Master of Environmental Management of Mountain Areas (EMMA)

Effectiveness of Fences as Livestock Protection

By: Klara Hansen

           Matriculation No. Bolzano: 14948

           Matriculation No. Innsbruck: 01644633

Supervisors: Prof. Dr. Dr. Matthias Gauly, Free University of Bozen, Bolzano

               Assoc. Prof. Dr. Georg Leitinger, University of Innsbruck

               Daniel Mettler lic. phil. I, AGRIDEA

               Andreas Schiess, BSc Agronom, AGRIDEA

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Acknowledgements

Index

List of Figures

List of Tables

List of Abbreviations

AAFRD: Alberta Agriculture, Food and Rural Development

BAFU: Bundesamt für Umwelt (Environmental Agency of Switzerland)

CHF: Swiss Francs

KORA: Koordinierte Forschungsprojekte zur Erhaltung und zum Management der Raubtiere in der Schweiz (Coordinated Scientific Research Projects on the Protection and Management of Predators in Switzerland)

LN: Landwirtschaftliche Nutzfläche (agricultural land which is not alpine pasture)

NGO: Non-governmental organization

1   Abstract

English:

After being extinct for many years, the wolf slowly repopulates Switzerland. This renews the old conflict with livestock farmers, who fear for their animals. However, the situation has changed because nowadays farmers have tools to effectively protect their herds.

In an earlier experiment with wolves in a zoo, it was found, that electric fences, were hardly ever overcome when certain qualities were ensured. Also, other studies ascribed electric fences as an effective protection method. But what types of fences are used in different regions of Switzerland? How are they managed and how practical are they? How well do they protect, and which are the challenges when setting them up?

The following study was done to answer these questions. It is based on three approaches: Checking reported wolf-attacks for the fence system and condition, interviewing experts on the topic, and thirdly, visiting farms in three wolf-populated regions and collecting data about the used fence types, fencing problems and other characteristics, which could be related to predation risk.

A number of reasons make it really difficult to assess the effectiveness of fences. However, results strongly suggest that electric fences can be very effective. Especially sufficient voltage and accurate setup seem to be the biggest challenges.

Deutsch:

Schon immer gab es Konflikte zwischen Wölfen und tierhaltenden Bauern und Bäuerinnen. Doch seitdem der Wolf in der Schweiz ausgerottet wurde, haben sich Zaunsysteme entwickelt, die einen effektiven Schutz vor Raubtierübergriffen sicherstellen können.

Eine vorangegangene Studie mit Gehegewölfen hat ergeben, dass Elektrozäune kaum überwunden werden, wenn auf bestimmte Eigenschaften geachtet wird. Auch andere Studien sprechen Elektrozäunen eine Effektivität im Herdenschutz zu. Doch welche Zaunsysteme werden auf den Schweizer Weiden genutzt? Wie beweisen sie sich im Feld? Wie funktioniert die Handhabung und was sind die größten Herausforderungen?

Zur Beantwortung dieser Fragen stützt sich die Arbeit auf drei Herangehensweisen: Analyse vom Zaunsystem von Rissvorfällen, Befragung von Experten zum Thema und drittens Betriebsbesichtigungen von Schafhaltenden in drei Wolf-beheimatenden Regionen der Schweiz, um Zaunsysteme, Probleme beim Zäunen und andere Eigenschaften, die das Rissrisiko erhöhen zu untersuchen.

Es gibt eine Anzahl von Gründen, die es schwierig macht die Effektivität von Zäunen wirklich statistisch korrekt zu messen. Die Ergebnisse dieser Studie deuten aber stark darauf hin, dass es möglich ist, mit Elektrozäunen Herden gut vor Wölfen zu schützen. Die Hypothesen werden bestätigt, dass vor allem eine ausreichende Stromspannung und das sorgfältige Aufstellen der Zäune die größten Herausforderungen sind.

2   Summary

After the repopulation of wolves in Switzerland, the country's strategy for coexistence with livestock management also includes killings of problem individuals. Problem wolves are defined as individuals who repeatedly have overcome livestock-protection measures. One of these livestock-protection measures are electric fences. The minimum requirements of protection fences seem to be a good compromise: for wolves to respect and feasible for farmers. Studies and experiences show, that wolves very rarely jump to overcome a fence. The most common way is to crawl or dig its way below the fence.

The goal of this study is to find out what fence types are used in the field, and how well they work for the farmer. What are the main difficulties using protection fences? Three approaches were used to answer these questions:

1. Livestock predations of the last 18 months were reviewed for the fence system and the possible strategy of the wolf to overcome it.

   Results show, that most predations happen in non-electrified or insufficiently electrified fences. Sometimes the fence was broken down, but it could not be recapitulated if the wolf actually overcame it. Sheep could have panicked because of the predator outside the fence and broken it down. Apart from the attacks of wolf individual M75, which evidently jumped over fences, only one of 40 predation events happened in well set-up, electric fence without obvious flaws. Careful assessment of the fence did not take place.

2. Eight experts were interviewed on the topic. All experts believe in electric fences as livestock protection, even though individuals can learn to jump over them. They stated that accurate fence setup is really important, and that wolves use the smallest flaws to get in.

3. 29 farms were visited to analyze structural differences in regions, ask farmers questions about their protection measures and assess fence qualities, and pasture characteristics important for the protectability. Three regions were chosen: the Calanda valley, with the oldest pack in Switzerland, the Augstbord region in Canton Wallis, which also is home to a pack and has experienced many predation events, and Einsiedeln in Canton Schwyz, which presents a region with only occasional wolf presence.

   In the Calanda region, all farmers use electric flock nets. Predation events are scarce on lowland pastures and farmers do not state that they have much extra work. In the Augstbord region, mesh wire fences are the most common fence type. Here also predations were very common. Einsiedeln shows, that most farmers do not start protection fencing, before serious damage is done in the region.

   Most common fence insufficiencies were non-electrification and accurate setup.

Protection capability of a fence depends on many variables and is therefore hard to measure. This study could not fully answer the question, but a clear tendency is visible.

3   Introduction

The image of the wolf jumping over a sheep fence is, for the most part, a myth. Although wolves are physically capable of jumping up to two meters, the large majority doesn't even think about leaving its feet.

This aversion against jumping makes fences as livestock protection feasible. But to prevent a wolf from his preference to crawl or dig below a fence is not the easiest task either.

Although this study often uses the word "**over**come" to say, that a wolf got behind a fence, it does **not** mean it actually jumped or climbed **over** it. Overcome can also mean it found a hole or a ditch, where the fence was not thoroughly closed or dug its way below.

To make coexistence of livestock management and wild wolves possible, Switzerland set thresholds for livestock-protection fences, which wolves naturally respect and are feasible for farmers. The very few individuals, which learn to overcome these thresholds and find livestock easy prey are so called problem individuals. There is the fear, that these individuals could teach others and make coexistence impractical and hopeless. Since it is impossible to break them of jumping, Switzerland made it possible to cull them. Those individuals are very few and can be removed without affecting reproduction rates.

This study wants to have a closer look at these thresholds. Which criteria are important to prevent wolves from entering? How difficult/feasible is it to build a fence, which meets the criteria? How do farmers put the findings into practice? What kind of fences are used and how are they managed?

To assess these questions, this study is based on three approaches: Reviewing old predation events and analyze them by fence type and condition. Second are expert interviews on their experiences with fences and the appendant problems, solutions and interdependencies with wildlife. The third approach is to visit farms in different regions of Switzerland and do a structural analysis about which fences are used, how they are maintained and how laborious the handling is. And most importantly: how efficient are they in protecting sheep from wolf predation?

4   Background

For understanding the relevance of the topic, this chapter summarizes the status quo of the wolf issue in Switzerland. Starting with a closer look at the species wolf, praxis and background of husbandry methods in Switzerland, it reviews the scientific state of knowledge on how wolves react to fences. After also quickly summarizing other protection methods, this chapter closes with explaining the political situation in Switzerland.

4.1   Wolf

The grey wolf (C*anis lupus)*, can be categorized in seven Eurasian (*Canis lupus lupus*) and five North American subspecies. Since there are large differences in size and appearance, this taxonomy remains controversial. The Swiss wolves originate from the Italian population (*C. l. italicus*), but since all European populations are growing, they might soon have contact to the northeastern and western populations ending in crossings (KORA).

Concerning the diet, wolves are very adaptable, but they mostly hunt ungulates. In Europe, wolves mainly hunt red deer, roe deer, chamois and wild boar. If not available, they can also prey on foxes, livestock, small rodents or feed on carrion. Fleeing animals can trigger the hunting instinct repeatedly, like sheep on an enclosed pasture. This is why wolves often kill more livestock than they can eat, what additionally heats up emotions of affected farmers (KORA).

The Eurasian wolves form packs of 4-7 animals usually consisting of two mating parents and their young. The young stay with the pack for 1-2 years before they usually leave to find a partner and a new territory. For that they can travel far distances of over 1000km. Although it is documented, that single foreign wolves can join another pack, it is a very rare exception. Single wolves usually stay out of a pack`s territory, which`s size varies around 200 km^2, depending on the amount of prey (KORA).

In most parts of Europe, the wolf was extinct during the 19th century. It only survived in Greece, Balkan and Baltic States, the Carpathians, Italy and on the Iberian Peninsula. Especially in Switzerland, hoofed game population were in dramatic lows due to excessive hunting and deforestation, which intensified the conflicts with farmers and hunters. Payments for wolf killings or even killing duties, organized hunts, more precise weapons and traps and the invention of strychnine made it possible to eradicate them throughout Switzerland. Throughout the 20th century there were sporadic visits from single wolves until in the 1990s wolf sightings and livestock killings became more frequent. It still took until 2012 for the first young to be born in the Calanda valley in the Canton of Sankt Gallen (KORA).

In 2017 42 individuals could be identified in Switzerland: Four packs (Calanda, Augstbord, Morobbia, Val d´Anniverse) of which three reproduced in 2017, three possible pairs and a number of single wolves, of which six were resident to a territory. 18 individuals have verifiably left Switzerland (KORA).

Even though wolf numbers are rising, and wolf territory expands, livestock damages are declining from 397 killed animals in 2016 to 235 in 2017. Damages happen almost exclusively on small ruminants (AGRIDEA 2018).

4.2   Landscape, Livestock and Fences

Even without mountain pastures, over 70% of Switzerland´s agricultural area is grassland and pastures. For compensating farmers working in difficult terrain, it is categorized in three classes: Talzone (valley zone), Hügelzone (hilly zone) and Bergzone (mountain zone), which is again divided in four classes (I-IV). The definition is a combination of elevation and topography. Compared to other species like cows and horses, small ruminants are more likely to be held in Hügel- and Bergzone. Only 30% of sheep and less than 20% of goats are held in Talzone. The number of sheep in Switzerland is declining from 417.000 individuals in 2012 to 311.000 in 2017, with an average of 40 sheep per farm. Around half of the sheep are sent to alpine pastures in the summer (Bundesamt für Statistik 2018).

Usually, sheep are held in the stable during the winter with an outside pen during the day. The outside pen is obligatory to a special Swiss label called RAUS (Regelmässiger Auslauf im Freien), under which 75,3% of Swiss livestock is produced (Schweizerfleisch).

In spring, they start the grazing period, starting with a couple of hours a day, to a full day and night grazing time. Most farms use fenced pastures in a rotational grazing system, since it is the system with least labor effort on the small Swiss land segments. Big unsegmented paddocks or herding without fences is in Switzerland almost exclusively done on alpine pastures. Grazing period depends on weather conditions and usually starts in late March and ends in November. If taken to alpine pastures, the grazing time on lowland pastures (LN) usually ranges around eight weeks in spring, as well as in the fall. Migrating herds during winter became quite rare in Switzerland. Still, there are about 30 shepherds left, which wander with their sheep on "winter pastures" (Hoffet & Mettler 2017).

Fences come in a variety of types. A common non-electric fence for sheep, is the mesh wire fence as seen in figure 1 on the right. It is about 1m high and needs wooden posts, to stay in place. It is very laborious to set it up, but very durable, can stay in place for many years and does not need much maintenance. Sheep accept it very well as a non-passable border (Faß 2018).

Figure 1: Mesh wire fence

Figure 2: Fix electric wire fence with wooden posts

Electric fences are either a number of wires between fence posts (wire fence), as seen in figure 2 or ready-to-use flock nets (figure 4). Wire fences can be fix, with thick (>1mm) high-tensile steel wire and usually wooden fence posts (figure 2), or mobile with multiple thin wires stranded in lightweight plastic ropes or tapes with posts out of metal, plastic (figure 3) or fiberglass. Plastic or fiberglass posts are lighter which makes mobile fencing possible.

Figure 3: Mobile electric wire fence with plastic posts

Figure 4: Electric flock net © AGRIDEA

The big disadvantage is, that they bend if there is tension on the wire. If not, all wires are strained evenly, which is hard to do, the less strained wire droops. Also, corners bend down, if strained strongly. Thick and non-weathered wires have a lower resistance, which means they conduct the electrons better, and fences are efficiently electrified farther away. Nets (as seen in figure 4) are usually 90cm high and 50m long, with integrated poles and can be stringed together. Higher nets exist, with heights of 1,05m up to 1,45m, but are a lot harder to move around. Set up is quick and easy and also bringing tension on the fence is easier. The big disadvantage of nets is that electricity is easily lead off, since the lowest electrified wire runs at 10cm. Also, since the interwoven wires are usually very thin, the electrical resistance is quite high. The more uneven the grounds, the more additional posts are needed, to keep the lowest wire at the right distance to the ground, and the more laborious are setup and maintenance (Faß 2018).

Electrification can come from the power network or a battery. Network-devices usually have a higher voltage and are a little more reliable, since batteries can run out. Electric fences need more maintenance, since tall plants can lead the voltage off and small faults can have a massive destructive effect on the whole fence. Best indicator for the electric power of a fence is the voltage. If battery is low, discharge high, a fault in the circuit or a high resistance of the fence material, it is shown in the lower voltage (Faß 2018).

The electric load an animal feels when touching the fence is depending on a number of variables, which are not shown by the voltage measurement. Most fences are connected to the positive pole of the energizer and the negative pole is grounded, which means that the circuit runs from the energizer to the fence, through the animal and the ground back to the energizer, as explained in figure 5. Inefficient grounding, dry ground or thick fur of the animal can lower the energy discharge massively (Faß 2018).


Figure 5: Electric circuit of a positively charged fence © Faß 2018

A possible solution is the installation of a grounded wire between the charged wires of the fence. When only touching the charged wire, the circuit closes again via the ground, but if the animal touches both, a charged and a grounded wire, at the same time, the circuit closes between the two touching points, as explained by figure 6. The high resistance of the ground is avoided, which makes the system especially interesting in dry regions or on stony grounds. Through this short cut, high discharges can run through the animal´s body. But the system has disadvantages: Because the resistance is so low, the current can be dangerous for children. The voltage easily adds up to over 12.000V, which is the permitted maximum of a freely assessable electric fence. This problem can be solved with a special interposed resistor (Faß 2018).
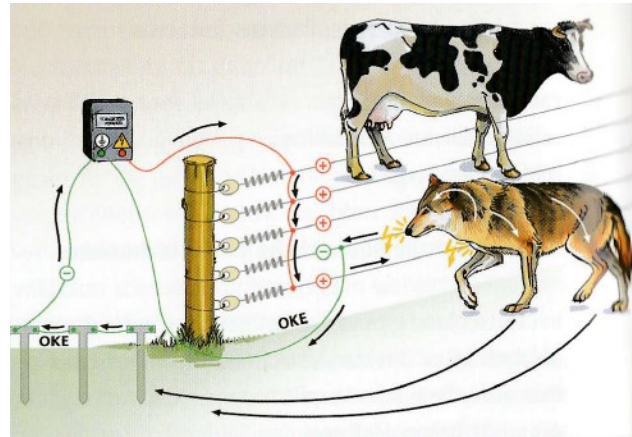
Figure 6: Electric fence with an alternated charged wire © Faß 2018

Figure 7: Alternately charged flock net

Flock nets are usually also charged positive. But they are also available with the possibility to have alternated wires: one charged and one grounded. This is done with plastic tubes, which keep the wires separate, as seen in figure 7 (Faß 2018).

The big problem with electric fences, is the risk they pose for wild animals. Deer, chamois, hedgehogs and other regularly fall victim to these borders. Nets seem to be more disastrous than wire fences, since it is easier to get tangled in and stuck. Mobile fences, which are regularly relocated are obviously a bigger problem, since deer are surprised by the fence. Visibility is a big problem. Orange, like most nets, is a signal color for humans, but most wild animals cannot distinguish well between red and green, which makes the fence in front of the green grass almost invisible for them. Nets in contrast colors like white or blue are better. Also, simple fladry material can support the fences visibility as seen in figure 8. Either way, for wildlife´s sake, fences which don't hold animals must be taken down immediately and never stand non-electrified (Faβ 2018).

Figure 8: Orange flock net enhanced with blue and white fladry for visibility

4.3   Wolf and Fence

Even though livestock protection is such a present and political important topic, scientific studies on how wolves behave around fences are very rare. Most consultative studies, codes of practice and also the political thresholds of fence-characteristics, are based on empirical values and common sense. The pressure on the fence is depending on many factors, as the presence of wolves and presence of prey, if single or in a pack, its experience with fences, vicinity to settlements and time of the day, to list just a few. With this huge number of factors influencing each other, changing fast and some almost impossible to measure, it is difficult to define a "wolf-proof" fence through empirical values. Experiments with kept wolves, which could erase those variables, however are criticized, since the animals might act differently than their wild relatives, since they are used to get their feed provided. Although both approaches have their disadvantages, they can give an overview and lead to best practice solutions on how the risk can be minimized. Since the wolf is an intelligent animal, individuals can learn how to overcome protection, and there is no risk-free solution.

Alberta Agriculture, Food and Rural Development (AAFRD) claim, that according to their study in the 1970s, electrical fencing can reduce sheep predation losses from coyotes by 90%. Five farms were chosen which have regularly had coyote predations. After equipping them with different kind of electric fencing, while paying special attention to a maximum ground distance of 15cm. In the following observation period of 1,5-2,5 grazing seasons, predations were eliminated or sharply reduced, while neighboring farms did not observe any decline (Dorrance & Bourne 1980). The same author published another fence efficiency study in 2002. There, the AAFRD set up a 24 months experiment on several trial sites. On these sites, farmers had experienced higher predations rates due to coyotes, than the provincial average of 1,5% of the total flock size. They tested several fence setups, the best result with 80% predation reduction showed a nine strand wire fence with alternating charged and grounded wire. The seven strand wire fence (almost same height) only reduced predation by 70%, and the electrified mesh wire (top and bottom) only by 65% (Bourne 2002).

