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Hogeschool VHL University of Applied Sciences

Hans Wilpstra

Student Forestry and Nature conservation

Minimising the livestock owner/wolf conflict in the Kresna gorge, Bulgaria.

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Author: Hans Wilpstra
Date: 15-12-2015
Study: Forestry and Nature Conservation
University: VHL University of applied science

Supervisor VHL: Jos Wintermans
Supervisors FWFF: Emilian Stoynov and Hristo Peshev

Summary

Conflicts between livestock owners and wolves are already present for ages in Europe. 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. (STOYNOV, 2014)

Fund for Wild Flora and Fauna (FWFF) is an organisation which is working on the conservation and restoration of vulture populations in Bulgaria. It has found that illegal poisoning in South-West Bulgaria has its origins mainly in conflicts between predators and livestock and is undoubtedly one of the main threats to biodiversity in Southern Europe and especially for threatened scavengers. (STOYNOV, 2014). To provide a 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. (STOYNOV, 2014)

This study is conducted to be part of FWFF human/predator conflict prevention program. It will focus on how to minimise or buffer losses from wolf depredation. This means that this study will on one side look for solutions to lower predation from wolves on livestock and on the other side will try to find measures to positively influence other business/livelihood related factors to increase livestock breeders their final profit/livelihoods.

The main research question for this study is :

How can the conflict between livestock breeders and wolves be minimised in the Kresna gorge, Bulgaria?

In several studies it is found that the most important factor influencing the conflicts between livestock breeders and predators seems to be the financial losses which livestock owners face because of livestock depredation by predators. This is for instance found in studies from (Treves, 2004) (Delibes-Mateos, 2013) (Bisi, 2007) (Graham, 2004) It is therefore in this study assumed that the size of a conflict between livestock breeders and wolves is directly related to the extent that wolves threaten peoples livelihoods. Next to this it is assumed that when livestock owners are content with their livelihoods for their families they will not be in (big)conflict with wolves.

After testing it can be concluded that the new method for estimating the size of the conflict between livestock owners and wolves seems to have potential for future investigations. During the first trial research it became clear that this method is quite easy to execute on a bigger scale. It just includes asking a few questions to livestock owners. Which, if it is done yearly, could be done mainly by phone. Next to this the method has shown to take into account more parameters then other research did until now. Most research until now just used wolf depredation numbers to make clear how big the problem/conflict is.

The following recommendations can be made to minimise the conflict in the kresna gorge:

First some recommendations for the livestock owners in the region to minimise the conflict:

1) Become part of a livestock breeding association which helps with:
- Finding the balance between cost and income from livestock breeding.

- Lowering livestock depredation
- Increasing income from subsidies for pastures and/or livestock

2) Find a second income source and/or produce all your food yourself.
3) Do not leave animals spending the nights free ranging.

And finally some recommendations for FWFF's role in minimising the conflict:

1) Start with wild prey reintroduction or strengthening of wild prey populations in the region.
2) Start fencing areas for village herds to protect their herds from depredation from wolves and there gardens from bigger livestock or wild prey.
3) Advise livestock owners to improve their livestock protection on basis of statistics within this research.
4) Stimulate livestock owners to become part of a livestock breeding organisation.
5) Help livestock owners with increasing their income from subsidies on pastures or other non-livestock related income sources.

Photo: 1 Cows grazing in the research region

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1. Introduction

Conflicts between livestock owners and wolves are already present for ages in Europe. 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. (STOYNOV, 2014)

Boitani (2000) considers monitoring of livestock damages as of great importance for the species' conservation and management in Europe. Next to the direct threat for the wolf, the conflicts with livestock breeders also affects threatened vulture species. Illegal poisoning is undoubtedly one of the main threats to biodiversity in Southern Europe and especially for threatened scavengers. (STOYNOV, 2014)The illegal poisoning in South-West Bulgaria has its origins mainly in conflicts between predators and livestock. The reason for this tendency is the recovery of wolf populations after mid 1980-ies (Genov etal., 2005; Spiridonov and Spasov, 2011), which has led to increased livestock depredation and persecution of predators. (STOYNOV, 2014)

1.1 Problem statement

There is a conflict between livestock owners and the wolf and there is a wish from FWFF as well as the livestock owners to measure and minimise this conflict. This study will try to find measures to minimise this conflict.

1.2 Company and study description

Fund for Wild Flora and Fauna (FWFF) is an organisation which is working on the conservation and restoration of vulture populations in Bulgaria. It has found that illegal poisoning in South-West Bulgaria has its origins mainly in conflicts between predators and livestock and is undoubtedly one of the main threats to biodiversity in Southern Europe and especially for threatened scavengers. (STOYNOV, 2014). To provide a 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. (STOYNOV, 2014)

This study is conducted to be part of FWFF human/predator conflict prevention program. It will focus on how to minimise or buffer losses from wolf depredation. This means that this study will on one side look for solutions to lower predation from wolves on livestock and on the other side will try to find measures to positively influence other business/livelihood related factors to increase livestock breeders their final profit/livelihoods.

1.3 Area description

The study area is the Struma River valley from the town of Simitli on the north to the town of Kresna on the south. On the east it reaches the main ridges and includes the western macroslopes of Pirin Mountains and on the west it almost reaches the Maleshevska Mountain close to the border with FYR of Macedonia from 100 m up 2900 m above sea level. It covers the territories of two municipalities –Simitli and Kresna and the total surface of the researched area is 400 km2. A map of the research area can be found in Annex 1.

The climate is transitory Mediterranean. The mixed oak forest – *Quercus pubescens*, *Carpinus orientalis* and *Fraxinus ornus*, as well as the mixed forests of *Juniperus excels* 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 a 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. (STOYNOV, 2014)

Photo 2: Typical landscape within the research area

1.4 Research Questions

Main research question:

How can the conflict between livestock breeders and wolves be minimised in the Kresna gorge, Bulgaria?

Sub-questions:

Introduction

Which factors are influencing the conflict between livestock owners and wolves?

Developing a field method to estimate livestock owner wolf conflict size

How can the different parameters stated in paragraph 3.1 be turned into an estimation of the conflict size between a single livestock owner and wolves ?

Estimation of livestock owner wolf conflict size

What is the estimated size of the livestock owner wolf conflict size within the questioned group of livestock owners?

Livestock depredation statistics

How many livestock is killed by wolves in the Kresna gorge in the period 2013-2014?

How big are the average annual financial losses from wolf predation on livestock in the period 2013-2014?

Analysis of data for wolf predation on livestock

How effective are different wolf predation prevention measures in the period 2013-2014?

Does the wolf predate more on certain species of livestock ?

Do wolves kill more animals in herds from a certain size or composition?

Does a bigger herd size lead to higher numbers of killed livestock?

Does a bigger herd size lead to a lower percentage of predated livestock?

Is there a difference in predation rate between amateur herds and professional herds? And is there a difference in predation rate between individual farmers and farmers who are part of an association?

Conclusion: Minimising the livestock owners wolf conflict size.

How can the current wolf predation prevention measures be improved?

Which new wolf predation prevention measures could be tested?

How can the livelihoods of livestock owners in the Kresna gorge be increased?

2. Method

To find information about the factors influencing the Livestock owner/wolf conflict a desk study is made. After this a questionnaire was put together and carried out to measure the parameters influencing the livestock owner/ wolf conflict in the Kresna gorge. This questionnaire included questions to find out:

- How many animals are killed on average every year.
- Which conflict prevention measures are in place.
- Which type of herds are more attacked.
- How livelihoods of livestock owners look like.
- How content livestock owners are with their profit/livelihoods.
- How serious they think they are in conflict with wolves.
- And finally some questions which are for other reasons interesting for FWFF.

To whole questionnaire is visible in annexes 2 and 3.

The results of the more personal/ livelihood related questions are used together with livestock depredation numbers to estimate the conflict size with a new method explained in paragraph 3.2

The results of the questions about conflict prevention measures and which type of herd are more attacked were analysed with Spss statistics. To check if the data was significant several different statistical calculations were done. Independent t- test were done to see if there is significant relation for instance between the type of shepherd and the number of killed animals. Two paired T-test were done to check if there is a significant relation between for instance the number of cattle within a herd and the number of kills in this herd. At last Chi-Square analysis were used to see if there are differences between the expected predation on basis of species abundance and the observed predation on basis of the questionnaires.

Finally three type of recommendations were made to minimise the conflict. The first type consist of improvements of wolf predation prevention measures. The second type of possible new wolf predation prevention measures and the last type of recommendations to increase livestock owners livelihoods.

Photo 3: Doing interviews in the field

3. Results

3.1 Conflicts between Livestock owners and wolves

Human/predator conflicts have been present for centuries in the world. Most of these conflicts are difficult to solve because they are influenced by several social and economic factors. However in several studies it is found that the most important factor influencing the conflicts between livestock breeders and predators seems to be the financial losses which livestock owners face because of livestock depredation by predators. This is for instance found in studies from (Treves, 2004) (Delibes-Mateos, 2013) (Bisi, 2007) (Graham, 2004)

Next to this in a study of (Suryawanshi, 2015)it is mentioned that peoples attitude towards predators seems to be strongly influenced by how much people in a village/or how much an individual is depended on livestock breeding as income source and correlated to this how much people/or how much an individual is depended on other income sources. **It is therefore in this study assumed that the size of a conflict between livestock breeders and wolves is directly related to the extent that wolves threaten peoples livelihoods. Next to this it is assumed that when livestock owners are content with their livelihoods for their families they will not be in (big)conflict with wolves.**

''A livelihood is a means of making a living. It encompasses people's capabilities, assets, income and activities required to secure the necessities of life'' (IFRC, 2015).

Peoples livelihoods are affected or influenced by the decisions they make on a daily basis on how they want to secure their basis needs. This includes decisions on how people want to make a living and where they want to spent their income on.

The livelihoods of farmers however are influenced by two different types of factors. On one site the more or less clear and quiet much researched parameters influencing wolf predation on livestock(including livestock protection) and on the other side the less researched more personal and business/livelihood related factors. For this study both will be researched.

The livelihoods of people working in livestock breeding are for a big part influenced by the decisions they make in their livestock breeding business. Decisions on how to protect their livestock, how to feed their animals, how much animals to keep, etc. However, the extend that livestock breeders livelihoods are influenced by decisions they make in their business depend also on all the other activities they execute to secure livelihoods.

To increase livestock breeders livelihoods therefore two different strategies could be distinguished. Firstly the livestock breeding businesses could be optimised by finding the optimal balance between business related costs(including depredation by wolf) and income. Secondly, more other sources of income/livelihoods could be found and the income from other sources could be increased.

3.2 Testing a field method to estimate conflict size with questionnaires

For FWFF it is crucial to know how big the size of the conflict between livestock owners and the wolf in the region is because it tells a lot about the risk of poison use to kill wolves in the region. This was the main reason for the extinction of vultures in the region where they work on the restoration of this species.

Until now most articles or reports about the size of a human predator conflict are about the number of livestock killed by predators in a certain region. This however ignores the personal situation of livestock owners as it does not take into account any information about the livelihoods of the livestock owners. That is why within this research a method is developed and tested to measure the conflict between a livestock owner and wolves taking into account the personal situation of the livestock owner.

To test this field method questionnaires are done with a number of livestock owners.

With this questionnaires information is gathered about the following parameters:

1) The extend that wolves threatens peoples livelihoods or the influence wolves have on peoples livelihoods.
2) The satisfaction livestock owners have with their income from livestock breeding.

To measure this parameters a value is given to them and finally a calculation is made.

