

RESEARCH ARTICLE

Optimizing small mustelid monitoring: Enclosed camera traps increase detection of the smallest carnivores

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Abstract

1. Land use changes in Europe contribute to the decline of once-abundant species. While these declines are well documented for some species, other, more elusive species could quietly disappear. As a result, small mustelids are believed to be declining across their historical range. Their small size and elusive ecology make small mustelids challenging to monitor and thus remain understudied. In this study, we tested the effectiveness of three camera trap-based methods to monitor common weasel *Mustela nivalis*, stoat *Mustela erminea*, and European polecat *Mustela putorius*.
2. We deployed unenclosed, semi-enclosed, and fully enclosed camera traps in a clustered design incorporating all methods during the fall of 2023 in two extensive agricultural areas in the Netherlands. Using a multi-scale occupancy approach, we assessed (1) how detection probabilities differ among the three camera trap methods for each small mustelid species and (2) how scent-based lures and placement near passages influenced detection probabilities.
3. We found that weasels had the highest detection probability in fully enclosed camera traps placed within clusters containing a scent-based lure. The detection probability of stoats was highest in fully enclosed camera traps, regardless of the presence or absence of lure, as well as in unenclosed camera traps with no lure nearby. Polecats had the highest detection probability in unenclosed camera traps, regardless of lure presence, and in semi-enclosed camera traps without lure nearby. Placing camera traps near passages increased detection probability for all three species.
4. *Practical implication:* This study advances monitoring protocols for small mustelids, a group facing suspected population declines despite limited data. We highlight different detection probabilities among three mustelid species using various camera-trap methods. Camera trap placement and species-specific use of scent-based lures, beneficial for weasels but not for stoats or polecats, should be considered by researchers and wildlife managers. Combining fully enclosed and unenclosed camera traps enhances species detection and offers broader

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ecological insights by monitoring other prey and predator mammals as bycatch. Our findings provide practical guidance for large-scale monitoring efforts of small mustelids across Europe.

KEYWORDS

common weasel, detection probability, Europe, European polecat, multi-scale occupancy, *Mustela*, non-invasive monitoring, stoat

1 | INTRODUCTION

Changes in land use intensity in Europe are driving biodiversity and habitat loss, with increasing agricultural intensity on one side and land abandonment on the other (Kuemmerle et al., 2016; Schils et al., 2022). The effect of land use change has been well documented for some species, such as ground-breeding meadow birds, which are decreasing in Europe due to the intensification of agriculture (Donald et al., 2001). In contrast, this effect is less well documented for carnivores, with research primarily focusing on generalist species. However, specialist species, such as small mustelids, are suggested to be declining in Europe, with evidence of decreasing numbers due to land use change (Sainsbury et al., 2019; Torre et al., 2018; Wright et al., 2022). Small mustelids in Europe prefer half-open landscapes with dense vegetation for cover, a habitat lost by land use intensification (Rondinini et al., 2006; Schils et al., 2022; Sidorovich et al., 2008; Zub et al., 2008). In addition, loss of linear landscape features increases predation risk and decreases habitat connectivity (Bright, 2000; Gehring et al., 2021; Gehring & Swihart, 2004). Habitat edges house a high abundance of available prey for small carnivores (Šálek et al., 2010), and a diverse availability of prey species allows small mustelids to switch to alternative prey when one becomes scarce, making them less vulnerable to local extinction (Macdonald et al., 2017; Zub et al., 2008, 2012). As land use intensity rises, small mammal populations decline, forcing small mustelids to rely on a narrower range of prey species (Aschwenden et al., 2007).

Small mustelids play an important role in ecosystem functioning and are considered sentinel species for a changing environment (King et al., 2007; Marneweck et al., 2022). Of the *Mustela* genus, three species occur across Europe: the common weasel *Mustela nivalis*, the stoat *Mustela erminea* and the European polecat *Mustela putorius* (Macdonald et al., 2017). Across the three species, diet diversity increases with body size. Weasels are the most specialized hunters, primarily preying on small rodents, while stoats, being slightly larger, can also hunt bigger prey like water voles and rabbits (Elmeros, 2006; Van Den Berge et al., 2022). Polecats, the largest of the three, have a more varied diet that includes rodents, lagomorphs, birds, and amphibians (Sainsbury et al., 2020; Van Den Berge et al., 2022). Differences in body size between the three species make them differently susceptible to predation, with weasels and stoats most vulnerable to avian predators (King et al., 2007). As a result, weasels and stoats prefer tall

vegetation within open landscapes as cover against predators (Mougeot et al., 2020).

Presence-absence data are of the utmost importance in ecology for studying the occurrence of a species, which is crucial for conservation (Kremen et al., 1994). Small mustelids are notoriously difficult to monitor as they occur in low densities, and their cryptic behaviour makes them difficult to observe directly (King et al., 2007). Previous research on the occurrence and population densities of small mustelids has heavily relied on live trapping and/or culling data (King et al., 2007; McDonald & Harris, 2002; Smith et al., 2008; Zub et al., 2008). Due to conservation and animal welfare, there is an increasing demand for effective non-invasive monitoring methods. Alternatives like snow tracking and tracking tunnels have been used successfully for small mustelids (Jachowski et al., 2024). However, both are labour-intensive and error-prone as prints of weasel and stoat can be misidentified, and snow tracking is limited by fresh snowfall in winter conditions (Jachowski et al., 2024).

