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Wolf attacks on dogs in Scandinavia 1995 – 2005

Will wolves in Scandinavia go extinct if dog owners are
allowed to kill a wolf attacking a dog?

Jessica Backeryd
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Teckning: Henrik Löfgren

Handledare: Jens Karlsson

Institutionen för ekologi
Grimsö forskningsstation
SLU
730 91 Riddarhyttan

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Abstract

Wolf attacks on hunting dogs are considered a major problem among many hunters in Scandinavia. This study is a descriptive summary of the 152 verified reports of wolf attacks on dogs in Scandinavia 1995 to 2005. I also predict the effects of different changes in the hunting legislation regarding the number of wolf killed dogs prevented and the number of wolves killed by dog owners. 86 % of the dogs in this study were attacked by wolves while used for hunting and a majority (71 %) of the attacked dogs was killed. 72 % of the killed dogs were partly or totally consumed by the wolves. Dogs of the breed harrier were overrepresented in being attacked, both numerically and in relation to their number of hunting days. Sex of the dog did not seem to affect the risk of a wolf attack. Older dogs (7 to 13 years old) ran a higher risk of being attacked than younger ones (1 to 6 years old). In 12 % of the cases the dog owners said they could have shot the wolf that attacked their dog, during or directly after the attack. If a dog owner is allowed to shoot a wolf before, during or after an attack on their dog, it could result in a maximum of 3 % of the Scandinavian wolves getting killed each year. By changing the legislation, one dog per year could be saved from being seriously injured or killed by wolves.

Introduction

Intraspecific predation is a major cause of mortality among animals and at least 14 species of carnivorous mammals, including wolves, sometimes attack and eat conspecifics. This behavior could be a strategy of reproductive competition and may occur directly by cannibalizing sexual competitors (Polis 1981).

Wolves are the progenitors of dogs (*Canis familiaris*) and the two species may interbreed (Fritts and Paul 1989). Aggressive interactions resulting in wolves killing dogs are also common (Fritts and Paul 1989; Persson and Sand 1998; Kojola *et al.* 2004). There are few studies made on wolf attacks on dogs (Fritts and Paul 1989; Kojola *et al.* 2002) and little is known about why some wolves attack dogs whereas others do not (Kojola and Kuittinen 2002; Wydeven *et al.* 2003).

After many years of persecution, the gray wolf (*Canis lupus*) is now recovering and expanding in many areas of Europe and North America. Especially the wolf populations in the European Western Alps and Scandinavia show a considerable growth rate (Chapron *et al.* 2003). However, when wolves move into semi-agricultural areas, a variety of conflicts with human activities will increase (Mech 1995). Depredation on livestock and pets, such as domestic dogs and competition with hunters, mainly for ungulates, occur in many areas (Mech 1995; Kojola *et al.* 2004; Treves *et al.* 2002; Naughton-Treves *et al.* 2003; Chapron *et al.* 2003). Wolves affect people emotionally and attract public attention far out of proportion to their numbers (Naughton-Treves *et al.* 2003) but conflicts like depredation may cause major management issues concerning the conservation and public acceptance of wolves (Mech 1995; Kojola and Kuittinen 2002; Chapron *et al.* 2003).

The gray wolf was nearly extinct from the Scandinavian Peninsula (Sweden and Norway) in the 1960s. The species was protected in 1966 in Sweden and in 1972 in Norway (Persson and Sand 1998). Between 1965 and 1977 there were only a few, often unconfirmed, observations of wolves on both sides of the Swedish-Norwegian border. In 1978 a successful reproduction was confirmed in the alpine area of Sweden and this year is regarded as the starting year of the wolf recovery in Scandinavia (Wabakken *et al.* 2001). After several years of reports on wolf sightings in areas further south in Sweden, it was in the winter 1980-81 verified through snow tracking that a few wolves were occupying the northern part of the province of Värmland (Persson and Sand 1998). The number of wolves probably never exceeded ten individuals during the 1980s but in 1991 the population started to grow when two successful reproductions occurred in two different places in Sweden. The average annual population increase was 29 % until 1999 and after that it has decreased to 10 % (Wabakken *et al.* 2001).

The number of wolves on the Scandinavian Peninsula during the winter 2004-05 ranged between 122 and 138 individuals and consisted of 14 wolf packs, 12-16 scent-marking pairs and an unknown number of single wolves (Wabakken *et al.* 2005). In 2001, a first management goal for the Swedish wolf population was settled in a parliamentary resolution. It was decided that the population should reach 20 reproductions each year, equivalent to 200 individuals. When this goal is achieved, an evaluation of the situation will be carried out. The Norwegian management goal is to have three wolf reproductions annually in Norway each year in addition to the ones shared with Sweden.

In several countries in Europe, the use of hunting dogs is a common way of hunting different game (Thelander 1992). Moose (*Alces alces*) hunting with unleashed dogs is an old tradition

in Scandinavia (Thelander 1992) and hunters often use different dog breeds, like Swedish or Norwegian elk hounds (Swe. jämthund and gråhund), that are specialized in tracking moose and putting it at bay. Breeds used for moose hunting are often also used to hunt brown bears (*Ursus arctos*) (Kojola and Kuittinen 2002). Another type of old traditional hunting in Scandinavia is the use of unleashed dogs which chase the game. When hunting roe deer (*Capreolus capreolus*), mountain hare (*Lepus timidus*) and brown hare (*Lepus europaeus*), different dog breeds, for example harriers (Swe. stövare), Swedish dachsbracke (Swe. drever) and dachshounds (Swe. tax), are used (Thelander 1992). These types of dogs slowly chase and continuously bark while tracking the game (Cederlund and Kjellander 1991; Thelander 1992). The unleashed hunting dogs are sometimes kilometers away from their owners, often in forested and remote areas, which increase the vulnerability to wolf depredation (Treves *et al.* 2002). There are more than 100 000 registered hunting dogs in Sweden and a similar number in Norway. Statistics from both the Swedish and the Norwegian Kennel clubs show that the numbers of newly registered dogs of the most common hunting breeds, are relatively constant in Sweden and show an increase in Norway (Swedish Kennel club 2006; Norwegian Kennel club 2006).

