# The use of camera traps and night vision equipment to record the presence of mammalian predators in a meadow bird landscape

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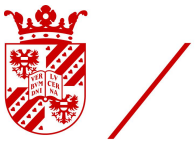

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## Abstract:

Mammalian predators currently limit the recovery of meadow bird populations, but are difficult to study due to their nocturnal lifestyle. In this study, I compared the effectiveness of camera traps and night-vision equipment to detect mammalian predators in a meadow bird landscape. Camera traps and night-time surveys using a thermal imaging devices were conducted in three main study areas. Here, the distribution of red foxes and beech marten was established by experiences field workers, based on tracks and signs, complemented with observations. In order to get an idea about the presence of domestic cats, I asked all households in the study area how many free-roaming cats they owned.

Red fox was not present in the study area in 2019 because of effective lethal control in early spring. Beech marten were found at 14 locations. Camera traps placed at 7 such locations could confirm the presence of beech marten at 3 of them (43%). At 18 other locations, only 4 beech martens were captured on camera. During night-time surveys, beech marten were found at 3 locations. Density of domestic cats was really high (on average 15.5 individuals per square kilometer). The effectiveness of camera traps and night-time observations to detect domestic cats within expected cat hotspots was comparable.

I conclude that night-time surveys using thermal imaging devices could be an effective way to monitor the presence/absence of mammalian predators. Camera traps appear to be slightly more effective but costs and time investments are very high.

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# Chapter 1: Introduction

In the Netherlands, meadow birds are in strong decline, despite large investments in restoration and conservation measures [van Turnhout *et al*., 2010]. Agricultural intensification is the prime cause for the decline of meadow birds, but predation (in itself possibly an effect of intensification of agriculture) by generalist predators strongly contributes to this [Geiger, 2011]. In addition, good evidence exists that nest and chick predation limits population recovery [Klug *et al*., 2009)]. The dominant role of predation is especially striking since the recovery of many predatory species during the last decades in the Netherlands can be regarded as a major conservation success, but now hampers the conservation of the specific iconic species of agricultural landscapes with high conservation value [IUCN, 2019].

Research on meadow bird predation hitherto has focussed on quantifying predation rates and identifying the different species of predators [Van der Vliet *et al*, 2008. Davidson, 2000] . The ecology of the predators themselves, such as their diet and habitat use throughout the year, has received little attention. This is surprising as knowledge on factors determining predation pressure in modern landscapes is required to come to best practise landscape-level measures to reduce predation pressure to levels that no longer limit the recovery of ground-breeding birds.

One problem in the study of especially mammalian predators is the fact that they are mainly nocturnal, and thus difficult to observe. Even determining the presence/absence of these predators can be complex. Two methods are commonly used to observe mammalian predators during the night. (1) Camera traps are nowadays routinely used to study the composition of the communities of mammals. (2) Night vision equipment such as thermal imaging camera's offer another interesting option to observe animals when it is dark.

In this study I compare the effectiveness of using camera traps and thermal imaging camera's to detect the night-time presence of Beech Marten (*Martes foina)*, Red Fox (*Vulpes vulpes)* and Domestic Cat (*Felis catus)*, in a meadow area just north of the city of Groningen (the Netherlands). Information on the presence if Beech Marten and Red Fox was obtained from experienced fieldworkers that roam the study area on a daily basis and thus should have a more or less complete picture on the presence and absence of predators. Information on the distribution of cats was derived from interviews with inhabitants of the study area, in combination with results from a GPS-tracking study in the study area.

# Chapter 2: Research Area

My study area was the grassland area north of the city of Groningen (the Netherlands). I focussed my research in three sub-areas: Paddenpoel, Koningslaagte and Winsumermeeden. Land use on these wet clayey soils is dominated by agriculture, which almost exclusively consists of dairy farming. Farming practices are intensive, with maximum use of slurry and artificial fertilizers. Water levels are lowered in order to allow access to the fields early in spring. Meadows are poor in the number of plant species (monocultures of perennial ryegrass). Grass is harvested 5 to 6 times per year, with the first cut around the end of April – beginning of May. Fields adjacent to the farms are often grazed by cattle.

