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Behaviour and survival of captive-reared orphaned stone martens (*Martes foina*) after release in the wild

by

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Presented for the degree of Doctor of Philosophy in the School of Life Sciences at the University of Sussex

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Declaration

I hereby declare that this thesis has not been submitted in whole or in part, either in the same or different form, for a degree or diploma or any other qualification at this or any other university. All the work described in this thesis was carried out by me at the field study sites in Luxembourg. Where other sources are referred to this is indicated.

Signature

Lieke Mevis

To Cédric

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Summary

It is common practice to re-release wildlife back into the wild, even though there is little data on the effectiveness of this practice with respect to animal welfare or cost effectiveness. The aim of my study was to examine the post-release behaviour of captive-reared orphaned stone martens (*Martes foina*) and the impact of conspecifics' presence on this behaviour. Radio-telemetry was used to collect behavioural and survival data; a questionnaire survey within the local community and live-trapping were used to determine the presence of other martens and to investigate public attitudes towards martens. Specific aims were to determine: (1) the post-release survival of martens; (2) the potential for human-marten conflict; (3) the martens' pattern of post-release ranging behaviour; and (4) the impact of conspecifics' presence on this behaviour. On the basis of previous studies, I expected abnormal behaviour immediately after release, together with a reasonable rate of short-term survival; but there was no previous evidence relating to mid- or long-term survival. A total of twelve martens were released, of which eight were followed successfully for at least 4 months. There was considerable individual variation in post-release behaviour. Survival rate was high (0.66), indicating that young martens were able to establish sustainable home ranges. Released martens did not seem to cause significant human-wildlife conflict and only one of the released animals settled in a village. Live-trapping and the questionnaire survey indicated that martens were already established in the area and I suggest that this was why more of the young captive-reared martens did not settle in villages. Public attitudes towards martens were generally positive. I conclude that in the medium-term, release of captive-reared martens is acceptable as regards animal welfare and cost-effectiveness. However, further work is needed to examine long-term survival and post-release behaviour.

CHAPTER 1: GENERAL INTRODUCTION

This thesis concerns the post-release behaviour and survival of orphaned juvenile stone martens (*Martes foina,* Erxleben, 1777). The animals in question were found in Luxembourg by members of the public and were thought to have become separated from their mother. They were brought to an animal rescue centre, where they were reared in captivity until they were about 24 weeks old. They were then released into the wild. The general aim of my project was to see how well these martens were able to establish themselves in the wild after release and, hence, to assess the viability of release as a way of managing this particular wildlife problem.

In this chapter, I review previous studies involving the release of carnivores, with special emphasis on the consequences of release for the animals concerned. I then set out the detailed aims and objectives of my project.

Release of animals into the wild is undertaken for a number of reasons. Firstly, captive rearing and release may be undertaken for purposes of conservation, to supplement populations of endangered species or to reintroduce them into their former range (Biggins et al. 1999, Ausband and Foresman 2007). Secondly, animals that cause disturbance to humans or damage to property may be captured and translocated as a way of managing the problem behaviour (Andrews et al. 1973, Conover 2002, Adams et al. 2004, Herr et al. 2008). Thirdly, animals that are injured, for example by road traffic, may be brought into rescue centres for treatment, following which they may be returned to the wild (personal observation). And, finally, members of the general public sometimes bring orphaned wildlife into rescue centres, so that these animals can be reared in captivity until they are old enough to be released (Robertson and Harris 1995, Herr et al. 2008). The subjects of the present study came into this last category: that is, they were young, apparently orphaned, stone martens found by members of the public in the wild and taken to a wildlife rescue centre to be reared prior to eventual release.

1.1 RELEASE

There has been dispute about the ethical implications of release. Is it kinder, in general, to release animals into the wild than, say, to euthanaze them or retain them in captivity? Whatever the reason for release of wildlife into the wild, relatively few data exist on the consequences of release, either from the point of view of animal welfare or as regards the survival rate of released individuals (Griffith et al. 1989, Robertson and Harris 1995, Linnell et al. 1997, Reeve 1998, Fischer and Lindenmayer 2000, Conover 2002, Herr et al. 2008). Hence, it is difficult to assess the cost-effectiveness of release as a management strategy.

Even more fundamentally, however, there is also no generally accepted definition of what is considered a successful release project. There are two approaches. From an ecological perspective a project can only be considered a success if it results in a self-sustaining viable population. At an individual level, this means that an animal should survive, reproduce and successfully raise offspring. However, it is often not possible, especially in long lived species, to get the necessary data on survival and reproduction within the limited time period of a research project. Hence, many authors take a more pragmatic perspective, defining a project as successful when initial signs of ecological success are observed. Whichever approach is adopted, it is crucial that researchers clearly define precisely what they consider constitutes a successful release (Fischer and Lindenmayer 2000).

1.1.1 CONSEQUENCES FOR RELEASED ANIMALS

Regardless of the precise definition of ‘success’, it is clear that different factors can affect the probability of survival of a released wild animal and that, generally, mortality is highest immediately following release (Moore and Smith 1991, Stamps and Swaisgood 2007). In carnivores, high mortality rates have been recorded immediately after release for European lynx (*Lynx lynx*), red wolf (*Canis rufus*), otters (*Lutra lutra*)

(Moore and Smith 1991), swift foxes (*Vulpus velox*) (Carbyn et al. 1994) and captive-reared fox (*Vulpus vulpus*) cubs (Robertson and Harris 1995). Released animals are faced with a number of different problems, and I describe these in the following paragraphs.

Firstly, the success of a release project depends strongly on the quality of the habitat the animals are released into. If a habitat is not selected carefully there might be a heightened risk of predation or there might not be enough resources available to sustain the released animals. The lack of sufficient resources in the release area led to disastrous failure of a reintroduction program involving the lynx (*Lynx canadensis*) in the Rocky mountains (Kloor 1999).

Even if an animal is released into what constitutes, for them, an ideal habitat, this might already be occupied by other conspecifics (Fischer and Lindenmayer 2000). This is particularly problematic for territorial animals, which are likely to drive out potential intruders (Roe and Roe 2003, Moreno et al. 2004). Local wolf (*Canis lupus*) packs attack unfamiliar wolves that pass through their territories (Fritts et al. 1984). In wolves translocated problem animals had lower survival rates than resident wolves in the release area and 67% never formed or joined a pack (Bradley et al. 2005).

Secondly, the life cycle stage of individuals at the time of release can strongly influence their survival after release (Sarrazin and Legendre 1999). For example, an animal that would have dispersed naturally at the time that it was released might be less affected by translocation than an individual that would not (Balharry 1993). Thirdly, a number of problems are associated with human interaction during the process of reintroduction. In reintroduction studies, wild-caught individuals do better than individuals that have spent time in captivity (Jule et al. 2008). Mortality rates were higher in captive-reared released swift foxes than in wild-caught ones (Carbyn et al. 1994). However, raccoons *(Procyon lotor*) that were translocated had similar survival rates as the local population and dispersion movement was limited (Mosillo et al. 1999).

Handling stress (Molony et al. 2006) or prelease conditioning of the animals to humans could reduce their fitness after release (Molony et al. 2006, Jule et al. 2008). In European badgers (*Meles meles*) trapping was associated with elevated cortisol levels, indicating stress (Schütz et al. 2006). American martens (*Martes americana*) broke their teeth by gnawing on their welded-wire shipping cages during a translocation study in Wisconsin, USA (Davis 1983). However, in wild-caught Eurasian otters (*Lutra lutra*), biochemical parameters considered to vary in relation to stress decreased during the time spent in captivity (Fernandez Moran et al. 2004). Animals that were raised in captivity could have a reduced immune-competence due to a lack of exposure to pathogens in the often relatively sterile captive environment, as a result of which they might not be able to fend off pathogens in their new environment (Biggins et al. 1998, Sarrazin and Legendre 1999, Mathews et al. 2006, Jule et al. 2008).

Additionally they might not be sufficiently prepared to survive independently in the wild, because they might not have learned vital behaviours such as hunting, foraging, social behaviours and locomotion, or might not have been exposed to an adequate environment (Biggins et al. 1998, Sarrazin and Legendre 1999, Jule et al. 2008, Reading et al. 2013). The importance of the captive environment is suggested by a number of studies. Training or exposure to enrichment to acquire hunting skills can be of vital importance for later survival (Reading et al. 2013). This is of particular importance for specialist feeders like carnivores. Black-footed ferrets which were exposed to live prey (Vargas and Anderson 1999) and to a complex environment during their captivity had better survival rates after release than animals reared in a cage and fed on dead food (Biggins et al. 1998, Vargas and Anderson 1999). Additionally they showed less post-release movement than ferrets that were raised in a deprived environment (Biggins et al. 1999). Similarly, semi-natural rearing conditions were associated with less post-release movement in the Iberian lynx (*Lynx pardinus*) (Rodriguez et al. 1995).

Fourthly, dispersing animals could prefer new habitats that contain stimuli comparable to those in their natal habitats. This is called natal habitat preference induction (NHPI) and can lead to prolonged travel distances after an animal's release because it searches for a habitat similar to the one it was raised in. Extensive movement in turn increases mortality risk and can lead to the animal leaving the area that was selected for it to be released into (Rogers 1986, Stamps and Swaisgood 2007). Other factors such as absence or presence of predators, competitors, or lack of food or shelter can also provoke extensive movement after release. Whatever the reasons are for extensive post-release movement, it has been recorded for translocated adult American martens (*Martes americana*) and fisher martens (*Martes pennantia*) (Powell 1979, Banci 1994) and sea otters (*Enhydra lutris*) (Estes et al. 1993). Previous studies of captive-reared and captive-bred foxes suggest that behaviour after release is likely to consist of two phases: an initial phase of erratic movement involving extensive travel, followed by a static phase in which the animal in question settles in a relatively restricted area (Robertson and Harris 1995). Similar results were found by Herr et al. (2008) who followed three captive-reared stone martens for over 130 days. In swift foxes, high mortality rates and poor reproduction were related to long initial dispersal distances, which affected adult females more than males and juveniles (Moehrenschlager and Macdonald 2003).

Across the five carnivore families considered in a review by Jule et. al. (2008), mustelids and ursids were slightly less affected by captivity than canids (Jule et al. 2008).

1.1.2 Hard release vs. soft release (quick-release vs. Gentle-release)

The precise way in which release is carried out is another factor that can influence the success of a release project. There are two basic types of release protocols, namely, 'hard' (or 'quick') release and 'soft' (or 'gentle') release. The former consists of simply releasing the animal into the wild without any further supporting measures, whereas the latter provides supporting measures. These vary from study to study but generally consist of providing the animal with food, shelter or both, during an initial adaptation period, the duration of which can vary. In some studies the animals are initially kept in pens within the release area, then the pens are simply opened after a while. In other studies the animals are released immediately into the wild but additional supporting measures are provided within the release area (Boitani and Powell 2012). [Some examples of studies on both methods: grey wolves (Fritts et al. 2001); swift foxes (Waters 2010); Canada lynx *(Lynx Canadensis)* (Devineau et al. 2011)]

There is surprisingly little evidence on the relative success of hard versus soft release protocols in mammals, overall mammals seem to do better under a soft release protocol. American martens (Davis 1983) and swift foxes (Carbyn et al. 1994) showed less post-release stress under a soft release protocol but survival was not monitored. However overall, in sables, American martens and fisher martens there does not seem to be a significant difference in overall release success between different types of soft- and hard release protocols (Boitani and Powell 2012).

Originally I planned to release orphaned juvenile martens using both hard and soft protocols, in order to compare the efficacy of these two methods. However, since hard release was found to result in good survival rates I abandoned this original plan and did not carry out any soft releases.

1.1.3 Possible human wildlife conflict as a consequence of release

The behaviour of wild animals after their release can be of vital importance for their survival. It can also potentially lead to human-wildlife conflict and, as a result of this, influence the animals' acceptance by the general public. This, in turn, is important for the overall success of the release project (Moore and Smith 1991, IUCN 1998, Fischer and Lindenmayer 2000). In carnivores in general, human activity is the main cause of death in any reintroduction study (Jule et al. 2008). Traffic accidents were cited as one of the main causes of failure of a reintroduction program of lynx (*Lynx canadensis*) in New York state (Kloor 1999). Additionally wildlife in general and carnivores in particular are often considered a nuisance to humans.

Black bears (*Ursus americanus*) that were translocated to resolve human-bear conflict showed homing behaviour, that is they returned to their former home range after translocation (Rogers 1986). However, females with cubs showed less dispersion movement and thus less homing behaviour (Wear 2005). Two out of four Amur tigers (*Panthera tigris altaica*) that were translocated after attacking humans and livestock moved to human settlements after their release and were consequently killed (Goodrich and Miquelle 2005). In some cases wolves (Bradley et al. 2005) returned to their original home ranges after being translocated. Urban raccoons (Rosatte and MacInnes 1989, O'Donnell and DeNicola 2006) and stone martens (Herr et al. 2008) that were translocated because they caused disturbance to humans returned to an urban habitat after being released to a rural habitat. Similarly, captive-reared animals could return to where they were born and raised for part of their life, or to similar habitats (Stamps and Swaisgood 2007). Additionally, animals that are habituated to humans, and thus have lost their natural fear of them, could be the cause of human-wildlife conflicts (Sarrazin and Legendre 1999).

1.1.4 Possible alternatives to release

There are a number of different alternatives to capture and release of animals that cause human-wildlife conflict. Depending on the nature of the conflict, animals can be excluded or deterred from the conflict site, but in severe cases lethal methods might be necessary (for more detailed discussion see Massei et al. 2010).

In the case of orphaned wildlife, however, like the subjects of the present project, the options are restricted. First of all, before any action is taken, it is desirable to ensure that the animal in question really is orphaned or abandoned, which involves the person who finds the animal waiting for the mother to return. If the mother does not return then there are only two alternatives to release: either the animal is kept in captivity for life, which raises other welfare and financial issues, or it is euthanazed. However, the general public perceives translocation and release to be more humane than lethal solutions (Conover 2002, Massei et al. 2010).

1.2 Study species: the stone marten

1.2.1 Taxonomic Status, distribution and conservation status

Stone martens (hereafter: martens) are one of eight species belonging to the genus *Martes*. They are medium-sized mustelids (Order Carnivora; Family Mustelidae) that occur across much of mainland Europe and Central Asia, from Spain in the west, through southern and central Europe to the Middle East and central Asia, as far east as the Altai and Tien Shan mountains and northwest China. They occur in Afghanistan, Pakistan, India, Nepal, Bhutan and northern Myanmar, and have been introduced to Wisconsin, U.S.A. However, they are absent from Scandinavia, the UK, Finland, the northern Baltic and northern European Russia (Figure 1.1). The species occurs from sea level up to 4200m (in Nepal). As regards conservation status, martens are listed as a species of “Least Concern” on The Red List™ (IUCN 2010)

1.2.2 Habitat

Depending on the region, martens live in deciduous woodland, wooded margins, open rocky hillsides and often near or even in human settlements. They den in hollow trees, stone heaps, lofts, stables, barns and house attics (Libois and Waechter 1991, Macdonald and Barrett 1993). In Luxembourg and elsewhere in continental Europe, martens are very common in towns (Ludwig 1999, Broekhuizen and Müskens 2000, Herrmann 2004, Herr 2008, Broekhuizen et al. 2010). Their territories are extremely variable in size depending on the habitat (e.g., town vs. woodland) (Herrmann 2004), ranging from 9.5 ha in urban habitats (Herr et al. 2009a) to over 800ha in rural habitats (Genovesi et al. 1997, Simon and Lang 2007). They are generally solitary and are strictly nocturnal. They tend to avoid open areas (Rondinini and Boitani 2002, Virgos and Garcia 2002, Grilo et al. 2010).

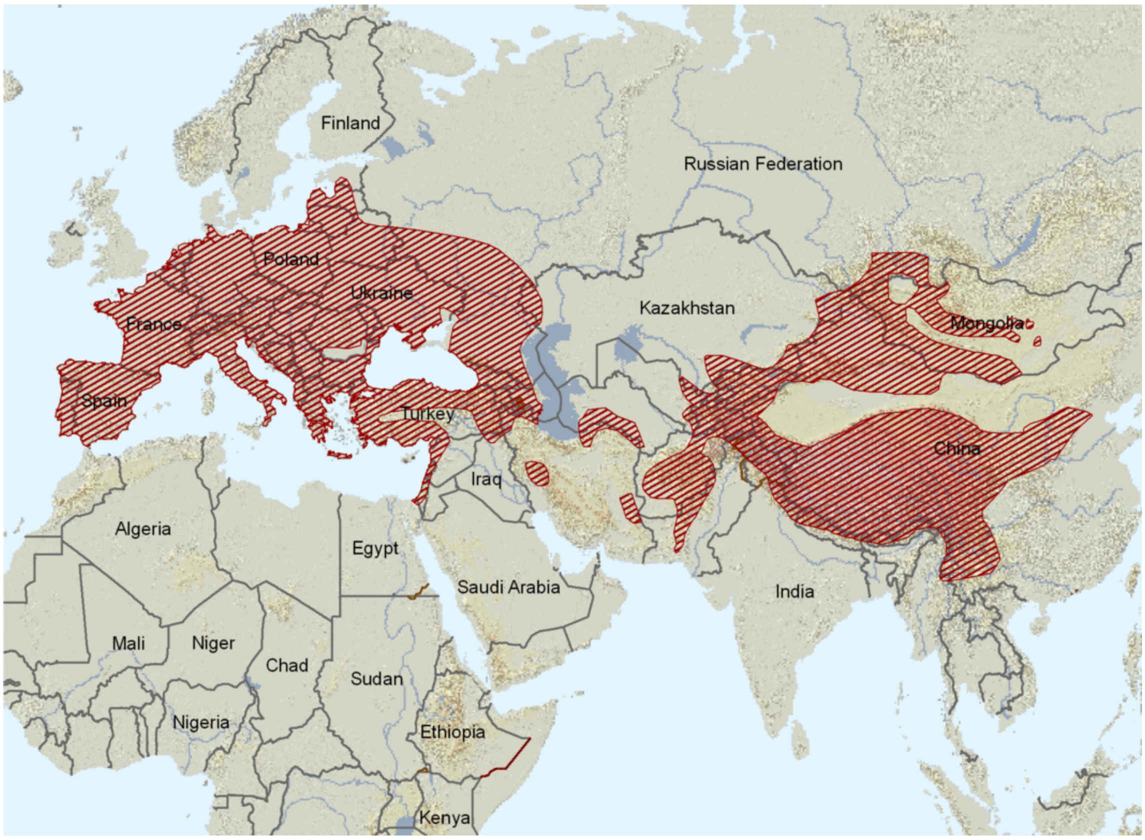


Figure 1.1
Stone marten natural distribution (IUCN 2010)

1.2.3 DIET

Martens are omnivorous, euryphagous and highly opportunistic predators (Lucherini and Crema 1993, Genovesi et al. 1996, Tóth Apáthy 1998, Lanszki et al. 1999, Baghli et al. 2002). Consequently, the composition of their diet depends on the seasonal availability of food resources within the various habitats they occupy (Lucherini and Crema 1993, Genovesi et al. 1996, Tóth Apáthy 1998, Lanszki et al. 1999). Martens feed on small mammals, ranging in size from small rodents such as mice or voles to rats and pet rabbits (Lucherini and Crema 1993, Genovesi et al. 1996, Tóth Apáthy 1998, Lanszki et al. 1999, Baghli et al. 2002, Lanszki 2003); on birds, ranging from smaller species such as sparrows, to doves or even poultry (Lucherini and Crema 1993, Genovesi et al. 1996, Tóth Apáthy 1998, Lanszki et al. 1999, Baghli et al. 2002); and on invertebrates (Lucherini and Crema 1993, Lanszki et al. 1999, Baghli et al. 2002, Lanszki 2003). Being scavengers, their diet can include larger animal species eaten as carrion (Lanszki et al. 1999). They also feed on eggs (Genovesi et al. 1996, Tóth Apáthy 1998) and they consume fruits (Lucherini and Crema 1993, Genovesi et al. 1996, Tóth Apáthy 1998, Lanszki et al. 1999), seeds and leaves of domestic and wild plant species (Lucherini and Crema 1993, Tóth Apáthy 1998, Lanszki et al. 1999, Baghli et al. 2002). In urban environments, they also feed on garbage (Tóth Apáthy 1998) and other food resources associated with human activity (Lanszki 2003).

1.2.4 MORPHOLOGY

As regards morphology, martens are sexually dimorphic with the male being larger than the female. They weigh 1.3-2.3 kg. Their head-body length is 42-48 cm; tail length is about 26cm; hind-foot length is 8-9cm; shoulder-height is 12 cm; and condylo-basal length (the length of the skull, measured from the front of the premaxilliary bones to the rear surface of the occipital condyles) is 78-85mm (Macdonald and Barrett 1993) (see Figure 1.2).

Figure 1.2
Picture of an adult stone marten (Beate Ludig ©)

1.2.5 Social system and Life history

Martens are solitary animals that show intrasexual territoriality. That is, males protect their territory against other males and females against other females. Males have larger territories, typically covering more than one female's territory (Skirnisson 1986, Herrmann 2004). The mating season lasts from July to mid-August (Schmidt 1943) but, owing to a delayed implantation period of 230 to 275 days, martens give birth in spring (early March to mid-April). The females take care of the young. The gestation period lasts 30 days (Canivenc et al. 1981) and around three (1-5) young are born per litter (Schmidt 1943, Madsen and Rasmussen 1985, Broekhuizen et al. 2010). The young are weaned at the age of 7 to 8 weeks (Herrmann 2004, Broekhuizen et al. 2010) and venture out of the den at 8 to 10 weeks (Herrmann 2004). They may disperse from August onwards but it is not known whether there is a typical dispersal period (Herrmann 2004). Martens reach sexual maturity at 1 to 2 years of age and can attain an age of 18 years in captivity.

1.2.6 Mortality

There are anecdotal records of predation on martens by domestic cats and red foxes (Lachat Feller 1993), and eagle owls (*Bubo bubo*) (Virgos et al. 2000); and a negative association has also been found between marten abundance and breeding eagle owl pairs in central Spain (Aubry et al. 2012). However, most deaths in the wild are caused by human activities such as trapping and shooting (Ruette et al. 2003), and traffic accidents (Grilo et al. 2009, Marchesi et al. 2010).

In the past, martens were heavily hunted for their fur. They were also seen as a pest species (see below: Human-marten conflict), which increased hunting pressure and lead to them being hunted to near extinction in some parts of Europe (Libois and Waechter 1991, Stubbe 1993). Nowadays, however, road mortality is a far more important factor. A study conducted in Portugal (Grilo et al. 2009) found martens to be the second most frequently killed carnivore on roads (see Figure 1.3), while one in Italy (Adriani et al. 2012) found them to be the second most frequently killed mustelid. These studies do not take the respective abundance of each species into account but, regardless of their abundance, it is not surprising, given their close association with human settlements, that martens are more likely to be killed on roads than other species, e.g., otters. Older estimates from the Alsace region suggest that 68 % of one year's offspring were victims of road traffic accidents (Marchesi et al. 2010). Little information is given about the exact research protocol of this study but, since it was based on a field study, the numbers must to refer to the moment of emergence from the den until the completion of the cubs' first year of life. Dead martens along the road side, especially in autumn and spring, are a common sight in Luxembourg (personal observation). The Portuguese study suggests that females provisioning their young are especially vulnerable (Grilo et al. 2009).

1.3 Human-Marten Conflict

1.3.1 Martens and cars

Martens are considered a pest species, especially when they occupy urban environments. In central Europe, martens damage parked cars by biting through ignition leads, coolant hoses and vacuum hoses, and by tearing up noise and heat insulation mats under car bonnets (Kugelschafter et al. 1984/85, Kuemmerle 1985, Ludwig 1999, Herr et al. 2009b, Broekhuizen et al. 2010). From the late 1970's this phenomenon spread from Switzerland through all of central Europe (Kugelschafter et al. 1984/85). In Germany, damage to cars by martens was estimated to cost over 20 million Euros in 1998 (Langwieder and Höpfl 2000). Although a number of "marten repellents" are commercially available, their effectiveness is questionable (Kugelschafter et al. 1997).

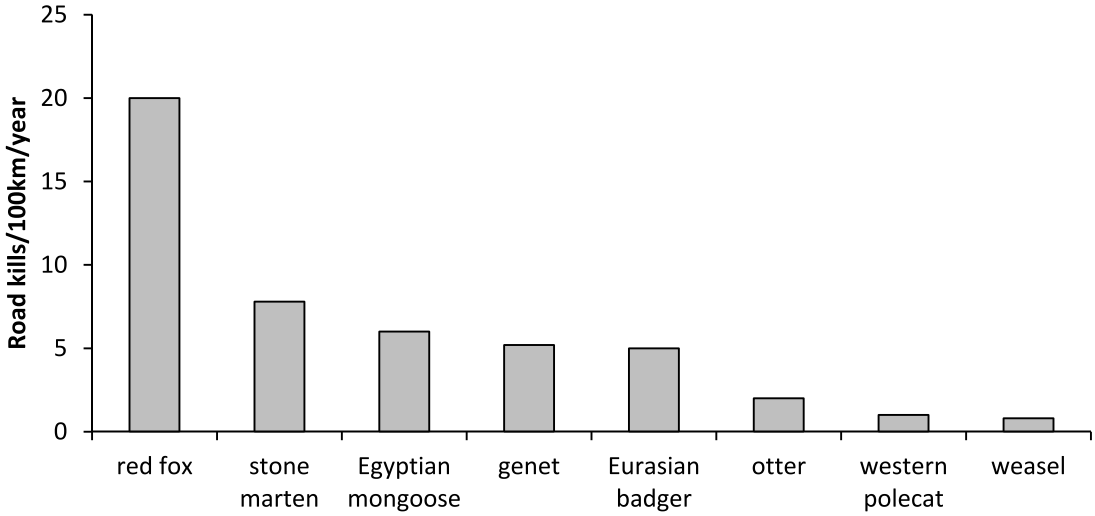


Figure 1.3
Frequency of carcasses of eight carnivore species found on the national roads and highways surveyed in southern Portugal, from January 2004 to December 2006 (Grilo et al. 2009).

1.3.2 Martens and houses

Another source of nuisance is the fact that martens sometimes den in inhabited buildings (Ludwig 1999), usually in empty roof voids or in attics. Here, they cause damage by depositing urine and faeces at latrine sites, which can soak through the ceiling and cause odours. Martens can also cause substantial damage by tearing up roof insulation; and people can feel disturbed by the noise that they cause, especially in spring when young are reared (Herr 2008). These problems can be avoided by excluding martens from the building, by blocking access routes (Herr 2008, Maanen and Hoksberg 2008). There are also anecdotal reports of martens digging up flower and vegetable beds (Herr 2008) but there is no clear evidence that martens really are responsible for such damage (personal observation).

1.3.3 Martens and domestic animals

In more rural environments, martens occasionally kill poultry. They primarily take eggs but sometimes enter henhouses and kill large numbers of chickens. Usually these chickens are not eaten, so the most likely explanation is that panicking chickens trigger the marten’s hunting instinct, resulting in a killing spree. This can be prevented by appropriately locking chickens up at night, so as to prevent martens from entering henhouses (Stubbe 1993).

There have also been reports of cats being attacked by martens (personal observation). However, according to Lachat Feller (1993b), martens and cats tend to ignore each other. This is substantiated by Herr (2008), who reported that encounters between cats and martens never involved physical contact and usually resulted in the marten fleeing. Additionally, hunters consider martens as competitors, as they prey on small game (personal observation).