Wolf attacks on dogs occur both in house yards (Fritts and Paul 1989; Kojola *et al.* 2002; Sidorovich *et al.* 2003; Treves *et al.* 2003) and in the forest (Persson and Sand 1998; Wabakken *et al.* 2001; Treves *et al.* 2003; Wydeven *et al.* 2003). There seems to be several possible reasons for wolves to attack dogs, including competition and predation (Kojola and Kuittinen 2002). Fritts and Paul (1989) and Kojola *et al.* (2004) suggested that some wolves are actively seeking for dogs, and Kojola *et al.* also suggested that aggressive behavior by wolves towards dogs may be an inherited behavior. Encounters may also be purely accidental or occur after the dog actively had tracked wolves (Karlsson *et al.* 2006).

Earlier studies have given varying results concerning when encounters between wolves and dogs are most common. Studies from Minnesota (Fritts and Paul 1989) and in the Tver Region of Russia (Bologov and Miltner 2001) showed that dogs most commonly got attacked in house yards, which was supported by Kojola *et al.* (2004) who showed that 70 % of the dogs in Finland were attacked in house yards. Similar results were obtained in a study in north-eastern Belarus, which included 247 wolf-killed dogs between 1990 and 2000. 130 of the dogs were guarding dogs, often chained, and were killed near houses. The other 117 dogs were killed in hunting situations. A study by Sidorovich *et al.* from 2003, showed that depredation by wolves on domestic animals and dogs increased during the years 1994 to 1997, when recorded numbers of wild ungulates in the study area was at their lowest. In a study on wolf attacks on dogs between 1976 and 2000 in Wisconsin, 32 of 35 dogs were killed in hunting situations (Treves *et al.* 2002). Fritts and Paul (1989) and Kojola and Kuittinen (2002) showed that wolf attacks on dogs in house yards or villages usually were made by a single wolf not belonging to a pack. This behavior could indicate that single wolves might have problems to catch wild prey on their own while dogs might be more easy prey to catch.

Dogs are usually cherished pets and although hunting dogs are often used primary for hunting they are also often considered as a member of the family. Getting a hunting dog killed, is both an emotional as well as an economic loss for many dog owners. The cost of replacing a well trained hunting dog may be counted in both time and money (USDA *et al.* 2006). There were 152 verified reports of dogs injured or killed by wolf in Sweden and Norway between 1995 and 2005 and the number of attacks has increased the past years.

There is a growing frustration among people hunting in areas with wolf territories, since hunters are afraid of releasing their hunting dogs in these areas.

Compensation system

A Swedish or a Norwegian dog owner who gets their dog injured or killed by any of the protected large predators; wolf, lynx (*Lynx lynx*) bear, wolverine (*Gulo gulo*) or golden eagle (*Aquila chrysaetos*), can receive compensation by the Swedish Environmental Protection Agency (EPA) and The Directorate for Nature Management (DN) respectively, if it can be verified that the dog was attacked by any of the predators mentioned above. The owner of a dog suspected to have been attacked by one of these predators, should immediately report the incident to the County Administration Board. A trained expert is sent out to examine the injuries on the dog in order to verify and document a potential predator attack. If possible, the place of the attack is also investigated. Verified reports of attacks of large predators on dogs are documented and recorded by the County Administrations Boards and by the Swedish wildlife damage center in Sweden and Statens Naturoppsyn (SNO) in Norway.

Regulations on hunting and game

There is at present a debate, especially among hunters and politicians, concerning a possible change of the Swedish (28 § Jaktförordningen 1987:905) and Norwegian (11 § Viltloven 1981-05-29-38) law regulating in which situation a person is permitted to kill any of the protected large predators; wolf, lynx, bear or wolverine in connection to an attack on domestic animals. Many hunters in Sweden consider that the current wording of the hunting regulation is unclear and they feel frustrated not knowing exactly when they have a legal right to defend their hunting dog if it should be attacked by a wolf. The current wording of the Swedish hunting regulation 28 § allows “*the owner or the keeper of the domestic animal*” to kill an attacking predator in immediate connection to an attack “*if there are reasons to suspect that the predator will attack the domestic animal, that the killing of the predator occurs in immediate connection to where the predator has injured or killed (a) domestic animal(s) and that it is not possible to ward off the attack by scaring the predator*”. There is strong opposition towards the condition that the predator must injure or kill the dog before the predator itself can be killed. The Norwegian hunting regulation 11 § allows the owner or someone representing the owner to “*kill a protected predator that attacks his/her domestic animal(s) or reindeer*”. As dogs are not defined as domestic animals in Norway, they are not included in this regulation.

The discussions about possible changes of the hunting regulations have resulted in several proposals of wordings, allowing a person to shoot:

- 1) a predator moving towards the dog to attack it
- 2) a predator while physically attacking the dog
- 3) a predator when it leaves the dog after physically attacking it
- 4) different combinations of the above

Objectives

The objectives of this study were to:

- 1) Make a descriptive summary of wolf attacks on dogs in Scandinavia 1995-2005.
- 2) Assess the effect of age, sex and breed of the dogs on the risk for a wolf attack.

- 3) Estimate the worst possible effects on the Scandinavian wolf population, if a law change made it legal to kill a wolf even before it had physically attacked the dog and injured it, or after it had left the dog.
- 4) Assess how many dogs that could be saved from being seriously injured or killed each year if changes in the hunting regulations made it possible to shoot a wolf either before or after an attack on a dog.

Methods

Data collection

The study was conducted at Grimsö wildlife research station during the period of February 3rd to March 13th 2006. Telephone-interviews were carried out with the Swedish and Norwegian dog owners who got their dog(s) injured or killed by (a) wolf/wolves between 1995 and 2005. Data included 152 verified reports of wolf attacks on dogs in Scandinavia (figure 1). The dog owners were asked a set of 42 preformed questions in order to record as clear as possible all details of the attacks (appendix 1).

