The impact of predators on livestock in the Abruzzo region of Italy

R. FICO *, G. MOROSETTI ** and A. GIOVANNINI *

Summary: Free-living populations of wolves (Canis lupus Linnaeus, 1758) and brown bears (Ursus arctos Linnaeus, 1758) regularly cause damage to livestock in the Abruzzo region of Italy. The laws of the region provide for compensation payments to owners for losses caused by predators.

In the present paper, 4,993 validated claims made between 1980 and 1988 are examined.

Losses ascribed to wolf, bear and wild boar attacks were 92.1%, 7.8% and 0.1%, respectively, of the total losses caused by predators during this period. The victims of wolf attacks were mostly sheep and goats (45.0%) and equids (38.5%), followed by cattle (16.4%) and rabbits, fowl and dogs (0.2%). Bears also principally attacked sheep and goats (67.6%), other targets being cattle (18.5%), equids (9.5%) and beehives (4.4%). A significant difference was observed between the number of attacks by wolves and bears, although both populations are of similar size. Other statistically significant differences have been observed between the periods in which the attacks take place on the different livestock and the predator species which reportedly caused the damage. Among cattle and equids, victims are mostly new-born or young animals, while among sheep and goats only adult animals are attacked.


INTRODUCTION

In the Italian regions where protected and endangered species such as wolves (Canis lupus Linnaeus, 1758) and brown bears (Ursus arctos Linnaeus, 1758) are present, compensation is paid by the authorities for the damage caused to livestock by these animals. To date, there have been no specific studies on livestock predation in Italy. The purpose of the present study is to quantify the phenomenon in the Abruzzo region and to point out some behavioural differences between these two species of wild carnivore.

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THE STUDY AREA

The Abruzzo region in central southern Italy has a total area of 10,741 km$^2$. It borders on the Adriatic Sea to the east and the Apennine mountains to the west, with peaks reaching over 2,500 m. The region has two distinct climatic areas, and the vegetation varies according to the altitude gradient and the corresponding climatic differences (9, 11). The region is divided into four provinces: Aquila, Teramo, Pescara and Chieti (Table I). The numbers of domestic livestock from 1980 to 1988 (16, 17, 18, 19) are shown in Figure 1. The relative percentages of the three livestock categories were as follows (mean values, 1980-1988):

- sheep/goats: 77.0%
- cattle: 19.3%
- equids: 3.7%.

**TABLE I**

*Population density and land use in the provinces of the Abruzzo region (Italy)*
(20, 21)

<table>
<thead>
<tr>
<th>Province</th>
<th>Total area (km$^2$)</th>
<th>Population density per km$^2$</th>
<th>Fields/plantations (km$^2$, %)</th>
<th>Forests (km$^2$, %)</th>
<th>Unproductive areas (km$^2$, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquila</td>
<td>5,034.46</td>
<td>59</td>
<td>3,243.32 (64.4%)</td>
<td>1,503.38 (29.8%)</td>
<td>287.76 (5.8%)</td>
</tr>
<tr>
<td>Teramo</td>
<td>1,948.27</td>
<td>145</td>
<td>1,377.97 (70.7%)</td>
<td>307.91 (15.8%)</td>
<td>262.39 (13.5%)</td>
</tr>
<tr>
<td>Pescara</td>
<td>1,224.67</td>
<td>241</td>
<td>953.34 (77.8%)</td>
<td>150.38 (12.3%)</td>
<td>120.95 (9.9%)</td>
</tr>
<tr>
<td>Chieti</td>
<td>2,558.67</td>
<td>149</td>
<td>1,964.18 (75.9%)</td>
<td>287.03 (11.1%)</td>
<td>335.49 (13.0%)</td>
</tr>
</tbody>
</table>

**FIG. 1**

*Livestock numbers in the Abruzzo region (Italy), 1980-1988* (16, 17, 18, 19)
Livestock husbandry methods routinely adopted in the Abruzzo region vary considerably. Cattle and equids are generally left on semi-free pasture in the mountainous areas from April to October. Foals are born mainly in April-May, while the calving season is concentrated in May-June. Although permanent supervision of herds is compulsory, this rule is often broken for economic reasons.