Most farmers assume that wolves jump to overcome fences, since their shepherd dogs also do. But what is often forgotten is, that dogs have to learn to do so. To teach a dog to jump over fences, the wires should not be electrified. Also, the height of the fence needs to be lower first. The trainer should hold the wire down and give the dog a jumping command. Books about training shepherd dogs warn, that if hit by an electric shock before knowing how to overcome the fence, dogs might be too scared to ever try again (Chifflard & Sehner 2009).

Experiments with kept wolves however show, that they have a different approach. In one setup, done by AGRIDEA in 2016, two different packs were starved for a week before trying to lure them with food over different fence types. Although physically capable, no wolf jumped over a fence, even at a height of only 65cm. With wire heights of 35 and 80 cm, the standard cattle-fence, the animals always passed the fence below. With the lowest wire at 25cm no wolf passed under the fence. When investigating the fence, the animals mostly kept their head lower than shoulder height, what suggests, that they check for flaws mainly on the ground. After failed attempts to pass the fence, the frequency of investigating the fence declined, even though hunger increased (Hilfiker et al. 2016).

Also, the Wolfcenter Dörveden in Germany did experiments with wolves and fences. Detailed experimental set-ups and results were not available, but the tendency of the animals to dig below fences, rather than jump over it, showed several times (Faß 2018).

The study from Canada, which was already mentioned above, also claims that 80% of coyotes crawl under fences, 10-15% pass the fence between ground level and shoulder height of the coyote (it does not leave its feet) and that only less than 5 % actually jump over fences. This was discovered through direct observations and communication with other coyote experts (Bourne 2002).

Those findings lead to the political thresholds of a "wolf-proof" fence. Policy makers in Germany expect some kind of solution to keep the predator from going under the fence. This can be done with buried mesh wire (ca. 50cm), a laid-out mesh (ca. 1m) or an electric wire running a little outside the fence with a spacer (figure 9) and close to the ground. If electrified, 90cm high nets or 4-wire fences with the lowest running at 20cm are accepted. If not, electrified authorities usually demand heights of 1,2-1,4m (aid infodienst 2016).

Figure 9: Electric wire running outside the fence

The minimum standards in Switzerland, published by AGRIDEA in their brochure "Wolfschutzzäune auf Kleinviehweiden" (Wolf-protection-fences on flock pastures) differ, since electrification is obligatory, with a pulse energy of at least five Joule and a voltage of at least 3000 Volt all around the fence, to count as protective. Mesh wire fences must be electrified with two additional wires running outside, one at a maximum of 20cm and one above the fence as shown in figure 10 (AGRIDEA 2016).

There are no risk-free solutions. Wolves have even been killing inside stables (Lütke Holz 2018). But the big problem with data about overcome electrical fences is, that they are not checked for flaws. Elevated surroundings, which help the predator to jump in, uneven grounds, little water streams, or not electrified gates can make high and strong fences useless. Also, the electric discharge is usually not

Figure 10: Electrified mesh wire

tested. Tall grass, insufficient grounding, weathered material or battery problems can lower the discharge energy to a level hardly perceptible for the wolf. Since the political thresholds are met, the attack is recorded as an overcome "wolf-proof" fence. For measuring fence effectiveness, this data is therefore not useful. Often, after an attack with electric nets, the fence is laying on the ground. Possible, that it lay there before the event or that the sheep took it down when stressed by the presence of the predator. Also, the correct setup cannot be checked afterwards. Either way, it is recorded as an attack in an electric fence, even if it is not sure if the wolf actually overcame the fence. And still, it cannot be excluded, that the wolf crawled or dug it´s way under the fence.

This problem is also discussed in a study about fence efficiency from the Moss-Våler territory Norway in 2002. Although they had some attacks in improved fence systems, livestock predation was over five times higher in non-electrified pastures. When checking the improved fences on their condition, it showed that almost every fence showed deviations from the given standard. The biggest problem was the lowest wire, which almost always exceeded the maximum height of 20cm distance from the ground (Wam et al. 2004).

A special case in Switzerland is Wolf M75. It has learned to jump over fences. As figure 11 shows, the attack series started in the Canton Tessin, where most fences are not electrified. It may have learned there, because of the missing negative imprint, how to climb or jump over a fence. It seemed, that it specialized on livestock. It killed over 40 sheep in 7 attacks between January 21st and March 12th, 2018, as mapped. The wolf was soon labeled "schadensstiftender Wolf" (damage causing wolf), as defined in the Swiss Game Law (see chapter 4.5.1). Several Cantons issued the authorization for killing (Amt für Natur, Jagd und Fischerei des Kanton St. Gallen. Verfügung vom 25. April 2017).

The case shows, that wolves can learn to jump over fences, and when they do so, can specialize on livestock, and that there is no risk-free solution.
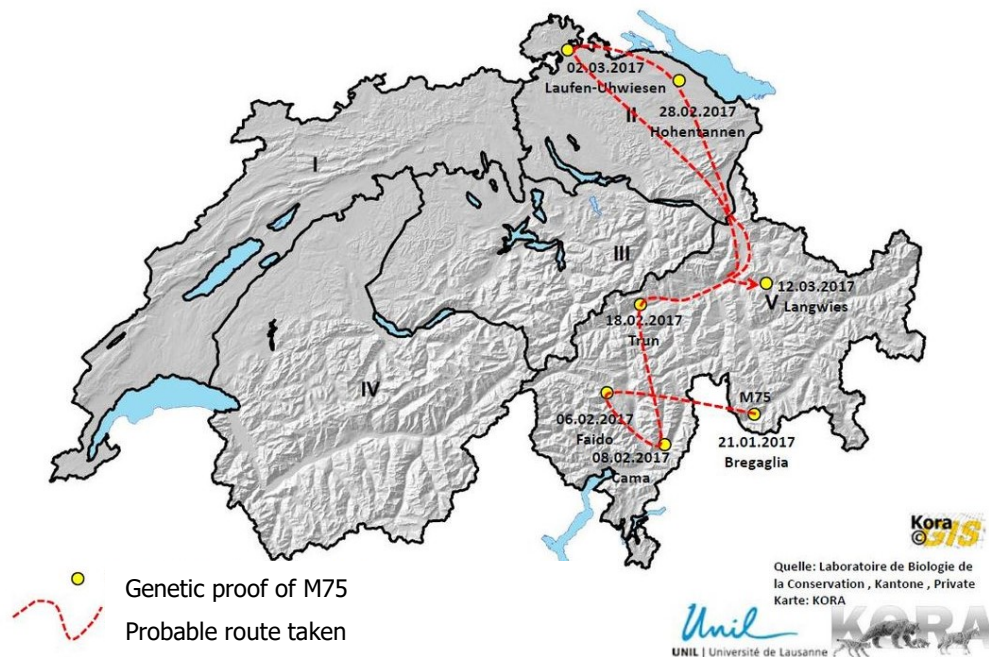

Figure 11: Attacks and probable route of problem individual M75 © KORA

The experiences in Switzerland have shown, that the 90cm heights seem sufficient to protect livestock from wolves, in most cases. Non-electric fences or with intermittent electrification have no protection effect (AGRIDEA 2018).

4.4   Other Livestock-Protection Methods

Many farmers use other or additional protection for their livestock. There are technical solutions and guardian animals. Since they lead to interdependencies with fences, they are listed and explained shortly in the following.

A much-used method is the night pen, as shown in figure 12, where all animals are gathered together during the night, when wolves are most active. The pen can be a fence or a stable. Fences are usually electrified and/or in combination with livestock guardian dogs. This method can be a very safe and easy solution, especially for small herd-sizes. On alpine pastures it is the safest and sometimes (If guardian animals are not allowed) the only solution. On these alpine pastures this is of course only possible when a herdsman is present to gather the flock, which is often not the case in small-scale structures (AGRIDEA).

Figure 12: Night pen on alpine pasture © AGRIDEA

Disadvantages of night pens are the extra work, shorter grazing times and that contagious diseases can spread more easily, which is a bigger problem with larger herds (Cugno & Lombardi 2004).

Figure 13: Fox Light

Fox Lights, as seen in figure 13, are blinking devices, which are supposed to scare wolves of, since they either don't know it or connect it with human settlements. The same applies to Alarm Guards which work with all different kind of sounds in random intervals. Possible sounds are sirens, people yelling, dogs barking or honks. Big advantages are the relatively easy handling, low costs and little maintenance. Disadvantages are that they are only repellents. Since predators can get used to it, they are mostly recommended as a temporary solution. Both can also be very annoying to people living close by (AGRIDEA).

Guardian animals can be a very effective protection method, but the success is again depending on a number of factors. Most important are the performance and experience of the individual guarding animal, topography and amount of cover, number of sheep per guardian animal, size of the grazing area and the flocking behavior of the sheep, to just name a few (AGRIDEA).

Figure 14: Livestock guardian dogs on the watch © AGRIDEA

The most common guardian animal are special dog breeds, which live with the sheep year round and have strong protection instincts. They are a very effective and efficient solution for areas which are difficult to fence, like vast and steep alpine pastures, as seen on picture 14 on the left. They work well in free herding, since they stay with the sheep. When used in fenced pastures, the control and maintenance of the fences can be reduced. Big flock sizes are not a problem, if they are kept together and don't scatter. But livestock guardian dogs have their disadvantages: There can be conflicts with tourists on alpine pastures, where they run free and might perceive the approaching person as a threat. On the farm, there might be conflicts with neighbors because of the noise. Farmers must be trained and willing to deal with these special dogs. In the winter, when the sheep are usually in the stable, dogs can get bored and start unwanted behavior, like playing with the newborn lambs. Then they need extra attention from the farmer (AGRIDEA).

Keeping lamas or donkeys, even though they can become prey themselves, can have a good protection benefit. They have a natural aggression against canines and other intruders. The offensive behavior scares the predators off, since they are used to fleeing prey. The advantages compared to guardian dogs, are that they are not aggressive towards humans and that they are herbivores and just be kept with the sheep without much special treatment. Disadvantage is, that they are only useful in smaller groups of sheep. Bigger groups would need more guardian animals, and donkeys and lamas then form their own herds and the protection of the sheep declines (AGRIDEA 2015).

Aside from electrification of fences, only night pens on alpine pastures and livestock guardian dogs are financially supported in Switzerland. Fox Lights, Alarm Guards, lamas and donkeys are not recognized as efficient protection measure and therefore not subsidized, as further explained in chapter 4.5.3.

4.5   Situation in Switzerland

This chapter summarizes the political status quo in Switzerland regarding the protection status and legal boundaries, jurisdictions and compensation schemes for farmers.

4.5.1   Protection Status

The wolf management concept in Switzerland is mainly based on two judicial fundamentals. The Berne Convention and the Swiss Game Law.

The Berne Convention on the Conservation of European Wildlife and Natural Habitats is a legal instrument in Europe and some African countries, which came into force in 1982. Additionally to the conservation of all wild flora and fauna and their habitats, the countries

should particularly protect endangered and vulnerable species, including migratory species. According to this, wolf and bear are listed in Annex II as strictly protected species, lynx as protected species in Switzerland (KORA).

The Swiss Game Law (Eidgenössische Jagdverordnung) defines the framework of how to handle protected large predators. It is possible for the state, to clear wolves for killing under certain conditions. The thresholds for so-called "schadenstiftende Wölfe" (damage causing wolves) are set to either 35 small ruminants in four months or 25 in one month. If the individual caused damages in the year before, 15 killed animals are enough for clearance. Those damages have to be in protected herds though. Killings of unprotected animals do not count. If at some point bigger livestock like cows and horses were attacked, the threshold can be lowered. The killing authorization for the wolf is limited to 60 days. The Law was revised in 2015 by the "Motion Engler" to meet concerns of the Swiss population towards the large predators. It is now possible to not only cull problem individuals but also for populational limitations (AGRIDEA).

BAFU has the statutory order to implement the Berne Convention directive and the provisions of the Swiss Game Law. For that, concepts are developed as an enforcement aid for the Cantonal authorities. These concepts lead the way to a compromise between species protection and livestock management. Fence thresholds can only be sustained, if wolves abide these borders. Since it is practically impossible to break the wolf´s habit, the admission of culling of problem individuals is therefore essential (BAFU).

4.5.2 Political Organization

The main organization of all wolf-related issues is done by BAFU (Bundesamt für Umwelt). Cooperating closely with all stakeholder, it developed a concept for the national wolf management, the first version published in 2004. It clarifies definitions, objectives, judicial support, rights and duties of all involved offices and executors. The main issues of the studies are monitoring, prevention of damage and dangerous situations, the promotion of livestock-protection measures, reporting of damages and threats, compensation schemes, definition of problem wolves, and what to do with them (BAFU 2016). A revision of the current management concept is in progress.

AGRIDEA is appointed by the BAFU as an independent office for all issues concerning coordination of livestock protection. The livestock-protection department of AGRIDEA is divided in the two offices technical livestock protection and livestock guardian dogs. It does scientific research and produces information material, like brochures and movies, for farmers, livestock-protection counselors, tourists and other stakeholder. It organizes information events, counselor meetings, and shepherd apprenticeships. AGRIDEA is also responsible for processing applications for protection compensation. Especially concerning livestock guardian dogs, AGRIDEA organizes dog tests (Einsatzbereitschaftsüberprüfung) and their official registration as livestock guardian dog, the obligatory guardian dog courses for farmers and demand and supply of dogs with breeding clubs and the placement of dogs (AGRIDEA).

Most Cantons have livestock-protection counselors. Usually those offices are established, when wolf damages become a problem in the region. Their purpose is to directly interact with the farmers. They usually have an agricultural background to understand the farmers' point of view concerning protection measures and to make communication easier. They

analyze the structure of the farm to find the best protection solution and inform about compensation possibilities. Usually they are contacted by the farmer, sometimes they act actively after they are informed about attack by the gamekeeper. Nevertheless, some farmers do not take advantage of the consolation. The cantonal counselors work together with the local gamekeepers and AGRIDEA (BAFU 2017).

The gamekeepers in Switzerland are public officials. They are the first ones, farmers should inform, when having a possible wolf attack. They record the damage, analyze the situation, and take DNA-samples. Gamekeepers are not trained in terms of livestock protection, they don't check the fence for flaws for example or analyze how the attack happened. But still, since they are on site, they are the ones to decide if the attack happened in a "protected" herd or not. Additionally to that, gamekeepers are also appointed to check and record wolf sightings, tracks or other evidence and forward them to KORA (BAFU 2017).

KORA – Coordinated Scientific Research Projects on the Protection and Management of Predators in Switzerland (Koordinierte Forschungsprojekte zur Erhaltung und zum Management der Raubtiere in der Schweiz) – is an in-state foundation, which is appointed by the BAFU for monitoring carnivores in Switzerland. For some projects they are also supported by other foundations for nature protection and science. They gather information about number of individuals, the dispersal, and reproduction. Evidence is categorized in three classes: First there are "Hard facts" such as dead animals, observations verified with photos, captured animals and genetic analysis. Second are verified reports from trained people, such as tracks or predations of livestock and wild animals. The third category are killings, tracks and scats that are not verified, and signs that are not verifiable such as animal sounds or unverified observations. Additionally to monitoring, KORA does research about carnivores in our modern cultivated landscape and their interactions with other animals and humans. Information work for public offices and other stakeholder is also part of its work. KORA works closely together with the cantonal hunting administrations and gamekeepers (KORA).

Additionally to those official groups, also non-governmental organizations (NGOs) and initiatives are active in the political discussion and practical execution. Pro Natura, the oldest nature protection organization in Switzerland, is actively supporting livestock-protection measures, to make a coexistence of predators and grazing livestock possible (Pro Natura). With the return of the wolf, supporters gathered in the society CH-Wolf, which also supports livestock-protection methods, especially on alpine pastures and does public information events (CH-Wolf).
A political group is the society "Lebensraum Schweiz ohne Grossraubtiere" (Switzerland without large predators), which wants to eliminate large predators in Switzerland, stating that there is no space for them in our cultural landscape (Lebensraum Schweiz ohne Grossraubtiere).

4.5.3   Compensation Schemes

In Switzerland all livestock losses and treatment of injuries due to wolf attacks are fully compensated (80% by BAFU, 20% by Cantons), no matter of the protection status. Compensation ranges between 200 and 2000 CHF, with an average of ca. 400 CHF/sheep, depending on its value. The value is usually determined by the gamekeeper and depends on the age of the animal and its pedigree value. The protection status of the herd is only

necessary for recording the individual wolf´s behavior for possible killing approvals (Eidgenössische Jagdverordnung).

In terms of livestock protection there is a variety of subsidies.

The standard 90cm electric nets, which count as official protection measure, are usually not specifically subsidized as livestock protection, since their costs are already integrated in the standard compensation scheme for all Swiss farmers. If farmers want to electrify their non-electric mesh-fences, which are already in place, they can apply for 0,7 CHF per meter. Also for special nets, with heights of over 90cm, this amount is paid. If the pasture is located in Bergzone, farmers can apply for additional 0,3 CHF/m for the extra labor costs each year. If the livestock-protection counselor considers it reasonable, additional labor costs can also be paid for farmers in Hügel- or Talzone (BAFU 2017).

High nets (minimum 1,05m), which are especially purchased for night pens on alpine pastures, are also subsidized with 80% of the custom value. The yearly expenses of guardian dogs are also subsidized, but not the husbandry of lamas or donkeys. Some Cantons have special funding for alternative protections measures, though (BAFU 2017).

Blue and white warning tape, which can be tied to the fences to enhance visibility is available for free at AGRIDEA (AGRIDEA).

The amount of compensation for livestock protection (guardian dogs excluded) is capped at 5000 CHF in 5 years per farm on lowland pastures and 2500 CHF for alpine pastures (BAFU 2017).

In 2017, around 40 applications for subsidization of fences and fence enhancement were received, adding up to 95.738 CHF, which is about 20.000 CHF less than the year before. More than half of that amount was demanded for fences on lowland pastures (LN-Flächen) (AGRIDEA 2018). The number of applications is relatively low, regarding the number of sheep farmers in Switzerland (8.364 in 2016, Bundesamt für Statistik). This could have several reasons: The standard 90cm nets are sufficient, farmers don't know or don't believe in the efficiency of fences as livestock protection, fence enhancements are too laborious, or farmers don't want to invest before damage is done. Last is confirmed by Andreas Schiess, who is responsible for the subsidy payments at AGRIDEA. According to him, most applications come from regions, which had predation events shortly before.

5   Materials and Methods

This study is based on three different approaches to clarify the efficiency of fences as a livestock-protection method: attack analysis, expert interviews and farm visits.

5.1   Attack Analysis

In a first step already happened predation attacks were analyzed.

