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FIRST DATA ON CANIDS DEPREDATION ON LIVESTOCK IN AN AREA OF RECENT RECOLONIZATION BY WOLF IN CENTRAL ITALY: CONSIDERATIONS ON CONFLICT SURVEY AND PREVENTION METHODS

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Abstract

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Wolf and dog depredation on livestock in the province of Rieti, central Italy, in 2007-2008, was studied. The study area was characterized by a high degree of human disturbance, widespread presence of free ranging dogs and a recent wolf recolonization. Because of the ineffectiveness of compensation programmes, it was not possible to use the official statistics to investigate the extent of the conflict, but sample interviews and surveys of farmers were used. Also, the farming protection tecniques adopted for different livestock species were analysed; the most utilized husbandry method was stabling for cattle and pigs, annual fenced grazing for horses and sheeps, and annual open grazing only for goats. Although sheep farms were the most attacked because of their availability (33.6% of the whole farms), goat farms were the most selected by predators because of their accessibility (40% of farms kept goats in annual open grazing). Management implications to mitigate livestock depredation were discussed.

Key words: wolf, livestock, free ranging dog, depredation, husbandry method, compensation programme.

Introduction

Conflict between man and wildlife is a process mainly related to human demographic growth (Woodroffe, 2000) and to the economic development system, which lead to continuous colonization of wild environments (Naughton-Treves et al., 2003; Treves, Karanth, 2003). Similar ecological traits for humans and carnivores (Fox, 1978; Treves, Karanth, 2003) drive the conflict to an immediate competition for both space and food. Consequently, during the last two centuries, the wolf (*Canis lupus*) was persecuted and eradicated from most of Europe (except small packs in Italy, Spain, Portugal, Greece, Scandinavia and the Balkan area), and from most of North America (except in Alaska, Minnesota and Canada) (Okarma, 1993; Mech, 1995; Ciucci, Boitani, 1998). During the last 30 years, the species growth was again settled in

those previous distributional areas, both in Europe (Promberger, Schroder, 1993; Wabakken, 2001; Boitani, 2003; Ansorge et al., 2006) and in North America (Fuller et al., 1992; Mech, 1995, 2001; Wydeven et al., 1995). This trend sustained by institution of protected areas, legal protection of the species, prey species reintroductions (Ciucci, Boitani, 1998), natural reforestation of agricultural areas caused by urbanization (Mladenoff et al., 1995; Apollonio, 1996; Antonelli et al., 2005), all joined to some species' ecological traits (high offsprings number, high dispersal distances and ecological flexibility) (Mech, 1995). In Italy, the wolves spread over all the Appennines and Western Alps (with permanent groups in France) (Boitani, Ciucci, 1993; Poulle et al., 1997; Ciucci, Boitani, 1998; Apollonio et al., 2004).

As described by Mech (1995), the recent wolf expansion has taken place in two phases: first in protected areas with high forest covering and low roads index (Thiel, 1985; Mech et al., 1988; Mladenoff et al., 1995), then in agricultural areas with high human settlement and use and high roads index (Fuller et al., 1992). In this way, over the years, wolf populations were adjusted to increased human disturbance (Thiel et al., 1998).

At present, the conflict increases in all of Europe and North America, especially in places of new colonization by wolves (Linnell et al., 2001; Fritts et al., 2003; Siderovich et al., 2003; Nowak et al., 2005; Skonhoft, 2006; Gula, 2008; Iliopoulos et al., 2009). Conflict prevention is carried out using wolf distribution predicting models (Mladenoff et al., 1995; Corsi et al., 1999; Treves et al., 2004; Gehring, Potter, 2005), and by assessing factors that predispose farms to depredation (Nass et al., 1984; Boitani et al., 1998; Ciucci, Boitani, 1998; Mech et al., 2000; Siderovich et al., 2003; Bradley, Pletscher, 2005). Despite the fact that compensation programmes for local farmers tried to relief the conflict in many countries (Boitani, 1982; Gunson, 1983; Fritts et al., 1992), it does not seem to be useful in preventing illegal killings of wolves (Ciucci, Boitani, 1998) and in increasing local population's tolerance for the predator (Naughton-Treves et al., 2003): actually they could induce a dependence on an economic incentive (Cozza et al., 1996; Boitani et al., 1998; Antonelli et al., 2005), as recently targeted by European Community.

The aim of this study was to collect livestock depredation data in an area of recent wolf recolonization, high anthropic disturbance, with a great presence of free ranging dogs and no refunding programmes still working; and examine husbandry methods in relation to depredation events to suggest some management goals to mitigate the conflict.

Material and methods

Study area

The study area is located in north-eastern Lazio (central Italy), Rieti district, inside the boundary of 12 local municipal districts in the Sabine mountains. It is spread over an area of 285,75 km^2 and the resident population is about 16,100, with a density of about 56.3 per km^2 (2001 census).

Altitude ranges from 300 to 1288 m a.s.l; the climate is mediterranean and the snow cover lasts only few days during winter, usually in late December–early January.

