

EFFECTS OF RECREATION ACTIVITIES ON A BROWN BEAR FAMILY GROUP IN SPAIN

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Abstract: Activity patterns, movements, and habitat use of a family group of brown bears (*Ursus arctos*), radiotracked during 5 months, were significantly different on holidays than on workdays in Somiedo Natural Park, Asturias, Spain. Straight-line distances between daily consecutive radiolocations during holidays (0.74 km, SD = 1.1, $n = 86$) were twice those of workdays (0.38 km, SD = 0.31, $n = 67$). Further, 43 visual observations (summing to 1,943 minutes) of the family group showed greater investment in activities such as travel, fleeing, and vigilance on holidays (55% vs. 39% on workdays). Habitats used during holidays differed, as demonstrated by a significant increase of rocky outcrops (26%, SD = 23, workdays; and 38%, SD = 25, holidays) and higher distances to unpaved roads (0.35 km, SD = 0.21, workdays; 0.45 km, SD = 0.22, holidays). Although our sample size was limited to an adult female with cubs in the western Cantabrian Range in a population of only 50–65 bears, the results show that she seemed to avoid human presence and may have fostered similar behavior in her cubs.

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Key words: activity patterns, brown bear, Cantabrian Range, daily movements, habitat use, human activity, tourism, *Ursus arctos*

Bears usually flee after detecting humans (Herrero 1985, Mattson 1990, Revenko 1994). Knowing the effects of human activities on brown bear ecology and behavior can assist management of critical habitats for persistence of bears in the Cantabrian Range and other small European populations. New human activities in wildlands are rapidly growing in the Cantabrian Range in northern Spain. Tourism is one of the most important at present, but there is scarce information on the effect of recreational activities on European brown bear movements, activity, and patterns of habitat use (Elgmork 1978, 1983; Zunino 1981; Mattson 1990).

By radiotracking a family of bears (mother and 2 cubs) for 5 months, we investigated the relationship between brown bear behavior and human presence. Our prediction was that daily movements, activity patterns, and habitat use of the brown bear family would be affected by the number of visitors and their activities (e.g., tourism, hunting) in the area.

STUDY AREA AND METHODS

Our study was located in Somiedo Natural Park (Fig. 1) in the western nucleus of the Cantabrian bear range, where only 50–65 bears remain (Palomero et al. 1993, Wiegand et al. 1998). The park was established in 1988 and encompasses 292 km² of rugged landscape, with 29.3% forest cover, mainly of beech (*Fagus sylvatica*), oak (*Quercus* spp.), birch (*Betula alba*), and chestnut (*Castanea sativa*) woodlands.

Paved road density was 0.59 km/km², and forest (unpaved) road density was 0.60 km/km². There were 36 villages with a total of about 1,760 inhabitants, where the main occupation was raising cattle (around 6,000), horses

(1,000), sheep, and goats. Tourism was an increasingly important economic activity in the park. In 1998, approximately 60,000 people visited the park.

We captured a 10-month-old male brown bear cub weighing 31 kg in an Aldrich foot snare (Margo Supplies, Calgary, Alberta, Canada) on 13 November 1997 and glued a radiotransmitter (Wagener, Koeln, Rheinland Westfalen, Germany) to the hair on its back. The bear was in a family group (mother and another cub) until 20 April 1998, when he became an independent juvenile. We used data only from the family group, because the juvenile may have used suboptimal habitats shortly after leaving the family unit.

The family group was radiolocated daily over a period of 151 days, but we were unable to find the signal (due to presumed long distances travel of the bears) on 4 days (22 and 23 November, 21 and 31 December), and no searching was conducted on 3 days (25 December and 19 and 20 March). The bear's position was estimated by triangulation with the software LOCATE II (version 1.3, available from V.O. Nams, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada) from ground bearings received on hand-held 2-element directional antennas (Telonics, Mesa, Arizona, USA). Locations were assigned Universal Transverse Mercator (UTM) grid coordinates. We attempted to avoid disturbing the bears: mean distance from bears to receiver was 1,027 m (SD = 546). We quantified location error by measuring the distance between the estimated triangulated location and the bear's observed position in the 26 cases where we saw the bear at nearly the same time (225 m, SD = 110).