Parts of the Paddenpoel and Koningslaagte area are nature reserves especially managed for meadow birds [Feenstra, 2019]. Here, the meadows are rich in herbs (herb-rich meadows). Farmyard manure is used to fertilize the fields, and first mowing dates are after the 15$^{th}$ of June. Water table is raised to just under the soil surface. Parts of these nature reserves are grazed by cattle.

The main meadow birds breeding in these areas are Black-tailed Godwit (*Limosa limosa)*, Redhank (*Tringa totanus)*, Lapwing (*Vanellus vanellus)* and Eurasian Oystercatcher (*Haematopus ostralegus)* [Feenstra, 2019]. Main mammalian predators are Red Fox, Beech Marten, Polecat (*Mustela putorius),* Stoat (*Mustela erminea)*, Least Weasel (*Mustela nivalis)*, and Domestic Cat. Main avian predators are Common Buzzard *Buteo buteo*, Marsh Harrier *Circus aeruginosus*, Common Kestrel ((*Falco tinnunculus)*, Carrion Crow (*Corvus corone)*, Grey Heron (*Ardea cinerea)*, and White Stork (*Ciconia ciconia)*.

In the three study areas, farmers, conservationists and hunters work together to conserve meadow birds, as coordinated by the farmer's collective 'Collectief Midden Groningen' [Collectief Midden Groningen]. On intensively managed grassland wet grassland patches are created ('plasdras') which attracts species like the Redshank and Lapwing [Van der Vegte, 2018]. In addition, the harvest of fields with high numbers of breeding meadow birds is delayed to after the main breeding season ('uitgesteld maaibeheer'). These fields with later mowing dates are often situated around wet grassland patches. In other grass fields nests of conspicuous species (Black-tailed Godwit, Oystercatcher, Lapwing, too lesser extent Redshank) are located by volunteers, and these nests are spared during mowing, leaving small islands of unmown grass. Finally, in the whole area predators are controlled by removing possible breeding sites of Buzzards and Carrion Crows, and lethal control of Red Foxes. Other predators are not controlled as they are protected by law.

*Weather*

The breeding season of 2019 was characterized by a hot and dry summer [KNMI, klimatologierapport 2019]. It started with a very soft and dry winter, essentially kickstarting the spring. Voles, a good prey to many present predators, were particularly abundant and therefore predation rates on meadow bird eggs and chicks were lower [Jacob *et al*., 2019]. While the spring started with rain, it ended with a dry period. An extra effort of artificially flooding (called a 'plas-dras') some areas was practiced to counter this.

# Chapter 3: Method of Research

## Approach

In order to test the effectiveness of the camera traps and night vision equipment to detect the presence of predators, I first had to know the true distribution of Red Fox, Beech Marten and Domestic Cat in the study area. Subsequently I used camera traps and night vision equipment to search for the presence of cats. By comparing these observations with the true distribution of predators I can evaluate the effectiveness of the methods.

## Information on the distribution of Red Fox, Beech Marten and Domestic Cat

*Red Fox and Beech Marten*

For information on the presence of Red Fox and Beech Marten I relied on information from experienced fieldworkers that visited the study area on a daily basis. They checked for traces such as prey remains and droppings near potential roosting sites. In addition, they collected data from farmers and other inhabitants on the presence of predators.

*Domestic Cat*

Domestic Cats are very abundant in the area as almost all farms would have one or several cats. In addition, many of the households in the villages next to the study area would own cats. I mapped the distribution of Domestic Cats in Koningslaagte, one of the study areas, as a case study. In order to do this, I visited every farm and house and asked whether the people owned cats, how many, and whether they were allowed outside during the night.

Subsequently, I combined this distribution data with information on the home range size of Domestic Cats, as collected by student Stefan van den Broek in 2019 in Winsumermeeden and Koningslaagte. He tracked cats living on farms using GPS-loggers and calculated the distances the cats moved from their homes. By combining this data with the information on the distribution of the cats, I could calculate a heatmap of potential cat abundance in the study area. In this calculation I did not consider any barriers for cat movement, but simply assumed that the cats could move in any direction.