Camera traps are valuable monitoring tools in wildlife ecology and an effective method for studying elusive and nocturnal species (Burton et al., 2015). However, using camera traps for small mustelids is challenging due to their small size and tendency to hide in tall vegetation, lowering detection probability (Kolowski & Forrester, 2017; Meek & Pittet, 2012). Camera traps frequently miss small mustelids that move at high speed due to the small detection zone for small species and the often too slow trigger speed (Glen et al., 2013). Detection probabilities of small mustelids by regular camera traps are commonly low (Barros et al., 2024; Croose et al., 2022; Jachowski et al., 2024). Detection probabilities of regular camera traps can be increased by directing the animal of interest towards the detection zone, for example, by using attractants or passages that channel animal movement (Hofmeester et al., 2019). As a response, researchers have developed specialised enclosed camera traps to direct animals closer to the camera, increasing detection probability.

Semi-enclosed camera-trapping methods were developed, such as the 'Hunt trap', the 'Struikrover®' and the 'Polecam', using camera traps placed in tubes with lure to direct animals towards the opening (Hofmeester et al., 2024; McCleery et al., 2014; Smaal & van Manen, 2022). While scent-based lures can increase detection in some cases (Buyaskas et al., 2020; Mills et al., 2019), they may have no or even adverse effects in others (Konradsen et al., 2024; Mills et al., 2019), making their use inconsistent. The *Mustela* is an example of a fully enclosed camera trap that has

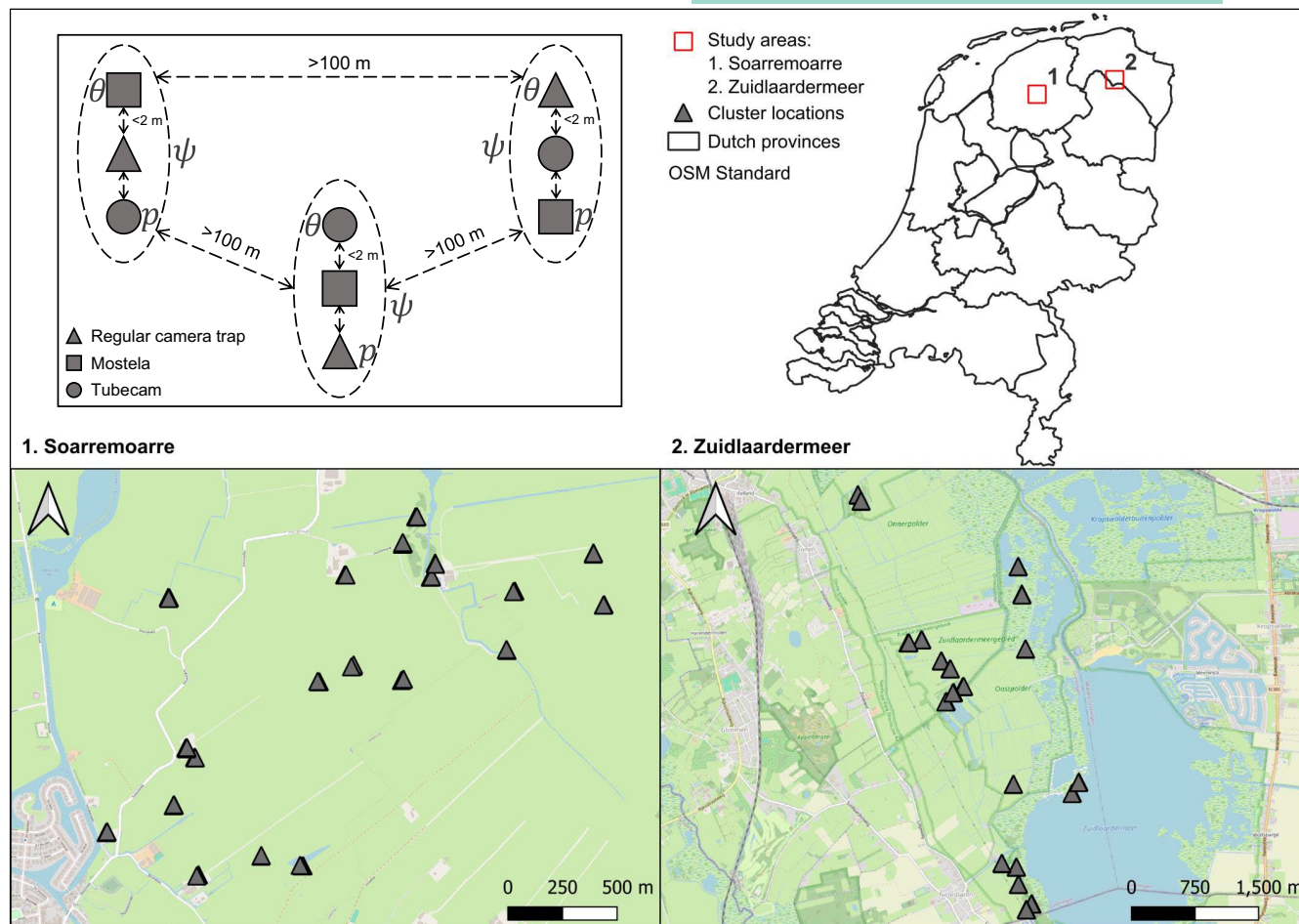


FIGURE 1 Study areas and design. The upper right panel shows the location of the two study areas in the Netherlands: (1) Soarremoarre (SM) and (2) Zuidlaardermeer (ZL), with cluster distributions shown in the bottom panels. The upper left panel illustrates the study design used in both areas. Clusters were spaced at least 100m apart, with methods placed no more than 2m apart within each cluster. Methods were rotated among locations within the cluster. The design also includes parameters from the multi-scale occupancy models: Occupancy probability at the cluster level (ψ), site-use probability of a camera-trapping method (θ) and detection probability of a camera-trapping method (p).

