Hot spot for pine marten (*Martes martes*) and first record of a natal den in Flanders (Belgium)

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Abstract: From 2000 to 2011, pine marten (*Martes martes*) reproduction has been regularly recorded in a small forest complex of about 250 hectares in the north of the Province of East Flanders (Flanders, Belgium). The local habitat is characterised by a mix of forest types, in which coppice stands and fen forest patches are prevailing on substantial surfaces, combined with many small satellite woodlands spread out around the margin. The home range size of a radio-collared breeding female, recorded from August 2010 to April 2011, appeared to be very small (<1 km²), elsewhere in Europe only found in the pristine forest of Bialowieza (Poland) which is home to a very dense pine marten population, or in 'a-typical' habitat composed of hedged farmland with small forest fragments in the French Ardennes. However, the location studied here appears to be peculiar not only as it is a small and fragmented habitat for pine marten, but even more as it is an isolated hot spot in an open landscape, far from any massive forest complex that holds a vital pine marten population. The home range was located in the most compact centre of the forest complex and was intensively used throughout the whole study period. Remarkably, a 20 metre broad channel was bisecting the home range, not at all being a barrier although it can only be crossed over by active swimming. This finding should be noted with respect to possible attempts of diminishing predation risks from martens (e.g. to rare breeding birds) by creating landscape 'barriers' such as broad ditches or even channels. Given the preliminary results of telemetry and camera trapping, the pine marten's social system remains unclear to some extent in situations where suitable habitat is very limiting and the presence of direct neighbours is obscure.

Keywords: pine marten, *Martes martes*, Sinaai, Flanders, Belgium, home range, natal den, fragmentation, isolation, telemetry, camera trapping.

Introduction

Pine martens (*Martes martes*) are very rare in Flanders and the southern provinces of the Netherlands and their prolonged presence during recent decades is not well understood (Van Den Berge et al. 2000). In order to get more insight in the situation, an on-going project to collect and autopsy traffic victims from all over Flanders was started in 1998. Additionally, camera trapping has been successfully tested and potential pine marten habitats have been systematically scanned for the presence of the species since 2008 (Van Den Berge 2009). Integrating all the available information (including chance sightings) from these programmes shows that pine martens are settled and breeding in at least three locations in Flanders: one in the Waasland region in the north of the Province of East Flanders and two in the Antwerp part of the Kempen region (figure 1). Recently, local reproduction has also been recorded at one location in the southern border zone of the Netherlands (Wijsman 2009). While the locations in the Kempen are in a quite well-forested landscape across the national border, the one in Waasland, situated at the other side of the river Schelde, is characterised by only small and scattered woodlands, far from any massive forest or large woodland complex (figure 1). In this respect, it is surprising to find a breed-