Sheep and goats are kept on pasture from June to October and are always guarded by shepherds and dogs. At night, the animals are kept in roped-off enclosures. The lambing season lasts all year long, with peaks in January-February and September-October, the latter period being the most important. Lambs are usually slaughtered within three to four months and, therefore, only adults are present in flocks in summer.

The Abruzzo region is the only area in Italy where wolves and bears are present simultaneously. Wolves are mostly observed in the Parco Nazionale d'Abruzzo (Aquila province) and on Mount Maiella (Chieti province). In 1976 (3), 1985 and 1986 (7), the wolf population was estimated as 34-35, 62-77 and 59-79 individuals respectively. The highest densities of brown bear and wolf populations are generally recorded in the same areas. In 1974 (26), 1980 (13), 1985 and 1988 (6), the brown bear population was estimated as 72, 45-80, 51-57 and 44-55 individuals respectively. National legislation has been in force to protect the bear since 1939 (8) and the wolf since 1976 (3, 5).

Only losses ascribed to the above two species are compensated for (in accordance with Regional Law No. 3/1974). The Provincial Departments of the State Forestry Corps are responsible for the assessment and payment of damages. There is no compensation for damage ascribed to dogs. According to the 1980-1981 census, the distribution of feral and stray dogs in the four provinces was as follows (4):

- Aquila: 4,300 dogs
- Pescara: 1,998 dogs
- Chieti: 3,113 dogs
- Teramo: 3,675 dogs.

**MATERIALS AND METHODS**

The data analysed in this paper concern claims for losses attributed to wild carnivores in these four provinces of the Abruzzo region from 1980 to 1988. Each claim referred to only one validated attack.

Data were collected on the number, species and age class (if registered) of the damaged domestic livestock and on the species of predator responsible for the attack. The category "sheep/goats" includes all sheep and goats (male and female, adults and young); "cattle" includes cows, bulls and calves; and "equids" covers mules, donkeys, horses and foals.

The Spearman rank correlation was used to relate the number of attacks on each prey category with the number of head present in each category (25). The uniformity of the monthly distribution for each prey category was evaluated on the basis of the Rayleigh test (1). The chi-square ($\chi^2$) test was used to evaluate the difference between the seasonal distributions of attacks (25).

Seasons were defined as follows: winter (January to March); spring (April to June); summer (July to September); and autumn (October to December).
RESULTS

Claims for losses caused by wild carnivores from 1980 to 1988 totalled 4,993 in the four provinces studied. Claims ascribed to wolf attacks numbered 4,600 (92.1%), while 389 attacks (7.8%) were ascribed to bears and 4 (0.1%) to wild boar. Attacks were distributed between the four provinces as follows:

- Aquila: 4,161 (83.3%)
- Teramo: 506 (10.1%)
- Chieti: 267 (5.3%)
- Pescara: 59 (1.2%).

Wolf attacks

The largest number of attacks, 2,068 (45.0%), were against sheep and goats, while 1,769 (38.5%) were against equids, 755 (16.4%) against cattle and 8 (0.2%) against other prey (fowl, rabbits, dogs).

The distribution by province of attacks attributed to wolves was as follows:

- Aquila: 3,778 (82.1%)
- Teramo: 505 (11.0%)
- Chieti: 263 (5.7%)
- Pescara: 54 (1.2%).

In the province of Aquila, where age classes of prey were recorded, lambs were attacked in 0.8% of cases, calves in 96.4% and foals in 91.3%. Most attacks involved a very low number of prey: in 50% of cases, the number of sheep/goats killed was less than 4 and in another 25% of cases the number of victims was between 4 and 7, while at least 75% of attacks against larger mammals involved only one animal (Table II).

TABLE II

<table>
<thead>
<tr>
<th>Prey</th>
<th>Min.</th>
<th>Max.</th>
<th>Number killed</th>
<th>Mode</th>
<th>Median</th>
<th>25</th>
<th>50</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep/goats</td>
<td>1</td>
<td>101</td>
<td>5.95</td>
<td>1.0</td>
<td>4.0</td>
<td>2.0</td>
<td>4.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Cattle</td>
<td>1</td>
<td>4</td>
<td>1.09</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Equids</td>
<td>1</td>
<td>10</td>
<td>1.10</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The claims regarding attacks on sheep and goats show an upward trend from 1981 onwards; those regarding equids show an increase from the same year, with a decrease in 1987 and 1988. The claims referring to cattle remain relatively constant from 1982 (Fig. 2).