The table of reported wolf attacks came from KORA. It is not attached in the appendix for privacy protection. The table was searched for events without livestock guardian dogs, not on alpine pastures and which happened between January 1st, 2017 and June 30th, 2018. Older attacks were left out, since the gamekeepers need to remember details. Attacks on alpine pastures were excluded, since the situations there are usually very complex and most rarely connected to fences. Livestock guardian dogs were excluded, since the maintenance of fences usually plays a minor role then. The gamekeepers who were on site to report the damage were contacted and the cases reviewed.

Questions about the attacks were:

1. What kind of fence systems was used?

If the fence system was not electrified, no further specifications were needed, since it can easily be overcome. If electrified however, other questions followed:

2. Was the fence fully intact? Was it checked for flaws?
3. Were animals outside the fence? Was the damage outside the fence?
4. How do you think, did the attack happen? Did the wolf overcome the fence? If yes, how?

A total of 257 killed farm animals were reported in approximately 59 attacks by wolves in the reviewed 18 months. The number of attacks is not always clear, since some carcasses are found later. Out of these, only 40 attacks happened on lowland pastures and without livestock guardian dogs. 38 of those cases could be reviewed. Two gamekeepers could not be contacted.

5.2   Expert Interviews

There are many rumors about wolf behavior and ecological changes initiated by the presence of the wolves. Since the number of wolves is relatively low, and quickly changing, there is yet no valuable scientific data about those issues. Even though they cannot be handled like scientific data, experiences and assumptions from people who are dealing with the topic for several years, can be very valuable. Gathering and analyzing them is also important for optimizing the third approach "farms visits".

The region in Switzerland with the longest experience with wolves is the Calanda valley, running through the Cantons Graubünden and Sankt Gallen. It is also a very stable territory, since the alpha-wolves have not changed since the formation of the pack and its size is relatively constant. Therefore, four experts have been chosen from this region, all of them are in office since the settlement of the pack.:

Sven Baumgartner is livestock-protection counselors of St. Gallen. He is master craftsman in agriculture and teaches among others small ruminant husbandry at the agricultural center St. Gallen (Landwirtschaftzentrum St. Gallen).

Jan Boner is livestock-protection counselor in the Canton Graubünden at the Plantahof in Landquart, which is an agricultural education- and counseling center. There he also teaches about working dogs. As a member of the association swiss livestock guardian dogs, he is involved in regular examination of livestock guardian dogs. Additionally, he is also responsible for an alp.

Rolf Wildhaber is gamekeeper in the Canton St. Gallen since 2005. The former mason is also range tenant and active hunter and since many years active in hunter education.

Claudio Spadin is gamekeeper in the Canton Graubünden since 2000. He was the first one to see one of the wolves in 2011 and has witnessed all seven reproductions of the pack. He is very present in the media concerning the Calanda-Pack.

As a representative of the Canton Wallis/Valais, Martin Brantschen, who is longest gamekeeper in office in the Canton, was interviewed to the situation in his territory.

Ralph Manz is responsible for the wolf-monitoring at KORA since 2012. He has the Swiss-wide overview of all documentations concerning large predators concerning population, development and predations. He is a former district forester and was for ten years manager of the WWF in Canton Wallis.

André Klingenberger is a forestry engineer and official in charge for wolf management in Saxony´s state forest and employed by the Biosphärenreservat Oberlausitzer Heide- u. Teichlandschaft. He is responsible for the counseling of farmers concerning livestock protection and monitoring wolf actions in Saxony. In 2017.

Ullrich Wotschikowsky is among others hunter, forester and wildlife biologist in Germany. Since the repopulation of the wolf, he gathers scientific and fact-based information and experiences on his website called "Wolfsite - Forum Isegrim". He is no fence specialist, as he remarks in the interview, but gathered a lot of information through discussions and accounts with other stakeholder.

The first five questions are about their experiences with fences:

1. How is your impression about the efficiency of electric fences regarding livestock protection?
2. In your view, what are the most important and the biggest weak points regarding electric fences?
3. What are your experiences about doubts about electric fences as livestock protection? (Labor, material, seasons)
4. When do fences pose a risk for wildlife and how could that be prevented?
5. What is your impression on how wolves behave around fences? Have you witnessed or experienced any situation?

The 6th question is about the differences of packs and single wolves. This question arose when taking the question to a future level, when pack-territories might be more common.

6. Do you have the impression, that there are more or less livestock damages when a pack is present versus a single wolf? How do you explain this?

Questions 7 and 8 were exclusively for the gamekeepers and Ralph Manz. They are added, since higher presence of prey lowers the pressure on livestock:

7. Do you have the impression that wildlife population changed since the presence of the pack? How do you explain this?
8. Do you have the impression that wildlife behavior changed since the presence of the pack? How do you explain this?

The interviews were all done in German and are freely translated into English. Most interviewees answered the questions via email some orally via telephone.

5.3   Farm Visits

The chapter farm visits can be subdivided in three categories: The structural analysis of the three regions, the questionnaire and the analysis of fence qualities.

5.3.1   Structural Analysis

Regions for the farm visits were chosen with a set of criteria. They should be quite different regarding husbandry methods and wolf experience for possible comparison. Figure 15 below, shows wolf evidences of 2017 in the explained categories, K1: hard facts, K2: verified reports and K3: not verified reports, and the chosen regions.
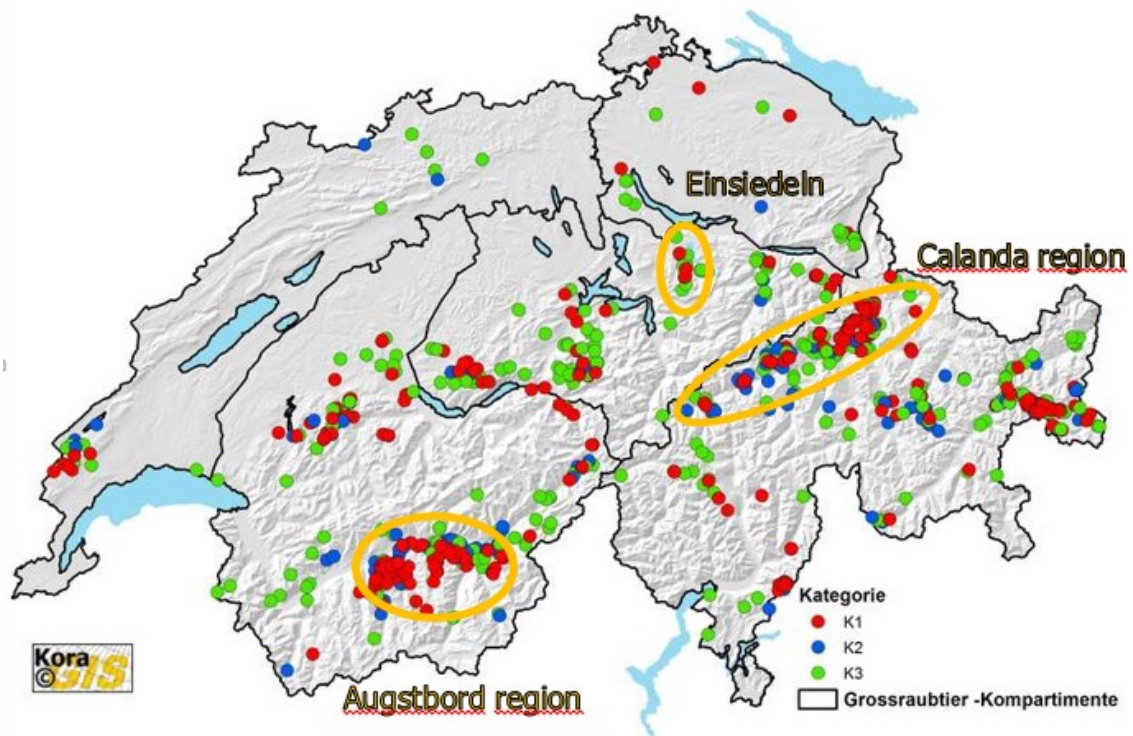
Figure 15: Wolf evidences in Switzerland in 2017 © KORA, adjoined the rough mapping of the visited regions

The Calanda valley, mostly in Canton St. Gallen, was chosen, because even though there has been a constant wolf pressure for years now, livestock damages were always quite low.

The Augstbord-region in Canton Valais also has a resident wolf pack but coming with a number of losses. After having severe losses on alpine pastures in 2014 and 2015, many farmers kept their flocks at home on lowland pastures in 2016. The effect was, that the wolves attacked also in the valley.

The region of Einsiedeln is in the Canton Schwyz. Altogether they had three attacks on livestock: Two in 2014 and one in 2017. Two of them were single males traveling through the region. One not identified, but probably a lynx attack, considering the attack scheme. One single wolf, M52, seems to be resident for some time now, but hasn't done any damage on livestock yet. The region of Einsiedeln was chosen, since it is interesting as an area where wolf-pressure is still low or irregular.

Although structural agriculture-data of the Cantons does not thoroughly represent the regions, it does show some significant differences. "Sheep farms" are here defined as farms with sheep. It is possible, that sheep play a minor role in the farm´s production.
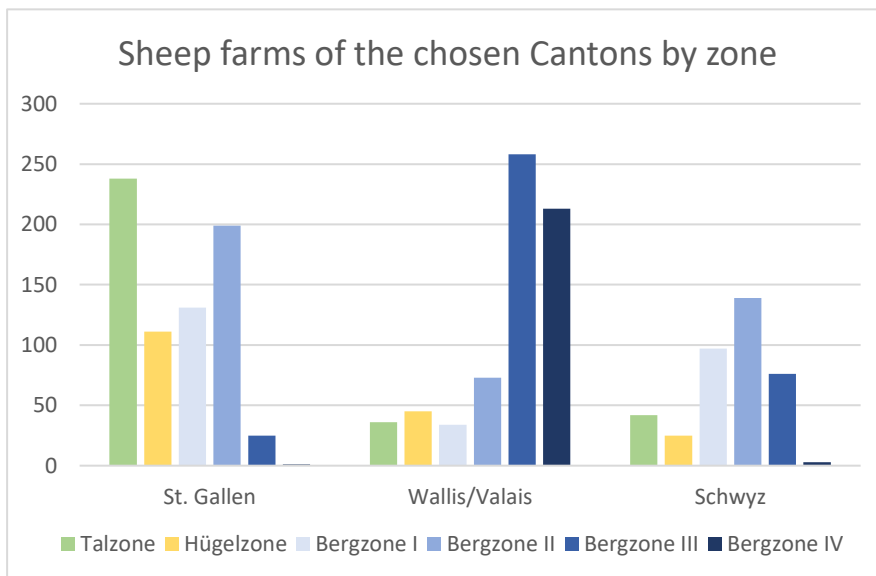
Figure 16: Sheep farms of the chosen Cantons by zone in 2017

Figure 16 on the left shows the number of sheep farms in the associated working zones of the year 2017. Sheep farms in St. Gallen and Schwyz mostly work in Bergzone II and below, while sheep farms in Wallis/Valais mostly work in the classes Bergzone III and IV.

The Calanda-Valley is in the mountainous part of St. Gallen, so the Talzone-farmer-share of the region is significantly lower, but still, only 25 sheep farms work in Bergzone III. Wallis' sheep-pastures are therefore higher and/or steeper than the other two.

The average number of sheep per farmer is ranging between 52 in St. Gallen and 56 in Wallis/Valais and therefore not very differing. Remarkable though is the distribution of full- and part-time famers. The share of full-time farmers is significantly higher in St. Gallen (70%) and Schwyz (67%) than in the Canton Wallis/Valais (35%).
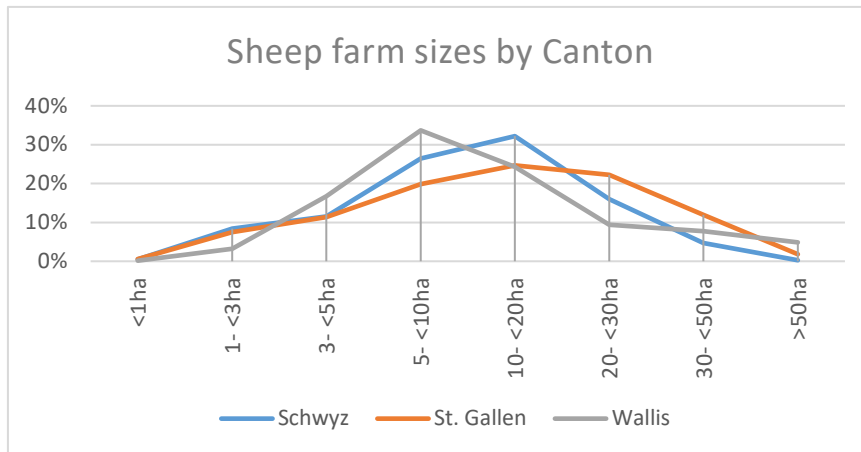
Differences of the Cantons also show in the distribution of sheep farm sizes, as plotted in figure 17 on the left. St. Gallen has a higher share of farms bigger than 20ha, while in Canton Wallis, the biggest share are farmers with 5-10ha (Bundesamt für Statistik).

Figure 17: Sheep farm sizes by Canton in 2017

The criteria for choosing the farm within the region were the willingness of the farmer, and the farm´s representability of the region. Farms with livestock guardian dogs were mostly left out, since they would distort the results. This led to the fact, that most visited farms were quite small, since larger farms usually have livestock guardian dogs. At first it was planned to visit ten farms per region. But since some farmers were not available or willing, it changed to 13 farms in the Augstbord-region and eight in the Calanda-valley and around Einsiedeln respectively, adding up to 29 visited farms.

5.3.2   Questionnaire

The development of the questionnaire for the farm visits was done according to criteria, which are explained in the following:

The first part of the questionnaire gathers information about the farm, how many and what kind of animals it holds, how many days they are usually on lowland pastures and if they are sent to alpine pastures or not. Next is the record of the fence structure. What fences are in use, in which portions and how big is the share of fully electrified pastures as defined by the AGRIDEA brochure. The rest of the first chapter (voltage, flaws, visibility) of the questionnaire was later dropped, since it is included in the last chapter about the fence quality of different pastures. Second chapter records any additional livestock-protection methods like blinking devices or guardian dogs. Chapter three is about fence and animal checking. How often do farmers check the fence electricity and flaws? What is their maintenance strategy and how demanding is the additional work (points from 0-4)? Do animals break out regularly and is wildlife a problem in their fencing system? The next chapter reports any attacks they know, either on their or their neighbors land (10km radius) or the alpine pastures and details about these attacks. The last chapter reports the changes they made to prevent wolf attacks. Did they change the fencing system, its maintenance or add any other livestock-protection measure? How costly and laborious were those changes? Did they have livestock-protection counseling? Do they know about AGRIDEA´s definitions of a "wolf-proof" fence and fencing technology in general? Last question is about if, what kind and how much financial support of livestock-protection measures they received.

5.3.3   Fence and Pasture Assessment

The assessment of fence quality and pasture protectability was done, if possible, on the three main pastures of each farm. Most farms only had two main pastures, which lead at the end to 46 assessed fences/pastures. The assessment was done with a coding system. Both fence quality and protectability were captured with five categories with four possible points each, adding up to 20 possible points.

The categories for fence quality were taken from AGRIDEA´s definition of a "wolf-proof" fence: fence system (or electrification), voltage, condition (or number of flaws), visibility and distance between the lowest charged wire and the ground. Depending on the distribution of points, 15 can be enough to count as "wolf-proof". Table 1 below summarizes the used coding system.

Table 1: Coding system for the assessment of fence quality

Fence quality

Points	1	2	3	4
System	Very bad, hardly electrified	Some non-electrified fractions	Basic protection	Additional protection
Voltage	None	<3000V	≥3000V	>5000V
Condition	Many (>5)	several (2-5)	Hardly any (1-2)	No flaws
Visibility	Very bad, mostly ingrown	Bad, no contrast colors or fladry, partly ingrown	Standard fence, some contrast colors or fladry	Very well, many contrast colors or fladry
Distance to the ground	> 30cm	> 20cm	< 20 cm	< 10cm

The scoring system has some weak points. Voltage, condition, visibility and distance to ground only makes sense for electrified fences. If a mesh wire fence is not tied the ground, for example, there is basically no protection at all. Also, the number of flaws is not interesting in a mesh wire pasture. Non-electrified fences usually scored 1 in system and voltage and 2 in condition and distance to ground, if not nicely dug in the ground.

For the protectability analysis, categories were taken partly from a study in northern Italy, where they analyzed the relation of wolf attacks and mountain pasture characteristics. They found out, that the probability of a wolf attacks increases with the complexity of the pasture shape, the amount of shrub cover and the closeness of forests (Dondina et al. 2014). Closeness to vegetative cover was also proven to increase the risk of livestock depredation by a study from Canada (Muhly et al. 2004). Additionally to that, ground characteristics were also included, since it is difficult to ground an electric fence in shallow

and dry soil. Steepness of the pasture was also accounted, since it makes maintenance and control much harder. Table 2 summarizes the used coding system.

Table 2: Coding system for the assessment of pasture protectability

Protectability

Points	1	2	3	4
Steepness	mostly > 45°	mostly 30°- 45°	mostly < 30°	Mostly even
Scrub encroachment	>30% of the pasture	10-30% of the pasture	<10% of the pasture	clear
Complexity of pasture shape	Impossible to see most pasture	Not really clear	Mostly free sight	Free sight
Forest border	Enclosed in the pasture	At the fence	<50m	Open field
Ground	Stony and dry	Dry and medium depth	Medium depth but moist	Deep and moist

At the end, the status of livestock-protection fencing-knowledge of the farmer was graded from 1-6, with 1 having no knowledge about it and 6 being very well informed. This was done through personal observation of the interviewer, since farmers are not capable of grading themselves. Also, the protection status of the farm was given an overall grade from 1-6 with 1 being not protected to 6 being very well protected. This does not only relate to the quality of the fence: This grade shows, that if farmers chose a different protection solution for their farm situation, they can have low fence quality grades but still be well protected against livestock damages.

6   Results

The following chapter reviews the results of the three approaches: the attack analysis, the expert interviews and the farm visits.

6.1   Attack Analysis

40 attacks happened on lowland pastures and without livestock guardian dogs between January 1st, 2017 and June 30th, 2018.

Gamekeepers are the first ones on site after the farmer. Their job is to assess the game damage for the compensation and not the fence type. Still, most of them remembered well the used fence system, but correct installation, if insufficiencies were not too obvious, however was hardly ever checked. Voltage was never measured, and the fences were not checked for flaws, or searched for crawling or digging signs. This means, that even in the two cases of "Electric fence meeting protection criteria and fully intact", it is not given that the wolf actually jumped over the fence.