**Field observations**

*Camera traps*

10 Bushnell camera traps (Trophycam HD 2017) were placed in the field for two weeks. This camera is motion-triggered and works during day as well as during the night. In order to maximize the success of picturing a predator the cameras were placed at locations where we expected predators to pass, such as dams, bridges and next to ditches. In the Paddepoel area I've setup camera's at 12 locations, in Koningslaagte at 7 locations and in Winssumermeeden at 6 locations. After a week the camera's would be checked and the memorycards would be swapped so the data was easier to manage and categorize. After two weeks the cameras were moved to another part of the study area. In this way I managed to cover the three study areas. A subset of locations was samples twice, depending on the availability and use of the locations. During every trip 5 cameras were checked, removed or replaced.

Left: Bushnell camera trap placed in a stick.


Right: Polecat captured on camera.

In the first few weeks, several camera setting were tested in the field or at home. A camera trap is activated by movement and to avoid large numbers of pictures of grass moving in the wind I restricted the number of pictures taken to two every minute. The sensibility of the (infra-red)sensor was set to "low", to avoid pictures of moving grass as much as possible. A timestamp was activated to show by the second in which the photo or video was taken, but this should be checked regularly as the camera tends to "reset" itself sometimes. They were eventually placed on sticks, at 25-30 cm above the ground to yet again evade grass movements but to still being able to capture anything that happens on ground level.

*Thermal imaging camera*

A thermal imaging camera (Pulsar Helion XP50) was used to look for predators during the night. A fixed route was covered by car or bike through the study area. One study area was covered per night and approximately 2-3 nights a week were covered for about two months. At every approximately 100 m a stop was made to scan the fields with the thermal imaging camera. All observations were noted on field maps. For logistic reasons, night-time counts were only conducted in Paddenpoel and Koningslaagte. One shift would take 3-4 hours by bike, and slightly less by car. Using a bike was slightly inconvenient because of the materials (thermal imaging camera, pen, paper etc.) you need to have by hand at every stop.

A cow seen at night using the thermal imaging camera.

# Chapter 4: Results

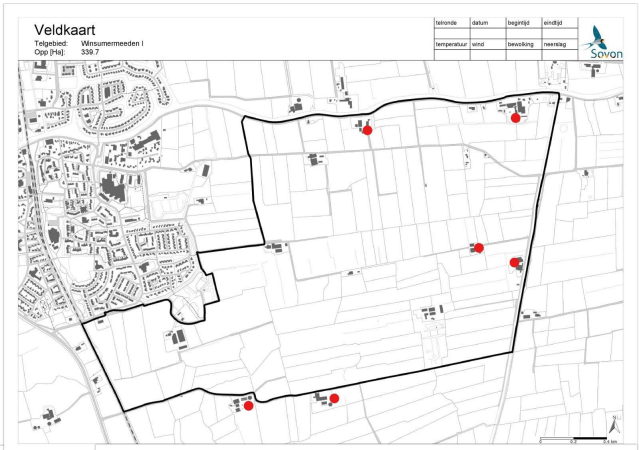
*Observations by experts*

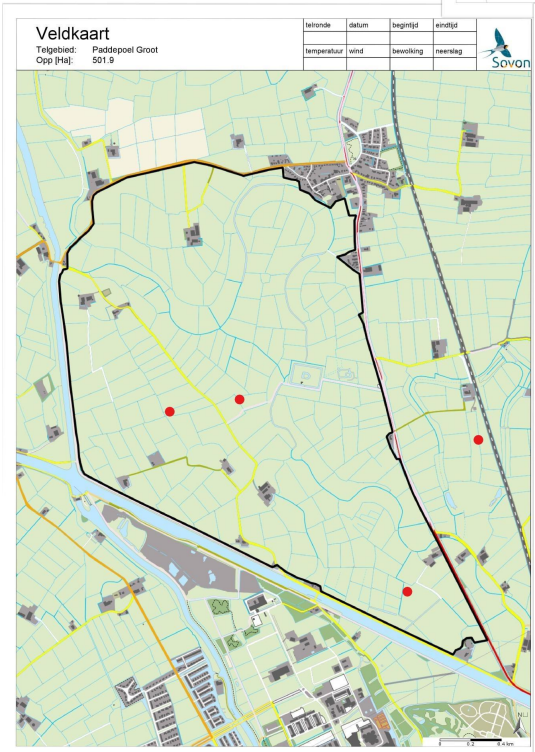
Experienced fieldworkers found 4 Beech Marten territories in Paddenpoel, 4 in Koningslaagte, and 6 in Winsumermeeden. This overview is the result of months of intensive fieldwork checking potential roosting sites often at a daily basis, complemented with observations by others.