A positive and statistically significant correlation can be observed between the number of wolf attacks on sheep and goats and the number of head of these species present in the year considered (n = 9, r_s = 0.72, P < 0.05). For the other livestock categories, the correlation was not significant (cattle: n = 9, r_s = -0.42; equids: n = 9, r_s = 0.63). A noticeable increase in wolf attacks on equids and cattle begins in April, while the period of greatest losses among sheep and goats begins in July (Fig. 3).
**Fig. 2**
Annual frequency of attacks by wolves on livestock in the Abruzzo region (Italy), 1980-1988

**Fig. 3**
Monthly frequency of attacks by wolves on livestock in the Abruzzo region (Italy)
The sample distribution parameters and results of the Rayleigh test are shown in Table III. The peak of attacks on sheep and goats occurs in mid-August, the peak for cattle is in mid-July, while attacks on horses occur mainly in late spring.

There is a significant difference between the seasonal distributions of attacks on the three livestock categories. The following results were obtained in the chi-square test:

- overall comparison: \( \chi^2 = 433.07, \ P < 0.0001 \)
- equids vs cattle: \( \chi^2 = 85.07, \ P < 0.0001 \)
- equids vs sheep/goats: \( \chi^2 = 426.86, \ P < 0.0001 \)
- cattle vs sheep/goats: \( \chi^2 = 56.32, \ P < 0.0001 \).

**TABLE III**

*Distribution during the year of predation by wolves on livestock in the Abruzzo region (Italy)*

<table>
<thead>
<tr>
<th>Prey</th>
<th>Mean angle in radians</th>
<th>Angular deviation in radians</th>
<th>Sample size</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep/goats</td>
<td>3.852 (August 12) *</td>
<td>1.075 (62) **</td>
<td>2,068</td>
<td>( P &lt; 0.001 )</td>
</tr>
<tr>
<td>Cattle</td>
<td>3.410 (July 17)</td>
<td>1.130 (66)</td>
<td>755</td>
<td>( P &lt; 0.001 )</td>
</tr>
<tr>
<td>Equids</td>
<td>2.553 (May 28)</td>
<td>1.100 (64)</td>
<td>1,763</td>
<td>( P &lt; 0.001 )</td>
</tr>
</tbody>
</table>

* date corresponding to mean angle
** number of days corresponding to angular deviation

**Bear attacks**

Claims for losses caused by bears concerned sheep and goats in 263 cases (67.6%), cattle in 72 cases (18.5%) and equids in 37 cases (9.5%). In 17 cases (4.4%) the claim concerned damage to bee-hives.

Bear attacks occurred in only three of the provinces studied and were distributed as follows:

- Aquila: 380 (97.7%)
- Chieti: 5 (1.3%)
- Pescara: 4 (1.0%).

In the province of Aquila, there were no cases of bears attacking lambs. Young animals were involved in 90.3% and 77.7% of attacks on cattle and equids respectively.

As in the case of the wolf, most attacks by bears involved a very low number of prey: in 50% of attacks on sheep and goats, only one or two animals were killed, and in another 25% of cases only three or four animals were involved, while at least 75% of attacks against larger mammals involved only one animal (Table IV).

There was a significant decrease in losses among all categories of livestock from 1981 to 1985. From 1985 onwards, an increase is registered (Fig. 4).
**TABLE IV**

*Statistical analysis of numbers of animals killed in a single bear attack on livestock in the Abruzzo region (Italy)*

<table>
<thead>
<tr>
<th>Prey</th>
<th>Min.</th>
<th>Max.</th>
<th>Number killed</th>
<th>Mode</th>
<th>Median</th>
<th>25</th>
<th>50</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep/goats</td>
<td>1</td>
<td>36</td>
<td>2.5</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Cattle</td>
<td>1</td>
<td>2</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Equids</td>
<td>1</td>
<td>3</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

A negative correlation was found between the annual number of attacks on sheep and goats and number of head present ($n = 9$, $r_s = -0.83$, $P < 0.01$); there was no significant correlation for other livestock categories (cattle: $n = 9$, $r_s = 0.56$; equids: $n = 9$, $r_s = -0.38$).