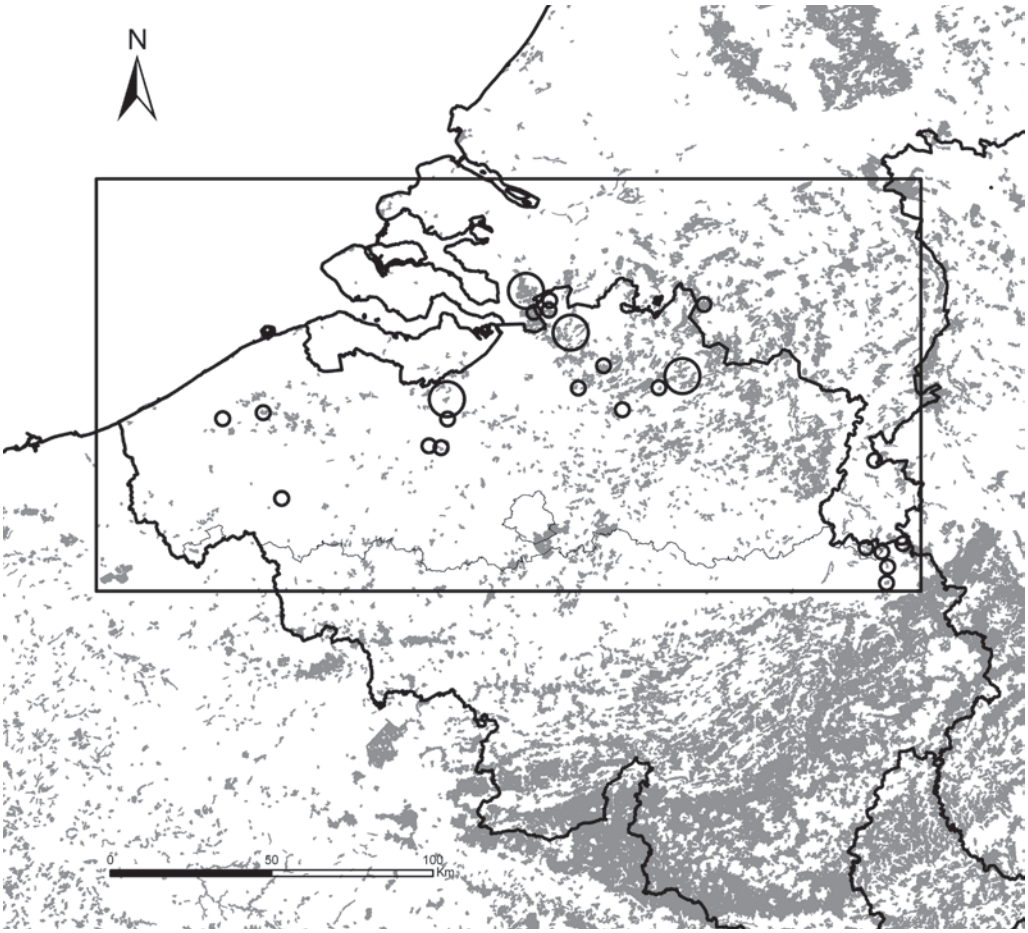

Figure 1. Reports of pine marten from 2000-2011 in Flanders (Belgium) and the southern Netherlands, related to the presence of forest (in grey) according to the CORINE land cover survey (2006). Circles indicate locations of (combinations of) traffic kills, camera trapping results and reliable sightings; large circles indicate reproduction sites, with the most western location being Sinaai. Flemish data sourced from the INBO carnivore databank, Dutch data from van der Lans et al. (2006) and H. Wijsman (communicated by his Boommarter Nieuwsbrief), and Walloon border data from R. Janssen (personal communication).

ing population has been there for more than ten years. This article gives an overview of our findings at this location, called Sinaai.

Methods and results

Study area

The Sinaai area consists of a complex of small woods and field woods ranging from 1-2 hectares to about 100 hectares in size, which are surrounded by arable land and meadows. The shortest distance to other more or less compact forests (of at least 100 hectares) in the region ranges from 3 to 8 km. The complex lies in the Moervaart Depression, an alluvial landscape of quaternary origin that has been developed within the Flemish Valley north of Gent. In historical times, it was predominantly in use as meadow land, drained by a dense network of ditches and water channels of varying