been especially developed to monitor small mustelids (Mos & Hofmeester, 2020). The Mostela combines a box with a camera trap and a tunnel through which the animal traverses. Mostelas rely on the hunting behaviour of small mustelids in holes of small rodents, drawing them into the Mostela tunnel without using an attractant (Mos & Hofmeester, 2020). An attractant-free approach may benefit population studies as attractants can violate model assumptions to estimate abundance (Hofmeester et al., 2019; Rovero & Zimmermann, 2016).

In the Netherlands, weasels, stoats, and polecats have become red-listed (van Norren et al., 2020). Currently, unenclosed, semi-enclosed and fully enclosed camera-trapping methods are commonly used for small mustelids by researchers and wildlife managers to assess their presence. However, little is known about their species-specific and relative effectiveness. Thus far, only Mostela's and unenclosed cameras have been compared to monitor small mustelids across Europe (Barros et al., 2024; Croose et al., 2022; Croose

et al., 2025). This study tested three camera trap types: unenclosed, semi-enclosed, and fully enclosed, for monitoring weasels, stoats, and polecats. We also tested the effect of a scent-based lure in semi-enclosed camera traps and the placement of camera traps near passages on detection probabilities. We expected unenclosed camera traps to best detect polecats due to their size, semi-enclosed camera traps to detect stoats best, as they are too cryptic for unenclosed camera traps and hunt less in tunnels, and fully enclosed camera traps to detect weasels best, given their size and hunting behaviour in tunnels. We also expected species-specific effects of scent-based lures, as previous studies report different results regarding detection probability for different species (Buyaskas et al., 2020; Konradsen et al., 2024), and expected passage placement to increase detection probability across all species due to the channelling effect of passages (Hofmeester et al., 2019). Our findings aim to support standardized monitoring of the suggested decline of small mustelids in Europe's half-open landscapes.

2 | MATERIALS AND METHODS

2.1 | Study area

We conducted the study in two areas in the north of the Netherlands between October and November 2023 (Figure 1). The climate in October and November 2023 in the north of the Netherlands was characterized by a mean temperature of 9.8°C and 361.2mm of precipitation.

1. Soarremoarre (hereafter: SM), near the town of Nes in the northwest of the Netherlands (53°03'36.9"N 5°52'11.2"E), comprises ca. 1360ha of agricultural meadows. Farmers and *It Fryske Gea* manage the area to provide suitable breeding grounds for meadow birds. Management includes raised water tables, creating herb-rich meadows, delayed mowing and management of meadow bird nest predators like carrion crow *Corvus corone*, red fox *Vulpes vulpes* and stone marten *Martes foina* during the breeding season (Jonge Poerink et al., 2024). Besides agricultural meadows, the area is characterised by a forest patch, reed habitat and a lake to the north. Human settlements and conventional agriculture surround the area.
2. Zuidlaardermeer (hereafter: ZL), southeast of the city of Groningen (53°08'29.0"N 6°40'15.4"E). ZL comprises roughly 2090ha of Natura 2000 nature-protected area and is managed by *Het Groninger Landschap*. The area is characterized by a lake (Zuidlaardermeer) and the surrounding riparian lands and polders consisting of meadows managed similarly to the SM meadows to accommodate meadow birds. Other habitats in the area consist of deciduous forest patches, reed lands, and *Juncus effusus*-dominated marshes. Predator management in this area consists of fox culling.

All land owners (e.g. farmers, *It Fryske Gea* and *Het Groninger Landschap*) granted us access to their lands to conduct this study.

2.2 | Camera-trapping methods

We tested unenclosed, semi-enclosed and fully enclosed camera-trapping methods. The unenclosed method consisted of standard camera traps on aluminium rods at knee height. Semi-enclosed camera traps (Tubecams) consisted of PVC tubes (D: 20cm, L: 40cm), with one end cut at a 45° angle and the other closed with a camera mount, similar to the Struikrover® (Smaal & van Manen, 2022). Fully enclosed camera traps were Mostelas based on the design of Mos and Hofmeester (2020), using plastic boxes (L: 60×W: 40×H: 18.5cm) with an internal tube (L: 40×D: 10cm) with a side opening (L: 35×W: 8.5cm). We used Reconyx® HF2X HyperFire 2™ cameras, set to take 10 pictures upon triggering with no delay and set to take hourly time-lapse pictures to ensure functioning throughout the study period.