Attacks on equids and cattle begin in April-May, while attacks on sheep and goats are markedly higher in the period July-October (Fig. 5). The peak of attacks on sheep and goats occurs in late August, attacks on cattle peak in mid-August, while most attacks on horses occur in mid-July (Table V).

![Graph showing annual frequency of attacks by bears on livestock in the Abruzzo region (Italy), 1980-1988](image-url)

**FIG. 4**

*Annual frequency of attacks by bears on livestock in the Abruzzo region (Italy), 1980-1988*
The seasonal distribution of attacks on equids differs significantly from the distribution of attacks on cattle and sheep/goats. The chi-square test gave the following results:

- overall comparison: $\chi^2 = 28.26, P = 0.0001$
- equids vs sheep/goats: $\chi^2 = 25.19, P < 0.0001$
- equids vs cattle: $\chi^2 = 10.29, P = 0.0001$
- cattle vs sheep/goats: $\chi^2 = 3.62, P = 0.0001$.

**TABLE V**

*Distribution of bear predation on livestock during the year in the Abruzzo region (Italy)*

<table>
<thead>
<tr>
<th>Prey</th>
<th>Mean angle in radians</th>
<th>Angular deviation in radians</th>
<th>Sample size</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep/goats</td>
<td>4.056 (August 24) *</td>
<td>0.860 (51) **</td>
<td>263</td>
<td>$P &lt; 0.001$</td>
</tr>
<tr>
<td>Cattle</td>
<td>3.869 (August 13)</td>
<td>0.860 (50)</td>
<td>72</td>
<td>$P &lt; 0.001$</td>
</tr>
<tr>
<td>Equids</td>
<td>3.325 (July 12)</td>
<td>0.940 (55)</td>
<td>37</td>
<td>$P &lt; 0.001$</td>
</tr>
</tbody>
</table>

* * date corresponding to mean angle
** number of days corresponding to angular deviation

The seasonal distribution of attacks by wolves and bears on each prey category was also compared. Wolves preyed on both sheep and goats ($\chi^2 = 28.87, P < 0.0001$) and cattle ($\chi^2 = 19.53, P = 0.0002$) significantly earlier than bears, while no statistically significant difference was noticed in predation on equids ($\chi^2 = 6.79, P = 0.0789$).

**FIG. 5**

*Monthly frequency of attacks by bears on livestock in the Abruzzo region (Italy)*
DISCUSSION

Given that wolf and bear populations in the Abruzzo region are of similar size, the considerable difference in the overall number of attacks on livestock between the two carnivore species can be related to feeding habits. In fact, meat forms only a small percentage of the diet of a bear (12, 26).

However, the frequent difficulty in distinguishing between a wolf kill and a dog kill may result in an overestimation of attacks by wolves.

Wolf attacks

There was a direct correlation between the number of wolf attacks on sheep and goats and the number of these animals present on pastures. A similar observation was made by Bogges and colleagues (2). The high percentage of attacks on equids (39.9%), despite the fact that this category constitutes only 3.7% of the farmed livestock in the region, suggests that wolf predation on equids is connected to breeding practices rather than to numerical availability. In fact, no significant correlation could be found between the number of attacks and the number of equids present. Furthermore, a recent study carried out in the Abruzzo region (23) showed that equids are one of the most common prey animals of the wolf. The absence of a similar significant correlation for attacks on cattle could be explained by the fact that cattle exhibit more effective antipredatory behaviour (5) with the result that, despite being more numerous than equids, cattle are preyed on to a lesser extent. Predation on equids begins to be frequent in April, with a peak in May, because of the availability of new-born and young foals on open pasture. In fact, the percentage of young animals among the equids attacked is very high (91.3%). Moreover, a typical feature of the hunting behaviour of wolves is the selection of younger and weaker prey (22). Attacks against cattle begin to be frequent in May, during the calving season. Attacks on sheep and goats mainly occur in the summer months when flocks are pasturing. Lambs or kids are rarely preyed upon, as they are sold very young. This study shows that wolves kill large numbers of sheep more rarely than generally supposed: the number of sheep attacked in a single flock exceeded seven animals in less than 25% of cases.

