# Hunting Effect on Individual Deer Stress Level

**P15.2 Fortgeschrittenes Praxisprojekt**

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# 2 Introduction

## 2.1 Background

Apart from the change in populations size, the effects of hunting on wildlife have so far been studied mainly on the basis of behavioral changes. This project aims to investigate the physiological stress response in red deer using a non-invasive method, the measurement of faecal cortisol metabolites (FCMs).

## 2.2 Data Generating Process

The data for the project origins in the *Bavarian Forest National Park*. Its location is highlighted in green in Figure 1. Within and on the borders of this area, red deer roam freely. Some of these deer have been **collared with a GPS-device**, which helps to track the movement. At some time, a **hunting event** happens and the deer experiences some amount of stress. Later, the deer defecates ("**defecation event**"). Subsequently, researchers visit the defecation location and collect a **faecal sample**.

**Stress is expected to be higher in proximity**[1] **to hunting events**. With higher stress, FCM values are expected to be higher. Huber et al. (2003) showed (Figure 2) that the FCM levels peak between 16 and 19 hours after a stress event (called "challenge"). Additionally we expect, that FCM levels are lower, the more time passes between defecation and sampling.


Figure 1: Location of Bavarian Forest National Park

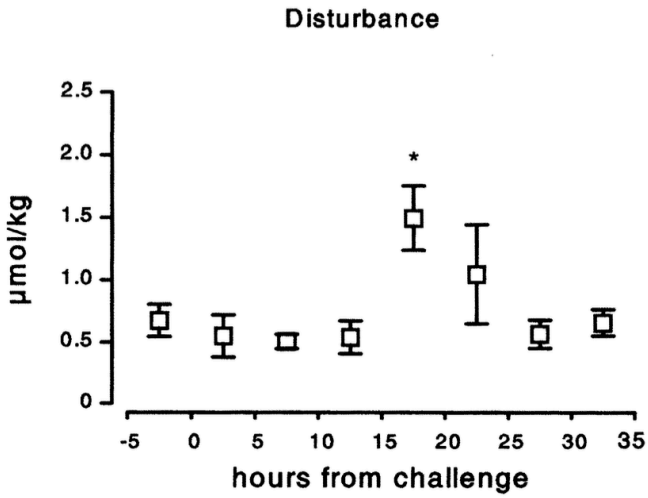


Figure 2: FCM levels over time

## 2.3 Research Question

Therefore our research question is two-fold:

- assess the effect of temporal and spatial distance on FCM level
- assess if the time between defecation event and sample collection affect the FCM levels

[1] this includes temporal and spatial proximity

# 3 Data Analysis

We were provided with four distinct Datasets. In the following subchapters we are going to describe the main features of each data set, but the reproduction data (see Chapter 7) and address any anomalies.

## 3.1 Hunting Events

The dataset contains the location and time of roughly 700 individual hunting events, spanning from 2020 to 2022. There are three main challenges:

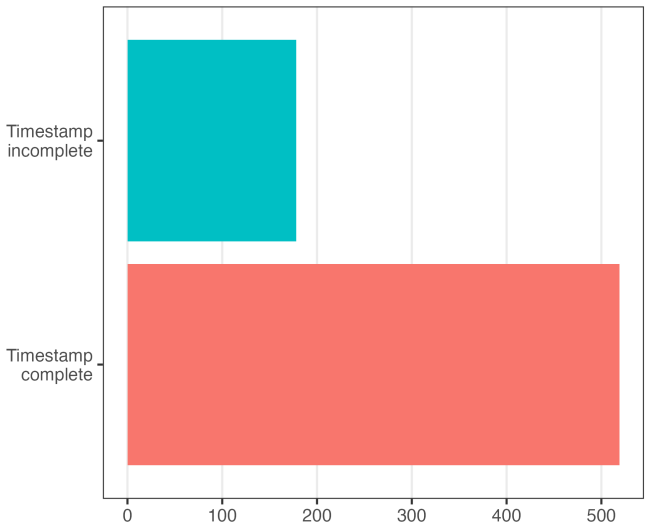


Figure 3: Hunts - completeness of timestamp

i) Just a little over 500 of these events have a complete timestamp, consisting of date and time of day (Figure 3).
ii) The events are not represented as a period of time, but as a as a single moment in time. Additionally, as shown in Figure 4, there appears to be seasonality in the occurrence of hunts.
iii) Similiarly to ii), the events are only associated with a single spatial point. The locations of the events with complete timestamps are illustrated in Figure 5.