It is also important to remark, that the gamekeepers are called, after the farmer discovered the attack. This means, that the farmer has the time to change the fence setup. This doesn't have to be an intentional cover-up: Broken down fences are usually repaired right away and fled animals recollected. If a farmer noticed that the battery of the energizer was low, it will probably soon be replaced. Figure 18 below, summarizes the used fence systems of the attacks.
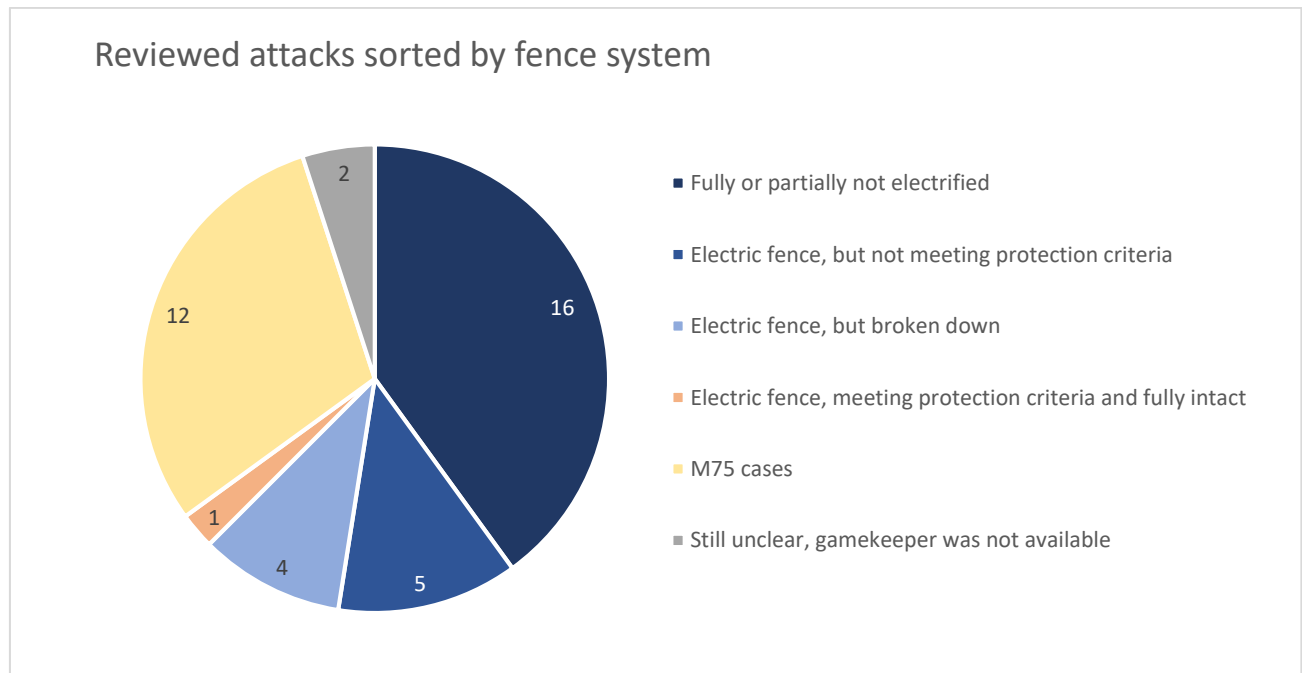
Figure 18: Reviewed attacks sorted by fence system

What was also interesting, when reviewing the cases with the gamekeepers, are the different fence systems, which do not meet the criteria. In one of those five cases, the electricity of the flock net was discharged by heavy snow fall. Two cases in the Canton Wallis/Valais only had an electric wire on top of the mesh wire, but no protection on the ground. The other two had wire fences with less than four wires, the height of the lowest wire was not measured.

Electric fences that were broken down, are difficult to assess. In three cases, the game-keepers think, that the wolf got in the fence and the panicking sheep broke the fence down. In the remaining two, the gamekeepers are quite sure, that the wolf did not over-come the fence, but that the sheep broke out before. One reported, that it was obvious that the herd was very nervous inside the fence, because the ground was very muddy. Even though the ground would have shown it nicely, he did not find any wolf traces inside. The dead sheep were outside. He believes, that the presence of the wolf caused the panic. But even if the cadavers weren't outside, this scenario is quite realistic, because the wolf could have killed remaining sheep inside by entering through the broken fence.

Anyway, broken fences could also have been broken before the attack and the quality setup of the fence cannot be assessed.

The cases of individual M75 are listed separately, if electrified or not, since his ability to jump over well set up fences is verified. The first evidence of it being able to jump over fences were traces in the snow in February 2017. He has also managed to jump over a wooden door in a stable and kill inside. One attack happened in a pasture which was secured with a 1,6m high reinforced grid. But the wooden door was 30cm of the ground, where the wolf could get in and out. Of one of the three attacks in Graubünden which M75 could not be accounted for, the DNA-sample could not be read properly. Here, the wolf most probable used a 1,5m high rock ledge, to jump inside the fence. It is probable though, that it was also M75, since it happened four days after and very close to another attack of his.

Only in one case, a wolf overcame a well set up electric fence. Maybe this individual (or maybe several. DNA-sample could not be read properly) has also learned to jump. Maybe there were inefficiencies in the setup, the gamekeeper didn't notice, or which were cor-rected before he arrived. The gamekeeper stated, that the pasture was on a slope, and from above, the wolf had a favorable jumping position and less than 90cm to jump. But again, the possible under-crawling cannot be ruled out.

When M75-, and non-clarified cases are excluded, over 80% of livestock predations hap-pened in non- or insufficiently electrified pastures. Around 15% cannot be assessed be-cause fences were broken down and the intact electric fence represents less than 4%. For a statistical assessment, it would be necessary to also have an overall distribution of which fence types are in use. If for example 80% of all used fences are non- or insufficiently electrified and only 4% were well set up, the probability of a wolf attack would not be lower in a "protection"-fence.

As an addition to the structural analysis done with the farm visits, figure 19 shows the Cantonal distribution and the used fence types of the attacked pastures. It shows, as later also the structural analysis of the regions the dominance of mesh wire fences in the Canton Wallis/Valais.

Reviewed attacks sorted by Canton and fence criteria

Legend:
- Fully or partially not electrified
- Electric fence, but not meeting protection criteria
- Electric fence, but broken down
- Electric fence, meeting protection criteria and fully intact
- M75 cases
- Unclear, gamekeeper was not available
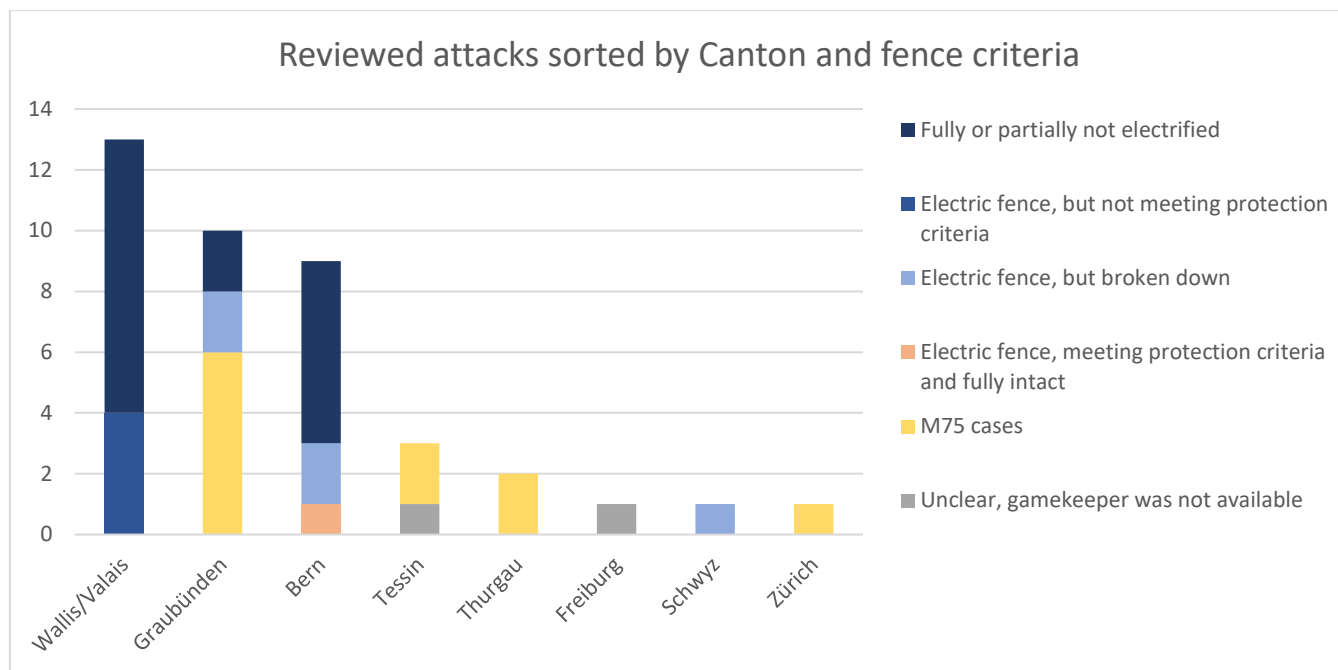
Figure 19: Reviewed attacks sorted by Canton and fence criteria

6.2 Expert Interviews

The gamekeeper in Graubünden Claudio Spadin and the local livestock-protection counselor Jan Boner answered the questions together. Common results of the interviews and interesting accounts are stated under the related questions. Full interviews are attached in the appendix.

1. *How is your impression about the efficiency of electric fences regarding livestock protection?*

Most experts believe in the efficiency of electric fences, if they are correctly installed. Only Ralph Manz stated, that he has the impression that generally protected herds experience less predation, but that he cannot break it down to only electric fences.

Rolf Wildhaber also told the story of a goat farmer, which uses a three-wire electric fence with over 4000V and the lowest wire running between 15 and 20cm. Mr. Wildhaber has photo traps installed very close to that pasture and has repeatedly caught wolves on camera. The goat farmer hasn't had any predation losses until now, even though close neighbor farms had.

An interesting input came from André Klingenberger. He said, that until a couple years ago electric fences protected well against wolves. Then, cases increased, where it seemed probable, that wolves jumped over the fence. Farmers were then advised to enhance fences with an additional polytape above, which helped first. But these special constructions have already been overjumped, too. Klingenberger stated too, that these cases usually happen in the same regions, meaning that single wolves or packs learned to overjump fences. Generally, he still believes in the

protection of electric fences. Another important point is, that Klingenberger has not heard of a case, where a wolf dug its way under an electric fence, even though it happened with non-electric fencing.

2. *In your view, what are the most important points and the biggest weak points regarding electric fences?*

One important point that was shared among the experts are that the fences have to be complete. Open or unelectrified parts, i.e. at a river for watering the animals, make the fence useless.

All experts agree that deficient setup is the biggest weak point. Especially noted are non-electrified parts, poorly maintained electrifiers, drained electric current by tall grass, grounding problems, under-crawling-possibilities, which hardens the theory of the attack analysis results. Klingenberger also stated that fence knowledge of hobby-farmers is often poor. For small herds, the pastures are often too small, and that sheep panic, when wolves come and break out. He also stated, that an electric fence has not yet be undermined.

3. *What are your experiences about disadvantages, doubts and conflicts about electric fences as livestock protection? (Labor, material, seasons)*

The most named conflict was labor. Mobile fencing can be very onerous for farmers especially on alpine areas, as Claudio Spadin/Jan Boner mention or for part-time farmers as Ralph Manz stated. For Rolf Wildhaber it is also old material like electrifiers, which don't bring enough voltage, which corresponds to Sven Baumgartner's believe, that acquisition costs are a problem. Sven Baumgartner also said, that flock nets are do not work well with big herds, especially sheep and that they are vulnerable to snowfall. The specific high predation nets don't seem to be more effective, but are much more laborious to handle, especially on mountain pastures.
For Martin Brantschen, the willingness of the farmers to change their fencing system is a big problem. This can be also added to labor- or material-costs.
For Klingenberger the biggest problem is fencing knowledge, and the lack of practice experience of the agricultural traders.

4. *When do fences pose a risk for wildlife and how could that be prevented?*

Fences seem especially problematic in areas of game passes. Fladry seems an easy solution to enhance visibility. That higher fences pose a higher risk is only mentioned by Martin Brantschen and Ralph Manz. Manz also stated, that it makes sense to consult a gamekeeper or use photo traps before setting up a fence in a new place to avoid crossing game passes. The gamekeepers also state, that it is important to not leave un-used and non-electrified fences up, after the animals leave the pasture, and that it is not enough to just lay it on the ground.

Klingenberger said, that the big problem are wild boars, which cannot overjump the fence like deer, and take the fence down and destroy its protection function.

5. *What is your impression on how wolves behave around fences? Have you witnessed or experienced any situation?*

Rolf Wildhaber tells a story about a video footage of individual M71. The wolf is already inside the fence and has killed several lambs, when the video starts. The pasture is on a slope, the cameraman comes from above. First the wolf searches on the ground for a flaw to crawl under the fence to escape. As he doesn't find one, he moves towards the cameraman turns around and jumps over the fence, where he before couldn't find a passage. M71 and M75 are the only individuals which have verifiable jumped over a fence. Wildhaber can imagine, that they learn to do so through private compost sites in backyards, where they have to climb or jump up a grid to get leftover food.

Martin Brantschen observed a wolf which was searching a fence for flaws, but no attack happened.

André Klingenberger also did some experiments with zoo wolves, where it shows, that they are very careful around electric fences and look for flaws mainly on the ground.

Other than that, the experts stated, that they believe that wolves mainly check on the ground, and that they use the smallest flaw to overcome a fence. But an electric shock is a very strong deterrence, which wolves respect well.

6. *Do you have the impression, that there are more or less livestock damages when a pack is present versus a single wolf? How do you explain this?*

The experts from the Calanda region believe, that there are less damages done by packs, however the stated explanations vary. Sven Baumgartner believes, that this can be traced back to the unpredictability and quick and frequent location change of single wolves. The experts from Graubünden on the other hand think it is just a matter of definition. In a pack territory, there are more pack-predations and in a single-wolf territory are more single-wolf-predations. Rolf Wildhaber on the other hand believes it is due to the more effective and efficient hunting techniques of packs. Together they are able to take down big deer and feed more on it. Single wolves are less efficient and rather take the risk of livestock. But he also states, that it could be also the individual Calanda pack, which avoids livestock. It is re-markable so Wildhaber, that several Calanda-young have been showing unwanted behavior. It seems that they are less shy. He traces this down to the fact, that there are no harmful situations for them connected to humans. In other countries where wolves are less protected, like Scandinavia, Eastern Europe or Italy, wolves show greater respect, because they are harmed by humans. For Ralph Manz, who has the Swiss wide overview, the situation is more complex. Number of livestock pre-dations is closely related to protection actions, and probably also to its maintenance over time. In the territory of the Augstbord pack in the Canton Wallis, predations are high but also protection actions low. In contrast to the Calanda territory, where predations are low, but protection actions high. If comparing the number of preda-tions to single wolves, the picture is very inhomogeneous, since singles can, de-pending on the protection situation, kill more livestock than a pack.

In Saxony, Klingenberger stated, most livestock predations happen in wolf territory, no matter if it is occupied by a pack or single wolf. He also said, that usually, when they have livestock predations outside a territory, soon enough there will be evidence of a new resident wolf or pack there.

Questions 7 and 8 were exclusively for the gamekeepers and wildlife experts:

7. *Do you have the impression that wildlife population changed since the presence of the pack? How do you explain this?*

Claudio Spadin states, that wildlife populations have decreased. Rolf Wildhaber specifies, that red deer population decreased but that they increased in other parts of Graubünden, which leads to the conclusion that at least parts of it migrated. Roe deer population was cut in half without any migration signs but is now on a stable level. Ibex and chamois population only have small declines. This was carefully monitored by the hunting department. For Ralph Manz the situation is more complex. He knows about these numbers, but he also states that they are depending on many variables, wolf presence just being one. Others are reproduction rates, winter mortality, traffic deaths and hunting pressure. The "quiet zones" for wildlife, where hunting is forbidden are used less. This leads to higher hunting rates around these quiet zones.

Martin Brantschen also said, that roe deer population decreased.

In East-Saxony in Germany, where 15 wolf packs live close together, Ullrich Wotschikowsy and Klingenberger said, the only indicator are the hunted animals. They agree on the fact, that red deer and wild boar populations increased. They disagree on roe deer, which stayed the same according to Wotschikowsky but had small decreases according to Klingenberger.

8. *Do you have the impression that wildlife behavior changed since the presence of the pack? How do you explain this?*

Swiss experts stated that wildlife is shyer, more careful and that they stay in different areas. Wildhaber also stated that ibex and chamois are staying closer to cliffs and rocks, where they faster than the predators. Experiences also show, so Manz, that deer adapt to the presence of the pack. They can predict predation, but also know when there is no danger of the wolf and can let it pass without fleeing.

6.3 Farm Visits

A sign for good farm selection, is that all but one farmer either experienced predation themselves or another farmer in the 10km radius. Since farm structures and fencing systems are quite similar within the regions, it is also most probable, that the 29 selected farms and their fence systems were typical for their region.

6.3.1 Structural Analysis

When looking at differences of the regions, it is remarkable, that the Calanda-valley, although high wolf pressure, has really low livestock damages on lowland pastures. Only one farmer experienced losses. It is also conspicuous, that in the Calanda region the used fence systems are almost exclusively the standard 90cm nets, as shown in figure 20 below.
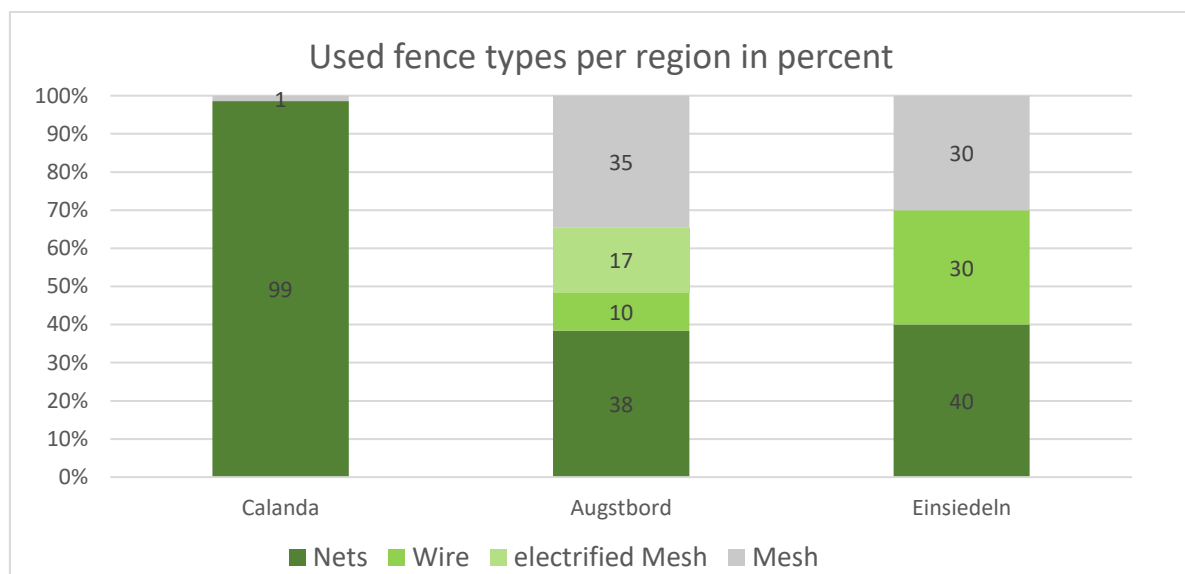
Figure 20: Used fence types per region in percent

Compared to the other two regions, they also have a much higher share of fences which are conform with the basic protection definition of AGRIDEA (99% compared to 65% in Augstbord and 58% in Einsiedeln). Which also explains the higher average fence quality grade (16,5 compared to 13,5 in Augstbord and 13,3 in Einsiedeln). Also, the average fence knowledge (5 compared to 4,15 in Augstbord and 4 in Einsiedeln) and overall protection status is higher (4,88 compared to 4,62 in Augstbord and 2,88 in Einsiedeln). The relatively small difference between Calanda and Augstbord regarding overall protection status is explainable with the fact, that around Augstbord are many farmers, who rather have their sheep in night pens, than electrifying the entire fence. This leads to relatively low fence quality grades but high protection status.