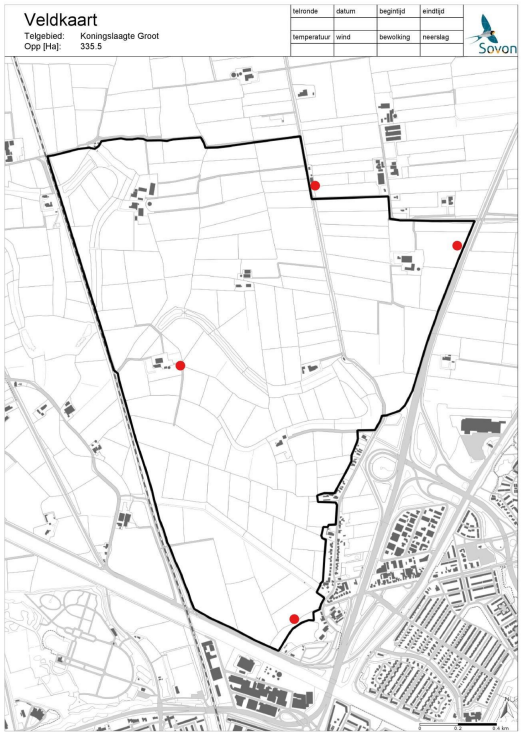
No Red Foxes were observed during the breeding season, apparently the lethal control of Red Foxes in winter and early spring had been effective. Only old tracks were found.

Locations of martens spotted by fieldworkers

● = marten spotted by fieldworkers



*Mapping the distribution of Domestic Cats in Koningslaagte*

Stefan van den Broek managed to collect data on the movements of 17 different Domestic Cats. These all lived on farms and were fed by their owners. As the cats were tracked multiple times the total number of tracks measures 41. One individual (Guus), a tomcat, roamed the farms and villages in a wider region, and as this behaviour was not representative for the general behaviour of the other cats, this track was not considered in further analysis.


Exampe of a cat equipped with a GPS-logger and the corresponding track.

From the tracking data, the frequency distribution of distances to the farm was calculated (figure 1). Cats regularly make trips into the fields, in which they do not remain in the fields directly adjacent to the farms. Nevertheless, 82% of the time the cats remained within 100 m from the farm. 11% of the time was spent at 100-200 m (160 minutes per day), and only 7% at more than 200 m (100 minutes per day). The maximum distance recorded was 855 m.

