Do volatile repellents reduce wolverine Gulo gulo predation on sheep?

Authors: Landa, Arild, and Tømmerås, Bjørn Åge

Source: Wildlife Biology, 2(2) : 119-126

Published By: Nordic Board for Wildlife Research

URL: https://doi.org/10.2981/wlb.1996.041

SHORT COMMUNICATION

Short communication articles are short scientific entities often dealing with methodological problems or with byproducts of larger research projects. The style should be the same as in original articles.

Do volatile repellents reduce wolverine *Gulo gulo* predation on sheep?

Arild Landa & Bjørn Åge Tømmerås

Landa, A. & Tømmerås, B.Å. 1996: Do volatile repellents reduce wolverine *Gulo gulo* predation on sheep. - Wildl. Biol. 2: 119-126.

Since the return of the wolverine *Gulo gulo* to the Snøhetta area in Norway in 1979, wolverine predation on sheep *Ovis aves* has increased in parallel with increases in the number of sheep. Reducing the predation would also reduce the economic losses suffered by sheep farmers and could increase their willingness to accept the presence of wolverines in the area. Therefore, experiments with volatile repellents to reduce predation by wolverines on sheep were carried out. Experiments showed that five oils and three pure chemicals gave distinctive avoidance reactions by captive wolverines. The release rates of the different chemicals were tested in the laboratory and a dispenser allowing the use of the chemicals as long-lasting repellents was developed. In 1993, half of the ewes and their lambs in areas with high losses due to wolverine predation were randomly chosen and fitted with dispensers containing these chemicals. In 1994, the test was repeated and the study area was expanded to include a nearby area, in which farmers had also suffered high wolverine predation on their sheep in recent years. All sheep flocks were monitored during the free-ranging grazing period, and when carcasses were found, necropsies were performed to ascertain the cause of death. Nearly all dispensers were damaged to some degree during the grazing period, but because family groups (ewes and their lambs) were marked, this is believed to probably not have affected the experiment significantly. In spite of the technical failures, significantly fewer losses occurred in the groups with dispensers than in the groups without dispensers. A better dispenser must be developed and a large-scale test should be performed before it is possible to conclude definitively that volatile repellents may be used as an operational instrument to reduce economic losses to sheep farmers and to help conserve wolverines.

Key words: wolverine, sheep, predation, olfactory repellents, Norway, Gulo gulo

Arild Landa & Bjørn Åge Tømmerås, Norwegian Institute for Nature Research, Tungasletta 2, N-7005 Trondheim, Norway

Received 28 December 1995, accepted 12 June 1996

Associate Editor: Thomas Palo

The problem of wolverine *Gulo gulo* predation on free-ranging sheep *Ovis aves* in mountain areas is well documented from Norway (Kvam et al. 1988, Overrein & Fox 1989, Loen 1991). Usually some sheep herds are severely hit, and in some years lamb losses exceed 40%. At present, the Norwegian government pays more than NOK 6 million (USD 945,000) per year in compensation for wolverine predation on sheep, and uses considerable amounts in the administration of compensation and on preventive measures. It has been difficult to document any reduced sheep losses as an effect of these preventive efforts. Sustainable management of viable populations of wolverine is an official policy in Norway (Miljøverndepartementet 1992). However, the conflict created by wolverine predation on sheep and domestic reindeer *Rangifer tarandus* results in strong local pressure for licenses to kill wolverines and in illegal killing. This poses a threat to the sustainable management of wolverines, which often occur in small populations.

The wolverine lives in a boreal/mountain ecosystem where reindeer, small game, small rodents (Rodentia) and birds are important prey species (Myhre & Myrberget 1975, Pulliainen 1968, Magoun 1987, Landa et al. in prep.). Sheep, usually completely unattended, are in the system throughout the short summer period when the general food supplies are highest. However, the importance of sheep as prey for wolverines is not known.

