MAMMAL COMMUNICATIONS Volume 5 ISSN 2056-872X (online)

A pilot study of a novel method to monitor weasels (*Mustela nivalis*) and stoats (*M. erminea*) in Britain

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ABSTRACT

Weasels (*Mustela nivalis*) and stoats (*M. erminea*) are considered to be widespread and common in Britain, but little is known of their abundance and population trends outside game estates, and there is currently no reliable, cost-effective method to monitor the two species across their range other than by seasonal, localised kill-trapping. We conducted a pilot study to determine the efficacy of a novel method for detecting the presence of live weasels and stoats in Britain. We trialled the 'Mostela', a wooden box comprising a plastic tunnel and a camera trap, at three sites in England. Weasels were detected at all three sites, with the time to an initial detection at a site ranging from 16 to 54 days. Stoats were detected at one site. Overall, a high number of trap nights was required to achieve a relatively low number of detections. Nevertheless, the method shows potential for future surveys and associated research, particularly on weasels.

INTRODUCTION

Weasels (*Mustela nivalis*) and stoats (*M. erminea*) are small mustelids native to Britain. Whilst both species are considered to be widespread and common in Britain, there are few data on their abundance and population trends at a national scale, and both species are currently listed as data deficient (Mathews *et al*., 2018). Monitoring live weasels and stoats has proved challenging, as easily detectable field signs are rarely found (McDonald & Harris, 1998) and they are infrequently seen. Stoats in particular are wide-ranging and may be cautious of traps, making trapping and monitoring operations difficult and expensive (King *et al.,* 2009). Currently, the only information on population trends is derived from game bag data collected as part of the Game and Wildlife Conservation Trust National Gamebag Census (GWCT, 2018). Whilst these data can detect coarse changes not detectable by any other method, they may be more of an indication of changes in trapping and hunting efforts than of changes in stoat and weasel population trends (McDonald & Harris, 1999).

Understanding the status of small mustelids in Britain is of particular current concern, as a key prey species for stoats, the European rabbit (*Oryctolagus cuniculus*), appears to be declining (Mathews *et al*., 2018). Past declines of rabbit populations due to the myxomatosis outbreak in the 1950s resulted in a severe reduction in stoat numbers; subsequently, the stoat population began to increase in the 1960s in line with the recovery of rabbit numbers (Sumption & Flowerdew, 1985). Elsewhere in Europe, the status of small mustelid populations is of such concern that weasels and stoats have been protected in Switzerland since 1978 (Akdesir *et al*., 2018) and were afforded full protected status in two provinces in the Netherlands in 2017 (Zoogdiervereniging, 2017). We conducted a pilot study to trial the efficacy of a novel method for detecting the distribution of weasels and stoats in Britain, and we discuss its potential application for wide-scale monitoring.

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Key words: weasel, stoat, monitoring, Mostela, population trends

Full citation: Croose, E. & Carter, S.P. (2019) A pilot study of a novel method to monitor weasels (*Mustela nivalis*) and stoats (*M. erminea*) in Britain. Mammal Communications 5: 6-12, London.

METHODS

Study sites

Fieldwork was carried out at three sites in England, where weasels and stoats had recently been sighted: Site 1 - Golden Cap Estate (National Trust), Dorset (50°44'5.604"N, 2°50'52.8"W), 1000 hectares, monitored March – June 2018; Site 2 - Croome Park (National Trust), Worcestershire (52°5'59.46"N, 2°10'3.54"W), 270 hectares, monitored May – September 2018; Site 3 - North Cave Wetlands (Yorkshire Wildlife Trust), Yorkshire (53°47'2.904"N, 0°39'8.208"W), 40 hectares, monitored June – September 2018. Nine Mostelas were deployed at Site 1 for 92 days, seven at Site 2 for 120 days and eight at Site 3 for 98 days (see Table 1).