2.3 | Field study

In both areas, we placed 20 clusters each (n=40), with each cluster containing all three camera trapping methods (Figure 1). Cluster locations were selected in consultation with local managers and field experts to avoid cattle disturbance and to optimize site use of weasels, stoats and polecats by focusing on linear landscape structures such as ditches and tall vegetation (Christie et al., 2006; Magrini et al., 2009; Rondinini et al., 2006). Clusters were spaced at least 100m apart to ensure independence (Kolowski et al., 2021), and cameras within clusters were placed approximately 2m apart. We positioned cameras along linear structures so that animals had an equal chance of encountering any of the methods when near a cluster. We rotated the order of the three camera-trapping methods each time a new cluster was deployed to ensure that no method was consistently positioned in the same location (outer or middle) within a cluster. Semi-enclosed camera traps often use scent-based lure as an attractant (Hofmeester et al., 2024; McCleery et al., 2014; Smaal & van Manen, 2022). To test for the effect of lure on the attraction of small mustelids, and to control for the effect of lure in the Tubecam on the other methods, we fitted half of the clusters with a scent-based lure. As the Tubecam resembles the design of the Struikrover®, we used a perforated can of sardines as lure (Smaal & van Manen, 2022). Scent-based lures consisting of a type of fish oil are often used in the monitoring of small mustelids and are considered an effective attractant (Bergeson et al., 2025; Ebel & White, 2024). Midway through the study, we swapped new lure placement between clusters. Note that lure was only applied within Tubecams. We placed roughly half of the clusters (n=22) at passages to test the effect on detection probability.

2.4 | Covariates

At each location, we logged the following attributes using the app ©MerginMaps: date and time of placement, location in coordinates, if a lure was used (yes/no), if the placement was located along a passage (yes/no), the type of passage (ditch crossing, dam, opening in vegetation or trail) and type of linear landscape element (natural [e.g. tall vegetation] or developed [e.g. ditches, paths, human constructions]).

2.5 | Statistical analysis

We processed the camera trap images using the software TRAPCAM-Aid (Dalenberg & Feldbrugge, 2024), an interactive camera trap database and annotating software developed especially for studying small mustelids. The software uses AI to detect animals and groups consecutive pictures taken within 5s, merging them in a composite picture where detected objects are combined in one image (Figure S1). After the AI annotation in TRAPCAM-Aid, we manually validated all pictures. We created daily detection histories

TABLE 1 Details of camera-trapping effort and detection days for the three small mustelid species per method and study area, in clusters with and without lure.

	Method	Trap nights	Lure at cluster	Weasel	Stoat	Polecat
Soarremoarre	Regular CT	1099	No	52	114	24
			Yes	68	81	26
	Tubecam	1068	No	65	74	7
			Yes	73	34	2
	Mostela	1053	No	79	125	2
			Yes	127	117	0
Zuidlaardermeer	Regular CT	920	No	3	3	10
			Yes	0	2	9
	Tubecam	956	No	3	6	1
			Yes	3	3	1
	Mostela	1061	No	1	7	0
			Yes	3	2	0

Note: Effort was evenly balanced between lure and no-lure clusters.

of the three species (1 for detected and 0 for non-detected) for each method at each cluster.

We tested the difference in detection probability between the three methods using multi-scale occupancy models (Nichols et al., 2008). Multi-scale occupancy models allow us to include additional information on multiple spatial subunits nested within main units, for example, the different methods within clusters. We used multi-scale occupancy models as described in Mordecai et al. (2011), Kéry and Royle (2016) and Hofmeester et al. (2021).

The multi-scale occupancy model starts with occupancy probability (ψ_i) that a species is present (1) or absent (0) at cluster i , denoted as z_i in the following equation:

$$z_i \sim \text{Bernoulli}(\psi_i), \quad (1)$$

Next is the site-use probability (presence or absence at one of the three camera-trapping methods; θ_{ij}), which is conditional on the presence of the species in the cluster i . We interpret site use as the probability of a species using the microhabitat in which a method is placed. Thus, the observation of a species at a camera, denoted as a_{ij} becomes:

$$a_{ij} | z_i \sim \text{Bernoulli}(z_i \times \theta_{ij}), \quad (2)$$

Lastly, the model describes the detection or non-detection (y_{ijk}) of a species on the k th instance at camera j , which is dependent on the detection probability on day k given its presence at camera j in cluster i . Denoted as follows:

$$y_{ijk} | a_{ij} \sim \text{Bernoulli}(a_{ij} \times p_{ijk}), \quad (3)$$

In our model, we estimated the detection probability based on detection histories with a survey length k of 1 day, and thus, our output of p_{ijk} is giving a daily detection probability per camera-trapping method. We added lure as a space-time dependent detection parameter for all methods within that cluster. We did this as, despite lure only being placed at half-enclosed cameras, we expected that the lure in one camera per cluster might still draw animals towards the cluster and thus influence all cameras. However, as the attraction might differ for all

cameras, for example, the lure in the half-enclosed camera 'drawing away' animals from the other two cameras, we estimated a method-specific parameter for the lure covariate. In addition, we added placement at passage (yes/no) as a binary parameter for detection probability that is constant over time.