The behavioural mechanisms involved when wolverines prey on sheep, both the behaviour of sheep and wolverines, are poorly known. Research to find ways for wolverines and sheep to coexist has received little attention so far and there has been no previous research on ways to alter wolverine predatory behaviour. Several research programs have been conducted on different carnivores with respect to altering their behaviour towards and preventing predation on domestic animals. These programs included fencing (Nass & Theade 1988), sound (Bomford & O'Brien 1990), toxic sheep collars (Connoly et al. 1978, Savarie & Sterner 1979), taste and olfactory chemicals (Cringan 1972, McColloch 1972, Conover & Kessler 1994) and guarding dogs (Green et al. 1984, Black & Green 1984). A commercial 'assault spray', containing oleoresin capsicum, has been shown to be effective in driving away grizzly/brown bears after sudden encounters (Hunt 1985).

The literature on smell and taste agent experiments on carnivores is relatively limited, but some is available on dogs *Canis familiaris* and coyotes *Canis latrans*. Donovan (1967) supposed that secretion from a dog's anal gland could be effective in frightening other dogs. Linhart et al. (1977) identified a number of potential 'anti-coyote' agents that had been tested by different researchers. With conditioned food aversion (CFA), sheep carcasses or sheep bait packages are treated with the emetic agent lithium chloride (LiCl). In theory, the predator becomes sick after ingesting the bait, develops an aversion to the taste, and subsequently avoids killing sheep (Conover et al. 1977, Forthman Quick et al. 1985). Two large-scale field evaluations on coyotes have been carried out (Bourne & Dorrance 1982, Gustavsen et al. 1982, Jelinski et al. 1983), but opposite conclusions were reached, and Conover & Kessler (1994) found that the method had not been applied in practical use because it is not sufficiently effective. The free-ranging summer pasturing system of Norwegian sheep husbandry would probably also prohibit use of such agents because of the possibilities of detrimental effects on non-target scavenging species such as golden eagle *Aquila chrysaëtos*, carrion crows *Corvus corone*, ravens *Corvus corax*, red fox *Vulpes vulpes* and arctic foxes *Alopex lagopus*.

To find potential olfactory aversive agents for wolverines, tests with many non-lethal chemicals and oils have been performed under controlled conditions in captivity (Landa et al. 1993, Landa & Tømmerås in press). After first having tested the aversion effect of each individual substance, a mixture of tiger balsam, ylang-ylang oil, tea-tree oil, peppermint oil, pelargonium oil, methyl salicylate, *p*-dichlorobenzene and amyl acetate was found to be most potent as a repellent and was used for field tests.

The aims of our study were: 1) to measure the extent to which sheep was included in the diet of the wolverine and 2) to test whether the repellent agents identified earlier could be attached to sheep and thereby cause a reduction in wolverine predation.

Study area and methods

The Snøhetta region in central South Norway, was recolonised by wolverines in 1976-79 (Landa & Skogland 1995). The wolverine is presently the only 'large' predator in this area and the population has been monitored by snow-tracking almost every year since 1979 (Kvam 1979, 1980, Kvam & Sørensen 1981, 1983, Overskaug et al. 1986, Sørensen & Kvam 1986, Kvam et al. 1987, Røskaft 1988, Landa & Skogland 1989, Loen 1991). Since 1990, annual monitoring has been supplemented with radio-tracking of wolverines. All sightings or indications of wolverine hunting or scavenging activities on different prey have been recorded. All dens and observations of females with cubs, or lone cubs, observed from May to September, have been recorded annually since 1979, when the first denning activity was recorded. Observations reported by the public were evaluated by interviewing of the observers.

To study the possible influence of sheep as prey on wolverine population dynamics, we tested if there were any correlations between sheep losses and sheep population size and between these variables and the recorded number of wolverines and wolverine reproductive output. Wolverines are known to store food (Haglund 1966). To test any possible effects of stored sheep carcasses, we tested if there were any correlations between the number of sheep claimed to have been lost due to wolverine predation during the autumn and the recorded wolverine numbers the following winter or wolverine reproductive output the following year. Since 1989, we collected scats and prey remains from all known dens in June. At this time of the year the dens are no longer used by wolverines. Scats were analysed using the frequency method

(Myhre & Myrberget 1975) and identifiable bone, hair or feather fragments were classified as either reindeer, small rodent, bird, sheep or hare.