It is also remarkable, that farmers in the Calanda valley didn't really make any adjustments in their livestock protection, since the presence of the wolf. The standard nets were already very common in this region. Only one farmer added blinking devices, and another enhanced the fence around the stable. Calanda interviewees also had more fulltime farmers (50%) among them, compared to the other two regions (23% Augstbord and 12% in

Einsiedeln). Even though some people, who were interviewed in the context of this study (gamekeepers, farmers and counselors), drew a connection between fence quality and the fact that a farm is run on regular- or sideline basis, this could not be shown with the collected data. Fence quality scores nor protection statuses are not considerably higher for fulltime farmers.

Figure 21 shows the distribution of fence quality. A score of >15% can be assessed as "wolf-proof", a score of >13 can be assessed as a fence, which generally could offer protection, if flaws were removed. A score of less than 13 cannot be seen as any kind of protection.

Fence quality per region

Legend: ≥15 (green), >13 (yellow), <13 (red)

Figure 21: Scores of the fence quality assessment sorted by regions
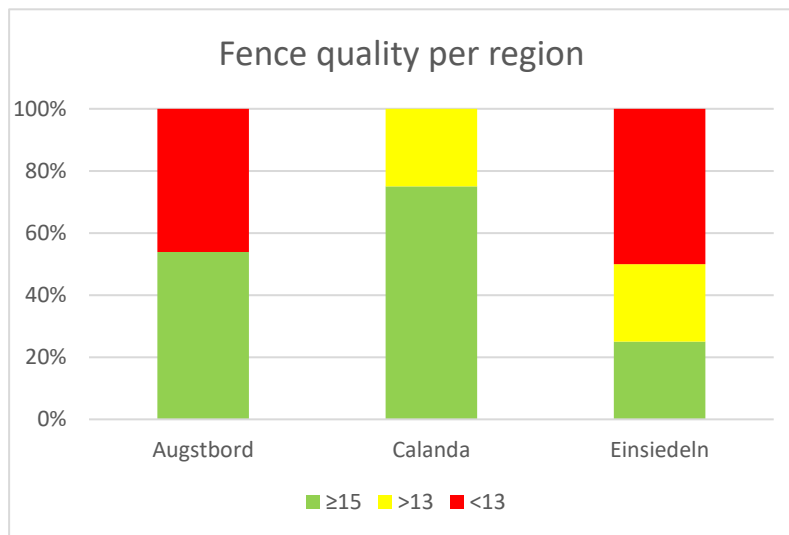
It shows clearly, that Einsiedeln with the low or unpredictable wolf pressure, has the lowest fence quality scores. Some farmers indicated, that as long as not too many predations happen, they will not enhance their fences. It would be too laborious or costly for relatively little effect. Interesting about the region of Einsiedeln was also, that five of the eight visited farms had guardian lamas. Reason for that might be, that there is a lama-breeder in the region and that lamas are rather useful against single wolves rather than a pack. The Augstbord region stands out, because six of the 13 farmers are using night pens as a protection measure, of which three are already retired and only keep sheep as a hobby. For them, since they are physically not in best shape but have a lot of time, it is much easier to securely fence the flock in a pen at night rather than electrifying the total fence.

6.3.2   Questionnaire

Eleven of the 29 visited farms already experienced depredation, eight of them being in the Augstbord region. A seasonal tendency is not discernible. Most attacks happened either in spring or fall, because in the summer, sheep (and also wolves and deer) are on the alpine pastures and in the stable in the winter.

All but five farmers knew about the AGRIDEA brochure about fences as livestock protection and most of them found them quite useful, even though many said, that it looks much easier in the brochure, than it is in praxis. A simple and cost free enhancement would be the recommended fladry, but only four farmers used them consistently. Four others had at least some parts enhanced with fladry. But surprisingly also problems with wildlife in fences are rare. Only four farmers stated, that they had incidences before, but not to a problematic extent.

Exemplary well set up protection fences were quite rare: just four farmers really put a lot of obvious effort into protection fencing. Only one farmer electrified his mesh wire fences

as recommended in the brochure. Two others enhanced only with one charged wire: One farmer above and one at the bottom. Also, the alternate charging of wires was very rare with only two farmers. Reason for that could be a lack of knowledge of those fences, the legally grey area of the strong voltages, or the fact, that it needs special nets for this. Extra high nets however were not that uncommon: seven farmers had exclusively higher nets, while four others had them partially.

Statements of the chapter "Control" have to be looked at critically, since farmers might state wrong information, to look better. All but one farmer stated for example, that they check their animals every day. Since this is obligatory by law, farmers who don't do so, would admit a criminal offence. About half the farmers state, that they check their fences daily and that most of the electrical fences are checked for voltage daily. The main clearing strategy of the electric fences is to cut the grass before setup. Eight farmers stated, that they only clear when necessary, and six, that they don't do any clearing activity at all.

Figure 22 below, shows the frequency of adaptions to the wolf presence. Multiple answers possible.
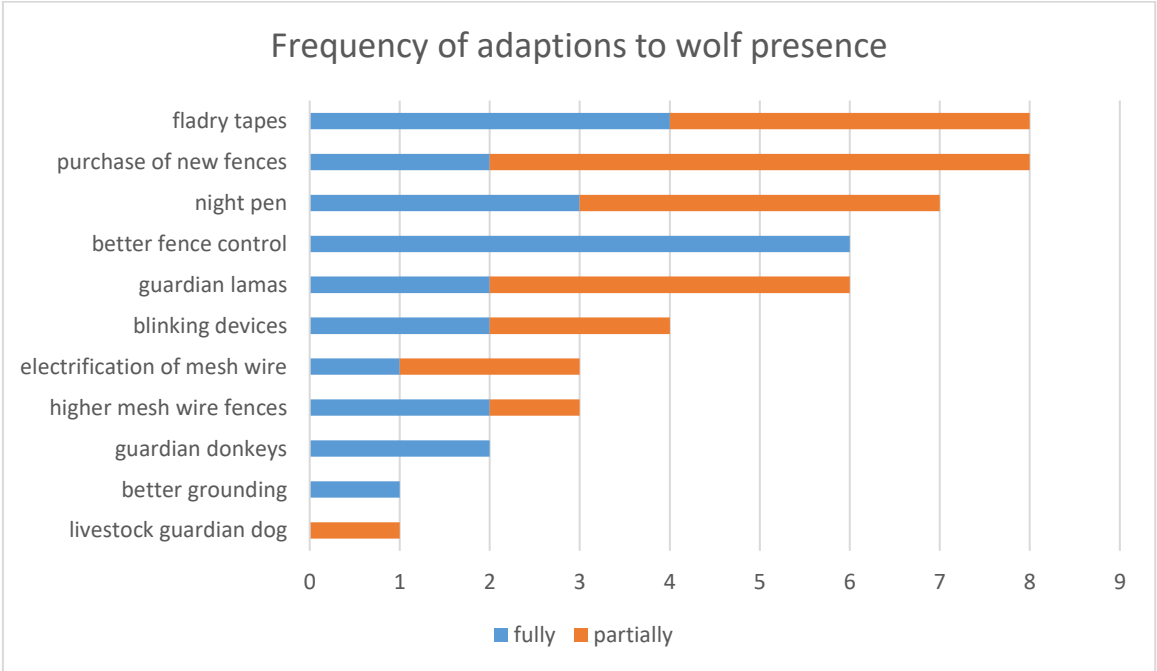
Figure 22: Frequency of adaptions to wolf presence

6.3.3   Fence and Pasture Assessment

Although a statistical analysis was not reasonable, because of the small number of visited farms, there are conspicuous tendencies visible. The following passages try to identify relations between these tendencies.

Tables 3 and 4 are replicates from chapter 5.3.3 for better understanding.

Table 3: Coding system for the assessment of fence quality

Fence quality

Points	1	2	3	4
System	Very bad, hardly electrified	Some non-electrified fractions	Basic protection	Additional protection
Voltage	None	<3000V	≥3000V	>5000V
Condition	Many (>5)	several (2-5)	Hardly any (1-2)	No flaws
Visibility	Very bad, mostly ingrown	Bad, no contrast colors or fladry, partly ingrown	Standard fence, some contrast colors or fladry	Very well, many contrast colors or fladry
Distance to the ground	> 30cm	> 20cm	< 20 cm	< 10cm

Table 4: Coding system for the assessment of pasture protectability

Protectability

Points	1	2	3	4
Steepness	mostly > 45°	mostly 30°- 45°	mostly < 30°	Mostly even
Scrub encroachment	>30% of the pasture	10-30% of the pasture	<10% of the pasture	clear
Complexity of pasture shape	Impossible to see most pasture	Not really clear	Mostly free sight	Free sight
Forest border	Enclosed in the pasture	At the fence	<50m	Open field
Ground	Stony and dry	Dry and medium depth	Medium depth but moist	Deep and moist

When looking at the average protectability, it turns out, that more attacks happened on pastures with a lower protectability score (Average protectability score of attacked farms 12,1, compared to 14,3 on not attacked farms as seen in figure 23). However, this is most probable correlated to the fact, that most attacks happened in the Augstbord region, laying in the Canton of Valais, an inner alpine dry area, which generally got lower protectability grades, because of the dryer ground and the generally steeper pastures. Most attacks happened in pastures, which were fully or partially enclosed by mesh wire fences (5), two attacks happened on pastures with electrified mesh wires, of which one did not have a charged ground wire and the other did not have a charged top wire. Three predations happened in standard nets, of which one was not properly electrified, the farmer admitted. The second one was not overcome by the wolf. The killed lambs were outside the fence and not protected. After the third net-attack, the fence was on the ground. One attack happened in a two-wire fence, with the lower wire being higher than 25cm.

Figure 23 puts the average fence quality, protectability, fence knowledge and protection status in relation to the fact if predation happened on the farm or not. It shows higher scores for all the variables. However, these numbers should not be seen without context. The fact that some predations happened several years ago questions all variables except the protectability. Maybe the attack happened in a different fence system, with a different quality grade. Also, the fence knowledge could have changed after the attack and the protection status especially, since most farmers make some changes to lower the risk for another attack. But since those variables rather increased after an attack, the difference would be even greater.
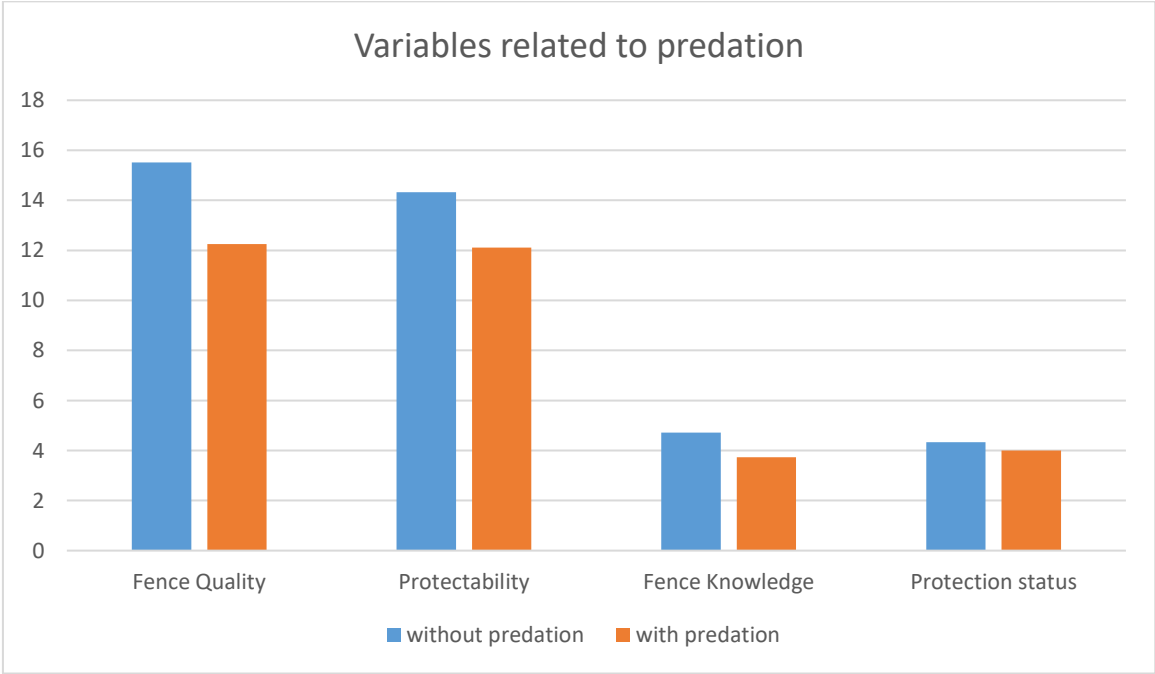
Figure 23: Variables related to predation on the visited farms

The distribution of fence quality scores in figure 24 does not show much. Obviously, the biggest problem was that many fences weren't electrified at all or had non-electrified parts. Distance to ground did not play that big of a roll, because there were only six farms which used wire fences and only three of them as the major fence type. With the mesh wire and the electric net fences, distance to the ground obviously isn't important. The average effort of keeping the fence clear was stated higher by wire-farmers (2,33 compared to 1,2 with nets and 1,33 with mesh wire. Farms who work with several fence types were categorized by which they used most). The reason even mesh wire farmers state an effort is, that some make an effort securing the mesh wire on the ground with pegs or putting an additional layer above, to rise the fence up to over 2m. This again shows, that what is done and used in the field is often too complex for simple standards and funded results.
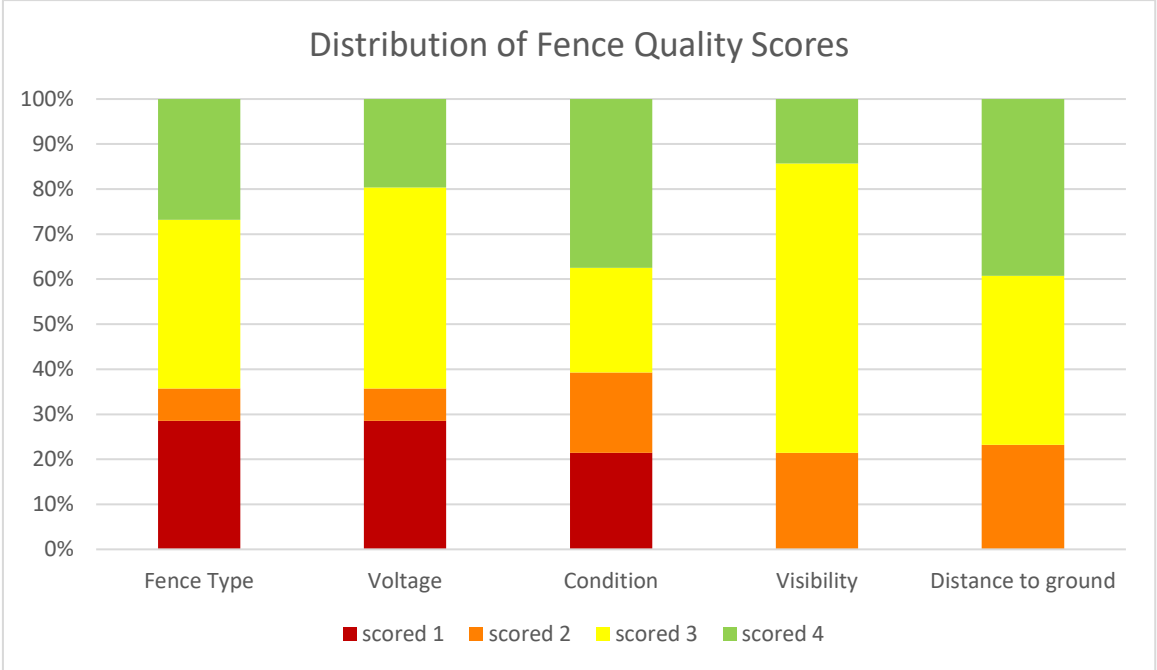
Figure 24: Distribution of fence quality scores