1.3.4 Martens and zoonoses

A final potential source of nuisance involves enhanced risk of disease. This is especially likely in urban environments, since urbanization of wildlife can lead not only to an increase in disease transmission within an animal species but also to increased risk of zoonoses. This is due to an increase in contact rates between wild and domestic animals, and animals and humans (Bradley and Altizer 2007). In practice, however, martens carry few diseases or parasites that are of importance to humans or domestic animals (Mayer 1988). A notable potential exception is rabies but in a study in Switzerland, undertaken during a rabies epizootic, only 2.6% of martens, compared to 76.6% of foxes, carried the virus (Steck and Wandeler 1980).

1.4 Public attitude towards martens

Given that martens cause a number of problems (see above), it seems likely that they are unpopular with the general public, especially since these problems have been and are still regularly covered in the press.

> "Edelmarder, Hausmarder und Iltis sind recht schädliche, blutrünstige Würger, denen man nicht eifrig genug nach stellen kann." (Feltgen 1902)

This citation from an early publication from the Luxembourg Natural History Museum reflects the image martens had in the past: it describes stone martens, pine martens and pole cats as deleterious, bloodthirsty stranglers that cannot be hunted enough. Since the early twentieth century, however, the problems related to martens have changed and so, accordingly, has the image of martens in the press. Nowadays martens are sometimes portrayed as car-eating monsters but more generally just as a wild animal that can occasionally cause problems. In the latter case, advice is usually given as to how to prevent martens from causing too much damage (Kugelschafter and Ludwig 1995, Ludwig 1999).

The only study I have been able to find of people's attitudes towards martens was one conducted amongst the community of Luxembourgish hunters and forest wardens. Of those that participated in the study, 50.5 % of the hunters and 20.7 % of the forest wardens considered stone martens to be a nuisance (Baghli et al. 1998). However, this study can hardly be seen as representative of public opinion in general.

As regards other carnivore species, a study in Switzerland showed that carnivores in general, and more specifically foxes, lynx and wolves, were seen overall as positive (Hunziker et al. 2001). Opinions on "urban foxes" were more divided, probably because they can transmit a potentially lethal zoonosis (even if infection rates are very low). However, there were also regional differences in people's opinions and it is notable that in Zurich, which is particularly exposed to problems caused by urban foxes, the majority saw urban foxes as positive. People reported being pleased to see foxes and perceived the presence of wildlife near their homes as improving their quality of life (König 2008). This suggests that even when carnivores come into conflict with human interests, public attitudes towards them are not always as negative as might be expected.

1.5 SUMMARY

Release has been carried out for various reasons, on a variety of carnivore species, and involving a variety of different release protocols. Both the ethical validity of release and its practical effectiveness as a wildlife management tool are open to question. However, relatively little information is available on the consequences of release from the point of view of the animals in question, or on its cost-effectiveness.

The present study was undertaken because release of orphaned martens is carried out routinely in Luxembourg, yet the costs and benefits of these actions are unknown. If release is detrimental to the welfare or survival of the released animal, other management techniques should be considered. In addition, the fact that martens are regarded as a pest species means that release could lead to human-marten conflict, for example if animals released into rural areas tend to disperse into urban habitat.

1.6 Aims and objectives

The overall aim of my study was to determine whether release constitutes a valid management tool for martens and, by implication, for other comparable species. I did this primarily by looking at the post-release behaviour of translocated, captive-reared orphaned martens, using radio-telemetry as the primary means of data collection. I compared my results with those of a previous study of adult wild stone martens in Luxembourg (Herr 2008), in order to determine to what extent the behaviour of released individuals appeared abnormal; and I examined the possible impact of the presence of conspecifics in the release area, using camera traps and cage traps. Finally, a survey was conducted, interviewing people from the local community, in order to confirm the presence of a wild marten population and determine people's attitudes towards martens. I did this because acceptance of the target species by the local population is vital to the success of any release project; and, in the particular case of martens in Luxembourg, the rescue centre which cared for the martens depended to a large extent on the support of the local community.

The main objectives of the study were: (1) to determine the post-release survival of captive-reared martens; (2) to examine the pattern of post-release ranging behaviour; (3) to see to what extent this may have been influenced by the presence of conspecifics; (4) to determine the extent to which released martens settled in habitats where they were likely to come into conflict with humans; (5) to see how the martens' behaviour potentially differed from that of "normal" wild martens; and (6) to assess public attitudes towards martens.

1.7 EXPECTATIONS AND PREDICTIONS

Captive-reared animals are expected to be impaired in terms of survival in the wild because they have been raised by humans rather than by a conspecific mother and because they have not recently been exposed to a natural environment. The quality of the captive environment is extremely important, especially in carnivores in which learning of hunting skills is crucial for survival. Additionally, captive-reared animals can potentially cause problems because they are habituated to humans to an unusual degree and may therefore be more ready to settle in anthropogenic habitats. I therefore expected captive-reared martens to have difficulty establishing themselves in the wild and to have relatively low survival rates. I also expected that they might prefer to settle in villages and thereby come into conflict with human interests.

On the basis of previous studies involving release of carnivores (see review above), I expected the post-release movement pattern of martens to consist of two phases: an initial phase of erratic movement involving extensive travel, followed by a static phase in which the animal in question settled in a relatively restricted area. I also expected the initial phase of extensive movement to constitute a time when released martens were especially vulnerable to threats such as traffic mortality. I expected their movement patterns to be influenced by the presence of conspecifics and I expected to find differences in behaviour between captive-reared orphaned martens and wild martens. All of these expectations, however, were based either on intuition or on previous studies of an opportunistic nature and involving small numbers of animals. Consequently, all required confirmation by more systematic research.

As regards public attitudes towards martens, I expected these to be mixed. On the one hand, martens are superficially attractive animals and would be expected to appeal to the public. On the other hand, they can come into conflict with humans, especially when they are present in urban environments (see review above). Attitudes towards martens would therefore be expected to be neither wholly positive nor wholly negative.

CHAPTER 2: GENERAL METHOD

2.1 STUDY SITE

During the first two seasons, fieldwork was conducted in the east of Luxembourg (Figure 2.1) in the commune of Junglinster (49°42'26"N, 6°15'11" E) (with a total population of 6143 inhabitants in 2009). During the third field season the martens were released in the commune of Roedgen (49.5735°N, 6.0333°E), in the south of the country (with a total population of 2139 inhabitants in 2009) (Figure 2.2). Both of these were rural areas containing small villages, of 69 to 2224 inhabitants in 2001 (Anonymous 2010b), surrounded by agricultural land, orchards and forests. Potential food sources were birds, small mammals, and seasonally available fruits from gardens and orchards (e.g., apples, plums, cherries) (Figure 2.3).

Denning sites were available in the roofs of houses; in agricultural buildings and sheds in and around villages; and in dense vegetation and rock crevices outside villages.

2.2 CLIMATE

Meteorological data were available from the Findel meteorological station (49°37'0"N; 6°12'0"E; altitude: 376m) (Pfister et al. 2005, Anonymous 2010a), situated ± 10 km South of the first study area and ± 10 km north-east of the second study area. The meteorological data for the study period are represented in Figure 2.2.

Although January 2010 had a few exceptionally cold days (see Figure 2.2), these weather conditions should still have been within the conditions martens can withstand, bearing in mind the wide distribution of the species in Europe (see Figure 1.1).

Figure 2.1
Maps with exact study site location

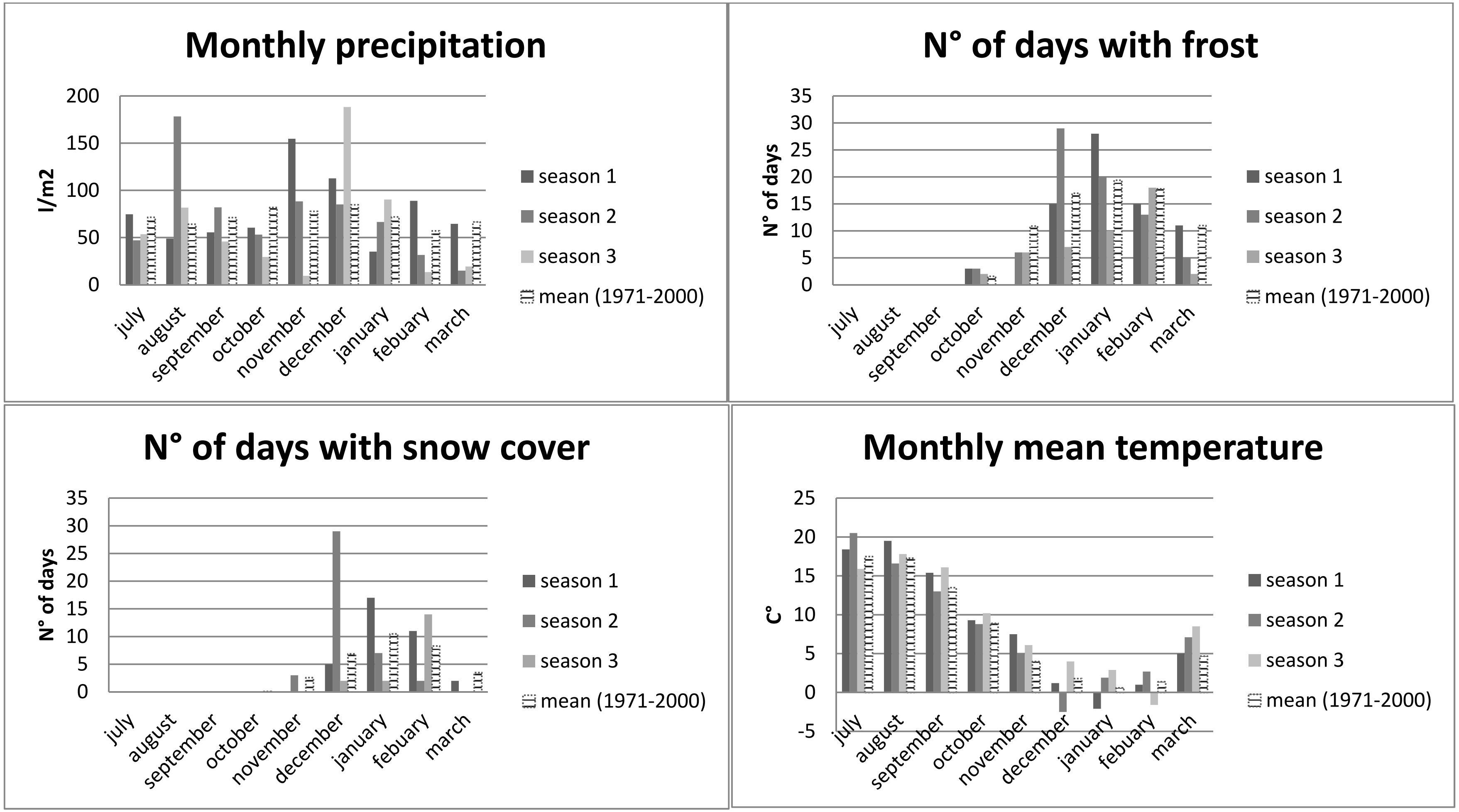


Figure 2.2
Monthly mean temperatures, total monthly precipitation, monthly number of days with frost and monthly number of days with snow cover for all three seasons (i.e., July to March), together with mean values from 1971-2000.

Figure 2.3
Picture of orphaned stone marten at the rescue centre

2.3 SUBJECTS

Martens were obtained from a rescue centre (Centre de Soins pour la Faune Sauvage, LNVL, Dudelange), to which they had been brought by members of the public. Wounded adult martens had usually been victims of traffic accidents. However, the centre mostly received orphaned martens (Figure 2.3) that people found on their property. Staff at the centre recorded the time and location at which the marten in question was found. Unfortunately, more detailed data, on the exact circumstances in which the orphaned martens were found (e.g., fate of mother, exact location on property), were not available. All animals were checked by a trained veterinarian on arrival at the Centre and received medical treatment if necessary. All medical treatments and rearing conditions and protocols were the complete responsibility of the rescue centre. I did not interfere with these protocols in order to avoid biasing the results.

Adult martens were housed individually. Young orphaned martens were housed together with their siblings, or sometimes litters were combined to form groups of 3-6 individuals of the same age cohort. The orphans remained in these cohort groups until release. Martens that had not yet been weaned from their mother were kept in incubators whereas adults and young that had reached weaning age were held in sheltered outside wire-mesh cages about 2x3x3 m in size. Cages were provided with an elevated nest box and tree branches that allowed the animals to climb and provided additional hiding places.

Martens that were not yet weaned were fed with milk (Milkodog® Vetoquinol S.A., Belgium). When they were judged fit enough by the keeper, they were weaned and fed, like the adults, on dead chicken fledglings, which were bought frozen, and canned cat food (various brands). Shortly before release, they were fed live mice to develop and test their hunting skills: martens that were able to kill a mouse were considered fit for release and were then fed again with dead chicken fledglings and cat food until the actual date of release. The martens from the third (final) field season had been unintentionally exposed to live pigeons as they had broken into a neighbouring pen and killed all the pigeons that were held in it.

Adult martens that had been injured were released after recovery. By contrast, orphaned martens were released at the time of year at which most of their wild conspecifics are thought to disperse naturally, namely, from the end of August to the beginning of September. At this time of year there is plenty of food available, which should increase the martens' chance of survival. The cost of raising a single marten was estimated to be between 150 and 180 € at the time of writing.

At the time of release all individuals were in good physical condition. Each individual that was followed after release was fitted with a radio collar (see below). It was also sexed and weighed; its neck circumference, body length (nose to base of tail) and tail length (base of tail to tip of tail) were measured (see Table 2.1); and a photograph of its throat patch was taken for later identification.

2.4 Seasons

Based on previous studies I divided my data into three biologically relevant seasons, taking into account the martens' reproductive biology and food availability. Summer (June-August) is the martens' mating season and mothers are still accompanied by their young. In autumn (September-November) food is abundant and there is little territoriality, but for young martens this is a challenging time as they start to disperse. It also is the time during which captive-reared martens were released. In winter (December-February) there is potentially little food available and temperatures are low, making this a stressful period (Marchesi 1989, Herrmann 2004, Herr 2008). Spring is irrelevant to the present project since no data were gathered during that season.

Table 2.1

Summary data for individuals re-released between 2009 and 2012

Individual	Weight g	Tail length cm	Body length cm	neck circumference cm	Collar frequency	Season
Brutus (M1)	1117	21	42.5	/	150.233	1
Rover (M2)	1910	25.5	51	16	150.253	1
Waldemar (M3)	1888	29	50.5	15	150.805	1
Knechtruprecht (M4)	1871	27.8	49.7	17	150.294	1
Lassie (F1)	1587	27	46	16	150.092	2
Mozart (M5)	1700	29	47.5	14.7	150.093	2
Rantanplan (M6)	1703	25	48	17	150.112	2
Elly (F2)	1639	27	47	17	150.211	2
Milou (M7)	1769	28	52	17	150.593	2
Leica (F3)	1490	24.5	48	15	150.042	3
Lamnda (F4)	1418	26.5	46	16	150.112	3
Flocky (F5)	1465	27	50	15	150.151	3

2.5 EQUIPMENT

The radio transmitters used during the first season were collar transmitters with external antennas (Biotrack Ltd, UK, model TW-3, frequency band 150 Mhz; pulse rate 50 pulse/min: see). The transmitter plus battery and Biothane collar weighed 40 g, which is <3% of the martens' body weight at the time of release (see Figure 2.4 and Table 2.1). During the second and the third season I used collar transmitters with internal antennas (Wagner, frequency band150 Mhz; pulse rate 40 pulse/min), which were left over from another project (see Figure 2.5). These collars weighed 34g. Similar collars have been used successfully in previous studies of martens (Skirnisson and Feddersen 1984, Herr et al. 2008, Zschille et al. 2008).

Three receiving antennas were used, two directional and one omni-directional. One of the directional antennas was a foldable H-antenna integrated into the receiver (model RX-98 H, TVP Positioning AB, Sweden). The second was a flexible three-element hand-held yagi antenna (Biotrack Ltd., UK). The omnidirectional antenna had a magnet base that could be attached to the roof of a car (Biotrack Ltd., UK), and was used when driving around trying to locate an animal whose whereabouts were unknown. The two directional antennas were used for tracking on foot.

Animals were trapped (see below) using foldable wire cage traps (model 206, 81x23x23 cm, Tomahawk Live Trap Co., Wisconsin, U.S.A.), triggered by stepping on a metal plate in the middle of the trap. They were covered with wooden trap covers, to shelter the marten from adverse environmental factors (e.g., light, rain, cold) once captured (Figure 2.6).

Figure 2.4
Radio collar produced by Biotrack

Figure 2.5
Radio collar produced by Wagner

Figure 2.6
Foldable wire mash cage trap with wooden cover

2.6 TRAPPING

2.6.1 LIVE TRAPPING

In the first year one wild juvenile marten was trapped in order to be trans-located (M1). Orphaned martens from the rescue centre were sometimes trapped after they had been released in order to check on their physical condition and on the state of their radio-collars, and to remove the radio collar at the end of the observation period. In the final field season, traps were clustered around the releasing site to capture adult wild martens, in order to detect the presence of a wild marten population.

To trap an individual, a trap was placed if possible in an area which it frequently used. If this information was not available, traps were placed along deer crossings and ditches, which previous studies have shown to be used by martens, while open areas were avoided (Ruette et al. 2003, Herrmann 2004). An additional consideration was that it was necessary to conceal traps and place them in locations that were relatively difficult to access, in order to avoid vandalism (Figure 2.7). This occurred on four occasions, when traps were triggered and displaced (probably thrown or kicked around). On one occasion the trap was severely damaged, but could be repaired.

Initially, traps were pre-baited to encourage martens to approach the traps and enter them. When traps were being visited regularly (i.e., baits were regularly taken), they were set and checked every 12 h. Initially hens' eggs were used as bait; in the final field season other baits were used including nuts, dried fruit, peanut butter, and canned sardines and mackerel. Pieces of freshly fried liver proved to be excellent baits. If an animal was caught, the trap cover was removed to identify the animal and if it was not the target marten, it was immediately released.

When a target marten was caught, it was dealt with using the procedure developed by Herr (2008). The trap was put into a clear plastic box to which was added a teaspoon of Isoflurane to temporarily immobilise the animal. Meanwhile, a syringe, containing a mixture of Ketamine Hydrochloride (8 mg/ 1kg body weight) and Medetomidine

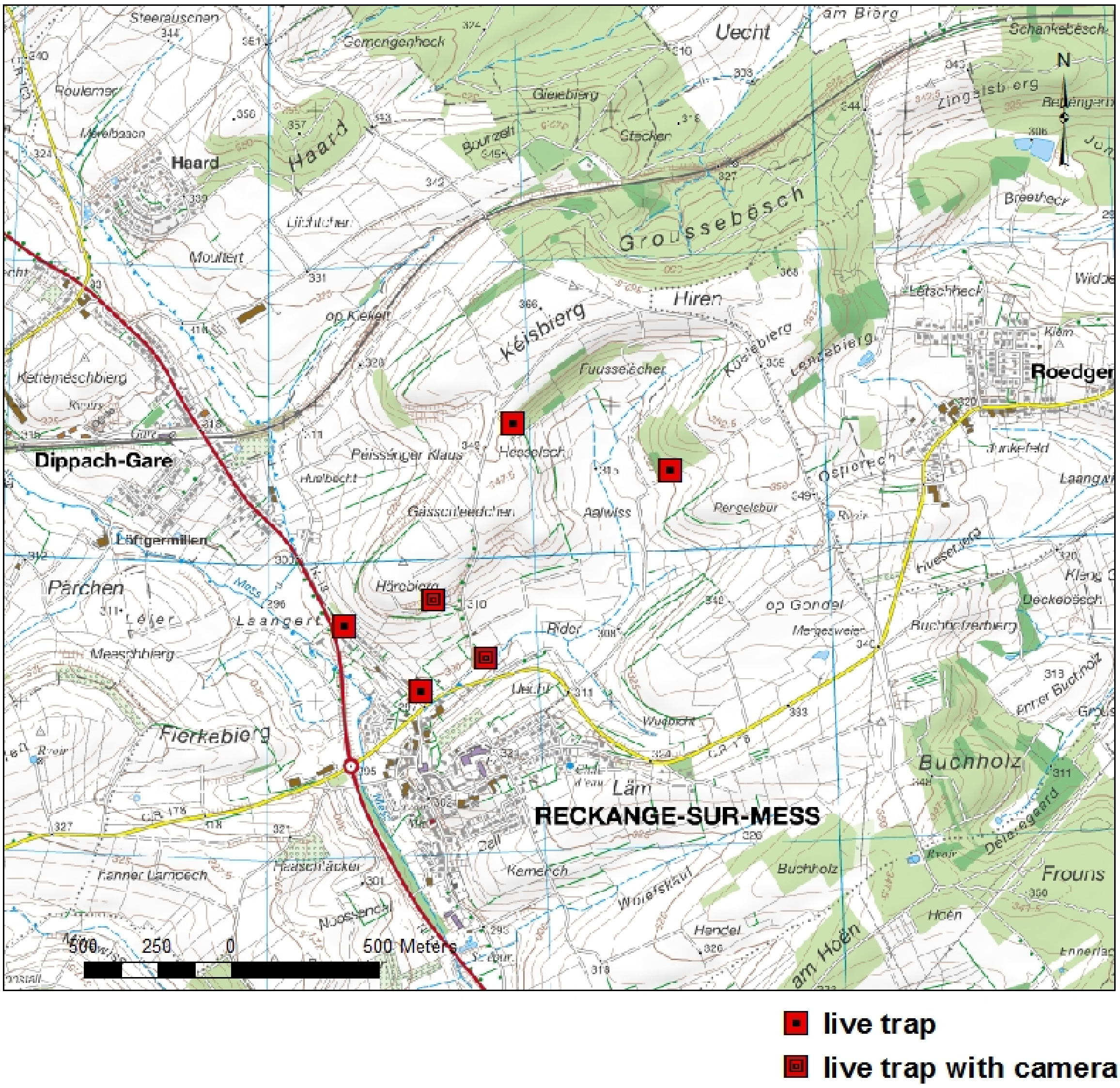


Figure 2.7
Live trap and camera trap positions for capturing adult martens during the third season.

Hydrochloride (0.04 mg /1 kg body weight), was prepared and put ready. When the marten no longer reacted to movement of the box the trap was removed from the box and the marten's upper leg was disinfected and injected intramuscularly with the previously prepared syringe. When the anaesthetic started working, the marten was removed from the trap and the radio collar was checked, replaced or put on, as appropriate. The animal was sexed, its neck circumference, body length (nose to base of tail) and tail length (base of tail to tip of tail) were measured, and it was weighed (see Table 2.1). A photograph of its throat patch was taken for later identification. Tooth wear, fur condition and a body condition score (BCS) were also recorded. A five point scale BCS was used ranging from very thin (1: Ribs easily felt with no fat cover; prominent visibility of individual ribs; abdominal tuck) through ideal weight (3: Ribs easily felt with slight fat cover; individual ribs not visible, no abdominal tuck) to obese (5: Ribs difficult to feel under thick fat cover) (adapted from: Kahn 2010). Finally, the animal was put in a cat carrier containing a burlap bag, and left alone for at least 4h before being released. Animals were only ever released after sunset. When directly handling martens, leather gloves were worn to reduce risk of injury.

2.6.2 Camera trapping

In the final season, camera traps were used to double check on traps that were regularly visited but were never triggered (see Figure 2.7). The cameras (PC500 HyperFire™, RECONYX™ Inc., Wisconsin, USA) were positioned at the same height as the baited traps, about 3m away from the trap and pointing at its entrance. The camera traps were set to trigger at each movement, shooting 5 consecutive pictures. According to the manufacturer the delay between detecting a movement and the first picture being taken should not exceed 0.2 sec, so the cameras were suitable for detecting a swift-moving animal like a marten. The cameras were equipped with a 4GB SD card and eight AA batteries. They were checked every 24h, which was more than enough to avoid them running out of either battery power or memory space.

2.7 ETHICAL ISSUES

For the present study martens had to be trapped, handled, anaesthetized and radio-collared. All treatments were carried out in accordance with the welfare regulations imposed by the Ministère de l'Environnement, Luxembourg, and with the permission of the Ministère de l'Environnement, reference: 68381 GW/sc. The license was issued in the name of Lieke Mevis. (Demande de dérogation, l'article 33 de la loi du 19 janvier 2004 concernant la protection de la nature et des ressources naturelles).

2.8 TELEMETRY

All radio tracking was carried out by me. Immediately after release, each individual was followed during the first 6 consecutive nights. Thereafter, I tried to follow each individual for at least 1 night per week for the next 6 months. Martens were tracked continuously throughout their activity period, from the moment of first emergence from their daytime den to their retreat into the daytime den the following morning (Harris et al. 1990, Kenward 2001). During each tracking session I focused on one individual, recording half-hourly positional fixes on the full and the half hours.

For each fix the individual's location was determined through triangulation by taking two cross bearings (Kenward 2001) or, if this was not possible due to signal reflections (caused by e.g. buildings, rocks, a hill or dense vegetation), I homed in on the focal animal. This was done by initially approaching the signal by car using the omni-directional antenna, and then taking a fix on foot, usually within 40 m of the focal animal. The location was noted on a paper map, recording whether the animal was active or not. As the transmitters were not equipped with an activity sensor, activity was determined by the presence of signal strength fluctuations over a period of 30s (Herr 2008).

Because martens are nocturnal they were not followed continuously during the day. However, I tried to locate every individual in its daytime den once per day during the first 6 months after release, and once per week during the following 6 months.

2.9 Data analysis

For data analyses the following programs were used. For special graphics (e.g., maps) and for calculation of home ranges, I used ArcView 9.3 GIS ™ (ESRI, Redlands, Ca., U.S.A.) with the “Home Range Tools for ArcGIS” extension (Hooge and Eichenlaub 2000). For other data analyses and graphical representations, I used Microsoft Office Excel© and SPSS©.

2.9.1 Home range analysis

A territory is defined in theory as “any defended area” (Nobel 1939); but to define an animal’s territory in practice, extensive behavioural observations are necessary (Burt 1943). An animal’s home range, by contrast, is the area through which it travels in pursuit of its normal activities (e.g., feeding, foraging, nesting, etc.) and, as such, is easier to determine. A home range can be stationary or shifting (Burt 1943) and home ranges can change over time depending on an individual’s development or other external factors (Börger et al. 2008). A home range is characterized by its size, shape and structure (Kenward 2001), which are usually determined from radio-telemetric data.

In the present study I was concerned with the home ranges of martens after they had been released. Telemetric data (fixes) were recorded initially on paper maps (1:20 000) (Cartes Topographique régionale touristique. Administration du cadastre et de la topographie) and were subsequently manually entered into ArcView GIS 9.3. They were analysed with the "Home Range Tools for ArcGIS" extension (Hooge and Eichenlaub 2000). Results were visualized in the form of individual home ranges.

2.9.2 Minimum convex polygons

There are a number of methods of visualising home ranges and determining their size and shape. Of these, minimum convex polygons (MCP) and kernel analysis are most commonly used (Kenward 2001, Börger et al. 2006). MCPs are obtained by connecting the outermost locations (fixes) of a data set with each other. Additionally, to get a more robust result, the data can be subsampled, using different percentages of the data to eliminate outliers (Börger et al. 2006). Supposedly, this method is relatively insensitive to small sample size and for many years it has been the most widely used method; these reasons together have made it especially popular for comparative studies. However, the MCP method suffers from a number of disadvantages (Börger et al. 2006). It makes biologically invalid assumptions, such as that the shape of a home range's convex polygon is only determined by the position of the outermost fixes collected, or that use of space within a home range is uniformly distributed. Additionally, when data are subsampled this is done without any biological rationale (Börger et al. 2006). Börger et. al. (2006) even state that the MCP method should not be used at all, since their results showed that there was an unpredictable change in variance when the sampling effort or the time scale of the data collection was changed.