We ran a separate multi-scale occupancy model for each species to account for expected differences among the three species. We modelled occupancy, site use and detection probability using the following logistic regression equations:

$$\text{logit}(\psi_i) = \alpha_0 + \alpha_1 \times \text{landscape element}_i + \alpha_2 \times \text{study area}_i, \quad (4)$$

$$\text{logit}(\theta_{ij}) = \beta_{0j}, \quad (5)$$

$$\text{logit}(p_{ijk}) = \delta_{0j} + \delta_{1j} \times \text{lure}_{ij} + \delta_2 \times \text{passage}_i, \quad (6)$$

where we calculated the intercept of average occupancy at cluster level (α_0). We added an intercept per camera-trapping method j to assess the effect of the methods on site use probability (β_{0j}) and detection probability (δ_{0j}). For occupancy, we included landscape structure (natural/developed) and study area (SM/ZM) as a binary variable in the model. The parameters α_1 and α_2 are the slopes of the covariates, study area and landscape element, respectively. Parameters δ_1 and δ_2 include the slopes for covariates of lure and passage, respectively.

We estimated the posterior distributions using Markov chain Monte Carlo (MCMC) implemented in JAGS (version 4.3.1; Plummer, 2022), called from R (R Core Team, 2024) using the package *jagsUI* (Kellner & Meredith, 2024). As priors, we used uninformative uniform priors between 0 and 1 for all intercept parameters and normally distributed priors with a mean of 0 and a precision of 0.01 for all slopes. We ran the models with three chains of 50,000 iterations with 20,000 iterations burn-in, keeping every 10th iteration. Model convergence was assessed using trace plots and the $\hat{R}$ statistic, assuming convergence when $\hat{R} < 1.1$ (Brooks & Gelman, 1998).

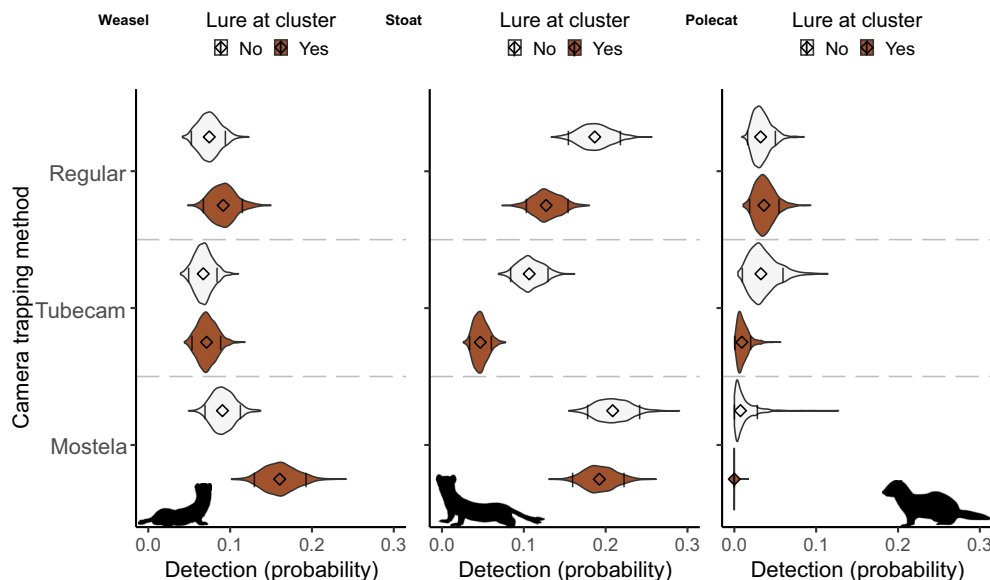


FIGURE 2 Violin plots showing posterior probability distributions for the three camera-trapping methods, with and without lure at the cluster, for weasel, stoat and polecat. Ticks indicate 89% credible intervals (highest density interval), and diamonds mark the median. Estimates are based on clusters not placed at passages. Species pictograms are from www.phylopic.org.

We present the posteriors of all parameters together with their medians and the 89% credible intervals calculated using the highest density interval (HDI) with the R package *bayestestR* (Makowski et al., 2019). We considered detection probabilities to be different when there was no overlap between the median and the 89% credible intervals of factors. Graphs were visualised using the R package *ggplot2* (Kassambara et al., 2021).

3 | RESULTS

We detected weasels, stoats and polecats on 477, 568 and 82 days, respectively, during 6157 trap nights (Table 1). In addition, we recorded six other carnivore species (Table S1). All models converged with a $\hat{R} < 1.1$.

3.1 | Detection probability

Weasels had the highest detection probability in Mostelas placed in clusters with lure. The other methods had lower and similar detection probabilities regardless of lure treatment (Figure 2; Tables S2 and S3). Stoats had the highest detection probabilities for Mostelas regardless of lure and regular camera traps without lure (Figure 2; Tables S2 and S3). Polecats had the lowest detection probability compared to the other species and had the highest detection probability for regular camera traps regardless of lure and Tubecams without lure (Figure 2; Tables S2 and S3).

Clusters placed at passages had a higher detection probability than clusters placed along linear landscape structures without passages for weasels ($\delta_2 = 1.14$, 89% HDI = 0.93–1.35), stoats ($\delta_2 = 0.53$,

89% HDI = 0.37–0.71) and polecats ($\delta_2 = 0.86$, 89% HDI = 0.34–1.40) (Tables S2 and S3).

3.2 | Site-use probability

Site use probability of weasels was highest at Tubecams compared to regular camera traps, while there was no difference between Mostelas and Tubecams (Figure 3; Tables S4 and S5). There was moderate evidence for higher site use of weasels at Mostelas compared to regular camera traps, as the median of regular camera traps was the same as the lower HDI of Mostela, and the upper HDI of regular camera traps only slightly overlapped with the median of Mostela. We found no evidence for a difference in the site use probability of stoats (Figure 3; Tables S4 and S5). Polecats had the highest site use probability for regular camera traps (Figure 3; Tables S4 and S5).