First the extend that wolves threaten peoples livelihoods is calculated. This involves the losses from wolves as a percentage of the total number of animals and the dependence of livestock owners on animals or products from their animals as their income source.

People whose income mainly consist of subsidy on livestock or income of meat/milk for instance will be more influenced by wolf predation as those who earn most of their money from subsidy on pastures. The same is true for people for who livestock breeding is there only income source and for people who are not self-sufficient in producing food and have to buy all their products in the shop.

Because people with the above stated characteristics are more depended on the number of livestock the grade they get for dependence on the number of livestock will get higher. The total number for dependence on the number of livestock is 5. Down here for every characteristic the points are stated which they receive.

Dependence on the number of livestock:

- Depending very much on subsidy for livestock: (1)
- Depending very much on selling milk and meat: (1)
- Mainly depended on income from livestock: No pension/No other income: (2)
- Not self-sufficient in producing food/ Depended on the store for food (1)

Total: 5

A pension or other income like a job for another person in the household is in this case seen as most influencing the dependence on the number of livestock. This is because it is a solid income which is not depended from livestock breeding.

Finally, to measure the extend that wolves threaten peoples livelihoods the following formula is used:

*Effect on livelihood= % of herd killed * Dependence on the number of livestock*

The % of herd which is killed is a result of calculations from wolf depredation on livestock for the same owner. The grade for dependence on the number of livestock is a result of the points given to characteristics stated before. The results is a number between 0 and 500.

The second parameter, *the satisfaction of livestock owners with their profit from livestock breeding* is directly taken from the interviews as a number on the scale from 1 to 5.

Finally a cross table for estimating the conflict size was made(end of this page) by comparing the information of the parameters to two extreme situations: one situation for a livestock owner who is in big conflict with wolves and one situation for a livestock owner who is not in conflict with wolves at all. For a table with information about the extreme situation see annex 4.

Down here an example of the calculation is given from a farmer within the trial research:

Owner 1:

- % of herd killed: 0

- Depending very much on subsidy for livestock: (1)
- Depending very much on selling milk and meat: (0)
- Mainly depended on income from livestock: No pension/No other income: (2)
- Depended on money from livestock breeding to buy food from the store: (0.5)

  Dependence on livestock breeding: total: 3.5

- *Satisfaction with income of livestock breeding: 1*

*Effect on livelihood= % of herd killed * Dependence on the number of livestock =* **0*3.5=0**

*Satisfaction of livestock owners with their profit from livestock breeding***=1**

	0 to 10	10 to 15	15 to 20	20 to 25	25 and above
1	**Little/No Conflict**	Little/No Conflict	Little/No Conflict	Average situation	Average situation
2	Little/No Conflict	Little/No Conflict	Average situation	Average situation	In conflict
3	Little/No Conflict	Average situation	Average situation	In conflict	In conflict
4	Average situation	Average situation	In conflict	In conflict	In big conflict
5	Average situation	In conflict	In conflict	In big conflict	In big conflict

Table 1 Livestock breeding/wolf conflict size estimation: Vertical: satisfaction with revenues with livestock breeding, Horizontal: effect on livelihoods

Result in table**: Little/No Conflict**

3.2.1 Analyses of the trial research

The results of the 8 owners within the trial research are visible in the left column of the table below. In the right column the results of another method based on only the % of the herd which is killed by wolves are visualised.

	New methode	Other method % of herd killed
Owner 1	0	0
10	Little/No Conflict	Little/No Conflict
Owner 2	8,82	1,96
30	Little/No Conflict	Little/No Conflict
Owner 3	25	12,5
20	In conflict	in big conflict
Owner 4	25	6,25
50	in big conflict	In conflict
Owner 5	15,705	10,47
20	Average situation	in big conflict
Owner 6	8,88	2,96
10	Little/No Conflict	Average situation
Owner 7	0,46	0,46
50	Average situation	Little/No Conflict
Owner 8	7,7	3,85
20	Little/No Conflict	Average situation

Table 2 Conflict size for 8 livestock breeders in the Kresna gorge estimated with two different methods

For the old method the following scale is used:

- 0-2.5: Little/ No conflict.
- 2.5-5: Average situation.
- 5-7.5: In conflict.
- 7.5 or above: in big conflict.

The differences between the above used methods are very much visible in the table. The results of just two livestock owners are the same. The new method seems better for estimating the conflict size as it takes into account more personal factors. These factors are stated in scientifically articles to be mainly influencing the size of the conflict between livestock owners and wolves.

Photo: 4 Livestock owner with his killed livestock by wolves. Photo credits Hristo Peshev.

3.3 The livestock owner wolf conflict in the Kresna gorge: Statistics 2013-2014.

3.3.1 Wolf predation on livestock.

The number of depredated livestock as shown in table 3 below seems to be more or less stable. The number in the table for last year is higher but we have to take into to account that the questionnaires were done from September- December 2014. So if we calculate the number of killed livestock for the month December with the depredation rate of 2013 and add these to the number of 2014(384/12=32, 348+32=380) we are almost the same level. However, also when the first questionnaires were done a new case could occur afterwards . This would mean that the number for 2014 would probably be a little bit higher than in 2013 but it is more and less stable

Depredation on livestock by Wolf											
2013						2014					
Cattle	Calf	Sheep	Goats	Equines	**Total**	Cattle	Calf	Sheep	Goats	Equines	**Total**
0	3	0	0	0	3	0	7		0	0	7
0	0	1	0	0	1	0	0	1	0	1	2
3	11	32	15	0	61	0	6	34	25	0	65
1	4	35	22	0	62	2	13	24	29	0	68
0	0	10	8	0	18	0	1	1	0	0	2
7	38	7	0	0	52	2	26	7	0	1	36
0	5	0	2	5	12	0	0	10	10	5	25
0	0	11	10	0	21	0	0	16	12	0	28
1	5	9	18	0	33	0	15	3	2	0	20
0	3	0	0	0	3	0	1	0	0	0	1
5	30	50	29	2	116	0	10	48	35	1	94
0	0	2	0	0	2	0	0	0	0	0	0
17	99	157	104	7	**384**	4	79	144	113	8	**348**

Table 3 Livestock depredation by Wolf in the Kresna Gorge 2013-2014 .

3.3.2 Annual financial losses caused by wolf predation.

To calculate the total financial losses for one year the data of 2013 is used as this the only year with livestock depredation data for all year. Calculations are bases on average prices for livestock from received from Emilian Stoynov as statics websites are not available. Prices in table 4 below are all in BGN and based on the following average prices: cow 1000lv, sheep 180lv, goat 150lv and equines 700lv.

	2013				
	Cattle total	**Sheep**	**Goats**	**Equines**	
BGN /individual	1000	180	150	700	
Individuals	116	157	104	7	
					Total
Total BGN	116000	28260	15600	4900	**164760**

Table 4 Annual cost of livestock depredation by wolves in the Kresna gorge

3.3.3 Analysis of current wolf predation prevention measures.

To analyse the different prevention measures a difference is made between cow herds and goat/sheep herds. Independent T- test are used to test if there is a significant relation between the different prevention measures and the livestock depredation. Next to that Chi-Square analysis are used to see what the difference is with the expected depredation per prevention measure on basis of the abundance of the livestock. For the results of the independent t-test I refer to Annex 5.

3.3.3.1 Type of shepherd

To analyse if there is difference in depredation rate between three types of shepherds all are compared on basis of the average percentage of the herd killed and the average number of animals which is killed per owner. This is performed for the herds with cattle as well as the sheep/goat herds.

Sheep/goat

The result for the sheep/goat herds are shown down below in Fig. 1

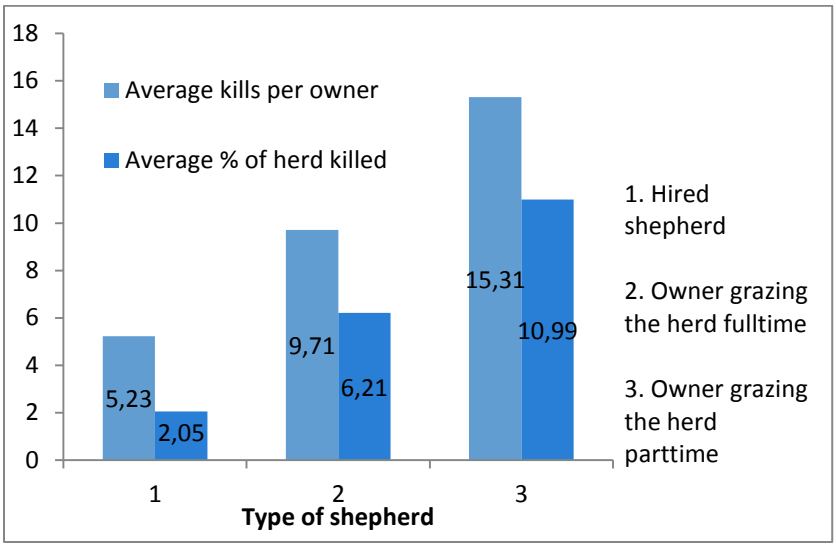

Fig. 1 Type of shepherd; average nr of kills and average % herd killed

As shown in Fig. 1 there is difference between sheep/goat herds with a hired shepherd, herds where the owner is grazing the herd fulltime and herds where the owner is grazing the herd part-time. Independent t-test are used to check if this difference is significant. These tests showed that the difference between a hired shepherd and an owner grazing the herd full- or part-time made a significant difference in the percentage of the herd killed(p=0.032 and p= 0.001).

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock abundance. The results are shown in table 5 below

Type of shepherd	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Hired shepherd(1)	39.1	13.15	**-25.95**
Owner grazing the herd full time(2)	37.06	39.46	+2.4
Owner grazing the herd part time(3)	23.85	47.39	**+23.54**

Table 5 Type of shepherd; expected and observed predation rate. ***(X^2=40.53, Df=22, p<0.010 Significant)***

As shown in table 5 sheep/goat herds with a hired shepherd have a significant lower depredation rate than expected on basis of their abundance and herds were the owner is grazing the herd part-time have a significant higher depredation rate than expected on basis of their abundance.

Cattle

The result for the herds with cattle are down below in Fig. 2

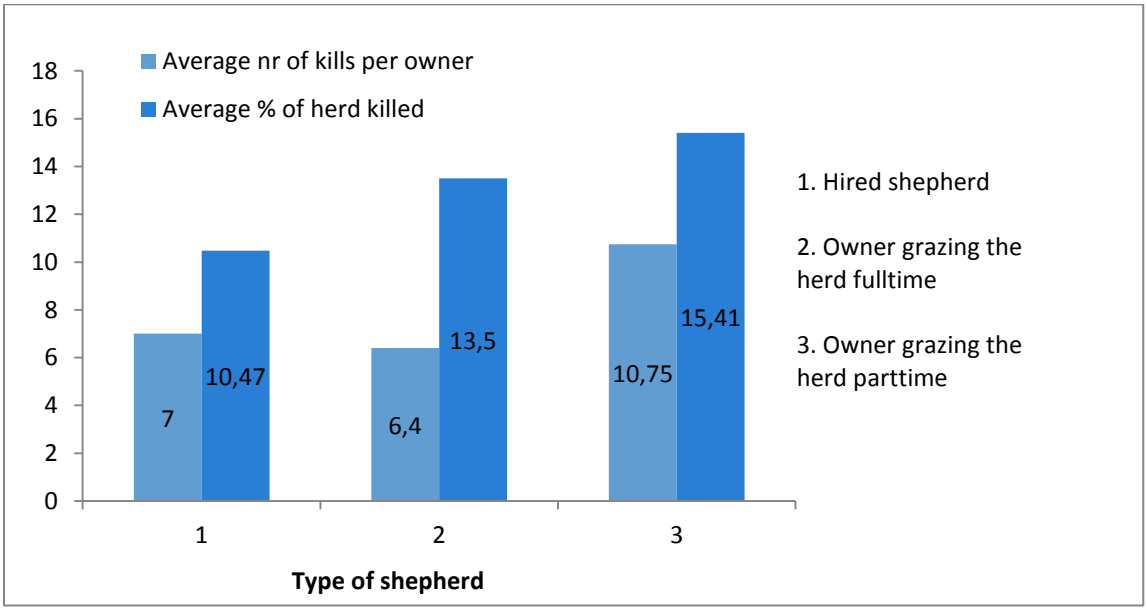

Fig. 2 Type of shepherd; average nr of kills and average % herd killed

As shown in Fig. 2 there is difference between cattle herds with a hired shepherd, herds where the owner is grazing fulltime and herds where the owner is grazing the herd part-time. Independent t-tests are used to check if this difference is significant. These tests showed that the difference between a hired shepherd and an owner grazing the herd full- or part-time was not significant.