Data collection

A monitoring device, the Mostela, developed by the Dutch Small Mustelid Foundation, has been used successfully to detect weasels and stoats in the Netherlands (Stichting Kleine Marters, 2018). The Mostela comprises a wooden box (measuring 620 mm x 300 mm x 175 mm) with a plastic tunnel (measuring 350 mm x 80 mm) running through it (Figure 1). Weasels and stoats are known to be able to comfortably fit into a tunnel of this diameter, based on trials carried out on captive animals, and studies in New Zealand have shown that stoats will enter tunnels as small as 50 mm diameter (Brown 2001). For a full description of the design, see https://stichtingkleinemarters.nl/bouwplan-mostela/. A trail camera (Bushnell Trophy Cam HD) was housed inside the box and trained on the tunnel to record footage and the time that animals entered.

Mostelas were trialled between March and September 2018 (see Table 1). They were located in or along hedgerows, fence lines, ditches and other vegetated linear features, which weasels and stoats are known to use (King 1989). A piece of pond liner was placed on top of each Mostela to provide protection from the rain. Distances between Mostelas varied from 50 m to 200 m.

A commercial weasel lure (Hawbaker's Weasel Lure, F&T Fur Harvester's Trading Post, https://www.fntpost.com/) was applied to vegetation adjacent to half of the Mostelas deployed, to examine whether an attractant influenced visitation rate. The lure was only applied once when the Mostela was put in place and was not re-applied during subsequent visits. No food bait was supplied inside the Mostela as, in the Netherlands, weasels and stoats enter Mostelas without bait, because they are naturally curious and will investigate holes and tunnels.

The Mostelas were checked at intervals of one to three weeks when the batteries in the cameras were replaced and video files downloaded from the SD cards. At Site 1, the Mostelas were maintained in the same location for the whole duration of the trial, whereas at Sites 2 and 3, Mostelas were moved around the site on an *ad hoc* basis, whether they detected a weasel or stoat or not, or on occasion, to relocate them to a safer place in response to disturbance by humans or maintenance work being carried out at the site.

Individual weasels and stoats could be distinguished on some occasions when the size difference between individuals was noticeable or the animals had distinguishable features. The back-belly line between the ventral and dorsal fur can be noticeably different in weasels and thus used to recognise individuals (Linn & Day 1966), while in stoats, the length of the tail can vary between individuals. The sex of the animal could occasionally be determined by the overall size of the animal and when the testes were visible in adult males.

RESULTS

From a total of 12,135 video clips recorded in 24 Mostelas across all three sites, 45 (0.4%) were of weasels and three (0.03%) of stoats (Table 1; Figure 3). Weasels were detected at all three sites, with the number of unique detections ranging from 3 to 16 per site (Table 1; Figure 3a). Stoats were detected at one site on three occasions (Table 1; Figure 3b). Although stoats were seen at the other two sites during the trial, they failed to be detected by the Mostelas.

The shortest latency to an initial weasel detection at a site was 16 days, whereas the longest was 54 days. The first stoat detection took 41 days. In some Mostelas, weasels and stoats visited on multiple occasions, whereas at others, only one visit was recorded. Three Mostelas recorded two individual weasels, identified by a noticeable size difference, and a further two recorded both weasels and stoats.

Interestingly, all except one of the Mostelas that detected weasels had no weasel lure applied. Of the two Mostelas in which stoats were detected, weasel lure was applied to one but not the other.

In 29% of videos of weasels and stoats, only part of the animal was visible (often only the back of the animal as it exited the Mostela), precluding individual identification. Furthermore, the quality of the footage was often not sufficient to identify distinguishing features, such as the variable back-belly line on weasels (Linn & Day 1966).

The majority of weasel detections (68%) occurred early-mid morning between 5am and 10am, tending towards predominantly crepuscular activity patterns (Figure 2). Two of the three stoat detections occurred at midday, whilst the third occurred mid-morning, indicating diurnal activity (Figure 2).

The following non-target species were also detected: wood mouse (*Apodemus sylvaticus*) (Figure 3c), bank vole (*Myodes glareolus*) (Figure 3d), field vole (*Microtus agrestis*), common shrew (*Sorex araneus),* pygmy shrew (*S. minutus*), water shrew (*Neomys fodiens*), American mink (*Neovison vison*) (Figure 3e), rabbit, grass snake (*Natrix natrix*) (Figure 3f), wren (*Troglodytes troglodytes*) and various insect species.