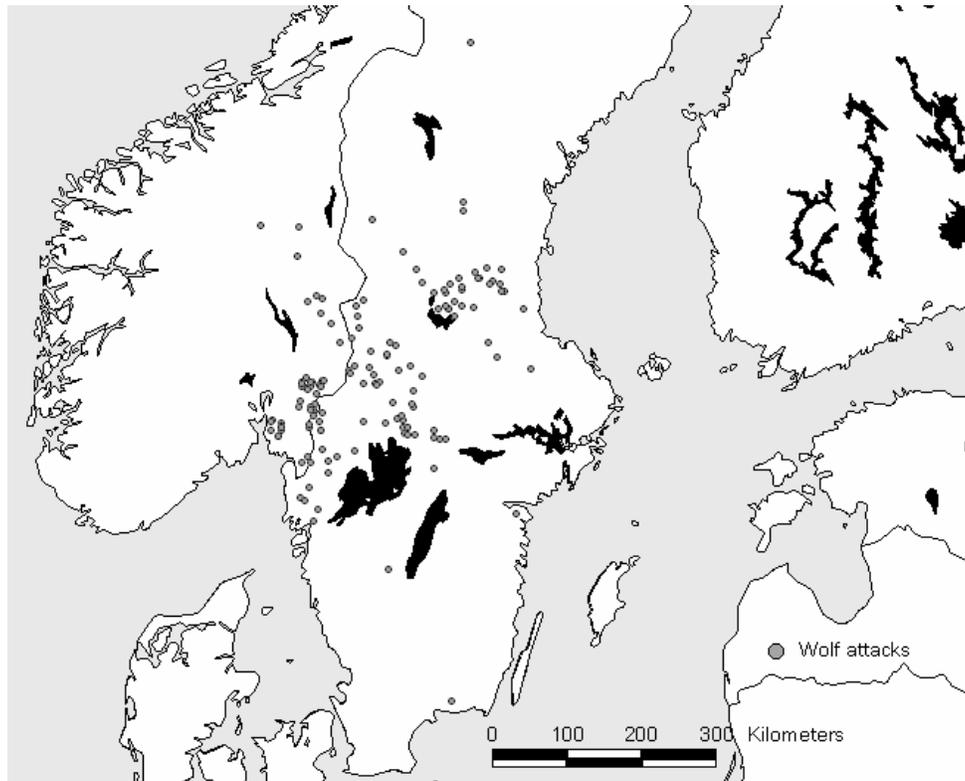


Figure 1. Wolf attacks on dogs in Sweden and Norway from 1995 to 2005. Each grey dot represents one attack (n=152).

Statistical tests were done in StatView (SAS Institute Inc. 1992-1998 version 5.0.1). Chi square tests were used to assess if breed, age or sex, affected the risk of a wolf attack, when number of hunting days were controlled for. Chi square tests were used to assess whether living in kennel versus inside the owner's house affected the risk of a wolf attack. Data from this study were also compared with those from an earlier study by Karlsson (unpubl. data).

Information on the dogs' breed, sex, age, whether they were injured or killed, where the wounds on the dogs were located, and whether killed dogs were partly or totally consumed, was taken from each of the verified reports of wolf attacks on the dogs in the study. A killed dog was classified as partly consumed if the wolf/wolves had eaten from one or several body parts of the dog and as totally consumed if the whole dog was consumed or if only the dogs' head was left.

Time of the year for the wolf attacks was classified as attacks during hunting season (21st of August to 28th of February) or not and attacks during hunting or not. Different situations when the dogs got attacked were classified as attacks while the dog was used for hunting, attacks in the forest in a non-hunting situation or attacks in house yards. Time of the day for the wolf attack was classified as morning (6 am - noon), afternoon (noon – 6 pm), evening (6 pm – midnight) and night (midnight – 6 am). Time from release of the dog until it was attacked by wolves, was classified into four categories: wolf attack within 15 minutes from release, 15 to 30 minutes, 30 to 60 minutes and 60 minutes or more from release.

The dog owners were asked if they knew whether the dog was chasing game or not when it was attacked by wolf/wolves.

The dogs were, according to weight, categorized into three classes: Small: 5-10 kg (Dachshound, German hunt terrier, Icelandic sheepdog, Border terrier and small Crossbreed), Middle-sized: 11-19 kg (Norwegian elk hound, Swedish dachsbracke, Finnish spitz, Border collie, Beagle, Bavarian mountain scenthound, Basset Griffon and middle-sized Crossbreed) and Large: 20-35 kg (Swedish elk hound, Harrier, Karelian bear dog, Wachtel dog and large Crossbreed).

Chi square tests were used to find out whether breed or body size had any affect on whether the dog was consumed or not and to test whether wounds were located differently on injured versus killed dogs.

Persons, who reported that they actually saw one or several wolves during the attack, were asked if they fired a warning shot or did something else to prevent the attack, and also if they thought it would have been possible for them to shoot the wolf. Based on this, maximum number of wolves that could have been shot in connection to an attack on a dog and number of dogs that could have been saved by doing so, was calculated.

Results

141 dog owners were interviewed. Nine persons could not, for various reasons, be reached and two persons did not want to answer any questions.

The number of confirmed wolf attacks on dogs in Sweden and Norway from 1995 to 2005 was 152 (table 1). There were substantial yearly variations ranging from no verified attacks in 1996 to 37 attacks in 2005. During the years 1995 to 1998, only five attacks on dogs were confirmed, which was not enough for comparisons between years. Therefore these cases were excluded from analyses that included between year comparisons.

Table 1. Documented wolf attacks on dogs in Sweden and Norway 1995 to 2005 (n=152).