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock abundance. The results are shown in table 2 below

Type of shepherd	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Hired shepherd(1)	32.21	24.62	**-7.59**
Owner grazing the herd full time(2)	31.51	32.16	0.55
Owner grazing the herd part time(3)	36.28	43.22	**6.94**

Table 6 Type of shepherd; expected and observed predation rate ***(X^2= 3.12, Df=11, p<0.975 not significant)***

As shown in table 6 cattle herds with a hired shepherd have a lower predation rate than expected on basis of their abundance and herds were the owner is grazing the herd part-time have a higher predation rate than expected on basis of their abundance. However the difference is not significant.

3.3.3.2 Type of night coral

To analyse if there is difference in depredation rate between four types of night corals all are compared on basis of the average percentage of the herd killed and the average number of animals which is killed per owner. This is performed for the herds with cattle as well as the sheep/goat herds. However, the sheep/ goat herds just use three type of corals and the cattle herds four.

Sheep/goat:

The result for the sheep/goat herds are shown down below in Fig. 3

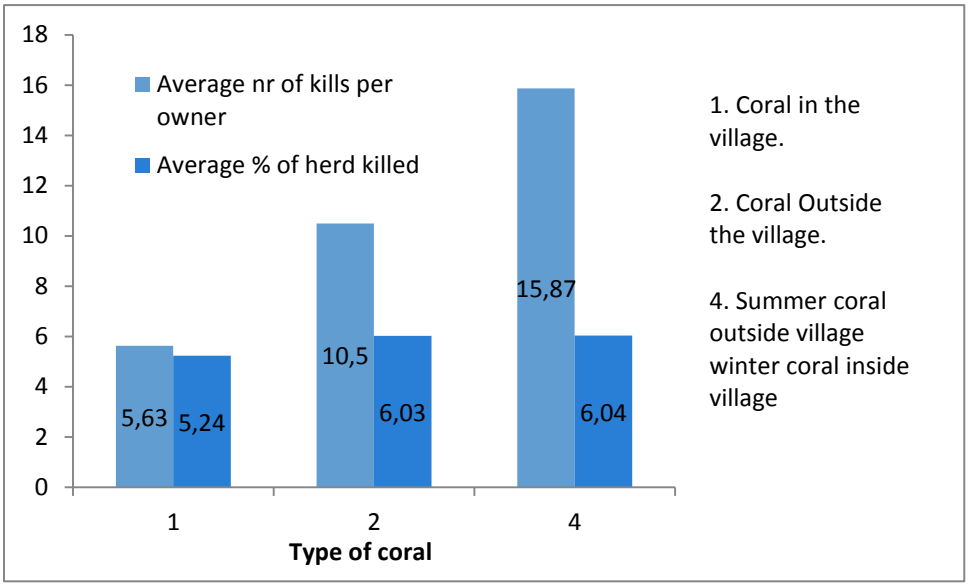

Fig. 3 Type of coral; average nr of kills and average % herd killed

As shown in Fig. 3 there is difference between sheep/goat herds which spent the night in a coral within the village, spent the night in a coral outside the village or spent the night in the summer in a coral outside the village and in the winter in a coral within the village. Independent t-tests are used to check if this difference is significant. These test showed that the difference between the 3 type of corals is not significant. This means that there is a difference but it is not provable whether it is a coincidence or not with the current data.

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock their abundance. The results are shown in table 7 below

During the night	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Coral inside the village	19.67	17.41	-2.26
Coral outside the village	35.59	36.56	+0.97
In summer coral outside village in winter coral inside village	44.74	46.03	+1.29

Table 7 Type of coral; expected and observed predation rate ***(X^2=0.32, Df= 3, p>0.950 not significant)***

As shown in Table 7 there is difference between the expected predation rate and the observed predation for the three different types of corals. However this difference is not significant as well.

Cattle

The result for the herds with cattle are down below in Fig. 4.

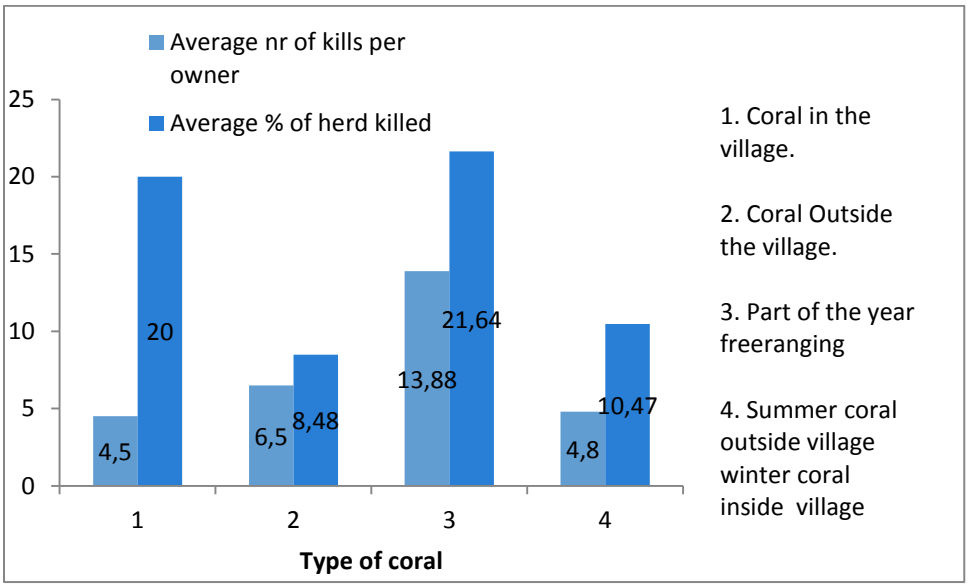

Fig. 4 Type of coral; average nr of kills and average % herd killed

As shown in Fig. 4 there is difference between cattle herds which spent the night in a coral within the village, spent the night in a coral outside the village, spent the night in the summer in a coral outside the village and in the winter in a coral within the village or spent the night a part of the year outside. Independent t-tests are used to check if this difference is significant. These tests showed that a coral outside the village or spending the night outside of the year makes a significant difference for the percentages of the herd which is killed. There are difference between all the type of corals in number of animals killed as well as the percentage of the herd killed but it is not provable whether it is a coincidence or not with the current data.

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock their abundance. The results are shown in table 8 below

During the night	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Coral inside the village	3.25	4.79	1.54
Coral outside the village	38.03	20.74	**-17.29**
Free ranging part of the year	36.31	59.04	**22.73**
In summer coral outside village in winter coral inside village	22.40	15.43	-6.97

Table 8 Type of coral; expected and observed predation rate ***(X^2=24,98, Df= 11, p<0.010 Significant)***

As shown in table 8 cattle herds which spent the night a part of the year free ranging have a significant higher depredation rate than expected on basis of their abundance and herds which are a part of the year or all year spending the night in a coral outside the village have a significant lower depredation rate than expected on basis of their abundance.

3.3.3.3 Dogs in optimum number

To analyse if there is difference in predation rate between herds with an optimum number of guarding dogs(>3) and herds with too few guarding dogs(<3) (STOYNOV, 2014) they are compared on basis of the average percentage of the herd killed and the average number of animals which is killed per owner. This is performed for the herds with cattle as well as the sheep/goat herds.

Sheep/goat:

The result for the sheep/goat herds are shown down below in Fig. 5.

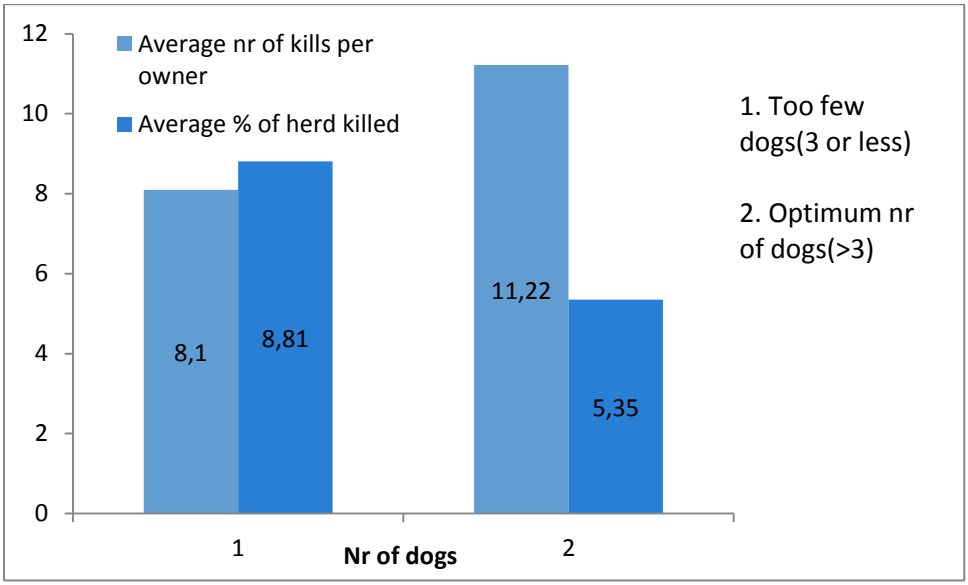

Fig. 5 Dogs in optimum nr; average nr of kills and average % herd killed

As shown in Fig. 5 there is difference between sheep/goat herds with an optimal number of dogs(>3) and herds with too few dogs(less than 3). Independent t-tests are used to check if this difference is significant. These tests showed that the difference between the herds is not significant. This means that there is a difference but it is not provable whether it is a coincidence or not with the current data.

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock their abundance. The results are shown in Table 9 below

Use of guarding dogs	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Too few dogs(3 or less)	14.05	21.86	+7.81
Optimum nr of dogs(>3)	85.95	78.14	-7.81

Table 9 Use of guarding dogs; expected and observed predation rate ***(X^2=5.05, Df=13, p>0.950 not significant)***

As shown in Table 9 there is difference between the expected predation rate and the observed predation for herds with optical number of dogs and herds with too few dogs. However this difference is not significant as well.

Cattle

The result for the herds with cattle are down below in Fig 6.