Table 1. Details of weasel and stoat detections in Mostelas at the three study sites

Site	Dates of survey	No. trap nights	Total no. videos	No. weasel videos*	No. weasel detections**	No. Mostelas detected in	No. days until first detection	No. stoat videos*	No. stoat detections**	No. Mostelas detected in	No. days until first detection
Golden Cap	07/03/18 – 06/06/18	666	2557	3	3	1	51	0	0	0	N/A
Croome Park	24/05/18 – 20/09/18	603	6752	22	16	5	16	0	0	0	N/A
North Cave	20/06/18 – 25/09/18	784	2826	20	9	4	54	3	3	2	41

**Denotes total number of videos in which an animal was recorded.*
***Denotes number of unique detections. If multiple consecutive videos were recorded of an animal at the same time, this is classed as one detection.*

Figure 1. The inside of the Mostela, comprising tunnel and trail camera (above) and the Mostela in a closed position for deployment in the field (below).

Figure 2. The time of day of weasel and stoat detections in the Mostelas.

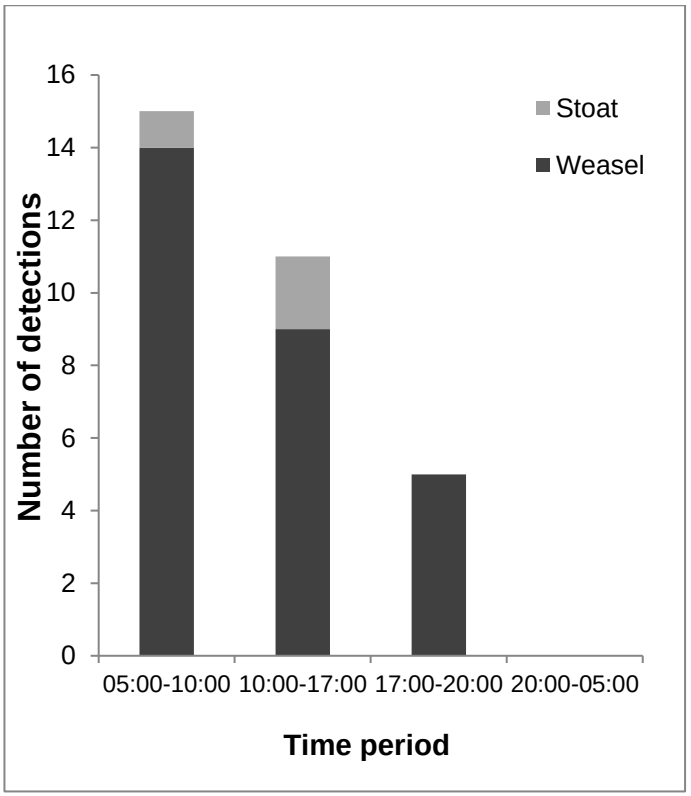

Figure 3 Example images of target and some non-target species detected in the Mostelas.

(a) Weasel

(b) Stoat

(c) *Apodemus* spp.

(d) Bank vole

(e) American mink

(f) Grass snake

DISCUSSION

This is the first wide-scale application of a novel device for detecting weasels and stoats in Britain. Whilst some improvements could be made, this method shows potential for future surveys and associated research on these challenging species.

In this study, the success rate for detecting weasels and stoats in Mostelas varied by study site. Weasels were detected in multiple Mostelas on multiple occasions at two sites (Croome Park and North Cave Wetlands), but only detected in one Mostela on three occasions at the other site. Nevertheless, this indicates that weasels will readily visit Mostelas if they are sited suitably, regardless of the absence of any food reward and the ineffective lure.