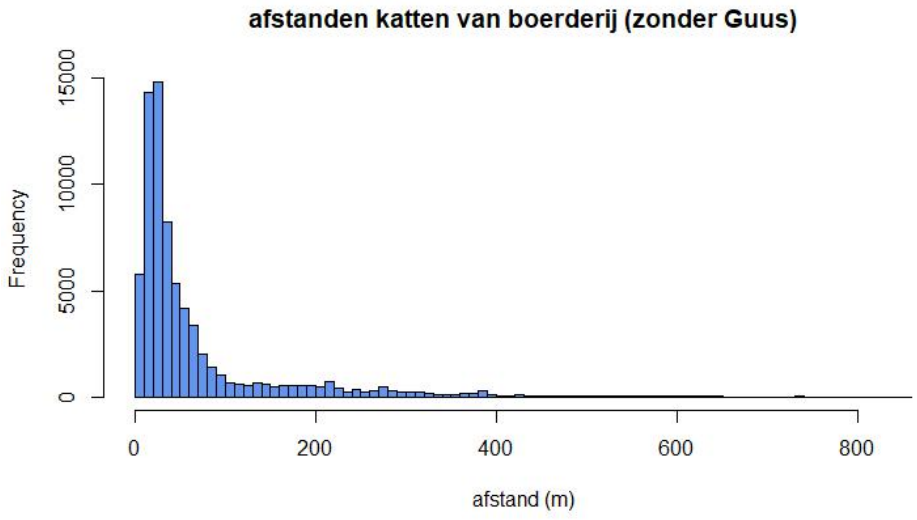



Figure 1. Frequency distribution of distances cats roam from their farm.

For Koningslaagte, I obtained information on the presence of Domestic Cats for 132 households. 60% (80 households) owned one or more Domestic Cats, on average 1.21 per household (or 0.73 if we would include also households without Domestic Cats). The overall density of Domestic Cats over the whole study area was 15.5 individuals per square kilometre.

