Wild boar movement: Analysis of scare-off measures with R

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Background & Research Goal

During the 1960s and 1970s the wild boar (Sus scrofa) population increased consistently in whole Europe and also in Switzerland. Especially since the 1980s the population numbers of wild boar did stay at a quite high number (Massei et al. 2015). These high numbers of wild boars originate likely because of low impact of recreational hunting to wild boar population growth, mild winters, reforestation, intensification of crop production, supplementary feeding and compensatory population responses of wild boar to hunting pressure (Massei et al. 2015, Geisser 2005). Since crop production intensified and agricultural crops provide an optimal and easily accessible food source for wild boar, the damage of crop fields and therefore also financial loss for the farmers increased (Suter et al. 2018). In the past these damages lead to increased conflicts with farmers. To lower these human-wildlife conflicts, several prevention methods exist, whereas electric fences and scare off shots showed to be the most effective ones (Suter & Eyholzer 2010), nevertheless tend both methods to be quite time consuming and very costly (Suter 2013, Suter & Eyholzer 2010). To improve the situation for all involved and to create more cost-effective and practical methods, scare-off measures were developed, implemented, and monitored in the canton Bern (Suter, 2013, Suter et al. 2018). To evaluate the success of the scare-off measures, GPS data from 19 wild boars were analyzed regarding their movement over time in combination with the reaction towards the scare-off measures. This study aims to analyze, with the program R, the statistical success rate of the scare-off measures.

RQ:

- Can the effectiveness of the wild boar scare-off measures sufficiently be detected and a success rate calculated by analyzing the movement of the wild boar?

- Can a dependency between the effectiveness of the wild boar scare-off measures, the hunting pressure (weak& medium) as well the intensity of the scare-off measures be detected?

Data & Methods

Data

The data was collected within the scope of the ZHAW project "Prävention von Wildschweinschäden in der Landwirtschaft und Management von Wildschweinen in Schutzgebieten" conducted by S. Suter, S. Stoller and B. Sigrist in 2018. The provided data of the wild boars contained an investigation period of around two years and each data point was attributed with a TierID, TierName, CollarID, Sex, Weight and Study area. Additionally, movement data was provided for each wild boar individual containing TierID, TierName, CollarID, Date and Time of the recorded data point as well as coordinates, time of day and moon illumination at the time of recording. The provided data for the scare-off measures consists exact coordinates of where they were installed and the information when and how they were operated. The data showed an overlap of the wild boar and scare off measure investigation period between the middle of 2014 until the middle of 2016, leaving the year 2017 completely out of the analysis (figure 1). All unfiltered data points and trajectories of each wild boar around the acoustic scare-off measures was given (see figure 2 as an example with the wild boar Fritz).

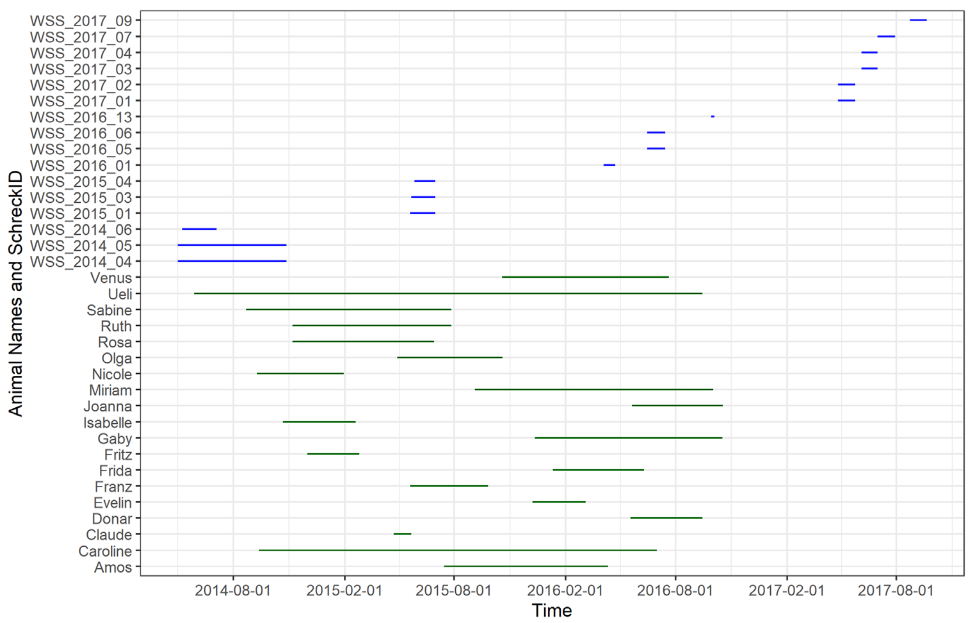

Figure 1:1 Investigation period of the wild boars (green) and the scare off measures (blue)

Limitations

The given data limits the analysis in a few ways. The recorded movement of the wild boar is only given in an interval of 15 minutes. Therefore, a reaction to the scare-off measure might not be recorded at all, as it might have happened in the 15 minutes between the recordings. The operational data of the scare-off measures contain the information on what date the scare-off measures were started and stopped and that they started every evening once it was dark enough, which was measured with a light sensor. However, the exact time when they went off to scare-off the wild boar was not recorded. That makes it difficult to draw a causality between scare-off measure and wild boar movement.

