moral & Marti, 2002).

Methods

Data collection

The first nest census of Egyptian vultures was carried out in the breeding season of 2000. We searched the whole study area looking for territorial pairs following a cliff-nesting raptor programme (Zuberogoitia *et al*., 2006). During breeding season more than 80 potential breeding sites for cliff raptors were monitored, which implies almost all the cliffs, quarries and rocky areas in the study area.

During the first season (2000) we detected 19 breeding sites, although four were rejected for monitoring due to technical difficulties which made it impossible to perform a complete monitoring protocol (1 – two nests placed more than 100 m below the top of the cliff; 2 – nest placed in a griffon vulture *Gyps fulvus* colony; 3 – nest placed on a private land). Therefore, we selected 15 pairs to be monitored every year between 2000 and 2007 and other appropriate places were checked every year for new nesting attempts.

The nest of each pair was determined by waiting and watching, after their return from wintering in Africa and during the pre-breeding period (between February and April), when they arrived at their territory and were searching for an appropriate hole to nest in (Donázar, 1993). The nest site visits continued in order to determine whether the pairs had begun reproduction (egg laying and incubation) and whether the chicks were developing correctly, and, in the event of interruption in any phase of the breeding season, to identify the probable cause of failure. Afterwards, between the end of June and the beginning of July, as the chicks were already 40–50 days old and developed enough to be ringed, we descended to the nests. Finally, we followed the first flights randomly, monitoring the development of the ringed chicks. Overall, we visited every nest site at least five times, including the visit to ring the chicks, in different phases of the breeding season.

Observations were carried out between 9:00 and 21:00 h from locations overlooking the nest site. Between one and three observers, normally two, spent on average 4 h four times (1 – pre-breeding period, 2 – incubation period, 3 – after chick was hatched and 4 – around the first flight period) during weekends every year. All nest site visits were made in good weather conditions (not raining or very cold days), with binoculars and telescopes. The first observations, in 2000, were carried out at short distances (Table 1), following the alert distance (AD) observed in other cliff raptors of the study area. Visits took place progressively further from the nest in each territory, depending on the

Table 1 Territories of Egyptian vultures *Neophron percnopterus* in Biscay and the maximum observation distance (m) with alert behaviour and the minimum observation distance without alert behaviour

	Maximum distance with alert reaction (m)	Minimum distance without alert reaction (m)
T1	125	
T2	221	1076
T3		730
T4	445	1410
T5		450
T6	365	1070
T7	789	959
T8	432	
T9	618	
T10	362	740
T11		530
T12		260
T13		588
T14	406	771
T15		908

Short distances were tested during the first breeding seasons at nest sites and were not repeated in order to avoid disturbances. Observation distances were determined by relief, habitat and visibility and, therefore, some nest sites could only be observed at fixed distances.

relief and the observation conditions, until the vultures were apparently unaware of the observers.

Disturbance detection

Data concerning disturbance types and their frequency, alert behaviour of adults and breeding success were collected from 15 different pairs of Egyptian vultures. The nest site visits allowed us to determine changes in the surrounding habitat of the nest site and human activity rates. We considered that a territory suffered a high disturbance when the human presence altered the behaviour of Egyptian vultures in more than 50% of the observation periods.

The human activities observed in the vicinity of the nests that could potentially cause disturbance included people hiking in the vicinity of the nest, birdwatchers observing the nest and other wildlife in the area, people collecting mushrooms, anglers and hunters, illegal raids to kill wolves *Canis lupus*, cyclists passing through the area making noise, cars, motorcycles and tractors passing or parking in the vicinity of the nest, people climbing the nesting cliff, forestry activities and shepherds with their livestock.