Confirmed wolf attacks on dogs 1995-2005 in:		
Year	Sweden	Norway
1995	0	1
1996	0	0
1997	0	1
1998	2	1
1999	13	7
2000	8	9
2001	8	8
2002	10	2
2003	18	4
2004	15	8
2005	30	7
Total	104	48

Between 1999 and 2005, 71% of the dogs were killed by wolf/wolves during the attack while 29% were injured (figure 2).

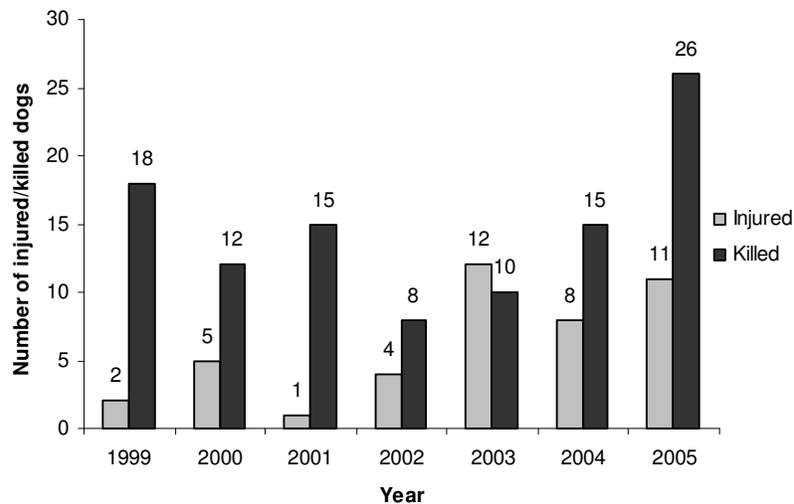


Figure 2. Annual distribution of injured and killed dogs in wolf attacks between 1999 and 2005 (n=147).

Dog breeds

Harrier was numerically the most common dog breed attacked by wolves between 1995 and 2005 (figure 3). In relation to their number of hunting days, harriers also ran a significantly higher risk of being attacked by wolves (table 2).

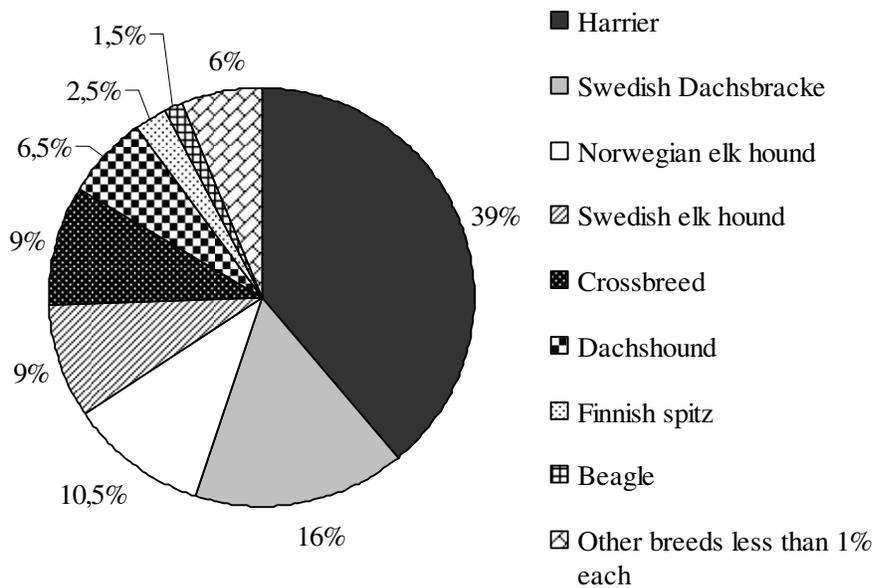


Figure 3. Distribution in percent of different dog breeds attacked by wolves (n=152).

Table 2. Dog breeds that were attacked by wolves in hunting situations, put in relation to their number of hunting days (only breeds with more than six dogs attacked are presented in the table, n=117, df=1).

Dog breed	Total number of hunting days during three hunting seasons in five different wolf territories (Karlsson, unpubl.data)	Minimum, average and maximum number of hunting days during three hunting seasons in a wolf territory (Karlsson, unpubl.data)			Dogs attacked by wolves while used for hunting	X ²	p
		Minimum	Average	Maximum			
Harrier	23001	135	1533	2875	55	12,3	0,0005
Swedish dachsbracke	11075	0	738	1991	21	0,65	0,42
Norwegian elk hound	6297	223	420	712	14	1,59	0,21
Crossbreed	4816	42	321	906	9	0,21	0,65
Swedish elk hound	10375	111	692	1398	12	1,54	0,21
Dachshound	7617	0	508	1266	6	3,56	0,06

Dogs attacked in different situations

92 % of the confirmed attacks (n=140) of wolves on dogs occurred during the hunting season. 86 % of the attacks (n=130) happened while the dog was used for hunting, 7 % (n=10) of the attacks occurred in house yards, 5 % (n=8) of the attacked dogs were running in the forest while not hunting and in four cases the situation is unknown.

Injured or killed dogs

For all breeds except Swedish elk hound, there was a larger risk of being killed rather than just injured when attacked by wolves: Crossbreed $\chi^2=5,05$, df=1, p=0,02; Swedish dachsbracke $\chi^2=12$, df=1, p=0,0005; Norwegian elk hound $\chi^2=6,4$, df=1, p=0,01; Harrier $\chi^2=3,3$, df=1, p=0,07; Dachshound $\chi^2=4,6$, df=1, p=0,03; Swedish elk hound $\chi^2=0,77$, df=1, p=0,38 (figure 4).