This study area was chosen because of some features which made it a representative sample for the aims of research. The field data collection worked well because the size of the area (not too big) allowed a good knowledge of geographic and social environment and also easy repeated surveys. Moreover, inside the Sabine mountain area, wolves were considered extinct during the past 30 years (Cammerini, 1998), but the area is also located near main demographic wolf's population sources in the northern portion of Rieti territory, with a distributional area linked

with Mt Laga, Mt Gran Sasso and Mt Sibillini. Finally, economic output in the district is mainly represented by primary and tertiary sectors (first of all agriculture and farming, then crafts and tourism).

Wolves and free ranging dogs presence Field data were collected during the years 2008-2009. Wolf presence inside the study area was estimated using and combining different methodologies: wolf-howling, snow-tracking, camera-trapping and field-surveys. Two sessions of wolf-howling (Harrington, Mech, 1982; Ciucci, Boitani, 1998) were conducted during July–August 2008 and July–August 2009, each consisting of 3 replications from 16 emission areas (Fuller, Sampson, 1988), for 6 continuous nights.

Two sessions of snow-tracking (Ballard et al., 1995) were conducted during December 2008 and December 2009 inside a restricted area with good snow cover. Five digital camera-traps were placed, where indirect signs of species presence were previously found. Organic samples (faeces, hairs, carcasses) were collected along 14 transects, during 7 days, monthly, from June 2009 to December 2009. The transects were chosen from the most suitable wolf areas, with high wooden cover, along secondary routes and tracks (Ciucci et al., 2003).

The presence of free ranging dogs was assessed by surveys on the streets of urban and suburban area of all municipal districts territories, during twilight and night hours from the car (Beck, 1973; Santamaria et al., 1990). Two replications of survey were conducted in every district. No subdivisions were made between free dogs categories (house dogs without control and stray dogs), and the feral dog category was excluded from the analysis. In fact, the presence of the first two categories (each prospective livestock predators and more easily investigated) was enough to highlight a conflict, which could only increase with feral dogs' presence.

Depredation data

In this study, official data about depredation occurrences (Blanco et al., 1992; Fritts et al., 1992; Fico et al., 1993; Ciucci, Boitani, 1998; Mech, 1998; Treves et al., 2002; Musiani et al., 2005; Harper et al., 2005; Gazzola et al., 2008; Gula, 2008; Iliopoulos et al., 2009) were used only to evaluate the level of conflict and to compare these data with the ones obtained from a random sample of interviews. Number of farms in the study area was obtained from the national database (Health Department), while the number of claims for compensation during the years 2007 and 2008 was obtained from Rieti administration.

All data about depredation losses in 2007–2008 and livestock abundance (except the number of killed animals per attack) were achieved from interviews of the farmers (Ciucci, Boitani, 1998; Boitani et al., 1998; Ciucci, 1999; Mech et al., 2000; Bradley, Pletscher, 2005; Iliopoulos et al., 2009). Also, data about husbandry methods (livestock species, farming methods, predator defence methods) were gathered from interviews.

The interviews were carried out speaking with owners directly at their farms, or by telephone calls. The random sample of interviews covered about the 19.4% ± 0.9% of farms abundance per each municipal districts (Table 2).

The categories of farming methods used are as follows:
- Annual open grazing
- Annual fenced grazing
- Seasonal open grazing
- Seasonal fenced grazing
- Stabling

The categories of daytime predator defence methods used are as follows:
- Open grazing without monitoring
- Open grazing with sheperd
- Open grazing with dogs
- Open grazing with shepherd and dogs
- Fenced grazing without monitoring
- Fenced grazing with sheperd
- Fenced grazing with dogs
- Fenced grazing with shepherd and dogs

The categories of night predator defence methods used are as follows:
- Open grazing without monitoring
- Open grazing with dogs

- Fenced grazing without monitoring
- Fenced grazing with dogs
- Stable

Statistical analysis

The t-test was used to compare the mean number of depredation events obtained from claims and from sample interviews. The χ^2 test was used to evaluate differences in data distribution between claims and sample interviews, and also to test the differences in farming methods and predator defence methods among livestock species. Usage/availability ranks comparison (Johnson, 1980) was used to evaluate canids preference for domestic prey species (second order selection); for that analysis, we used municipalities as sampling units, farms number of each livestock species per municipalities as availability and predation events number of each livestock species per municipalities as usage. Moreover, for this, test farms which reared more than one livestock species were used as different units, and farms which stabled animals were excluded because of their inaccessibility to predators. All tests were performed with significant level always set at $p < 0.05$.

Results

Wolves and dogs presence

Data collected from transects and snow tracking highlighted the settled presence of wolf in the study area. As confirmation of indirect signs, a wolf was photographed in April 2009 (Fig. 1) in a mountain area between Cottanello and Contigliano municipal territories, and another wolf was found alive in a poacher's trap in Monte S Giovanni territory (September 2009) and then released.

Fig. 1. Wolf picture obtained from camera trap.

A stable presence of free ranging dogs, both free house and stray, was found in all municipal territories. The habit of leaving house dogs free during day and night is widespread in all the study area. Moreover, it is common for abandoned hunting dogs (and others) to become stray.