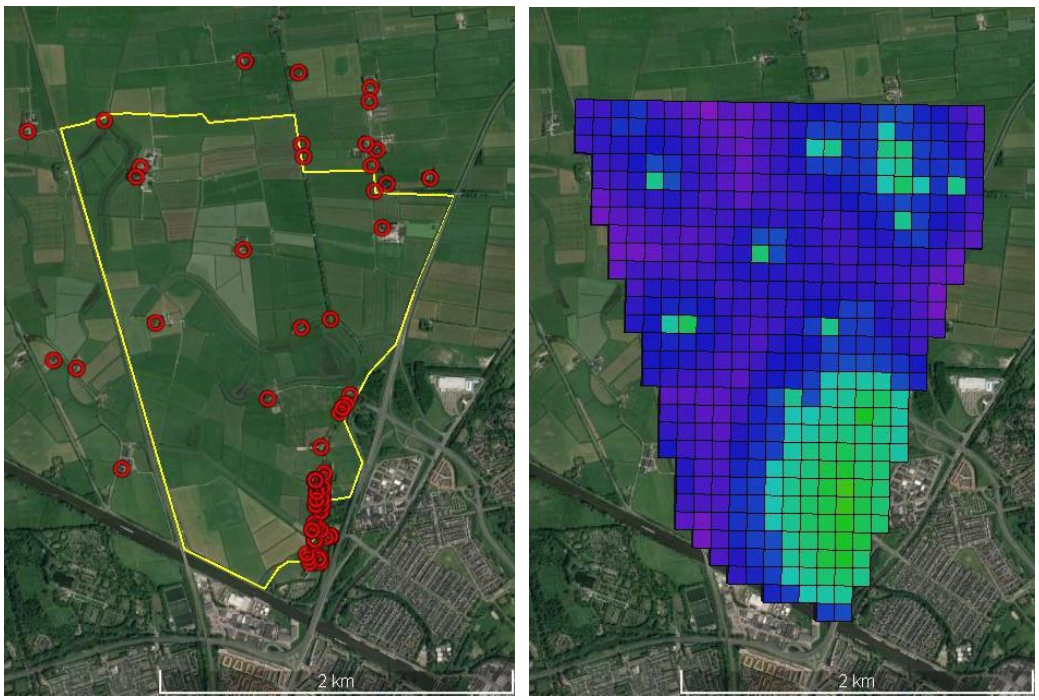
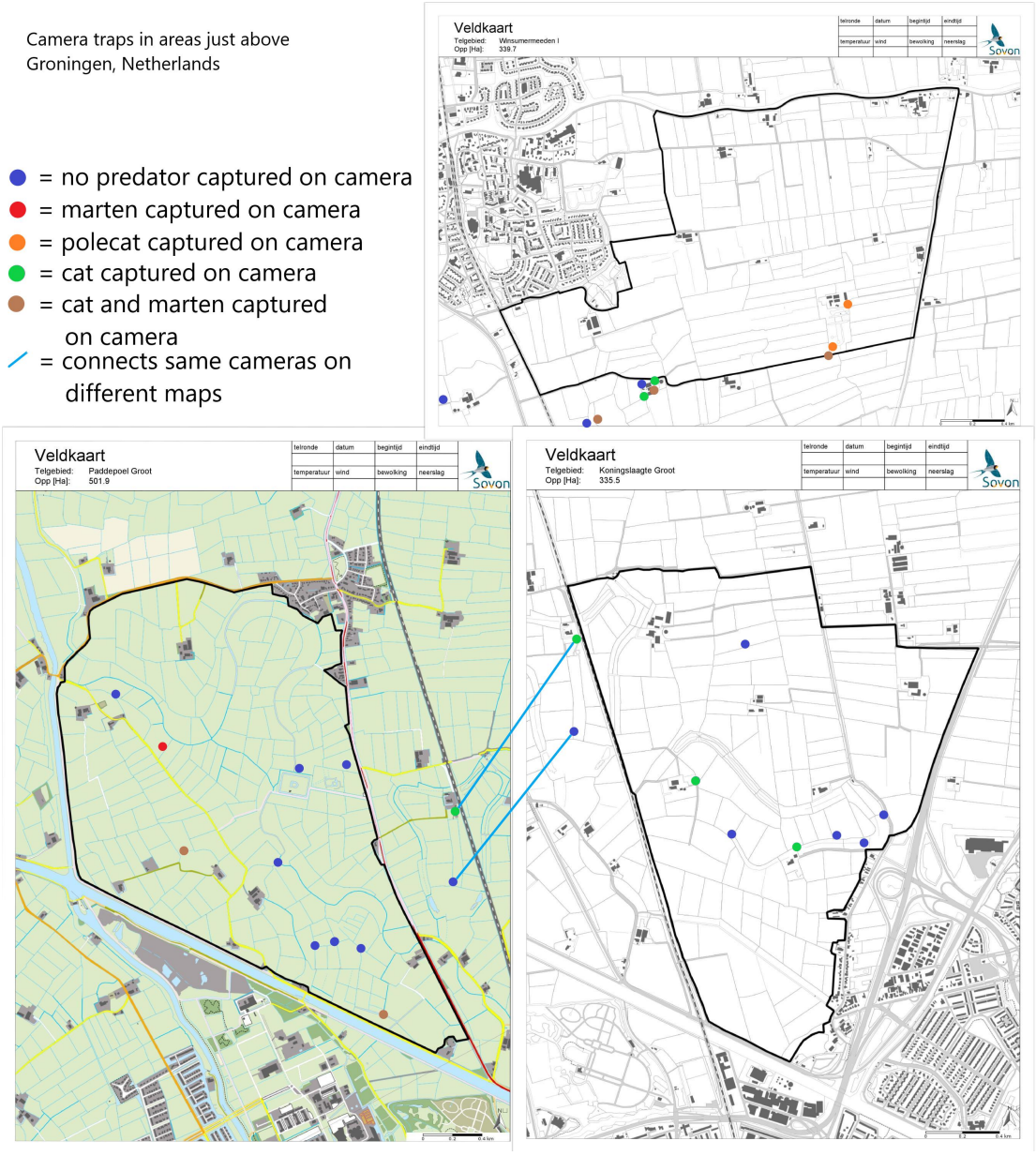



Figure 2. Left: households that own Domestic Cats. Right: inferred cumulative presence of Domestic Cats throughout the Koningslaagte study area, based on the distribution of Domestic Cats and the distances they roam from their houses based on GPS-tracking.

By combining the information on the distribution of the Domestic Cats with the results of the GPS-tracking study, we can calculate the expected cumulative presence of Domestic Cats throughout the whole study area (figure 2). This shows that the density of Domestic Cats is so high that there is no area were no cats can be expected. Furthermore, there are clear hotspots where a higher number of Domestic Cats is expected. A clear hotspot is the southeast corner of the study area, as it is bordering a neighbourhood (Woldijk, Groningerweg) with many households that own cats. Another hotspot is situated in the north-eastern corner of the study area where a concentration of farms with cats occurs.