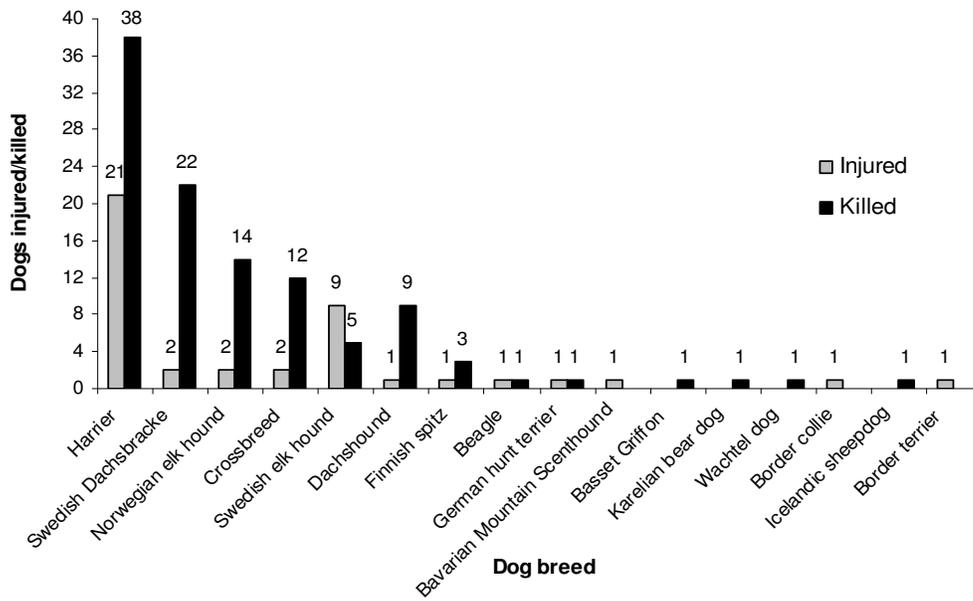


Figure 4. Number of dogs of different breeds injured or killed by wolves (n=152).

Location of wounds on injured or killed dogs

In 67 of the wolf attacks on dogs, 42 dogs were injured and 25 were killed but not consumed. Bite marks on the back of the neck were significantly more common among killed dogs compared to injured dogs (table 3).

Table 3. Locations of documented wounds on dogs injured or killed by wolves. Only dogs that had been killed but not consumed by the wolf/wolves are presented in the table (df=1).

Dogs with bite marks/bleedings on:	Injured dogs (n=42)	Killed dogs (n=25)	χ^2	p
Nose/head	3	3	0,38	0,54
Neck	8	8	0,87	0,35
Throat	5	5	0,59	0,44
Back of the neck	4	8	3,60	0,05
Withers	4	6	1,86	0,17
Shoulder	4	5	1,10	0,29
Forelegs	3	2	0,01	0,90
Back	30	15	0,19	0,67
Abdomen	8	9	1,37	0,24
Thighs	28	9	1,83	0,18
Hind legs	12	4	0,86	0,35
Sexual organs	5	0	2,86	0,09

Dogs killed and consumed by wolves

In 78 of 109 wolf attacks on dogs (72%), the killed dogs were partly or totally consumed. Middle-sized and large dogs (> 11 kilograms) were more often consumed than left intact by the wolves. For small dogs (< 11 kilograms) there was no difference between being consumed or left intact (table 4).

Table 4. Consumption of dogs of different size (df=1).

Weight of dog	Dog consumed	Dog not consumed	χ^2	p
5-10 kg	8	5	0,46	0,50
11-19 kg	34	9	10,1	0,001
20-35 kg	36	9	11,25	0,0008

Harriers and Norwegian elk hounds were more often partly or totally consumed by the wolves than other breeds (table 5).

Table 5. Consumption of dogs of different breeds (>5 dogs killed, df=1).

Breed	Dog consumed	Dog not consumed	X ²	p
Harrier	29	7	9,48	0,0021
Swedish dachsbracke	12	6	1,41	0,23
Norwegian elk hound	12	2	5,05	0,02
Crossbreed	7	4	0,55	0,46
Dachshound	6	3	0,67	0,41

Influence of sex and age on the risk of wolf attacks

The sex of the dog was known in 149 of the wolf attacks on dogs. There was no difference between the sexes regarding risk of being attacked (table 6).

Table 6. Male and female dogs that were attacked in hunting situations, put in relation to their number of hunting days (df=1).

Dogs' sex	Number of hunting days (Karlsson, unpubl. data)	Percentage of hunting days	Dogs attacked by wolf/wolves (n=149)	Percentage of encounters	X ²	p
Male dog	40329	52 %	72	48 %	0,80	0,37
Female dog	37258	48 %	77	52 %		

The age of the attacked dogs was known in 148 of the 152 cases. In relation to number of hunting days, older dogs (7 to 13 years old) ran a significantly higher risk of being attacked by wolves than younger ones (1 to 6 years old) (table 7).

Table 7. Dogs of different ages that were attacked by wolves in hunting situations, put in relation to their number of hunting days (df=1).

Dogs' age	Number of hunting days (Karlsson, unpubl. data)	Percentage of hunting days	Dogs attacked by wolf/wolves (n=148)	Percentage of encounters	X ²	p
1 - 6	47134	61 %	76	51 %	5,56	0,02
7 - 13	29944	39 %	72	49 %		

Time of the day and time from release of hunting dogs to attack by wolves

In 55% of the cases (n=71) when the dogs were used for hunting, they were attacked by wolf/wolves between 6 am and noon. 19% of the dogs (n=25) between noon and 6 pm. 3 % of them (n=4) between 6 pm and midnight and 2 % of them (n=2) between midnight and 6 am. In the rest of the attacks (n=28) the time was unknown.

In 17 % of the cases (n=23) the hunting dog was attacked by wolves within 15 minutes after being released by its owner. In 14 % of the cases (n=19) the dog was attacked after 15 to 30 minutes, in 20 % of the cases (n=28) it was attacked after 30 to 60 minutes and in 28 % of the cases (n=38) the dog had been running loose for 60 minutes or more when attacked by the wolf/wolves. In the rest of the cases (n=30) the time of the attack was unknown.