2.9.3 Kernel analysis

Kernel analysis calculates the boundaries of a home range on the basis of the complete utilisation distribution or UD ["the name given to the distribution of an animal's position in the plane" (Worton 1989)]. It is a nonparametric, probabilistic density estimation (Worton 1989) which describes the probability of finding an individual in any one place. To do this a bivariate probability function with a unit volume (the ”kernel”) is centred over each recorded point. Then a regular grid is superimposed and by summing the overlapping volumes of the kernels, the probability density estimate is calculated for each grid intersection. Using these probability density estimates a bivariate kernel probability density estimator is calculated over the entire grid. In areas with few observations the kernel probability estimator will have a relatively low value, whereas in areas with many observations it will be high. Home ranges are estimated by drawing lines around the added volumes of kernels at grid intersections. The resulting contour lines are called isopleths and can be drawn for different probability levels; representing home range polygons at different probability levels. 95% and 50% probability levels are typically used (Rodgers and Kie 2011) although Börger et. al. (2006) recommend isopleths between 90% and 50%.

The kernel method is commonly used, it takes multiple activity centres into account (Kenward 2001) and it is robust to changes in spatial resolution of the data (Hansteen et al. 1997). However, a critical component of this method is the bandwidth (smoothing parameter, h), the choice of which is the most important step in deriving the kernel density estimator (Worton 1989, Hemson et al. 2005, Gitzen et al. 2006, Horne and Garton 2006, Fieberg 2007, Rodgers and Kie 2011). There is no general agreement as to how to choose an appropriate value of h but the choice of a larger or a smaller h value depends on the research question. When the value of h is small, the fine details of the results can be seen; whereas with a larger value of h only the most prominent features can be observed (Worton 1989). However, there is a risk of “over- or under-smoothing” the data by choosing a too large or too small h respectively, which will produce a distorted utilization distribution (UD) (Rodgers and Kie 2011).

2.9.4 Importance of the sampling regime

Börger et. al. (2006) showed that in order to obtain valid estimates of home range size and shape it is not sufficient to standardize the number of fixes collected per animal: rather, the whole sampling regime has to be standardized. In particular, to comply with basic assumptions of non-parametric statistical models the number of days and the time intervals over which the data are collected should be standardized to avoid misleading statistical results (Börger et al. 2006). In the present study this was done as far as was possible (see section 2.8 above).

2.9.5 Autocorrelation

When an animal's position at time t+1 is a function of its position at time t, its location data are said to be autocorrelated (Swihart and Slade 1985b). The importance of autocorrelation in telemetry data has been debated (Swihart and Slade 1985b, a, Cresswell and Smith 1992). Earlier studies recommended collecting non-autocorrelated data, because using probabilistic methods with autocorrelated location data will lead to an under-estimation of home range size (Swihart and Slade 1985a, Cresswell and Smith 1992). This perceived problem was often solved by sub-sampling data. However, many of the relevant studies of the effects of autocorrelation have been based on simulated data and removing autocorrelation from a real dataset by arbitrarily subsampling the data is now considered to risk removing important biological information (De Solla et al. 1999, Blundell et al. 2001, Rodgers and Kie 2011).

In any case, data collected over a period time from the same animal living in a well-defined home range, within which it does not move completely at random, will never be fully independent (Rooney et al. 1998). Therefore, it has been argued, number of observations should be maximised but the sample intervals should be kept constant (McNay and Bunnell 1994, De Solla et al. 1999, Fieberg 2007).

Accordingly, I did not subsample my data when deriving estimates of home range size and shape.

2.9.6 Tests of difference

To test for differences between home range sizes, travel speeds and travel distances statistical tests of difference were used. Depending on the data, related or unrelated tests were use and if the data allowed for it, parametric tests of difference were used. Data were plotted in the form of frequency graphs and tested for normality using Shapiro-Wilks W tests, and for similarity of variance using Levene's tests of equality of variance. If not all the assumptions required by parametric tests were fulfilled, non-parametric alternatives were used (Zar 1999, Sokal and Rohlf 2012).

2.9.7 Handling data

All calculations were based on the entire data set for any one animal. This included the last fix before leaving the daytime den at the beginning of the night and the first fix after entering the resting place at the end of the night. Duplicates were removed from the fix data to avoid distortion of the home range estimate (Rodgers and Kie 2011) but I did not sub-sample the data (see above).

2.9.8 Definition of, and methods used to determine home range size, travel speed and travel distance

Travel speed was determined by measuring the distance between two consecutive data points and dividing it by the time elapsed between these same records. Distance travelled per night was determined by summing up all the distances between the consecutive data points. (This measure may be slightly biased as the observer did not always stay until the very end of the night and might therefore have missed some movement.) Home ranges were determined using MCP and kernel methods (see above).

I used the MCP method because it is still the most commonly used method and therefore allows comparison with other studies. However, any such comparisons should be regarded with caution because of the various problems associated with this method (see above). I decided to not exclude any fixes, that is, I used MCP 100%, because I felt there was no point in arbitrarily excluding outliers without a valid biological reason. In addition, I conducted fixed kernel analyses with a bandwidth value that was calculated using the reference bandwidth (h_{REF}). I used 90 % and 50% isopleths to represent the home range and the core areas respectively.

To test for differences, when the data allowed for parametric testing I used paired t-tests for related and t-tests for unrelated data. The non-parametric tests used were Wilcoxon Mann-Whitney signed-rank tests for related data and Mann Whitney U-tests for unrelated data. For the survey data in Chapter 5, chi-square tests and parametric and non-parametric tests of correlation were used. Confidence levels were set at P = 0.05.

2.9.9 Mortality rate and definition of success

As discussed in the general introduction, there are various ways of defining what constitutes a 'successful' release. As martens are a long-lived species and only reach sexual maturity at 1 to 2 years of age, determining reproductive success would have been beyond the scope of my project. Instead, therefore, I chose a pragmatic approach and focussed on survival. The release of an animal was considered a success if the animal in question survived for the entire study period or at least, since not all animals were followed for the entire study period, if it survived its first winter (i.e., survived for about 4 months from the time of release).

Base on this definition of survival, the mortality rate and the financial cost of raising a surviving marten were calculated using the following formulas:

EQUATION 2.1

$$mortality\ rate = \frac{known\ mortality}{individuals\ released - individuals\ with\ unknown\ fate}$$

EQUATION 2.2

$$financial\ cost = \frac{(individuals\ released - individuals\ with\ unknown\ fate) \times cost\ of\ raising\ an\ individual}{known\ survival}$$

CHAPTER 3: BEHAVIOUR AND SURVIVAL OF RELEASED JUVENILE MARTENS

3.1 INTRODUCTION

3.1.1 SHOULD CAPTIVE-REARED ORPHANED MARTENS BE RELEASED INTO THE WILD?

It is common practice to bring injured or orphaned wildlife into rescue centres where they are treated and released into the wild (Robertson and Harris 1995, Herr et al. 2008). However, wildlife rehabilitation is often criticized as a waste of time and resources and of no conservation value (Sharp 1996). As mentioned in Chapter 1, release projects are often labour intensive and although little is published on the financial costs involved, these generally tend to be high (Fischer and Lindenmayer 2000, Massei et al. 2010, Lewis et al. 2012). In addition, success rates for release projects are generally low, though they vary considerably depending on the quality of project planning and on the species involved (Griffith et al. 1989, Wolf et al. 1996, Linnell et al. 1997, Massei et al. 2010). If reintroductions are implemented for conservation purposes (i.e., replenishing an existing population or introducing individuals into former ranges), people are often more willing to take the risk regardless of the high costs involved, even though success rates for these projects are particularly low (Griffith et al. 1989, Fischer and Lindenmayer 2000).

Since the orphaned martens followed in my study belonged to a species of least concern (IUCN 2010), it is particularly questionable whether the effort and cost involved in raising, nursing and releasing these orphans is worthwhile. However, the rescue centres involved are generally NGOs financed by the general public, who might stop supporting them if they treated only endangered species (personal observation). In part, therefore, the decision whether or not to undertake release of animals is a matter of public opinion rather than a simple cost/benefit calculation. People who like animals to the extent that they actively support rescue centres, including volunteers and staff, often find it difficult to classify animals as more or less worth saving based on their protection status. Therefore, by treating all of the animals that are brought in, rescue centres ensure the necessary support to help both endangered and non-endangered species (personal observation). Additionally, a survey conducted among volunteers and staff of wildlife rescue centres in Texas showed that a majority (76%) thought that most of the treated animals would survive (McGaughey 2012), despite the fact that the actual success rates of reintroduction studies tend to be low (Griffith et al. 1989, Wolf et al. 1996, Linnell et al. 1997, Massei et al. 2010). This leads me to the next point.

In addition to financial cost and public opinion, animal welfare is an important issue. Release at a location novel to the animal can be assumed to be intrinsically stressful; and, additional to this, if an animal is not able to establish itself in the wild after release, it risks starving to death, being attacked by resident territory-holders or being killed by road traffic, any of which would constitute additional unnecessary suffering (Kirkwood and Sainsbury 1996, Kirkwood and Best 1998). If success rates of released martens are extremely low and thus their welfare is strongly impaired, they should not be released at all and other options should be considered, even if these are less popular with the general public (Kirkwood and Sainsbury 1996, Kirkwood and Best 1998, Massei et al. 2010).

Welfare is particularly problematic when releasing captive-reared carnivores, as they are often specialist feeders and also tend to be long-lived species that rely strongly on behaviours learned early in life, such as hunting and social behaviours (Aubry et al. 2012). Fortunately, unlike many carnivores, martens are opportunistic omnivores which, throughout their lives, can learn to exploit new food resources. They are also solitary (Herrmann 2004), so they may rely less on the need to acquire complex and subtle social behaviours. In these respects, therefore, martens might be more amenable to release than most other carnivores, though this does not exclude other potential post-release problems, as follows.

3.1.2 Potential problems after release

Martens are a K-selected species, that is, a relatively small number of young are intensively cared for, for a relatively extensive time (Ricklefs and Miller 1999). From the 19th week onwards, young martens regularly accompany their mothers on excursions, during which they follow her closely (Skirnisson 1986, Lucas 1989, Herrmann 2004), mimicking her behaviour. Indeed, not only do they copy their mother, but observations indicate that mothers might actively show their young different food sources and suitable day hides (Herrmann 2004), and how to avoid cars (Skirnisson 1986). This underlines the importance to young martens of learning and dependence on their mother (Herrmann 2004) and is probably why, in carnivore reintroductions in general, wild-caught animals have much higher survival rates than captive-reared animals (Jule et al. 2008). It is difficult to predict how much captive-reared orphaned martens might have missed out on maternal care that potentially could be essential for survival.

As mentioned in Chapter 1, there are a number of other problems related to the release of carnivores in the short term, including homing behaviour, extensive movement and erratic movement, all of which are related to increased mortality risk. Herr (2008) followed two captive-reared martens after their release and observed initial erratic movement, after which the animals then restricted their movement to a small area. The short-term survival rates of these martens were higher than those of other comparable released species.

In Denmark, two out of 53 martens showed clear homing behaviour after translocation (Rassmussen et al. 1986). This sort of behaviour could lead to human-marten conflict, especially if the animals in question have had long exposure to humans during captivity and are habituated to humans and a human-altered environment (Stamps and Swaisgood 2007). One reason for homing behaviour is that the release site could have been unsuitable, either because of a lack of resources or available territories (Fischer and Lindenmayer 2000). However, the release sites for my study were carefully chosen, paying special attention to the availability of food and cover; and even if individuals had moved over longer distances they would have been unlikely to end up in a highly unsuitable area. However, since martens have been recorded all over Luxembourg (Baghli et al. 1998), it is very likely that the relevant areas were already occupied by conspecifics.

Whether captive-reared orphaned stone martens should be released into the wild should depend, in the first place, on the extent to which this is detrimental to their welfare. This cannot be predicted with certainty. One way of judging whether the welfare of released martens is impaired is to compare their ranging behaviour with that of wild individuals. With this in mind, therefore, I now review what is known about space use in wild martens.

3.1.3 Space use

3.1.3.1 Habitat

Marten habitat use is mainly determined by the availability of cover and food. Within a rural setting, villages should be preferred over fields and forests due to the abundance of structures that allow for cover and also because of year-round food availability (Skirnisson 1986, Herrmann 2004). As regards cover, Herr (2010) showed that urban martens, although they denned almost exclusively in anthropogenic structures, had a preference for uninhabited buildings, where they would encounter little human disturbance.

Herrmann (2004) differentiated between “village” and “field/forest” martens according to the proportion of their range that covered either habitat. Like Herr (2010) in urban martens, he found that “village” martens had a stronger preference for man-made structures than “field/forest” martens, and attributed this to a difference in availability. “Field/forest” martens avoided large parts of their ranges consisting of open fields (Herrmann 2004). Thus, the claim that martens have larger ranges in rural habitat could be a consequence of the method used to define them, if this involves the inclusion of large unused areas (see Chapter 2) (Herr et al. 2010).

3.1.3.2 Home range size

There are a number of problems in comparing home range sizes from the literature. Most importantly, there is no standardized method, either of sampling or of data analysis. As regards sampling, methods vary from occasionally recording the position of an individual's different day hides to complete nightly follows recording positions every 15 min.

As regards data analysis, older studies in particular rely for the computation of home range sizes on the minimum convex polygon (MCP) method. This has been criticised on various grounds but continues to be used for reasons of comparability, even though this comparability is questionable (Börger et al. 2006). Additionally, even within the MCP method there has been no agreement on the percentage of data points that should be used in computing home range size.

During the last few decades the Kernel method has become more popular as a way of determining home range size and conformation but, like the MCP method, it has been used with different probability levels and bandwidths. Indeed, many publications do not even state what bandwidth was used, despite the fact that this impacts significantly on the size and shape of the resultant home range.

Table 3.1 attempts to summarise the variety of methods used by different projects and illustrates how difficult it is to make direct comparisons within the available literature, since sampling method and type of analysis used will impact strongly on the results (Börger et al. 2006) (see also Chapter 2). Additionally most studies rely on relatively small samples: more than half of the studies I found had a sample size of six or fewer individuals.

Table 3.1
Summary of stone marten home range sizes from the literature, including where available the methods used, sample size and habitat type.

project	author(s) and year	publication type	sample size	statistics used	Fix rate	home range size	Habitat type	country
	Skirnisson (1986)	book	10(2jm,2jf,1sm,2am,3af)	MCP		range: 20-310 ha	rural (v/ov)	D
	(Kalpers 1984)	paper	1 (1am) †	MCP		60 ha	Semi-urban	B
	Föhrenbach (1987)	thesis	9 (2am,3sm,2sf,1jm,1jf)	MCP, MAM, LCM	15 min	85.4 ha (SD?); range:9-203ha	rural	
	Rondinini &Boitani (2002)	paper	8 (4m,4f)	MCP	2/day	152 (SD 8.9)ha	rural	IT
	Lopez-Martin (1992)	paper	1 (m)	MCP	1/day	52.5 ha	rural	E
	Lachat Feller (1993)	thesis	8 (3am, 5af) †	MCP	15 min	72 ha (SD?) (range: 2-193); m 111(range: 2-193) ha, f 49 (range: 27-97)ha	rural	CH
	Santos & Santos-Reis (2009)	paper	5 (2f, 3m)	KH50 & 95 no h given	1/day	310.9ha (mean? SD?)	rural (ov)	P
	Broekhuizen et. al.(1989)	paper	6 (1 jf & 3 af & 2am) †	MCP			urban	NL
	Broekhuizen (1983)	paper	12 (lost 3, 2 a)	MCP100	15 min	range: 78-777 ha	rural (farms)	NL
same	Herrmann (1994)	paper	14(3jm, 5jf, 1sm, 2sf, 1am, 2af)	MCP100	15 min	rang 16-211 ha	rural (v/ov)	D
same	Herrmann (2004)	book	14 +data Skirnisson 1986	MCP100	15 min		rural (v/ov)	D
same	Genovesi et. al. (1997)	paper	16(2sf,4sm,3af,7am) †	MCP 100		range: 63.28- 800.59 ha	rural (v/ov)	I
same	Genovesi & Boitani (1995)	paper	9	MCP 100	15 min	352,52(SD 224,75)ha	rural (v)	I
	Müskens &Broekhuizen (2005)	report	4 (1am, 2af, 1sf) †	MCP 95		range: 8.5-59.5 ha f 8.5-20.5 ha, m: 59.5 ha	rural (v)	NL
	Prigioni&Sammariva(1997)	report	3 (jf)	MCP	15 min	3.6 (SD 2.3)ha/ range: 1.8-3.6ha*	rural (v)	IT
	Lucas (1989)	report	2 (1af,1jf) af & pup	MCP	15 min		urban	NL
	van Walree (1990)	report	1 (af) † af & pup	MCP 90	15 min		urban	NL
	Hovens & Janss (1990)	report	5 (3af, 2jf) †	MCP95 & 100	15 min		urban	NL
	Herr et. al. (2009)	paper	14 (1sf, 1jf, 9af,3am) †	MCP100&95,KH95&50 h least-square cross-validation	15 min	range: 9.5-135.8 ha (MCP100)	urban	Lux

f (female), m(male), a (adult), s (sub-adult), j (juvenile); MCP (Minimum Convex Polygon), KH (Kernel), MAM (maximum area method); LCM (linked cell method), v (village), ov (outside a village), h (bandwidth). †More than half of subjects were adults. *Based on mean nightly home ranges likely to have underestimated the total home range

Nevertheless, regardless of the method used there is overall agreement that martens show intrasexual territoriality, with adult males having larger home ranges than adult females. Also, martens in a rural environment are thought to have larger ranges than martens in an urban environment (Skirnisson 1986, Genovesi et al. 1997, Herrmann 2004, Broekhuizen et al. 2010). Within a rural habitat the micro-habitat in which martens live influences home range size, since home ranges are smallest in villages, larger in the forest and largest in habitats dominated by fields (Herrmann 2004). This lead Herrmann (2004) to conclude that home range sizes increase as habitat quality decreases.

Other factors possibly affecting home range size are age and seasonality. As regards age, Genovesi (1997) found that adults had larger home ranges than sub-adults but this has yet to be confirmed by other studies. As regards seasonality, a seasonal difference between home range sizes was reported by Herrmann (2004) in a rural environment, with martens having the smallest home ranges in winter and the largest in summer. This has not been confirmed either by Herr (2008) in an urban environment or by Skirnisson (1986) in a rural environment. However, there is no overall agreement on the exact definition on seasons used so, given the strong individual variability and relatively small samples sizes of the relevant studies, more research is needed.

Overall, martens' reported home range sizes, across different habitats and sexes, vary by more than two orders of magnitude, ranging from 2 to 800 ha. There is also a considerable degree of individual variation, within different studies, regardless of the method used (see Table 3.1).

3.1.3.3 Travel distance

The longest actual nightly distance (sum of distances travelled between consecutive data fixes during one night) a marten travelled in Skirnisson's (1986) study was 14 km, while the longest distance recorded by Herr (2008) was 10.1 km. Interestingly, these distances were recorded for females in spring, even though on average males travel over longer distances than females (Skirnisson 1986, Genovesi et al. 1997, Herr 2008). This seasonal increase in female movement is associated with raising young and may reflect the increased foraging needs associated with raising a litter (Skirnisson 1986).

Genovesi et. al. (1997) found that males travelled on average 5320 and females 1454 m/night. Sub-adults travelled further than adults, especially during dispersal (Genovesi et al. 1997). The fact that males travel over longer distances per night on average could be related to more extensive patrolling of their territories (Genovesi et al. 1997).

3.1.3.4 Dispersal

Females seem to reach independence earlier than males, a trend previously observed in other mustelid species (Skirnisson 1986). From the 19th week onwards young martens regularly go on excursions during which they are led by their mothers (Herrmann 2004), while from the 21st week onwards they move independently around their mother's territory. They then occupy part of their mothers' home range before they finally disperse from August onwards (Herrmann 2004).

Skirnisson (1986) found that young were tolerated within their mother's home range until they were at least 22 weeks old, but there are records of a marten staying in its mother's home range for up to two years (Broekhuizen et al. 2010). There are also records of martens taking over part of their mother's territory (Broekhuizen et al. 2010). Thus the mother exerts a strong influence on the dispersal of young martens.

During dispersal Skirnisson (1986) found that martens could move actual distances of between 5 and 8 km per night, though the linear distance from their mother's range did not exceed 3 km. Bowman et. al. (2002) found that dispersal distance in mammals could be predicted by their home range size but, as noted above, home range sizes as communicated in the marten literature are so variable that it is difficult to evaluate this hypothesis.

3.1.4 Releases in stone martens

Herrmann (2004) followed two captive-reared martens for 2 months after release, using radio-telemetry; but whether they survived in the long term is unknown as their signals were lost. In another study, three captive-reared juvenile martens were followed for 4.5 months, whereas a translocated adult marten, in the same study, only survived for 7 days (Herr et al. 2008). Similarly, Skirnisson (1986) translocated two adult martens, of which one was lost due to extensive movement during the first night and the second of which was killed by a dog. It seems, then, that young released martens may do better than translocated adults, though more data are needed to confirm this. If this difference is substantiated, it could be explained by the social organisation of stone martens, as follows.

As already noted, martens show intrasexual territoriality, that is, adult males defend their territories against adult males and adult females against adult females. Outside the mating season, Müsken et. al. (1989) found no territoriality between an adult male and a sub-adult male as long as the latter had not reached sexual maturity. Lucas (1989) followed an adult female stone marten with her (female) young during the dispersal period of the latter, and observed that they were on several occasions visited, at their nesting site, by an adult and a sub-adult male. Herrmann (1994) also found occasional overlap between adult and sub-adult home ranges. Taken together, these observations suggest that adult territory holders, although highly intolerant of adult intruders of the same sex, may be tolerant of immature individuals – a phenomenon that is well documented in pine martens (Balharry 1993). If Balharry's (1993) findings on pine martens are indeed substantiated in stone martens, this would suggest that the success or otherwise of release could be strongly affected by the stage of the animal's life cycle at which the release is carried out.

3.1.5 Aims and expectations

The overall aim of my study was to investigate some of the costs and benefits of raising and releasing orphaned martens. As mentioned in Chapter 1, the financial cost of raising an orphaned marten up to the time of its release into the wild was 150-180 € at the time of writing. However, if only a proportion of released animals survives, the cost per successful release will obviously be higher. In addition, a released animal that survived might be responsible for additional financial costs if it came into conflict with human interests, for example because it caused damage to property, and there might be welfare costs of release if the released animal suffered more than it would have done had it remained in captivity or been humanely killed. Conversely, release would be beneficial from the point of view of welfare if the animal suffered less after release than it would have done had it remained in captivity. Clearly, then, any attempt to determine the costs and benefits of releasing orphaned martens requires investigating their survival and behaviour after release.

With these considerations in mind the objectives of the work described in this thesis were to determine:

- Whether released martens were able to survive in the medium term, i.e., for their first winter (3 months) and/ or for the entire study period (6 months).

- Whether they managed to establish a stable home range.

- Whether they displayed normal movement patterns (i.e., movement patterns similar to those of wild martens).

- Whether there was potential for human-marten conflict.

3.2 Methods

Juvenile martens were radio-collared prior to release and then tracked, mainly on foot. The methods are described fully in Chapter 2.

3.3 Results

3.3.1 Overview of results

Overall, 12 martens were released. In the first year, I released one wild-caught juvenile male (Brutus, M1) and three captive-reared juvenile males (Rover, M2; Waldemar, M3; and Knechtruprecht, M4) from the wildlife rescue centre of the LNVL (Lëtzebuerger Natur an Vullenschutz Liga). The wild-caught male was trapped in July 2009 in Luxembourg City and translocated to a forest near Junglinster (49°44'5"N; 6°17'14"E), where it was released. The captive-reared males were released in September 2009 in the same region (Figure 2.2). All four individuals were tracked for over 6 months (see Table 3.2). Waldemar was killed after 6 ½ months by a car and Brutus' signal was lost after 9 months, so his fate was unknown.

In the second year, five more captive-reared martens, two females (Lassie, F1; Elly, F2) and three males (Mozart, M5; Rantanplan, M6; Millou, M7), were released in the same region as those released during the previous year. At the beginning of the observation period Mozart, Lassie and Rantanplan lost their collars. Rantanplan was found dead shortly thereafter, he had been hit by a car. The remaining two martens, Elly and Milou, were successfully tracked during the entire second season.

In the third year, three captive-reared martens, all female (Leica, F3; Flocky, F4; and Lamnda, F5), were released near Roedgen (49.5735°N; 6.0333°E) (Figure 2.2). Leica was killed after 3 weeks but the cause of death could not be determined as by the time she was found she had been partly eaten by crows *(Corvus corone corone)* and

Table 3.2
Summary of data collected for each individual.

Individual	Date of release	N° of nights followed	Overall observation period (in months)	Total n° of fixes used	Date of last data point collected	Individual was no longer followed because	Distance between release and last data point (km)	Max. distance recorded from release site (km)
Brutus (M1)	20/07/2009	27	9	550	04/04/2010	Loss of signal	4.2	5.0
Rover (M2)	01/09/2009	20	8	530	17/05/2010	End of field season	0.5	0.9
Waldemar (M3)	16/09/2009	18	6,5	468	31/03/2010	Death (road kill 31/03/2010)	1.0	2.5
Knechtruprecht (M4)	30/09/2009	19	8	471	17/05/2010	End of field season	6.2	7.1
Lassie (F1)	17/08/2010	4	0.1	69	21/08/2010	Lost collar	1.4	1.6
Mozart (M5)	27/08/2010	5	0.2	138	01/09/2010	Lost collar	2.6	1
Rantanplan (M6)	06/09/2010	6	0.2	118	14/09/2010	Death (road kill; 18/10/2010)	1.5	2.4
Elly (F2)	16/09/2010	20	6	457	21/02/2011	End of field season	4.2	4.5
Milou (M7)	30/09/2010	20	6	462	22/02/2011	End of field season	4.0	6
Leica (F3)	22/08/2011	6	1	130	27/09/2011	Death (unknown)	0.6	0.4
Lamnda (F4)	01/09/2011	20	5	384	20/04/2012	End of field season	1.7	1.8
Flocky (F5)	16/09/2011	14	4	217	03/01/2011	Loss of signal	2.2	2.4

ploughed under by a tractor. Flocky was followed for 4 months before her signal was lost and Lamnda was followed for the entire field season.

3.3.2 Detailed results for individual animals

Season 1 (2009-2010)

Brutus (M1, the wild caught juvenile) moved to the nearest village, 0.6 km from the release site, during the first night after release, and used a barn as his main daytime den for a week. From there he undertook regular excursions in the surrounding areas. During the third night I saw Brutus carrying a chicken egg, which he probably took from a hen house that belonged to the same farm as the barn he stayed in. After a month and a half he moved out of the village, staying in a shed or in nearby woodland during the day. He still undertook excursions on a regular basis but seemed to have established a stable home range, which included woodland, hedgerows and orchards. For reasons unknown, he left this home range after 2 months and, after moving around for 2 days, re-established himself on an elevated plain further away from human settlements than his previous home range. This range included the edges of the woodland surrounding the plain and the hedgerows along an agricultural road leading to a barn, which he occasionally used as a den. His signal was lost after 9 months (see Figure 3.1). As there was no obvious difference between his behaviour and that of the other martens his data set was pooled with that of the captive-reared martens for purposes of analysis.

Rover (M2) and Waldemar (M3) behaved similarly, insofar as they moved over a relatively large area during the first few days after their release. However, they then quite quickly settled in small forests, occupying ranges of about 26.3 ha and 49.6 ha respectively. Rover’s home range was a small forest which was crossed by a narrow and very quiet road. Along the edges of the forest there were fruit trees which he occasionally visited during autumn (see Figure 3.2).