However, there were occasions at one site where weasels were not detected in a Mostela yet were detected in an adjacent Mostela located only ~50 m away. This suggests that optimum placement is crucial and weasel detections may be increased by moving the Mostelas to new locations frequently. By contrast, stoats were detected infrequently at one site, despite being known to be present at the other two sites. In New Zealand, stoats can be reluctant to enter confined spaces (C.M. King, *pers. comms*) and fully enter trapping tunnels (Brown 2001). This may explain the limited number of stoat detections in the Mostelas and consequently, the Mostelas may not be a suitable method, in isolation, for detecting stoats. The use of a lure outside of the Mostela did not appear to be beneficial in attracting weasels or stoats, or to inhibit other non-mustelid species. Studies in New Zealand have found that the use of scent lures or food bait increases detections of stoats, and thus increases the effectiveness of trapping efforts (King & Edgar 1977; Clapperton *et al*. 1999; Garvey *et al.* 2016). Furthermore, baited hair tubes have been effective at detecting Irish stoats (*Mustela erminea hibernica*) in Ireland (McAney 2010). However, in the Netherlands, weasels and stoats enter Mostelas which are deployed without lure or food bait (J. Mos, *pers. comm.*). Nevertheless, it would be worthwhile trialling different lures, such as rabbit gut scent, in order to investigate whether they increase the visitation rate, particularly of stoats, in Mostelas.

The latency to initial detection of a weasel in a Mostela was long ranging from 16 to 54 days across sites, and for a stoat was 41 days. The overall low detection rate of stoats, and of weasels at one site, may simply be due to low population densities or could relate to sub-optimal placement of the Mostelas, possibly in parts of the animal's home range which are rarely visited. Detection rate may also vary seasonally and be influenced by land use and management practices. For example, work in the Netherlands suggests that variation in detection rate of weasels is influenced by the timing of grass cutting: after mowing has taken place, weasels are more likely to be restricted to hedgerows and other vegetated features, increasing the chances of encountering a Mostela (J. Mos, *pers. comm.*).

Overall, a high number of trap nights and personnel hours was required to achieve a relatively low number of weasel and stoat detections. On occasions, the batteries in the trail cameras ran out prior to the Mostela being checked or the camera malfunctioned for an unknown reason, meaning that the Mostela was 'inactive' for a few days. It is possible that during this time, weasels or stoats visited the Mostela, but were not recorded.

The high number of visits by small mammal species (mice, voles and shrews) resulted in a high volume of videos of non-target species. This was a resource consideration because it was time-consuming to review the videos (although this could be addressed through a citizen-science project whereby volunteers review and categorise camera trap footage online) and it also reduced battery life in the cameras. However, the diversity of species recorded indicates potential for Mostelas to be used to collect data on other species. For example, Mostelas in their present form or slightly modified could be used to detect American mink (detected in three Mostelas at one site during this study) in order to monitor distributional changes and inform trapping programmes, particularly at locations where mink rafts cannot be used. They could also potentially help improve the prospects for critically endangered European mink (*Mustela lutreola*) elsewhere in Europe, where an effective, non-invasive method would improve the ability to monitor extant and reintroduced populations.

Furthermore, there is potential to use Mostelas to monitor grass snakes and other snake species in suitable habitats, avoiding the need for visual transects and refugia searching (Sewell *et al.,* 2013).

Future work should initially focus on optimising and standardising the use of the Mostela, particularly with respect to placement, spacing, density and length of survey time to improve detectability and cost-effectiveness. Secondly, it would be worthwhile trialling different lures to investigate whether they improve the detection rate for weasels and stoats. Finally, it may be beneficial to calibrate the efficacy of Mostelas using another method, such as live trapping. If the detection rate of weasels and stoats can be improved, there would be opportunities for estimating population abundance, density and site occupancy (e.g. King *et al.* 2007) of these challenging species, as well as investigating temporal and spatial resource use and partitioning.

ACKNOWLEDGEMENTS

We are grateful to Jeroen Mos, Erwin van Maanen and Fokko Billijam (Dutch Small Mustelid Foundation) for advice on the design and deployment of the Mostelas, and for commenting on the manuscript (JM & EvM). We thank the National Trust and Yorkshire Wildlife Trust for granting permission to work on their land, and we thank Gemma Baron (National Trust), Katherine Alker (National Trust) and Tony Martin (Yorkshire Wildlife Trust) for facilitating site access. We are very grateful to Gareth Dowle and Gemma Fisher for their significant contribution to fieldwork and reviewing video footage. We thank Don MacPherson for making the Mostelas. We are grateful to Carolyn King and two anonymous reviewers whose helpful comments greatly improved the manuscript.

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