Depredation data

Number of farms per municipalities extracted from national database and sample farms, randomly selected for interviews, are shown in Table 1.

T a b l e 1. Farms abundance and random sample farms for each municipality.

Municipalities	Farms (n)	Farms density (n/km^2)	Sampled farms (n)	Sampled farms (%)
Casperia	53	2	10	18.8
Contigliano	107	1.9	21	19.6
Cottanello	78	2.1	15	19.2
Greccio	52	2.9	10	19.2
Mompeo	22	2	4	18.1
Montasola	30	2.3	6	20
Monte S Giovanni	67	2.9	14	20.8
Montenero	27	0.8	5	18.5
Poggio Catino	46	3	9	19.5
Poggio Mirteto	69	2.6	13	18.8
Roccantica	35	2	7	20
Salisano	28	1.6	6	21.4
TOTAL	614	2.1	120	19.5

Data from national database and data from sample interviews significantly differed (χ^2= 13.15; df=4; p<0.05) in the percentage distribution of farms for each livestock species, especially for goat and sheep farms, which resulted more frequently from sample interviews than those shown from official statistics (Fig. 2).

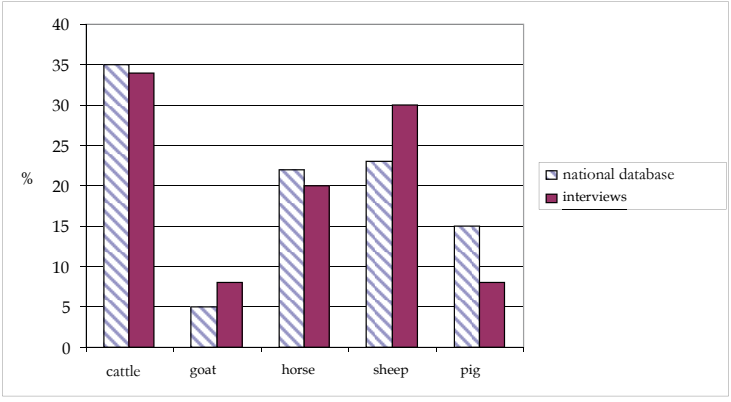

Fig. 2. Percentage abundance of farms for each livestock species as taken from national database and sample interviews.

The number of predation events for each municipality highly differed between claims and interviews (Table 2).

T a b l e 2. Predation events during 2007 and 2008 at municipal level, collected from claims and interviews.

	Predation events in 2007–2008 (n)	
Municipality	**Claims (n)**	**Interviews (n)**
Casperia	0	4
Contigliano	4	7
Cottanello	6	8
Greccio	0	3
Mompeo	0	0
Montasola	0	0
Montenero	0	2
M S Giovanni	3	6
Poggio Catino	0	1
Poggio Mirteto	0	2
Roccantica	2	2
Salisano	0	1
TOTAL	15	36

Thirty-six predation events were referred to 30% of sampled farms (120): from the full number of farms, it was possible to extrapolate 180 predation events during 2 years; the claims (15) corresponding to only to 8.3% of them.

The mean number of predation events per municipalities varied from the lowest for goats (1.33) to the highest for sheep (3.11), with no significant difference between claims data and interviews data (Table 3).

T a b l e 3. Predation event per municipality refers to each livestock species and t values for claims and interviews comparison.

	Predation event per municipality (mean ± sd)		
Species	**Claims**	**Interviews**	**t**
Cattle	1.75 ± 0.95	2.16 ± 1.46	0.45; n = 8; p > 0.05
Goat	2	1.33 ± 0.5	1.17; n = 5; p > 0.05
Horse		1.5 ± 0.7	
Sheep	2 ± 1	3.11 ± 1.96	0.88; n = 10; p > 0.05
Pig		2	

The number of animals killed on each attack, obtained from claims, was lowest in cattle (1) and highest in sheep, with 8.5 animals (Table 4).

T a b l e 4. Killed animals per attack, as result from claims.

Species	Killed animals per attack (median)
Cattle	1
Goat	3
Sheep	8.5

Analysis on depredation data highlighed a selective predation by dogs and wolves on livestock ($F_{4,8}$= 10.3; p< 0.01): the goat was the most affected species, in relation to its availability on the area (Tables 5 and 6). Sheep (51%) and then cattle (27%) were the species most affected by predation in the area, if we didn't examine their availability and any selective process (Fig. 3).

T a b l e 5. Percentage of farms (not stabled) and predation events per livestock species for each municipality.