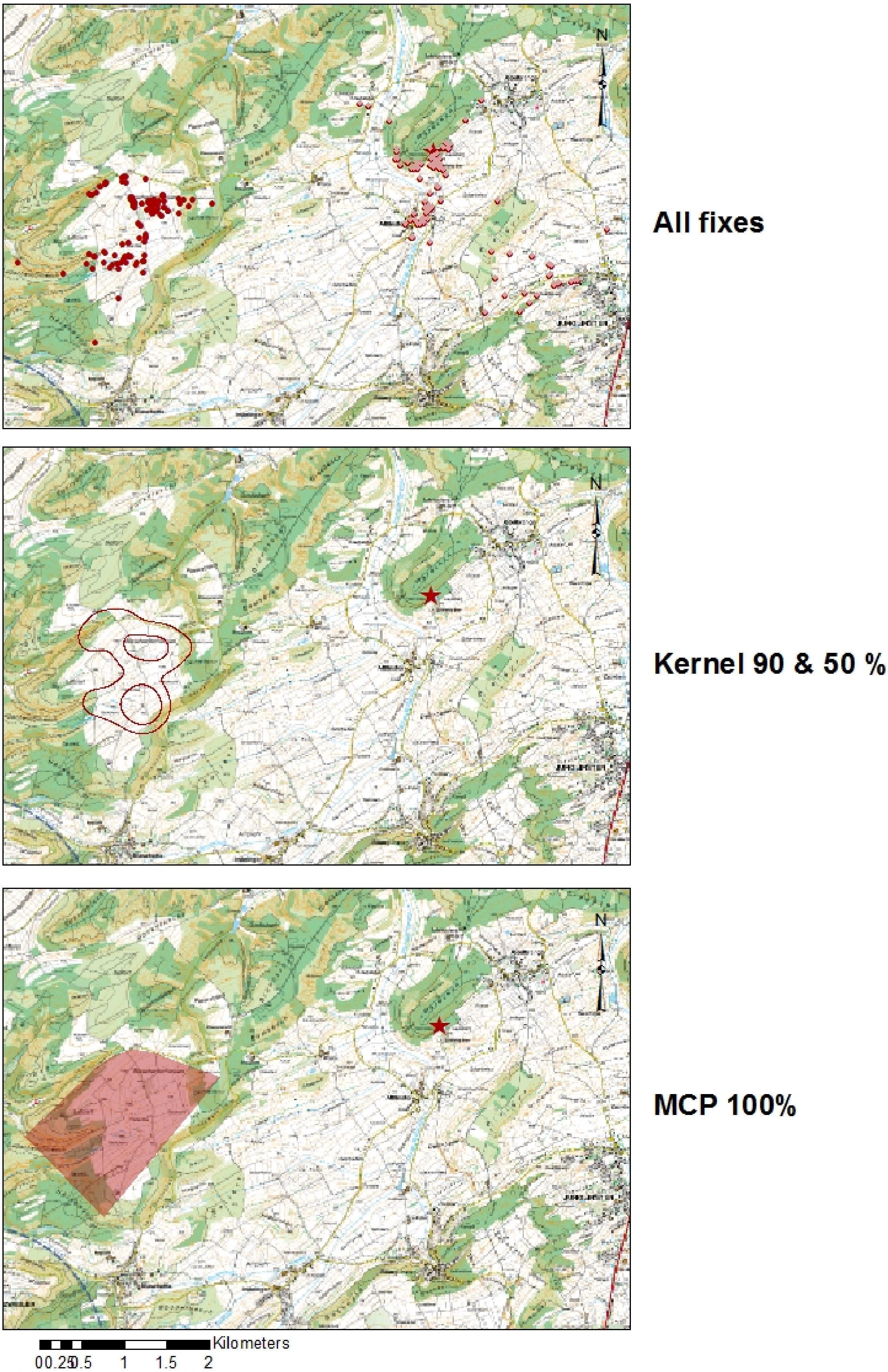


Figure 3.1
Brutus (M1)’s final home range using the Kernel and MCP methods. The red star represents M1’s release site. Top: all of M1’s fixes collected during nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner lines a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M1’s data. Values of range size: Kernel 50% = 30.8 ha, Kernel 90% = 90.86 ha; MCP 100% = 224.82 ha.

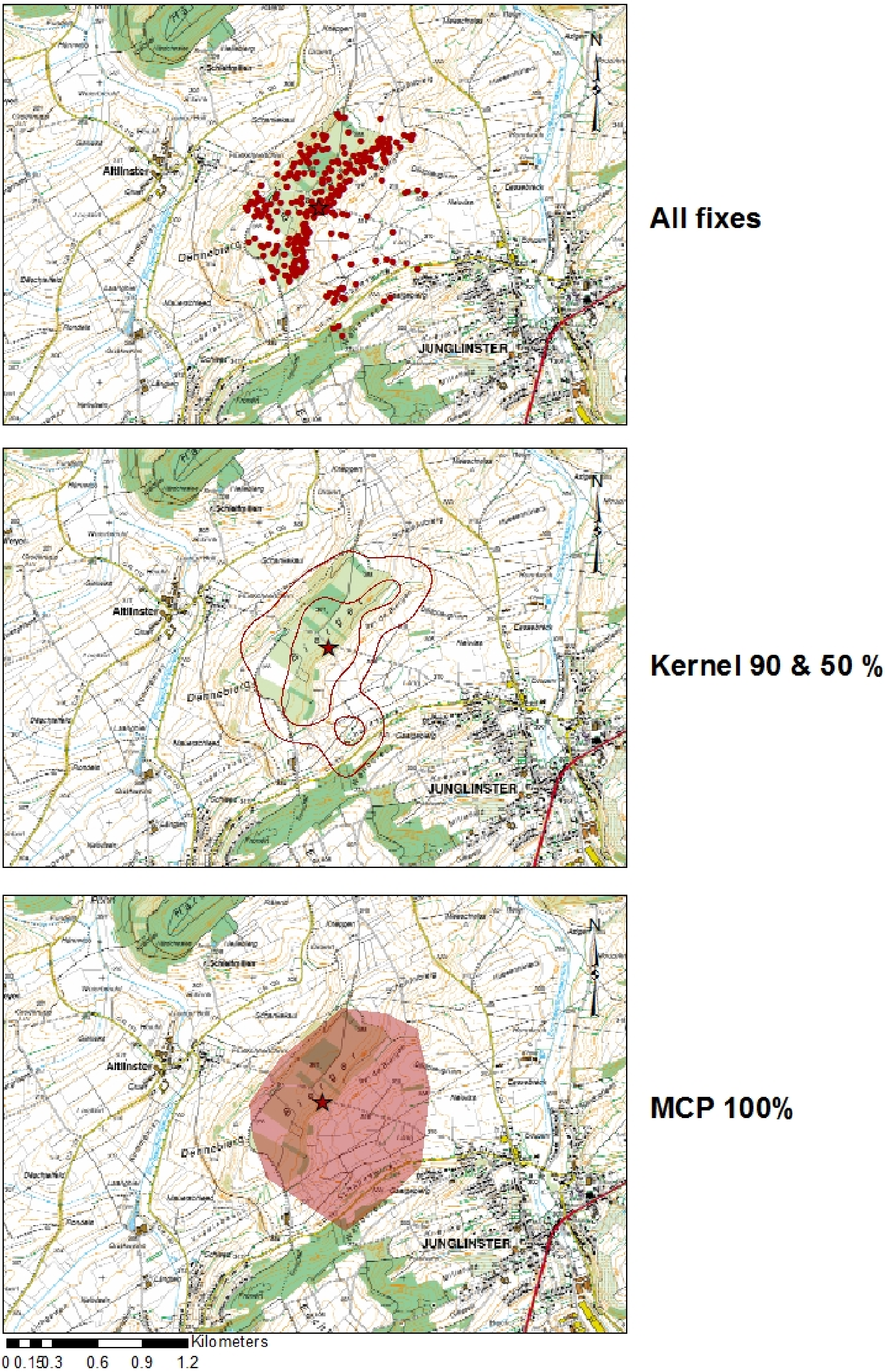


Figure 3.2

Rover (M2)'s final home range using the Kernel and MCP methods. The red star represents M2's release site. Top: all of M2's fixes collected during nightly follows. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner lines a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M2's data. Values of range size: Kernel 50% = 36.93 ha; Kernel 90% = 73.02 ha; MCP 100% = 125.58 ha.

Waldemar spent most of his time in a small forest but he sometimes ventured into hedgerows in the fields surrounding it. His home range contained no fruit trees. He was killed by a car after 6 ½ months. This was probably caused by an increase in movement related to the onset of spring, since the home range Waldemar had initially settled in did not include any roads. When his body was found he was in good physical condition, indicating that he had found enough food in his initial range (see Figure 3.3).

Knechtruprecht (M4) behaved quite differently from the other martens and differently from what would have been expected. He stayed near the release site for two days and then moved over a large actual distance of 4 km in one night. He then stayed in a very small area for a few days and moved over a large distance again; and again stayed in a very small area for a few days. He repeated this kind of behaviour a total of five times and never returned to the places where he had previously stayed. After 3.5 months, however, he seemed to have settled and he remained in the same home range for the rest of the observation period. His final home range was larger than the areas he used during his initial short stays and included the edge of a forest and an old farm (see Figure 3.4). The farm was located 1.5 km from the next village and was still inhabited, but the barn and stables were no longer in use. The farm offered plenty of hiding places and a few old fruit trees but these did not bear any fruit when Knechtruprecht was observed there. The old lady that still lived in the farmhouse occasionally caught him feeding on the food she put out for her cats.

Season 2 (2010-2011)

Lassie (F1), Mozart (M5) and Rantanplan (M6) were all lost shortly after release, as they lost their collars. Thus, only a few data were available for these individuals. Their release sites were marked by a number of small wooded patches surrounded by fields with numerous hedge rows. There were a few fruit trees, but there were no records of the martens visiting them (see Figures 3.5, 3.6 & 3.7).

During the period they were observed, the movements of these three animals were similar to those of Rover and Waldemar in the first year: they showed extensive

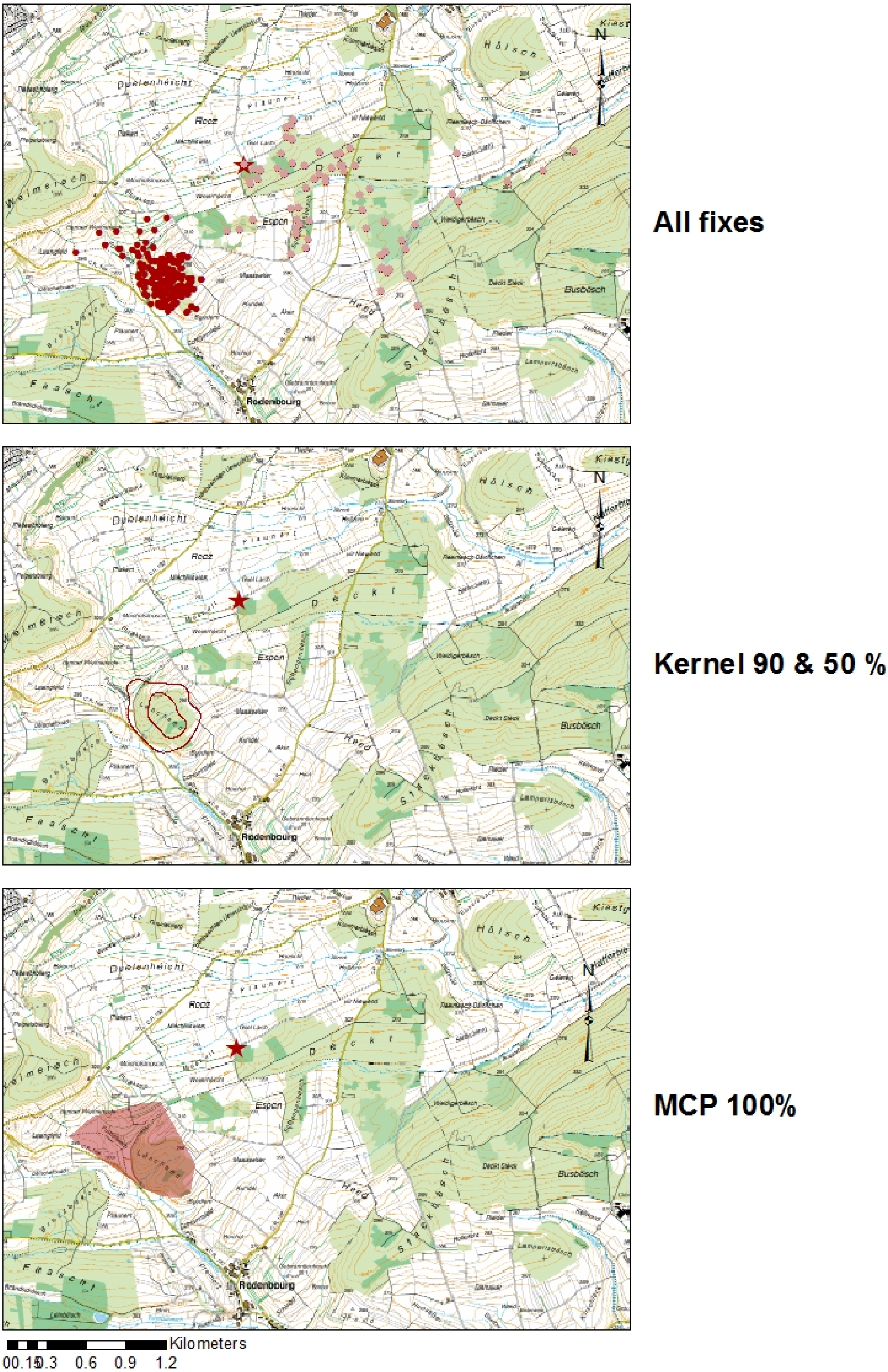


Figure 3.3

Waldemar (M3)'s final home range using the Kernel and MCP methods. The red star represents M3's release site. Top: all of M3's fixes collected during nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner line a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M3's data. Values of range size: Kernel 50% = 6.5 ha; Kernel 90% = 16.15 ha; MCP 100% = 40.53 ha.

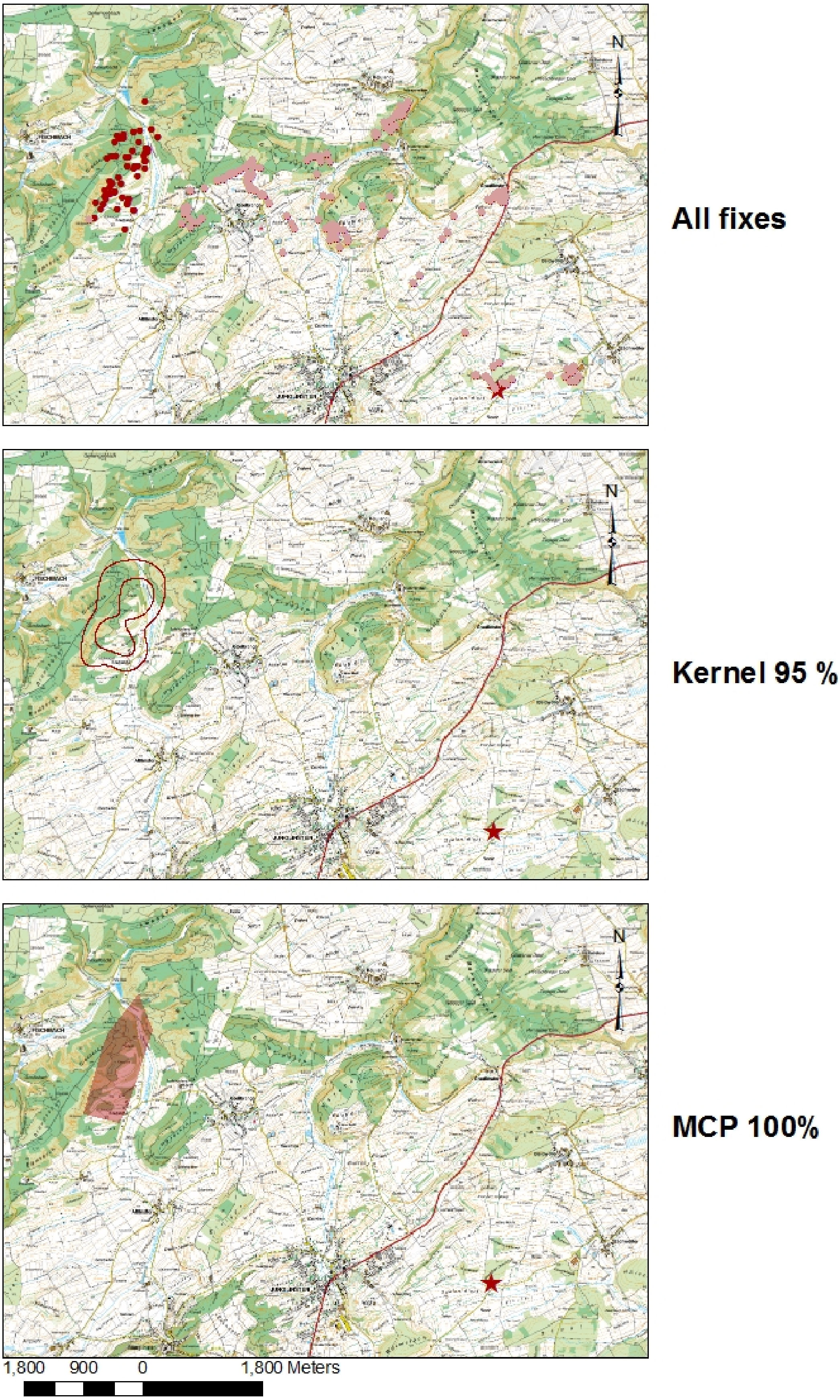


Figure 3.4

Knechtruprecht (M4)’s final home range using the Kernel and MCP methods. The red star represents M4’s release site. Top: all of M4’s fixes collected during nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner line a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M4’s data. Values of range size: Kernel 50% = 52.44 ha; Kernel 90% = 99.49 ha; MCP 100% = 102.76 ha.

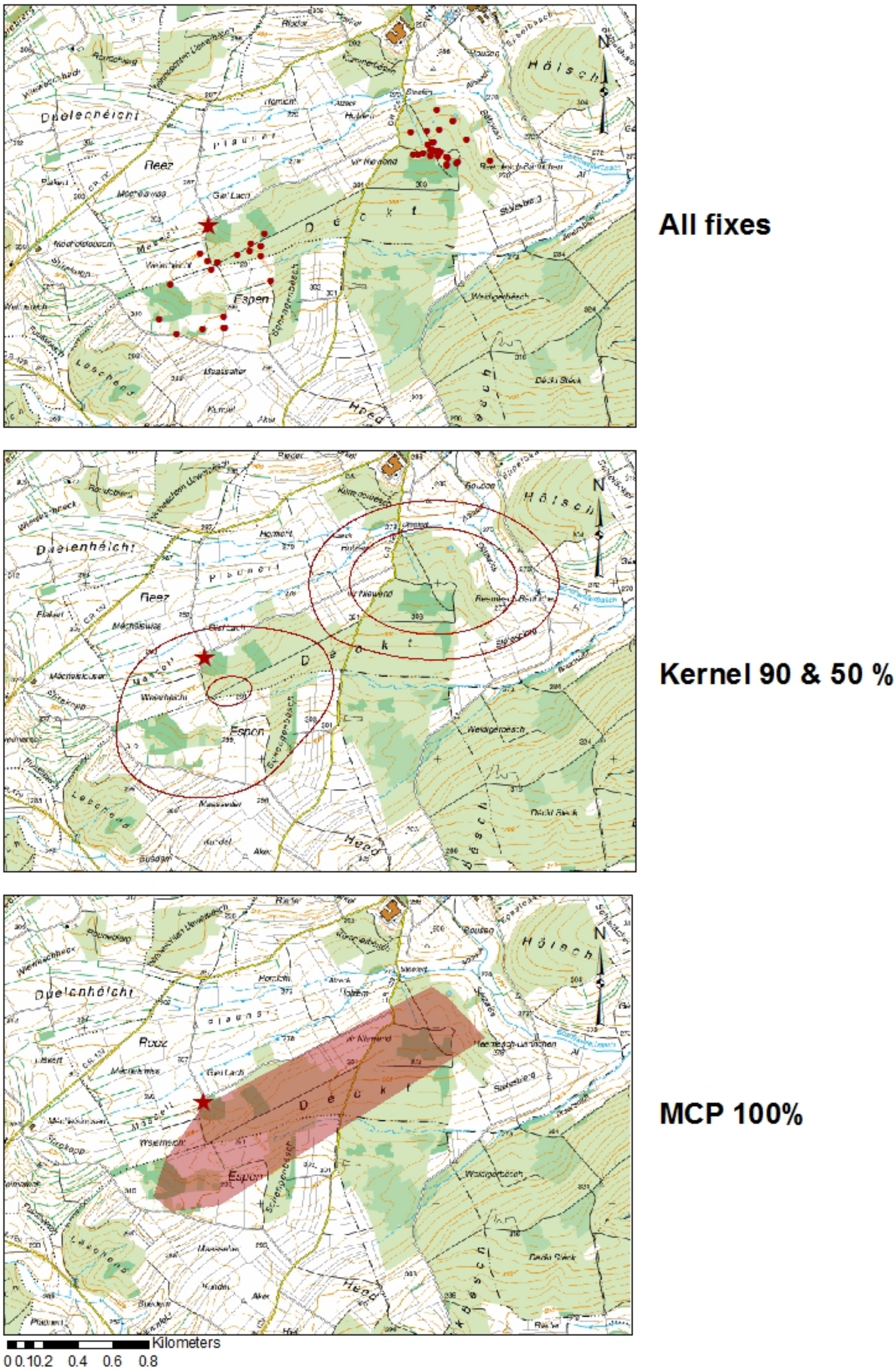


Figure 3.5
Lassie (F1)'s final home range using the Kernel and MCP methods. The red star represents F1's release site. Top: all of F1's fixes collected during nightly follows. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer lines represent isopleths with a Kernel density of 90% and the inner lines a density of 50%. Bottom: map with Multi Convex Polygon using 100% of F1's data.
Values of range size: Kernel 50% = 48.82 ha; Kernel 90% = 146.56 ha; MCP 100% = 88.64 ha.

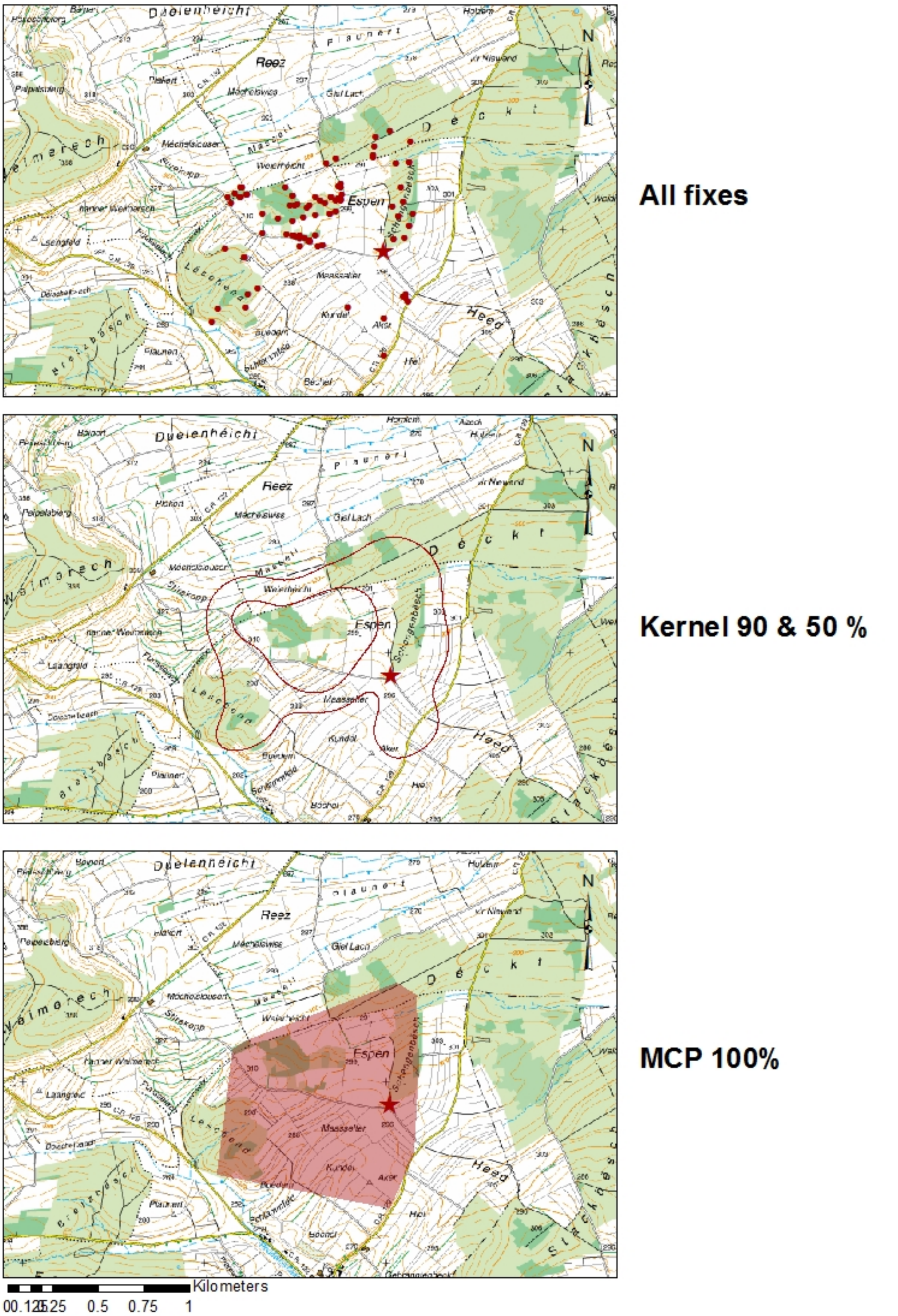


Figure 3.6

Mozart (M5)'s final home range using the Kernel and MCP methods. The red star represents M5's release site. Top: all of M5's fixes collected during nightly follows. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner line a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M5's data.

Values of range size: Kernel 50% = 30.92 ha; Kernel 90% = 82.88 ha; MCP 100% = 102.38 ha.