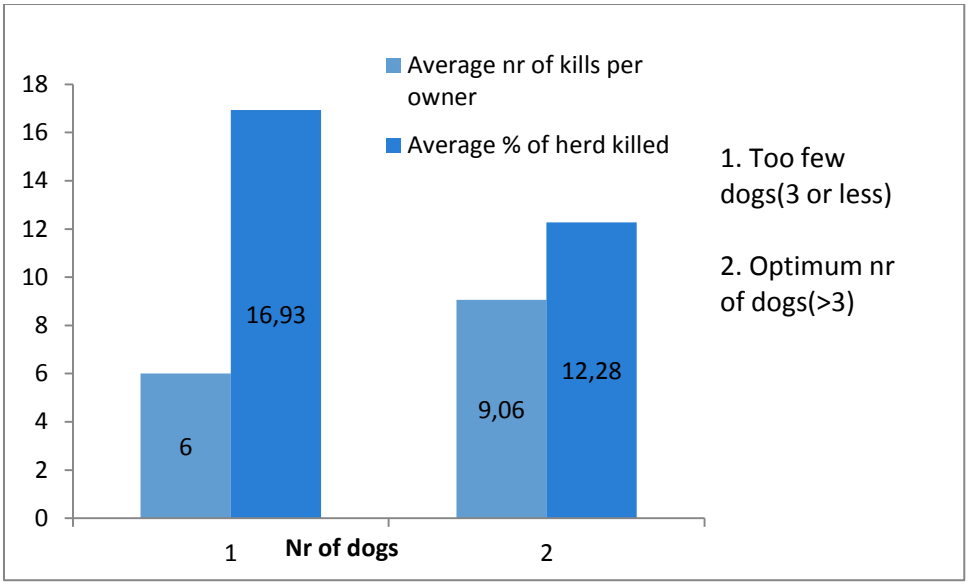

Fig. 6 Dogs in optimum nr; average nr of kills and average % herd killed

As shown in Fig 6 there is difference between cattle herds with an optimal number of dogs(>3) and herds with too few dogs(less than 3). Independent t-tests are used to check if this difference is significant. These tests showed that the difference between the herds is not significant. This means that there is a difference but it is not provable whether it is coincidence or not with the current data.

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock their abundance. The results are shown in table 10 below

Use of guarding dogs	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Too few dogs(3 or less)	20.37	27.14	6.77
Optimum nr of dogs(>3)	79.63	72.86	-6.77

Table 10 Use of guarding dogs; expected and observed predation rate ***(X^2=2.82, Df=8, p>0.900 not significant)***

As shown in table 10 there is difference between the expected predation rate and the observed predation for herds with optical number of dogs and herds with too few dogs. However this difference is not significant as well.

3.3.4 Analysis of wolf predation on livestock

3.3.4.1 Wolf selection of livestock species.

To see if the wolf predates more on certain livestock species than on others the actual wolf predation is compared with the expected predation on basis of their abundance. As also done by (Stoynov et al, 2014) in almost the same area. The data collection however was different. Instead of using data of wolf damage claims from 10 years, questionnaires were held for farmers with more than 30 sheep/goats or more than 5 cattle/horses. The questionnaires were done in a period of 3 months. Livestock owners with or without conflicts were surveyed which resulted in a big data set for livestock and predation.

Species	Expected predation rate%		% more than expected predation rate	
	Wilpstra	Stoynov	Wilpstra	Stoynov
	Kresna gorge	SW Bulgaria	Kresna gorge	SW Bulgaria
Cattle	14.33	5	**+12.85**	+100
Goats	31.19	39	-1.54	+20.51
Sheep	52.87	45	-11.75	-11.11
Equines	1.61	11	+0.44	-45.45

Table 11 Wolf species selection among livestock species ***(X^2=14.33, Df=3, p=<0.01 Significant)***

As table 11 above shows there are some mayor differences with the data of (STOYNOV, 2014)but the area was almost the same. The current data shows that there is a difference between the expected and the observed predation rate but that it is not as big as calculated by (STOYNOV, 2014) before. The reason for this probably is the way of collecting the data. By actively collecting data from farmers in the research area this study only takes into account the people which were questioned. It excludes all the farmers which could have problems with wolves but did not reported these problems. These farmers are included into (STOYNOV, 2014)'s study as they are living in the municipality. This makes (STOYNOV, 2014)'s study less trustable.

The result clearly shows that the wolf favours cattle instead of the other livestock species or cattle is more vulnerable for wolf attacks. However, 178 of the in total 199 killed cattle were calves which is about 89% as also found in (STOYNOV, 2014)'s study.

At last it is good to tell that the presence of an association which consist mainly of goat farmers may have influence the numbers for predated goats in the research area as they are very good in training their dogs and protecting their livestock. In paragraph 3.3.4.3 a comparison is made between ordinary livestock breeders and livestock breeders within this association.

3.3.4.2 Wolf predation on herds from different sizes and composition

To analyse if the wolf predates more in herds from a certain size or composition the herds are divided in four groups(A,B,C,D) for sheep/goat herds and five groups(A,B,C,D,E) for the cattle herds. After this the percentage is calculated how much the wolf predates in each group, compared to the total predation. Next to that the average number of animals that is killed per owner per group and the average % of herd killed per group is calculated. The same is performed for the herds with different composition(mixed and homogenous) but this only done for the sheep/goat herds because cattle is most often not mixed. To check if the differences are significant independent t-tests are done. Also chi squared tests are used to compare the observed predation rate with the expected predation rate.

To see if the two hypothesises: 1 ; ''if the herd size grows the number of victims also grows'' and 2; '' if the herds size grows the depredated percentage of the herd decreases'' is true, two paired t tests are carried out. The results of the two paired t test can be found in Annex 6.

Sheep/goat:

- **Different herd size**

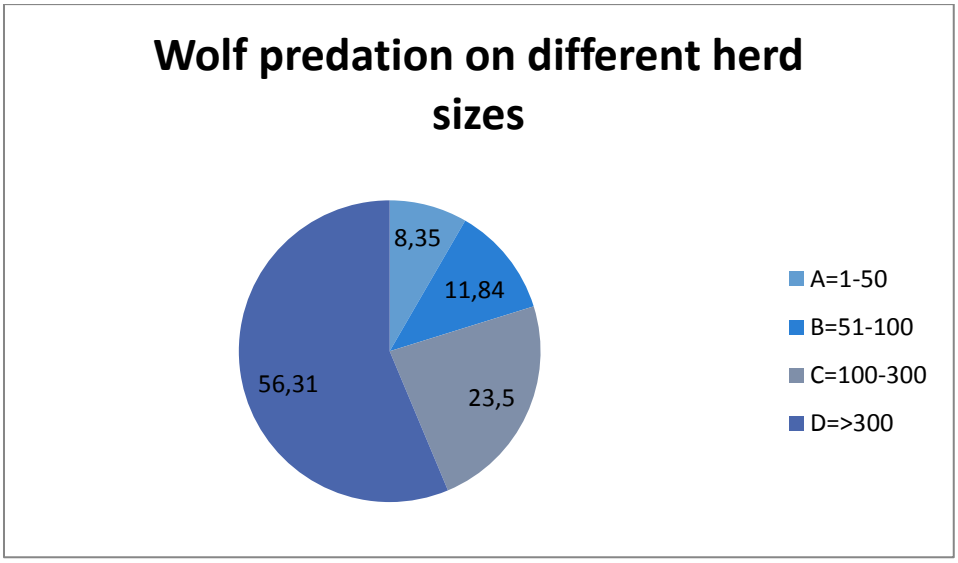

Fig. 7 Wolf predation on different herd sizes

As shown in Fig. 7 above the wolf makes the most victims in herds with more than 300 sheep/goats. It looks like it prefers to predate on bigger herds because smallest herds have the smallest percentage of the total depredation and the bigger the herd the higher the number of victims. This is the same for Fig. 8 below where the average number of killed animals per owner and the average percentage of the herd killed are shown.

Independent t test are used to check if the differences between the groups with different herd size is significant. This showed that only the difference between group D and all the other groups(A,B,C) is significant (p=0.002,p=0.009,p=0.007).

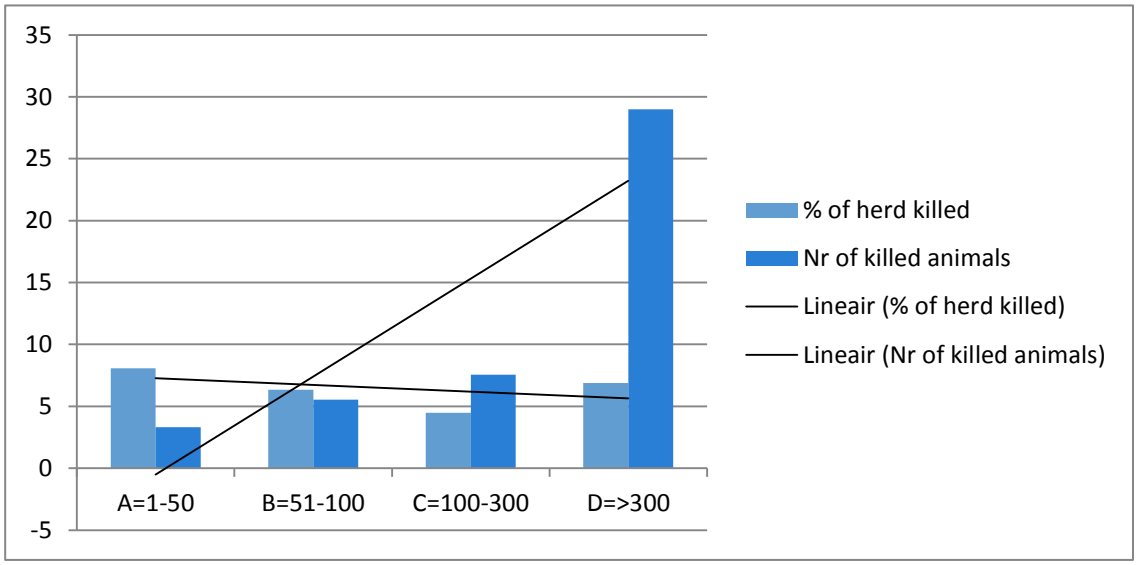

Fig. 8 Herd size; average nr of killed animals and average % herd killed

At last a chi squared analysis is performed. The results are shown in table 12 below. It shows that group C is less attacked than expected and D more than expected. However, it is not provable whether it is a coincidence or not with the current data.

