Monitoring weasels (*Mustela nivalis*) with nest boxes

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Abstract: In November 2014 we placed ground-placed nest boxes for small mustelids, equipped with a track tube entrance, in a study area near Taarlo, Province of Drenthe, the Netherlands (6.62 E, 53.03 N) and checked these monthly until September 2016. Weasels (*Mustela nivalis*) used the boxes for resting and occasionally for catching rodents. The boxes were more frequently visited in summer and autumn than in winter and spring, probably as a result of seasonal fluctuations in the population caused by reproduction and mortality. It remains to be seen if annual population fluctuations can be reliably monitored.

Keywords: weasel, *Mustela nivalis*, monitoring, nest boxes, footprints, track tube, temperature logger.

Introduction

Because of their small size, sparse distribution, low abundance and obscure way of life, a systematic survey of weasels (*Mustela nivalis*) in the field, and monitoring in particular, are near-impossible without using destructive methods (McDonald & Harris 1999) or labour-intensive methods such as life traps. Tracks are difficult to find, let alone to identify reliably, and droppings can only be identified to species with help of DNA analysis. We initially sought to establish the presence of weasels in the study area with the help of track tubes (www.kleinemarters.nl). Between 1 March and 14 November 2014 we placed unbaited track tubes (40 cm pcv-tubes, diameter 8 cm) for a period of 14 days at 213 locations, but these resulted in only two weasels' tracks. We also experimented with a camera box or Mostela camera trap (van Maanen et al. 2015), but with little success. We therefore opted for a combination of methods: providing nest boxes (Criel 1988, 1990) and track tubes and the use of camera traps. This paper describes the efficacy of these non-lethal methods in monitoring weasel occurrence and behaviour.

Methods

Nest boxes made of wood or vertical slices of large pvc-tubes were placed on the ground, so that the inner space (20x20 cm) was accessible by two diagonal entrance holes with a diameter of 45 mm (www.zoogdierenwerkgroep.be). To enter the nest box weasels had to pass through a 40 cm long pvc-tube (diameter 8 cm). The bottom of the tube contained a platform with adhesion primer (paper is often eaten by snails) on which tracks can be traced. A flat sponge was added, soaked in a mixture of burnt bone-dust and oil, to improve the resolution of the track. To prevent the oil from leaking, the sponge compartment was surrounded by a rim of silicon-free sealant.

The nest boxes were placed in an area of 2.5x3 km near Taarlo in Drenthe (6.62 E, 53.03 N), with a mean distance of 285 m between the boxes (figure 1). We tried to position the boxes in a regular grid, but often landscape characteristics forced us to deviate from the predetermined grid. To increase the probabil-