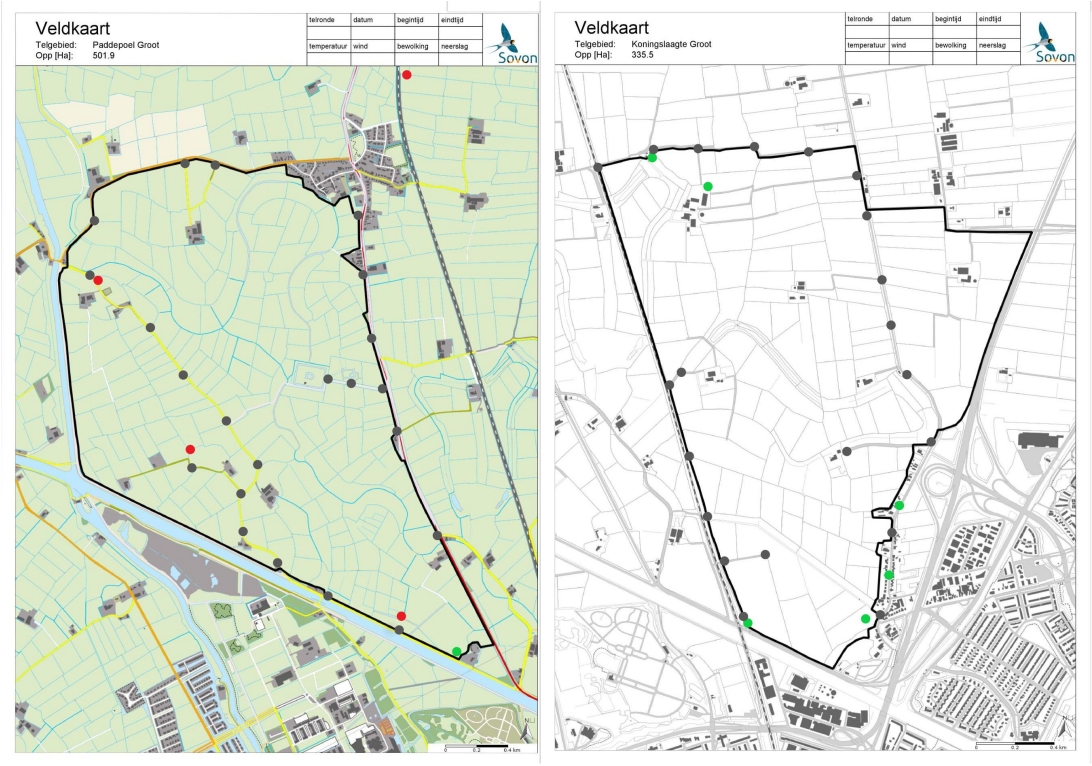
*Observations by Camera Traps*

With the camera traps no foxes were detected in any of the study areas. In Paddepoel, Beech Marten was detected at three locations, in Winsumermeeden at four locations, and none in Koningslaagte. Cats were captured on camera at three locations in Koningslaagte.



*Observations by Thermal Imaging*

No Red Foxes were seen during the night-time surveys. In Paddenpoel Beech Marten was observed at three different locations. No Beech Marten was encountered in Koningslaagte. In Koningslaagte Domectic Cats were seen at six different locations.




● = observation point
● = marten seen with night vision
● = cat seen with night vision

*Combining Distribution Information with Observations*

Apparently no Red Foxes were present in the study areas in 2019. They were not found by the expert fieldworkers, and not detected on the camera traps nor the nigh-time surveys using night-vision equipment.

Camera traps were located at seven locations were experts indicated that Beech Martens were present. At three of these locations, Beech Martens were captured on camera (43%). At one location where experts did not indicate the presence of Beech Marten one individual was pictured.

In Koningslaagte, five camera traps were located within hotspots of expected Domestic Cat activity. On two of these cameras (40%) Domestic Cats were registered.

During night-time observations, we scanned six locations where the experts indicated the presence of Beech Martens. On only two of these locations (33%)

Beech Martens were observed. At one location in Paddepoel a Beech Marten was observed where the experts did not indicate the presence of Beech Marten.