Bear attacks

A comparison between the number of bear attacks on sheep and goats and the size of the populations of these livestock species in a given year shows a significant inverse correlation. Since the number of potential prey increased over the period considered in this study, this result could be explained by a decrease in the bear population. In fact, twenty-two bear carcasses were found between 1981 and 1984 (6) and attacks ascribed to bears in 1985 were markedly low in number. The monthly distribution of bear attacks significantly differs from the distribution for wolves. Since the same number of potential prey is available to both predators, the difference in distribution may reflect the seasonal patterns of food-seeking activity among bears; Zunino (26) describes this activity as peaking in late spring (April-May) and early autumn (September-October).

CONCLUSIONS

From the data presented in this study, it appears that the impact of predators on livestock may be linked to inadequate husbandry methods in those areas where predators are present. A similar observation has also been made by Robel and
colleagues (24). The above data indicate that losses could be reduced by nearly 40% if
new-born or young foals and calves were not sent to graze outdoors. Improved
surveillance of “at risk” herds (e.g. near large wooded areas and in areas with
confirmed, constant predator populations) would further decrease the number of
attacks. From this point of view, the problem of distinguishing between attacks by
wolves and those by stray or feral dogs is of no relevance. Moreover, field surveys in this
region are unable, at present, to confirm the hypothesis that feral dogs are responsible
for serious livestock losses (10, 14, 15). However, further studies are required in order to
clarify the ecological and ethological aspects of this problem.

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statistical analysis of the data.

L'IMPACT DES PRÉDATEURS SUR LES ANIMAUX D'ÉLEVAGE DANS LA

Résumé : Les populations de loups (Canis lupus Linnaeus, 1758) et d'ours
bruns (Ursus arctos Linnaeus, 1758) vivant en liberté attaquent régulièrement
les animaux d'élevage dans la région des Abruzzes (Italie). La législation
régionale prévoit l'indemnisation des pertes dues à ces prédateurs.

Les auteurs ont étudié 4 993 demandes d'indemnisation acceptées entre 1980

Les pertes imputées à des attaques de loups, d'ours et de sangliers s'élevaient
respectivement à 92,1 %, 7,8 % et 0,1 % des pertes totales dues aux prédateurs
pendant cette période. Les victimes des attaques de loups étaient surtout les
ovins et les caprins (45,0 %), puis les équidés (38,5 %), les bovins (16,4 %) et
enfin les lapins, les volailles et les chiens (0,2 %). Les principales victimes des
ours étaient aussi les ovins et les caprins (67,6 %), les autres cibles étant les
bovins (18,5 %), les équidés (9,5 %) et les ruches (4,4 %). Une différence
significative a été observée entre le nombre d'attaques respectivement imputées
aux loups et aux ours bien que ces populations soient de même taille. Les autres
différences statistiques observées ont concerné la période des attaques pour
each espèce attaquée parmi les animaux d'élevage et pour chaque espèce
jugée responsable. Parmi les bovins et les équidés, les victimes sont
principalement les nouveau-nés et les jeunes animaux tandis que chez les ovins
et les caprins, seuls les adultes sont attaqués.

brun – Prédation.
Resumen: Las poblaciones de lobos (Canis lupus Linnaeus, 1758) y de osos pardos (Ursus arctos Linnaeus, 1758) que viven en libertad atacan regularmente el ganado en la región de los Abruzos (Italia). La legislación regional prevé indemnizaciones por los daños que causan estos depredadores.

Los autores estudiaron 4.993 solicitudes de indemnización que fueron aceptadas entre 1980 y 1988.

Las pérdidas por ataques de lobos, osos y jabalíes se elevaban, respectivamente, a un 92,1%, 7,8% y 0,1% del total imputable a depredadores durante el período. Las víctimas de los lobos eran sobre todo ovinos y caprinos (45,0%), équidos (38,5%), bovinos (16,4%) y, por último, conejos, aves y perros (0,2%). Las víctimas principales de los osos también eran los ovinos y caprinos (67,6%), además de los bovinos (18,5%), los équidos (9,5%) y las colmenas (4,4%). Se observó una diferencia significativa entre la cantidad de ataques imputados a lobos y osos, pese a que las poblaciones respectivas cuenten con una cantidad similar de individuos. Las otras diferencias estadísticas observadas se refieren al período de los ataques, en función de cada depredador y de cada especie atacada. Las víctimas entre los bovinos y los équidos son fundamentalmente los recién nacidos y los animales jóvenes pero sólo los adultos ovinos y caprinos fueron atacados.


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REFERENCES