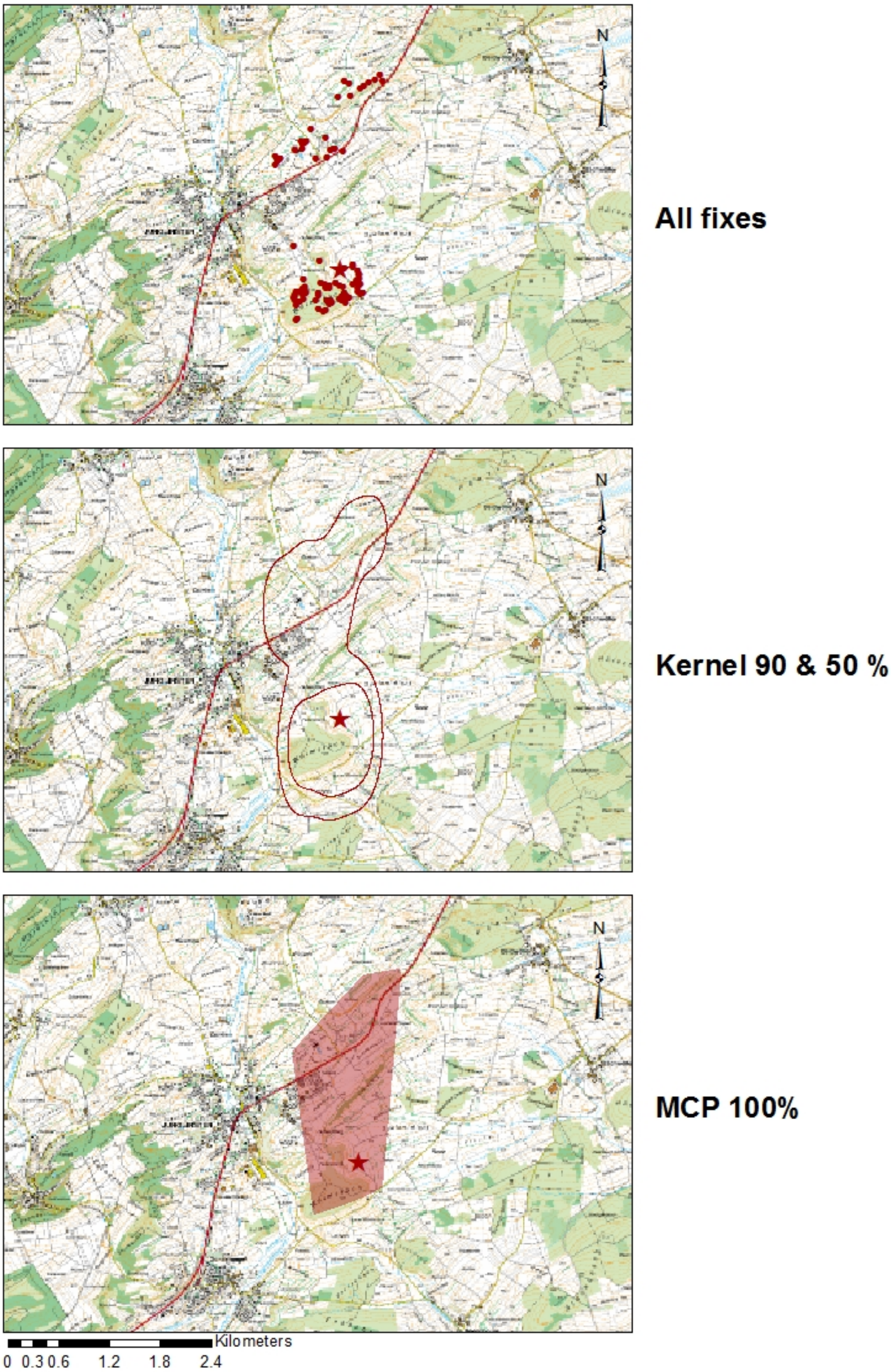


Figure 3.7

Rantanplan (M6)'s final home range using the Kernel and MCP methods. The red star represents M6's release site. Top: all of M6's fixes collected during nightly follows. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner line a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M6's data.

Values of range size: Kernel 50% = 109.56 ha; Kernel 90% = 273.09 ha; MCP 100% = 252.54 ha.

exploring behaviour around their release site in the first few nights, then settled in a relatively smaller area after about a month. Unfortunately, no more data were available for Lassie and Mozart. Rantanplan was found dead, killed by a car, a month and a half after release: although he had lost his collar, he could be identified from the picture taken of his throat patch before his release.

During the first three weeks Elly (F2) remained close to her release site and showed little exploratory behaviour. She then moved away from where she was released and was found at 3.5 km linear distance from the release site. This was probably due to a farmer disturbing Elly by ploughing a field, until after sunset, immediately adjacent to the wooded patch in which Elly was staying. During the following two weeks she moved around a lot within this new area. She occasionally used a barn within a village as a daytime den but she mainly slept in bushes in fields surrounding the village. Finally, she settled at the site of a biogas generator just outside the village, where she stayed for the next 3.5 months, usually sleeping during daytime in the same barn and paying occasional visits to a small stream about 100 m away. In January, however, she started extending her home range, undergoing further excursions about 1.5 km away. She occasionally spent a day in a barn near a neighbouring village but still returned regularly to her usual home range (see Figure 3.8).

Milou (M7) spent the first 5 days very close to his release site. During the 6th night he ventured a little further and then, on subsequent nights, continued to explore further afield while still remaining in the same area. During the 12th night I observed Milou catching rats near a building site and bringing his prey back to the edge of the forest to eat it. He made three such trips to the building site, each time bringing back a dead rat. Two weeks after his release, Milou moved to a village 3 km linear distance from his release site, where he stayed in a stable for 2 days and then used a pipe in an abandoned water supply system, just outside the village, as a daytime den for over 2 weeks. He then moved again to a different area 1.5 km away. This second move was probably due to human disturbance since I found empty beer cans and food wrappings around the abandoned water supply system, indicating that it had been the site of a party. Milou was found again in an area further away from human settlements, where

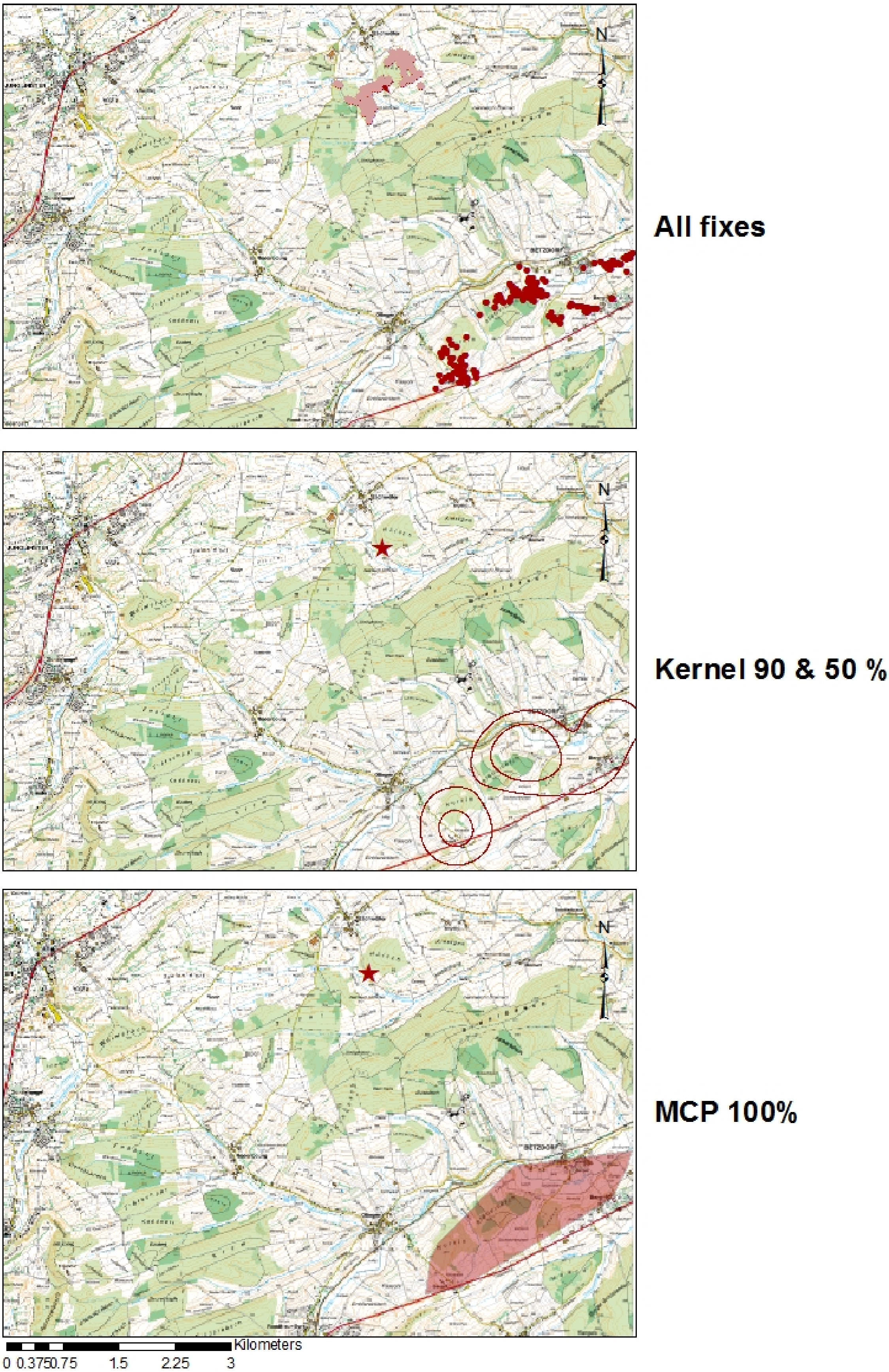


Figure 3.8
Elly (F2)'s final home range using the Kernel and MCP methods. The red star represents F2's release site. Top: all of F2's fixes collected during F2's nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer lines represent an isopleth with a Kernel density of 90% and the inner lines a density of 50%. Bottom: map with Multi Convex Polygon using 100% of F2's data. Values of range size: Kernel 50% = 83.25 ha; Kernel 90% = 245.29 ha; MCP 100% = 235.04 ha.

he spent a lot of his time along a small stream. He remained in this area for the rest of the study but continued to undertake long excursions outside his usual range. Within his range he had about four resting sites to which he would return regularly, including a sewage pipe passing underneath a street, and two places along the stream between washed-out roots of trees and in under-storey. In poor weather conditions he would move very little and used the same daytime den for a number of consecutive nights (see Figure 3.9).

Season 3 (2011-2012)

The three martens released in the third year were exceptionally tame. It is not clear whether this was due to the fact that they were female or due to a slightly different rearing regime. During the last few weeks of their captivity they were cared for by different personnel, as the main carer at the rescue centre was on holiday.

Leica (F3) moved very little during the first six nights after release: she never moved very far away from her release site and did not once venture out of the hedgerow next to which she was released, even though she could easily have reached a number of different nearby hedgerows, wooded patches and orchards (see Figure 3.10). She was found dead after a month but the cause of death could not be determined, since she was already in an advanced state of decomposition and had been dragged along and ploughed under by a tractor.

Flocky (F5) moved little during the first night but in the following five nights she moved over a large area, tending to explore a particular locality for a few hours and then moving on again. When moving from one locality to the next she avoided open areas and used vegetation such as hedgerows as corridors; and during the first six nights she never used the same day hide twice. She stayed in and around a wooded patch near Roedgen during subsequent weeks and was lost after 4 months (see Figure 3.11).

Lamnda (F4) dashed off immediately after her release, crossing an open field. After about an hour she ended up in a small forest, 300 m from the release site, in which she

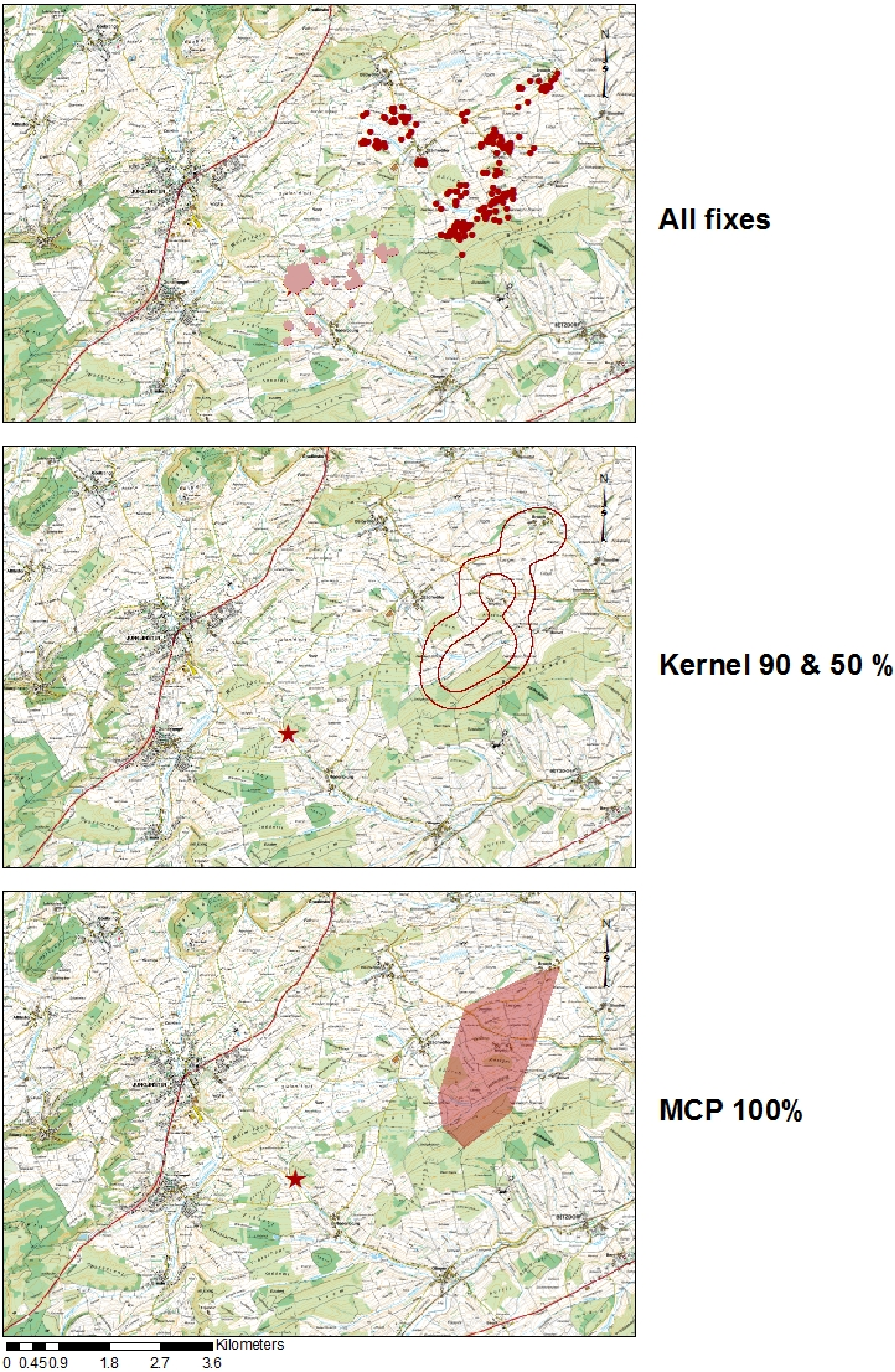


Figure 3.9

Milou (M7)'s final home range using the Kernel and MCP methods. The red star represents M7's release site. Top: all of M7's fixes collected during nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner line a density of 50%. Bottom: map with Multi Convex Polygon using 100% of M7's data. Values of range size: Kernel 50% = 148.97 ha; Kernel 90% = 320.56 ha; MCP 100% = 356.27 ha.

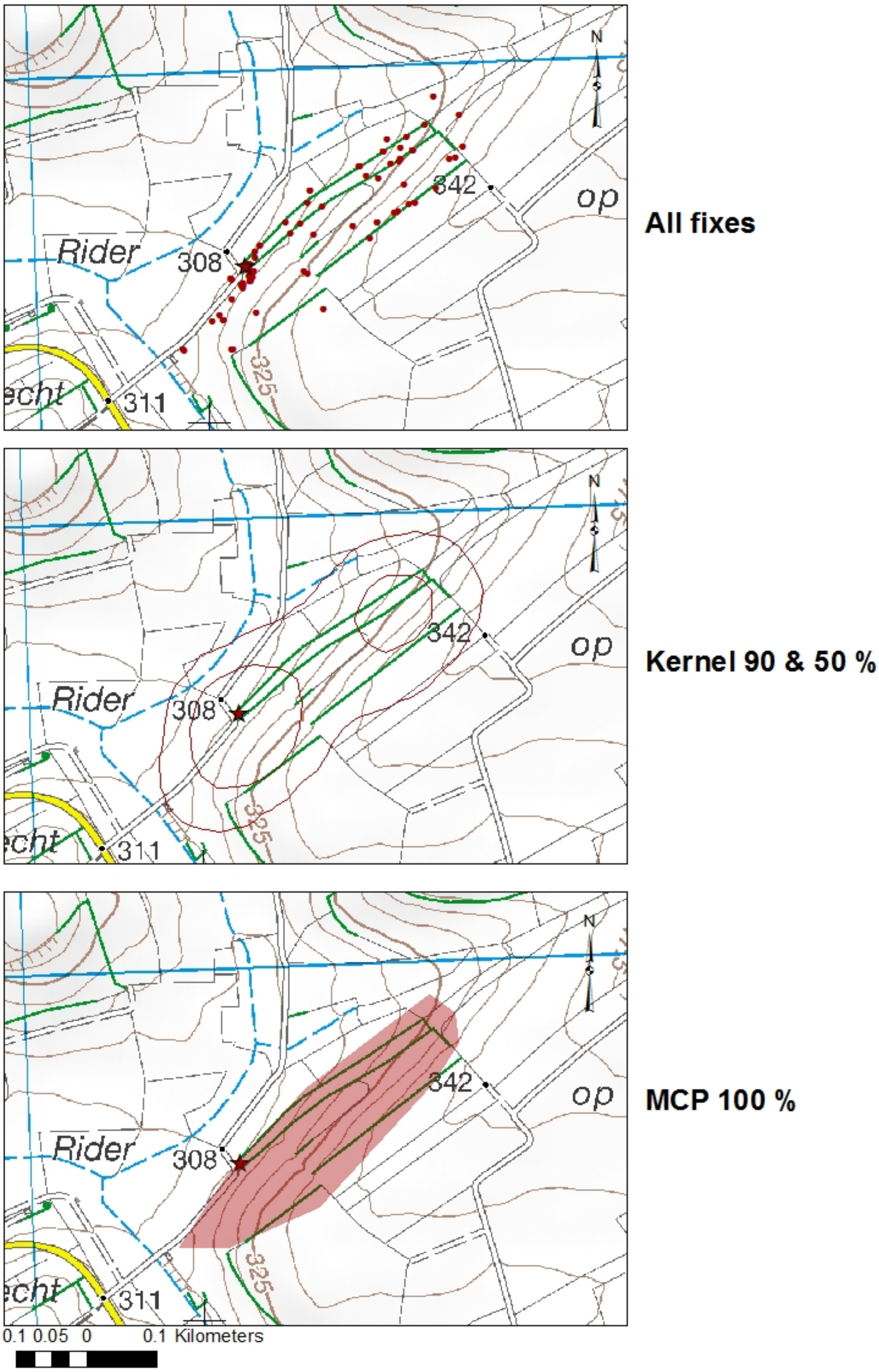


Figure 3.10

Leica (F3)'s final home range using the Kernel and MCP methods. The red star represents F3's release site. Top: all of F3's fixes collected during F3's nightly follows. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner lines a density of 50%. Bottom: map with Multi Convex Polygon using 100% of F3's data.

Values of range size: Kernel 50% = 3.11 ha; Kernel 90% = 7.35 ha; MCP 100% = 5.18 ha.

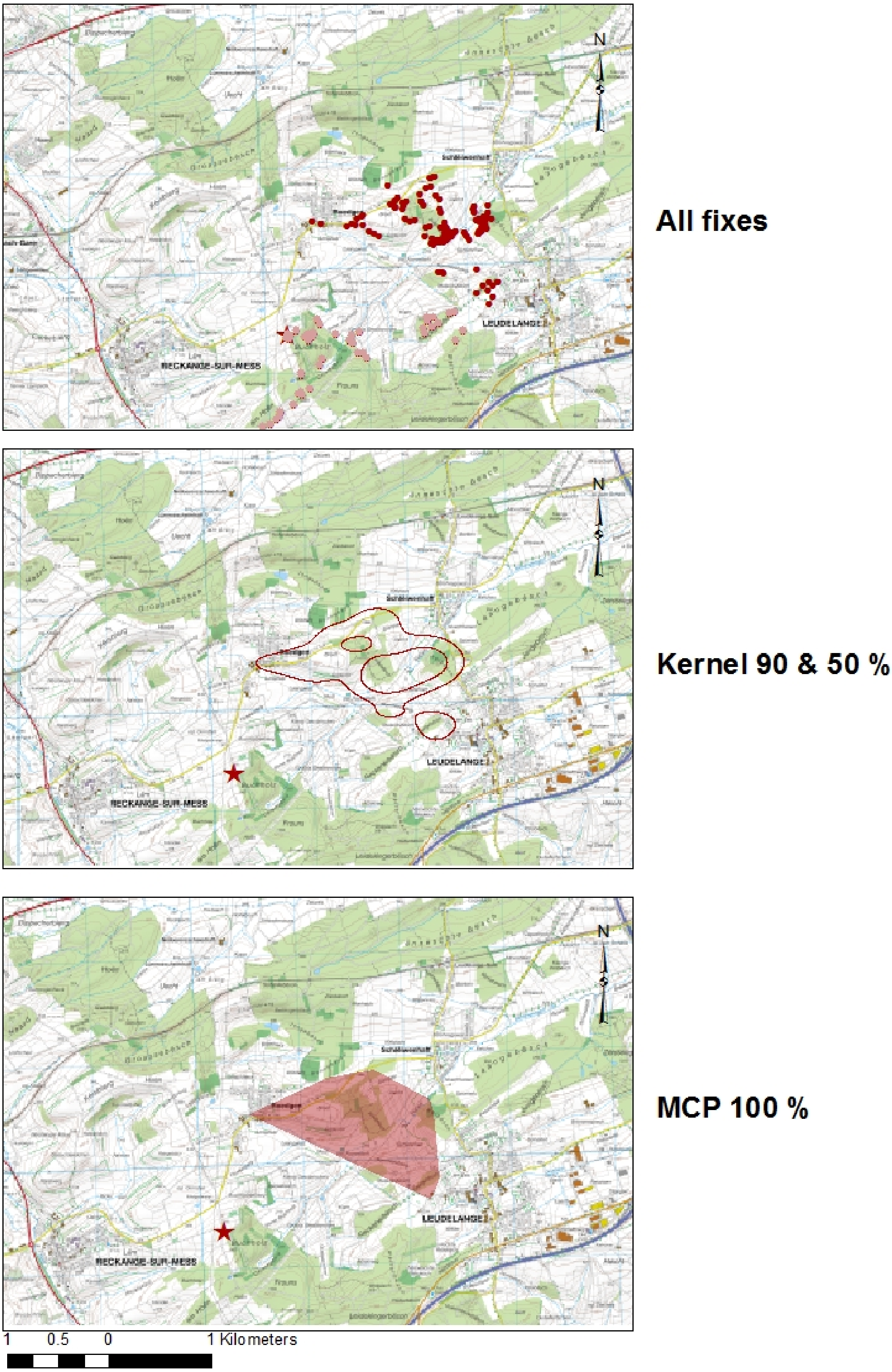


Figure 3.11
Flocky (F5)'s final home range using the Kernel and MCP methods. The red star represents F5's release site. Top: all of F5's fixes collected during nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer lines represent an isopleth with a Kernel density of 90% and the inner lines a density of 50%. Bottom: map with Multi Convex Polygon using 100% of F5's data. Values of range size: Kernel 50% = 30.75 ha; Kernel 90% = 90.98 ha; MCP 100% = 120.91 ha.

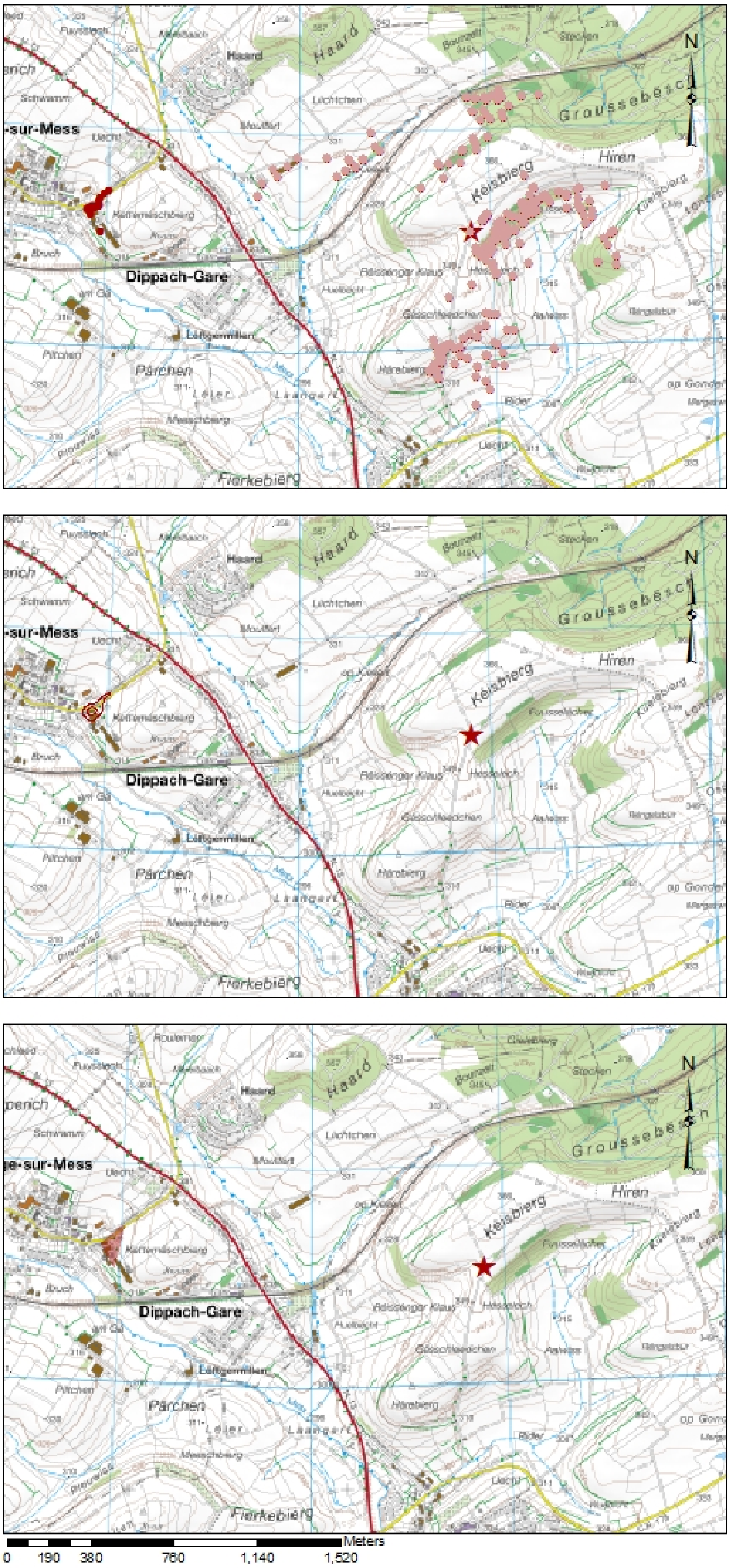
spent the rest of the night and all of the second night. At the beginning of the third night she moved to a different forest, 600 m from the previous one, in the same valley, where she stayed for the two following nights. Halfway through the 5th night she moved to a hedgerow, surrounded by fields on an otherwise bare plateau. On both occasions she had to cross open fields to get to the new location and on the second occasion she crossed a newly built railway track with no vegetation for cover. After three weeks she moved back to settle in the small forest where she had spent the first two nights after her release, and a week later (i.e., a month after her release) an adult stone marten was seen within her home range.

Over time Lamnda extended her home range to include another small forest, a few hedgerows and orchards, and the garden of a house right at the edge of a village. Until the end of autumn she showed a regular pattern, spending a few hours each night foraging in the available orchards. Forty-eight days after her release a farmer was ploughing a field, after sunset, between her daytime den and an orchard she had been visiting regularly, which seems to have delayed her regular visit. After three months she moved to a village 2 km away and spent the rest of the observation period denning in the barn of a farm. It is not clear why she moved but the night she moved was particularly stormy, with wind speeds of up to 60 km/h (see Figure 3.12).

Five months after Lamnda's release the owner of the farm she settled in told me that one of his neighbours had complained about a marten tearing up the insulation of his car engine. It is possible that Lamnda was responsible for this damage.