Herd size:	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
A = 1-50	6.21	8.35	+2.14
B = 51-100	11.41	11.84	+0.43
C=100-300	32.64	23.50	**-9.14**
D= >300	49.74	56.31	**+6.57**

Table 12 Herd size; expected and observed predation rate ***(X^2=4.18, Df=9, P>0.100 Not significant)***

- **Different herd composition**

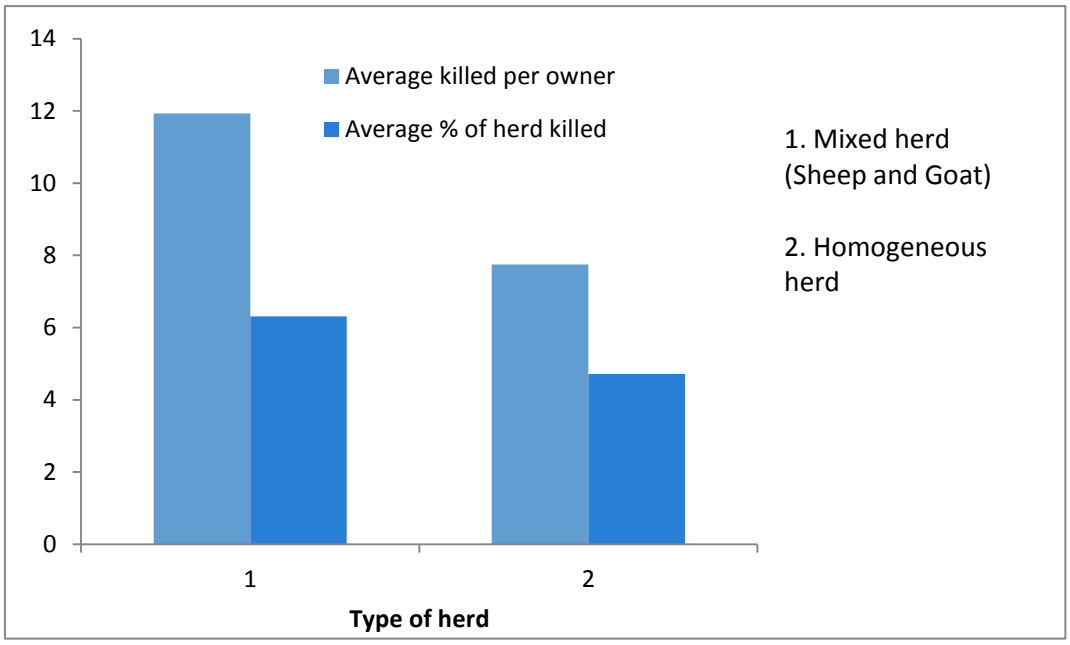

Fig. 9 Type of herd; average nr killed and average % herd killed

Type of herd	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Mixed herd(sheep and goat)	62.10	69.06	+6.96
Homogenous herd	37.90	30.94	-6.96

Table 13 Type of herd; expected and observed predation rate ***(X^2=2.06, Df=9, P>0.990 Not significant)***

At last also the chi squared analysis showed that mixed herds are more predated than expected and homogenous are less predated than expected. However, again it is not provable whether it is a coincidence or not with the current data.

- **Hypothesis 1:** 'if the herd size grows the number of victims also grows'

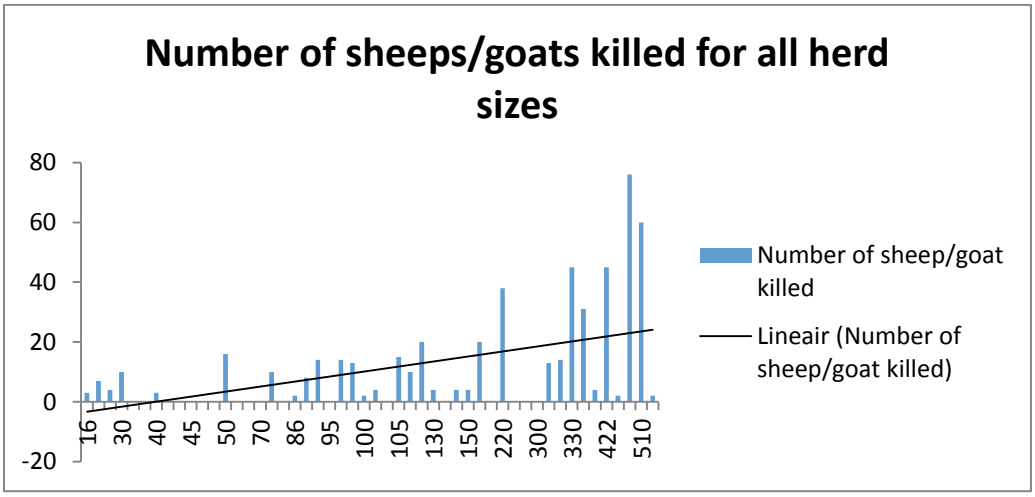

Fig. 10 Number of sheep/goats killed for all herd sizes

As Fig.10 shows that there is relation between the size of herd and the number of the victims. When the size of the herd grows also the number of victims increases. This relation was found to be significant with a paired t test (df=49,P=0.00) with a correlation of 0.509).

- **Hypothesis 2:** '' if the herds size grows the depredated percentage of the herd decreases''

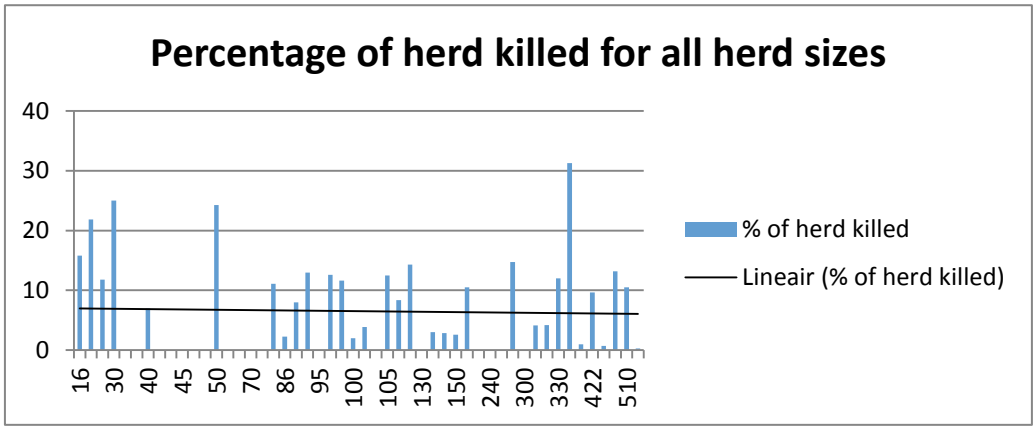

Fig. 1 Percentage of herd killed for all herd sizes

As Fig. 11 shows there is relation between the size of herd and the percentage of the herd which is killed. When the size of the herd grows the number of victims increases but the percentage of the herd which is killed decreases . This relation was found to be significant with a paired t test (df=49,P=0.00) with a correlation of -0.004).

Cattle

- **Different herd size**

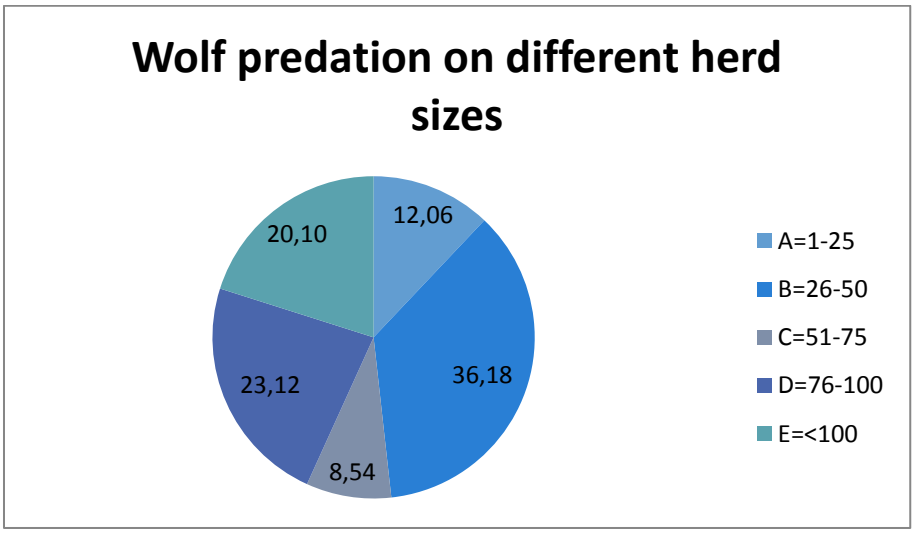

Fig. 12 Wolf predation on different herd sizes

As shown in Fig. 12 the wolf makes the most victims in herds with 26-50 cattle. Looking at the number of herds which have this size it is also most abundant so it looks more or less logical. Looking at Fig. 13 below however, it looks like it prefers to predate on bigger herds because the smallest herds have the lowest average number of depredation per owner and the bigger the herd the higher the number of victims. So the average number of killed animals per owner in group B is lower because this herd size is more abundant but the total predation in this group is higher.

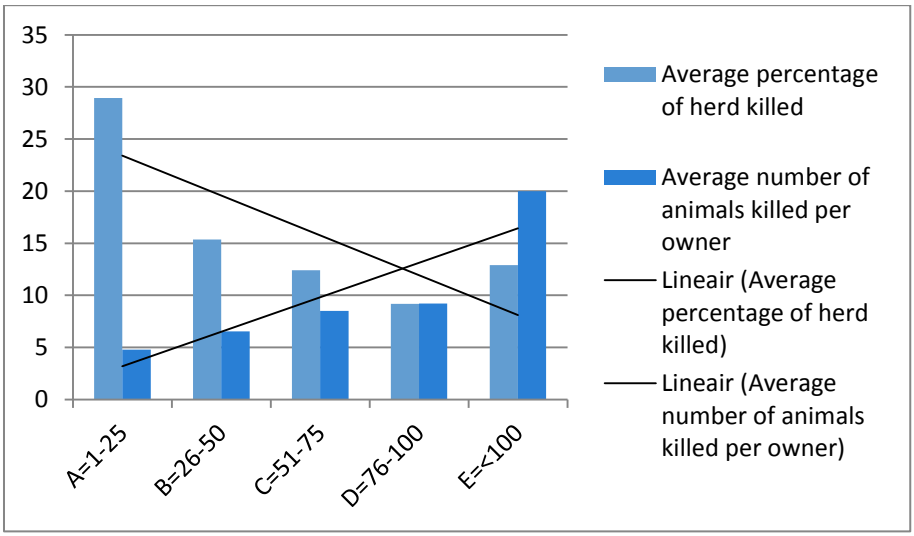

Fig. 2 Herd size; nr of animals killed and % herd killed

Independent t test are used to check if the differences between the groups with different herd size is significant. This showed that the difference between group A and E and the difference between group B and E are significant looking at the number of killed cattle (p=0.002,p=0.024) Next to that it showed that the difference between group A and group B and D is significant looking at the percentage of the herd killed(p=0.049,p=0.023) .

At last a chi squared analysis is performed. The results are shown in table 14 below. It shows that group D is significantly less attacked than expected and A and B significantly more than expected.

Herd size:	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
A=1-25	4.54	12.06	7.52
B=26-50	30.52	36.18	5.66
C=51-75	9.22	8.54	-0.68
D=76-100	34.97	23.12	-11.85
E=<100	20.75	20.10	-0.65

Table 14 Herd size; expected and observed predation rate ***(X^2=17.63, Df=8, P<0.025 Significant)***

- **Hypothesis 1:** 'if the herd size grows the number of victims also grows'

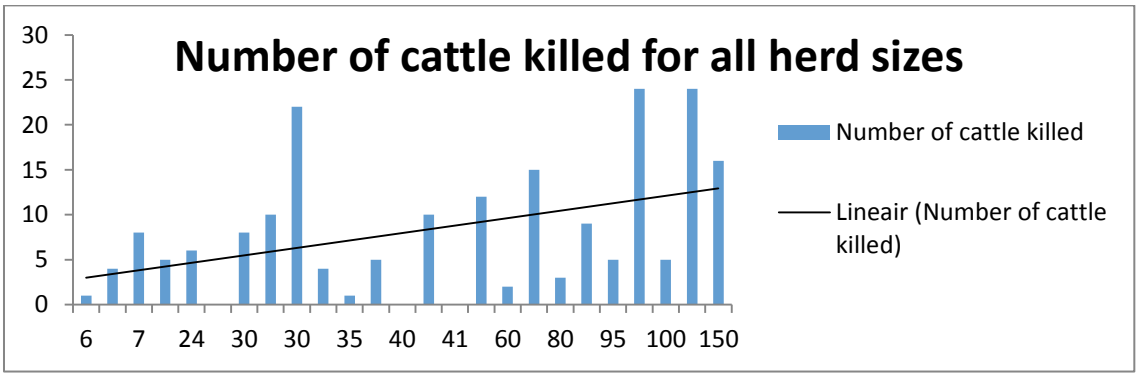

Fig. 14 Number of cattle killed for all herd sizes

As Fig. 14 shows there is relation between the size of herd and the number of the victim. When the size of the herd grows also the number of victims increases. This relation was found to be significant with a paired t test (df=24,P=0.00) with a correlation of 0.481).