In Koningslaagte Domestic Cats were regularly observed during the night-time surveys. 11 survey points were located within the hotspots of expected Domestic Cat presence. On five of these points, Domestic Cats were indeed observed (45%). One Domestic Cat was observed outside the expected hotspot areas.

# Chapter 5: Discussion and Conclusion

We evaluated two methods to survey the presence of mammalian predators in a practical field setting in a meadow-bird landscape north of the city of Groningen.

In order to be able to evaluate the effectiveness of the methods, we first needed to establish the true presence of the predators (Red Fox, Beech Marten, Domestic Cat) in our study areas. For this we relied on experts that spent many hours in the field searching for tracks of predators near potential roosting sites, complemented with observations from farmers, hunters and others. Due to the fact that I observed (by camera traps or by night-time vision equipment) Beech Martens outside the areas indicated by the experts, we can conclude that even after months of intensive observations by skilled experts no complete picture on the distribution of predators was obtained. However, it should be noted that we do not know the distances Beech Martens move during the night, and because martens can have a territory that spans many hectares, it cannot be excluded that these observations were individuals that were relatively far away from known roosting locations [López-Martín *et al*, 1992].

For Domestic Cats we relied on a combination of a field survey (asking all households whether they owned Domestic Cats) and information on home range size from a GPS-tracking study. This indicated that Domestic Cats could occur everywhere in the study area, although also clear hotspots were visible. In our rather simple analysis, we did not consider Domestic Cats being restricted in their movements by barriers such as water. As it is likely that the movements of Domestic Cats are affected by these kind of landscape structures, this should be implemented in a future more sophisticated version of the model predicting cumulative Domestic Cat presence [MacPete, 2019].

Although most of the inhabitants of the area were present during one of our visits, we still couldn't reach all locals. In addition, not all inhabitants wanted to participate or couldn't exactly tell how many cats they had. The latter was especially true for some farms, where cats usually roam around freely and are not necessarily being treated as in-house pets.

In addition, several respondents reported the presence of feral cats in the area (i.e. non-owned and non-fed cats). The number of feral cats is hard to guess, but might comprise several tens of individuals, i.e. 5-10% of the number of owned cats. Farm cats sometimes have a nature in between domestic and feral cats. They are not necessarily fed, although the farms provide shelter to them, and the owners consider them as pets. The presence of feral cats and the unbound

nature of some farm cats make it difficult to generalize when talking about ‘cats’ in meadow bird areas [Horn *et al*, 2011].

Camera traps did not succeed to confirm the presence of Beech Martens at all locations were they were present. Their effectiveness is about 43%. The effectiveness of camera traps to detect Domestic Cats in hotspot areas was rather similar (40%). Night-time surveys using night-vision equipment was less effective in detecting Beech Martens (33%). The effectiveness to detect Domestic Cats was higher (45%) and comparable to the effectiveness of camera traps.

Differences between camera traps and night-time observations: (re)placing and processing camera traps is a lot of work. As these cameras are expensive (which also makes them susceptible of theft), altogether the use of camera traps is quite expensive [Meek *et al*, 2016]. It’s great for long observations at a specific location, but only that specific area is being covered which animals could easily evade. For an overview of animal biodiversity at a certain location (rather than scanning areas for select species), the above method could be more effective [Wearn *et al,* 2019]. Night-time observations are much less work, although the work is at unfavourable night hours. The locations are only checked for very short time periods, but a much larger area is checked in a relative short time span. As effectiveness is rather similar, I would recommend to use night-vision equipment if you are going to monitor a larger area.

Effectiveness of camera traps is similar for Beech Marten and Domestic Cat, but for night-time observations effectiveness seems lower for Beech Marten compared to Domestic Cat. This could be related to behaviour as Beech Martens, due to their wild nature, are easily scared by (human) observers. In addition, Beech Martens presumably do not roam open areas but try to hide also when they move for foraging [Rondinini *et al*, 2002]. Hence, it would be easy to miss a Beech Marten moving through the landscape using night-vision equipment. . Domestic cats, as they have less to fear, are more careless in their movements and will show up more easily, even in the wide open.

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