The evaporation rates of the different agents to which captive wolverines responded (Landa & Tømmerås in press) were first tested in the laboratory. We developed low density polyethylene dispensers with a release rate of 0.8 mg to 3.0 mg per day at 20°C. The most powerful agents from the captivity experiments were portioned in separate dispensers in the 1993 field test of evaporation rates under ambient temperatures throughout the grazing season. The dispensers were attached to a specially designed wool clip on an elastic collar. The wool clip was constructed to keep the dispenser in position in the upper neck region because wolverines almost invariably kill sheep with bites in this part of the body (Myrberget & Sørensen 1981, Landa et al. 1986). During the 1994 field tests, we used a mixture of all the agents in one polyethylene dispenser. The amount of each substance was 0.25 ml. With seven agents used, the total amount of liquid in each dispenser was thus 1.75 ml. In 1994, the dispenser was sewn onto the elastic collar and the wool clip was improved. We also tested a set up where the dispenser was enclosed in a cloth bag and attached to a conventional ear tag. A set up where the dispenser was taped onto the top edge of the bell collar of ewes was also employed. We performed a small-scale test in sheep pens to ensure that the agents did not alter ewe/lamb interactions.

Sheep flocks used in field tests were chosen according to the following criteria: 1) high documented wolverine predation rates (min. 10% losses during the previous two

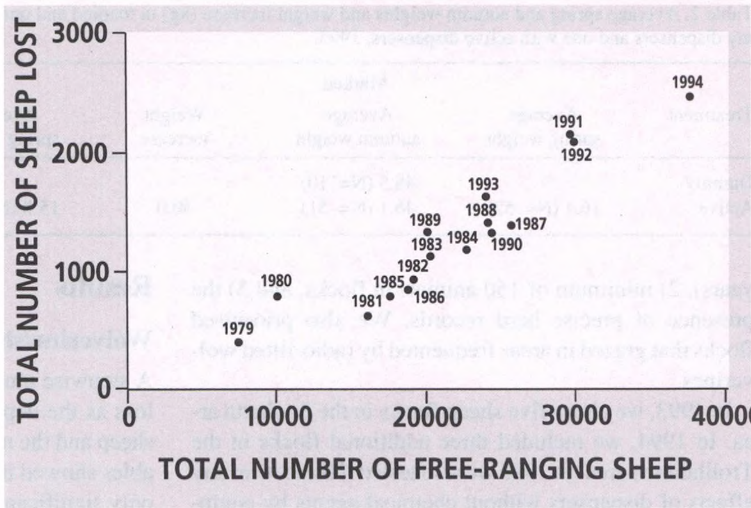

Figure 1. Relationship between the number of free-ranging and lost sheep in organised grazing districts within the summer range at Snøhetta, 1979-1994.

Table 1. Recorded numbers of wolverines, dens, successful breeding attempts, sheep remains in wolverine scats and total numbers of free-ranging and lost sheep in the Snøhetta area, 1979-1995.

Year	Number of wolverines	Number of dens	Number of successful breeding attempts	% occurrence of sheep in collected scats (N=dens)	Total number of free-ranging sheep	Total number of sheep lost
1979	7	2	0	-	7,490	359
1980	-	2	2	-	10,024	799
1981	12	3	3	-	16,164	623
1982	-	3	2	-	19,434	914
1983	-	2	2	-	20,367	1,126
1984	14	3	0	-	22,824	1,167
1985	9	3	2	-	17,693	784
1986	-	2	2	-	18,969	838
1987	11	4	2	-	25,934	1,367
1988	-	3	3	-	24,136	1,405
1989	12	4	4	7 (3)	20,244	1,309
1990	-	3	1	3 (3)	24,517	1,311
1991	16	2	2	18 (1)	29,957	2,128
1992	12	2	2	0 (1)	30,107	2,072
1993	-	3	2	36 (1)	24,199	1,611
1994	-	3	1	33 (1)	37,801	2,451
1995	17	4	2	16 (3)	-	-

Table 2. Average spring and autumn weights and weight increase (kg) in marked and unmarked lambs in two sheep flocks, one with dummy dispensers and one with active dispensers, 1993.

Treatment	Marked			Unmarked		
	Average spring weight	Average autumn weight	Weight increase	Average spring weight	Average autumn weight	Weight increase
Dummy	-	48.5 (N=110)	-	-	47.6 (N=115)	-
Active	16.1 (N= 52)	46.1 (N= 51)	30.0	15.0 (N= 41)	43.3 (N= 37)	28.3

years), 2) minimum of 150 animals in flocks, and 3) the presence of precise herd records. We also prioritised flocks that grazed in areas frequented by radio-fitted wolverines.