- **Hypothesis 2:** '' if the herds size grows the depredated percentage of the herd decreases''

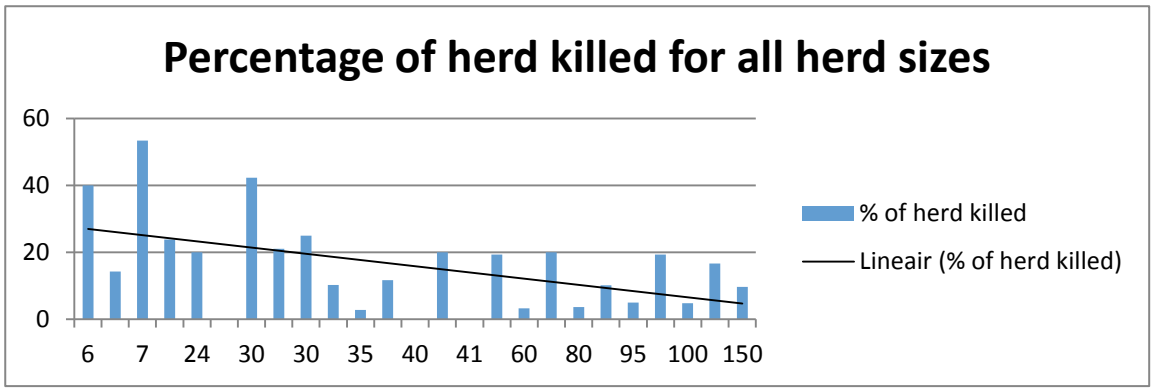

Fig. 15 Percentage of herd killed for all herd sizes

As Fig. 15 shows there is relation between the size of herd and the percentage of the herd which is killed. When the size of the herd grows the number of victims increases but the percentage of the herd which is killed decreases . This relation was found to be significant with a paired t test (df=24,P=0.00) with a correlation of -0.396).

3.3.4.3 Wolf predation on professional and amateur livestock breeders

To analyse if there is difference in depredation rate between amateur and professional or ordinary livestock breeders village herds and herds which are part of association are compared to the other herds. In the area there are only goat/sheep associations and village herds which consist only of goats and sheep so this analysis is not carried out for cattle.

- **Village herds vs other herds.**

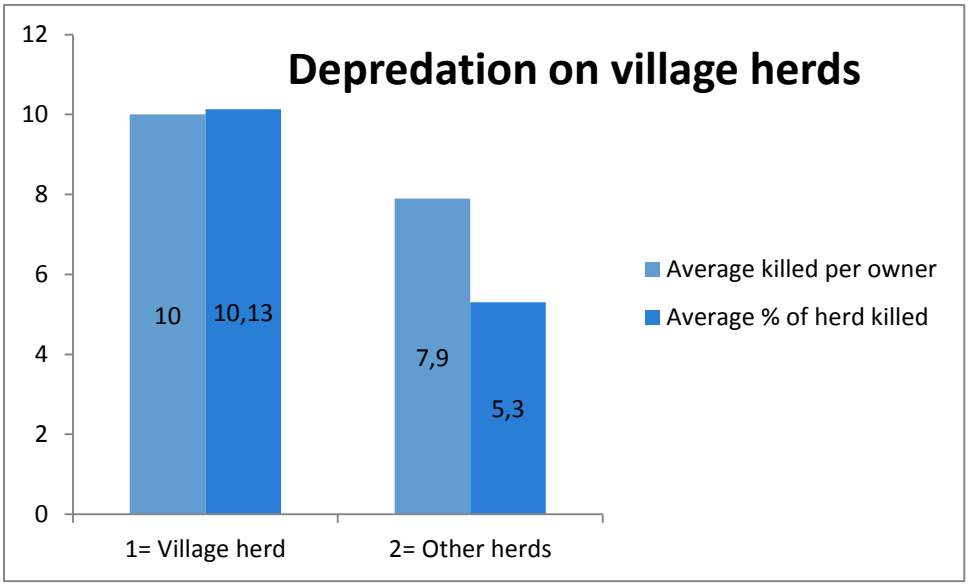

Fig. 16 Depredation on village herds

As shown in Fig. 16 above village herds suffer bigger losses than other herds for the number of killed animals as well as the percentage of their herds which is killed. Independent t-test are used to check if this difference is significant. These tests showed that the difference between the herds is not significant. This means that there is a difference but it is not provable whether it is a coincidence or not with the current data.

Next to the t-test a chi- square analysis is used to show the difference between the observed predation rate and the expected predation rate on basis of the livestock their abundance. The results are shown in table 15 below.

Village herd or other	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Village herd	4.40	8.50	4.1
Other herds	95.60	91.50	-4.1

Table 15 Village herds or other; expected and observed predation rate ***(X^2=4.00, Df=10, P>0.900 Not significant)***

As shown in table 15 above there is difference between the expected predation rate and the observed predation rate for village herds. However this difference is not significant as well.

- **Herds outside or inside associations**

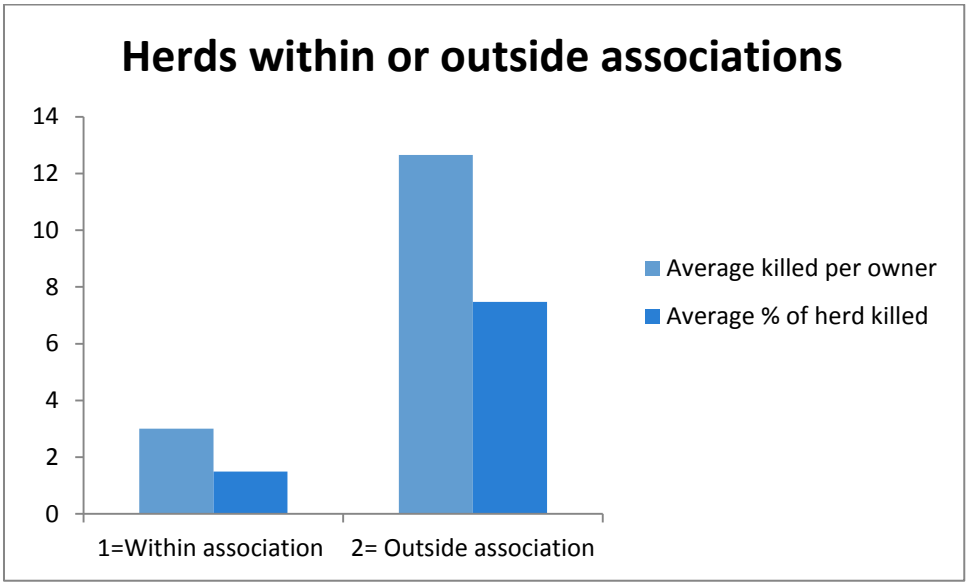

Fig. 17 Depredation on herds within or outside associations

As shown in Fig. 17 the wolf makes the most victims in herds outside associations and also the percentage of the herd killed and the number of animals killed per owner is higher in herds outside associations. Independent t-test are used to check if this difference is significant. These tests showed that the difference between the herds is significant for the percentage of the herd killed but not significant for number of killed sheep/goats.

Next to the t-test a chi- square analysis is carried out to show the difference between the observed predation rate and the expected predation rate on basis of the livestock their abundance. The results are shown in table 16 below.

Association or not	Expected predation rate (%)	Observed predation rate (%)	Difference with expected predation rate (%)
Owner within Association	28.53	6.96	**-21.57**
Other owners	71.47	93.04	+21.57

Table 16 Association or not; Expected and observed predation rate ***(x^2=22.82, Df=13, P<0.050 Significant)***

As shown in table 16 there is difference between the expected predation rate and the observed predation rate for herds in and outside associations and difference was found to be significant.

3.4 Minimising the livestock owner wolf conflict in the Kresna gorge

To minimise the conflict between livestock owners and wolves the two influencing parameters namely the satisfaction with income from livestock breeding and the extend that wolves threaten peoples livelihoods should be positively influenced. This could be done by lowering wolf depredation numbers on livestock, this measures are found in 3.4.1 and 3.4.2. This however could also be done by increasing peoples livelihoods and making them more in depended from the number of their livestock, information about this is found in 3.4.3.

3.4.1 Possible improvement of current wolf predation prevention measures

To reduce problems with wolves the way of protecting the livestock should be optimised. This could be done with small changes in every day livestock management. One of the aims of this study was to find relations between the way of keeping the livestock and the wolf depredation. The following relations were found:

Cattle

The study showed that:

1. The bigger herd gets the higher the number of victims but the lower the percentage of the herd which is killed.
2. People who graze their animals their selves all year round or have a hired shepherd all year round have less victims then people who graze the herd part-time their selves.
3. Cattle herds which spent the night a part of the year free ranging have a higher percentage of the herd is killed than cattle herds which spent the night all year round in a coral outside village.
4. Cattle herds with three or less dogs have more kills than herds with more than three dogs.

To improve the protection of cattle herds the following points can be advised:

1. Do not leave the animals free ranging in the night(w*as found to make a significant difference)*
2. Do not graze animals part-time but have 1 person responsible.
3. Have a sufficient number of dogs guarding the herd(>3) .

Photo 5: Livestock guarding dogs

Sheep/Goat

The study showed that:

1. The bigger herd gets the higher the number of victims but the lower the percentage of the herd which is killed.
2. People who have a hired shepherd all year round have less victims then people who graze the animals part-time or full time their selves. The reason for this could be that professional livestock breeders with good guarding dogs most often have a hired shepherd.
3. People who use a summer and winter coral have more victims than those who have only one coral. However, the percentage of the herd killed is not much higher for the people with summer and winter coral so it could also be that bigger owners use summer and winter coral and have more victims because they are more vulnerable(point 1).
4. People with an sufficient number of dogs have on average more animals killed. However, again the percentage of the herd which is killed is lower for people with a sufficient number of dogs so probably these are the bigger owners which are more vulnerable(point 1) and that is why they have more animals killed.
5. Mixed herds have more animals killed than homogenous herds and also the percentage of the herd which is killed is higher.
6. Village herds have on average more animals killed and the percentage of the herd which is killed is also higher.
7. There is a significant difference between the herds in or outside associations. Herds inside associations have a significant lower percentage of the herd killed then those outside.

To improve the protection of sheep/goat herds the following points can be advised:

1. Let livestock breeders become part of an association(*was found to make a significant difference)*
2. Do not graze animals part-time but have 1 person responsible.
3. Try to graze animals in homogenous herds.

3.4.2 Possible new wolf predation prevention measures for the Kresna gorge

On global scale several measures are taken to prevent predation from wolves on livestock. This include all the measures which are on the moment used in the Kresna gorge. However there are also some different/new ones. Down here the possible new measures for the Kresna gorge are described and their suitability for the Kresna gorge is discussed.

- Electric fences by (Schoenian, 2011)

‘’In most situations, predator control begins with a good fence. A fence is the first line of defence against intruders. However, predators can penetrate a fence by digging under, jumping between the wires, crawling through holes in the mesh, or jumping over the top of the fence. Woven wire (or net) fences in good repair will deter many predators from entering pastures, especially if vertical stays are no more than 6 inches apart and horizontal wires spaced 2 to 4 inches apart in the bottom portion of the fence. Although more expensive to install than high tensile electric fences, woven wire fences have many advantages and should be considered for perimeter or boundary fences.