Did the dog chase game or not

In 62 % of the cases (n=93) the dog chased game when it was attacked by the wolf/wolves. In 22 % of the cases (n=33) the dog had lost the tracks of the game or had not yet started to chase game. In the rest of the cases (n=25) it is unknown.

Influence of dogs usually being in a kennel on the risk of wolf attacks

Of 119 dogs that were attacked by wolves in hunting situations, 71 % (n=85) usually lived indoors with their owners and 29 % (n=34) usually lived outdoors in a kennel. In relation to hunting days, dogs that usually lived in a kennel ran a significantly lower risk of being attacked by wolves than dogs living indoors (table 8).

Table 8. Dogs in hunting situations attacked by wolves. Dogs divided in two groups; usually kept indoors with owner or usually kept outdoors in kennels (df=1).

Dog usually kept:	Number of hunting days (Karlsson, unpubl. data)	Percentage of hunting days	Dogs attacked by wolf/wolves (n=119)	Percentage of encounters	X ²	p
Indoors	16042	32 %	85	71 %	83,6	0,0001
Outdoors	33799	68 %	34	29 %		

Wolf/Wolves seen in connection to attacks on dog

On 43 occasions of 147, the dog owner and/or other persons in company with the dog owner saw the wolf/wolves before, during or after the attack on the dog at distances ranging from 5 to 200 meters (figure 5). In three of the 43 occasions when at least one wolf was sighted (7 %), the dog owner and/or other persons in company with the dog owner saw the wolf/wolves immediately before the attack, in 17 cases (40 %) the actual attack on the dog was seen and in 23 cases (53 %), the wolf/wolves were seen directly after the attack when standing over the injured or killed dog or was about to leave it (table 9b). On one of the occasions four wolves were seen, on five occasions two wolves were seen and in the others a single wolf was seen.

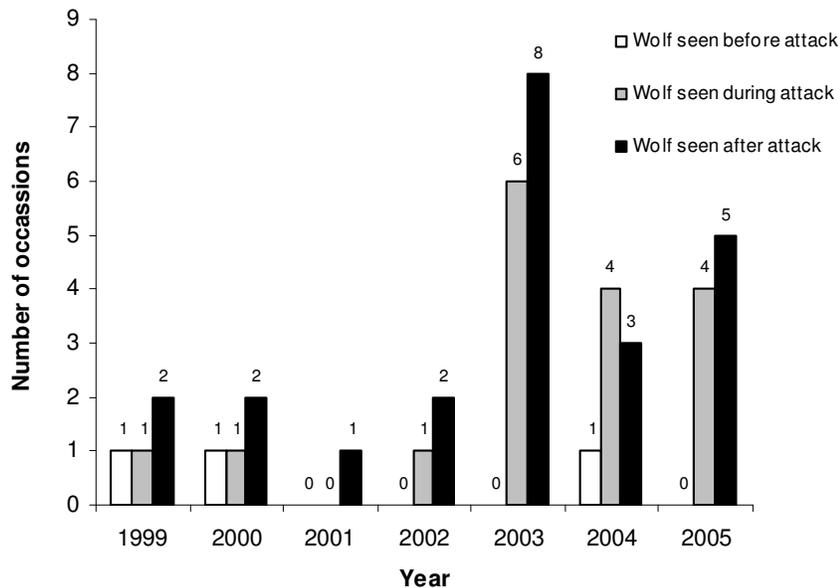


Figure 5. Number of occasions where a person saw wolf/wolves in connection to an attack on a dog (n=43).

Given that every person (not only dog owners), who saw a wolf in connection to the attack on their dog would have shot and killed the wolf, on average 5 % annually of the Scandinavian wolf population would have been killed (table 9a).

Table 9a. Number and proportion of wolf population potentially affected if everyone who saw a wolf in connection to an attack on a dog shot and killed the wolf. Minimum numbers of wolves are based on the annual counts of wolves in Scandinavia (Aronson *et al.* 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006).

Year	Minimum number of wolves in Scandinavia	Wolves seen before attack	Wolves seen during attack	Wolves seen after attack	Wolves seen sometime in connection to attack
1999	62	1 (2 %)	1 (2 %)	2 (3 %)	4 (5 %)
2000	67	1 (1 %)	1 (1 %)	2 (3 %)	4 (3 %)
2001	87	0	0 %	1 (1 %)	1 (1 %)
2002	98	0	1 (1 %)	2 (2 %)	3 (2 %)
2003	76	0	6 (8 %)	8 (11 %)	14 (12 %)
2004	101	1 (1 %)	4 (4 %)	3 (3 %)	8 (5 %)
2005	127	0	4 (3 %)	5 (4 %)	9 (5 %)
Average		1 %	3 %	4 %	5 %

Table 9b. Number and proportion of attacks where wolves were seen before, during or after attacking the dog

Year	Number of wolf attacks	Wolves seen before attack	Wolves seen during attack	Wolves seen after attack
1999	20	1 (5 %)	1 (5 %)	2 (10 %)
2000	17	1 (6 %)	1 (6 %)	2 (12 %)
2001	16	0	0	1 (6 %)
2002	12	0	1 (8 %)	2 (17 %)
2003	22	0	6 (27 %)	8 (36 %)
2004	23	1 (4 %)	4 (17 %)	3 (13 %)
2005	37	0	4 (11 %)	5 (14 %)
Average	21	2 %	11 %	15 %

In 17 of the 43 occasions where the dog owner saw wolf/wolves in connection to the attack, the person said they had the wolf within range and could have shot it. It was on average 12 % and the annual range was 0 % to 27 %. 12 persons said they could have shot the wolf while physically attacking the dog and five persons said they could have shot the wolf directly after the attack on the dog. If these 17 persons would have shot, on average 3 % of the wolves (0 % to 8 % over the years) could have been killed. On two of the occasions, the wolf was shot in connection to the attack. On five occasions, a warning shot was fired by the dog owner to try to stop the attack. On 17 occasions the dog owner tried to stop the attack, usually by shouting and/or running towards the wolf/wolves and the dog (table 10).