3.3 | Occupancy probability

We found no evidence of a difference in occupancy probability between different types of landscape elements (natural/developed) for any of the three species (Figure 4a; Tables S6 and S7). All three species showed a higher occupancy probability in SM compared to ZL (Figure 4b; Tables S6 and S7).

4 | DISCUSSION

Ongoing land-use changes in Europe impact species inhabiting half-open extensive agricultural areas. While this is well documented

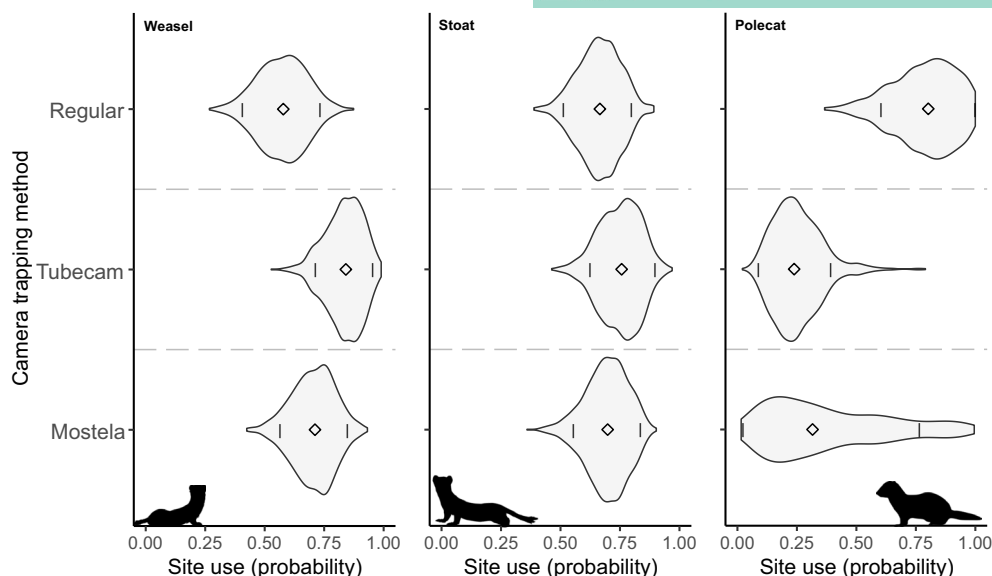


FIGURE 3 Violin plots showing posterior site-use probabilities for each camera-trapping method for weasel, stoat, and polecat. Ticks indicate 89% credible intervals (highest density interval), and diamonds mark the median. Species pictograms are from www.phylopic.org.

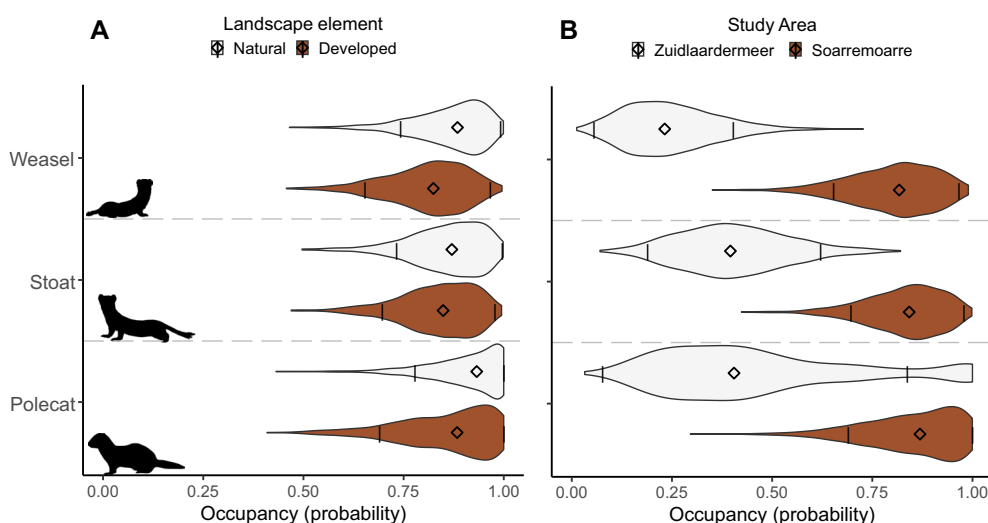


FIGURE 4 Violin plots showing posterior occupancy probabilities at the cluster level for weasel, stoat, and polecat across (A) landscape elements in Soarremoarre and (B) study areas with natural landscape elements. Ticks indicate 89% credible intervals (highest density interval), and diamonds mark the median. Species pictograms are from www.phylopic.org.

for some species, the effect on other, more elusive species like the common weasel, stoat and European polecat, generally referred to as small mustelids, is less known. Due to their small size, low densities and elusive nature, small mustelids are difficult to monitor using regular monitoring methods, such as camera traps that are normally deployed. However, for targeted conservation measures, knowledge about the occurrence of the three species and population trends is vital. Hence, there is a demand for specialized camera-trap systems to monitor small mustelids effectively. Here, we tested three gradients of enclosed camera traps: unenclosed (regular camera trap), semi-enclosed (Tubecam) and fully enclosed

(Mostela), to monitor weasels, stoats and polecats. In addition, we tested the effect of a scent-based lure placed in proximity to the methods and placement near passages on detection probability. We found the highest detection probability for weasels in Mostelas in proximity to the lure. Stoats had the highest detection probability in Mostelas regardless of the lure, and regular camera traps without proximity to the lure. Polecats had the highest detection probability for regular camera traps regardless of the lure, and for Tubecams with no lure nearby. We found a higher detection probability for all three species when a camera-trapping method was placed near a passage.