Municipality	Reared species									
	Cattle		Goat		Horse		Sheep		Pig	
	n farms %	n predation events %	n farms %	n predation events %	n farms %	n predation events %	n farms %	n predation events %	n farms %	n predation events %
Casperia	25	14.2	18.8	28.6	25	0	31.2	57.2	0	0
Contigliano	31.6	22.2	15.8	11.1	10.5	0	42.1	66.7	0	0
Cottanello	38.5	36.4	7.7	9	19.2	0	30.8	45.6	3.8	9
Greccio	33.4	0	8.3	0	8.3	0	50	100	0	0
Mompeo	25	0	0	0	75	0	0	0	0	0
Montasola	28.6	0	0	0	57.1	0	14.3	0	0	0
Montenero	20	0	0	0	0	0	80	100	0	0
Monte S Giovanni	37.5	18.2	9.4	18.2	18.7	18.2	28.1	45.4	6.3	0
Poggio Catino	45.4	33.3	18.2	33.3	27.4	0	9	33.4	0	0
Poggio Mirteto	18.2	0	9	50	9	0	63.8	50	0	0
Roccantica	23	50	0	0	38.5	50	30.8	0	7.7	0
Salisano	40	0	0	0	40	0	20	10	0	0

T a b l e 6. Ranking of species from the most preferred by canids predators and mean difference in ranks (d).

Species	d	Rank
Goat	-0.95	1
Pig	-0.79	2
Sheep	-0.37	3
Cattle	1	4
Horse	1.12	5

Farm husbandry variables

Farming methods among livestock species differed significantly ($\chi 2 = 47.38$; df = 16; $p < 0.01$). In fact, cattle and pigs were preferentially stabled (27% and 66%, respectively); goats were mainly settled in annual open grazing (40%); horses and sheeps in annual fence grazing (53.8 and 45.4%, respectively). Instead, no significant differences were found in predators' defence methods during day ($\chi 2 = 39.47$; n = 28; $p > 0.05$) and during night ($\chi 2 = 21.88$; n = 16; $p > 0.05$) among livestock. As a whole, during daylight, fenced grazing was the most used defence methods (26%) and during night, stabling (53.1%).

Predation events were never related to farming methods and predator defence methods, with the exception of goats for which the number of attacks by canids significantly differed among farming methods ($\chi 2 = 8.42$; df = 3; $p < 0.05$).

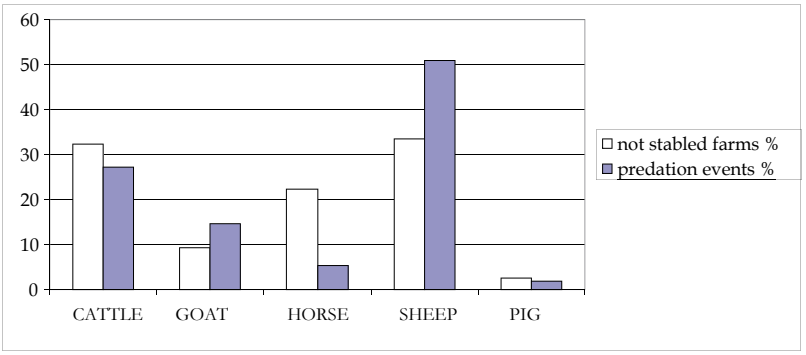

Fig. 3. Percentage of farms and predation events for each species.

Discussion

Wolves and free ranging dogs presence

This research gathered preliminary and only qualitative data about wolves and vagant dogs, because of the almost complete lack of statistics on their presence and distribution in the Sabine mountains area.

The only study conducted on this area (Cammerini, 1998) reports data on wolf's presence from 1960 to 1995, estimated through the number of killed animals: after 1975, a total disappearance of the species in the area is reported (mainly caused by direct hunting); only from the latter half of the 1980s their presence was again reported, probably due to crossing individuals and not settled breeding pairs.

Results from this study highlighted a natural reappearance of the wolf in the whole area, probably from the populations living in Mt Laga, from where the species never disappeared, even though during 1970–1975 it was reduced to very low densities (Zimen, Boitani, 1975).

Only the national census by Boitani, Fabbri (1983) and (Boitani, 1983) reported data about vagant dogs' presence in the Rieti district. That evaluation was carried out using questionnaires for Forestry Service; 32% of the free ranging dogs (both uncontrolled, stray and feral) on the whole number of dogs that were detected in the Rieti district. Data from this study confirmed a relevant settled presence of vagant dogs in the study area and a widespread habit to keep dogs uncontrolled, letting them move freely in the villages and countryside, also in present days.

Canids-livestock conflict

Despite the use of the number of farms, and not the number of animals, as domestic prey availability, results from this research show a clear selection for goats by predators, according to other similar local conditions (Vos, 2000; Latini et al., 2005; Iliopoulos et al., 2009). Instead, sheeps were the most depredated species in terms of number of predation events (Ciucci, Boitani, 1998; Ciucci, 1999; Gazzola et al., 2008), mean number of attacks per municipality and mean number of killed animals per attack. These data reflected the actual and greater sheep

farms abundance in the study area (33.6%). Sheep mean predation events per municipalities were in agreement with data by Ciucci, Boitani (1998) in Tuscany and by Boitani et al. (1998) in Cilento National Park. Instead, data on killed sheeps per attack weren't comparable with other researches, because of the low amount of data (only 5 claims) and a noticeable surplus of killing event (Ciucci, Boitani, 1998) (35 sheeps in the same attack), with respect to the mean of 1–4 animals (Boitani et al., 1998; Ciucci, Boitani, 1998; Reggioni et al., 2005; Iliopoulos et al., 2009).