When looking at the distribution of protectability scores in figure 25, it shows, that many pastures are steep and close to a forest. Encroachment and complexity of the pasture shape is not too much of a problem. Soil properties for good grounding also don't seem big of an issue. But this characteristic was stated by farmer, not measured. The Augstbord region laying in the Canton of Valais, an inner alpine dry region, has bigger problems with grounding. All but two pastures with a score less than 3 were in this region.
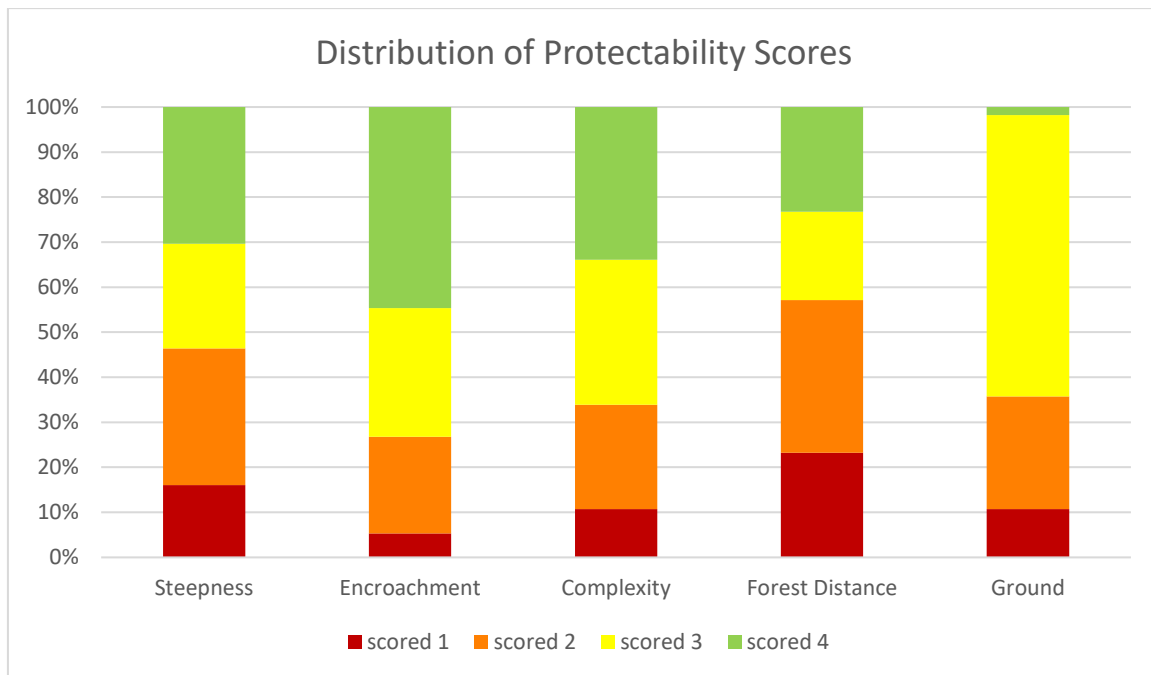
Figure 25: Distribution of pasture protectability scores

When looking at the distribution of fence quality related to protectability in figure 26, even though again the numbers are too small to make a statistical calculation, it slightly looks like better fences are more likely to be on easier pastures, which also makes logical sense. But it also shows, that the two best fences are on harder terrain. After all, it is possible to fence even the hardest pastures. But also, the two farmers with the best fences (score 20), were two out of three, who said that the laborious extra fencing effort is too high for economic work.
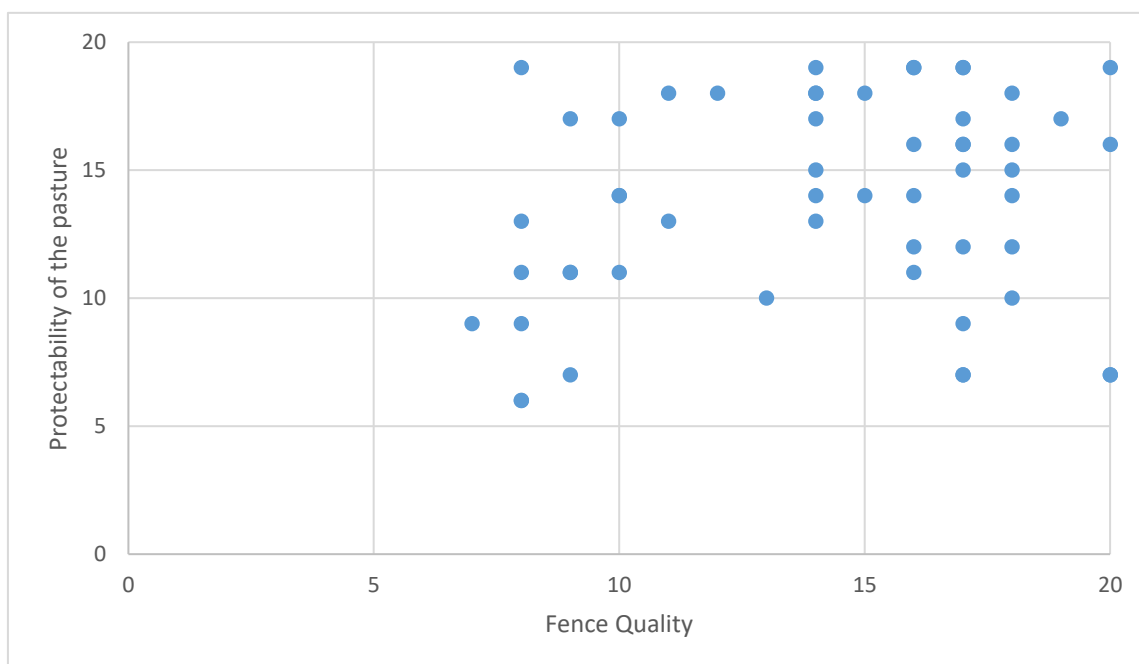
Figure 26: Relation of fence quality and pasture protectability

7　Discussion

It is very difficult to measure the effectiveness of fences in livestock protection. This study could again not fully answer this question. How effective a fence is, only shows when a wolf tries to get in. But how hard it tries is important and impossible to measure. It is depending on wolf and prey population, their fitness, temporary conditions like hunger and the individual experiences of the wolf. Does the wolf check the fence for flaws? How long does it try to overcome the fence? This also raises the question of how effective a fence has to be. Regions with high prey populations for example might be safe with less effective fences.

Attack analysis could actually be a very useful way to measure the effectiveness of fences in livestock protection. The big problem in this situation was, that some gamekeepers don't know about protection fences. Their job is not to analyze the situation and check the whole fence for flaws. Before doing so, they need special training. Also, the predation scene should not change before the gamekeeper gets there. This is of course difficult, if the fence broke down and sheep are on the loose. Still, since gamekeepers remembered really well the situations, conclusions can be drawn from the results. Another problem with this approach is statistical. If electric fences are not often used, but still overcome, their effect would be doubtful.

Most interviewed experts were very convinced of the efficiency of electric fences. Most answers about important points of an electric fence are very similar and clear, which indicates, that there is a strong correlation. Since most experts come from Switzerland, it is possible, that they heard similar speeches or influenced each other's opinion. That the biggest problem about electric fencing seems the amount of labor, also shows in the similar answers. When looking at the questions 6 (relating packs versus single wolfs), 7 and 8 (population and behavior of wildlife) things become very complex. Answers of Ralph Manz seem to be more wide-angled and careful with simple conclusions. Interesting was the statement of André Klingenberger, who said, that if wolfs learn to jump over fences, an elevation of those was only temporarily effective.

The farm visits were also successful regarding the structural analysis of what kind of fences are used. For measuring effectiveness of fences, this approach had some serious deficiencies. The number of visited farms was too small to draw statistical conclusions. Many of the visited farms had additional protection measures, which bias the results. Additionally to that, farmers with non-protective fences might have just been lucky, that their herds weren't attacked. Also fence types and qualities were very different. Too many different flaws and insufficiencies exist, to draw strong conclusions. Another difficulty was the assessment of pastures, where several fence types were used.

Additionally to that, knowledge of wolf behavior is very scarce. The low predation numbers in Calanda might just be because the individual wolves there are very specified and drawn to wild prey. Maybe, because farmers mostly used electric fences already when settling, the wolves just never learned to go on livestock. Maybe it is easier for packs to hunt successfully wild prey than for individuals. Possible, that single wolves learn faster than a pack, since they are more often forced to try new hunting methods. But these assumptions will be hard to measure. But the results of this study do give reason for presumptions. It seems that only very few wolves learn to overjump electric fences and that most overcome fences have serious flaws in the setup.

8   Conclusions and Recommendations

So, what do these results mean for all the stakeholders?

For farmers, there is no need to invest in extra-high fences. Wolves, which jump over 90cm, will probably soon learn how to overcome greater heights. High nets are heavier and bigger and therefore more laborious. It would make more sense to invest in high quality fences with low electric resistance to lose less voltage on longer fence distances. For farmers, who don't want to take any depredation risk, higher fences can make sense. But in that case, livestock protection would be better enhanced with additional guardian animals. Alternated charged wires are a good solution to bridge bad soil conductivity but should always be used with a special interposed resistor, to not pose a risk for children and young livestock. Non-electrified fences do not provide any protection, no matter how high they are, or how well pegged into the ground. Mesh wire fences should be electrified with at least two charged wires, one close to the ground and one above the fences. Before enhancing fences with a lot of effort, farmers should enquire about the criteria of a live-stock-protection fence. Good fence knowledge and careful setup is essential for an effective protection. For farmers as also for livestock counselors the question arises which protection measure is most efficient. Effective electric fencing does need a lot work and attention and is not the best solution for all farm- and pasture types or regions. Another protection measure or combination might be a more efficient solution.

For the wolf-management the results lead to the fact, that, to ensure a coexistence with farming, it is important to cull the problem individuals, which have learned to jump over electric fences. This has to happen before they wreak havoc or teach their "hunting" techniques to others. It might be time, to change the definition of "schadenstiftender Wolf". It is not important how many individual sheep one killed, but the fact, that it learned to jump and the number of "jumping" attacks. To really understand, if a wolf jumped or not, attacks should always be properly analyzed. Since gamekeeper are already on the site to collect the DNA-data, they should be trained to check the fencing system, flaws and sum up how the attack happened and if and how the wolf overcame the fence or other protection methods. Their data collections are actually useless when not checking the fence properly, since also the definition of "schadenstiftender Wolf" is depending on that.

The results of this study also give reason to reform the subsidization and compensation payments in Switzerland. Why do farmers not make more effort for protecting their live-stock? Is it the additional workload or financial issues? Since their predation losses are fully covered, a financial pressure is not given. But unprotected herds teach the wolves about the easy livestock prey. Farmers have the moral obligation to keep any suffering away from the animals in their care. Unprotected herds in wolf territory is grossly negligent. Maybe it needs structural changes for farmers to change their protection behavior. Predation payments for protected animals only or legal obligations to some kind of effective protection measure could be a solution for that. But this sounds easier than it is. An example for that is Germany, where predation compensation is paid for protected animals only. The degree of protection is always an issue and little, for the farmer unknown deficits in the fence setup can lead to tragic depredations without any compensation. The generous payments and culling of problem individuals in Switzerland cools the heated discussion down. Subsidization of protection measures are quite well organized. Farmers claimed though, that only high nets are specially funded, which, regarding the results of this study, does not make sense anymore.

For the remaining pro- and contra wolf advocates in the society, the results also lead to a good compromise. The political protection of the large predators will most probably not change much. Maybe it becomes easier to remove individuals, but a total extinction of the wolf will most probably not happen in Switzerland. And even if, legal borders are not too impressive for wildlife and individuals will always re-migrate. The pro- or contra wolf discussion is vital in society but not really in politics. Organizations which keep up the hope for farmers, that this might happen soon, and that they would get rid of the problem, are actually enhancing the conflict. Farmers rather wait and see, than try to protect their herds. Disastrous depredations of unprotected herds are the results, which is fuel on the fiery discussion. That wolves naturally not jump, makes it quite easy to find a compromise. Wolves have to adhere to the minimum requirements. If they don't, farmers are helped with the culling. That problem individuals can be culled should not enrage the pro-wolf-advocates, since it makes coexistence much easier and might actually help in the long term to ensure their wider and more peaceful existence.

As for future studies, the results lead to endless recommendations. Since the repopulation of wolves in Europe is so young, this study is definitely missing longtime experiences. Any further investigations of the behavior of wolves in our fast-changing landscape and land use are necessary. There are so many correlations, links and parallels to assess, it is hard to find a place to start. Correlations between presence of wolves and prey are as important as further analyses of protection fencing.

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10   Appendices

Interviews

Expert Interview - Sven Baumgartner, Livestock-Protection Counselor in St. Gallen

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Ja, sie wirken bei guter Stromführung und optimaler Erstellung.

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und grössten Schwachstellen von Herdenschutzzäunen?

Erdungsproblem der Stromführenden Apparate, mangelnde Erstellung der Zäune. Gut gespannte Zäune, Unterschlupf Möglichkeiten vermeiden.

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede)

- Mögliche Konflikte mit Jagd, wenn Zäune bei nichtgebrauch stehengelassen werden

- Zaunsystem ist nicht bei jeder Herdengrösse anwendbar, oder Tiergattung. (Easy Net bei Grossen Herden schlecht anwendbar gerade bei Schafen.)

- Anschaffungskosten

- im Herbst, Winter bei Schneefall müssen die Zäune teilweise demontiert werden, da sie sonst durch den Schnee zusammengedrückt werden.

4. Wann stellen landwirtschaftliche Zäune für Wildtiere eine Gefahr da, und wie könnte das verhindert werden?

Nicht elektrifizierte Zäune, Zäune ohne Tiere auf der Fläche, in Wildwechselzonen. Hilfe sind Flatterbänder zur besseren Sichtbarkeit.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Er verhält sich am Zaun vorsichtig. Überspringen ist äußerst selten und muss erlernt werden. Meistens wird ein Durchschlupf gesucht.

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Wenn ja, wie erklären Sie sich das?

Ja. Einzelwölfe tauchen unberechenbar auf. Sie sind nicht vorhersehbar und können sehr schnell den Standort wechseln auf ihrer Wanderschaft. Einen Wolf der Sesshaft ist, ist auch besser, da er in seinem Gebiet lebt. Das Rudel lebt in einem Gebiet, welches ungefähr abzuschätzen ist.

Expert Interview – Answered together by
Jan Boner, Livestock-Protection Counselor in Graubünden and
Claudio Spadin, Gamekeeper in Graubünden

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Geschlossen elektrifiziert wirken sie bisher im ganzen Kantonsgebiet erfolgreich. Eine Ausnahme wurde in Trun bestätigt und identifiziert (M75)

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und größten Schwachstellen von Herdenschutzzäunen?

Die wichtigsten Eckpunkte: geschlossen elektrifiziert, korrekt installiert und unterhalten, max. 15cm ab Boden, 90cm hoch. Schwachstellen: offene Stellen, mangelhafter Unterhalt, fehlerhafte Installation.

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede)

z.B. Arbeitsbelastung. Im Sömmerungsgebiet deutlich höher, daher bleiben wir bei Höhen von 0.9m, da gleich wirksam wie 1.05 aber wesentlich leichter.

Materialqualität, sehr unterschiedlich, Materialauswahl trifft der Landwirt

oder saisonale Unterschiede.

Zäune im Gelände ohne Herde stellen vor allem für Wildtiere ein Risiko dar. Wir begrüssen LITZEN.

4. Wann stellen Landwirtschafts-Zäune für Wildtiere ein Problem dar und was könnten mögliche Lösungen sein?

Zäune sind oft ein Problem für die Wildtiere, vor allem Maschenzäune.

Problem:

wenn sich kein Vieh auf der Weide befindet und die Zäune trotzdem stehen bleiben.

Nur abgelegt werden.

An unübersichtlichen Stellen.

Wenn Wildwechsel unterbrochen werden.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Die Erfahrungen haben gezeigt, dass wenn der Zaun geschlossen und gut elektrifiziert ist, keine Übergriffe an Nutztiere stattfanden. Beobachtungen diesbezüglich habe ich keine gemacht.

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Wenn ja, wie erklären Sie sich das?

Im Rudelgebiet gibt es mehr (nur) Risse durchs Rudel. Ausserhalb gibt es Risse dur Einzeltiere. Da Wir ein Rudel auf Kantonsgebiet definieren und im restlichen Kantonsgebiet Einzelwölfe leben, fanden mehr Risse durch Einzelwölfe statt.

7. Haben Sie den Eindruck, dass sich die Wildbestände seit Anwesenheit des Wolfs verändert haben? Wenn ja, wie?

Sicherlich gab es Veränderungen.

Die Anzahl der Wildtiere ist sicher kleiner als vor der Anwesenheit der Wölfe. Das Wild ist vorsichtiger und weniger sichtbar als vorher.

8. Haben Sie den Eindruck, dass sich das Wildverhalten seit Anwesenheit des Wolfs verändert hat? Wenn ja, wie?

Sicherlich gab es Veränderungen.

Das Verhalten hat sich verändert, das Wild hat die Einstandsgebiete gewechselt. Nutzt andere Weideflächen, ist vorsichtiger und scheuer, die Verteilung ist anders und WSG haben nicht mehr die gleiche Bedeutung. Das Wild hat sich auch auf die Anwesenheit der Wölfe eingestellt.

Expert Interview – Rolf Wildhaber, Gamekeeper in St. Gallen

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Wenn korrekt unterhalten und mit ausreichend Stromspannung, ja. Ich weiss von einem Betrieb, der Ziegen auf einer Weide hat, an welcher regelmässig Wölfe vorbeiziehen, und welcher noch keine Wolfsrisse zu verzeichnen hat. Die Anwesenheit der Wölfe ist durch eine Wildtierkamera schon einige Male bestätigt worden. Die Ziegen sind mit drei elektrischen Bändern eingezäunt. Die untere läuft auf einer Höhe zwischen 15 und 20 cm. Der Zaun führt ordentlich Strom, mit einer Spannung von über 4000 Volt. Nahegelegene Nachbarbetriebe hatten schon Nutztierrisse durch den Wolf zu verzeichnen.

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und grössten Schwachstellen von Herdenschutzzäunen?

Wichtig ist die Stromführung! Die Wölfe müssen stark negativ geprägt werden. Die grössten Schwachstellen sind der Grassaufwuchs und die oft alten und schlecht gewarteten Viehhüterapparate. Ich stellt schon mehrfach schwach oder nicht mehr funktionstüchtige Elektroapparate fest.

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede)

Wissen um „Wolf-sichere" Zäune ist bei den Bauern theoretisch vorhanden. Probleme sind aber die Arbeitsbelastung und die Materialqualität. Alte Viehhüterapparate bringen oft nicht mehr genug Leistung für die teils langen Zäune. Besonders auf der Alp ist dann oft das Problem mit den ungenügend ausgebildeten Hirten. Doch gute Hirten sind den Bauern oft zu teuer, genauso wie neue und gute Hüteapparate.

4. Wann stellen Landwirtschafts-Zäune für Wildtiere ein Problem dar und was könnten mögliche Lösungen sein?

Wirklich ein Problem sind die Zäune nur an Stellen mit Wildwechsel. Die „Problemstellen" sind demnach oft bekannt. Mit dem blau/weissen Flatterbändern konnten wir die Schäden dort gut minimieren. Die Lösung ist sehr leicht und wird bei den Landwirten gut angenommen. Schliesslich ist ein Flatterband leicht montiert, stört nicht beim Umstellen der Zäune und hält relativ lange. Die Bauern sind ja auch froh, wenn ihre Zäune nicht beschädigt werden und ihre Tiere nicht ausbrechen.