In 1993, we chose five sheep flocks in the Snøhetta area. In 1994, we included three additional flocks in the Trollheimen area. In 1993 we also tested if there were any effects of dispensers without chemical agents by equipping two flocks with empty dispensers. These flocks were chosen according to the same criteria as above, but were as geographically distinct from the others as possible. Although difficult to control, this was done to ensure that wolverines that had experienced real repellents should not find the dummy control group. Each test flock was divided into two groups, one control group not fitted with dispensers and one test group fitted with dispensers. All test animals were chosen randomly, but if possible we fitted whole family groups, that is, a ewe and her lambs, with dispensers. The sheep were fitted with dispensers when they were released on their summer ranges, varying from the end of May until the end of June. During summer the flocks ranged freely without supervision by shepherds, and they were gathered from the beginning of September until October.

All experimental flocks were monitored by trained personnel throughout the grazing season. In areas frequented by radio-fitted wolverines, the personnel carried receivers. Post-mortem analyses were performed on sheep carcasses using the method described by Myrberget & Sørensen (1981) and Sørensen et al. (1984).

Results

Wolverine/sheep interactions

A stepwise multiple regression analysis with total sheep loss as the dependent variable and number of pasturing sheep and the number of wolverines as independent variables showed that the number of pasturing sheep was the only significant factor correlated with losses ($R^2 = 0.88$, $F = 46.0$, $P = 0.000$, $y = -421.7 + 0.07x$, Fig. 1). The analysis of scats collected at den sites showed that the percentage of occurrence of sheep ranged from 0 to 36% in scats from the 12 dens sampled over the last seven years and averaged 13% (Table 1). Snow-tracking showed that wolverines occasionally visited carcasses in winter, indicating a certain use of stored lambs killed the previous autumn. There was no correlation between sheep losses the previous autumn and recorded number of wolverines in winter ($r_s = 0.46$, N = 8 years, $P = 0.124$, Spearman rank, one-tail). Furthermore, there was no relationship between sheep losses and the recorded number of wolverine breeding attempts ($r_s = 0.22$, N = 16 years, $P = 0.20$, Spearman rank, one-tail), nor with the number of successful wolverine breeding attempts the next season ($r_s = -0.18$, N = 16 years, $P = 0.26$, Spearman rank, one-tail, see Table 1).

Test of ewe/lamb relationship

We found no change in the behaviour of ewes towards their newly born lambs in pens after attaching dispensers containing the chemical agents on ewes and lambs (N = 2). Furthermore, the field experiments did not show any indication that ewes altered their behaviour towards their

Table 3. Number of ewes and lambs released in spring and number of lost ewes and lambs in test flocks, 1993.

		Released				Lost			
		Marked		Unmarked		Marked		Unmarked	
Flock no.	Treatment	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs
1	Active dispenser	30	90	62	90	0	3	1	17
3	-	43	79	48	85	0	1	3	6
4	-	21	54	38	37	0	0	0	2
2	Dummy dispenser	68	112		115	1	2	2	4
5	-	54	104	70	109	0	5	4	13

lambs as a result of being marked with dispensers. We found no decrease in the weights of marked lambs as compared with unmarked (Table 2).

Field test of repellents in 1993

In the flocks with dummy dispensers in 1993, lamb loss was significantly higher in the untreated (7.6%) than in the treated group (3.2%), ($\chi^2 = 4.03$, df = 1, P = 0.044, Table 3). Among experimental flocks marked with active dispensers, the untreated group showed much higher losses (11.8%) than the treated group (1.8%), ($\chi^2 = 17.46$, df = 1, P = 0.000, see Table 3). In flock no 3, which grazed in the same area as flock no 2, we found one marked and three unmarked lambs that were killed by wolverines. In flock no 4 no carcasses were found.

The elastic collar proved to be too tight on the largest lambs, but not critically so. The collars tended to collect twigs and coniferous needles, which reduced the quality of the wool in the neck region somewhat. About 20-25% of the wool clips were either lost or broken. Of the remaining partly intact marks, more than 40% of the wool clips had loosened from the attachment area so that the repellents were out of position. Only about 3% of the dispensers were completely intact, because many of the tubes containing chemicals had opened during the grazing season.