<u>Summary</u>

Behaviour immediately following release varied from individual to individual. Some of the released individuals started moving away immediately, covering a significant distance in only a few hours (M3, M2, M6, F4), while others remained close to the release site for some time before starting to explore (M4, F2, M7, F5). However, in both circumstances the animals showed clear signs of stress (i.e., tensed body, ducking, defecating) immediately after release.



All fixes

Kernel 90 & 50 %

MCP 100 %

Figure 3.12
Lamnda (F4)'s final home range using the Kernel and MCP methods. The red star represents F4's release site. Top: all of F4's fixes collected during nightly follows, fixes used for final home range are dark red. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner line a density of 50%. Bottom: map with Multi Convex Polygon using 100% of F4's data. Values of range size: Kernel 50% = 0.13 ha; Kernel 90% = 0.53 ha; MCP 100% = 0.82 ha.

3.3.3 SPACE USE

3.3.3.1 HABITAT USE

Only one marten settled in a village (F4). All the others that could be followed long enough to establish their home range settled outside of villages, even if on some occasions they passed through a village during excursions. Regardless of whether they moved from the release site or stayed in the release area, the ranges they settled in were typically composed of small wooded patches, or edges of larger forests, surrounded mainly by fields interspersed with hedgerows, occasionally orchards, and rarely other anthropogenic structures such as barns. In one specific case a released marten settled on the site of a biogas generator. If anthropogenic structures were chosen these were usually associated with agricultural activity.

3.3.3.2 HOME RANGES

As described in Chapter 2 the MCP method using 100% of the data were used to calculate home range size, in order to allow comparison with other studies; and the Kernel method with the reference bandwidth (h_{REF}) was used to provide a more detailed visualisation of the pattern of space use. A Kernel density of 50% was defined as the core area of a home range and a density of 90% to define the complete home range of an individual. Because individuals tended to move around somewhat before they settled, and sometimes stayed in one place for a while and then left not to return, their final home range was determined by excluding spatio-temporal clusters of activity which an animal had left without returning to them for the rest of the observation period. In addition, the final home range was defined as an area in which the animal in question had stayed continuously for at least two months. Thus if an animal would leave an area in which it had stayed for at least two months just before the end of the study, this was counted as an excursion (and therefore as part of its range), as it could not be said with certainty whether the animal had left the area for good or not. To define the final home range, data from the nightly follows and data from the daily checks at the animal's day hide were used as this allowed for more precision.

Overall the martens' cumulative home ranges reached asymptotic size about 2 months after they were released (see Figure 3.13). Thus by the beginning of winter most animals had settled. However, with the onset of spring Knechtruprecht and Milou showed renewed exploring behaviour, which, in winter, had levelled off in all individuals (see Figure 3.13). The mean final home range size, based on the KH90%, was 117.1 ha (SD: 103.2 ha). (F1, F3, M5 and M6 were excluded from this calculation, because too little data were available to estimate valid home ranges.) There was a considerable degree of variation between individuals, even between individuals of the same sex; and even if individuals were radio-tracked over a substantial period of time (see Table 3.3). However, the large SD value for mean final home range size is probably to some extent a consequence of the small sample size.

3.3.3.3 Differences between the sexes

There was no significant difference in home range size between males and females (Mann-Whitney test, U= 7, n_1 = 5, n_2 = 3, P=0.881) but males travelled at a significantly faster rate (i.e., moved further per hour) than did females (U= 0, n_1=5, n_2=7, P=0.004).

3.3.3.4 Seasonal differences and difference between the first six days after release and the rest of the study period

No significant difference was found in overall home range sizes between autumn and winter (Wilcoxon Mann-Whitney test, T=6, n=7, N=7, P=0.176). However, there was a nearly significant difference between core area sizes (T=3, n=7, N=7, P=0.06), which were smaller in winter than in autumn (see Figure 3.14). No significant seasonal

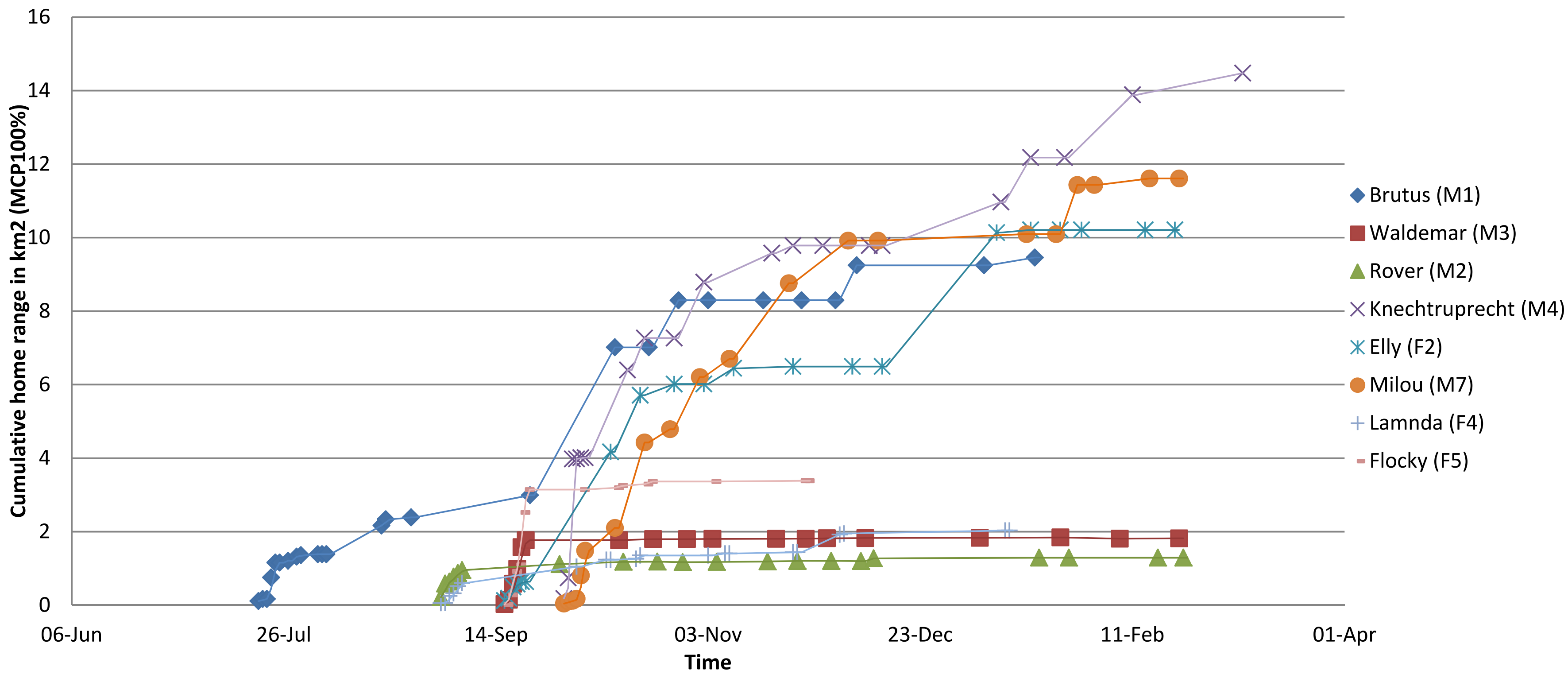


Figure 3.13

Cumulative individual home range sizes (MCP 100%) in km^2 over time.

Table 3.3
Summary of individual home range sizes (in ha) over the entire study period and in the area the animal had settled in towards the end of the study period ('final range'). The home range core was expressed as 50% (KH 50%) isopleths and the home range as 90 % (KH 90%) isopleths. Isopleths were obtained using a fixed Kernel estimation, with a reference bandwidth (h_{REF}). Ranges based on MCP 100% are also given (see Figures 3.1-3.12).

	Entire study period			Final range		
Marten	**MCP 100% ha**	**KH 90% ha**	**KH 50% ha**	**MCP 100% ha**	**KH 90% ha**	**KH 50% ha**
Brutus (M1)	1371.57	651.92	276.14	224.82	90.86	30.80
Rover (M2)*	125.58	73.02	36.93	125.58	73.02	36.93
Waldemar (M3)	350.49	202.43	36.34	40.53	16.15	6.50
Knechtruprecht (M4)	1972.69	1425.80	722.88	102.76	99.49	52.44
Lassie (F1) †	88.64	146.56	48.82	88.64	146.56	48.82
Mozart (M5) †	102.38	82.88	30.92	102.38	82.88	30.92
Rantanplan (M6) †	252.54	273.09	109.56	252.54	273.09	109.56
Elly (F2)	1020.92	790.67	349.16	235.04	245.29	83.25
Milou (M7)	1160.76	1097.44	541.73	356.27	320.56	148.97
Leica (F3) †	5.18	7.35	3.11	5.18	7.35	3.11
Lamnda (F4)	203.08	160.99	69.91	0.82	0.53	0.13
Flocky (F5)	338.24	311.69	121.19	120.91	90.98	30.75

*Individual that stayed within the same range over the entire study period.
†Individual for whom less than a month's worth of data were available.

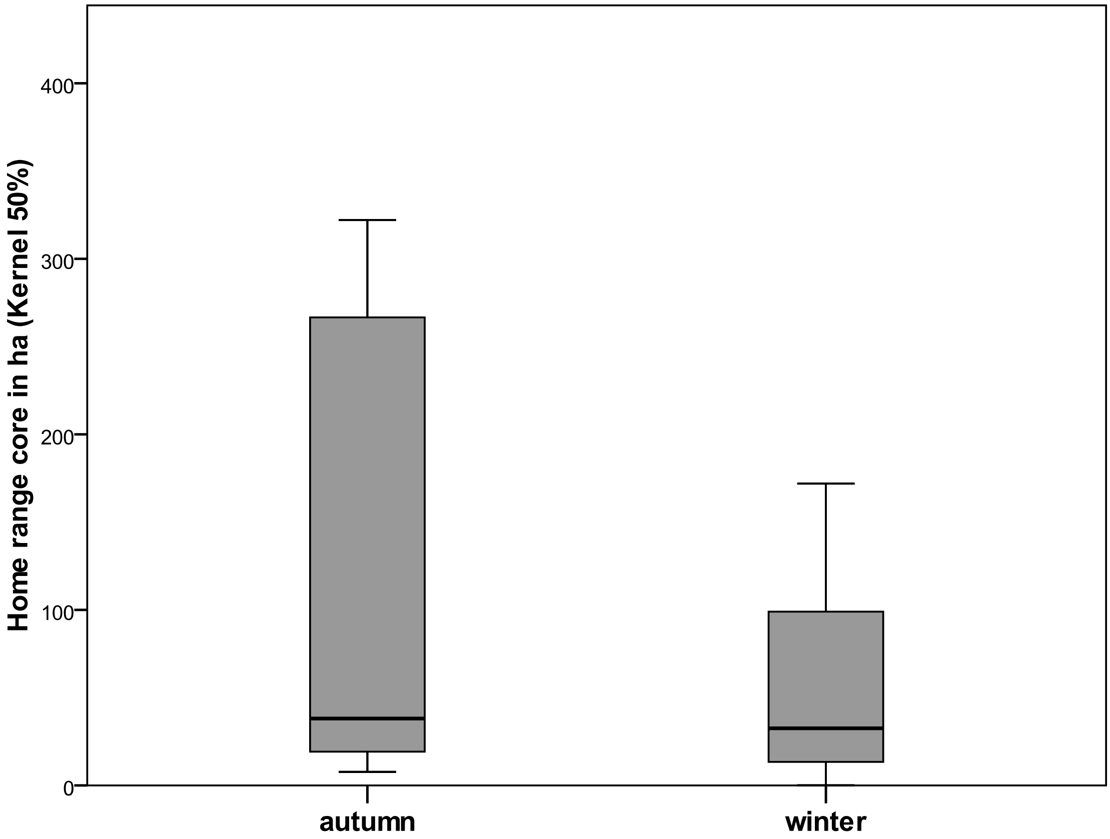


Figure 3.14
Seasonal difference in size of median home range core (K50%) in ha. (Wilcoxon Mann-Whitney test, T=3, n=7, N=7, P=0.06).

difference was found in mean individual speed (m/h) (T=11, n=7, N=7, P=0.61), nor was there a significant difference between the first six nights after release and the rest of the study period in mean individual speed (m/h) (T=14, n=8, N=8, P=0.58).

3.3.3.5 Movement patterns and home range shift

The furthest linear distance a marten moved from its release point during the relevant observation period was 7.1 km (M4) (see Table 3.2). On average females moved over an actual distance of 1.618 (SD 0.389) km/night and their mean travel speed was of 0.18 (SD 0.04) km/h. Males moved over an actual distance of 3.049 (SD 0.432) km/night on average, at a mean speed of 0.32 (SD 0.04) km/h. Individuals' mean home range shift from the first 6 days following release to the following season (autumn or summer) was 1.5 (SD 1.1) km, while the mean home range shift between autumn and winter was 1.2 (SD 0.8) km (see Table 3.4). There was a high degree of individual variation that could not be related to obvious factors such as sex or season, but this was probably to some extent a consequence of the small sample sizes.

3.3.4 Feeding

Direct observations of feeding behaviour were rare but Brutus was seen carrying a chicken egg and Millou carrying rat carcasses. Brutus and Rover spent extended periods of time in orchards when fruit was available and I found the remains of a half-eaten pigeon in Lamnda's territory. This suggests that the released martens readily exploited a variety of foods.

3.3.5 Human-marten conflict

Only one of the released martens established itself in a village, even though all could have done so from where they were released. This suggests that released martens may

Table 3.4
Summary of individual home range shifts between the first six days following release and the following season; and between different seasons.

ID	shift 6days-autumn (km)	shift autumn-winter (km)	shift 6 days-summer (km)	shift summer-autumn (km)	6days-following season (km)
f2	3.1	1			3.1
m1		1.4	0.1	1.9	0.1
m2	0.2	0.1			0.2
m3	1.4	0.05			1.4
m4	3.1	2.4			3.1
m7	2.4	1.7			2.4
f4	0.5	1.9			0.5
f5	1.2				1.2
mean	1.7	1.2			1.5
S.D.	1.1	0.8			1.1

not generally become problematic from the point of view of human residents. However, one individual did settle in a village and may have caused damage to a car.

3.3.6 Mortality

In the first season one marten was killed in a road traffic accident shortly after the field season ended, while in the second season one marten was fatally injured by a car shortly after its release. In the third season one animal died: the cause of death in this case was unknown but a road traffic accident can be excluded.

Altogether, out of the 12 martens that were released, two were lost and their fate was unknown. Of the remaining 10 animals whose fate was known, three died. Thus, the best estimate of mortality is 0.33.

3.4 Discussion

3.4.1 Space use

I made no predictions about dispersal distance in the released martens; but on the basis of previous studies (see Chapter 1 and the Introduction to this chapter) I expected there to be increased movement distances and speeds immediately following release, and seasonal variation in movement distances and speeds. I also predicted more extensive movement in males than in females. As regards home range size, I expected this to be small overall and to lack seasonal variation, but I expected ranges to be larger in males than in females.

In fact, the final home range sizes, ranging from 91 to 0.5 ha, lay within the spectrum of published results (compare Table 3.1 & 3.3). As predicted, I did not find a seasonal difference between home range sizes; but I did not find a seasonal difference in movement patterns either. No significant difference was found in home range size between males and females, but males moved over longer distances. These results seem counter-intuitive, as martens are known to show intrasexual territoriality, with males generally having larger ranges and thereby monopolizing access to a number of females (Skirnisson 1986, Genovesi et al. 1997, Herrmann 2004, Broekhuizen et al. 2010). One study has also shown a difference in movement patterns associated with different seasons (Genovesi et al. 1997).

In the wild, however, young martens stay within their mother's territory for a variable period of time lasting up to two years (Broekhuizen et al. 2010). Thus, regardless of its sex, the range of a young marten would not exceed that of its mother. My martens were orphans, so the issue of the size of their mothers' ranges does not arise. However, they had not reached sexual maturity so the males had no need to monopolize any females, and this probably explains the lack of a sex difference in range size. The fact that males moved over longer distances than females could indicate their predisposition for larger home ranges or, like adult male pine martens, they might even when immature patrol their ranges more rigorously (Balharry 1993). Seasonal differences in movement patterns are associated with reproductive status in adult stone martens: an increase in movement is associated with increased territoriality during the mating season (Genovesi et al. 1997) and with females raising their young (Skirnisson 1986). However, these factors are irrelevant for dispersing young so would not apply to my released juvenile martens.

Compared to wild adult martens, these individuals showed relatively large home range shifts, both between seasons and between the first days after release and the following season. The largest home range shift found by Herr (2009) was of 143 m, which is considerably below the several kilometres found for some individuals in this study. This could reflect individual's dispersal behaviour.

As regards dispersal, the furthest linear distance an individual moved from its release site ranged from 0.4 to 7.1 km, with an average of 3.3 (SD 2.1) km (see Table 3.2). When compared to the few records on release or dispersal in this species (Skirnisson 1986, Lucas 1989, Herrmann 2004, Herr et al. 2008), these distances seem to be within the normal range. I did not find a significant difference in mean individual distance moved per hour between the first six days following release and the rest of the study period, which is surprising because I expected erratic movement following release. Probably the lack of any systematic trend was a combination of the small sample size and the existence of strong individual differences in the first reaction to release. Thus, some individuals started moving away immediately after release, covering a significant distance in only a few hours (M3, M2, M6, F4), while others remained close to the release site for some time before starting to explore (M4, F2, M7, F5). However, in both circumstances the animals showed clear signs of stress (i.e., tensed body, ducking, defecating) immediately following release.

Only one marten settled in a village and it did so towards the end of the study. This was contrary to my expectation since villages are considered to be more resource-rich habitats (Herrmann 2004) and there were villages close to all of the release areas. The released martens might have avoided villages because these were already occupied by resident martens. However, Balharry (1993) found that within the normal intrasexual territorial distribution of adult pine martens, young transient individuals were tolerated. On the other hand, Balharry (1993) also noted that he did not know to what extent the young pine martens in his study were related to the adult territory holders. The released stone martens in my study were definitely not related to the local population, so this could explain why they were apparently not tolerated by resident village territory-holders, whereas young pine martens in Balharry’s study were tolerated.

3.4.2 Human conflict

A heightened risk of human-marten conflict was expected but was not confirmed since all but one of the released martens settled outside villages, where they were unlikely to come into close contact with humans. I was unable to find, in the literature, any information about the proportion of martens within a population that cause problems, so there was nothing with which to compare my own data. One marten was seen stealing an egg, but since it had not settled near a village this was unlikely to have occurred routinely. The marten that did settle in a village might have been responsible for damaging a car. However, she had never been located at the site of the incident so whether or not she was responsible cannot be confirmed.

Conversely, martens were observed preying on animals (rats and potentially a pigeon) that are considered, in an agricultural setting, to be pest species. Thus release of martens might be beneficial to the agricultural community, especially since most of the anthropogenic structures which the released martens occupied (e.g., barns) were related to agriculture. Indeed, I was told by one farmer that he was glad to have a marten living in the barn in which he kept his animal feed (personal communication).

However, martens are long lived, and if the released individuals were to move into a village at a later stage, human-marten conflict could be a problem. It is unlikely that the released martens were habituated to humans, since individuals that were recaptured at the end of the study showed no remaining signs of tameness: they were either fearful or aggressive. In addition, I observed several cases in which martens apparently responded to human interference by moving to a different location from that in which they were settled at the time.

3.4.3 Mortality

Based on previous studies I expected the released martens to survive in the short term, but made no predictions about medium- to long-term survival. The death rate of 0.33 was not high compared to estimates of 68% mortality in a single year's offspring in the wild (Marchesi et al. 2010). The main cause of death was car accidents, as is the case in wild marten populations (Grilo et al. 2009) (see also Chapter 1). None of my martens whose cause of death could be established was starved; on the contrary, all were in good physical condition. Taken together, therefore, the results show that captive-reared stone martens can survive in the medium-term and there are indications that they might survive in the longer term. However, the fact that Waldemar was hit by a car six months after his release suggests that in a long-lived species like the marten, six months might not be enough to give a complete picture. It also suggests that extensive movement in unfamiliar surroundings, which is generally supposed to be particularly dangerous, may not be restricted to the first 6 months following release. Additionally it should be noted that, with a death rate of 0.33, the actual rearing cost was of 214-257 € per surviving animal, rather than 150-180 €.

3.4.4. Comparison between M1 and the captive-reared martens

It was surprising that the wild-caught juvenile marten (M1) did not behave conspicuously differently from the captive-reared martens, especially since one of my main predictions was that the captive experience of the martens would influence their behaviour and welfare. However, like the captive-reared martens, Brutus (M1) was trapped and translocated to a rural, unfamiliar environment and, like the captive-reared martens, he was exposed to the stress of fitting the collar and transportation. Indeed, it is likely that this was even more stressful to him than the other martens, that at that time were still used to humans. Perhaps, then, these similarities in the experiences of M1 and the captive-reared martens overshadowed the differences in rearing environment. However, further work would be needed on a larger sample of wild-caught translocated juveniles to be sure that captive rearing per se has no influence on post-release behaviour.

3.5 Conclusions

Translocation and release are perceived, by the general public, to be a more humane form of wildlife management than is lethal control (Conover 2002, Massei et al. 2010).

However, whether it is justifiable to rear orphaned stone martens in captivity is debateable, especially since they are not an endangered species.

Nevertheless, the present results show that at least in the medium-term (i.e., through their first winter), captive-reared stone martens can survive after release, despite the fact that no supporting measures were taken (i.e., release was 'hard' rather than 'soft': see Chapter 1). Furthermore, all the martens that were recaptured, or were found dead after they had been killed by cars, were in good physical condition. This indicates that martens that do not get hit by cars have a good chance of surviving in the long term. However, further work is necessary, preferably on a larger sample of animals, to provide direct information about long-term survival.

From a management point of view, it is especially interesting that only one of the martens established itself in a village, even though all were released in places where they could easily have done so. This suggests that released individuals do not necessarily, and may not generally, become problematic from the point of view of human residents. However, it also raises the question as to why more of the released animals did not settle in villages, given that these are high-quality habitats for martens. One hypothesis is that sub-adult martens might not be tolerated by adult resident territory-holders to whom they are not genetically related. The next two chapters describe attempts to determine whether or not villages close to one of the release sites were indeed occupied by resident adult martens.

CHAPTER 4: BEHAVIOUR OF A WILD-CAUGHT MARTEN

4.1 INTRODUCTION

In the previous chapter I hypothesised that the captive-reared orphaned stone martens released for this project did not settle in villages because they were not tolerated within these high-quality habitats by the local population of territory-holding adults. To test this hypothesis I wanted to capture and radio-track wild adult martens from the population surrounding one of the release sites. The site chosen was the one used for the final season, during which three females were released near the villages of Reckange-sur-Mess and Roedgen. Unfortunately, however, I was only able to capture one wild female and to track her for a month during the period June-July. In addition, the animal in question was a juvenile female still being cared for by her mother, so she could not provide the kind of information I was seeking about the presence and behaviour of adult territory holders. However, the fact that she was still being cared for by her mother allowed me to make interferences about the effects of the mother's presence. In this chapter, therefore, I present results from this animal and compare them with the results obtained from the captive-reared juveniles.

4.1.1 BEHAVIOUR OF SUB-ADULT MARTENS STILL BEING CARED FOR BY THEIR MOTHER

As mentioned in Chapter 3, martens' upbringing is marked by intensive maternal care. At the time that I started following the wild-caught juvenile female (i.e., mid-June) she was probably about 13 weeks old and would only just have started leaving the nest together with her mother. In the wild this period is marked by strong dependence: young follow their mothers closely, mimicking their behaviour and being guided by them (Skirnisson 1986). Only from mid to late July do young start gaining more independence (Skirnisson 1986, Lucas 1989). During this period they start exploring, on their own, always however staying within the limits of their mother's range (Skirnisson

1986, Herrmann 2004). Dispersal generally starts later: at the earliest from August onwards (Skirnisson 1986, Lucas 1989, Herrmann 2004, Broekhuizen et al. 2010) but often later than this (see Figure 4.1).

4.1.2 Social system

As noted in Chapters 2 & 3, martens show strong intrasexual territoriality (Skirnisson 1986, Herrmann 2004, Broekhuizen et al. 2010). However, sub-adult, non-reproductive martens seem to be tolerated within adult territories (Lucas 1989, Müskens et al. 1989, Herrmann 2004, Broekhuizen et al. 2010) and this may be why translocation is more successful with young than with adult martens (Skirnisson 1986, Herr et al. 2008). This led me to expect that captive-reared orphaned martens would be tolerated by territory-holding members of the local marten population. Contrary to this expectation, however, the results presented in Chapter 3 suggest that the released martens may have been excluded from villages by resident territory holders.

In his study on pine martens, Balharry (1993) hypothesized that relatedness could influence acceptance by territory holders, though he had no data to support this idea. If the hypothesis is correct, adult males and females might only tolerate their own sub-adult offspring within their territories. This would mean that adult males would indirectly contribute to raising the young by accepting sub-adult offspring in their range, thus effectively sharing their resources with them.

If Balharry's hypothesis holds true for stone martens, this could explain why my released martens did not settle in villages, despite the fact that these constitute high-quality habitats. That is, if the villages were already occupied by a local population of wild martens these were certainly not closely genetically related to the released animals; and this may be why they excluded the released animals from their ranges.

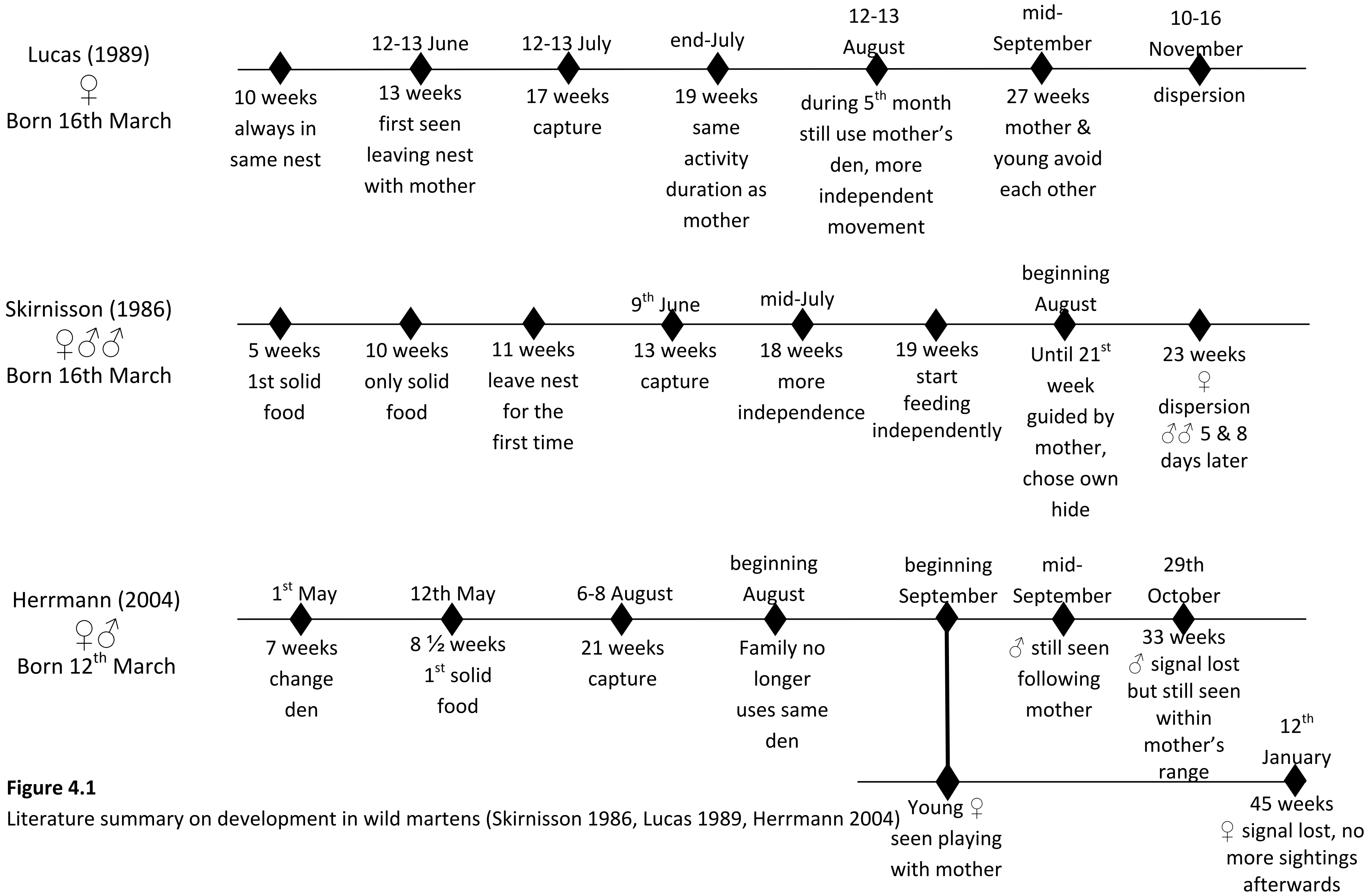


Figure 4.1
Literature summary on development in wild martens (Skirnisson 1986, Lucas 1989, Herrmann 2004)

4.1.3 AIMS

The original aim was to capture adult wild martens from the local population and to determine to what extent their distribution influenced the dispersal behaviour of the released orphans. In addition, their recorded movement patterns could be compared with those of the released orphans. In the event, however, as already noted, only a single juvenile wild female was caught, so the original aim could not be achieved. Nevertheless, I decided to follow the wild juvenile to determine its home range and compare its behaviour to that of the captive-reared orphaned martens'.