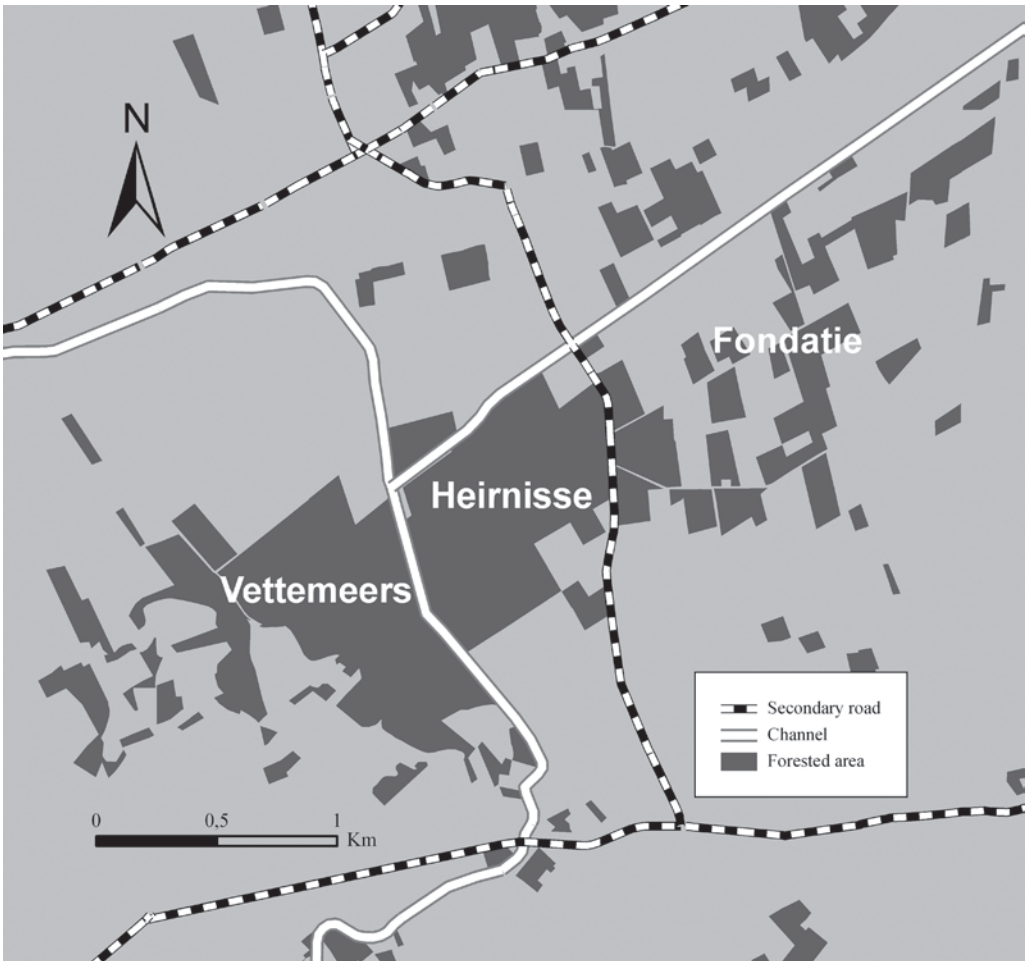

Figure 2. The sub-areas of the pine marten reproduction site Sinaai in the north of the Province of East Flanders (Flanders, Belgium).

dimensions. From the end of the 18th century onwards there was some small scale afforestation which gave the area its current characteristics (Baeté et al. 2004). One can identify three sub-areas (figure 2). The central part, called the Heirnisse, is bordered on two sides by small channels, the Moervaart in the west and the Stekense Vaart in the north. East of the Heirnisse is the Fondatie, the two are separated from each other by a secondary road. The Fondatie is a more open sub-area with only scattered woods. To the west of the Heirnisse, i.e. on the other side of the Moervaart channel, there is the Vettemeers. Both the Heirnisse and the Vettemeers are relatively extensive forests. The Heirnisse became a strict (non-intervention) forest reserve in the 1990s and is owned by the Flemish government. In the other two areas a private nature reserve is being established. However, the land in the Vettemeers is still mostly in private ownership.

The Heirnisse is characterised by stands of coppices: mainly alder (*Alnus* sp.), birch (*Betula* sp.) and hazel (*Corylus avellana*), mixed with older Canadian poplars (*Populus x canadensis*), some small stands of matured oaks (*Quercus robur*) and middle-aged Corsican pine (*Pinus nigra*). There is a widespread network of ditches

Photo 1. The Heirnisse at Sinaai is characterised by stands of coppice mixed with fen forest, sedge and reed beds. *Photograph: INBO.*

and much land is covered by bramble thickets. Locally fen forest, sedge and reed beds are prevailing (photo 1). After the area was designated as a forest reserve an attempt was made (in 2004) to eliminate all American oak (*Quercus rubra*) coppice and American black cherry (*Prunus serotina*), leaving all the trunks on the spot and resulting in several quasi clear-cut bramble patches totalling about two hectares. In 2010 it was decided to scrape all the dead wood together and create massive wood heaps. The Vettemeers and Fondatie originate from the same historical complex and have similar forest stands, although these have been substantially desiccated in recent decades, resulting in dry ditches, an absence of marsh vegetation and more vertically structured forest stands. Both areas are locally interspersed with small to medium-sized clusters of spruce (*Picea abies*) and contain some artificial ponds. Unlike the Heirnisse there are some inhabited parcels. The whole complex contains about 250 hectares of forest, mostly concentrated in the Heirnisse and the Vettemeers, separated from each other by the Moervaart channel.