Farming methods in the study area did not affect the size of depredation on cattle, sheep, horse and pig farms, although these methods differed highly among these livestock species. This was in contrast with conclusions suggested in other studies for cattle (Fritts et al., 1992; Fico et al., 1993; Cozza et al., 1996; Boitani et al., 1998; Oakleaf et al., 2003), horses (Fico et al., 1993; Cozza et al., 1996) and sheeps (Ciucci, Boitani, 1998; Iliopoulos et al., 2009). Only for goats was found a correlation between farming method (40% of the goat farms manage animals in annual open grazing) and amount of predation events.

As suggested by Huggard (1993), prey selection by predator is a complex process, involving not only prey availability, but also other factors such as vulnerability, predictability and accessibility. Accessibility (Mech, 1970; Ciucci, Boitani, 1998), as encounter rate increased by annual open grazing, was the primary factor in the selective choice of canids predators for goats (Nass et al., 1984; Iliopoulos et al., 2009).

The opportunistic predation process operated by wolves in the choice between wildlife ungulates and livestock (Gula, 2009) was also operated by both wolves and vagant dogs among livestock species. Whereas wolves (and feral dogs) seem to prefer livestock only when and where wild ungulates are few and when and where domestic prey are accessible (Meriggi, Lovari, 1996), free ranging dogs, uncontrolled and stray, as suggested by Boitani and Ciucci (1995), seem to be mainly responsible for livestock damages, not usually hunting wildlife ungulates and being more confident with humans and their activities.

Management implications

Although, at ecological level, wolves seem to prefer wooded and wild areas whereas stray dogs choose places close to human settlements and activities, in this study area this discrimination was uncertain, because the low altitude and the warm climate historically facilitate intensive agriculture–farming activities all over the Sabine mountains, with a widespread antropic disturbance. Wolf repopulation of an area like this was a clear index of not only the natural population expansion of the species in Italy, but also an important cause of conflict increase. Central Italy, particularly the Lazio region, was mainly involved in great conflict between canids and farming activities, with 46% of national annual refunding costs, no implementations of law about stray dogs control and a high level of illegal killings of wolves (Verucci, 1999, 2002; Ciucci, Boitani, 1998, 2005) at present being the primary causes of death for the species in Italy (Genovesi 2002).

The regional law (LR 29/1997) includes only indemnity for wolf (and not dog) depredation, and requires Veterinary Services personnel to distinguish between the two predators. As often reported, the distinction cannot be surely done in most cases (Ciucci, Boitani, 1998, 2005). Moreover, at present, compensation indemnities were not payed since 2006 because of lack of

regional public funds; this is the main cause of damage data undervaluation in the study area (only 8.3% of depredation events were claimed during 2007 and 2008). However, the mitigation of the conflict in recent wolf recolonization area does not have to rely on these indemnities programmes, which were already described as ineffective in reducing the conflict and illegal killings of wolves (Ciucci, Boitani, 1998). An effective control of free ranging dogs population and an intensification of husbandry methods should work to reduce and prevent the conflict. As demonstrated by these results for goats, the most selected prey species was the most accessible one (Gazzola et al., 2008), and so farmers should act in reducing the prey availability.

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References

Ansorge, H., Kluth, G. & Hahne S. (2006). Feeding ecology of wolves *Canis lupus* returning to Germany. *Acta Theriol.*, 51, 99–106. DOI: 10.1007/BF03192661.

Antonelli, F., Giannuzzi Savelli, B. & Boitani L. (2005). Il ruolo dei finanziamenti agli allevatori nei conflitti tra bestiame domestico e carnivori selvatici. In P. Ciucci, C. Teofili & L. Boitani (Eds.), Grandi carnivori e zootecnia tra conflitto e coesistenza. *INFS, Biologia e Conservazione della Fauna*, 115, 64–73.

Apollonio, M. (1996). Evoluzione dell'ambiente e delle attività antropiche nelle areeappenniniche in relazione alla presenza del lupo (*Canis lupus*). In F. Cecere (Ed.), Atti del Convegno "Dalla parte del lupo". *Atti e Studi*, 10, 54–63.

Apollonio, M., Mattioli, L., Scandura, M., Mauri, L., Gazzola, A. & Avanzinelli E. (2004). Wolves in the Casentinesi Forests: insights for wolf conservation in Italy from a protected area with a rich wild prey community. *Biol. Conserv*., 120, 249–260. DOI: 10.1016/j.biocon.2004.02.021.

Ballard, W.B., McNay, M.E., Gardner, C.L. & Reed D.J. (1995). Use of line intercept track sampling for estimating wolf densities. In L.N. Carbyn, S.H. Fritts & D.R. Seip (Eds.), *Ecology and conservation of wolves in changing world* (pp. 469–480). Edmonton: Canadian Circumpolar Institute.