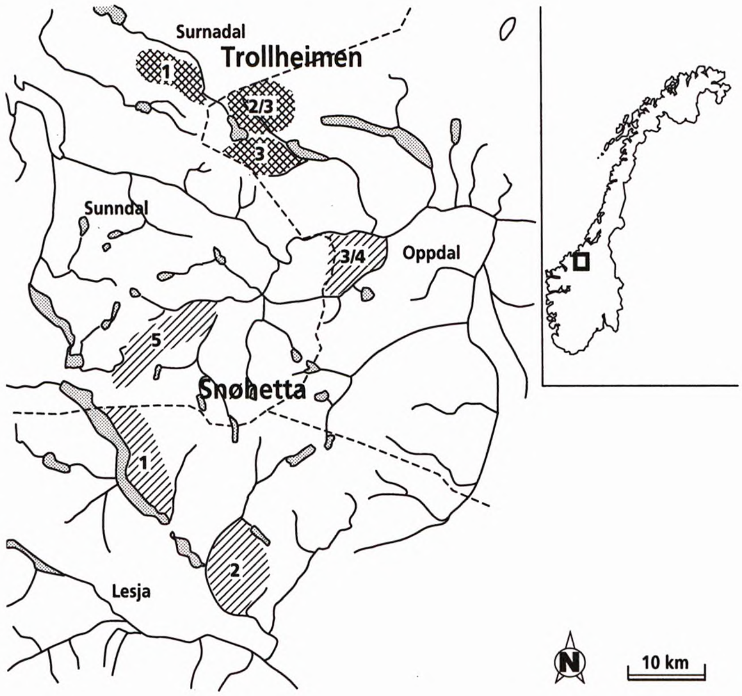

Figure 2. Geographical distribution of summer pasture for the experimental flocks in the Snøhetta area (1-5), and the Trollheimen area (1-3).

Field test of repellents in 1994

In the experiment where repellents were attached to the ear tags of the lambs, the treated group showed statistically lower losses (6.3%) than the untreated group (12.7%), ($\chi^2 = 10.17$, df = 1, P = 0.001, Fig. 2, Table 4). In this area we found 15 lamb carcasses, of which nine had been killed by wolverines; five of these were marked (see Table 4). About 51% of the collected dispensers at-

Table 4. Numbers of ewes and lambs released in spring and the total number of lost sheep in flocks with active dispensers in the Snøhetta and Trollheimen areas, 1994.

	Released				Total loss			
	Marked		Unmarked		Marked		Unmarked	
Flock	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs
Snøhetta								
1	41	89	42	78	1	18	1	25
2	42	105	66	90	1	2	1	11
3	40	80	40	49	2	5	1	3
4	25	50	23	40	0	1	0	2
5	71	135	72	138	2	3	0	9
Trollheimen								
1	68	125	72	115	0	11	2	18
2	37	63	39	47	0	16	1	16
3	95	196	105	169	0	27	2	36

tached to ear tags were broken or had lost the chemical content during the grazing season. Over 36% of the conventional ear tags were lost and additionally 26% of the dispensers had fallen off during the grazing season. Therefore, only about 38% of the lambs had completely intact marks when collected.

In the three flocks tested with the repellent dispensers sewn onto an elastic collar attached to the neck by an improved wool clip (see Fig. 2), there was also statistically lower lamb losses in the treated group (14.0%) than in the untreated group (21.1%) ($\chi^2 = 6.23$, df = 1, P = 0.013, see Table 4). Six lamb carcasses were found and four (two marked, two unmarked) of these had been killed by wolverines. More than 80% of the collected ampoules used together with the elastic collar had breakages or were too poorly welded so that the chemical content probably disappeared too fast during the grazing season. The specially designed wool clips were all in position at collection in one of the flocks where the lambs were relatively large at the time of marking. In the two other test flocks, where the lambs were relatively small when marked and released, about 30% of the wool clips were out of position.

