

## HOW TO AVOID DEPREDATION ON LIVESTOCK BY WOLF – THEORIES AND TESTS

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### Abstract

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To minimize and avoid Man/Predators conflict based on depredation on livestock and to secure safe environment for the vultures in SW Bulgaria, where the usage of poison baits as a revenge towards predators is a serious threat, we have studied wolf *Canis lupus* Linnaeus, 1758 - livestock conflict in the Struma River Valley and surrounding mountains. We have investigated patterns over 300 verified wolf attacks on livestock between 2004 and 2013.

Although we used different methodology to obtain data (namely claims for compensation instead of inquiry), but also longer period of collection, our data generally supports the statement of (Iliopoulos et al., 2009) concerning the expectations of depredation on different livestock types in terms of their availability. Most of the results we had received fully resembled these of the cited study in Central Greece.

We set up and tested some theories in order to avoid or minimize livestock depredation as follows: 1. The higher the number of the herd, the higher the exposition to depredation; 2. The higher the number of the guarding dogs, the lesser the depredation rate; 3. The mixed herds of sheep and goats are more exposed to depredation than the herds of sheep and goats raised separately; 4. The goats are more exposed to depredation because of their grazing manner; 5. Improving the night corrals for sheep and goats eliminates the extreme cases of depredation; 6. The herds grazing on rough terrain and bushy pastures with forest patches are more exposed to depredation; 7. Shifting from sheep or goats rearing to cattle breeding may reduce the rate of depredation in a certain holding.

All mentioned theories were proven to be true with different rate of significance. There are two #5 and #7 that we consider could drastically change the situation and decrease the rate of depredation over livestock in SW Bulgaria while some important specific measures should be applied.

We have noticed that the actual rate of depredated cattle comes from the higher portion of killed calves up to 120 kg live body mass. The total percentage of depredated cattle is 13.67% of all reported cases, (10.16% attacks over calves with less than 120 kg body mass and 3.51% cows). This might have conservation implications, if calves were kept in enclosures and weren't exposed to predators until reaching higher body mass.

We proposed two livestock breeders to shift from sheep and mixed sheep and goat herds to cattle. Thus one of the involved livestock breeders in the experiment has shifted from 120 sheep to about 20 cows, while the other from 120 sheep and 50 goats established a new herd of 25 cows. The two herds increased soon after to 32 and 41 cows and calves respectively.

From about 40 and 60 depredation cases over the projected sheep and mixed sheep and goats herds in 2010 and 2011 the newly established cattle herds were not attacked at all for the period 2012–October 2013, although the wolf presence was still noticed in the observed areas.

*Key words:* Wolf, man/predators conflict, husbandry methods, vultures, conservation, SW Bulgaria

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## Introduction

In central, north-eastern Europe and North America wolves *Canis lupus* Linnaeus, 1758 feed mainly on wild ungulates. In southern Europe, especially in areas with important livestock production, wolves may depend heavily on livestock as prey (Iliopoulos et al., 2009).

Predation on livestock is the crucial factor promoting wolf persecution. At least two factors militate against a solution to the problem of predation by the wolf on domestic animals in southern Europe: the persistence of inappropriate methods of livestock rising i.e. left unguarded in the countryside and the low level of public awareness of wildlife management planning. In particular, the latter leads to misinformation and a distorted understanding of the wolf-human conflict (Meriggi and Lovari, 1996).

Boitani (2000) considers monitoring of livestock damages as of great importance for the species' conservation and management in Europe.

Such monitoring is not provided in Bulgaria. Some data is collected only by conservation NGOs active in certain regions and within some periods of time.

Despite of direct threat for the wolf, its conflict with livestock breeders also affects the more threatened vultures. The Fund for Wild Flora and Fauna (FWFF) is working on conservation and restocking of vultures in southwest Bulgaria and thus finds necessary the problem of poisoning to be controlled.