Further it was not possible to investigate the influence of the different hunting pressure since the available data after the pre-processing was only within the weak hunting pressure areas.

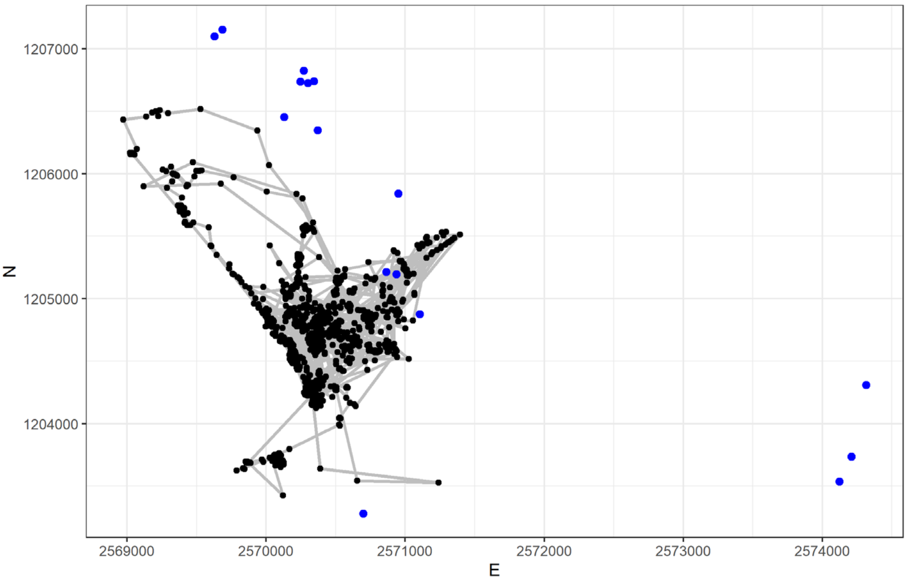

Figure 2:2 all unfiltered data points (black) and trajectory (grey) of wild boar Fritz recorded around the scare-off measures (blue)

Pre-processing

To analyze the provided data accordingly certain pre-processing steps needed to be taken. First, the data files for the scare-off measures were joined to add the information of the hunting pressure (weak& medium). Further, the new file was filtered by region, so only the scare-off measures in the reagion "Fanel" was left. For these scare-off measures, the times of dawn (end time) and dusk (start time) was calculated with the package "suncalc" for each day the scare off measures were activated. This was done in order to get the start and end time of the activation time since the scare off measures were activated when an integrated light sensor did not detect daylight anymore. Second, the wild boar movement data was adapted and expanded. The Euclidean distance was calculated between each recorded point of wild boar movement and each location of a scare-off measure. With this information, buffers could be set as factors at 500 (near), 1000 (midway) and 1500 (far) meters. The largest buffer was set to 1500 meters as Krähenmann (2015) detected, that the acoustic sound of the scare off measures can be heard by the wild boars up to that distance. Data points with a distance greater than 1500 were removed. Further, the datafile was filtered by date to match the timespan, on which the scare-off measures were activated. After this step a few scare-off measures could not be taken into account anymore, as there was no matching wild boar movement data. Due to this, the influence of the hunting pressure on the effect of the scare-off measure could not be analyzed, as there were only scare-off measures with weak hunting pressure left.

Methods

To measure the effect, that the scare-off measures might have had on the wild boar, the speed of the wild boars was calculated. Therefore, the time and distance between two data points had to be calculated first. The speed of the wild boar was further used for statistical analysis.

For the statistical analysis it is important to check the data for certain test requirements, such as if the data is normal distributed and if a variance homogeneity occurs. The Kolmogorov-Smirnov test was used to check the normal distribution and the Levene test to check the homogeneity of variance. The test showed that the data was not normally distributed and homogeneity of variance did not occur. Therefore, the non-parametric Kruskal Wallis test was used to test whether the speed of the wild boar depend on the proximity to the scare-off measure and whether there were differences in speed between day and night. The statistical tests were carried out once for all data, as well as individually for each scare-off measure.

The statistical analysis and data visualisation were carried out with R (Version 4.0.5). Level of significance (p) was set to 0.05.