4.2 METHOD

Foldable wire cage traps, with wooden covers were used (see Chapter 2, Figure 2.6). Six traps were placed in the area in which orphaned martens were released, in autumn 2011. The traps were placed in the area in a semi-randomized manner, taking marten behaviour into account and in order to avoid vandalism (see Chapter 2 for detailed description). Two traps were placed in private gardens, with the owners' consent (for exact positions of traps see Chapter 2, Figure 2.7). The cage traps were put into place towards the end of February 2012.

After three months of pre-baiting no animal had been caught, although in one trap baits were taken regularly without triggering the trap. Therefore, two camera traps were put in place to see which animals were approaching the traps and taking the baits (see Figure 2.7) (see Chapter 2 for detailed description). The camera traps were deployed for 42 nights. Since the camera traps revealed that a marten was visiting one of the traps (the one from which bait had been taken), this trap continued to be baited and set. Eventually, In June 2012, a juvenile female was caught in this trap.

To allow for comparison the same protocol was used for trapping and radio-tracking as was used for the released orphaned martens and the same methods were used to summarize the data (see Chapter 2). However, due to the low catch rate compared to other studies (Ruette et al. 2003, Herr 2008) and thus the small amount of data no statistical tests could be used.

4.3 Results

The camera traps recorded a number of different bird and mammal species. Carnivores that were recorded included a few cats (*Felis silvestris*), a fox (*Vulpes vulpes*) vixen with her cub, a common weasel (*Mustela nivalis*) and an adult and juvenile stone marten. The adult marten was sighted on two occasions, and on one of these occasions it was accompanied by the juvenile marten.

One marten, a young female, was live-trapped on June 25th 2012. She was estimated to be 13 weeks old, in which case she would still have been dependent on her mother. The mother was not observed, but tracks and scratch marks were found on and around the cat carrier in which the young female was held, while recovering from the anaesthetics until her release the same evening; and it seems likely that these resulted from the mother attempting to rescue her offspring. If the young female was indeed still dependent on her mother, it is likely that the two martens that were camera-trapped (see above) were this young animal and her mother.

The live-trapped marten was measured and fitted with a radio collar (see Chapter 2 for protocol). A total of 145 fixes were collected during 10 nights, over a period of one month, before the signal was lost.

4.3.1 Movements and den use

After her release the young female Belle (F6) stayed for 1.5 h near the cat carrier from which she was released; then, most likely accompanied by her mother, she went straight to a barn within the village of Reckange-sur-Mess, in which she stayed for the rest of the night. This was one of three dens that she used regularly for the rest of the observation period. Her movements appeared goal-oriented, in that she moved directly from one place to another and did not show any random movements. It was therefore clear that she was familiar with her surroundings. Her signal could no longer be detected after July 25th.

4.3.2 Space use

During the observation period Belle (F6) was living in a village, presumably within the home range of her mother. The mean distance she travelled per night was 761.6 (SD 471.6) m, while the mean travel speed was 166.9 (SD 96.6) m/h. Her speed differed little between the first 6 nights after her release [86.2 (SD 47.5) m] and the rest of the observation period [79.3 (SD 49) m]. Her home range was 56.4 ha (K90%) while her home range core was 20.9 ha (K50%) (see Figure 4.2). Her range shifted very little (300 m) between the first six days after release and the remainder of the observation period. Her cumulative home range size reached an asymptote after less than two weeks (see Figure 4.3).

4.4 Discussion

My own observations and the records of juvenile martens the same age suggest that Belle was still living within her mother's home range. It follows that the martens recorded by the camera traps were most likely Belle and her mother. Belle was followed for a month before the signal was lost, most likely owing to battery failure since the collar was an old one left over from another project.

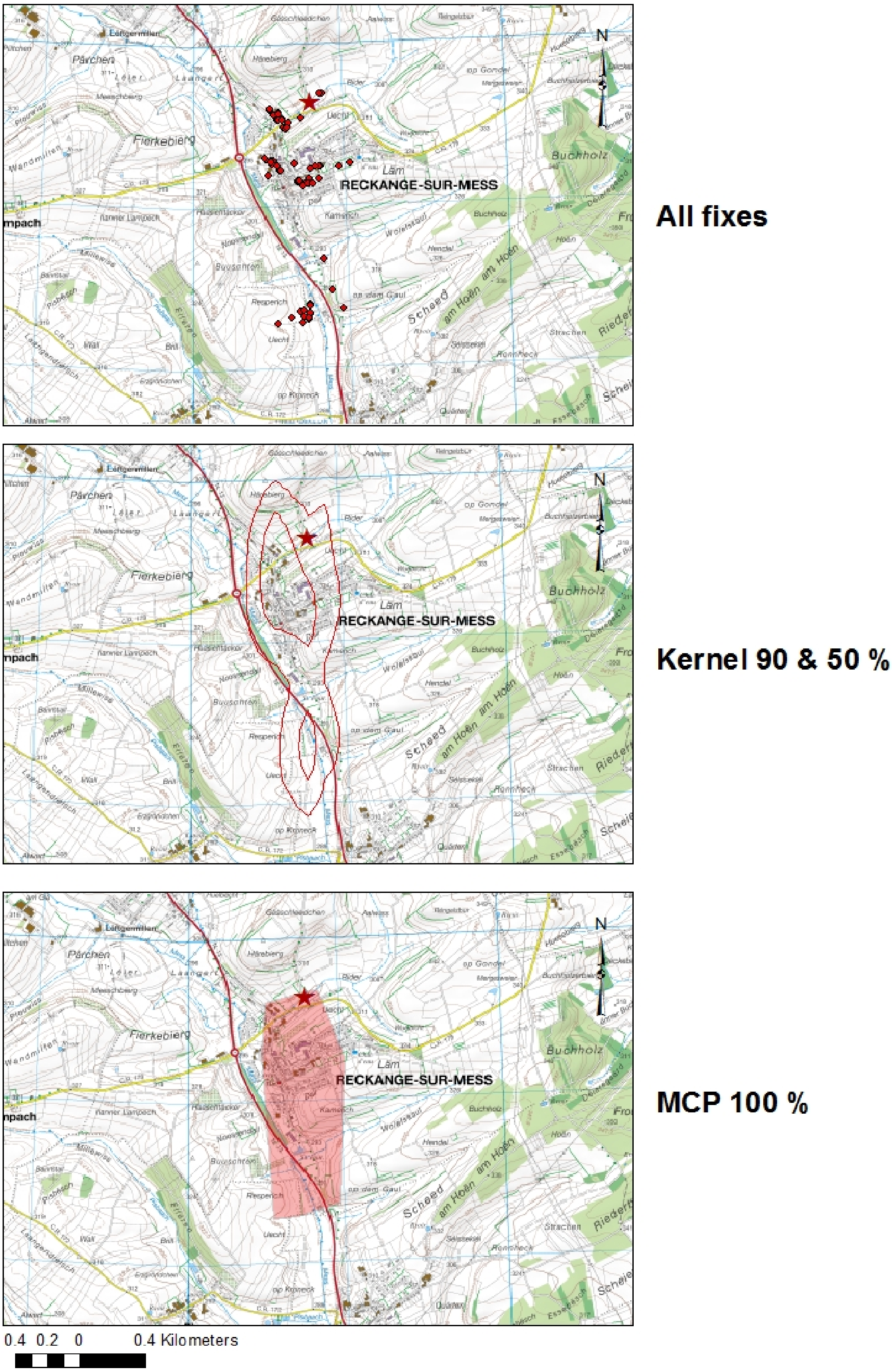


Figure 4.2

Home range of Belle (F6) represented by different methods. The red star represents F6's release site. Top: map with all of F6's fixes used for statistical analysis, collected during nightly follows. Middle: map with isopleths (lines drawn around regions with equal kernel densities). The outer line represents an isopleth with a Kernel density of 90% and the inner lines ones of 50%. Bottom: map with Multi Convex Polygon using 100% of F6's data. Home range sizes: Kernel 50% = 20.9 ha, Kernel 90% = 56.4 ha; MCP 100% = 61 ha.

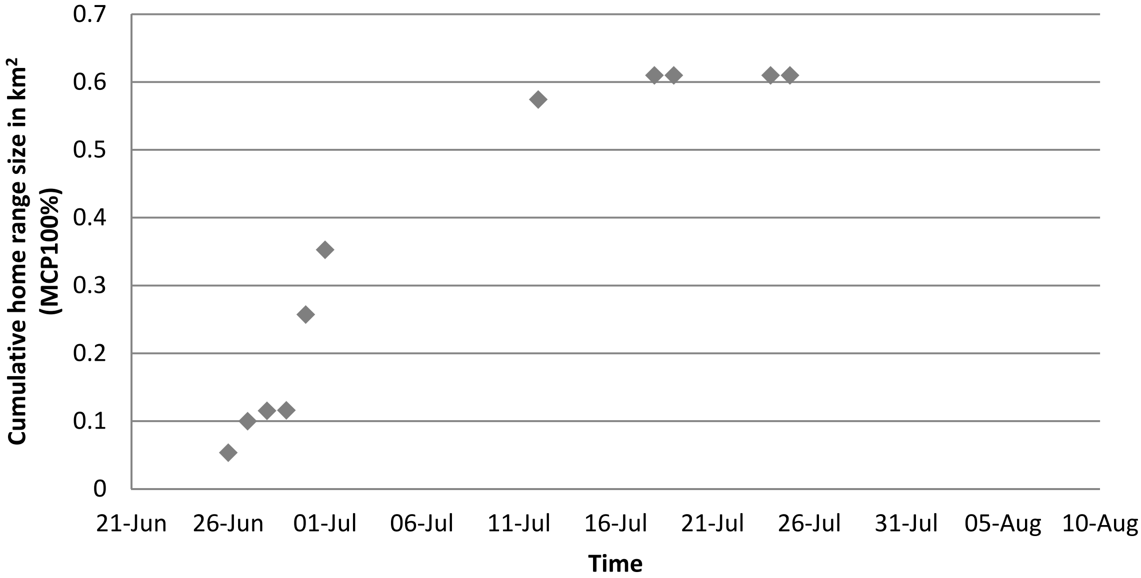


Figure 4.3
Cumulative individual home range size (MCP 100%)of Belle (F6) in km^2 against time.

4.4.1 COMPARISON WITH DATA FROM THE ORPHANED MARTENS

At the time of release Belle was about six weeks younger than the released martens and appeared to be still accompanied by her mother (see above). From the beginning she had about three dens that she used regularly over the entire observation period. It is therefore not surprising that from the beginning of the observation period her movements appeared less random and more goal-oriented then those of the captive-reared martens. Unlike the captive-reared martens, which showed more goal directed behaviour only after they had settled in one area, she gave every impression of being familiar with her surroundings from the very beginning of the period in which she was followed.

The habitat Belle used was also very different from that used by all but one of the captive-reared martens, in that more than half of her range lay within the village of Reckange-sur-Mess and most of the time she used human-built structures for denning (see Figure 4.2).

That Belle's cumulative home ranged levelled off after less than two weeks (see Figure 4.3), compared to the two months it took for the released orphaned martens, is probably also due to the fact that Belle already had a home range, namely, within that of her mother. Since at the time she was followed (June 25th-July 25th) she had not yet started to disperse and was most likely still being guided by her mother, she did not have to independently explore her surrounds before she settled down.

The same considerations probably explain why Belle's final cumulative home range size (MCP100%) was smaller than those of most of the released martens (see Figure 4.4).

Her final home range (K90%) and home range core (K50%) were within the range of those of the captive-reared martens, but clearly at the lower end (see Table 3.2). There are two possible reasons for these differences, which are not necessarily mutually exclusive. First, the differences could reflect the fact that Belle might only have occupied part of her mother's territory, since she was still so young. Secondly, the differences could have been due to the fact that she occupied a range within a village.

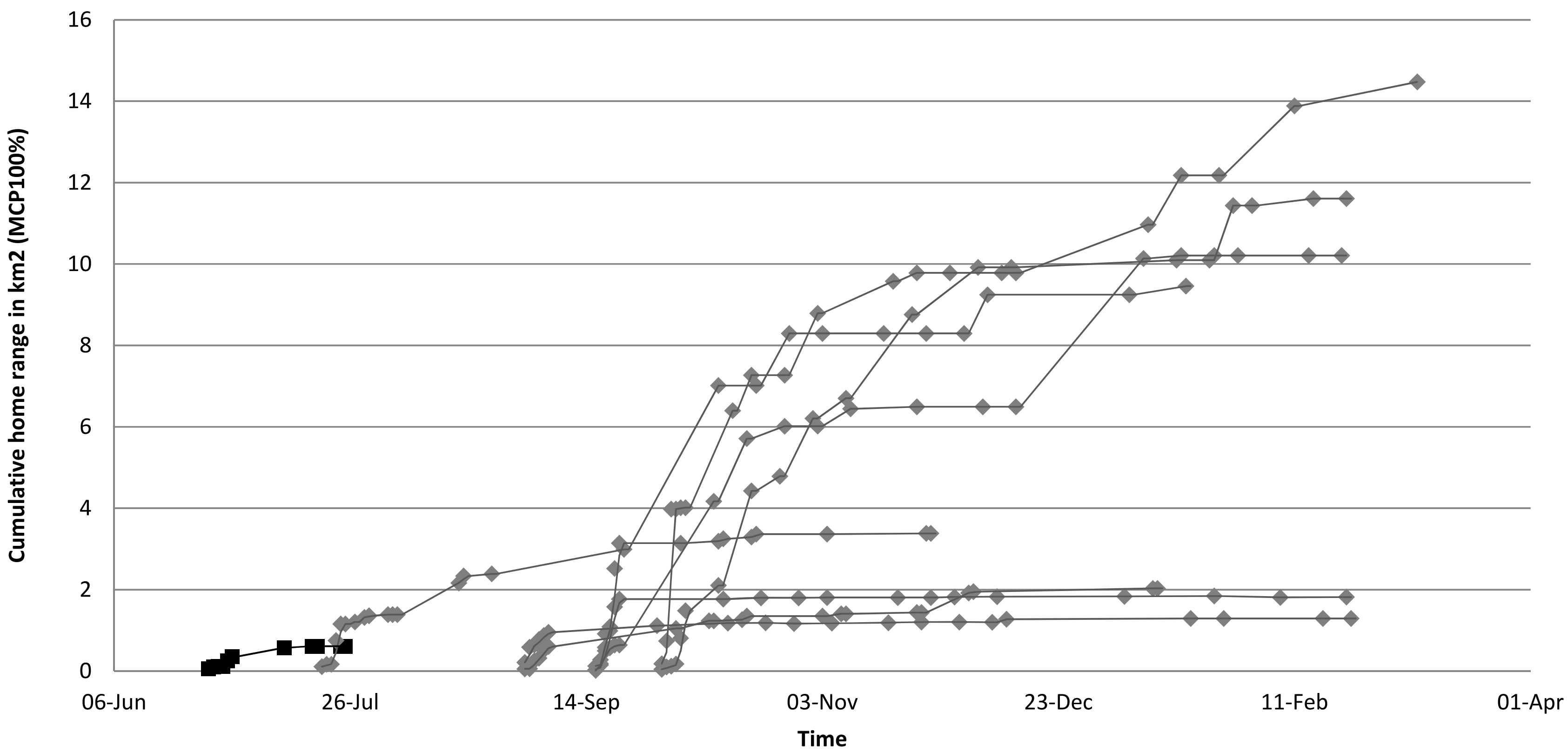


Figure 4.4

Cumulative individual home range sizes (MCP 100%) in km^2 against time. Belle's (F6's) data are shown in black; the data of individual captive-reared orphaned martens are shown in grey.

The latter hypothesis is supported by the fact that one of the only two captive-reared martens that had smaller ranges than Belle was Lamnda (F4), who also settled in a village.

As regards mean travel speed, Belle's speed was lower than those of the captive-reared martens. This could possibly reflect Belle's small home range size, but orphaned martens with similar range sizes moved faster than her. Another possibility is that her slow movement reflects her age. However, as for all Belle's results, more data are necessary before any firm conclusions can be drawn.

4.4.2 What impact might the presence of resident martens have on the released martens?

The presence of a wild sub-adult female (Belle) is unlikely to have impacted directly on the behaviour of the released orphans. However, Belle was almost certainly still living within the range of her mother; and the presence of the mother (i.e., an adult reproductive female) is likely to have influenced the dispersal behaviour of the young captive-reared females released in this area. In addition, given that martens exhibit a system of solitary intrasexual territoriality (see Chapter 1), it is likely that there was also a resident male, whose range overlapped at least partly with those of Belle and her mother.

Belle's range, and thus at least part of her mother's range and potentially part of the range of an adult male, covered most of the village. This could at least partly explain why the released martens did not move into the part of the village that was part of this female's territory, even though this was high-quality habitat due to higher availability of resources such as food and shelter (Herrmann 2004). Additionally, the released martens were habituated to humans. Given that sub-adult martens are found within the territories of adults (Lucas 1989, Müskens et al. 1989, Herrmann 2004, Broekhuizen et al. 2010), and that the young orphans released for this project cannot have been genetically related to the local wild martens, my results are consistent with the idea that martens tolerate their own sub-adult offspring, but not unrelated sub-adults, within their territories.

To confirm this idea, however, a more complete picture is needed of the marten population within the village. Additionally, better evidence is needed that there were no martens present outside the villages, where the captive-reared sub-adults did successfully settle. As regards the latter, a project on pine martens (*Martes martes*) was conducted in an area surrounding the release sites used in the first and second years of my project, prior to the start of my project. This pine marten project involved extensive trapping. In two years a total of nine pine martens and only one stone marten were trapped (personal communication, Armin Liese) despite the fact that the traps used were appropriate, and the baits attractive, to both species. It is possible that pine martens enter traps more easily than stone martens but a study by Ruette et al (2003) suggests otherwise. Thus insofar as evidence is available, it suggests that the low success rate of trapping stone martens outside the village of Reckange-sur-Mess was indeed due to the low population density of stone martens outside villages in this part of Luxembourg.

4.5 Conclusions

The post-release behaviour of a wild juvenile female (Belle) caught within the village of Reckange-sur-Mess differed in various ways from that of the captive-reared released orphans: her movements were more goal-directed, she moved less and her range was smaller. At least some of these differences were probably due to the fact that she was moving around in familiar surroundings, still guided by her mother. However, other factors, such as her younger age and the fact that her range was in a village rather than in rural habitat, cannot be discounted.

The presence of a reproductive adult female (and possibly also a reproductive male) within the village of Reckange-sur-Mess may in part explain why the released sub-adult martens did not move into the village. However, further evidence of the presence of resident wild martens in the surrounding village is necessary to substantiate this hypothesis.

CHAPTER 5: MARTEN SURVEY 2012

5.1 INTRODUCTION

To verify the theory that released martens might not move from the release area into surrounding villages due to presence of conspecifics, I tried capturing wild martens in the study area. However this proved to be far more difficult than expected. Only one juvenile marten was captured (see Chapter 4) and martens were only seen on three occasions. I therefore tried a different method of finding out whether martens were present in the study area, namely, conducting a survey in the villages (Reckange-sur-Mess and Roedgen) surrounding the second release site. For this survey people were asked whether they were aware of martens on their property or in their village.

Although the main aim of the study was to find out whether martens were present in the study area, I decided to use this opportunity also to ask people for their opinions about, and their experience of, stone martens and conservation in general. One reason for doing this was that acceptance by the general public is crucial for the success of any release project (Moore and Smith 1991, IUCN 1998, Fischer and Lindenmayer 2000). In the present case, the two main reasons were, firstly, that if martens are very unpopular, people could try to get rid of them in and around their homes. Secondly, and perhaps more importantly, the rescue centre that raises and releases the orphaned martens relies in part on donations. Consequently, they would risk losing funds if what they were doing was unpopular with the general public. As noted in Chapter 1, martens do cause a number of problems, and it seems reasonable to assume that this makes them unpopular with the general public.

I decided also to seek people's opinions about conservation in general because their opinions about martens could be affected by their attitude towards environmental issues. That is, someone who cares about the environment and its protection could be more likely to feel positive towards an animal regardless of its status as a pest species. A past study on people's opinions about the environment and its protection, mandated by the Directorate-General for the Environment of the European Commission, found that in Luxembourg 96% of people said that protecting the environment was important to them personally, only 3% stated that they did not think it was important and 1 % did not know. The same study also found that there was a change in behaviour compared to a similar study that the same authority conducted four years earlier, namely, an increase in activities that reduce the consumption of resources, such as recycling, saving energy and water, etc (Anonymous 2011).

5.1.1 Aims and Predictions

The main aim of the survey was to find out whether and where there were martens present in the villages around the final release site. It was expected to get at least some confirmation of marten presence since the captured wild marten's home range covered parts of one of the villages (see above Chapter 4) and I had previously seen a marten on three occasions in Reckange-sur-Mess.

A secondary aim was to find out about people's opinions about martens and what influenced these opinions. People's past experience with martens was expected to influence their perception of martens and, in particular, I expected people that had had negative experiences with martens to be more likely to dislike them. If damage was associated with high financial cost I expected people to perceive martens even more negatively. Similarly, people's opinions might be influenced by the nature of what was damaged and by how recently they had experienced this damage. Finally, a positive correlation was expected between the perceived importance of conservation and the acceptance of martens regardless of their status as a pest species.

An alternative hypothesis is that people could simply dislike martens regardless of their own experience, possibly due to the amount of bad press martens get. In this case, there should be an overall dislike of the marten regardless of an individual's past experience or of their attitude towards the environment.

5.2 Method

5.2.1 Data collection

The survey was conducted in Roedgen and Reckange-sur-Mess, the two villages closest to the final release site. For the survey, I conducted face-to-face interviews by contacting people in their homes. I desisted from self-completion questionnaires because of the small population size. Even though self-completion questionnaires are much more convenient, they have extremely low response rates (Bryman 2012) and I would have risked missing valuable data.

5.2.1.1 Questionnaire

A questionnaire survey can involve two types of question. ‘Open’ questions allow people to answer them in their own words, whereas ‘closed’ questions come with a number of set answers from which a respondent can choose. Open questions have the advantage that because respondents can answer in their own words, they might come up with arguments that the researcher had not thought of before. However, open questions are time-consuming to record and analyse (Bryman 2012). Since the research questions that I was addressing were simple and straightforward, closed questions were the better choice. They are less time consuming, and easier to administer, encode, analyse and compare. They also reduce variability, and the questions and answers have a clear meaning (Bryman 2012).

In a survey, questions involving opinions and attitudes should precede questions on behaviour and knowledge, as the latter are less affected by question order. However, opinions should not be sought at the very beginning of a questionnaire (Bryman 2012). Therefore, I first covered marten presence, as this involved simple straightforward questions, clearly related to the topic. This made them a good introduction, which then led on to questions involving people’s opinions about martens and conservation.

Only then did I ask about damage caused by martens, because I wanted to avoid influencing responses to the opinion questions.

To find out about the presence of martens on the interviewee’s property I asked a number of simple questions. I asked interviewees whether they had seen martens, heard them or found traces of them in various locations, namely, in their house, in their garden, in or around the village or somewhere else. If interviewees were unsure, I presented them with pictures of martens and typical marten signs (i.e., faeces, tracks, etc.). If an interviewee had noticed martens in or around the village, I asked them to point out the position of this sighting on a map.

I checked for reliability by asking for the time of day at which the interviewee had seen or heard martens and when they had last noticed a marten. For example, if someone claimed that they had seen or heard a marten at midday I could be pretty confident that this was not a genuine sighting. Generally, however, people would express uncertainty about any observations they had made and usually it was possible to conclude from their description whether or not the observation was of a marten. In case of doubt the observation was not included in the subsequent analysis.

I used semantic differential type questions to ask people for their general opinions and feelings about stone martens. Interviewees were asked to respond to concepts using a scale ranging between bipolar adjective pairs (e.g., as was used in question 6: negative vs. positive). This type of question is mainly used to get affective responses, focusing on the evaluative dimension (Punch 2005). I used a five-point scale in order to allow for a neutral option and to obtain a more refined scaling towards either end of the scale.

To find out how important environmental protection was to interviewees (question 7), I used the same question as was used for the Eurobarometer 365: ‘How important is protecting the environment to you personally? Very important, fairly important, not very important, not at all important, neutral or I don’t know’ (Anonymous 2011). The use of an already existing measuring instrument (in this case, interview question) has the advantage that more is known about its properties and it facilitates comparisons with other research results (Punch 2005, Bryman 2012).

For people to evaluate their own behaviour I asked the following question: ‘In your opinion, are you currently doing very much, fairly much, fairly little, very little to protect the environment?’ This was based on a similar question in the Eurobarometer 365. This question was likely to give a more varied response compared to the previous one, since previous studies show that virtually everyone (96% of people in Luxembourg) considers conservation to be important (Anonymous 2011).

I then asked whether interviewees had experienced damage to their property by martens. If they had, I asked when this had occurred and how much it had cost. Detailed demographic questions (income, education etc) were not included as the planned sample size was too small for this type of information to be valid.

The questionnaire was piloted on eight people. Subjects for the pilot study were not taken from the sample population, so as to avoid interfering with the final test sample. However, they were chosen to reflect the test population as much as possible (Bryman 2012). After administering the questionnaire, pilot subjects were asked for critical feedback as regards the comprehensibility, duration and validity of the questions. As a result of this, minor changes were made to the wording of the questions. (See Appendix 1 for questionnaires.)

5.2.1.2 Interview Protocol

At the start of the interview I would present myself and my project. I would then ask whether the interviewee would participate and if they agreed I would immediately start with the first question. For questions with ‘neutral’ and ‘I don’t know’ options, these options were not read out loud and were only noted down if people gave one of these answers spontaneously. At the end of the questionnaire people were thanked for their cooperation.