Illegal poisoning is undoubtedly one of the main threats to biodiversity in Southern Europe and especially for threatened scavengers. The problem appears in Spain, Greece, Bulgaria, Italy, Portugal, Austria, Croatia and others, where thousands of vultures, eagles, black and red kites are still getting poisoned even after the official ban of the use of poison baits for predators' control.

The illegal poisoning in SW Bulgaria has its origins mainly in conflicts between predators (especially dogs and wolves) and livestock. The reason for this tendency is the recovery of wolf populations after mid 1980-ies (Genov et al., 2005; Spiridonov and Spasov, 2011), which has led to increased livestock depredation and persecution of predators.

To provide safe environment for the vultures in SW Bulgaria FWFF as an NGO implements a compensation and prevention programme to reduce the livestock depredation and illegal poison baits use.

Aims of this study were to: (1) describe figures on livestock losses caused by wolves (2) examine factors associated with the wolf depredation (3) suggest management priorities to mitigate the problem of wolf depredation.

The study "Wolf depredation on livestock in central Greece" presented by (Iliopoulos et al., 2009) answered to

many of our questions, we thus used our data to compare with his results and to further examine some theoretical issues and to prove or reject the following theories:

1. The higher the number of the herd, the higher the exposition to depredation;
2. The higher the number of the guarding dogs, the lesser the depredation rate;
3. The mixed herds of sheep and goats are more exposed to depredation than the herds of sheep and goats raised separately;
4. The goats are more exposed to depredation because of their grazing manner;
5. Improving the night corrals for sheep and goats eliminate the extreme cases of depredation;
6. The herds grazing on rough terrain and bushy pastures with forest patches are more exposed to depredation;
7. Shifting from sheep or goats rearing to cattle breeding may reduce the rate of depredation in a certain holding.

## Study area

The study area is Struma River valley from the town of Blagoevgrad (42°00'N, 23°04'E) on the north to the border with Greece (41°22'N, 23°20'E) on the south. On the east it reaches the main ridges and includes the western macroslopes of the Rila and Pirin Mountains and on the west the Maleshevska Mountain up to the border with FYR of Macedonia from 100 m up 2900 m above sea level. It covers the territories of six municipalities – Blagoevgrad, Simitli, Kresna, Strumyani, Sandanski and Petrich with total surface of 3504 km<sup>2</sup>.

The climate is transitory Mediterranean. The mixed oak forest – *Quercus pubescens*, *Carpinus orientalis* and *Fraxinus ornus*, as well as the mixed forests of *Juniperus excelsa* and *Q. pubescens* with undergrowth of evergreen Mediterranean shrubs are widely spread at an altitude of up to 500 m. There are also sparse artificial plantations of Austrian Pine *Pinus nigra* as well as farmlands, mainly pastures (Kostadinova and Gramatikov, 2007). Large parts of the area are covered by mosaic of small open grassland plots and bushes and creeping deciduous forest. On higher altitudes the forest is dominated by beech *Fagus sylvatica* and further up by coniferous forest. Most of the area, except the valley's bottom is represented by rough terrain with steep slopes and deep gorges. Any flat plot is turned into arable land.

Availability of the livestock expressed as the number of heads per species and per municipality, was provided by the Bulgarian National Statistical Institute. About 5645 cattle, 49124 sheep, 43145 goats, 11973 equines (equal number horses and donkeys) in total graze in the study area.

Sheep and goat herds graze only during daylight and are guarded by shepherds, with or without the aid of guarding dogs. Sheep and goat herds consisted of one or both species (mixed herds). In SW Bulgaria most of the holdings are

small between 1-50 sheep and/or goats and the herds that exceed 200 animals are very rare. Cattle herds graze unguarded during day and night, accompanied or not by guard dog(s).