Results

The speed of the wild boar could be calculated successfully for each scare-off measure within a radius of 1500 meters (Figure 3).

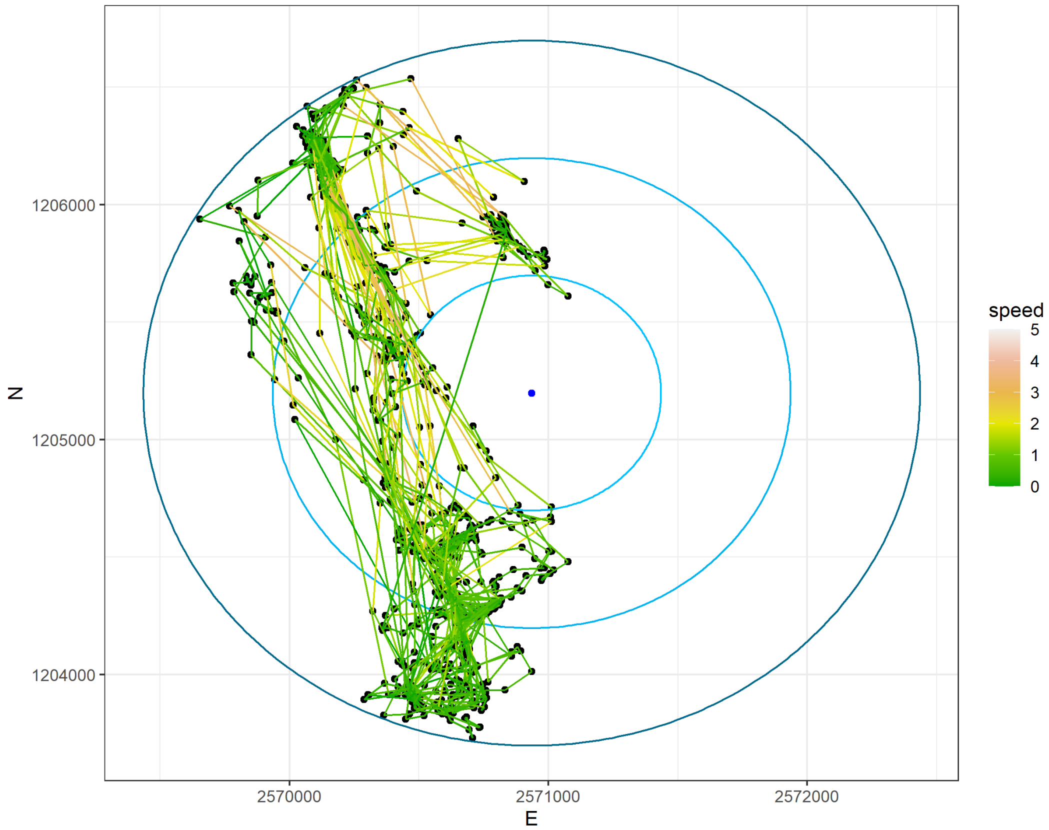

Figure 3: filtered data points and speed (km/h) at night time within the buffers of 500, 1000 and 1500 meters from the scare-off measure (blue) of the wild boar Caroline

The initial research question, whether the effect of the scare-off measures is dependent on the hunting pressure, could not be answered, due to insufficient data. However, with the calculated distance and speed, an effect of the scare-off measures could be detected. The statistical analysis showed that there are significant differences of speed depending on the proximity of the wild boar to the scare-off measure ($p < 0.001$, df = 2) (Figure 4), as well as dependent on the time of day ($p < 0.001$, df = 1) (Figure 5). The results of the analysis of the individual scare-off measures as well as the analysis of all data were significant in terms of the dependency of speed of the wild boar on the distance to the scare-off measure (Table 1).

Table 1: Resultus from the statistical Analysis of the speed dependent on the distance to the scare-off measure

ID Scare-off measure	near:midway	midway:far	near:far
Overall	< 0.001	< 0.001	< 0.001
WSS_2014_04	< 0.001	< 0.001	< 0.001
WSS_2014_05	< 0.05	< 0.001	< 0.001
WSS_2015_01_s	< 0.001	< 0.001	< 0.05
WSS_2015_01_a	< 0.001	< 0.001	< 0.001
WSS_2015_03_s	< 0.001	< 0.001	< 0.001
WSS_2015_03_a	< 0.001	< 0.05	< 0.001
WSS_2015_04	< < 0.001	< 0.001	< 0.001