Blanco, J.C., Reig, S. & Cuesta L. (1992). Distribution, status and conservation problems of the wolf *Canis lupus* in Spain. *Biol. Conserv*., 60, 73–80. DOI: 10.1016/0006-3207(92)91157-N.

Boitani, L. (1982). Wolf management in intensively used areas of Italy. In F.H. Harrington & P.C. Paquet (Eds.), *Wolves of the world. Perspectives of behaviour, ecology and conservation* (pp. 158–172). New Jersey: Noyes Publishing Company. ,

Boitani, L. (1983): Wolf and dog competition in Italy. *Acta Zool. Fenn*., 174, 259–264.

Boitani, L. & Fabbri M.L. (1983). Censimento dei cani in Italia con particolare riguardo al fenomeno del randagismo. *Ricerche di Biologia della Selvaggina*, 73, 1–42.

Boitani, L. & Ciucci P. (1993), Wolves in Italy: critical issue for their conservation. In C. Promberger & W. Schroder (Eds.). *Wolves in Europe: status and perspectives* (pp. 75–90). Atti del convegno "Wolves in Europe: current status and prospect". Munich Wildlife Society.

Boitani, L. & Ciucci P. (1995). Comparative social ecology of feral dogs and wolves. *Ethol. Ecol. Evol*., 7, 49–72.

Boitani, L., Ciucci, P. & Morini P. (1998). *Studio delle popolazioni di cinghiale e lupo nel Parco Nazionale del Cilento e Vallo di Diano*. Ente PN Cilento e Vallo Diano.

Boitani, L. (2003). Wolf conservation and recovery. In L.D. Mech & L. Boitani (Eds.), *Wolf behaviour, ecology andconservation* (pp. 317-340). Chicago: University of Chicago Press.

Bradley, E.H. & Pletscher D.H. (2005). Assessing factors related to wolf depredation of cattle in fenced pastures in Montana and Idaho. *Wildl. Soc. Bull*., 33, 1256–1265. DOI: 10.2193/0091-7648(2005)33[1256:AFRTWD]2.0.CO.

Cammerini, G. (1998). *Il lupo nella provincia di Rieti*. Provincia di Rieti.

Ciucci, P. & Boitani L. (1998a). *Il lupo*. Elementi di biologia, gestione e ricerca. Documenti Tecnici 23.

Ciucci, P. & Boitani L. (1998b). Wolf and dog depredation on livestock in central Italy.*Wildl. Soc. Bull*., 26, 504–514.

Ciucci, P. (1999). *Impatto dei grandi carnivori sulla zootecnia e randagismo canino*. Legambiente.

Ciucci, P., Masi, M. & Boitani L. (2003). Winter habitat and travel route selection by wolves in northern Appennines, Italy. *Ecography*, 26, 223–235. DOI: 10.1034/j.1600-0587.2003.03353.x.

Ciucci, P. & Boitani L. (2005). Conflitto tra lupo e zootecnia in Italia: metodi di studio, stato delle conoscenze, prospettive di ricerca e conservazione. In P. Ciucci, C. Teofili & L. Boitani (Eds.), Grandi carnivori e zootecnia tra conflitto e coesistenza. *Biol. Conserv. Fauna*, 115, 26–51.

Corsi, F., Duprè, E. & Boitani L. (1999). A large scale model of wolf distribution in Italy for conservation planning. *Conserv. Biol*., 13, 150–159. DOI: 10.1046/j.1523-1739.1999.97269.x.

Cozza, K., Fico, R., Battistini, M.L. & Rogers E. (1996). The damage conservation interface illustrated by predation on domestic livestock in central Italy. *Biol. Conserv*., 78, 329–336. DOI: 10.1016/S0006-3207(96)00053-5.

Fico, R., Morosetti, G. & Giovannini A. (1993). The impact of predators on livestock in the Abruzzo region in Italy. *Rev. Sci. Tech. OIE*, 12, 39–50.

Fox, M.W. (1978). *Wolf and man, evolution in parallel*. San Diego: Academic Press.

Fritts, S.H., Paul, W.J., Mech, L.D. & Scott D.P. (1992). Trends and management of wolf-livestock conflicts in Minnesota. *U.S. Fish Wildl. Serv. Res. Publ*., 181, 1–27.

Fritts, S.H., Stephenson, R.O., Hayes, R.D. & Boitani L. (2003). Wolves and human. In L.D. Mech & L. Boitani (Eds.), Wolves behaviour, ecology and conservation (pp. 289–316). Chicago: University of Chicago Press.

Fuller, T.K. & Sampson B.A. (1988). Evaluation of simulated howling survey for wolves. *J. Wildl. Manag*., 52, 60–63.

Fuller, T.K., Berg, W.E., Radde, G.L., Lenarz, M.S. & Joselyn G.B. (1992). A history and current estimate of wolf distribution and numbers in Minnesota. *Wildl. Soc. Bull.*, 20, 42–55.

Gazzola, A., Capitani, C., Mattioli, L. & Apollonio M. (2008). Livestock damage and wolf presence. *J. Zool.*, 274, 261–269. DOI: 10.1111/j.1469-7998.2007.00381.x.