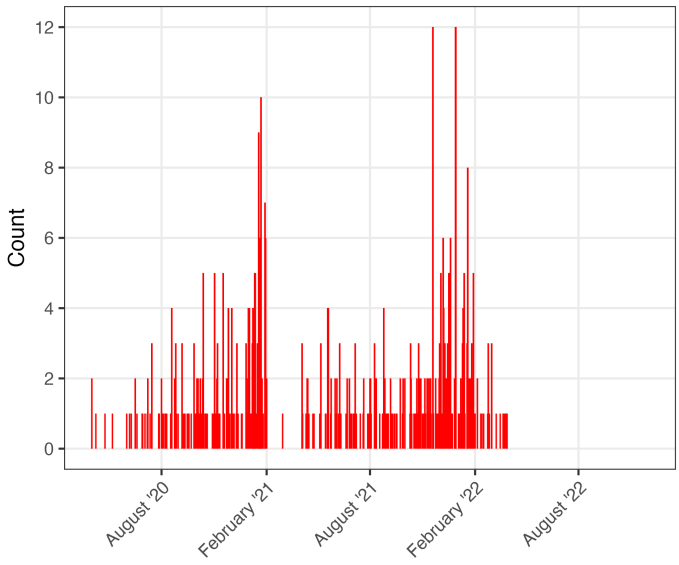


Figure 4: Hunts - Daily Count

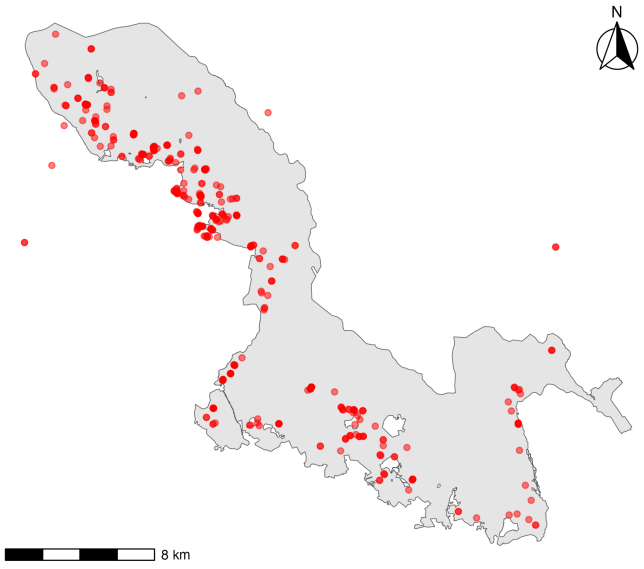


Figure 5: Hunts - Locations

## 3.2 Movement Data

There are **40 collared deers** which movements have been tracked completely or partially between February 2020 and February 2023. Some collars stopped working before the end-date, some deers got collared *within* the timespan of interest. The location of each individual deer is **tracked on an hourly basis**. The Movement of four randomly selected deer is visualised in Figure 6. During the winter months, the deers roam in one of four enclosures within the national park.