The presence of pine marten

Beside some information based on oral history from local people, the first concrete record of pine martens being present at Sinaai dates from the 7th of July 2000, when a young male was found as traffic kill (Van Den Berge et al. 2000, Van Den Berge & De Pauw 2003). With a baculum (os penis) weight of only 0.12 g, this animal obviously appeared to be born in spring 2000 according to Broekhuizen & Müskens (2000b), still living in the parental territory at that time according to Broekhuizen & Müskens (2000a), and so proving the first and definitive record of reproduction in Flanders. On the 5th of June 2004 another traffic kill was found on the same section of road: an adult female, clearly lactating. However, as the dead body was gravely damaged, neither the uterus

Figure 3. Home range measured as the minimum convex polygon (MCP 100) of a female breeding pine marten from the 4th of August 2010 till the 1st of April 2011 at the Sinaai location. Black dots: telemetry fixings indicating inactivity. White dots indicate activity (with minimum intervals of 24 hours).

nor the ovaries could be inspected for recent gestation. As false gestation is known to occur in martens (Broekhuizen & Müskens 2000b), lactation itself could not be considered as further proof of local reproduction. Moreover, based on three independent tooth sections for cementum aging by a specialised laboratory (Matson's Lab, Montana, USA), this female should only be one year old – i.e. born in spring 2003 – being too young to have had offspring. Nevertheless, two days after the finding of the dead female, a local naturalist observed two or three young pine martens playing in the shrubs and succeeded in filming them. So, most probably there were two adult females in the same reproduction territory that year.

On the 1st of June 2005, we ourselves made a prolonged chance observation of a fleeing adult female with at least two young, climbing into an oak tree and making themselves rigid on the branches of it.

During the following years, the continued presence of pine martens seemed likely as there were regular findings of scats and prey remnants (especially of middle sized birds and eggs), although confusion with polecat (*Mustela putorius*) or stone marten (*Martes foina*) could not always be excluded. According to local naturalists, polecat used to be a 'common' inhabitant in the area, and proof of the presence of

stone marten was provided by the finding of a traffic kill near the Fondatie, in spring 2011. In autumn 2007 the first pine marten was photographed by a camera trap (Trailmaster TM550) in the Heirnisse (using valerian oil as a lure) and in the following summer (July) another type of camera trap (Moultry M40) registered a pine marten in the Fondatie. By contrast, we did not succeed in recording any pine martens in any of the surrounding forested areas of the Waasland region (Kloosterbos, Puyenbroek and Heidebos) despite intensive effort using up to five cameras together (minimum one/km²).

In 2008 and 2009, the presence of marten scats and prey remnants was very noticeable in both the Heirnisse and the Fondatie, suggesting increased (territorial) activity and probable reproduction. Therefore, in the summer of 2009 the camera trapping technique (Moultry M40/D40/I60; Spypoint IR8; Reconyx HC600) was combined with a feeding place (fruit, honey, peanut butter) in both these sub-areas to detect the presence of young animals. This plan appeared to be very successful and resulted during several weeks in plenty of photographs and videos of up to three pine martens together: apparently an adult female with her two young (photo 2). The last family pictures date from mid-September, after which camera trapping was only occasionally successful.

In the early spring of 2010 an exhaustive attempt was made to survey all possible natal den sites, especially tree cavities, in both the Heirnisse and the Fondatie (Conings 2010). However, pine marten activity in spring seemed much less than in the preceding two years and the inspection of all known tree cavities (93 in the Heirnisse and 63 in the Fondatie) remained negative. Camera trapping resulted in pictures of just one single adult marten, suggesting there was no successful breeding in 2010.