Daily movements were estimated from distances between consecutive daily locations. Bear activity was documented through 43 visual observations (1,943 minutes)

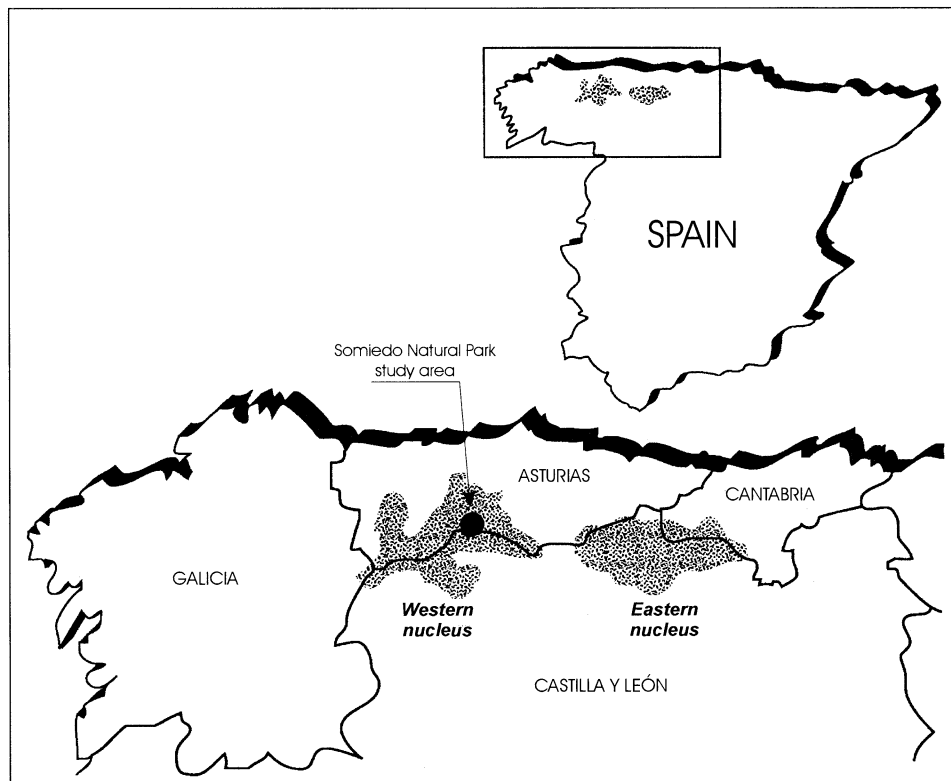


Fig. 1. Study area (Somiedo Natural Park, black dot) and the range of the brown bear (shaded areas) in northern Spain.

of the family group, noting the time devoted to each type of activity (feeding, play, fleeing, travel, resting).

We estimated patterns of habitat use by quantifying geographic variables obtained from a geographic information system (ArcView 3.1, and ArcInfo 7.0.4, ESRI Inc., Redlands, California, USA). Variables chosen to define habitat were elevation, slope, and distances to paved roads, unpaved roads, and villages from each estimated location point. We also quantified percent forest and rocky outcrop surface in a circle with a 250 m radius (19.6 ha) around each location.

Intensity of human presence was grouped into 2 categories: high intensity (holidays) and low intensity (workdays). We considered holidays all days with a high potential number of visitors: weekends (including Monday, when we recorded the distance moved since Sunday), holidays and the following day, 24 days around Christmas, and 10 days around Easter. In all, 88 days were considered holidays and 70 workdays. To test the presumed relationship between holidays and numbers of visitors, we used data from the Reception Center of the Natural Park: a total of 4,176 people registered during our study period, 91% on holidays and 9% on workdays.

Comparisons of means were made by using the Mann-Whitney *U*-test. Significance was taken as $P < 0.1$.

RESULTS

Daily Movements

The mean straight-line distance between consecutive daily locations was 0.55 km ($SD = 0.88$, $n = 143$) with a maximum of 6.65 km, and 95% of distances were < 1.7 km. There was no evidence of denning. The period between 30 January and 2 February (inclusive) was the longest without apparent activity and the coldest of the winter. Mean daily distance moved by the family group during workdays was 0.38 km ($SD = 0.31$, $n = 67$), significantly less than the 0.74 km ($SD = 1.1$, $n = 86$) recorded on holidays ($P < 0.1$).

The family group moved > 1 km on 21 days, and 17 of these were on holidays, including 2 days in which bears returned to the usual core area immediately after a weekend (Fig. 2). We failed to radiolocate the bears on 3 occasions, all during holidays. We presume our inability to locate the bears on these occasions was because they moved far from our research base. After 2 days' absence, the bears were found 3.0 km from their previous location, and after one day's absence, they were found 3.6 km away.