Egyptian vultures were very sensitive to disturbances when they wanted to enter the nest, but once in it, they got used to a relatively high level of disturbance. (1) During the pre-breeding season (February and March), when they were carrying nest material, they waited a long time after a disturbance had gone before entering the nest. Sometimes, when the disturbance was continuous, for example due to forestry activities, the pair did not lay their eggs in this nest, changing to another place or not breeding at all. (2) During the incubating period (March–May), disturbances were less damaging because the adult interchange rate is low (two or three times per 24 h). Hence, an adult wanting to enter the nest could feasibly wait for several hours until the disturbances had gone. (3) During the chicks' first month of life (May–June) one adult remained in the nest, while the other was looking for food. In this period, disturbances only affected the incubating adult when they took place very close to the nest, and affected the feeding rate of the chicks because the flying adult would not enter the nest until the disturbance had gone. Nevertheless, the feeding demand of small chicks is low in this time, thus adults could delay feeding without evident consequences. (4) During the second half of growing (June–July), the feeding demand of chicks obliges both adults to search for food and the feeding rate increases proportionally to age (Donázar, 1993). In this period, when both adults were out, any disturbance could delay the feeding event (see Romin & Muck, 1999). Moreover, this is the period when a maximum number of people are enjoying outdoor activities because the weather conditions are usually favourable and the daylight period is at its longest. It was during this period that we detected the highest mortality of chicks due to starvation, because the disturbances were continuous for one whole day and more frequent during the weekends with the inevitable result that adults could not attend to the nestlings. In fact, considering the known loss occurrence ($n = 24$), 79.2% of the losses occurred when chicks were 30–50 days old, and 20.1% during the incubating period.

Maximum alert distance (MAD)

Alert behaviour was considered to be when a single vulture was prevented from entering its nest and flew around the cliff in apparent uneasiness. This behaviour was more evident, as we have explained above in stage 4, when adults were raising chicks, and, therefore, we tested the ADs in this period. We measured AD as the distance between the observer (us) and the nest. The viewpoints were situated progressively further away in each territory (Table 1), until the vultures were apparently unaware of the observers. We avoided repeating waits at distances at which alert behaviour in adults had been previously observed because of their threat status (e.g. González *et al.*, 2006) and following an ethical protocol. Therefore, the sample size of AD was limited to prevent negative effects on the breeding success, and to avoid pseudo-replication of data. Once we established the MAD (safe distance), following observations carried out at this distance did not alarm the birds or alter their behaviour. Safe distances were heavily dependent on what distances were available (relief, habitat and visibility). Distances were measured on a geographic information system using digital cartography and georeferenced aerial photographs at 1:5000 scale.

MAD was calculated as the mid-point between the maximum distance at which alert behaviour was recorded and the minimum distance at which birds showed no alert behaviour. Buffer areas were calculated as $\Pi \times (1.5\text{MAD})^2$ (Fox & Madsen, 1997; Fernández-Juricic *et al.*, 2005).

Table 2 Territories of Egyptian vultures *Neophron percnopterus* and their different nest sites in Biscay

Territories	Nest	Disturbance causes	Frequency	Distance (m)	Affection period
T1	N1	A, B, E, G, I	Chronic effect	30	2000–2003
T3	N1	C, E, G	Chronic effect	300	2007
T5	N1	A	Chronic effect	10	2003
T6	N2	J	Chronic effect	5	2004
T7	N1	A, B, E, G, H, I	Chronic effect	50	2000–2003
	N2	A, B, E, G, H, I	Chronic effect	100	2004–2006
T8	N1	B, E, G	Chronic effect	5	2002–2004
T4	N1	G, H, I	High rate	114	2000, 2001
	N2	G, H, I	High rate	195	2002–2005
	N3	G, H, I	High rate	289	2006, 2007
T9	N1	G, I	High rate	246	2000–2007
T10	N1	G, H, I	High rate	173	2002, 2003
	N2	G, H, I	High rate	175	2004, 2005
T13	N1	F, G	High rate	100	2000–2007
T14	N1	F, G	High rate	100	2000, 2001, 2003
	N2	F	High rate	2	2007
T2	N1	E, G, H, I	Low rate	860	2000–2002
	N2	E, G, H, I	Low rate	860	2003
	N3	E, G, H, I	Low rate	300	2004
	N4	E, G, H, I	Low rate	860	2006
	N5	E, G, H, I	Low rate	860	2005, 2007
T3	N1	G, I	Low rate	300	2002–2006
T5	N1	G, I	Low rate	300	2000–2002
	N2	D	Low rate	450	2003–2005
	N3	D	Low rate	778	2006, 2007
T6	N1	I	Low rate	365	2000, 2001, 2005–2007
	N2	I	Low rate	365	2002, 2003
T10	N3	D	Low rate	740	2006, 2007
T11	N1	D	Low rate	530	2002–2006
T12	N1	D	Low rate	454	2000, 2001, 2004–2007
	N2	D	Low rate	390	2002–2003
T14	N2	G, H, I	Low rate	771	2002, 2005, 2006
T15	N1	G, I	Low rate	600	2001
	N2	G, I	Low rate	700	2004
	N3	G, I	Low rate	750	2005–2007