With the exception of the Sinaai location, there is hardly any other recent information about even the temporary presence of pine marten in East Flanders (figure 1). Besides a reliable chance observation of a pine marten

Photo 2. Still from a video-trap movie (Moultry I 60) recorded on the 12th of September 2009 in the Heirnisse at Sinaai: two young pine martens foraging at the foreground on a feeding place and the adult female passing in the background (left). *Photograph: INBO.*

hunting a squirrel in the city park of Lokeren on the 31st of August 2008 (some five km from the Sinaai location), only one other traffic victim has ever been found. On the 18th of March 2010, a sub-adult male of about eleven months old was killed in the municipality of Kalken, about 15 km from the Sinaai location. His throat patch pattern appeared to be different from the young animals frequently photographed at the Sinaai location in 2009, suggesting another breeding location (Van Den Berge 2010). However, a subsequent camera trapping session in the neighbouring Berlare forest during the summer of 2010 remained unsuccessfully, although some observations suggest there was local reproduction in this forest complex in 2000 and 2001.

Radio telemetry and natal den

On the 4th of August 2010 we succeeded in catching alive an adult female pine marten at the Sinaai location which we radio collared and then recorded telemetrically for the next eight months (radio-collar Televilt 151 MHz band, Telonics TR-4 receiver with a H-aerial) to the early spring of 2011. Because of the low level of tooth abrasion, the animal was estimated to be in its second year of life, i.e. born

in spring 2009. According to the nipple physiognomy, no young had ever been breastfed.

During the whole telemetry period the radio-collared marten was located by triangulation two to four times a week, mainly by day, with minimum time intervals of 24 hours. According to the signal interval, it was possible to distinguish between the activity of the marten (active or resting). When the animal was active and moving around, the first fixing was selected.

In total, 123 successful fixing days were realised (figure 3) and the spread of the fixing locations soon became quite predictable, indicating a stable home range size. According to Stier (2000) and Schröpfer et al. (1989), pine marten home ranges can be characterised by the distribution of the fixings during the resting phases, i.e. mainly by day. Apart from that, at least 32% of the telemetry records during day time indicated spontaneous activity, being well spread all over the fixings. So, to interpret home range position, the lack of a substantial number of nocturnal fixings should not be a problem.

As a fact, the most striking finding was the position of the home range, which was located on both sides of the Moervaart channel, combining the sub-areas of the Heirnisse and the Vettemeers during the whole investigation period. In absence of any bridge or other construction, the 20 metre broad channel could only be crossed over by voluntary swimming, which must have occurred at least 41 times. By contrast we found no indication that the secondary road bordering the Heirnisse was ever crossed as we did not record any visit to the Fondatie during the telemetry period, even though it is known that this sub-area was inhabited by pine marten in 2008 and 2009.

In small woods or scattered forest complexes, the application of the minimum convex polygon method (MCP) to calculate the home range surface can result in an important overestimation by including parts of unforested and unused land (Stier 2000, Mergey 2007). However, given the concrete position of the fixings, which were almost all concentrated in the compact forest core (figure 3), this method appears quite advantageous here, and moreover it allows for comparison with other studies. So, enclosing all the fixings (MCP100), home range totals only 0.92 km², whereas in the Vettemeers the home range border appears to be amply situated within the sub-area, i.e. not coinciding with its irregular borders or including any substantial unforested land.

Day hides could only be looked for when the marten was in the Heirnisse, as unfortunately we had no permission to enter the strictly private properties of the Vettemeers. Day hides were only looked for by spot-check, as they soon appeared to be almost always located in very dense sub-layer vegetation (bramble, sedge and reed beds), without possibility to see the animal but all the more disturbing it. The marten was not once found visible, e.g. resting on a bird's nest, although another pine marten was seen twice on a hawk's eyrie in the Heirnisse on the 4th and 12th of May 2011. In winter, dense spruce canopy was chosen as a day hide a few times, while in snow periods the marten invariably hided in the immense wood heaps, sometimes without leaving them for two or tree days.

In the last ten days of March, the marten was repeatedly (but not permanently) recorded at one particular site, in an inaccessible private property at the Vettemeers sub-area. During the night of the 23rd to the 24th of March, the animal even never left the site, and on consecutive days the transmitter signal always indicated exactly the same site. The last signal was received on the 1s of April when the life time of the transmitter battery ended.

