

CHANGES IN BROWN BEAR PREDATION ON LIVESTOCK IN THE WESTERN FRENCH PYRENEES FROM 1968 to 1979

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Abstract: As a result of declining populations and habitat loss over the past decades, the Pyrenean brown bear (*Ursus arctos Pyrenaicus*) is limited to 2 isolated populations confined to remote areas of the Pyrenees. The remnant population in the western French Pyrenees is the largest and best known. Confronted with the lack of bear population data, we decided to analyze bear predation on livestock data recorded between 1968 and 1979 for insight into recent bear population size and trends. During the 12-year study we investigated 606 bear attacks in detail. The investigations were in response to farmer claims for compensation following acts of bear predation on livestock. During the study period, the number of attacks per year and the range of bear predations decreased gradually. This decline occurred throughout their range to varying degrees. This disparity was particularly marked west of the Aspe River in an area where human disturbance is great.

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Many hunting stories from the Middle Ages acknowledge the presence of bears in the foothills of the north pyrenean piedmont region. Since then, bear populations slowly retreated until they occupied a few valley bottoms in the 20th century. In 1937, Bourdelle (1937) estimated the population at 200 animals; years later, Couturier (1954) noted that bear range continued to shrink. The population broke up at last into 2 distinct nuclei; one located in the western Pyrenees and the other in the central and oriental Pyrenees (Camarra 1981, 1982, 1983; FIEP 1981; Parde 1983). Roben (1980) was incorrect when he said that the last brown bears survive in the Western Pyrenees.

Census methods used by these authors (interviews, local inquiries) do not provide good population estimates, so the only reliable data concern bear presence.

Just before 1962, when bears became protected in France, the mountain hunting association initiated a procedure to settle claims associated with bear depredations. Accurate bear depredation data could thus be recorded. Since then, the reimbursement procedure has become standardized, and damage claims are paid from a special fund by the Office National de la Chasse. The National Park of the Western Pyrenees investigates the bear depredation complaints.

The continuous presence of field workers in the western Pyrenees from 1981 to 1983 allowed us to estimate the bear population at 13-16 animals dispersed over 800 km² (Camarra 1981, 1982, 1983 unpubl. data). But these data do not allow an evaluation of population trend. To evaluate trend, we used bear attacks on livestock between 1968-79 as an index of bear presence.

Once the carcass of a domestic animal is discovered, an expert report is completed defining the cause

of death. Data such as the condition of the carcass, its location, and the presence of nearby bear marks are recorded. The only claims liable for payment are those that prove the animal was killed by a bear. Occasionally a lost animal is never found and animals die for reasons other than bear attacks and are found by bears. If these carcasses are found with bear marks, the farmer will be paid for losses without proof they had been preyed upon.

Between 1968 and 1979 farmers were indemnified against the meat value of the animal and for the lost opportunity for doing business during the season under consideration. As of 1980, the inconvenience of calling the game keepers was also taken into account, so that compensation payments are currently twice the meat value. Because of the difference in amounts paid out after 1980, we limited our study period to 1968-79.

The bear damage reports were completed by game wardens of the Western Pyrenees National Park. Data analysis was part of a contract between the Office National de la Chasse and the Societe Nationale de Protection de la Nature. I am particularly grateful to the Western Pyrenees National Park game wardens and the Office National de la Chasse game keepers, who provided valuable assistance at various stages of the field work.

STUDY AREA

In 1970, this isolated bear habitat was comprised of over 120,000 ha in the Pyrenees Mountains covered with forests fragmented by traditional pastoral activities. The forests generally occur between 400 and 1,800 m on north-facing slopes and cover almost 40% of the area. The other parts of the range are made up of prairies, pastures, and rocky slopes.

RESULTS

Conditions of Bear Attacks

We have little predation data with regard to bovine, horse, and caprine herds that roam uncontrolled. Sheep flocks under strict control are frequently attacked at night while they are near the shepherd's hut. Flock size does not seem to influence the frequency of bear attacks, but the number of flocks, the way they are tended, their location, and the local weather conditions are related to bear losses.

The highest rate of attacks was observed during the summer when flocks occupied high-elevation and subalpine pastures. The number of attacks peaked between late August and the 3rd week in September. Bear predation rates are low in spring and autumn because few domestic livestock are in the mountains at that time; depredations are nonexistent during winter.

Number of Attacks

We recorded 606 attacks, representing an annual mean of 52 with a peak of 80 attacks in 1969 and a minimum of 16 in 1976. No consistent trend was apparent. The number of attacks and the range of predation, i.e., where these attacks took place, remained relatively stable (Table 1).

Sites of Attack

Although the number of flocks was consistent throughout the study area and did not change much during the study (Dalla Rosa 1980, Caussimont 1981), we noticed marked differences in the rate of

bear predation from 1 site to another and between years. The 12 years show bear attacks occurring over about 1,200 km², which approximates the distribution and range reported during the same period by indices of presence (sightings, trails, feces). These zones are situated within an east-west oriented rectangle 62.5 by 30 km. The highest predation rates are in the central part of the study area, mostly on the east- and west-facing slopes of the Aspe Valley. In fact, 49.5% of the attacks occurred within an area representing only 10% of the predation range.

On either side of the central part of the study area lies a zone where depredations occur less frequently. However, some attacks, especially in 1972, take place outside the common bear range.