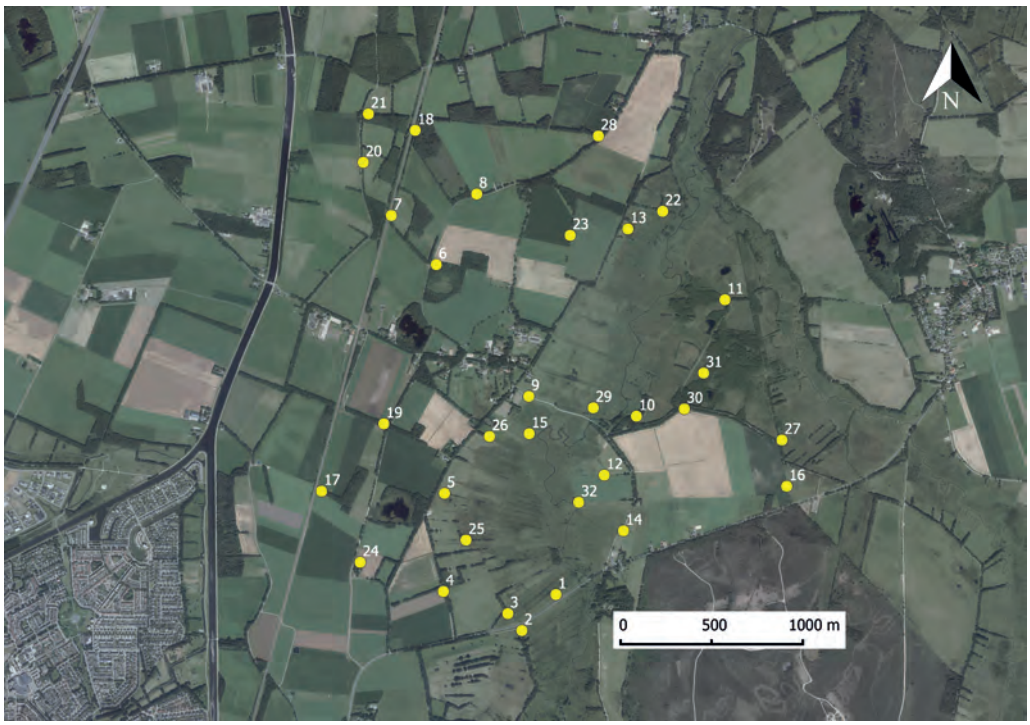

Figure 1. Distribution of nest boxes in the study area near Taarlo. Numbers correspond with numbers in figure 2 and in the text (Map data: PDOK).

ity of attracting weasels, we placed the boxes on line-shaped elements or on gradients in the terrain, such as hedgerows, ditches or edges of woodland (Šálek et al. 2010). Some boxes were placed in intensively used farmland outside the river valley. The boxes were well-hidden to avoid human detection or destruction. Despite the locations being carefully chosen, three boxes were lost during mechanised landscape maintenance. These were replaced as soon we became aware of their destruction.

A large part of the study area is covered by the river valley of the Drentsche Aa. For a long time this was an area of wet meadows, hedgerows and woodlots embedded in small-scale farmland with fields, heaths and small villages. From 1970 onwards the vicinity of the Drentsche Aa was drained, agriculture intensified and field sizes increased. Despite its protected status, the valley gradually became drier. At the end of the 20th century ditches

Figure 2. Weasel footprints on the platform of the track tube. Nest box no. 1, 22 August 2016. *Photo: Matthijs Smaal.*

were filled in order to counter drainage. Nowadays large sections of the river valley are very wet and partly changed into marshland. Slightly drier grasslands are mown once a year in August-October. A thorough description of

the area can be found in Spek et al. (2015). The river valley is surrounded by intensively used farmland with woodlots. Some of the boxes were located in the hedgerows that cross this landscape.

Boxes were checked monthly for tracks. The tracks were photographed, the platforms cleaned and, when necessary, coloration oil was added. Tracks of weasels look like very small cat tracks with pad widths of about 2 mm (figure 2). Tracks of mice and voles are more subtle and look like a flock of small points and dashes. Tracks of stoat (*Mustela erminea*) are generally larger and less clear than those of weasel because of their larger size and their feet being more hairy (the pad size of a stoat's hind foot, excluding nails, is 50% larger than that of weasels; see IJsseling & Scheygrond 1943: 352 and 355, although their figures do not distinguish between the sexes). We may have mistaken tracks of stoat for those of weasel, since the prints were not always crystal clear. Nine prints were confirmed as weasel by a photograph of the individual; by contrast we did not obtain any pictures of stoat. Not all the tracks recorded were of good enough quality to be identified. Individual pad prints of brown rats (*Rattus norvegicus*) can be very similar to those of weasels, although brown rats have longer toes. In this study we identified 122 tracks as belonging to weasels and 22 tracks that remained unspecified, which were omitted from the analysis. In nine cases (with a different nest box and/or different year) we confirmed our determination of weasels' presence with camera images.

In order not to disturb the animals we rarely opened the nest boxes to inspect the inside. In order to validate the use of boxes