Gehring, T.M. & Potter B.A. (2005). Wolf habitat analysis in Michigan: an example of the need for proactive land management for carnivore species. *Wildl. Soc. Bull*., 33, 1237–1244. DOI: 10.2193/0091-7648(2005)33[1237:WHAIMA]2.0.CO.

Genovesi, P. (2002). *Piano d'azione nazionale per la conservazione del lupo* (*Canis lupus*). Quaderni di Conservazione della Natura 13.

Gula, R. (2008). Wolf depredation on domestic animals in the Polish Carpathian Mountains. *J. Wildl. Manag*., 72, 283–289. DOI: 10.2193/2006-368.

Gunson, J.R. (1983). Wolf depredation of livestock on western Canada. In L.N. Carby (Ed.), *Wolves in Canada and Alaska: their status, biology and management* (pp. 201–205). Can. Wildl. Serv. Rep. N. 45.

Harper, E.K., Paul, W.J. & Mech L.D. (2005). Causes of wolf depredation increase in Minnesota from 1979–1998. *Wildl. Soc. Bull*., 33, 888–896. DOI: 10.2193/0091-7648(2005)33[888:COWDIM]2.0.CO.

Harrington, F.H. & Mech L.D. (1982). An analysis of howling response parameters useful for wolf pack censusing. *J. Wildl. Manag*., 46, 686–693.

Huggard, D.J. (1993). Prey selectivity of wolves in Banff National Park. I. Prey species. *Can. J. Zool*., 71, 130–139. DOI: 10.1139/z93-019.

Iliopoulos, Y., Sgardelis, S., Koutis, V. & Savaris D. (2009). Wolf depredation on livestock in central Greece. *Acta Theriol*., 54, 11–22. DOI: 10.1007/BF03193133.

Johnson, D.H. (1980). The comparison of usage and availability measurements for evaluating resource preference. *Ecology*, 61, 65–71. DOI: 10.2307/1937156.

Latini, R., Sulli, C., Gentile, L. & Di Benedetto A. (2005). Conflitto tra grandi carnivori e attività antropiche nel Parco Nazionale d'Abruzzo, Lazio e Molise: entità, esperienze e prospettive di gestione. In P. Ciucci, C. Teofili & L. Boitani (Eds.), Grandi carnivori e zootecnia tra conflitto e coesistenza. *Biol. Conserv. Fauna*, 115, 151–159.

Linnell, J.D.C., Swenson, S.E. & Anderson R. (2001). Predators and people: conservation of large carnivores is possible at high human densities if management policy is favourable. *Anim. Conserv*., 4, 345–349. DOI: 10.1017/S1367943001001408.

Mech, L.D. (1970). *The wolf, the ecology and behaviour of an endangered species*. Doubleday: Natural History Press.

Mech, L.D., Fritts, S.H., Radde, G. & Paul W.J. (1988). Wolf distribution in Minnesota relative to road density. *Wildl. Soc. Bull*., 16, 85–87.

Mech, L.D. (1995). The challenge and opportunity of recovering wolf populations. *Conserv. Biol*., 9, 270–278. DOI: 10.1046/j.1523-1739.1995.9020270.x.

Mech, L.D. (1998). Estimating costs of maintaining a recovered wolf population in agricultural regions of Minnesota. *Wildl. Soc. Bull*., 26, 817–822.

Mech, L.D., Harper, E.K., Meier, T.J. & Paul W.J. (2000). Assessing factors that may predispose Minnesota farms to wolf predation on cattle. *Wildl. Soc. Bull.*, 28,623–629.

Mech, L.D. (2001). Managing Minnesota's recovered wolves. *Wildl. Soc. Bull.*, 29, 70–77.

Meriggi, A. & Lovari S. (1996). A review of wolf predation in southern Europe: does the wolf prefer wild prey to livestock? *J. Appl. Ecol*., 33, 1561–1571. http://www.jstor.org/stable/2404794

Mladenoff, D.J., Sickley, T.A., Haight, R.G. & Wydeven A.P. (1995). A regional landscape analysis and prediction of favourable gray wolf habitat in northern Great Lakes region. *Conserv. Biol.*, 9, 279–294. DOI: 10.1046/j.1523-1739.1995.9020279.x.

Musiani, M., Muhly, T., Gates, C.C., Callaghan, C., Smith, M.E. & Tosoni E. (2005). Seasonality and reoccurrence of depredation and wolf control in western North America. *Wildl. Soc. Bull*., 33, 876–887. DOI: 10.2193/0091-7648(2005)33[876:SARODA]2.0.CO.

Nass, R.D., Lynch, G. & Theade J. (1984). Circumstances associated with predation rates on sheep and goats. *J. Range Manag*., 37, 423–426.

Naughton-Treves, L., Grossberg, R. & Treves A. (2003). Paying for tolerance: rural citizens' attitude toward wolf depredation and compensation. *Conserv. Biol*., 17, 1500–1511. DOI: 10.1111/j.1523-1739.2003.00060.x.