Wichtig ist auch, die Zäune vor bzw. nach Ende der Beweidung abzubrechen. Durch anwesende Nutztiere wird das Wild aufmerksamer.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Die allermeisten Wölfe lassen sich von Stromführung gut beeindrucken. Die Individuen M71 und M75 haben aber nachweislich gelernt auch elektrische Zäune zu überspringen. Von M75 sind es Spuren im Schnee, die den Sprung zeigen, von M71 gibt es sogar ein Videobeweis. Die anwesende Bäuerin beginnt zu filmen, als sie den Wolf in der Weide sieht, er hat bereits vier Lämmer gerissen. Die Weide liegt am Hang, der hergerufene Bauer kommt von oben. Als er ihn versucht zu vertreiben, sucht dieser nach einem Durchschlupf an der unteren Zaunseite. Als er keinen findet, geht er auf den Bauern zu, dreht dann aber wieder ab, und springt dann mit Anlauf ohne Zögern im unteren Bereich über den Zaun, wo er vorher keinen Durchschlupf gefunden hat. Die erste Wahl der Wölfe ist deshalb meiner Meinung nach, der Durchschlupf. Einzelne Tiere haben aber auch gelernt zu springen.

Ich glaube ein Problem sind die Kompostbehälter in den Gärten. Diese sind oft Gitter, an denen junge unerfahrene Wölfe lernen zu klettern bzw. zu springen. Da diese natürlich nicht elektrisch sind, probieren die Tiere so lange, bis es ihnen gelingt, mit einer positiven Belohnung: den Essensresten.

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Wenn ja, wie erklären Sie sich das?

In der Calanda-Region: Ja. Als die Elterntiere des Rudels sich hier niedergelassen haben, gab es Risse auf der Alp Ramuz. Als diese dann mit Zäunen und Hunden gesichert wurde, sind von diesen Individuen keine Risse mehr passiert, auch nicht auf ungeschützten Weiden. Ein Rudel kann viel effizienter jagen als ein Einzelwolf. Ich habe schon mehrfach grosses und kräftiges gerissenes Rotwild gefunden. Das ist für einen Einzelwolf meiner Meinung nach fast unmöglich. Junge, unerfahrene Tiere gehen eher ein Risiko, wie einen Nutztierriss, ein.

Im Calanda auffällig ist aber, dass zwar die Elterntiere sehr zurückhaltend sind, der Nachwuchs aber schon mehrmals auffällig wurde. Meiner Meinung nach, liegt das daran, dass die Tiere den Respekt vor dem Menschen nicht genug lernen. In Ländern, in denen der Wolfschutz nicht so stark ist wie in der Schweiz, beispielsweise in Osteuropa oder Skandinavien, machen die Tiere einen grossen Bogen um den Menschen, weil sie gelernt haben, dass dieser gefährlich sein kann. Ist diese negative Prägung nicht vorhanden, werden Wölfe immer die Grenzen testen und die Scheu verlieren.

7. Haben Sie den Eindruck, dass sich die Wildbestände seit Anwesenheit des Wolfs verändert haben? Wenn ja, wie?

Rotwildbestände sind in der Tat, nachgewiesen durch das Wildmonitoring, im Wolfsrevier zurückgegangen. In den umliegenden Regionen wie Gemeinde Bad Ragaz, Vilters Wangs und Mels oder im Prättigau sind sie aber gestiegen. Das heisst die Tiere sind teilweise abgewandert.

Rehbestände sind fast halbiert worden, halten sich aber jetzt stabil. Hier konnte keine Abwanderung festgestellt werden.

Die häufigsten Wolfsopfer sind die jungen Kälber/Kitze.

Bei den Gäms- und Steinböcken hat es kleinere Bestandesreduktionen ergeben.

8. Haben Sie den Eindruck, dass sich das Wildverhalten seit Anwesenheit des Wolfs verändert hat? Wenn ja, wie?

Rotwild ist teilweise abgewandert. Insgesamt sind die Tiere scheuer geworden und meiden bestimmt Gebiete. Bei den Gäms- und Steinböcken hat es kleinere Verschiebungen in die Nähe von Felswänden und vom Wald über die Waldgrenze ergeben.

Expert Interview – Martin Brantschen, Gamekeeper in Wallis/Valais

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Ja den Eindruck habe ich

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und grössten Schwachstellen von Herdenschutzzäunen?

Genügend Strom ist wichtig, Höhe des Zaunes und der Vorspanner scheinen mir ebenso wichtig, auch der Unterhalt scheint mir aber sehr wichtig.

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede)

Der Wille zum Schutz ist zum Teil noch ungenügend. Zum Zaunmaterial glaube ich werden die interessierten Bauern meine ich recht gut beraten (Kurse)

4. Wann stellen Landwirtschafts-Zäune für Wildtiere ein Problem dar und was könnten mögliche Lösungen sein?

Landwirtschaftszäune können für Wildtiere ganz klar zum Problem werden, wenn sie nach der Beweidung nicht abgebaut werden. Bis jetzt hat man Schafweiden mit Gitterzäunen umsäumt, woran sich die Wildtiere mit der Zeit gewöhnen, den vielfach senkt sich der Zaun nach dem Schneedruck und die Wildtiere können sie überspringen. Jetzt aber wird als Wolfschutz auf diesen Zäunen mittels 3-5 Litzen aufgestockt, und somit ist die Gefahr zum Verheddern für die Wildtiere recht gross oder diese Einstände werden sogar gemieden. Im Weiteren kommt hinzu, das zweitrangige Mähwiesen, zum Teil abgelegen, für die Bauern nicht allzu interessant sind und eingezäunt werden und so der Wildlebensraum auch schwindet. Als Lösungen scheint mir der Abbau nach Beweidung, zumindest aber mit Weiteren Unterhalt und offene Tore, was aber für viele Bauern anscheinend nicht zumutbar ist, zeitlich gesehen.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Habe mal beobachtet, dass sich Wolf dem Zaun entlang schlich, und vermutlich eine Einlassstelle suchte. Zu einem Angriff kam es nicht und die Beobachtung war nachts mittels Wärmebildkamera.

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Wenn ja, wie erklären Sie sich das?

Nein, kann ich nicht bestätigen, denn der Herdenschutz erfolgt sehr schleppend.

7. Haben Sie den Eindruck, dass sich die Wildbestände seit Anwesenheit des Wolfs verändert haben? Wenn ja, wie?

Rehbestände haben gelitten.

8. Haben Sie den Eindruck, dass sich das Wildverhalten seit Anwesenheit des Wolfs verändert hat? Wenn ja, wie?

Das Verhalten hat sich geändert, indem das Wild anders einsteht, unruhiger äst, immer sichernd und heimlicher wird. Beim Rotwild scheint mir eine bessere Verteilung und kleinere Gruppen festzustellen.

Expert Interview – Ralph Manz, KORA

Vorweg: Alle meine Antworten sind nicht wissenschaftlich überprüft worden, mit Ausnahme des Zaunprojektes von AGRIDEA vom 2015 mit Gehegewölfen in Frankreich. Meine Äusserungen sind also zum vornherein schon Interpretationen. Es gibt keine wissenschaftlich robusten Untersuchungen mit freilebenden Wölfen und Zaunprojekten aus alpinen Gebieten. Meines Wissens wurden auch nie Beobachtungen von Hirten, Schafhalter und anderen Personen von Wölfen im Zusammenhang mit Nutztieren (in der Nähe von Zäunen, Herden, Mutterkühen etc.) analysiert.

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Mein Eindruck ist, dass es bei geschützten Nutztieren (generell Herdenschutzmassnahmen, das können verschiedenen Massnahmen sein), weniger zu Schäden durch Wölfe kommt als in ungeschützten Herden. Ich kann das nicht explizit auf Elektrozäune reduzieren.

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und grössten Schwachstellen von Herdenschutzzäunen?

Fehlende Elektrifizierung und mangelnder Unterhalt und falschen Aufstellen (Bäche, Vertiefungen)

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede)

Ich bin zu wenig direkt in die Praxis involviert als dass ich dazu eine robuste Aussage machen könnte. Bei der im Wallis (v.a Oberwallis) sehr verbreiteten Nebenerwerbslandwirtschaft ist es immer eine Frage der verfügbaren Zeit und der Personen, die für die Hilfe zur Verfügung stehen. Noch mehr Hirten- und /oder Zaunhilfen würden für die Nebenerwerbslandwirte sicher eine willkommene Unterstützung sein.

4. Wann stellen Landwirtschafts-Zäune für Wildtiere ein Problem dar und was könnten mögliche Lösungen sein?

Wenn sie zu hoch und am falschen Ort aufgestellt werden.

Generell sollte man sich vor dem Aufstellen der Zäune vom lokalen Wildhüter beraten lassen. Er weiss wo mögliche Wildwechsel entlang des Bereiches Wald –Weide verlaufen. Lösungen könnten sein, dass man Wildwechsel mit Fotofallen überwacht damit man weiss wie die Wildtiere auf den Zaun reagieren. Auch das Markieren der Zäune mit Flatterbändern markiert den Wildtieren die Höhe des Zaunes und vermindert das Verheddern im Zaun.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Hunde stammen vom Wolf ab. Die wenigen Hunde, die ich beobachten konnte haben jeweils den Weg unter den Zaun gewählt. Man muss ihnen das Springen zuerst anlernen. Es gibt ausnahmsweise Hunde, die von alleine direkt über einen Zaum springen (meistens sind das grössere Rassen).

Es war für mich interessant zu sehen, dass die Wölfe im Zaunprojekt von AGRIDEA praktisch ausnahmslos gegraben haben. ABER; es gibt natürlich auch Spezialisten unter den Wölfen, die das Überspringen oder Untergraben einmal gelernt haben ohne dabei negative Erfahrungen gemacht zu haben. Ich gehe davon aus, dass diese Wölfe dies dann gezielt

und häufig anwenden. Ich frage mich was Wölfe an einem Hang mit 30° Neigung machen, wenn der Zaun 1.10m hoch ist.

Aus dem deutschen Bundesland Sachsen gibt es Berichte wo Wölfe Zäune sowohl untergraben als auch übersprungen haben (AGRIDEA Herdenschutz Aktuell 2017 Informationen und Erfahrungsaustausch, 16. November2017, Köniz BE, Vortrag von André Klingenberger Sachbearbeiter Wolfsmanagement, Staatsbetrieb Sachsenforst, Folie 17).

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Wenn ja, wie erklären Sie sich das?

Es gibt dazu keine offizielle Publikation aus der Schweiz. Die Analyse der Effizienz von Herdenschutzmassnahmen bei Präsenz von Einzelwölfen und/oder Rudeln ist sehr komplex.

Ich habe mir die Mühe genommen die Situation der Nutztierrisse beim Calandarudel seit seiner Existenz zusammen zu stellen und jährlich zu aktualisieren (Anzahl der von den Kantonen St.Gallen und Graubünden gemeldeten Nutztierrisse im angenommenen Streifgebiet des Rudels plus die genetisch bekannten Wölfen des Calandarudels, unpubl.). Bei einem zweiten Rudelgebiet (Augstbordrudel, Oberwallis) habe ich dasselbe gemacht. Dabei zeigen sich grosse Unterschiede in Bezug zur Anzahl der gerissenen Nutztiere/Jahr in zwei verschiedenen Rudelgebieten. Die Anzahl der gerissenen Nutztiere hängt stark von der Umsetzung der Herdenschutzmassnahmen und wahrscheinlich auch von deren Aufrechterhaltung über die Zeit ab. Vergleicht man die Anzahl Risse in Rudelgebieten mit dem Potential von Rissen bei der Präsenz von Einzelwölfen ergibt sich ein sehr inhomogenes Bild. Einzelwölfe können je nach Herdenschutzsituation mehr Tier reissen als ein Rudel. Dabei muss man jedoch jede Alp einzeln beurteilen. Es ist nicht möglich zu sagen, wenn man es so oder so macht, dann ist das das Resultat. Was man jedoch sicher sagen kann ist, dass Herdenschutzmassnahmen einen grossen Teil der Nutztierschäden verhindern können.

7. Haben Sie den Eindruck, dass sich die Wildbestände seit Anwesenheit des Wolfs verändert haben? Wenn ja, wie?

Das ist eine sehr komplexe Fragestellung für die es, zumindest aus alpinen Gebieten, keine umfassenden Antworten gibt. Ob sich die Wildbestände aufgrund der Anwesenheit der Wölfe verändern, hängt vom Jagddruck, der Wintersterblichkeit und den Ausfällen infolge von Verkehr und Krankheiten ab. Die jährliche Reproduktionsrate der Schalenwildbestände spielt ebenfalls eine wichtige Rolle. Welchen Einfluss nun die Wölfe auf einen Wildbestand haben ist hochkomplex und anhängig von vielen Faktoren. Dazu bräuchte es langjährige wissenschaftliche Studien, um darüber verlässliche Aussagen machen zu können.

Das AJF (Amt für Jagd und Fischerei des Kantons Graubünden) schreibt in ihrem Jahresbericht 2017 (auch 2016), „dass Jagd im Einflussbereich des Calandarudels schwieriger wird. Das durch die Präsenz des Rudels veränderte Verhalten des Wildes hat zu einer deutlichen Änderung des Wildvorkommens und der Sichtbarkeit des Wildes geführt. Die Jagdstrecken im Einflussgebiet des Calandarudels liegen seit der Bildung des Calandarudels auf einem deutlich tieferen Niveau. Das zeigt sich insbesondere bei den Hirschwildstrecken, die im gleichen Beobachtungszeitraum im ganzen Kanton Graubünden eine stark steigende Tendenz aufweisen".

8. Haben Sie den Eindruck, dass sich das Wildverhalten seit Anwesenheit des Wolfs verändert hat? Wenn ja, wie?

Beobachtungen und Berichte zeigen, dass sich das Wild, da wo Wölfe territorial in Rudel leben, auf die Präsenz der Wölfe einstellt hat. Zum Beispiel kann eine Gruppe Hirsche einen Wolf auch auf kurze Distanz völlig gelassen vorbeiziehen lassen, ohne mit Flucht zu reagieren. Das zeigt das Schalenwild die Gefahr eines Wolfangriffs sehr genau einschätzen kann.

Es ist davon auszugehen und Beobachtungen bestätigen dies, dass die Wildbestände auf die Anwesenheit des Wolfes reagieren indem sie ihre Einstände anders wählen und heimlicher werden. Aus verschiedenen Jahren ist bekannt, dass die Anwesenheit der Calandawölfe (Kanton Graubünden) in einem Wildasyl (Banngebiet, in dem die Jagd untersagt ist), das Wild veranlasst hat dieses während der Jagdzeit zu verlassen. In der Folge wurden viele Hirsche in der Umgebungszone des Wildasyls geschossen.

Expert Interview – André Klingenberger, Wolf Management in Saxony and Biosphärenreservat Oberlausitzer Heide- u. Teichlandschaft

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Bis vor 2-3 Jahren haben wir sehr gute Erfahrungen gemacht. Dann haben sich Fälle gehäuft, bei denen zu vermuten war, dass der Wolf den Zaun übersprungen hat. Danach wurde Breitbandlitze („Flatterbänder") über den Zäunen gespannt, was anfangs funktioniert hat, aber später teilweise auch überwunden worden ist.

Es ist aber auffällig, dass es dabei räumliche Schadenschwerpunkte gibt. Soll heissen, es sind Einzelindividuen, die gelernt haben, Zäune zu überspringen. Grundsätzlich schützten Elektrozäune auch weiterhin gut. In Verbindung mit Herdenschutzhunden stellen sie sogar die effektivste Herdenschutzmethode dar.

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und grössten Schwachstellen von Herdenschutzzäunen?

In Sachsen werden 1,2 m hohe Festzäune mit festem Bodenabschluss als Mindestschutz anerkannt, ihre Schutzwirkung steht jedoch in Frage. Sie werden regelmässig untergraben, übersprungen oder teilweise sogar durchbissen.

Schäden gibt es hauptsächlich bei Hobbyhaltern, die mit den Materialien oft nicht professionell umgehen können. Es werden z.B. elektrifizierte Litzen an Maschendrahtzäunen festgebunden. Bei Berufsschäfern gibt es da kaum Probleme.

Häufigste Schwachstellen sind oft schlecht gespannte Ecken, bei denen der Zaun dann durchhängt, nicht ausgezäunte Gewässer und Spannungsverluste im hohen Gras. Bei unseren sandigen Böden ist ungenügende Erdung auch ein Problem. Aber mehrere 1 m-tiefe Erdungsstäbe sind bei häufigem Umbau der Koppel natürlich auch mühsam. Bei Litzenzäunen werden die vorgegebenen maximalen Abstände von 20 cm teilweise überschritten.

Dass Elektrozäune untergraben werden haben wir noch nicht erlebt.

Oft ist die Koppel auch zu klein. Wir raten selbst bei kleinen Gruppen von z.B. 3 Tieren mindestens einem Weideumfang von zwei Netzlängen, damit die Schafe bei Wolfspräsenz nicht ausbrechen und dann ausserhalb gerissen werden. Wichtig ist dabei auch schmale Flächenformen zu vermeiden.

Die Weidestromgeräte waren noch vor 5-10 Jahren nicht so leistungsstark, mittlerweile haben die meisten angebotenen Geräte aber eine gute Schlagkraft.

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede)

Das Zaunwissen bei den Hobbyhaltern ist wohl das grösste Problem, und auch die mangelnde Praxiserfahrung bei den Landhändlern, die die Zaunprodukte vertreiben. Beratungskapazitäten müssten da dringend vergrössert werden.

4. Wann stellen Landwirtschafts-Zäune für Wildtiere ein Problem dar und was könnten mögliche Lösungen sein?

Mit Hirschen und Rehen gibt es weniger Probleme, da diese die Zäune gut überspringen können. Wildschweine sind problematischer, da sie oft die Netze zu Boden reissen und zerstören. Breitbandlitzen an der Oberseite zur visuellen Verstärkung reduzieren die Wildschäden, auch bei Schwarzwild.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Wir haben im Wolfsgehege Tests mit Netzen gemacht und Futter als Anreiz genutzt. Es ist da natürlich immer die Frage, ob sich Gehegewölfe nicht anders verhalten als ihre wilden Verwandten. Aber es ist deutlich, dass die Tiere sich sehr vorsichtig am Zaun bewegen und vor allem mit tiefem Kopf den Zaun am Boden nach Schwachstellen kontrollieren.

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Oder andersherum? Wenn ja, wie erklären Sie sich das?

Ich habe den Eindruck, dass die Mehrzahl der Nutztierrisse in etablierten Territorien stattfinden. Ein Einzelwolf kann aber auch resident sein, und damit ein etabliertes Territorium darstellen. Wenn wir in einem neuen Gebiet Risse aufnehmen, komm meistens zeitlich verzögert auch eine Bestätigung für die Anwesenheit von einem oder mehreren territorialen Wölfen.

7. Haben Sie den Eindruck, dass sich die Wildbestände seit Anwesenheit des Wolfs verändert haben? Wenn ja, wie?

Da es kein wirkliches Monitoring der Bestände gibt, ist der einzige Indikator die Jagdstrecken. Diese schwanken von Jahr zu Jahr, was auch normal ist. Beim Reh sind vielleicht leichte Rückgänge zu verzeichnen, starke Einbrüche gibt es aber nicht. Beim Rot- und Schwarzwild gehen die Zahlen sogar nach oben. Das liegt wohl hauptsächlich an der Landwirtschaft. Der häufige Anbau von Raps und Mais bieten energiereiche Äsung und über längere Zeit auch eine gute Deckung.