## Materials and Methods

### *Examination of damage claims*

We directly examined damage claims from January 2003 through October 2013. Since 2003, a compensation system was initiated by FWFF. We received only a portion of all actual depredation cases in the area, as the obtaining of data was related with the calls by livestock owners, village mayors or others, when and if they know about the FWFF's compensation scheme. Each verified livestock loss caused by predation, was eligible for direct replacement of a live sheep or goat as compensation from FWFF's own herds. A trained person (Stanchev, Peshev and Stoynov) visited the attack site within 24 hours. Similarly to the protocol reported by Iliopoulos et al 2009 we examined attack sites for blood spilled over and close to carcasses, to exclude cases of post mortem consumption. We also used the following secondary criteria: presence of throat bites, presence and number of injured animals, signs of struggle, dragging of carcasses and predator consumption patterns. In total, we examined 316 livestock damage claims. Figures on livestock losses are referred only to kill and seriously injured livestock found and examined in the attack site.

### **Information on associated factors**

During field visits we asked each farmer to report: (1) who is the owner of the animal (if other form the herder), (2) if he herder was in the vicinity of the attack site, (3) site, date and hour of attack, (4) livestock herd size during attack, (5) presence/absence and number of guarding dogs, (6) frequency of predator attacks, (6) number and species of predators observed, (7) attack circumstances (8) basic data for the other nearest livestock herds.

### **Statistical analyses**

We used GHI-squared tests with two-tailed P value to: (a) examine if cattle, sheep, goats and horses suffered losses proportionally to their relative availability; to compare the frequency of wolf attacks and preys in: (b) the night corrals and on pastures in the daytime, (c) the mixed versus homogeneous herds and (d) the herds with or without or insufficient number of guard dogs. We considered (1) insufficient number of dogs –if any dogs were available, but not the optimum number and/or race; and (2) optimum number of dogs (from 3 to 9 depend on the herd size (Iliopoulos et al., 2009) and (3) none – if no dogs were used to guard the herd.

For the accuracy of the statistical results of (c) and (d), we excluded night incidents and measured only wolf attacks on goats and sheep herds .

### **Experimental shift from sheep and goat rearing to cattle**

We proposed two livestock breeders that suffered permanent wolf attacks and losses by depredation to shift from sheep and mixed sheep and goat herds to cattle. We previously tried to help them with supplying sufficient number of good guarding dogs. The wolf attacks continued and although frequent interactions between the dogs and the wolves were reported the depredation of livestock continued. Thus one of the involved livestock breeders in the experiment has shifted from 120 sheep to about 20 cows, while the other from 120 sheep and 50 goats established a new herd of 25 cows. We asked them to keep the way of rearing their livestock namely the herds to be accompanied by guarding dogs and a man during the day on the pasture and to be kept closed in a corral during the night. We also asked them to keep their calves in the corral and not to release them on the pasture until reaching 120 kg body mass.

## Results

### **Number of attacks validated**

Out of 312 reported cases 285 damage claims were assigned to predation by wolves. Among them 46 attacks were on cattle, 101 on sheep, 142 on goats and 17 on horses and donkeys.

We removed the night attacks (all cattle, donkeys and horses) as well as the extreme killings of sheep and goats, that also happened during the night in the corrals or when the herd or part of it was leaved unguarded on the pasture.

### **Wolf selection of livestock species and size classes**

Wolves attacked cattle 200% and goats 17.95% more often than expected, whereas sheep 26.66% and horses/donkeys 72.73% less often than expected, based on their relative availability ( $\chi^2 = 86.93$  df = 3,  $p < 0.0001$ ) (Table 1).

From a total of 540 killed animals, 96.11% were less than 120 kg body mass. In case of cattle, wolves preyed heavily on calves < 120 kg that constituted 72.54% of all cattle. This is so also for the horses and donkeys.

### **Guarding dogs**

The predator attacks over the herds guarded by dogs accounted for almost half (47.87%) of the 211 wolf attacks occurrences. Not quite statistically significant differences were found in the number of killed animals per attack in the herds with no or insufficient guarding dogs number versus those with optimal number of dogs ( $\chi^2 = 3.147$ , df = 1,  $p > 0.05$ ).