High-tensile, electric fencing is another option for predator-proof fencing. Perimeter fences should consist of at least five strands of high-tensile smooth wire. Increasing the number of wires will improve the effectiveness of the fence as a deterrent to predators.

To be effective, the wires need to be properly spaced. The bottom wires need to be closer than the top wires. Where there is adequate soil moisture, all of the wires should be electrified. Otherwise, the fence should have a mixture of both live and ground wires. Fourt-eight inches is a good height for keeping sheep in and predators out.

Fence lines need to be kept clean from vegetation. Weeds and grass that touch the fence will reduce voltage and lessen the effectiveness of the fence. Fence lines can be kept clean with herbicides or hand-held weed cutters.''

- Fladry and turbofladry by (DEFENDERS OF WILDLIFE, 2008)

'' Fladry fences are much less expensive to produce and install than wire or permanent fencing. Fladry is also easily moved and can be quickly installed over large areas—even by one person. How the fladry is hung and the materials used play a role in its effectiveness, so it is important to seek the advice of wolf managers experienced with this method before trying it. Fladry also requires regular maintenance. Cattle are known to chew and pull on it, and a broken, tangled, pinned down or otherwise compromised fladry barrier is likely to fail. Regular maintenance, including the replacement of aged, torn or faded fladry, is essential. Fladry alone is most effective as a short-term deterrent. As with all proactive methods, wolves may stop responding after a period of exposure, rendering the method ineffective for preventing losses. The added "bite" of turbofladry—fladry on top of electrified line—uses electric shock to enhance the negative experience of wolves that come into contact with fladry. This reduces the chances of the wolves losing their fear of fladry, likely extending the time that this barrier remains effective. Turbofladry is more expensive, but estimates show it can be three or more times as effective. Like regular fladry, turbobarriers are highly portable and relatively easy to produce, but still require substantial maintenance to remain effective.''

- Wild prey her introduction/protection

As stated in (MERIGGI, 1996) : '' The simultaneous reintroduction of several wild ungulate species is likely to reduce predation on livestock and may prove to be one of the most effective conservation measures''.

In Bulgaria the reintroduction or strengthening of native wild ungulates species to places where populations are weakened or became extinct might have a significant impact on the predation of livestock by wolves. The diet of wolves in hunting reserve Studen kladenec in Bulgaria for instance contains for 74% of wild prey where from 70% is the reintroduced Fallow deer (Schulte, 2014). In Kraiste however the diet of the wolves contains just 53% of wild prey and for 47% of livestock (TSINGARSKA, Influence of wolves, on the populations of wild and domestic hoofed mammals, 2006)

The native wild ungulates species for Bulgaria which could be reintroduced are from the populations could be strengthened are: Wild boar, Roe deer, Red deer, Fallow deer, European Bison and Balkan chamois

3.4.3 Increasing livelihoods and making livestock owners less depended on the number of animals

As stated in paragraph 3.1 to increase livelihoods from livestock owners two different strategies could be used: increasing profit from livestock breeding or increasing profit from other sources.

To increase the profit from livestock breeding firstly the costs can be lowered and secondly the income can be increased. However the balance has to be found. The cost for livestock protection could for instance be lowered however this could mean more cost from livestock depredation by wolves. The same could be true for the herd size and the cost of feeding etc. Finding this balance will mean optimising the business and also optimising the profit.

Finding the balance between the following things might be important to increase profit from a livestock breeding business:

- The size of the herd vs the cost of livestock depredation and cost for feeding:

  When the size of herds increases the percentage of the herd which is killed by predators decreases(see page 26 and 28). The cost for feeding increases but also the amount of meat which could be sold and the livestock subsidy increases.

- The usage of dogs to protect livestock vs the cost of livestock depredation:

  It is shown that having a good number of dogs helps to prevent predation on livestock by wolves(see page 20 and 21). These dogs however also need food but these cost are lower than those of depredated livestock by wolves.

- The usage of a summer coral vs the cost of livestock depredation:

  It is shown that having livestock locked up during the night helps prevent livestock depredation by wolves(see pages 17 and 18). Building a summer coral however cost money.

Finding this balance might be a process of learning by doing. However it might in some cases be reached faster with some help and education from other more experienced livestock breeders. Joining a livestock breeding association might there for be a good thing to do(see page 30 and 31)

Another good thing to do which does not involves very much cost for a livestock breeding business is applying for subsidies for pastures. This could give farmers an additional income which is not very much depended on the number of animals. Help with this could again come from associations which are sometimes more experienced in this.

Next to increasing profit or livelihoods from livestock breeding also profit or livelihoods from other sources could be looked for. This could for instance be a second job or business or producing most of the products needed to life by yourself.

Conclusion

It can be concluded that the new method for estimating the size of the conflict between livestock owners and wolves seems to have potential for future investigations. During the first trial research it became clear that this method is quite easy to execute on a bigger scale. It just includes asking a few questions to livestock owners. Which, if it is done yearly, could be done mainly by the phone. Next to this the method has shown to take into account more parameters then other research did until now. Most research until now just used wolf depredation numbers to make clear how big the problem/conflict is.

The following recommendations can be made to minimise the conflict in the kresna gorge:

First some recommendations for the livestock owners in the region to minimise the conflict:

1) Become part of a livestock breeding association which helps with:
- Finding the balance between cost and income from livestock breeding.
- Lowering livestock depredation
- Increasing income from subsidies on pastures and/or livestock
2) Find a second income source and/or produce all your food yourself.
3) Do not leave animals spending the nights free ranging.

And finally some recommendations for FWFF's role in minimising the conflict:

1) Start with wild prey reintroduction or strengthening of wild prey populations in the region.
2) Start fencing areas for village herds to protect their herds from depredation from wolves and there gardens from bigger livestock or wild prey.
3) Advise livestock owners to improve their livestock protection on basis of statistics within this research.
4) Stimulate livestock owners to become part of a livestock breeding organisation.
5) Help livestock owners with increasing their income from subsidies on pastures or other non-livestock related income sources.

Photo 6: Cows in the research region

Discussion

Because this study is based on information given by the livestock breeders it means that there is always a risk that somebody is not telling the truth. Numbers could be made up, killed animals could be forgotten, etc. Next to this also the study could include kills caused by feral dogs, jackals or bears because people are not always able to see which predator has killed their animal. At last because of the time involved in executing all the questionnaires some people could have had more kills for 2014 after we had visit them. However, with the data of 26 cattle farmers and 50 sheep/goat farmers there was enough data to statistically analyse, but with more data more could be significantly proven.

Because all of the research could not be executed without volunteers to translate questionnaires the amount of work which could be done in 2015 was less than expected before. This is why the new developed field method was just tested on a small scale with 8 livestock owners. It is recommended to enlarge this trial research. However, looking to the first results is seems to have potential for the future.

Photo 7: Herd of goats and sheep in the coral

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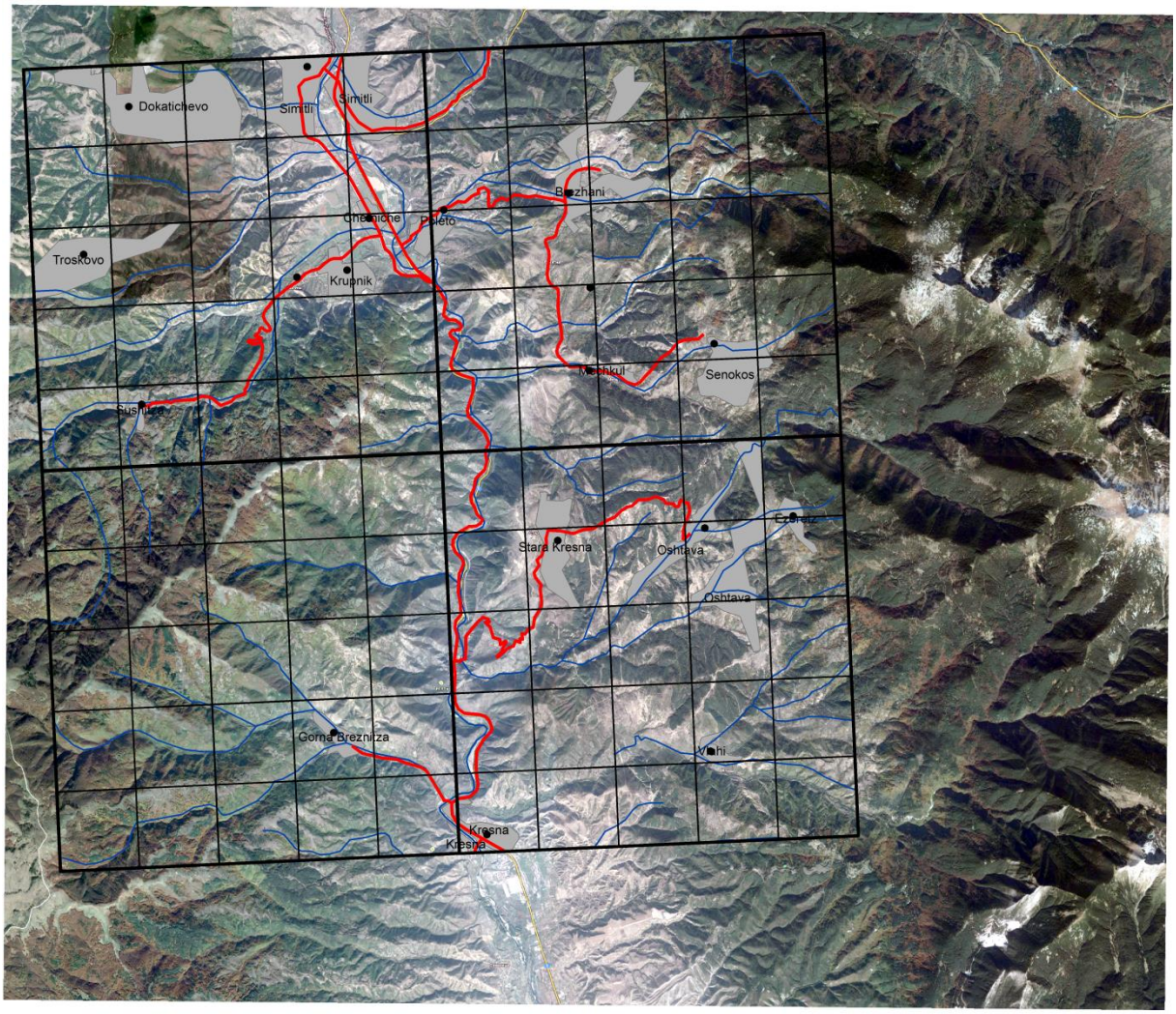
Annexes

Annex 1: Map of the research area.