Table 10. Number of dog owners who saw wolf or wolves in connection to the attack on their dog, what they did to try to stop the attack and if they could have shot the wolf. Results are based on the total numbers of wolf attacks on dogs each year.

Year	1999	2000	2001	2002	2003	2004	2005
Total number of wolf attacks	n=20	n=17	n=16	n=12	n=22	n=23	n=37
Shot a warning shot	0	0	1	1	2	0	1
Did something to try to stop the attack**	1	2	0	2	7	3	2
Could have shot the wolf	1	2	0	2	6*	3	3*

* One wolf was shot during the attack on the dog.

**Involves stamping on the ground, shouting or/and running towards the wolf.

Discussion

A similar study in Wisconsin by Treves *et al.* (2002) showed that 91 % of the dogs were attacked by wolves while the dog was used for hunting and the equivalent in this study was 86 %. Unleashed hunting dogs that run into wolves' territories often seem to be considered as intruders or as competitors by the wolves (Wydeven *et al.* 2003).

Between 2003 and 2005, 63 % of the verified wolf attacks on dogs in Scandinavia have occurred within known wolf territories (Karlsson *et al.* 2006). A majority (71 %) of the attacked dogs in this study was killed (figure 2) and 72 % of the killed dogs were partly or totally consumed. This indicates that even if dogs were killed from territorial defense or in a fight by other reasons, they were often treated as food by the wolves after their death. Middle-sized and larger dogs were consumed by wolves to a larger extent than smaller dogs (table 4). But since the sample size of small dogs (<11 kilograms) was small (n=13), no conclusions may be drawn from those results. In the studies by Bologov and Miltner 2001; Fritts and Paul 1989; Kojola and Kuittinen 2002; Kojola *et al.* 2004 and Sidorovich *et al.* 2003, dogs got attacked by wolves in farm yards or similar to the same extent or more as in hunting situations. The dogs that were killed and consumed in yards were probably seen mainly as prey by the wolves. In the studies by Bologov and Miltner (2001) and Sidorovich *et al.* (2003), low abundance of wolves' natural prey wild ungulates increased the number of

wolf attacks on dogs in house yards. Dogs that are attacked by wolves outside known territories may be seen as competitors for prey or for potential partners. It is also possible that the dog and the wolf/wolves meet by mere accident, or that the wolf/wolves actively track the dog or the reverse (Karlsson *et al.* 2006).

Harriers were attacked by wolves twice as often or more than dogs of other breeds but their number of hunting days were also twice as many as for example Swedish elk hounds and three times as many as for Norwegian elk hounds (table 2). In a study of Kojola and Kuitinen (2002) 43 % of the attacked dogs were moose hunting dogs and harriers. Harriers are used for hare hunting where the dogs chase and track the game while continuously barking. These kinds of hunting dogs may range several kilometers from their owners during the hunt, exposing themselves in a large area. They may also be further away from their owners during the hunt than for example moose hunting dogs, and will thereby get more exposed for wolves.

The wounds on the attacked dogs were most often located on the dogs' back, thighs and hind legs (table 3). Bite marks on the back of the neck were significantly more common among killed dogs compared to injured dogs (table 3). This may imply that wolves sometimes aim at killing the dog and then direct the bites to the back of the neck. It may also just be a consequence of the fact that a bite in that area, from a large animal like a wolf, will more often result in death.

Dogs of all ages were attacked by wolves while used for hunting. Older dogs (7 to 13 years old), were more often attacked by wolves than younger ones (1 to 6 years old). It is possible that younger dogs are more cautious and behave differently in an encounter with wolf/wolves.

Results indicated that Swedish elk hounds were the only ones being more often injured than killed when attacked by wolves (figure 4). An explanation to this could be the size of these dogs. A fully grown Swedish elk hound weighs 25 to 30 kilograms and stand 55 to 60 centimeters of the ground. It is possible that some dogs defended themselves well enough to interrupt a fight since the wolf may have considered the dog as an equal and did not want to risk getting injured. There is information from the late 19th century, when hunting of wolves was legally permitted, that some Swedish wolf hunters used Swedish elk hounds as hunting dogs when tracking wolves and that when these dogs got into fights with wolves, they were good at defending themselves and seldom got injured (Berg 1960).

There was no significant difference regarding the risk for male- and female dogs of being attacked (table 6). Sillero-Zubiri and Macdonald (1998) made a study on the scent-marking and territorial behaviour of Ethiopian wolves. Their results showed that one-to-one fights between a territory defending wolf and an intruding wolf were most often sex-specific with either two female or two male wolves fighting. If conditions are the same in Scandinavia, it is possible that a dog running into a wolves' territory is regarded as an intruding wolf and that male- and female wolves attack dogs of the same sex as themselves to the same extent. But since it is usually not known which wolf or wolves that are responsible for injuring or killing a dog, too little is known on if male wolves have a preference for attacking male dogs and if female wolves more often attack female dogs.

A majority (55 %) of the hunting dogs in this study were attacked by wolves before noon and this may be considered a natural consequence of hunters starting their hunting day and

releasing their dogs at dawn or early in the morning. To search the hunting area for wolf tracks if snow conditions are good and if necessary move the hunting to another area, may prevent some of the wolf attacks on dogs from happening. In 17 % of the cases, hunting dogs were attacked within 15 minutes after being released, which may indicate that the dogs were released close to where the wolf/wolves were.

Dogs usually living indoors with their owner(s) were more often attacked by wolves than dogs that spent most of their time in a kennel (table 8). This was an unexpected result since there has been a theory suggesting that dogs mostly kept indoors would smell of humans, which could act as a deterrent to wolves. Could the result mean that dogs kept in kennels, often two dogs or more together, may have developed a more “wolflike” social behaviour than dogs living indoors with humans, and thus better at avoiding encounters with wolves? Not all encounters between dogs and wolves are aggressive. There are a number of alternative situations that may occur. Wolf and dog have been observed playing together (J. Karlsson, pers. comment) and it is unknown how many times a free running hunting dog and a wolf have met without something happening or how often a dog and a wolf are aware of each other at a distance but choose to avoid the other.