**Table 1**

**The wolf prey selection among the livestock species in SW Bulgaria, compared with the results of Iliopoulos et al. (2009) in Central Greece**

Species	Expected predation rate, %		Recorded attack events, %		Recorded animals killed, %	
	Southwest Bulgaria	Central Greece	Southwest Bulgaria	Central Greece	Southwest Bulgaria	Central Greece
Cattle	5	3.4	+ 200	+ 218	+ 100	+ 45
Goats	39	38.4	+ 17.95	+ 43	+ 20.51	+ 52
Sheep	45	58.2	- 26.66	- 41	- 11.11	- 37
Horses	11		- 72.73		- 45.45	

### Night corrals

Attacks in the night corrals constituted only 10.63% of overall verified wolf attacks. There was an extreme significant difference in the number of killed animals per attack during the night in the corrals and in daytime on the pastures ( $\chi^2 = 47.99$ ,  $df = 1$ ,  $p < 0.0001$ ).

### Size of herds

The proportion of wolf attacks over different sized herds was as follows: A (1–50 ind) = 14%; B (51–100 ind) = 23%; C (< 100 ind) = 63%;

### Mixed and homogenous herds

Comparing the number of attacks and killed animals in mixed (sheep and goats) and homogenous (sheep or goats) herds there was detected an extremely significant difference ( $\chi^2 = 68.63$ ,  $df = 1$ ,  $p < 0.0001$ ).

### Terrain

More than 95% of all verified attacks happened on a rough terrain in mixed small open grass areas with forest and bush patches in the altitude of 200–1800 m.a.s.l. Over 80% of the attacks were in the same landscape but in the altitude horizon of 300–800 m.a.s.l.

### Experimental shift from sheep and goats to cattle

Two livestock breeders shifted from sheep and mixed sheep and goat herds to cattle. Thus one of the involved livestock breeders in the experiment has shifted from 120 sheep to about 20 cows, while the other from 120 sheep and 50 goats established a new herd of 25 cows. The two herds increased soon after to 32 and 41 cows and calves respectively.

From about 40 and 60 depredation cases over the projected sheep and mixed sheep and goats herds in 2010 and 2011 the newly established cattle herds were not attacked at all for the period 2012–October 2013, although the wolf presence was still noticed in the observed areas.

## Discussion

Our theoretical statements found their answers as follows:

### Statement (1). The higher the number of the herd, the higher the exposition to depredation

Iliopoulos et al. (2009) reports that the total losses per farm were positively correlated with the size of livestock unit but percentage losses per capita increased with decreasing flock size.

Larger sheep and goat farms experienced more attacks and total animal losses, as also reported by Vos (2000) in northern Portugal. Larger flocks face higher encounter rates with wolves, are more dispersed and serve as greater attractants for wolves, because they contain more individuals at lower condition.

We undoubtedly proved this for SW Bulgaria, however there could hardly be found conservation implication, as the keeping of larger size herds is generally economically more efficient in terms of labour involved.

### Statement (2). The higher the number of the guarding dogs, the lesser the depredation rate

Sheepdog use reduced losses per attack. Optimal sheepdog number ranged from 3 to 9 animals depending on flock size. Losses per attack were positively related to the number of wolf's involved (Iliopoulos et al., 2009).

Although we had generally the same impression by our observations in the guarded and none/or poorly guarded herds by dogs in SW Bulgaria, our data do not support this statement. Here is important to note, that keeping dogs in optimal number and condition was always a challenge to most of the shepherds we were observing. The dogs were frequently dying from diseases, hit by cars on the roads, poisoned, or starving and thus just not expressing the expected guarding behaviour. This largely is related to the low economic profile of the livestock breeders in the area and keeping the livestock in or close to villages, but not in re-

mote farms. We also several times received information for livestock depredation from the guarding dogs, which also could bias the results. However we will continue studying the guarding dogs use, but for the moment we could not say this is a priority conservation measure.

Finally looking for conservation implications, all these factors are too complex and serious as to be managed on large scale, without active involvement of the State (may be subsidies for feeding of livestock guarding dogs in Natura 2000 zones with presence of wolves should be introduced).