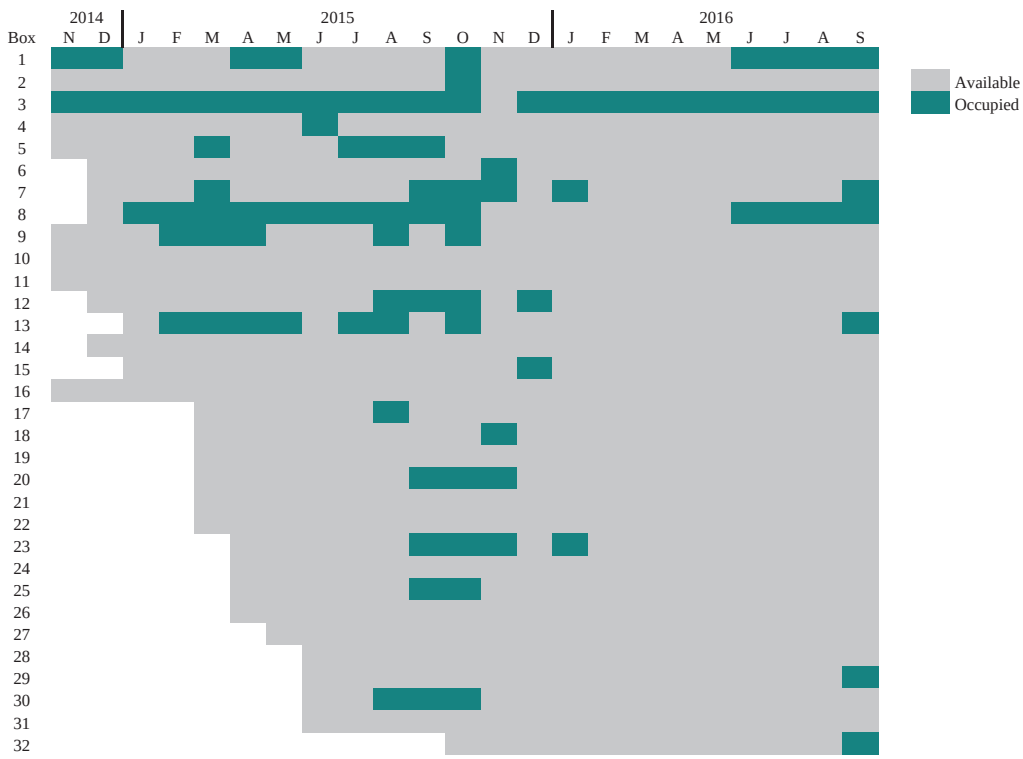

Figure 3. Availability and monthly use of nest boxes by weasels in the study area. Numbers refer to the map in figure 1.

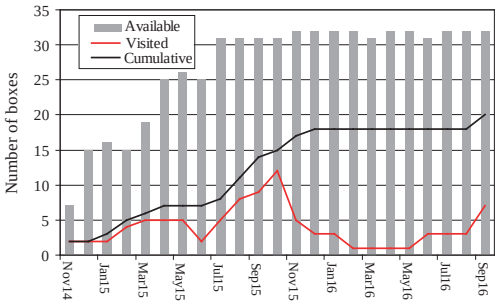

Figure 4. Available nest boxes and visits by weasels in the course of the study period (November 2014 - September 2015). 'Cumulative' is the number of individual boxes that were visited at least once.

by weasels, we mounted a temperature logger (Easylog USB-logger) inside nest box 3. The logger can store 35,000 measurements accurate to the nearest 0.1 °C. Initially we opted for an interval of 20 seconds between measurements, but later on changed this to every 1 or 2 minutes. When the logger was active, we checked the box more frequently to harmonise fluctuations of within-box temperature with visits of weasels, mice (Muridae) or voles (Cricetidae) and with fluctuations in ambient temperature. The logger was operational between 9 December 2015 and 23 February 2016 and between 17 April and 1 August 2016. During these periods 166,785 valid measurements were collected.

Results

Occupancy of boxes by weasels

It usually took several months before the nest boxes were visited by a weasel; 12 out of the 32 nest boxes were not visited at all. Three of the boxes were frequented by weasels 20, 28 and 29 days after they were put in place (i.e. weasel presence was recorded during the first check, so they were perhaps visited earlier than this). Duration of usage of a nest box (presumably by the same individual) ranged from one month to twelve months (figure 3).

Figure 5. Nest made out of fur and moss by a weasel. Nest box no. 3, 20 March 2015. *Photo: Matthijs Smaal.*

The number of boxes visited by weasels at any one time fluctuated considerably (3-38% per month). Box visits were more common in spring and summer 2015, with the maximum occupation in that year being reached in October. In November nest box occupancy declined and reached a minimum in February 2016, continuing until May. In June numbers started to increase again, and reached an annual high in September 2016. Overall occupancy was much lower in 2016 than in 2015 (figures 3 and 4).