Main disturbance causes are pointed out: A, forestry activities; B, new forest tracks; C, new quarry; D, roads; E, motocross; F, climbers; G, hikers and mountain bikers; H, birdwatchers; I, shepherds; J, fire. Nests are classified depending on the disturbance rate suffered: chronic effect, when disturbance causes were detected almost everyday or the effect was permanent such as a forestry cut around the nest; high rate, when disturbances were detected more than 50% of the times; low rate, when disturbances were occasionally detected. Minimum distance between the nest and the disturbance cause is also considered.

Results

A total of 100 breeding attempts of 15 breeding pairs were monitored over the study period. In this time, 10 territories suffered chronic or continuous disturbances (Table 2), resulting in 42 affected breeding attempts. The most aggressive disturbances were due to new forest tracks close to the nest sites, which involved three pairs losing a total of 13 clutches out of 13 breeding attempts (100%) and the loss of the three territories (Table 3). Two of these pairs (T1 and T8) did not change the nest site, while the other pair (T7) tried to nest in another cliff also affected by the forest track. Another pair (T5), which had bred successfully three times, lost a clutch due to forestry work and changed the nest site to another cliff placed 1500 m away where they bred successfully. Outdoor activities, mainly climbing and hiking, deeply affected four pairs, two of them (T13 and T14) within Natural Parks, which lost 11 clutches out of 25 breeding attempts (44%). Two of these pairs changed the nest site 949 m (T14) and 4565 m (T10), respectively, and since then have bred successfully. Finally, one pair (T6) lost a clutch due to a fire caused to eliminate bushes in a cattle area and last year a small mine was opened 300 m from another nest causing the loss of the chick of the only pair (T3) which had previously bred successfully every year.

The average number of chicks fledged per breeding pair ranged between 0.64 and 0.86 per year over the study period (see Fig. 1). This rate ranged between 0 and 0.6 chicks fledged per breeding pair per year in those territories affected by disturbances, while ranging between 0.75 and

Table 3 Breeding success of the Egyptian vulture *Neophron percnopterus* monitored territories in Biscay during the study period, including the different nest sites

		Year							
Territories	Nest	2000	2001	2002	2003	2004	2005	2006	2007
T1	N1	0	0	0	0				
T2	N1	0	1	1					
	N2				0				
	N3					1			
	N4							1	
	N5						1		1
T3	N1			1	1	1	1	1	0
T4	N1	0	0						
	N2			1	1	1	2		
	N3							1	1
T5	N1	2	2	2	0				
	N2					2	2		
	N3							1	2
T6	N1	1	1				1	0	2
	N2			1	1	0			
T7	N1	0	0	0	0				
	N2					0	0	0	
T8	N1			1	0	0			
T9	N1	2	2	2	0	1	0	0	1
T10	N1			0	0				
	N2					0	0		
	N3							2	1
T11	N1			0	0	0	0	0	
T12	N1	2			2	0	1	1	1
	N2		1	2					
T13	N1	0	0	1	2	2	2	0	2
T14	N1	0	1		0				
	N2			0		1	1	1	0
	N2								
T15	N1		1						
	N2					0			
	N3						1	1	0

0, loss of eggs or chicks; 1, one fledgling; 2, two fledglings; ( ) = no clutch.