A once-only visit to the site on the 12th of April confirmed the assumption of a natal den at that location: an old nest cavity of a black woodpecker (*Dryocopus martius*) in a big gray poplar (*Populus x canescens*) with two entries and a massive latrine on a branch stump. According to Kleef (2000) and Kleef & Tydeman (2009), the lengthy and uninter-

Table 1. Pine marten reproduction at Sinaai between 2000 and 2011.

2000	Certainly	Traffic kill of young male on the 7th of July
2001	No information	
2002	No information	
2003	Probably	Traffic kill of subadult female on the 5th of June 2004 (about 14 months old)
2004	Certainly	Direct observation of at least two young on the 7th of June
2005	Certainly	Direct observation of adult female with at least two young, on the 1st of June
2006	No information	
2007	No information	
2008	Probably	Remarkable presence of field signs (scats, prey remnants)
2009	Certainly	Plenty of visual evidence from camera trapping of at least two young
2010	Probably not	Intensive camera trapping unsuccessful for young
2011	Certainly	Localisation of natal den with two young

rupted stay of the female at this site between the early evening of the 23rd and the morning of the 24th of March was indicative of her giving birth then.

The following weeks, a local naturalist with free entrance to the private domain observed the den tree during the day for many hours. The adult female was seen several times, leaving the cavity for a latrine visit or to go and search for prey. On the 20th of May, two kittens were noticed for the first time at the entries of the den, while on the 24th of May the adult female was seen encouraging her kittens to leave the den. On the 27th and 28th of May, no more martens were seen, in spite of about seven hours of observation.

What followed ...

From the 14th of June, the adult female was camera-trapped several times in the Heirnisse together with her two kittens (photo 3), indicating that those young martens had also swam successfully over the Moervaart channel. After some weeks, the size difference indicated that one young was a female and the other a male, with a much bigger stature than his mother.

Surprisingly, on the 19th of September the adult female (recognisable by her radio-collar) was camera-trapped in a remote corner in the Fondatie sub-area, about 1.6 km away from the eastern border of her known home range. Since then, this animal could not be photographed any more in the Heirnisse, but was residing in the Fondatie as was proven by camera trapping, at least up until mid-November (the closing date for manuscripts for this issue).

On the 29th of September, the male young (recognisable thanks to his throat patch pattern) was live-trapped in the middle of the Heirnisse and also radio-collared. Recording this animal telemetrically (31 fixing days) showed its lasting presence in the natal home range at least up to the 22nd of November, being a late date not to have yet dispersed according to Broekhuizen & Müskens (2000a). At least two round trips over the Moervaart channel were recorded, but no fixing was made in the Fondatie. During this period, the animal was also regularly camera-trapped – all alone – on the usual feeding place in the Heirnisse.

Discussion and conclusions

The Sinaai location undoubtedly appears to be a hot spot for pine marten in Flanders, despite only having a small sized forest complex and being situated in a mainly open landscape. At least in 2000, 2004, 2005, 2009 and 2011 there was successful reproduction (table 1), and the species has probably been permanently present for more than a decade now.

Photo 3. Camera-trap photo (Reconyx HC600) recorded on the 11th of July 2011 in the Heirnisse at Sinaai: the radio-collared adult female (right) and male young (left) on a feeding table and the second young on the floor under the table. *Photograph: INBO.*

According to the overview of mean home range sizes of pine marten in Europe, given by Zalewski & Jędrzejewksi (2006), the found (eight months) home range of the radio-collared breeding female appears to be very small (<1 km²), although this does lie within the range (0.54-2.61 km²) of the authors' own results from the pristine, continuous, forest of Bialowieza (Poland) which has a very high marten population density. On the other hand, Mergey et al. (2011) found in the French Ardennes that home ranges in fragmented habitat, with an abundant food supply, were between two and three times smaller than in forest, probably due to the confinements imposed by the configuration of the landscape which contains only small suitable habitat fragments. As the home range found in our study was located in the most compact centre within the forest complex – leaving alone the integral sub-area of the Fondatie as well as a substantial part of the Vettemeers – the question remains how to explain the given situation. Zalewski & Jędrzejewksi (2006) reported only very little inter- and intrasexual home range overlap, even in a dense population, while Mergey (2007) also found overlap to be very exceptional. Given the prolonged presence of the species and regular reproduction, at least the temporary and repeated presence of a mature male in the (direct) surroundings must be guaranteed. However, as Mergey et al. (2011) found that male home ranges were 2.3 times larger than those of females, in our study area the possible configuration of the respective home ranges should cause spatial problems. So, as a social system of floating males and resident females seems unlikely in the given landscape, a cluster of small sized neighbouring and essentially overlapping home ranges can be supposed. As a fact, in Sinaai, the presence of a second adult pine marten beyond the mating season was noticed twice in the central breeding home range: in 2004 a false pregnant female was killed on the road bordering the forest core area, and in May 2011 a resting animal was observed in the very middle of the breeding home range.