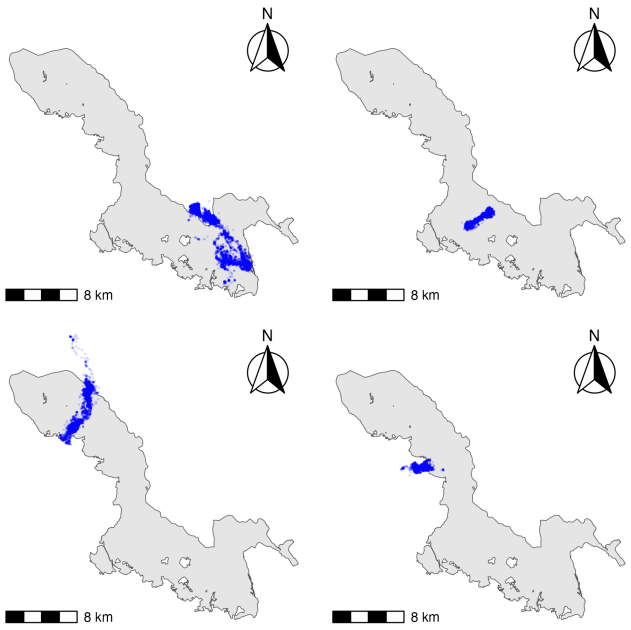


Figure 6: Deers - Locations of four Deer

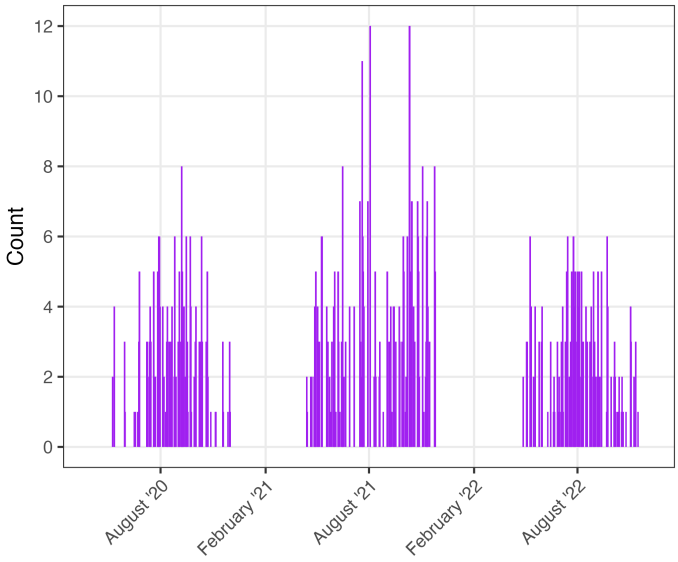


Figure 7: Samples - Daily Count

## 3.3 Faecal Sample Data

The faecal sample dataset contains information on **809 faecal samples**. Most importantly, the FCM-level (in nanograms per gram [ng/g]), the location of the sample, as shown in Figure 8, the associated collared deer, the approximate time of defecation and the time of sampling. The samples were taken at irregular intervals, but with obvious seasonality (see Figure 7) from 2020 to 2022.

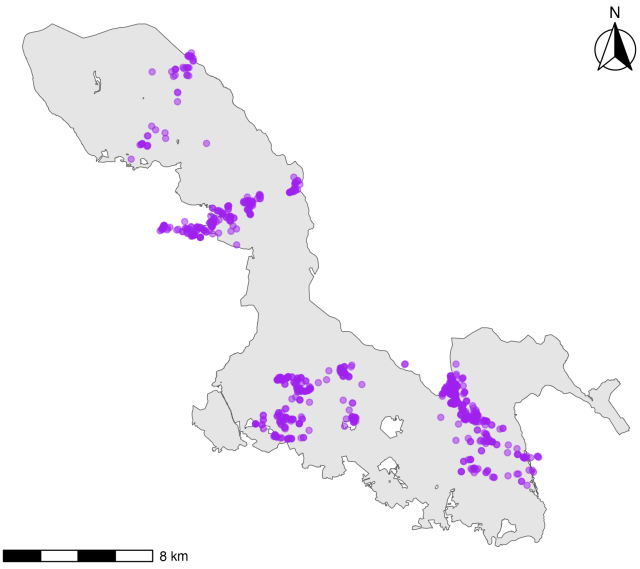


Figure 8: Samples - Locations

# 4 Data Preprocessing

## 4.1 Filtering

## 4.2 Assumptions

We had to make several assumptions about the data. First, we assumed that the movement of each deer between two points is approximately linear and at a constant speed, i.e. we used linear interpolation to determine the coordinates between two signals from the GPS collar. We also assumed that each hunting event was actually a sound event (i.e. a shot was fired). Therefore, we weighted the value of our score function by $\frac{1}{d^2}$, where $d$ is the Euclidean distance between a given deer and a given hunting event. Furthermore we assumed that there is no effect of terrain, weather or vegetation on a deer's perception of a hunting event.

## 4.3 Uncertainties

# 5 Model Selection

## 5.1 subtopic 1

## 5.2 subtopic 2

# 6 Model Evaluation

## 6.1 subtopic 1

## 6.2 subtopic 2

# 7 Conclusion & Outlook

We deliberately chose not to include the pregnancy data in our model as it only contains information on some deer. As we are not able to label the remainder of the deer as “pregnant”/“not pregnant”, we are convinced that including this information would lead to a huge bias. However, we are strongly in favor of adding additional characteristics that could explain a shift in baseline stress levels.

Huber, Susanne, Rupert Palme, Wolfgang Zenker, and Erich Möstl. 2003. “Non-Invasive Monitoring of the Adrenocortical Response in Red Deer.” *Journal of Wildlife Management* 67 (April): 258–66. https://doi.org/10.2307/3802767.