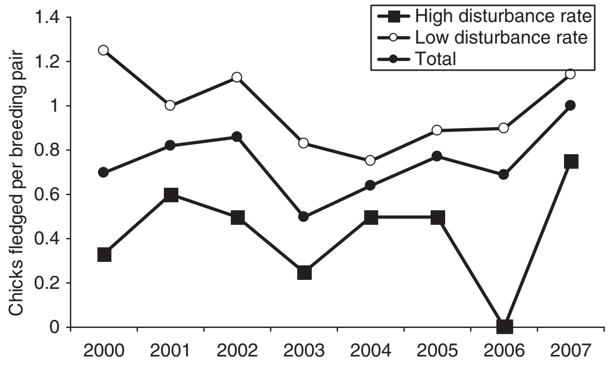

Figure 1 Breeding success of Egyptian vulture *Neophron percnopterus* on disturbed and undisturbed sites over the study period.

1.25 chicks fledged per breeding pair per year in those territories free of disturbances. There were significant differences in the breeding success of pairs with or without disturbances (Student *t*-test, $t = -5.458$, d.f. = 13, $P = 0.000$).

Twelve nest sites (24.49%) were changed without evident disturbances at an average distance of 125.8 m (SD = 425.85, max = 2700 m) and seven nest sites (19.44%) were changed after disturbances at an average distance of 228.0 m (SD = 815.9, max = 4565 m). There were no differences in the distance between one nest and the new one considering those situations free of disturbances and those after disturbances (Mann–Whitney *U*-test, $U = 845$, $P = 0.652$, $n = 85$).

There were no statistical relationships between breeding success and monthly rainfall (Spearman's correlation test, $R_s = -0.415$, $P = 0.307$, NS) and number of rainy days in May and June (Spearman's correlation test, $R_s = 0.162$, $P = 0.702$, NS).

The effect of disturbances was tested at 39 different points of 13 nest sites (Table 1). Adults did not enter the nest when somebody was at an average of 307 m (SD = 146, max = 618, $n = 19$), while adults entered the nest when the observer was at an average of 837.5 m (SD = 401.8, min = 260, $n = 20$). There were significant differences between both situations (Student *t*-test, $t = -5.421$, $P = 0.000$).

MAD was estimated at 605 m and the buffer area was 57 ha.

Discussion

Wildlife conservation today in areas of high human density is a very complicated undertaking (Woodroffe, Thirgood & Rabinowitz, 2005; Markovchick-Nicholls *et al.*, 2008). Habitat alteration, large infrastructures, poisons, biocides and illegal hunting are just some of the typical threats associated with urbanization. Moreover, the comparatively high quality of life in Europe makes for large numbers of people indulging in modern outdoor pastimes (trekking, climbing, rafting, mountain-bike, motor-bike, bird-watching, photography and many others), which provoke an ever-increasing human presence in the field (Bathe, 2007). Such activities are characteristically part of visitor programmes in Natural Parks and other protected areas of special interest due to the landscape, wildlife or both. The increasing presence of people in the wilderness has marked effects on the spatial and temporal distribution, foraging behaviour and breeding success of wildlife (Fernández-Juricic & Telleria, 2000; Gill, Norris & Sutherland, 2001; Liberatori & Penteriani, 2001; Bautista *et al.*, 2004). In this context, the conservation of a highly sensitive and endangered species such as the Egyptian vulture has many complications to achieve even minimum objectives. Our study showed that some human activities, particularly in the close surrounds of the nest, have an influence on Egyptian vulture behaviour, particularly on the probability of the nest being left unattended, and therefore also on the probability of nest failure. Arroyo & Razin (2006) and González *et al.* (2006) showed similar influence of disturbances on the bearded vulture *Gypaetus barbatus* and the Spanish imperial eagle *Aquila adalberti*.

The breeding success of Egyptian vultures in industrialized areas is strongly influenced by human activities around the nest site. Human activities and habitat modification close to the nest can cause a breeding pair to leave the nest for an alternative one, or to definitively stop attempting to breed in the area if no other cliffs are available in the immediate vicinity. In such cases, the territory may continue to be occupied, as in our study, but with no breeding attempts made. This situation could continue until the breeding pair dies or a vacancy in a neighbouring territory arises and in either case, it will cause the loss of a breeding area. In our study this happened in three territories, affecting 20% of the breeding population.

Other pairs affected by habitat alterations moved to alternative areas where less suitable cliffs are available, but this means a redistribution of territories and implies a reduction in the availability of potential and maybe optimal nest sites for the affected pair. The observed tendency is the loss of nest sites and the occupation of other cliffs, perceived to be of lower quality, which may result in an increase of breeding failures (Sergio & Newton, 2003) and could have a definitive effect on population size and dynamics (Gill, 2007).