Discussion

During the more than 70 years for which wolverines were absent from the Snøhetta area, the sheep management system changed from a sheep herding system to a free-ranging and unattended system, where sheep are released in spring and collected in the autumn. With the return of the wolverine, increased sheep losses, mainly lambs, due to wolverine predation have been documented annually (e.g. Kvam et al. 1988). Between 10% and 20% of the sheep are found and wolverine predation accounts for 50-85% of the mortality (Mortensen 1995, Børset 1995). The amount of meat required for the basal metabolism of an adult wolverine has been calculated to be 100 - 180 gram daily (Iversen 1972, Kvam & Sørensen 1981), which means that one wolverine would not need more than 3 - 5 lambs during the summer-autumn period. The number of lambs killed by wolverines (70-100 lambs/wolverine/season) is therefore much higher than what should be expected from the wolverine's metabolic needs.

However, in spite of the problems with wolverine predation in the area, and in spite of the annual compensation for more than 1,200 sheep paid by the government at present, the number of sheep in organised grazing districts in the area has increased more than fivefold since 1979. Our analysis demonstrates that sheep mortality is increasing in a density-independent fashion. Although the wolverine is an important predator on sheep, we have no proof that sheep is an essential part of wolverine diet. Landa et al. (in prep.) found that the abundance of small rodents was the most important factor correlated with wolverine breeding success and that reindeer, mostly from scavenging, was the most frequent food during winter. Considering the small wolverine population size, the annual claims for kill permits, and the danger of illegal actions reducing the wolverine population, combined with few management options to solve the problems, we feel justified in trying methods to alter wolverine behaviour towards sheep.

Although a high proportion of technical failures occurred in both years of field experiments, there was a consistent and statistically significant pattern of lower losses in treated groups than in untreated groups, both in dummy experiments and repellent experiments. Since all marked family groups were chosen randomly, such differences should not be expected unless wolverines selectively avoided marked sheep. The largest effects were found in active dispenser experimental flocks, but the dummy experiments indicate that also dummy dispensers helped reduce wolverine predation. Thus, simple mechanic arrangements could be effective. Because lambs from both marked and unmarked groups pastured together in smaller groups, this could have resulted in a lower loss also in the control group. The random marking of whole families could have influenced our results even though we had a high degree of technical failures, as our captivity experiments showed that wolverines responded to small amounts of the chemical agents. Therefore, one explanation could be that, in spite of technical failures, some of the volatile agents were present throughout most of the pasturing season even if an ampoule was open.

Many factors influence the detection of dead lambs and the determination of the cause of death, including personnel experience, pasturing pattern, vegetation, intensity and time of predation. There is an element of uncertainty in concluding that losses below the normal expectation in our test flocks are caused by lowered wolverine predation, when wolverine predation only was documented a few times within, or close to, our test flocks. But this is unavoidable in experiments like this. The observation that treated lambs with intact repellents were killed and the variation in lamb losses indicate that both predation pressure and individual variation in wolverine predatory behaviour and shyness could be important.

In conclusion, repellents do seem to work, but essential questions have not been answered by our tests. What will happen when all the sheep within a large area are marked and the wolverines no longer are given a choice between marked and unmarked sheep? Will wolverines simply switch back to their natural prey or habituate to the volatile agents? Large-scale tests must be performed before it can be determined whether the use of averting agents may allow wolverines to persist in areas with large numbers of untended sheep grazing on open range.

Acknowledgements - the study was supported by the Norwegian Directorate for Nature Management and 'Tiltaksfondet' in the Norwegian Ministry of Agriculture. We are grateful to the developmental division of the University of Trondheim and Nymec A/S. The sheep farmers and their families by whom we were allowed to carry out our field tests are warmly acknowledged: Helge Gilberg, Terje Håkenstad, Nils Hjellmo, Odd Roald Uv, John Uvsløkk, Ola Bruset, Leif Helmersen and Harald Storli. We also thank NINAs field and office personnel Lill Lock Olden, Jorun Pettersen, Anja Wannag, Lars Bergersen, Eistein Grødal, Jon Nørstebø, Ken Gudvangen, Rolf Røymo, Idar Hansen and Roy Andersen. Valuable comments on this manuscript have been given by Jon Swenson.

References

Black, H.L. & Green, J.F. 1984: Navajo use of mixed-breed dogs for management of predators. - Journal of Range Management 38: 11-15.