**Statement (3). The mixed herds of sheep and goats are more exposed to depredation than the herds of sheep and goats raised separately**

In rough terrain with small grassland patches in bush and forest habitats in SW Bulgaria (about 80% from the available pastures), less wolf attacks will be encountered on homogenous sheep herds, rather than homogenous goat herds. Most exposed to wolf attacks are mixed sheep and goats herds.

Having in mind the grass and bush/trees cover on these pastures, they could be better utilized by goats rather than sheep, if wolf depredation would not have been a factor.

**Statement (4). The goats are more exposed to depredation because of their grazing manner**

Iliopoulos et al. (2009) states that wolves killed more goats and less sheep than expected.

We also proved that to be the case in SW Bulgaria. But having in mind the landscape and the trophic behaviour and preferences of the two livestock species, it seems the area is more suitable for goats, if the wolf depredation was not a factor.

**Statement (5). Improving the night corrals for sheep and goats eliminates the extreme cases of depredation**

Iliopoulos et al. (2009) reports that the wolf attacks on strayed, or kept inside non predator-proof enclosures, sheep and goats, were on average two to four times respectively more destructive than those when livestock was guarded by a shepherd.

Our data fully supports that as about 11% of all reported cases of livestock depredation in SW Bulgaria are related with extreme number of killed sheep and goats > 5 individuals up to 60 per case (55.79% of all killed animals). This happened during the night when the wolves enter the corral, or when the entire or large portion from the herd is left unguarded on the pasture.

The use of massively built corrals or the use of electric fences around them may reduce the loss from depredation. Furthermore these cases are not beneficial even for the wolves, because they do not feed on the extra killed animals.

**Statement (6). The herds grazing on rough terrain and bushy pastures with forest patches are more exposed to depredation;**

Virtually all reported cases of livestock depredation in SW Bulgaria come from such areas. The flat and three-less bottom of the Struma River valley is turned into arable land and used for plant growing. The alpine three-less zone of Rila, Pirin and Maleshevska Mountains is too high, and could be used only in summer. Only large herds' holders (that are minority in the area) could move their herds to mountains in summer. However this is done mainly by cattle breeders that may leave their cattle to free range in the mountains, as the conditions for shepherds are poor.

**Statement (7). Shifting from sheep or goats rearing to cattle breeding may reduce the rate of depredation in a certain holding.**

We have noticed that the actual rate of depredated cattle comes from the higher portion of killed calves up to 120 kg live body mass. The total percentage of depredated cattle is 13.67% of all reported cases, but these are 10.16% over calves with less than 120 kg body mass and only 3.51% cows >120 kg. This might have conservation implications, if calves were kept in enclosures and weren't exposed to predators until reaching higher body mass.

From about 40 and 60 depredation cases over the involved in the experiment sheep and mixed sheep and goats herds in 2010 and 2011, after shifting to cattle the newly established herds were not attacked at all for the period January 2012–October 2013, although the wolf presence was still noticed in the observed areas.

It is important to note that the small herds of cattle are grazed during the day accompanied by a man and kept in corrals during the night. Also the calves are not released to graze until they reach at least 120 kg body mass and later they are closely observed by the shepherds on the pastures.

## Conclusions

The results of Iliopoulos et al 2009 about wolf depredation in Central Greece are to larger extend applicable also to SW Bulgaria, where any difference observed may be related to the difference of livestock breeding in both areas (farm method in Greece and village herds in Bulgaria). The last is on the way to change gradually after 2007 when Bulgaria joined EU and the subsidies for agriculture were introduced.

All mentioned theories were proven to be true with different rate of significance. There are two #5 and #7 that we consider could drastically change the situation and decrease the rate of depredation over livestock in SW Bulgaria while

some important specific measures should be applied. Thus conservation priority for mitigation of the Man/Wolf conflict in SW Bulgaria should be given to:

- Improvement and use of the night corrals for livestock
- Sheep and goats farms suffering permanent wolf attacks to shift to cattle breeding.
- Cattle to be herded during the day and to be settled in corrals during the night.
- Calves up to 120 kg body mass to be kept in corrals during the night and day, or to be kept under close supervision by the herder on the pasture.

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