Moreover, the frequent presence of people in the breeding areas alters the behaviour of adults, mainly during the second half of the nestling period. In fact, Egyptian vultures are extremely cautious when they approach the nest, and tend not to enter if any disturbance is occurring in the surroundings. The average 307 m distance from where human disturbance could alter the behaviour of breeding birds is similar to those estimated for other large raptors (golden eagle *Aquila chrysaetos*, Holmes *et al.*, 1993; bearded vulture *G. barbatus*, Arroyo & Razin, 2006; Spanish imperial eagle *A. adalberti*, González *et al.*, 2006). We proved that an average distance of 837 m could be valid when experienced naturalists observe discreetly the feeding behaviour of the species, and even so adults show a distinct uneasiness. One pair (T13) was relatively habituated to human presence due to the continuous frequency of people climbing and hiking close to the nest site (Ferrer *et al.*, 2007), although according to González *et al.* (2007) even if the results showed that some habituation does exist, this could not prevent a decrease in reproductive success. In fact, the habituated pair lost three out of eight clutches, when the chicks were almost full grown. The occasional presence of people inside the protection radius would delay the feeding event, but their continuous presence experienced under good weather conditions may cause repeated and extended delays of the feeding visits, increased energy expenditure and presumably weight loss among the chicks. Actually, several chicks of exposed pairs died after a long period of sunny days. This could explain why there were no relationships between breeding success and rainfall in a wet area where rain is known to reduce the breeding success of other birds of prey (Zuberogoitia, 2000; Zuberogoitia *et al.*, 2006).

The evident effect of disturbances on the breeding success of Egyptian vultures reflects the importance of urgent and appropriate management of conservation practice. A high number of breeding failures (44%) affected pairs nesting in Natural Parks as a consequence of disturbances caused by people climbing the cliffs where the nests are placed. In the same way, three pairs currently established in the new Natural Park (Armañon) will suffer the same problems from now on, when people come in large numbers, attracted by the very data that should protect them. Policies applied within Natural Parks need to be revised in order to ensure that they fulfil the principles of conservation of endangered species (Romin & Muck, 1999).

Conservation implications

Martínez *et al.* (2003*a*,*b*) suggested that conservation in Spain needs a mechanism to coordinate the scientific community and environmental agencies led mostly by technicians. Afterwards, management mechanisms should be appropriately monitored with regard to wildlife conservation. Our data show the deep impact of human disturbances around the nesting cliff. In most cases, this impact caused the continuous loss of clutches until the total disappearance of the species from the territory. It is therefore urgent and vital that scientists, birdwatchers, environmental companies and local, regional and state authorities work together to preserve nest sites from human disturbances and environmental changes. In the absence of such cooperation, there is no official norm which establishes minimum protection distances around nest sites.

The safety distance, indicated by our research, would be 605 m and the buffer area 57 ha around the nest, similar to the figures for the Spanish eagle obtained by González *et al.* (2006). Sometimes, in a densely populated area such as ours, keeping people outside this boundary is almost impossible. Responses of nesting raptors to human disturbances are generally determined by the type, duration, magnitude, noise level and timing of activity relative to nesting phenology (Romin & Muck, 1999). In this way, we have seen that a high rate of human presence around the nest site (Table 2), even considering short time disturbances such as hikers, mountain-bikers or shepherds, could provoke the loss of the nest; the same activities undertaken less frequently and at greater distances may be tolerated (Table 2). These distances are normally determined by forest tracks, which are the main cause of territory abandonment when a new one is developed close to the nest. Hence, knowing the nest sites and other unoccupied territories spatial buffers need to be established to prevent habitat alterations, including new tracks and seasonal buffers, which are restrictions on the times when human activities should be allowed to occur within the spatial buffers (see Romin & Muck, 1999). Of course, this implies great cooperation on the part of the authorities, mainly in Natural Parks and other protected areas, which were initially set up for wildlife conservation but today are emerging as a double-edged blade given the number of visitors wanting to enjoy these natural sites.

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