Daily use of nest boxes by weasels

In general weasels left few, if any, traces inside the nest boxes. Only one box (no. 3) contained some sort of nest, made from moss and pieces of vole skin (figure 5), together with remains of at least 53 voles (106 incisors from the lower mandible, and many feet) (figure 6). This finding was made on 18 November 2015, after the nest box had been occupied for twelve consecutive months. We have no indication that nest boxes were used for reproduction.

Visits by weasels were registered via consid-

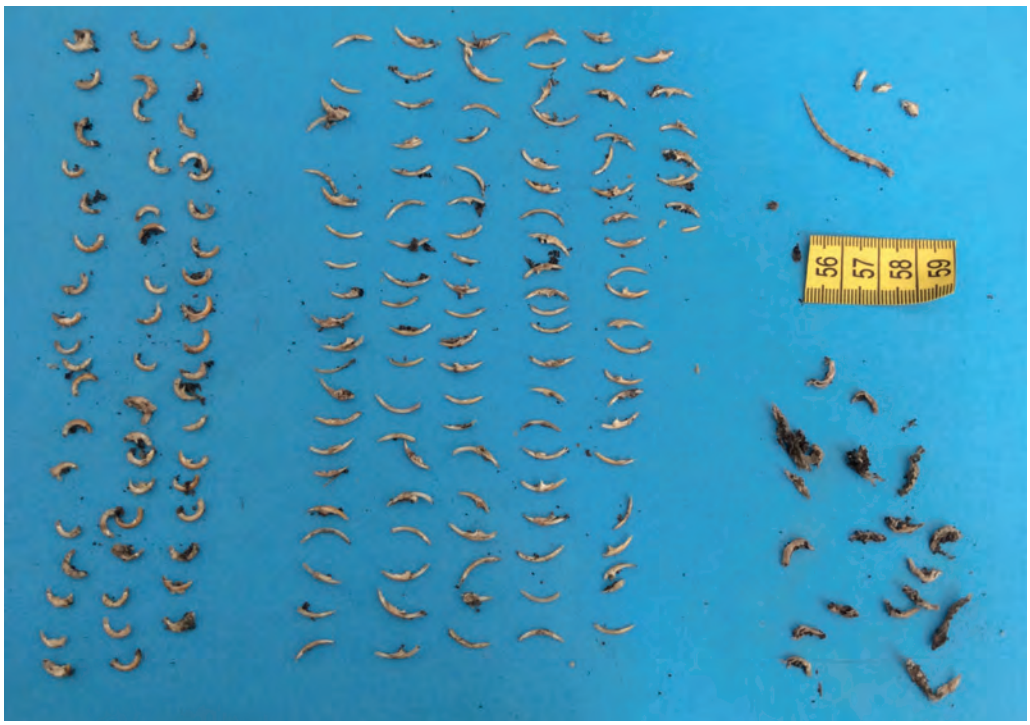

Figure 6. Incisors and feet of voles that were collected from nest box no. 3 after this box had been in use for 12 consecutive months. 22 November 2015. *Photo: Matthijs Smaal.*

erable rises in temperature in the box (+1.2-7.0 °C, mean 4.1 °C in consecutive measurements), probably caused by direct skin contact. All rises of this kind coincided with weasel visits.

When the animals prolonged their stay the temperature inside the box remained relatively high compared to the ambient temperature. After leaving the nest box temperature dropped in a typical curve (figure 7). Direct sunlight rarely changed the temperature in the nest box by more than 0.2 °C between measurements (occasionally up to 0.8 °C on hot days around noon). Apart from these outliers, short-lived fluctuations of 0.4-1.4 °C were recorded when weasels were absent, probably triggered by mice or voles. We cannot exclude the possibility that weasels produce a similar pattern when visiting the nest box for just a moment.

The data of the temperature logger showed that nest box no. 3 was visited intermittently, with visits varying considerably in duration. Temperature rises that were probably caused by a weasel occurred on three occasions in December 2015, twice (on the same day) in February 2016, four times in April and once in June. In December the visits lasted between six and a half and nine and a half hours. In all the other cases the visits lasted half an hour less (in April often for less than two minutes). These data show that visits became shorter towards spring. This difference was not correlated with temperature since temperatures in December 2015 were generally higher than in February and April 2016. There was no discernible pattern in the timing of visits across the day.