4.1 | Detection probability

Due to size differences, we predicted that the detection probability of weasels, stoats, and polecats would be highest in the fully enclosed, semi enclosed and unenclosed camera traps, respectively. Similar to other studies, we found that Mostelas effectively detected weasels (Barros et al., 2024; Croose et al., 2025; Croose & Carter, 2019; Mos & Hofmeester, 2020). Stoats had a higher detection probability in Mostelas and unenclosed camera traps than in Tubecams, contrary to our expectations. Mostelas often have a low detection probability for stoats (Croose et al., 2022, 2025; Konradsen et al., 2024), and semi enclosed camera traps are proven to detect small mustelids, but their relative effectiveness remains unclear (Hofmeester et al., 2024; McCleery et al., 2014; Smaal & van Manen, 2022). Consistent with previous studies, we found Tubecams to effectively monitor polecats (Hofmeester et al., 2024; McCleery et al., 2014; Smaal & van Manen, 2022). In addition, unenclosed camera traps had a similar detection probability. As hypothesized, these results seem to align with differences in species biology. Unenclosed cameras likely miss weasels and stoats due to their small body size and high moving speed (Glen et al., 2013; Meek & Pittet, 2012). Fully enclosed camera traps benefit from the tunnelling behaviour of both weasels and stoat as an attractant, directing the animal close to the sensor and lens of the camera, thus increasing detection over semi and unenclosed camera traps (Jachowski et al., 2024; King et al., 2007). The relatively higher detection probability of the unenclosed camera trap in monitoring polecats is, likewise, explained by their size and (relative to the two smaller species) restraint to hunt prey in burrows, thus to some degree avoiding enclosed camera traps.

Our findings that the effect of lure on detecting small mustelids varies across species and methods are consistent with previous studies. In some studies, detection probability increased with either lure or bait (Buyaskas et al., 2020; Ebel & White, 2024), while in other studies, no effect was found (Croose & Carter, 2019; Konradsen et al., 2024). We only found an increase in detection probability for weasels in Mostelas placed in clusters with lure. We argue that weasels could be attracted to clusters with lure from a distance; however, instead of approaching the Tubecam with lure, they might be more attracted to the tube of the Mostela. We found no effect of lure for stoats, which could be explained by the idea that only the combination of bait and lure is an effective method to attract stoats (Ebel & White, 2024). Detection probability of polecats did not increase in clusters containing lure. Hofmeester et al. (2024) stated that scent-based lures increased the detection of polecats, like 'Struikrover®' (Smaal & van Manen, 2022). Using lures potentially comes with unwanted side effects, such as attracting unwanted species, increasing labour to annotate pictures (Jachowski et al., 2024). Additionally, using a lure may alter species behaviour, potentially violating specific statistical model assumptions and leading to an overestimation of parameters such as abundance (Hofmeester et al., 2019; Rovero & Zimmermann, 2016).

Placing clusters containing the three camera-trapping methods at passages in linear landscape structures (e.g. ditch crossings, field

entrances, and openings in vegetation) increased detection probability for all three species. Correct placement of cameras on linear landscape structures is important to efficiently monitor small mustelids (Jachowski et al., 2021, 2024). Placing camera traps at passages within linear landscapes that have a channelling effect on animal movement can increase detection probability for the three species (Hofmeester et al., 2019). It is important to consider that interspecific competition could lead to the avoidance of passages by smaller species, specifically weasels, when these passages are used by larger species (Monterroso et al., 2020; St-Pierre et al., 2006). This effect could be increased when scent-based lures attract larger carnivores, such as stone martens and red foxes, to such passages. However, as detection probabilities for all three species were higher when cameras were placed at passages in our study, we do not think potential avoidance of passages impacted the detection of small carnivores in our system. However, it is important to note that this might be different in other systems, especially those that have a richer small carnivore assemblage. Based on this, we recommend placing camera-trapping methods at passages rather than using a lure when aiming to maximise detection probabilities, while being aware of potential interspecific avoidance behaviour.

4.2 | Site use probability

As mentioned earlier, site use probability is difficult to interpret because it likely reflects both the specific microsite where a camera was placed and the method used. Assuming our correction for detection differences accounts for the effect of method, we interpret site use as using particular microhabitats where methods were deployed. Although not systematic, different methods may have been placed in different microsites due to practical constraints associated with each method. Regular camera traps have to be placed facing openings in vegetation, while semi- and fully enclosed camera traps can be placed in or under tall vegetation (Jachowski et al., 2024). Thus, we can consider the lower site use probability of weasels for regular camera traps as an avoidance of open microhabitat, which is in line with the idea that weasels avoid open areas due to predation risk (Macdonald et al., 2017; Mougeot et al., 2020; Šálek et al., 2010). Stoats and polecats, larger than weasels, show less avoidance of open habitats, which is remarkable for stoats, who are only slightly larger and are still susceptible to predation by aerial predators (King et al., 2007). Thus, the differences in method effectiveness across species are likely partly related to the microhabitats where the methods can be deployed.