8. Haben Sie den Eindruck, dass sich das Wildverhalten seit Anwesenheit des Wolfs verändert hat? Wenn ja, wie?

Das Wild ist in seinem Verhalten unberechenbarer geworden, was den Zeitaufwand für die Jäger erhöht. Hier sind neue Jagdstrategien wie z.B. verstärkte Gemeinschaftsjagden erforderlich.

1. Haben Sie den Eindruck, dass Elektrozäune gut gegen Wölfe wirken?

Ich habe nicht "den Eindruck", sondern es ist sicher: WENN Zaun, dann elektrifiziert. Elektrozäune vermitteln nachhaltig eine schmerzhafte Erfahrung und sie erfordern keinen Untergrabeschutz.

2. Was sind Ihrer Meinung nach, die wichtigsten Eckpunkte und grössten Schwachstellen von Herdenschutzzäunen?

Ein HS-Zaun muss wirklich komplett sein. Es darf keine noch so kleine Lücke geben. Also muss sehr sorgfältig gearbeitet werden. Immer noch werden Zäune U-förmig aufgestellt und man meint, ein Bach wirkt wie ein Zaun. Und es ist wichtig, SOFORT und ÜBERALL im Wolfsgebiet Zäune aufzustellen, BEVOR die Wölfe lernen, dass Schafe leichte Beute sind.

3. Was sind die Erfahrungen aus Ihrer Region mit Konflikten beim Thema Zäune? (z.B. Arbeitsbelastung, Materialqualität, Materialauswahl oder saisonale Unterschiede?

In Bayern sind erst 3 Paare. Habe noch keine lokale Erfahrung.

4. Wann stellen Landwirtschafts-Zäune für Wildtiere ein Problem dar und was könnten mögliche Lösungen sein?

Sie stellen m. E. KEIN Problem dar, weil (bei uns) die Flächen, die gezäunt werden müssten bzw. gezäunt sind, nur einen kleinen Bruchteil der Fläche ausmachen, die von Wildtieren (Schalenwild) genutzt werden. Im Gebirge befürchte ich Unfälle von Raufußhühnern, auch Habicht oder Adler u. a. - also sollten sie optisch auffällig sein. Und niemals auf einem Grat aufgestellt werden.

5. Was ist Ihr Gefühl, wie sich ein Wolf am Zaun verhält? Haben Sie schon Erfahrungen oder Beobachtungen gemacht?

Ich schließe aus Beobachtungen an meinem Hund: er probiert, unten durchzukommen. Bei dieser Gelegenheit hat mein Hund (Wachtel) mal einen Schlag von einem Elektrozaun bekommen - ich dachte, ich sehe ihn nie wieder. Es ist ihm noch ein zweites Mal passiert - danach konnte ich mit ihm dort nicht mehr mit dem Fahrrad hinfahren. Er hatte Angst vor dem Zaun ODER (?) der Örtlichkeit.

6. Haben Sie den Eindruck, dass es mehr Nutztierrisse durch einen Einzelwolf gibt, statt durch Rudel? Wenn ja, wie erklären Sie sich das?

a) Nicht mehr Risse insgesamt, aber "pro Kopf Wolf", weil ein Wolf allein geauso viele Tiere umbringen kann wie ein Rudel.

b) Es gibt Rudel, die bereits schlechte Erfahrungen mit (elektrischen) Zäunen gemacht haben und deshalb Zäune meiden. Einzelwölfe sind i. d. R. junge unerfahrene Tiere, die ihre Erfahrungen erst machen müssen ...

7. Haben Sie den Eindruck, dass sich die Wildbestände seit Anwesenheit des Wolfs verändert haben? Wenn ja, wie?

Der einzige Indikator, den wir haben, sind die gemeldeten Jagdstrecken. In Ostsachsen, wo wir inzwischen ca. 15 Rudel "dicht an dicht" nebeneinander haben, sind die Strecken seit 2008 bei Reh- und Rotwild gleichgeblieben. Damwild ist von 400 auf 700 gestiegen, Schwarzwild noch steiler. Muffelwild ist fast ausgerottet.

8. Haben Sie den Eindruck, dass sich das Wildverhalten seit Anwesenheit des Wolfs verändert hat? Wenn ja, wie?

Keine eigenen Beobachtungen.

Table Summary Questionnaires

Region	Voll/Neben/Hobby	Schafe	Ziegen	Netz	Litze	KG	KG elektr. >90	"+/-"	Flatterbänder	Anteil elektr	Weitere Schutzmassnahmen	Tiere	Zaun	Spannung	Unterhalt	Aufwand	Wild im Zaun
Augstbord	Vollerwerb	78		100	0		0	0	nein	100		mehrmals täg täglich	kein	kein	kein	0	kein
Augstbord	Nebenerwerb	52		50	50		0	50	nein/wenig	50	Nachtpferch	mehrmals tägl seten	keine			0	kein
Augstbord	Nebenerwerb	50		0	5litzig 30	0 70 nur unt		100	nein	100	Nachtpferch teilweise	selten	täglich		14 tägg ausr	3	kein
Augstbord	Vollerwerb	140		100	0				nein	100		täglich	oft	täglich	0	0	mässig
Augstbord	Nebenerwerb		10	100	0			100	nein	100	nein	täglich	täglich	täglich	vormähen	3	kein
Augstbord	Hobby	37		100	0	100			nein	100		mehrmals tägl seten	kein	kein	kein	0	kein
Augstbord	Hobby	12		0	0	100			nein	0	Nachtpferch	keine	vormähen	keine	kein	0	kein
Augstbord	Nebenerwerb			0	0				nein	0	Nachtpferch	mehrmals tägl seten	kein	vormähen	kein	3	kein
Augstbord	Vollerwerb	45		0	0		100		ja	100	Blinklampen	täglich	vormähen	täglich	kein	2	nein
Augstbord	Nebenerwerb	200		0	0	50		100	nein	100	Blinklampen	oft	täglich	oft	vormähen	3	kein
Augstbord	Vollerwerb	41	21	50	0				ja	0	Nachtpferch	täglich	täglich	täglich	vormähen	4	kein
Augstbord	Hobby	100		100	0			100 ja	100	HSH	oft	täglich	täglich	vormähen	3	kein
Augstbord	Nebenerwerb	100		0	0	100			nein	0	Blinklampen, Esel	mehrmals tägl seten	keine	keine	kein	3	kein
Augstbord	Hobby	30		0	0	50 50 nur obe		ja	50	Nachtpferch teilweise	täglich	täglich	täglich	kein	3	kein
Augstbord	Nebenerwerb		50	0 5litzig 100			100	nein	50	Blinklampen, Nachtpferch teilweise	täglich	täglich	täglich	vormähen	4	kein
Augstbord	Nebenerwerb			0				100	nein	100	Esel	täglich	oft	täglich	vormähen	2	kein
Calanda	Vollerwerb	4	8	100	0			100	nein	100		oft	täglich	täglich	vormähen	2	kein
Calanda	Hobby	80		100	0			100	nein	100		oft	täglich	täglich	vormähen	3	kein
Calanda	Nebenerwerb	80		100	0				nein	100	Blinklampen	täglich	täglich	täglich	bei Bedarf	0	kein
Calanda	Vollerwerb	40		99	0	1			nein	99		täglich	oft	oft	kein	0	kein
Calanda	Vollerwerb	40	20	100	0			100	teilweise	100		täglich	oft	oft	bei Bedarf	2	kein
Calanda	Vollerwerb	22		90	0	10			nein	90		täglich	täglich	täglich	vormähen	2	kein
Calanda	Nebenerwerb	37		100	0				nein	100	Lama	täglich	täglich	täglich	bei Bedarf	2	kein
Calanda	Nebenerwerb	34		100	0				nein	100	Lama	täglich	täglich	täglich	kein	3	kein
Einsiedeln	Nebenerwerb	280		60	10	30		10	teilweise	50	Lama	täglich	täglich	täglich	vormähen/be	0	mässig
Einsiedeln	Hobby	29		100	0				nein	100	Lama	täglich	täglich	täglich	vormähen/be	0	kein
Einsiedeln	Nebenerwerb	35		20	0	80			teilweise	0	Blinklampen	mehrmals wö seten	keine	keine	kein	0	kein
Einsiedeln	Vollerwerb	140		20	0	80		10	nein	20	Lama	oft	täglich	oft	vormähen	2	kein
Einsiedeln	Nebenerwerb	84		80 4litzig 20			20	20 ja	100 (Lama)	mehrmals täg täglich	täglich	selten	1-2 wochen a	3	mässig
Einsiedeln	Hobby	120		30 4litzig 30	40			nein	0	Nachtpferch teilweise	täglich	täglich	selten	kein	2	mässig
Einsiedeln	Nebenerwerb	42		0 2/3-litzig 1				nein	0	Nachtpferch teilweise	täglich	täglich	täglich	bei Bedarf	2	kein
Einsiedeln	Nebenerwerb	120		10 2-litzig 80		10		0	nein	100		täglich	täglich	täglich	bei Bedarf	0	kein
Einsiedeln	Nebenerwerb								nein	90	Lama						

Risse	Nachbar	Selber	innen/aussen	Zaun am Details	System	Beratung	Anpassungen	Aufwand fin.	Aufwand zeitl	wer wurde ko	zufriedenheit	Merkblätter
ja	ja	2012 Herbst	innen	kein Strom	Netz	nein	Erdung verbessert	1	1	WH	keine	hilfreich
ja	nein	2016 Frühjahr und nein	innen	im Dorf, beim zweiten Angriff im Netz	KG/Netz	ja	Netze gekauft, Nachtpferch	3	3	WH/HSB	hilfreich	unbekant
ja	nein	2016 Frühjahr	innen	oben nur extra KG	KG elektr.	ja	Verbesserung Elektrifizierung, bessere Zaunkontrolle	2	3	WH	sehr zufrieden	hilfreich
ja	nein				KG elektr.			0	0			hilfreich
ja	nein	2016 Herbst	innen		KG	Ja	Nachtpferch	0	4		hilfreich	hilfreich
ja	nein					ja	Neukauf, Flatterbänder, Kontrolle	4	3	WH/HSB	wenger	unbekant
ja	nein			unten keine Litze	KG elektr. Ob ja	ja	Nachtpferch	1	2		hilfreich	hilfreich
ja	nein	2015 Frühjahr		nur ein Hund vor ort	Netz/KG	nein	Verbesserung Elektrifizierung	2	4	WH/HSB	hilfreich	hilfreich
ja	nein	2016 `17 Herbst innerhalb	innerhalb			ja	Elektrifizierung, Verbesserung, HSH, bessere Kontrolle, Zaunerhöhung / Flatterbänder	3	3	WH	sehr unzufrieden	hilfreich
ja	nein				Neukauf	ja	Neukauf	4	4		unzufrieden	hilfreich
ja	ja	2010 Herbst	innerhalb	nur verletzt	Netz	nein, gabs nic	Zaunerhöhung, Netze kaputt	2	3	niemand	keine	unbekant
ja	nein	2016 Frühjahr	innerhalb	teilw. Natürl. Grenze	KG	ja	Zaunerhöhung, Nachtpferch	1	3	WH	wenger	hilfreich
ja	nein					nein	Gründung nach Wolfspräsenz, 5Litzenzäune	3	3		keine	hilfreich
ja	nein					nein		3	2		hilfreich	hilfreich
ja	nein					Ja	Zaunkontrolle, Blinklampen	2	1		sehr zufrieden	unbekant
ja	nein					nein		1	1		hilfreich	hilfreich
ja	nein					nein	auslauf	3	2		keine	hilfreich
nein	nein					ja	noch keine	2	2		sehr zufrieden	hilfreich
ja	ja	aussen	aussen	Lämmer waren ausserhalb	Netz	nein		2	2	WH	keine	hilfreich
ja	nein				nein	ja	Lama	0	1		keine	hilfreich
nein	nein				nein	ja	Alp Neukauf, Lama	1	1		sehr zufrieden	bekannt
nein	nein					nein	Blinklampen	1	1		kein	hilfreich
nein	nein	2016 Sommer	innen	wahrsch. Luchs	KG	ja	Lama, Neukauf elektr., Bessere Kontrolle, Nachtpferch Teilweise	2	2	WH/HSB	sehr zufrieden	wenger
ja	nein					ja	Neukauf, bessere Zaunkontrolle, Zaunerhöhung	2	3		hilfreich	hilfreich
ja	nein	2014 Frühjahr	innerhalb		2-Litzenzaun	Ja	Neukauf, nachts einstallen teilweise	0	3		wenger	hilfreich
ja	nein					Ja	keine	1	0		hilfreich	hilfreich

Table Fence and Pasture Assessment

Weide 1

Nutzung	Erschliessung	Fence Quality1						Protectability 1					
		System	Voltage	Condition	Visibility	Ground	total	steep	scrubs	complex	forest	ground	total
Mähweide	sehr gut	3	3	4	3	4	17	4	4	4	2	3	17
Weide	schlecht	1	1	2	3	2	9	2	3	1	2	3	11
Weide	gut	4	4	4	3	3	18	3	3	3	3	3	15
Weide	gut	3	2	3	3	4	15	3	4	4	4	3	18
Weide	gut	4	4	4	4	4	20	1	2	2	1	1	7
Weide	gut	1	1	1	3	2	8	3	3	3	2	2	13
Weide	gut	1	1	2	3	2	9	3	2	2	2	2	11
Weide	gut	4	3	4	4	3	18	3	2	2	1	2	10
Weide	ok	1	1	1	3	3	9	1	2	2	1	1	7
Mähweide	gut	4	4	4	4	4	20	3	4	3	4	2	16
Weide	schlecht	1	1	1	3	2	8	2	2	2	1	2	9
Mähweide	ok	1	3	2	4	3	13	3	2	2	1	2	10
Weide	ok	4	4	4	2	3	17	1	2	2	1	1	7
Weide	gut	3	3	4	3	3	16	4	4	4	4	3	19
Mähweide	sehr gut	3	3	4	3	4	17	4	4	4	4	3	19
Mähweide	sehr gut	3	3	3	3	4	16	3	4	4	2	3	16
Mähweide	sehr gut	3	2	3	3	3	14	4	4	4	4	3	19
Mähweide	sehr gut	4	3	4	3	4	18	3	4	4	4	3	18
Mähweide	gut	3	4	4	3	4	18	4	3	4	2	3	16
Mähweide	gut	3	3	4	3	4	17	3	4	3	3	3	16
Weide	gut	3	3	3	2	4	15	1	4	4	3	2	14
Weide	gut	1	1	2	3	3	10	2	3	3	3	3	14
Weide	sehr gut	3	4	3	3	4	17	2	4	4	3	3	16
Weide	sehr gut	1	1	2	4	2	10	2	2	3	1	3	11
Weide	gut	1	1	1	2	2	7	2	2	1	1	3	9
Weide	sehr gut	4	4	4	3	3	18	2	3	3	3	3	14
Mähweide	sehr gut	1	1	1	2	3	8	2	3	1	2	3	11
Weide	gut	2	4	3	2	3	14	2	3	3	2	3	13
Weide	sehr schlecht	2	3	2	2	2	11	2	3	3	2	3	13

Weide 2

Nutzung	Erschliessung	Fence Quality2						Protectability 2					
		System	Voltage	Condition	Visibility	Ground	total	steep	scrubs	complex	forest	ground	total
Weide	gut	3	3	1	3	4	14	3	4	3	4	3	17
Mähweide	gut	1	1	2	3	2	9	4	4	4	3	2	17
Weide	schlecht	4	3	3	3	3	16	3	3	2	2	2	12
Mähweide	gut	0	0	0	0	0	0	4	4	3	2	3	16
		0	0	0	0	0	0	0	0	0	0	0	0
Weide	schlecht	1	1	1	3	2	8	1	1	1	1	2	6
Mähweide	gut	1	1	1	3	2	8	4	4	4	4	3	19
Weide	gut	0	0	0	0	0	0	0	0	0	0	0	0
Weide	ok	0	0	0	0	0	0	0	0	0	0	0	0
Weide	ok	4	4	4	4	4	20	2	1	1	1	2	7
		0	0	0	0	0	0	0	0	0	0	0	0
Mähweide	ok	1	1	1	2	3	8	2	1	1	1	1	6
Weide		4	4	4	2	3	17	1	2	2	1	1	7
Weide	ok	3	3	4	3	3	16	4	4	4	4	3	19
Weide	schlecht	3	3	4	3	4	17	2	2	2	1	2	9
Weide	ok	3	3	3	3	4	16	1	3	2	2	3	11
Weide	ok	3	2	3	3	3	14	2	4	3	2	3	14
Weide	mässig	4	3	4	3	4	18	2	3	2	2	3	12
Weide	gut	3	3	4	3	4	17	1	3	3	2	3	12
Weide	gut	3	3	3	3	4	16	2	3	3	2	4	14
Weide	ok	3	3	2	2	4	14	2	4	3	3	3	15
Mähweide	gut	3	3	3	3	2	14	4	4	4	3	3	18
		0	0	0	0	0	0	0	0	0	0	0	0
Weide	sehr gut	1	1	3	3	3	11	4	3	4	4	3	18
Mähweide	gut	3	3	2	3	3	14	4	4	4	3	3	18
Mähweide	sehr gut	4	3	4	4	4	19	4	4	3	3	3	17
Mähweide	sehr gut	2	3	2	2	3	12	3	4	4	4	3	18
		0	0	0	0	0	0	0	0	0	0	0	0
Mähweide	sehr gut	4	3	3	3	4	17	4	4	4	4	3	19

Nutzung	Erschliessung	Fence Quality 3						Protectability 3					
		System	Voltage	Condition	Visibility	Ground	total	steep	scrubs	complex	forest	ground	total
							0						0
Mähweide	gut	2	1	1	3	3	10	3	4	4	4	2	17
							0						0
Weide	ok						0	4	3	3	2	3	15
							0						0
Mähweide	gut	1	1	1	3	2	8	4	4	4	4	3	19
							0						0
Weide	ok						0						0
							0						0
Mähweide	mässig	4	4	4	4	4	20	4	4	3	2	2	15
							0						0
							0						0
		4	4	4	2	3	17	1	2	2	1	1	7
							0						0
							0						0
							0						0
							0						0
							0						0
							0						0
							0						0
							0						0
Weide	mässig	3	2	1	2	2	10	3	3	3	2	3	14
							0						0
							0						0
							0						0
							0						0
							0						0
							0						0

11   Declaration

I declare that I have developed and written the enclosed Master Thesis completely by myself and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. The Master Thesis was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

Location, Date, Signature