Changes Over Time and Space

An analysis of the annual number of bear attacks, i.e., predation rates, recorded during the study shows a slight downward tendency ($r = -0.30$, $df = 10$), which corresponds to 16.7 fewer attacks (Table 1). The analysis of variance confirms this correlation.

To study geographic variation in the distribution of predation rates, we partitioned the study area into 2,500-ha squares according to the Lambert III grid layout. This method enables us to plot, year by year, the quadrats in which at least 1 attack had taken place and assess changes in the range of predations. The bear predation range decreased an average of 2 quadrats per year, but it declined less rapidly than the annual number of attacks. These findings were confirmed by analysis of variance. This declining distribution was confirmed by comparing the locations of bear attacks that had been reported in the 1st 3 years (1968–70) with those reported in the last 3 years (1977–80) of the study. Most changes took place at the eastern and western edges of the range. However, the temporary extension of the predation range was noticed in the eastern part of the range in 1973, 1974, and 1975. After the discovery in September 1975 of a dead old male bear at the foot of a cliff (Omnes 1980), bear attacks suddenly ceased in this region.

Dividing the study area into quadrats allowed us to evaluate annual changes in predation rates at a given site, i.e., within a given quadrat. The mean annual rate of predation was 1 attack/2,500 ha quadrat. We observed geographic variations in the annual predation rate ranging from 0.08 to 5.40 attacks/2,500 ha. In addition to measuring mean annual pre-

Table 1. Number of bear attacks on livestock and range of predation in the western Pyrenees, 1968–79.

Year	No. of attacks	Range of predation (km ²)
1968	64	475
1969	80	700
1970	54	550
1971	51	500
1972	51	600
1973	46	400
1974	46	500
1975	35	400
1976	16	200
1977	62	425
1978	56	425
1979	64	500

dation rates, we compared these to the overall predation pattern throughout the study area to obtain a good representation of sites with important negative trends. Data obtained in each quadrat show some sites with opposite trends with respect to the annual rate of predation. These differences in the degree of bear predation are much more marked west than east of the Aspe River (Table 2).

Peak and minimum levels of predation that had been observed in 1969 and 1976, respectively, west of the Aspe River did not occur in the eastern range.

Because differences in rate of predation are relatively significant across the Aspe River, we believe the 2 subpopulations located on either side are fairly independent. The recent home range study of some individual bears confirms this in that bears seldom crossed the river (Camarra, unpubl. data).

Predation Rates and Prey Availability

The sites with the highest livestock densities, mostly of sheep, are not necessarily those with the highest rate of predation. This is all the more significant because I observed few attacks on unattended flocks in the boundary zones of the predation area, whereas predation rates were high in some centrally located sites where shepherds and dogs carefully tended their flocks.

DISCUSSION

Bear predation rates on livestock may serve as an index of abundance of bear populations. Although we know that other factors, such as weather, food

availability, and human activity are involved, their impact is not clear and they cannot account for the large differences in the bear depredation rate. We noticed weak relationships between rainy conditions and a high rate of predation and between warm weather and a low rate (Camarra, unpubl. data; Ribeyre 1974). A better knowledge of the individual differences in bear behavior could shed new light on this phenomenon. Differences in behavioral patterns are difficult to observe because bear populations are small, persecuted, and thus unstable. The conclusions resulting from our analysis are still very general and therefore formulated in terms of hypotheses.

This analysis shows that the rate of predation and the bear predation range decreased more rapidly than the number of livestock. This indicates an actual but slight reduction in bear numbers and a reduction of their range during 1968–79. If, in accordance with counts carried out since 1981, we agree that the 1979 bear population numbered some 15 individuals (Camarra 1981, 1982, 1983), then the bear population might have reached 20 individuals in 1968. It seems that the bear predation range has not decreased as rapidly as the rate of predation and perhaps the size of the bear population. This supposes that the decline in bear population might be followed closely by an increase in the size of their home ranges. Nevertheless, we noticed a relationship between the steady occurrence of indices of bear presence and the number of bear attacks on livestock. Moreover, the absence of livestock does not influence the rate of bear occurrence as much as natural factors do.

We noticed some very rare cases of temporary enlargement of the bear range that were confirmed by actual sighting of 2 adult bears. The subsequent discovery of the carcass of a large maie was the last mark of bear presence on this site. The 2nd animal probably went back to the more centrally located sites, which makes me think that the presence of a group of several individuals increases sedentariness in bears. This hypothesis might be corroborated by the fact that in the central and eastern parts of the Pyrenees, an area with a sparse bear population, bears were more sporadically observed than in the surrounding area of the western nuclei.

A more detailed analysis of changes in the rate of predation in each site shows the development of a different trend on either side of the Aspe River. On the eastern side, predation rates are evenly declining in all sites, whereas west of the Aspe River predation rates declined more sharply but unevenly throughout

Table 2. Number of bear attacks east and west of the Aspe River, western Pyrenees, 1968–79.

Year	West of Aspe River	East of Aspe River
1968	43	21
1969	66	20
1970	32	22
1971	34	17
1972	30	21
1973	31	15
1974	27	19
1975	21	14
1976	6	10
1977	45	17
1978	44	12
1979	44	20
Mean	35.25	17.33
SD ^a	+ 0.21	+ 0.024
	- 0.16	- 0.066

^a Standard Deviation between annual number of attacks per quadrat.

the area. It is worth noting that there were no access roads for cars east of the Aspe River, whereas on the other side a relatively dense network of roads was constructed during the study period.

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