Nowak, S., Myslajek, W. & Jedrzejeska B. (2005). Patterns of wolf *Canis lupus* predation on wild and domestic ungulates in Western Carpathian Mountains (S Poland). *Acta Theriol*., 50, 263–276. DOI:10.1007/BF03194489.

Oakleaf, J.K., Mack, C. & Murray D.L. (2003). Effects of wolves on livestock calf survival and movements in Central Idaho. *J. Wildl. Manag*., 67, 299–306.

Okarma, H. (1993): Status and management of the wolf in Poland. *Biol. Conserv*., 66, 153–158. DOI: 10.1016/0006-3207(93)90001-H

Poulle, M.L., Carles, L. & Lequette B. (1997). Significance of ungulates in the diet of recently settled wolves in Mercantour Mountains (southeastern France). *Revue Ecologie*, 52, 357–368.

Promberger, C. & Schroder W. (1993). *Wolves in Europe: status and perspectives*. Atti del convegno "Wolves in Europe: current status and prospect". Munich Wildlife Society.

Reggioni, W., Andreani, M., Carletti, M., Moretti, F. & Rigotto F. (2005). Conflitto tra lupo (*Canis lupus*) e zootecnia nell'Appennino Tosco- Emiliano. Monitoraggio, prevenzione e mitigazione. In P. Ciucci, C. Teofili & L. Boitani (Eds.), Grandi carnivori e zootecnia tra conflitto e coesistenza. *Biol. Conserv. Fauna*, 115, 116–125.

Santamaria, A., Passannanti, S. & Di Franza D. (1990). Censimento dei cani randagi in un quartiere di Napoli. *Acta Medica Veterinaria*, 36, 201–213.

Siderovich, V.E., Tihomirova, L.L. & Jedrzejewska B. (2003). Wolf (*Canis lupus*) numbers, diet and damage to livestock in relation to hunting and ungulate abundance in northeastern Belarus during 1990–2000. *Wildl. Biol*., 9, 103–111.

Skonhoft, A. (2006). The costs and benefits of animal predation: an analysis of Scandinavian wolf re-colonization. *Ecological Economics*, 58, 830–841. DOI: 10.1016/j.ecolecon.2005.09.020.

Thiel, R.P. (1985). Relation between road densities and wolf habitat suitability in Wisconsin. *Am. Midl. Nat*., 113, 404–407.

Thiel, R.P., Merrill, S. & Mech L.D. (1998). Tolerance of denning wolves, *Canis lupus*, to human disturbance. *Can. Field-Nat*., 112, 340–342.

Treves, A., Jurewicz, R.R., Naughton-Treves, L., Rose, R.A., Willging, R.C. & Wydeven A.P. (2002). Wolf depredation on domestic animals in Wisconsin, 1976–2000. *Wildl. Soc. Bull*., 30, 231–241.

Treves, A. & Karanth K.U. (2003). Human-carnivore conflict and perspectives on carnivore management worldwide. *Conserv. Biol*., 17, 1491–1499. DOI: 10.1111/j.1523-1739.2003.00059.x.

Treves, A., Naughton-Treves, L., Harper, E.K., Mladenoff, D.J., Rose, R.A., Sickley, T.A. & Wydeven A.P. (2004). Predicting human-carnivore conflict: a spatial model derived from 25 years of data on wolf depredation on livestock. *Conserv. Biol*., 18, 114–125. DOI: 10.1111/j.1523-1739.2004.00189.x.

Verucci, P. (1999). La conservazione del lupo nel Lazio: problemi e proposte. *Ambiente e Territorio*, 5, 17.

Verucci, P. (2002). Il conflitto lupo-zootecnia nel Lazio: quadro normativo e dati preliminari della situazione nel sistema delle aree protette regionali. In G. Boscagli, L. Vielmi& O. de Curtis (Eds.), *Il lupo e i parchi* (pp. 149–153). Ente PN Foreste Casentinesi.

Vos, J. (2000). Food habits and livestock depredation of two Iberian wolf packs (*Canis lupus signatus*) in the north of Portugal. *J. Zool*., 251, 457–462. DOI: 10.1111/j.1469-7998.2000.tb00801.x.

Wabakken, P., Sand, H., Liberg, O. & Bjarvall A. (2001). The recovery, distribution, and population dynamics of wolves on the Scandinavian peninsula 1978–1998. *Can. J. Zool*., 79, 710–725. DOI:10.1139/z01-029

Woodroffe, R. (2000). Predators and people: using human densities to interpret declines of large carnivores. *Anim. Conserv*., 3, 165–173. DOI: 10.1111/j.1469-1795.2000.tb00241.x.

Wydeven, A.P., Schultz, R.N. & Thiel R.P. (1995). Monitoring a recovering gray wolf population in Wisconsin, 1979–1995. In L.N. Carbyn, S.H. Fritts & D.R. Seip (Eds.), *Ecology and conservation of wolves in changing world* (pp. 147–156). Edmonton: Canadian Circumpolar Institute.

Zimen, E. & Boitani L. (1975). Number and distribution of wolves in Italy. *Zeitschrift für Säugetierkunde*, 40, 102–112.