Bomford, M. & O'Brien, P.H. 1990: Sonic deterrents in animal damage control; a review of device tests and effectiveness. - Wildlife Society Bulletin 18: 411-422.

Bourne, J. & Dorrance, M.J. 1982: A field test of lithium chloride aversion to reduce coyote predation on domestic sheep. - Journal of Wildlife Management 46: 235-239.

Børset, A. 1995: Forvaltning av freda rovvilt i Møre og Romsdal 1991-94. - Fylkesmannen i Møre og Romsdal Rapport 10: 1-45. (In Norwegian).

Connoly, G.E., Griffiths R.E., jr. & Savaire, P.J. 1978: Toxic collar for control of sheep-killing coyotes: a progress report. - In: Eighth Vertebrate Pest Conference Proceedings. University of California, Davis, California, pp. 197-205.

Conover, M.R. & Kessler, K.K. 1994: Diminished producer participation in an aversive conditioning program to reduce coyote predation on sheep. - Wildlife Society Bulletin 22: 229-233.

Conover, M.R., Franicik, J.G. & Miller, D.E. 1977: An experimental evaluation of aversive conditioning for controlling coyote predation. - Journal of Wildlife Management 41: 775-779.

Cringan, A.T. 1972: Odor repellents. - National Wool Grower 62: 14-35.

Donovan, C.A. 1967: Some clinical observations on sexual attraction and deterrence in dogs and cattle. - Veterinary Medicine/ Small Animal Clinician: 1047-1049.

Forthman Quick, D.L., Gustavson, C.R. & Rusiniak, K.W. 1985: Coyote control and taste aversion. - Appetite 6: 272-275.

Green J.S., Woodruff, R.A. & Tueller, T.T. 1984: Livestock-guarding dogs for predator control: costs benefits, practicality. - Wildlife Society Bulletin 12: 44-50.

Gustavsen C.R., Jowsey, J.R. & Milligan, D.N. 1982: A 3-year evaluation of taste aversion coyote control research in Saskatchewan. - Journal of Range management 36: 16-19.

Haglund, B. 1966: De stora rovdjurens vintervanor. (In Swedish with English summary: Winter habits of the Lynx (Lynx lynx L.) and wolverines (Gulo gulo L.) as revealed by tracking in the snow. - Viltrevy 4: 81-310.

Hunt, C.L. 1985: Descriptions of five promising deterrent and repellent products for use on bears. Final Report. - U.S. Fish and Wildlife Service, Office of Grizzly Bear Recovery Coordinator, University of Montana, Missoula, 55 pp.

Iversen, J.A. 1972: Basal energy metabolism of mustelids. - Journal of compiled Physiology 81: 345-362.

Jelinski, D.E., Rounds, R.C. & Jowsey, J.R. 1983: Coyote predation on sheep, and control by aversive conditioning in Saskatchewan. - Journal of Range Management 36: 16-19.

Kvam, T. 1979: Jervesporing i Snøhetta-Rondane våren 1979. - DVF, Viltforskningen, Viltrapport 7: 1-28. (In Norwegian).

Kvam, T. 1980: Population status of the wolverine Gulo gulo in some central Norwegian mountain areas. - Fauna 33: 117-127.

Kvam, T. & Sørensen, O.J. 1981: Jervens status i Snøhetta, Rondane og en del omliggende fjellstrøk 1981. - DVF, Viltforskningen, Viltrapport 19: 1-29. (In Norwegian).

Kvam, T. & Sørensen, O.J. 1983: Utviklingen i jervestammen i Snøhettaområdet i perioden 1979-1982. - DVF, Viltforskningen, Arbeidsrapport 4: 1-13. (In Norwegian).

Kvam, T., Overskaug, K. & Sørensen, O.J. 1987: Jerveinventering i Snøhetta-området våren 1986. - DVF, Viltforskningen, Rovviltrapport 1: 1-13. (In Norwegian).

Kvam, T., Overskaug, K. & Sørensen, O.J. 1988: The wolverine Gulo gulo in Norway. - Lutra 31: 7-20.

Landa, A., Overskaug, K., Sørensen, O.J. & Kvam, T. 1986: Spor og Tegn (Store rovdyr), 1986, - DN-Viltforskningen, Trondheim, 14 pp. (In Norwegian).