Other species visiting the nest boxes

The nest boxes we provided were suitable for animals up to the size of a stoat. A few tracks of brown rats were recorded in the track tubes

attached to the nest box, and several times they were photographed by camera traps near nest boxes. Tracks of mice, voles and shrews (wood mouse *Apodemus sylvaticus*, bank vole *Myodes glareolus*, field vole *Microtus agrestis*, Eurasian harvest mouse *Micromys minutis*, common shrew *Sorex araneus* and pygmy shrew *S. minutus* as evident from camera) were frequently recorded in the track tubes.

Discussion

Nest boxes were used by weasels as a temporary den, possibly also during hunting and in at least one case as a deposit to store prey. Weasels did not use the boxes to give birth or nurse a litter, possibly because the type we provided was too spacious and the entrances are sufficiently wide to allow stoats to enter. The presence of the larger and probably dominant stoat (King & Powell 2007) may affect occupancy rate of boxes by weasels, but the two species are known to coexist without much competition by using disparate habitats and by exploiting different food niches, with the weasel showing a more flexible and generalised habitat choice and a preference for voles (Aunapuu & Oksanen 2003). Moreover, although a stoat was photographed in the study area and DNA analysis of five mustelid droppings from the study area revealed that one out of five was of stoat (the rest Weasel; Elske Schut, Gendika BV): given the scarcity of field observations, stoats can be considered to be rare in the Drentsche Aa region.

The importance of voles as prey was illustrated by a pile of incisors of at least 53 voles found in one of the nest boxes, presumably the remains of a cache of a single weasel. Caching is well-known in weasels (e.g. Oksanen 1983, Rechstein 1993), a characteristic behaviour evolved under conditions of unpredictable food supply (King & Powell 2007). Weasel diets in Europe are typically dominated by small mammals (e.g. 46% and 61% of all prey; respectively Tapper 1979 and Brugge 1977), even so in more recent decades with declining food availability (see review in King & Powell 2007).

During nearly two years of research we recorded low numbers of weasels in boxes in spring, an increase in summer, a peak in autumn and low numbers in winter. This pattern is in line with expected population fluctuations due to reproduction between March and September (Deanesly 1944, Jędrzejewska 1987). We had, however, expected a more intensive use of nest boxes during winter, when weasels are known to search for drier places to rest (Zub et al. 2008).

Using nest boxes for monitoring small mustelids may seem a less elegant and more labour-intensive method than the use of track tubes or camera boxes. However, apart from production and placement in the field, which is time-consuming, checking 32 boxes takes less than a day and they are simple to manage as they stay at the same location. The permanence of location is an advantage, as weasels seem to take a long time to encounter (or get used to) nest boxes. In this regard, the advised time span for providing track tubes or camera boxes, i.e. 1-2 weeks (www.kleinemarters.nl), may be too short in areas where weasels are scarce. As weasels used the nest boxes for several purposes, the occupancy rate may increase over time. Whether recorded annual fluctuations reflect reality remains to be validated. To improve the efficacy, we plan to develop a nest box in which a camera can be placed as soon as the box is used. This will be especially useful to validate identifications of tracks, because, to date, we have been unable to unambiguously distinguish tracks of weasel and stoat (unlike Aunapuu & Oksanen 2003 and Norrdahl & Korpimäki 1995, who made species-specific identifications from tracks in snow).

Acknowledgements: We thank Rob Bijlsma, Dirk Criel, Jan Dekker, Jasja Dekker, Maurice la Haye, Tim Hofmeester, Hans Kleef, Frank van der Knaap, Monique de Lange, Guido Lek, Erwin van Maanen,