We did not detect changes in bear movement in response to other human activities. Hunting drives, mainly of wild boars (*Sus scrofa*), were legal in the Game Management

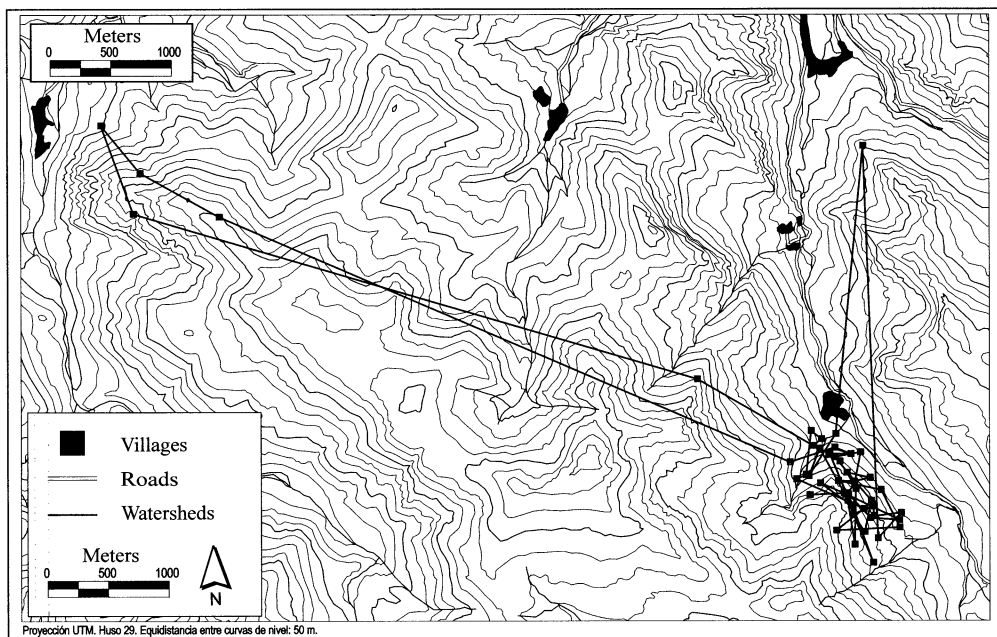


Fig. 2. Two cases of long distance movements by the radiomarked bears between 19 November and 11 December 1997. Travels took place 2 of the 3 weekends of that period. All radiolocations collected in the 23-day period are indicated to show the usual area of movements of the family group.

Unit, which included the bears' home range. Average distances moved the day following hunting drives (0.39 km, SD = 0.46, $n = 25$) did not differ from a random sample ($n = 25$) of days without hunting activity ($P > 0.1$).

Activity

The family group was observed 18 times during holidays (849 minutes) and 25 times on workdays (1,094 minutes). During workdays, bears devoted 39.2% of time we observed them to travel, vigilance, or fleeing, but these behaviors increased ($P < 0.05$) to 54.7% of the time during holidays.

Habitat Use

We found a significant increase ($P < 0.01$) in mean percentage of rocky outcrops within 19.6 ha circles centered on estimated locations during holidays (38%, SD = 25) compared with workdays (26% mean, SD = 23). Mean distance to unpaved roads was also larger during holidays (0.45 km, SD = 22) than during workdays (0.35 km, SD = 0.21, Table 1).

Observed Interactions with Human Activities

In 5 instances we observed apparent displacement of bears by humans. These included the following.

8 December 1997. — Three visitors hiking on a cattle path (in an area closed to tourists) came within 100 m of the bears. This incident coincided with the longest move-

ment we observed (>6 km from the usual winter area). The family group returned to the usual area 2 days later.

23 December 1997. — The simultaneous occurrence of agricultural activities (with machinery used), a small group of tourists, and 2 researchers within 200 m of the resting bears appeared to cause a 3.1 km movement.

28 December 1997. — Radiotracking on foot by 3 researchers on a forest road 450 m from the bears seemed to cause a movement of 800 m within 75 minutes.

12 February 1998. — The approach of the research all-terrain vehicle to within 350 m of the family group probably caused a 450 m movement within 5 minutes. The bears were 750 m from a village and 300 m from a forest road at the time of this incident.