It is too early yet to be able to interpret the most recent findings on the presence and absence of individual animals. Although the camera trap technique has proved to be a very useful tool to detect or document pine marten presence and possible local reproduction, the other way round it is very tricky to postulate hard conclusions: absence can't be proven. Indeed, during preceding years, the technique was not always successful, sometimes resulting in periods without any marten pictures, while the animal(s) certainly were present. Although it is known that territorial individuals sometimes make short excursions outside their home ranges (see e.g. Müskens et al. 2000), our camera trapping results suggest that the adult breeding female has left her previous home range – in favour of the male young? – and moved into the Fondatie at least for a prolonged period of several weeks.

In the near future, we hope to recapture the adult radio-collared female and replace the silent transmitter by a new one for some extra months of tracking, and afterwards remove it definitively. We also plan to start genetic kinship research as a follow up step to gain more clarity about some of our findings. In the main time, our findings yet indicate that pine martens do have a future even in the small scale

fragmented forests of Flanders. Some lessons can be learned from the particular home range position on both sides of a middle sized channel, e.g. with respect to possible attempts of diminishing predation risks from martens (e.g. to rare breeding birds) by creating landscape 'barriers' such as broad ditches or even channels.

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Samenvatting

Hot spot voor boommarter (*Martes martes*) en eerste formele vaststelling van een nestboom in Vlaanderen (België)

Hoewel boommarters (*Martes martes*) reeds vele decennia bijzonder zeldzaam zijn in Vlaanderen en het zuiden van Nederland, duidt hun langdurige aanwezigheid hoe dan ook op lokale voortplanting. Voor Vlaanderen kon in 2000 daarvan voor het eerst bevestiging gevonden worden in een klein en geïsoleerd boscomplex te Sinaai (Oost-Vlaanderen). Sindsdien lijkt, op basis van een combinatie aan onderzoeksmethoden (waaronder de inzet van cameravallen), permanente aanwezigheid van boommarters in het gebied zeer aannemelijk en vond succesvolle voortplanting met zekerheid nog minstens vier keer (in 2004, 2005, 2009 en 2011) plaats. Tijdens twee voorjaren d.i. buiten de paartijd, werd de aanwezigheid van een tweede adult dier in het voortplantingsterritorium vastgesteld. In augustus 2010 werd een lokaal gevestigd wijfje met een halsbandzender uitgerust en gedurende acht maanden telemetrisch gevolgd, dit is tot eind maart 2011. De home range van dit dier bleek minder dan 1 km² groot en beperkte zich tot het compacte, centrale deel van het boscomplex, evenwel gelegen aan weerszijden van een 20 meter breed kanaal dat enkel zwemmend kan worden overgestoken. Dit wijfje bracht op 24 maart 2011 twee jongen ter wereld – de eerste gedocumenteerde geboortedatum in Vlaanderen. Kort na hun vertrek uit de nestboom bleken ook deze jongen het kanaal reeds succesvol te kunnen oversteken. Voor een territoriale soort met grote individuele leefgebieden is de langdurige aanwezigheid en herhaaldelijke succesvolle voortplanting in een klein en geïsoleerd bosgebied opmerkelijk. De landschappelijke configuratie maakt het opbouwen van een klassieke sociale structuur, waarbij in principe ook de leefgebieden van mannetjes en wijfjes nauwelijks of niet overlappen, heel moeilijk. Voorlopig lijkt het er op, dat het moederdier in het najaar haar home range verplaatste naar een aanpalend deelgebied, terwijl haar mannelijk jong in het geboorteterritorium resideert.

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