4.3 | Occupancy probability

We found a higher occupancy probability for Soarremoarre compared to Zuidlaardermeer for all three species. Compared to other studies, we found higher occupancy probability for weasels (Barros et al., 2024) and stoats (Croose et al., 2022; Konradsen et al., 2024).

These differences may result from extensive agricultural management in both areas, creating an open landscape with plenty of vegetation for cover and abundant prey (Aschwenden et al., 2007; Sidorovich et al., 2008; Zub et al., 2008). Our data do not explain the difference in occupancy probability between the two study areas. We found no evidence of a difference in occupancy probability between the linear landscape types. Both natural (e.g. reeds, shrubs, hedgerows) and human-developed (e.g. ditches, paths, fences) linear landscape features often have taller vegetation than field interiors due to grazing and mowing. Such field edges, often designated as ecological compensation areas in extensive agriculture, are key habitats for small mammals (Aschwenden et al., 2007). Thus, small mustelids likely benefit equally from both habitat types, providing sufficient prey and shelter against predators.

4.4 | Application and further research

This study contributes to an increasing effort to develop standardised protocols to monitor small mustelids. This is especially important as monitoring data are generally lacking, while expert views are that populations are declining (van Norren et al., 2020; Wright et al., 2022). We observed differences in the detection probabilities of the three small mustelid species across the three camera-trapping methods. Integrating both unenclosed and fully enclosed camera traps in a study design or monitoring programme allows researchers and wildlife managers to monitor weasels, stoats, and polecats simultaneously. In addition, combining enclosed and unenclosed camera traps provides additional information on species important to understanding small mustelid ecologies, such as prey and larger predators (Barros et al., 2024; Macdonald et al., 2017). Also, placement in the correct microhabitat (e.g. tall vegetation for stoat and weasel, and openings in vegetation for polecat) and near passages improves the detection probability of camera traps. We acknowledge that camera placement in this study was targeted based on field signs, aimed at optimising the detection of an elusive species group, which is subjective and hard to standardise. While standardised placement following predefined rules may be preferable to meet model requirements, such approaches often appear unfeasible due to field conditions and the strong microsite selection of small mustelids. We have shown that scent-based lures can be beneficial for studying weasels, but have little to no effect on monitoring stoats and polecats. However, these findings contradict previous studies; therefore, we recommend testing different types of lure and/or bait as an attractant for small mustelids in different settings (Buyaskas et al., 2020; Croose & Carter, 2019; Ebel & White, 2024; Konradsen et al., 2024). Depending on the study's purpose, using scent-based lures is not unambiguous and can violate model assumptions, attracting unwanted species and increasing workload (Hofmeester et al., 2019; Jachowski et al., 2024). Hence, using lures as an attractant has drawbacks and should be well considered when monitoring small mustelids. Our findings provide novel guidelines for using species-specific camera-trapping methods, camera placement, and attractants that could be

adopted for large-scale monitoring of an elusive and likely declining species group across Europe.

AUTHOR CONTRIBUTIONS

Pieter J. Otte, Tim R. Hofmeester, Jasja Dekker, Bob Jonge Poerink and Christian Smit conceived the ideas and methodology. Pieter J. Otte collected the data. Pieter J. Otte and Tim R. Hofmeester analysed the data. Pieter J. Otte led the writing of the manuscript; all authors critically reviewed the manuscript and gave final approval for publication.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

All data and scripts used in this manuscript are available from Zenodo: <https://doi.org/10.5281/zenodo.16744697> (Otte, 2025).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Figure S1. Composite picture of a stoat in Zuidlaardermeer captured by a regular camera trap as made by the AI software TRAPCAM-Aid.

Table S1. Overview of the number of pictures taken per species detected by the different camera-trapping methods in the two study areas. Some species, which have not been identified on a species level, have been grouped.

Table S2. Estimates of the intercepts of the parameters lure and passage included in detection probability (p) three camera-trapping methods, including 89% credible interval (highest density interval) for the three small mustelid species.

Table S3. Estimates of the log odds of the intercepts and slopes of the covariates lure and passage on detection probability (p) of the three camera-trapping methods, including 89% credible interval (highest density interval), for the three small mustelid species. Estimates in bold have an 89% credible interval that does not overlap with zero.

Table S4. Estimates of the intercepts of site use per camera-trapping method (θ), including 89% credible intervals (highest density interval) for the three small mustelid species.

Table S5. Estimates of the log odds of the intercepts of site use (θ) per camera-trapping method, including 89% credible intervals (highest density interval) for the three small mustelid species. Estimates in bold have an 89% credible interval that does not overlap with zero.

Table S6. Estimates intercepts of the parameters landscape element and study area included in occupancy probability (ψ), including 89% credible interval (highest density interval) for the three small mustelid species.

Table S7. Estimates of the log odds of the intercepts and slopes of the covariates landscape element and study area on occupancy

probability (ψ) including 89% credible interval (highest density interval), for the three small mustelid species. Estimates in bold have an 89% credible interval that does not overlap with zero.

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