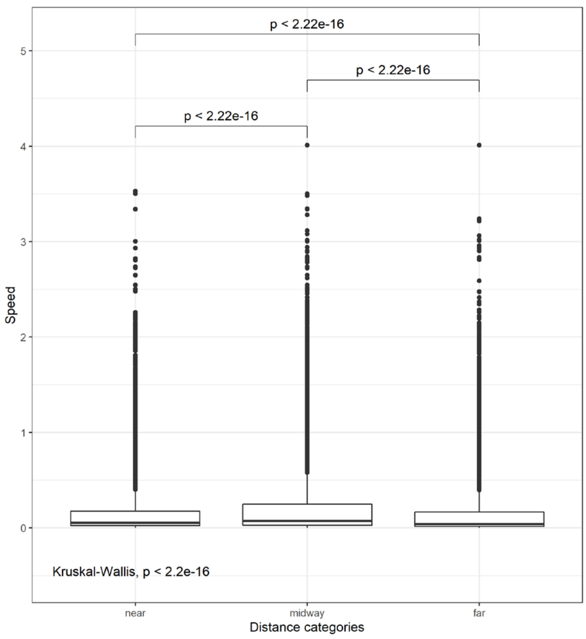

Figure 4: Results of the statistical analysis of the speed dependent on the distance to the scare-off measures

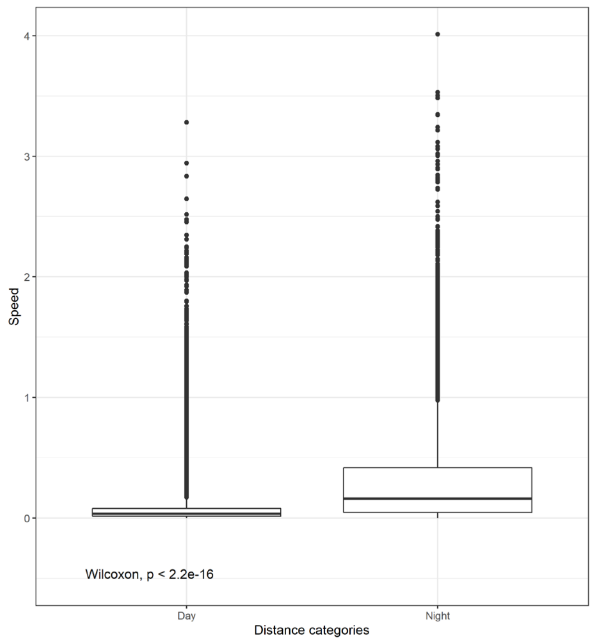

Figure 5 Result of the statistical analysis of the speed dependent on the time of day

Discussion

The commonly used scare-off measures, such as warning shots, aversive conditioning with dogs or anti wild boar fences require a lot of time, effort and patience. Whereas the analyzation of this study showed that the acoustic scare-off measures had an influence on the wild boar movement pattern and is therefore considered to be more effective. Another advantage of the acoustic scare-off measure is the remote operation process. It is less time consuming and takes less effort for the farmers and hunters in comparison with aversive conditioning with dogs, warning shots or even hunting.

Even though the data showed a significant effect on the wild boar movement there were, as mentioned before, certain limiting factors during the analyzation. As the first research question states it was aimed to calculate a success rate for the scare-off measures. Unfortunately, this was not possible due to the insufficient granularity of the wild boar data and the missing recordings of the exact scare-off events. In order to calculate the success rate, the exact times of the scare-off events have to be known. An additional limitation in the data was the 15 minutes interval recording of the wild boar movement, as with this interval movements could have potentially been missed, since the wild boars could have moved towards the scare off measure within the 15 minutes between the recording. To calculate the success rate, all immediate reactions between scare- off measures and wild boar movement should have been recorded. Therefore, it is advised for further studies to implement motion detectors within the scare-off measures rather than using interval periods of 15 minutes.

Since the operation data only contained data about the starting and end times of the scare-off measures the direct causality between the measures and the wild boar movement was rather difficult to see. Even though the results showed a significance in the dependency of distance and speed, it could not be directly set into context with the wild boar movement.

As previous studies showed, the most effective method to scare off wild boars and to protect the fields of the farmers, is a combination of two or more methods, since implementing only the acoustic scare-off measures could lead to a certain adaption of the wild boars and loose its scare-off effect in the long term (Suter et al. 2018). Therefore, it would have been very interesting to investigate the influence of the different hunting pressure intensities. Unfortunately, the available data was only within the weak hunting pressure areas and a comparison with medium and strong hunting pressure areas was therefore not possible. It is likely that different intensities of hunting pressure in combination with the acoustic scare off measures, influence the wild boar movement pattern differently (Dr. phil. nat. Boldt 2015).

Further studies should take these into consideration and could additionally implement the distance of where the wild boars scare to in comparison with the direction in which the acoustic scare-off measures show and if the acoustic scare-off measures cause a negative effect on the wild boar movement pattern by scaring them further off then intended (Suter et al. 2018).

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