19 February 1998. — Five shots during a wild boar hunting drive, 1.2 km from the bears, were the probable cause of a 700 m movement within 45 minutes. This movement included crossing a ridge to another drainage.

DISCUSSION

Knowledge of bear reactions to human activities such as tourism and hunting is available from North America (McLellan and Shackleton 1989, Kasworm and Manley 1990, Albert and Bowyer 1991, Fagen and Fagen 1994, Olson and Gilbert 1994, Mace and Waller 1996) but scarce in Europe (Elgmork 1978, 1983; Zunino 1981). Our results suggest that brown bear activity patterns, movements, and habitat use in Somiedo Natural Park were significantly

Table 1. Variables means (standard deviation in parentheses) of habitat used by bears during workdays and holidays

	Elevation m	Slope°	% cover (19.6 ha buffer around locations)		Distance (in km) to		
			Forest	Rocky outcrop	Paved road	Unpaved road	Villages
Holidays	1251 (170)	34 (7)	61 (20)	38 (25)	0.60 (0.30)	0.45 (0.22)	0.67 (0.30)
Workdays	1258 (146)	33 (6)	60 (19)	26 (23)	0.58 (0.27)	0.35 (0.21)	0.65 (0.27)
<i>P</i> values ^a				— ^b		—	

^a Mann-Whitney *U*-test = 0.01 > *p* > 0.001

^b — indicates 0.01 < *p* < 0.001

affected by the presence of humans in bear habitat.

We are confident that we were usually far enough from the bears when observing or tracking that our presence did not influence their movements, but this made it difficult to identify causes of their reactions. Human activities related to holidays were mainly those involved with recreation, such as touring, visiting relatives, and hunting. Detailed data on recreation activities were scarce in the Cantabrian Range, but tourism has recently increased rapidly, particularly during holidays. By 1998 the numbers of registered visitors was 6 times those of 1990, while commercial licenses related to tourism increased from 2 in 1988 to 41 in 1998. Hunting activity also increased in the bear range by 73% since 1988. During the 6-month hunting season of 1998–99, approximately 300 wild boar hunting drives occurred in Somiedo Natural Park (i.e., one drive per km² on average). Visitors to residents living near bear habitat could have contributed to the increase of bear movements during holidays, but this was difficult to measure.

Despite increased mechanization and new forest road construction in recent years, recreational activities are more unpredictable in time and space and are more extensively distributed than are traditional activities (livestock raising and agriculture). As well, the rapid development of recreation is a recent phenomenon. Traditional partitioning of habitat by European brown bears and rural human residents facilitated mutual avoidance (Mattson 1990). Some (usually small) areas rarely visited by humans have constituted critical refuges for bears (Zunino 1976, Naves and Palomero 1993). However, under some circumstances, brown bears can become habituated to human activities and stop avoiding people (McCullough 1982). Habituation occurs most frequently where human activity is predictable in space and time, and is facilitated by concentrated foraging areas, such as human garbage dumps (Mace and Waller 1996) and salmon (*Oncorhynchus* spp.) streams. In the Cantabrian Range, there seems to be a degree of habituation to traditional human activities that are predictable in space, time, and intensity, such as paved road use, livestock raising, agricultural activities, and village life in general. How-

ever, low intensity but relatively unpredictable recreational activities could have a large effect on bears. It appears that factors such as visual contact, distance, and location of the human activity are more important to bears than intensity of activity.

A previous study in Somiedo Natural Park found that bear locations were generally far from human developments, despite bear food production usually being higher in valley bottoms, near the human activities (J. Naves, P. García, A. Fernández, and A. Ruano, 1997, *Uso del hábitat por el oso pardo en Somiedo: Influencia de las actividades humanas [1994–1996]*, Principado de Asturias, Oviedo, Spain). Also, Wiegand et al. (1998) concluded that the Cantabrian bear population had declined 5% annually over the last 2 decades. Mattson (1990) suggested that European brown bears could be innately so wary that human density alone may influence population viability, even in the absence of direct mortality. Additional disturbance could further decrease reproductive success (McCullough 1982). Under these conditions, the rapid increase of modern recreational activities could compromise the effectiveness of formerly secure sites (Zunino and Herrero 1972, Zunino 1981, Roth 1983).

We caution that we collected data on only a single family group of bears and only during a portion of a single year. We will require data on bear habitat requirements from a larger sample of tagged individuals before more definitive conclusions can be made. Meanwhile, park management administration should take steps to minimize the effects of recreation activities on bears.

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