Landa, A. & Skogland, T. 1989: Bestandstelling av jerv i Snøhetta og omliggede fjell vinteren 1989. - NINA, Oppdragsmelding 011: 1-26. (In Norwegian).

Landa, A. & Skogland, T. 1995: The relationship between population density and body size of wolverines Gulu gulo in Scandinavia. - Wildlife Biology 1: 165-175.

Landa, A., Strand, O., Swenson, J.E. & Skogland, T. (in prep.): Interrelationships between wolverines and their prey in southern Norway. - Submitted to Canadian Journal of Zoology.

Landa, A., Tømmerås, B.Å. & Skogland, T. 1993: Testing av lukt og smaksrepellenter og utprøving av effekt for å redusere jervpredasjon på sau (In Norwegian with English summary: Test of olfaction and taste repellents, and a pilot project to test their effects in reducing wolverine predation on sheep). - NINA Oppdragsmelding 243: 1-20.

Landa, A. & Tømmerås, B.Å. in press: A test of aversive agents on wolverines. - Journal of Wildlife Management.

Linhart, S.B., Dasch, G.J., Roberts, J.D. & Savaire, P.J. 1977: Test methods for determining the efficiency of coyote attractants and repellents. - In: Jackson, W.B. & Marsh, R.E. (eds.); Test methods for vertebrate pests control and management plans, ASTM STP 625. American Society for Testing and Materials, pp. 114-122

Loen, J. 1991: Store rovdyr i Sør-Trøndelag og jerven i Dovre/Rondane, 1991. Bestander, konflikter og tiltak. - Fylkesmannen i Sør Trøndelag, Rapport 7: 1-40. (In Norwegian).

Magoun, A.J. 1987: Summer and Winter Diets of Wolverines, Gulo gulo, in Arctic Alaska. - Canadian Field-Nature 191: 392-397.

McColloch, R J. 1972: Aversive agents. - National Wool Grower 62: 14, 35-36.

Miljøverndepartementet 1992: Om forvaltning av bjørn, jerv, ulv og gaupe (Rovviltmeldingen). - Stortingsmelding nr. 27, 1991-92, pp 13-23. (In Norwegian).

Mortensen, A. J. 1995: Forvaltning av fredet rovvilt i Oppland 1994. - Fylkesmannen i Oppland 7: 1-25. (In Norwegian).

Myhre, R. & Myrberget, S. 1975: Diet of wolverines (Gulo gulo) in Norway. - Journal of Mammalogy 56: 752-757.

Myrberget, S. & Sørensen, O.J. (eds.) 1981: Spor og Sportegn etter store rovdyr. - Viltrapport 15: 86-97. (In Norwegian).

Nass. R.D. & Theade, J. 1988: Electric fences for reducing sheep losses to predators. - Journal of Range Management 41: 251-252.

Overrein, Ø. & Fox, J.L. 1989: The wolverine and livestock predation in North Norway. - In: Myrberget, S. (ed.); Transactions the

XIXth IUGB Congress, Vol II: Wildlife management, Norwegian Institute for Nature Research, Trondheim, p. 604.
Overskaug, K., Kvam, T. & Sørensen, O.J. 1986: Jerv i Norge 1985. - Rovviltprosjektet, arbeidsrapport 28: 1-53. (In Norwegian).
Pulliainen, E. 1968: Breeding biology of the wolverines (Gulo gulo) in Finland. - Annales Zoologica Fennica 5: 338-344.
Røskaft, E. 1988: Årsrapport Prosjekt jerv 1987. - Økoforsk notat 3: 1-29. (In Norwegian).
Savarie, P.J. & Sterner, R.T. 1979: Evaluation of toxic collars for selective control of coyotes that attack sheep. - Journal of Wildlife Management 43: 780-783.
Sørensen, O.J. & Kvam, T. (eds.) 1986: Jerveundersøkelser i Snøhettaområdet 1984 og Bjørneregistrering i Namskogan våren/forsommeren 1985, Rovviltprosjektet. Rapport 21: 3-14. (In Norwegian).
Sørensen, O.J., Mysterud, I. & Kvam, T. 1984: Sentral registrering av store rovdyr i Norge. (In Norwegian with English summary: Central registration of large carnivores in Norway.) - DVF, Viltforskningen, Viltrapport 30: 1-157.