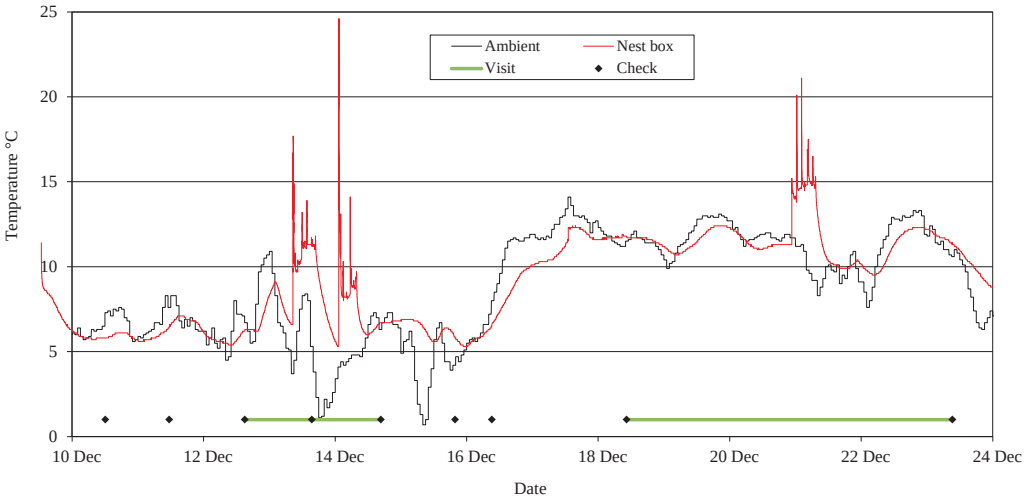

Figure 7. Temperature inside nest box no. 3 (measured with logger) and ambient temperature (hourly measurements at Eelde, 11 km north of the study area at a height of 1.5 m, source: KNMI) between 10 and 24 December 2015. According to tracks, weasel visited the nest box twice during this period. Track tubes were checked intermittently (dots).

Jeroen Mos, Aaldrik Pot, Johann Prescher, Jasper Schut, Peter van Stiphout and Karol Zub for discussing the merits and drawbacks of different methods and helping us to identify tracks. Staatsbosbeheer gave us permission to work in the protected river valley of the Drentsche Aa. Elske Schut of Gendika BV analysed the DNA of the five droppings. Special thanks to Rob Bijlsma who provided us with literature and improved the manuscript. We furthermore thank two anonymous reviewers for their constructive feedback and Nicholas Parrott (TextualHealing.eu) for editing the English.

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Samenvatting

Monitoren van wezels (*Mustela nivalis*) met behulp van nestkasten

Tussen november 2014 en september 2016 werd een monitoringonderzoek uitgevoerd naar wezels in een gebied van 750 ha bij Taarlo, Drenthe (6.62 E, 53.03 N). Twee-endertig op de grond geplaatste nestkasten voor kleine marterachtigen, voorzien van een sporenplank, werden maandelijks gecontroleerd. Om verstoring te voorkomen, werden de nestkasten zelf zelden geopend. De kasten waren min of meer regelmatig verspreid over het gebied geplaatst met een gemiddelde onderlinge afstand van 285 m, en waren steeds goed verstopt langs een houtwal, sloot of bosrand. In één van de nestkasten werden de frequentie en duur van wezelbezoeken vastgelegd met behulp van een temperatuurlogger. In de meeste gevallen duurde het enkele maanden totdat de nestkasten voor het eerst werden bezocht door wezels. Daarna vertoonde de bezettingsgraad sterke fluctuaties (3-38%), waarbij de bezetting hoger was in 2015 dan in 2016. Van de belopen nestkasten was er slechts één die een soort van nest bevatte, gemaakt van mos en muizenhuid. In deze kast lagen ook de snijtanden en voetjes van tenminste 53 woelmuizen, wat er waarschijnlijk op duidt dat de kast als tijdelijke opslagplaats voor prooi is gebruikt. Het is uit te sluiten dat de nestkasten gedurende de onderzoeksperiode zijn gebruikt om jongen in groot te brengen. Bezoeken van wezels aan de nestkast met temperatuurlogger kenmerkten zicht door sterke stijgingen en dalingen in de temperatuur. Dergelijke grote temperatuurschommelingen werden alleen vastgesteld wanneer op de sporenplank tevens prenten van wezels werden aangetroffen. Geringere veranderingen in temperatuur werden waarschijnlijk teweeg gebracht door bezoek van muizen of door veranderingen in de buitentemperatuur. Uit de data van de temperatuurlogger blijkt dat de wezel deze nestkast onregelmatig en op niet-vaste tijdstippen bezocht; de bezoekduur varieerde hierbij van minder dan 2 tot 493 minuten (n=10 bezoeken tussen 13 december 2015 en 20 juni 2016).

Received: 3 October 2016
Accepted: 30 March 2017