Annex 2: Used Questionnaire 2014

Name Farmer:		**Phone Number:**				**Adress:**					
		Cattle	Sheep	Goats	Horses	Donkeys	Pigs	Chickens	Dogs	Total	Beehives
Number of livestock owned by the farmer:											
Where do you deposit your dead animals?											
Fwff											
Carriage											
Dig it or leave it											
Give it to the dogs											
Have you ever seen vultures in your area?	Yes										
	No										
		Cattle	Sheep	Goats	Horses	Donkeys	Pigs	Chickens	Dogs	Total	Beehives
Number of killed livestock from predators:	**2013**										
	Wolf										
	Dog										
	Bear										
	Jackal										
	2014										
	Wolf										
	Dog										
	Bear										
	Jackal										
Number of livestock you know is killed by predators in the region:	**2013**										
	Wolf										
	Dog										
	Bear										
	Jackal										
	2014										
	Wolf										
	Dog										
	Bear										
	Jackal										

(If there is no killed livestock) attacks on livestock?	Yes	No
Area of grazing(show it on map)	Name place	Plot nr
Summer	same	
Winter	same	
Place of killed or attacked livestock (show it on map)	Name place	Plot nr

Way of keeping of the livestock?
Grazing
Closed rearing
Owner grazing the herd
Hired shepherd
Transhumance
Collective herd

The animals spent the night in:
Coral within the village
Coral outside the village
Free ranging
Summer coral outside village Winter coral within the village

Do you think the number of killed livestock has changed?
Increased
Decreased
Stable
Do not know

Are there any guarding dogs?	Breed	Number	1 karachan	4 hunting dogs
Non- working guarding dogs?	Breed	Number	none	

Do you know about poisoning cases?
Yes
No

Do you know about any compensation program for livestock depredation?
insurance company
State compensation program
NGO compensation program (FWFF)
Compensation by hunters
Don't know

Is it working for you?
Yes
No

What is the best solution in your opinion to decrease livestock depredation in your area?
Full extirpation of wolves by shooting
Yes
No
Shooting the problematic wolves
Yes
No
Use of poisoned baits to kill wolves
Yes
No

Use of Guarding dogs

Yes

No

Shift from small livestock(sheep and goat) to cattle

Yes

No

Increase of number of wild prey?(deers, wild boar, etc.)

Yes

No

How many wolves were seen in the area?(highest number seen together

1

2

3

4

5

6

7

8

9

Are hunters active in the area?

Yes

No

Annex 3: Used Questionnaire 2015

	1	2	3	4	5
How content are you with the final profit you receive from livestock breeding on a scale from 1 to 5? (1 content 5 not content at all)					
Are you in conflict with wolves and how big is this conflict on a scale from 1 to 5?(1 not in conflict, 5 in big conflict)					
Is the wolf depredation threatening your livelihoods and to what extend on a scale from 1 to 5?					

	2015	Calf	Cattle	Sheep	Goats	Horses	Donkeys
Number of livestock owned by the farmer:							

Number of killed livestock from predators:	**2014**	Calf	Cattle	Sheep	Goats	Horses	Donkeys
	Wolf						
	Dog						
	Bear						
	Jackal						
	2015						
	Wolf						
	Dog						
	Bear						
	Jackal						

What are the main yearly cost for your business from high to low? (1 to 6)

Fourage

Shepherd
Rent for pastures
Livestock depredation
Veterinairy costs
Other cost Namely:

What are the main yearly income sources for your business from high to low?(1 to 6)
Livestock subsidy
Subsidy on pastures
Profit from milk
Profit from meat
Profit from wool hair or skin
Other profit Namely:

Does your familie have other sorts of income next to livestock breeding and what other income sources from high to low?(1 to 3)
Income of other persons in family or second job
Pension
Other income sources Namely:

How dependent are you on the supermarket on a scale from 1 to 4?
Only go to supermarket for products we cannot produce ourselves. Produce own milk, meat and crops.(1)
Go to supermarket for vegetables use own milk and meat(2)
Go to the supermarket for meat and vegetables(3)
Take everything from supermarket(4)

Annex 4: Extreme situations

	In big conflict
1	Not content with final profit of livestock breeding/Livelihoods
2	Financial losses from wolves high/high % of herd killed by wolves
3	Livelihoods for big part depended on (the number of) livestock
	Income mostly depending on:
	- Subsidy for livestock
	- Selling milk and meat
	Mainly depended on income from livestock: No pension/No other income
	Not self-sufficient in producing food/ Depended on the store for food

	Not in conflict
1	Content with profit of livestock breeding/livelihoods
2	Financial losses from wolves low/ low percentage of herd killed by wolves
3	Livelihoods for a small part depended on (the number of) livestock
	Income mostly depending on:
	- Subsidy from pastures
	Partly depended on income from livestock: Pension / Other job
	Self-sufficient in producing food / Producing most products which they consume

Annex 5: Independent t-test.

Sheep/goats

Type of Shepherd	Correlation and Independent T- test (type of shepherd and nr of killed livestock)
1 vs 2	Correlation 0.161 Relation, Df=32 P=0.362 → No significant difference
1 vs 3	Correlation 0.284 Relation, Df=27 P=0.136 → No significant difference
2 vs 3	Correlation 0.162 Relation, Df= 35 P=0.339→ No significant difference
Type of Shepherd	**Correlation and Independent T- test (type of shepherd and % of herd killed)**
1 vs 2	Correlation 0.369 Relation, Df=32 P=0.032 → **Significant difference**
1 vs 3	Correlation 0.599 Relation, Df=27 P=0.001 → **Significant difference**
2 vs 3	Correlation 0.216 Relation, Df= 35 P=0.199→ No significant difference

During the night	Correlation and Independent T- test (type of coral and nr of killed livestock)
1 vs 2	Correlation 0.200 Relation, Df=32 P=0.256 → No significant difference
1 vs 4	Correlation 0.301 Relation, Df=29 P=0.100 → No significant difference
2 vs 4	Correlation 0.141 Relation, Df= 31 P=0.452→ No significant difference
During the night	**Correlation and Independent T- test (type of coral and % of herd killed)**
1 vs 2	Correlation 0.030 Relation, Df=32 P=0.866 → No significant difference
1 vs 4	Correlation 0.111 Relation, Df= 29 P=0.552 → No significant difference
2 vs 4	Correlation 0.084 Relation, Df=31 P=0.648→ No significant difference

Use of dogs	Correlation and Independent T- test (Use of dogs and nr of killed livestock)
1 vs 2	Correlation 0.087 Relation, Df=48 P=0.548 → No significant difference
Use of dogs	**Correlation and Independent T- test (Use of dogs and % of herd killed)**
1 vs 2	Correlation -0.141 Relation, Df=48 P=0.328 → No significant difference

Herd size	Correlation and Independent T- test (Herd size and nr sheep/goat killed)
A vs B	Df=22 P=0.339 → No significant difference
B vs C	Df= 25 P=0.580→ No significant difference
A vs C	Df=27 P=0.199→ No significant difference
A vs D	Df=21 P=0.002→ **Significant difference**
D vs B	Df=19 P=0.009→ **Significant difference**
D vs C	Df=24 P=0.007→ **Significant difference**
Herd size	**Correlation and Independent T- test (Herd size and % of herd killed)**
A vs B	Df=22 P=0.433 → No significant difference
B vs C	Df=25 P=0.767 → No significant difference
A vs C	Df=27 P=0.256 → No significant difference
A vs D	Df=21 P=0.894 → No significant difference
D vs B	Df=19 P=0.330 → No significant difference
D vs C	Df=24 P=0.177 → No significant difference

Herd composition	Correlation and Independent T- test (Type of herd and nr of killed livestock)
1 vs 2	Correlation -0.125 Relation, Df=47 P=0.391 → No significant difference
Herd composition	**Correlation and Independent T- test (Use of dogs and % of herd killed)**
1 vs 2	Correlation -0.168 Relation, Df=47 P=0.249 → No significant difference

Village herd vs other	**Correlation and Independent T- test (Village herd vs other and nr of killed livestock)**
1 vs 2	Correlation -0.46 Relation, Df=42 P=0.768 → No significant difference
Village herd vs other	**Correlation and Independent T- test (Village herd vs other and % of herd killed)**
1 vs 2	Correlation -0.211 Relation, Df=42 P=0.170 → No significant difference

Association or not	**Correlation and Independent T- test (Association or not and nr of killed livestock)**
1 vs 2	Correlation 0.254 Relation, Df=48 P=0.076 → No significant difference
Association or not	**Correlation and Independent T- test (Association or not and % of herd killed)**
1 vs 2	Correlation 0.317 Relation, Df=48 P=0.025 → **Significant difference**

Cattle

Type of Shepherd	**Independent T- test (type of shepherd and nr of killed livestock)**
1 vs 2	Df=15 P=0.866 → No significant difference
1 vs 3	Df=13 P=0.389 → No significant difference
2 vs 3	Df= 16 P=0.195→ No significant difference
Type of Shepherd	**Independent T- test (type of shepherd and % of herd killed)**
1 vs 2	Df=15 P=0.162 → No significant difference
1 vs 3	Df=13 P=0.058 → No significant difference
2 vs 3	Df= 16 P=0.904→ No significant difference

During the night	**Correlation and Independent T- test (type of coral and nr of killed livestock)**
1 vs 2	Df=6 P=0.777 → No significant difference
1 vs 3	Df=9 P=0.181 → No significant difference
1 vs 4	Df=5 P=0.800 → No significant difference
2 vs 3	Df=13 P=0.180 → No significant difference
2 vs 4	Df= 9 P=0.884 → No significant difference
3 vs 4	Df= 12 P=0.109 → No significant difference
During the night	**Correlation and Independent T- test (type of coral and % of herd killed)**
1 vs 2	Df=6 P=0.066 → No significant difference
1 vs 3	Df=9 P=0.618 → No significant difference
1 vs 4	Df=5 P=0.940→ No significant difference
2 vs 3	Df=13 P=0.026→ **Significant difference**
2 vs 4	Df=9 P=0.177 → No significant difference
3 vs 4	Df=12 P=0.444 → No significant difference

Use of dogs	**Correlation and Independent T- test (Use of dogs and nr of killed livestock)**
1 vs 2	Df=23 P=0.322 → No significant difference
Use of dogs	**Correlation and Independent T- test (Use of dogs and % of herd killed)**
1 vs 2	Df=23 P=0.484 → No significant difference

Herd size	Correlation and Independent T- test (Herd size and nr cattle killed)
A vs B	Df=14 P=0.593 → No significant difference
A vs C	Df= 5 P=0.392 → No significant difference
A vs D	Df=8 P=0.303 → No significant difference
A vs E	Df=5 P=0.002→ **Significant difference**
B vs C	Df=11 P=0.725 → No significant difference
B vs D	Df=14 P=0.514→ No significant difference
B vs E	Df=11 P=0.024→ **Significant difference**
C vs D	Df=5 P=0.927 → No significant difference
C vs E	Df=2 P=0.271 → No significant difference
D vs E	Df=5 P=0.170 → No significant difference
Herd size	**Correlation and Independent T- test (Herd size and % of herd killed)**
A vs B	Df=14 P=0.049 → **Significant difference**
A vs C	Df= 5 P=0.204→ No significant difference
A vs D	Df=8 P=0.023 → **Significant difference**
A vs E	Df=5 P=0.217 → No significant difference
B vs C	Df=11 P=0.829→ No significant difference
B vs D	Df=14 P=0.419→ No significant difference
B vs E	Df=11 P=0.944→ No significant difference
C vs D	Df=5 P=0.664 → No significant difference
C vs E	Df=2 P=0.881 → No significant difference
D vs E	Df=5 P=0.421 → No significant difference

Annex 6: Paired t tests

Correlation and Paired T test (nr of sheep/goat and nr of sheep/goat killed)
Correlation 0.509 Relation, Df=49 P=0.00 → **Significant difference**

Correlation and Paired T test (nr of sheep/goat and % of herd killed)
Correlation -0.004 Relation, Df=49 P=0.00 → **Significant difference**

Correlation and Paired T test (nr of cattle and nr of cattle killed)
Correlation 0.481 Relation, Df=24 P=0.00 → **Significant difference**

Correlation and Paired T test (nr of cattle and % of herd killed)
Correlation -0.396 Relation, Df=24 P=0.00 → **Significant difference**