The results from this study show that a change of the legislation toward a more liberal formulation of the hunting regulations would have little effect on the current Scandinavian wolf population, provided that hunters will not misuse it and shoot in unprovoked situations. It should neither constitute a threat to the growth of the population nor to the conservation strategies. Supposing the frequencies of wolf attacks on dogs in Scandinavia the following years will be about the same as the past years, between 20 and 40 dogs annually will be attacked by wolves. If a dog owner should shoot a wolf while physically attacking, or directly after attacking their dog, it could result in a maximum of 3 % of the Scandinavian wolves getting killed each year. Calculations of possibly killed wolves each year are maximum numbers since it is not likely that all the 17 dog owners in this study who said they had the wolf within range would have succeeded to shoot and kill it. In several of the cases, the dog owner did not have a suitable gun (a shotgun instead of a rifle), or the gun was unloaded, or he would not have had enough time to shoot, or would not have shot, because of running the risk of injuring the dog. Another factor that should be considered when estimating number of possibly killed wolves is that several of the attacks on dogs have occurred in the same wolf territories. The same wolf or wolves may in some cases have been involved in more than one attack on a dog. This means that if a wolf would have been killed by a dog owner during some of the first attacks on a dog in a particular territory, the following attacks would never have happened. The calculations of possibly killed wolves each year could therefore include wolves that have been shot more than once! It is however not possible to say in how many cases this could have happened since too little is known on whether one or several wolf/wolves in a territory have a preference of attacking dogs.

There are apprehensions from wolf advocates that more liberal formulations of the hunting regulation may give opportunities of misuse so that wolves may be shot illegally in situations where they are said to have tried to attack a dog, although that was not the case. Allowing a dog owner to shoot a wolf *before* physically attacking a dog will save, on average, one dog every other year from being seriously injured or killed by wolves (table 9b). Assuming that 50 % of the attacked dogs could be saved by shooting the wolf *during* the attack, a change of the legislation would thus result in one dog per year additionally being saved from injuries or death (table 9b). If changes in the hunting regulations would come about, the results from this study could be useable as a reference to detect misuse. The detailed annual counts of the

Scandinavian wolf population would also show an eventual decrease of the population or the growth, if illegal killing of wolves should increase.

Conclusions

- 86 % of the wolf attacks on dogs occurred while the dog was used for hunting.
- In relation to their number of hunting days, harriers were weakly overrepresented in being attacked by wolves.
- Sex of the dog did not seem to affect the risk of being attacked by wolves.
- Older dogs (7 to 13 years) ran a higher risk of being attacked by wolves than younger (1 to 6 years) ones
- A possible change in the hunting regulations would have little effect on the current Scandinavian wolf population. A maximum of 3 % yearly of the population could possibly get killed.
- By changing the legislation, on average one dog per year could be saved from being seriously injured or killed by wolves.

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Appendix 1

Questions to dog owners:

(Answers to questions marked with * were in most cases already documented by the trained expert when investigating the dog)

Observe that not all questions were analyzed in this study.

- 1) Name of dog owner*
- 2) Country; Sweden or Norway*
- 3) Telephone number*
- 4) Breed of dog?*
- 5) Age of dog?*
- 6) Sex?*
- 7) Dog neutered? yes/no
- 8) Dog insured? yes/no
- 9) Date, time and place of dogs' injury or death?*
- 10) Community? *
- 11) County? *
- 12) Dog attacked inside or outside a wolf territory?*
- 13) Location?*
- 14) Dog injured or killed?*
- 15) Bite marks/bleedings/consumed on: nose/head, throat, neck, withers, shoulder, forelegs, back, abdomen, thighs, hind legs and sexual organs?*
- 16) Was the dog consumed?*
- 17) Was the dog attacked during hunting or not, if not, unleashed at home, tied up at home or running loose?
- 18) How many hunting days did the dog have the previous hunting season?
- 19) Which game is/was generally hunted with the dog?
- 20) What game have been shot with the dog; moose, roe deer, hare, game birds, red fox (*Vulpes vulpes*), lynx or badger (*Meles meles*), if any, how many?
- 21) At what time was the dog released and how long afterwards was it attacked?
- 22) What was the distance from where you were to the place where the dog was attacked?
- 23) Was the dog chasing game when it was attacked?
- 24) How many wolves attacked the dog?
- 25) Is it possible that the dog chased the wolf before the attack, if so, why do you think so?
- 26) Is it possible that the dog chased the wolf after being attacked?
- 27) Could there have been a carcass near the place of the attack?
- 28) Were any other persons hunting in the same area?
- 29) Were any other hunting dogs released in the same area?
- 30) Was there a so called "wolf phone" (reporting the approximate location of radio-collared wolves) for this area, if so, had you used it?
- 31) Did you search the area for wolf tracks before hunting?
- 32) Did you do anything to prevent a possible wolf attack (use perfume on the dog, use a safety vest etc.)?
- 33) Where did the dog sleep the night before the attack, indoors or outdoors?
- 34) Does/did the dog normally sleep indoors or outdoors?
- 35) Did the dog have a radio-collar?
- 36) Did the dog have a collar with a bell?
- 37) Did you or someone else see the wolf/wolves directly before the dog was attacked, if so, at what distance?
- 38) Did you or someone else see the wolf/wolves attack the dog, if so, who saw it and at what distance?
- 39) Did you or someone else see the wolf/wolves directly after the dog was attacked, if so, at what distance?

- 40) Could you or someone else have shot the wolf/wolves, if so, when -before, -during or -after the dog was attacked?
- 41) Did you shoot a warning shot?
- 42) Did you do anything else to try to stop the attack?

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SLU
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