5.2.1.3 Sampling method

The survey was conducted in Reckange-sur-Mess and Roedgen, adjacent to the second release site. These villages both belong to the commune of Reckange, which had a population of 2138 in 2011 (Source: STATEC, Institut national de la statistique et des études économiques du Grand-Duché du Luxembourg). Age and sex distribution were similar to those of Luxembourg overall (Figure 5.1). However, the small scale of the project means that the results may not be typical of the country as a whole.

Absolute rather than relative sample size is important (Bryman 2012), so I tried to get as many people as possible to answer the questionnaire. I conducted a variation on random walk sampling, whereby I rang at every door and if there was no response I would come back three days later. If there was no response after the second try, I considered the address to be uncontactable.

However, I did not use a purely random sampling method because, in such a small population, this would have led to a sample strongly biased towards elderly people and housewives (who were more likely to be at home regardless of time of day). Rather, I used a semi-random quota system in which random walk sampling was combined with quotas. To achieve this the population was divided up into two gender categories (male and female) and three age categories (young adults, aged 15-29; adults, aged 30-54; and elderly people, aged 55+). The aim was then to obtain a sample of interviewees that reflected the population in terms of the relative proportions of these categories.

Quota sampling systems involve a methodological weakness in that the final selection is likely to depend on the availability or approachability of the interviewees (Bryman 2012). Therefore, to deal with the problem of availability I conducted door-to-door interviews every day between 18:00 and 20:00. This was intended to maximise the likelihood of reaching all age and sex classes, since at this time of day most people should be at home regardless of their occupation.

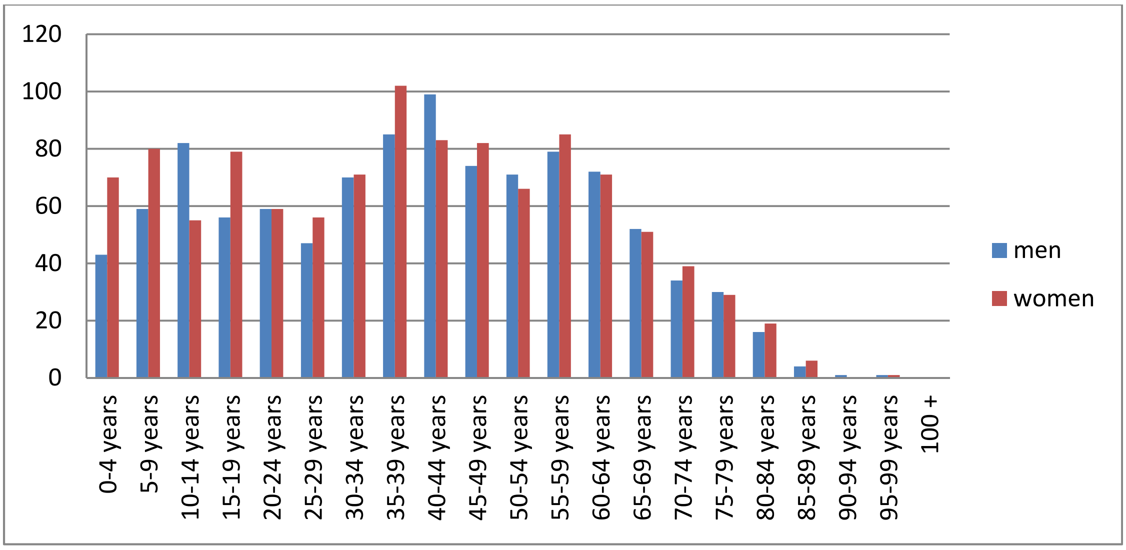


Figure 5.1
Number of men and women living in the commune of Reckange-sur-Mess, to which the target villages belonged, in 2011 Source: STATEC (Anonymous 2010b).

Another problem with quota sampling is that the interviewer might not interview a potential interviewee, because he/she misjudges whether the person in question fits the quota (Bryman 2012). To avoid this, the quotas were kept as simple as possible, that is, gender and only three age groups (see above). This also had the advantage that the number of strata stayed low, which was important for later analyses in view of the small sample size. Additionally, I would always ask the person who answered the door which age group they fell into (gender being obvious). If they did not fit the quota, I would ask whether someone else in their household would fit the category I still needed and if I could come back at a later time to see this person. If this was not possible I would interview the person anyway, as the main objective of this study was to detect marten presence and the questions relevant to this aspect of the survey were assumed to be age independent (in contrast to the questions seeking interviewees' opinions).

Despite the use of a quota system, the sample was still in practice biased towards elderly people. Therefore the data had to be weighted, as described below.

5.2.2 Data analyses

Response rate was calculated using the following equation:

EQUATION 5.1

$$response\ rate = \frac{number\ of\ usable\ questionnaires}{total\ sample - unsuitable\ or\ uncontactable\ members\ of\ the\ sample} \times 100$$

5.2.2.1 Presence of martens

For analysis of the marten presence data only questionnaires that were considered to be reliable (see above) were taken into account. Data were divided up into eleven spatial units for Reckange-sur-Mess and for Roedgen. When the units were being defined people's property boundaries had to be taken into account (as they were asked for marten presence on their property), a minimum of three questionnaires had to be available for each unit and the units had to be roughly the same size. None of the units exceeded 44 ha, which was considered a fine enough scale. A marten was considered to be present if at least one person had seen a marten on their property within a unit.

5.2.2.2 Interviewees' Opinions

For the opinion poll all the questionnaires were used. First of all, I looked at people's opinions about martens. I then looked at how important protecting the environment was to people and how much they considered that they did to protect it. The results regarding the importance of protecting the environment were compared to the results found in the Eurobarometer 365 survey (Anonymous 2011). Finally I looked at whether people's opinions about martens were influenced by age or by their personal experience with martens (i.e., whether they had experienced damage caused by martens in the past, when this happened and what type of damage it was). These data were summarised in contingency tables (see Appendix 2). I used tests of association, chi square tests and correlations depending on the available data to assess significance (Zar 1999, Bryman 2012, Sokal and Rohlf 2012).

5.2.2.3 WEIGHTING

The main aim of this study was to look at marten presence in the survey area, while people's opinions about martens or the environment were of secondary importance. I therefore interviewed people even if they did not match the age or sex category I needed, in order to get an as complete as possible picture of marten presence within the villages. For the opinion questions, therefore, the data had to be weighted.

This was done using the following formula:

EQUATION 5.2

$$\pi_k = \%\ of\ stratum\ in\ population / \%\ of\ stratum\ in\ the\ sample$$

Or:

$$\pi_k = \frac{N_k/N}{n_k/n},$$

With:

π_k = weight for stratum k

N = population

n = sample

N_k = number of individuals belonging to stratum k within the population

n_k = number of individuals belonging to stratum k within the sample

The resulting values were purely proportional weights with no scaling effect (Maletta 2007). To weight the results for one stratum (e.g., females aged 15-29) the results were multiplied by the respective value ($\pi_{♀15\text{-}29}$).

5.2.3 Ethical issues

For the survey, neither the natural history museum nor the Ministry of environment have guidelines as to the ethical issues involved in carrying out opinion polls. The study conformed to the code and guidelines of ESOMAR (The European Society for Opinion and Market Research)(ESOMAR 2007).

5.3 Results

I attempted to contact 334 households and achieved a response rate of 95% (see equation 5.1). Thus of all the households I managed to contact 95% were willing to participate in the study, resulting in 197 usable questionnaires.

5.3.1 Marten Presence

Surveying the local population proved to be an effective method to detect marten presence, especially given the high response rate. Martens were reported by interviewees virtually all over the surveyed area, although people were more likely to see martens in or around their homes than elsewhere. This was most likely due to spatio-temporal overlap: that is, people were generally in or around their home during the martens' activity period. A few people told me that they had seen dead martens along the roadside, but people's reports on marten presence in other parts of the survey area were so rare and imprecise that I eventually stopped recording them.

The results show that within the last year, martens were sighted almost everywhere in both villages (Figures 5.2 and 5.3). There was only one exception, in one street in Reckange-sur-Mess, where people stated that they had never seen a marten although they had regularly seen foxes in their gardens and on the street (see g in Figure 5.2). Subsequently a man living on the corner of the same street told me that before the

Figures 5.2 & 5.3: Marten presence results from the door to door survey. The maps show people's most recent marten detections over eight consecutive time spans. The data is divided up into eleven spatial units (a-k) for Reckange-sur-Mess (Figure 5.2) and five (l-p) for Roedgen (Figure 5.3). Spatial units in which martens were sighted during the relevant time interval are shaded blue. For each of these spatial units, the bar graphs represent the number of people interviewed and their most recent detection of a marten on their property. The 4 first maps cover most of September 2012; '2-3 months ago' covers summer 2012, during this time F6 was followed; '3-6 months ago' covers spring 2012; '6 months to a year ago' cover autumn and winter 2011, during which period F3, F4 and F5 were followed; 'more than a year ago' does not coincide with any of my direct observations in this area. Only because some spatial unites do not come up in older observations this does not mean that there were no martens there just that there had been more recent observations. Within the last year there were marten observations in the whole of both villages except for unit g (shaded in dark blue) in Reckange-sur-Mess. However, in this area regular fox sightings were reported.

Figure 5.2

Marten presence data per street over time, as witnessed by the inhabitants of Reckange-sur-Mess

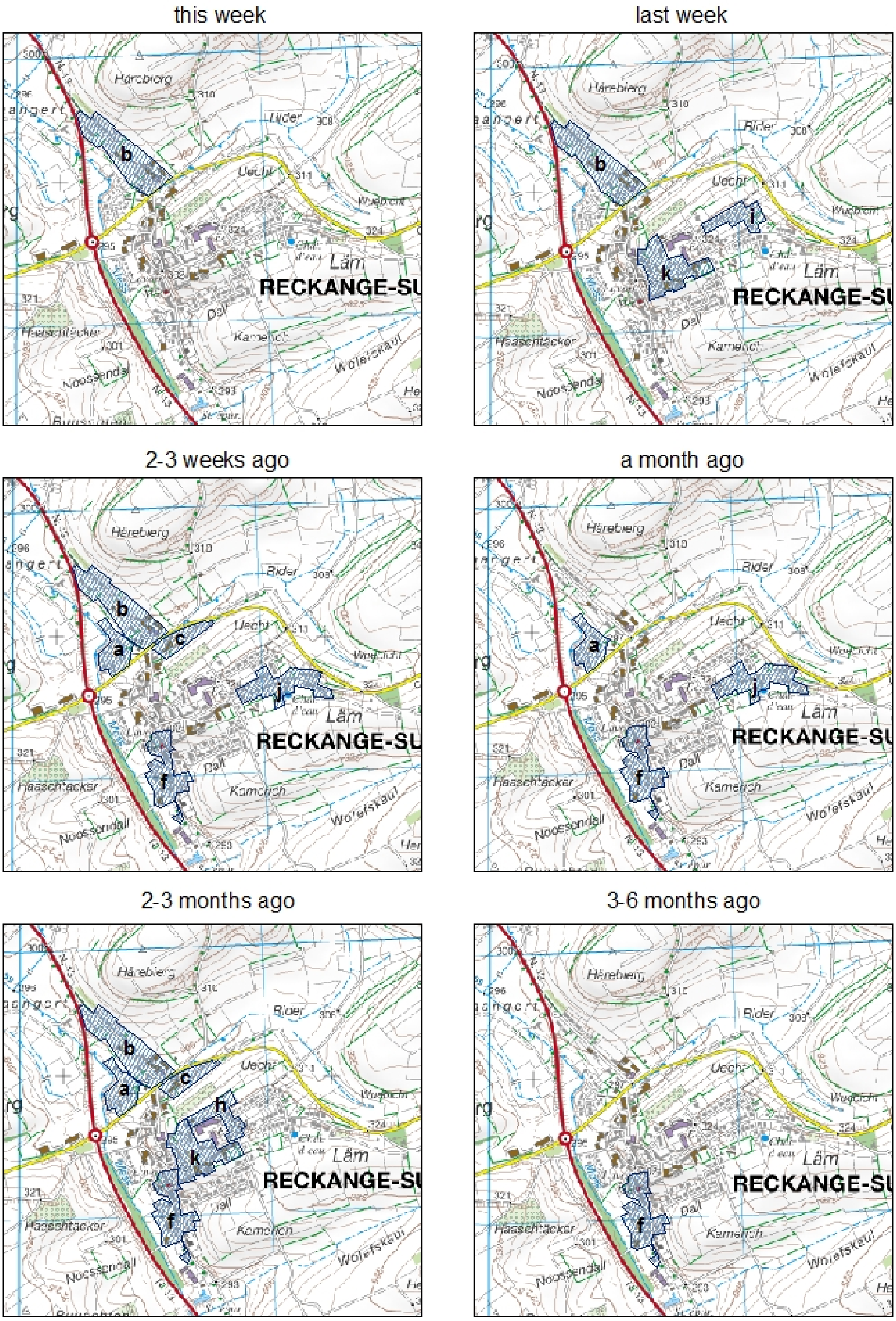
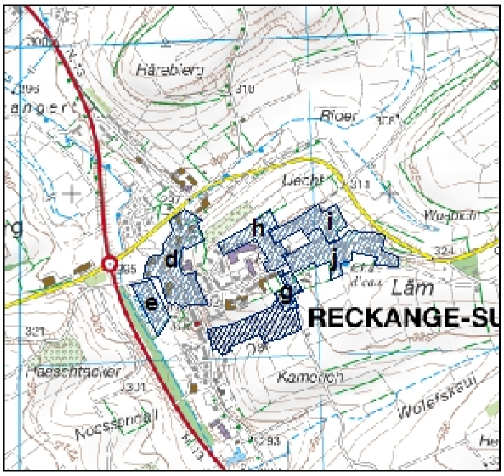


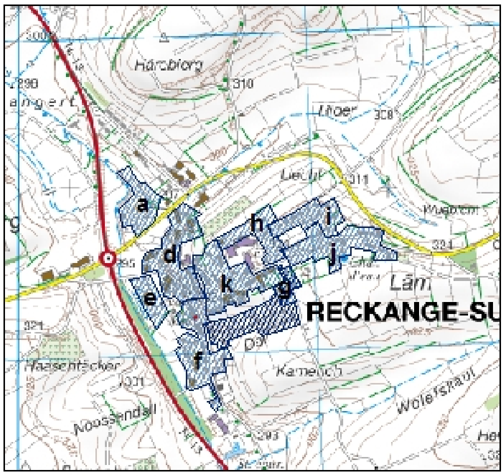
Figure 5.2 (cont)

Marten presence data per street over time, as witnessed by the inhabitants of Reckange-sur-Mess (continued)

6 months to a year ago



more than a year ago



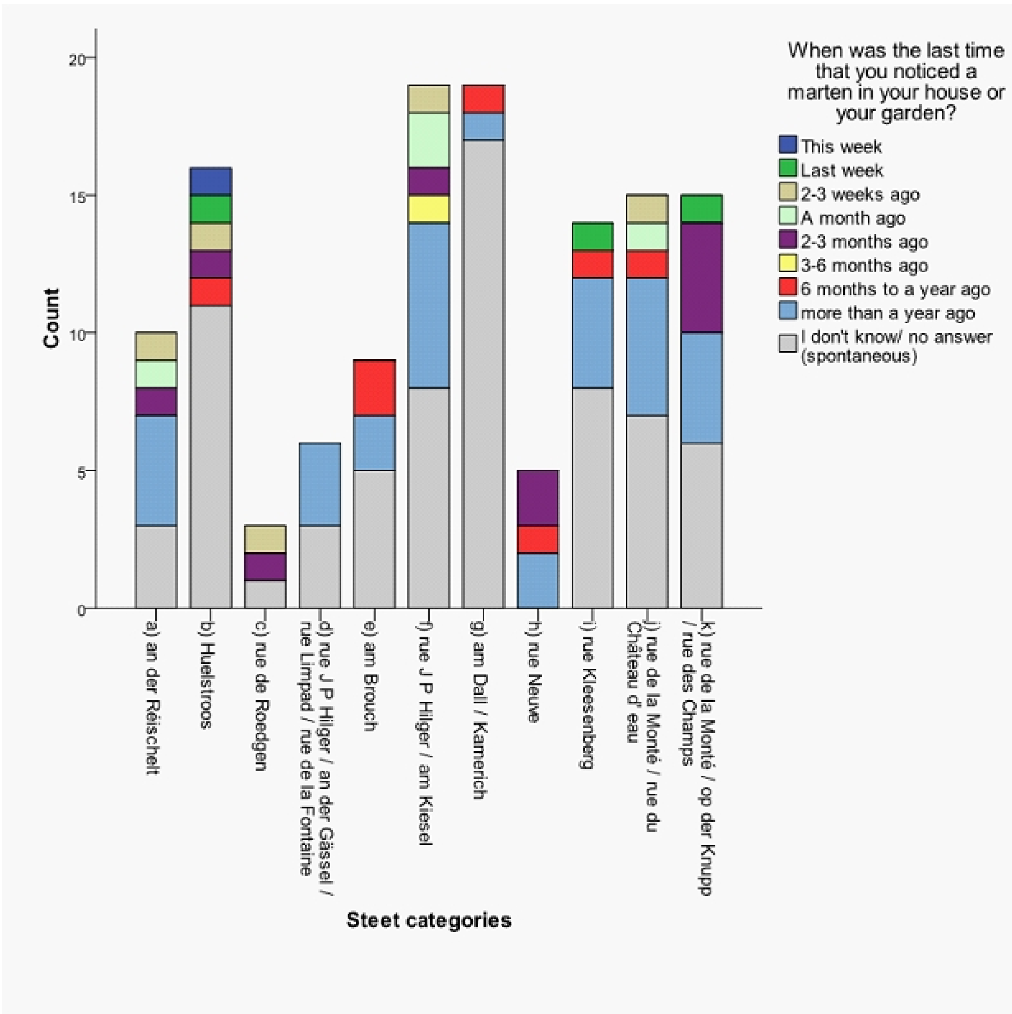


Figure 5.3

Marten presence data per street over time, as witnessed by the inhabitants of Roedgen

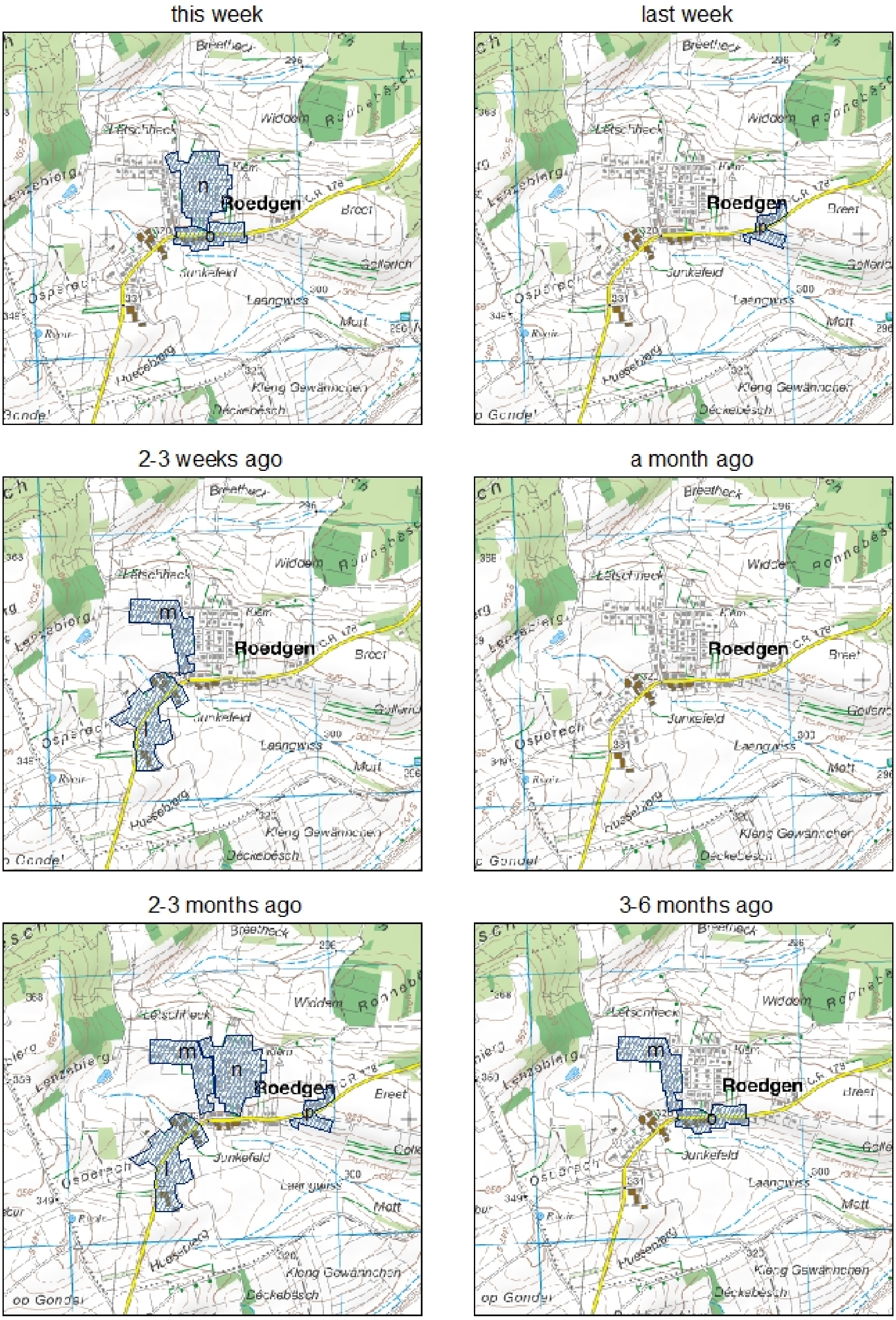
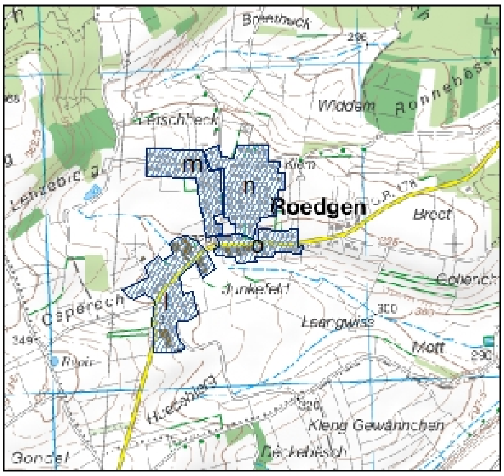


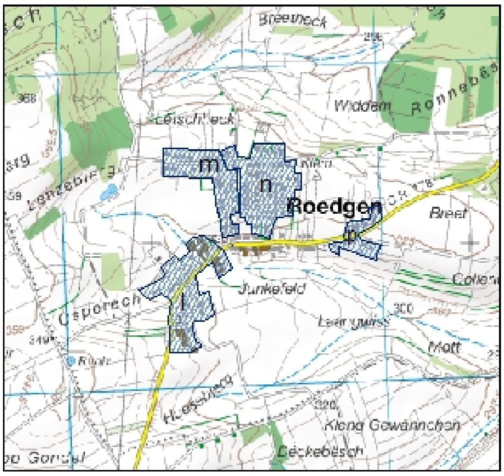
Figure 5.3 (cont)

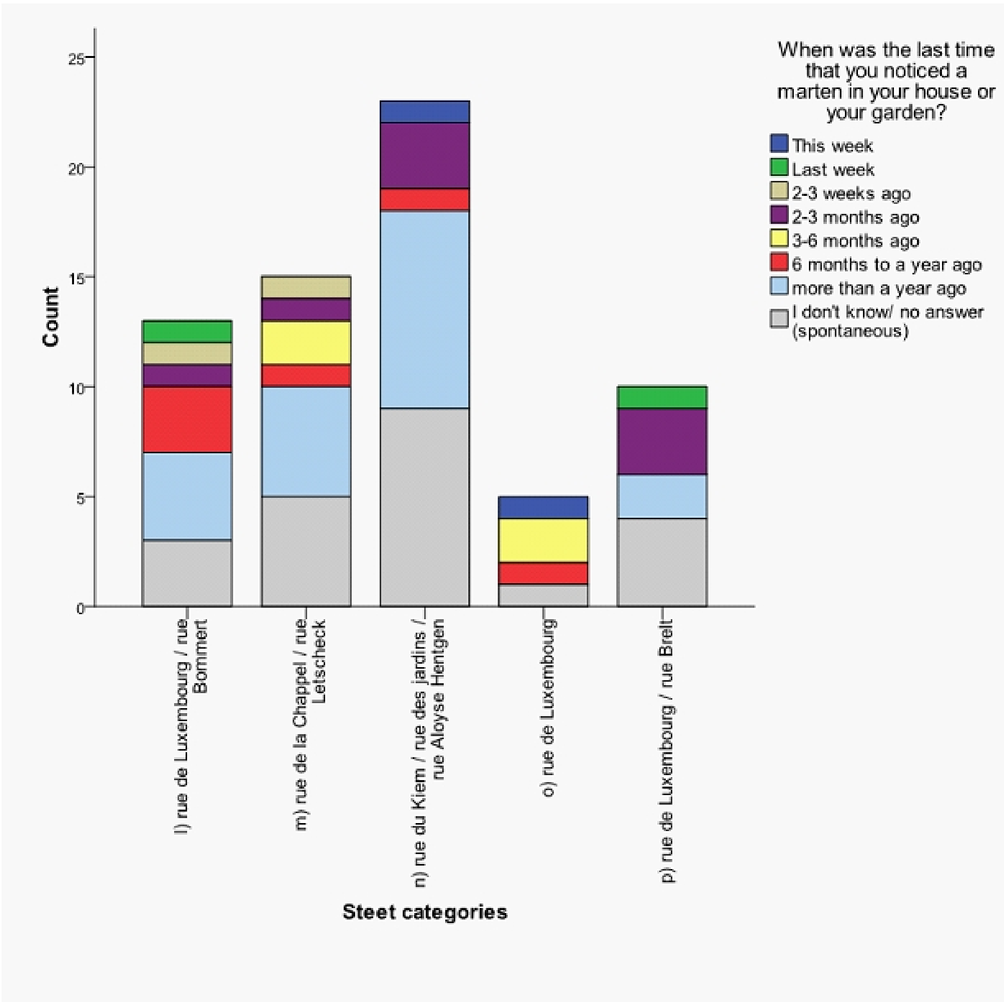
Marten presence data per street over time, as witnessed by the inhabitants of Roedgen (continued)

6 months to a year ago



more than a year ago





area had been developed he had seen martens, but that they had not returned after the houses had been built.

Figure 5.4 summarises the situation during the third season around the last release site. Even though small parts of the released martens' ranges overlapped with areas that the survey showed to be occupied, the cores of their ranges did not, nor did the released martens settle in these areas.

5.3.2 Opinions about martens

41.63 % of people considered martens to be fairly positive and 17.39% considered them to be very positive, making 58.02 % positive responses overall. On a number of occasions people spontaneously said that they enjoyed seeing wildlife around their village. 21.24 % of people considered martens as negative but only 3.96 % as very negative, making 25.2 % negative responses overall. The remaining 15.78% took a neutral stand. Thus the attitude of a majority of people towards martens was positive (see Figure 5.5).

5.3.2.1 Influence of age on opinion

No correlation was found between age of respondents at the time of the interview and their opinion of martens (r_s = 0.039, df = 196, P = 0.585), their attitude towards the environment (r_s = -0.11, df = 196, P = 0.875), or their judgement of their own behaviour (r_s = -0.135, df = 196, P = 0.071). Young people seemed to give less "extreme" answers i.e. they were more likely to say they perceived martens as fairly positive rather than very positive. However, overall they had roughly the same proportion of positive answers as other age categories. They also gave relatively more neutral answers.

Overview of individuals' homeranges, released in the last season and the areas occupied by wild martens

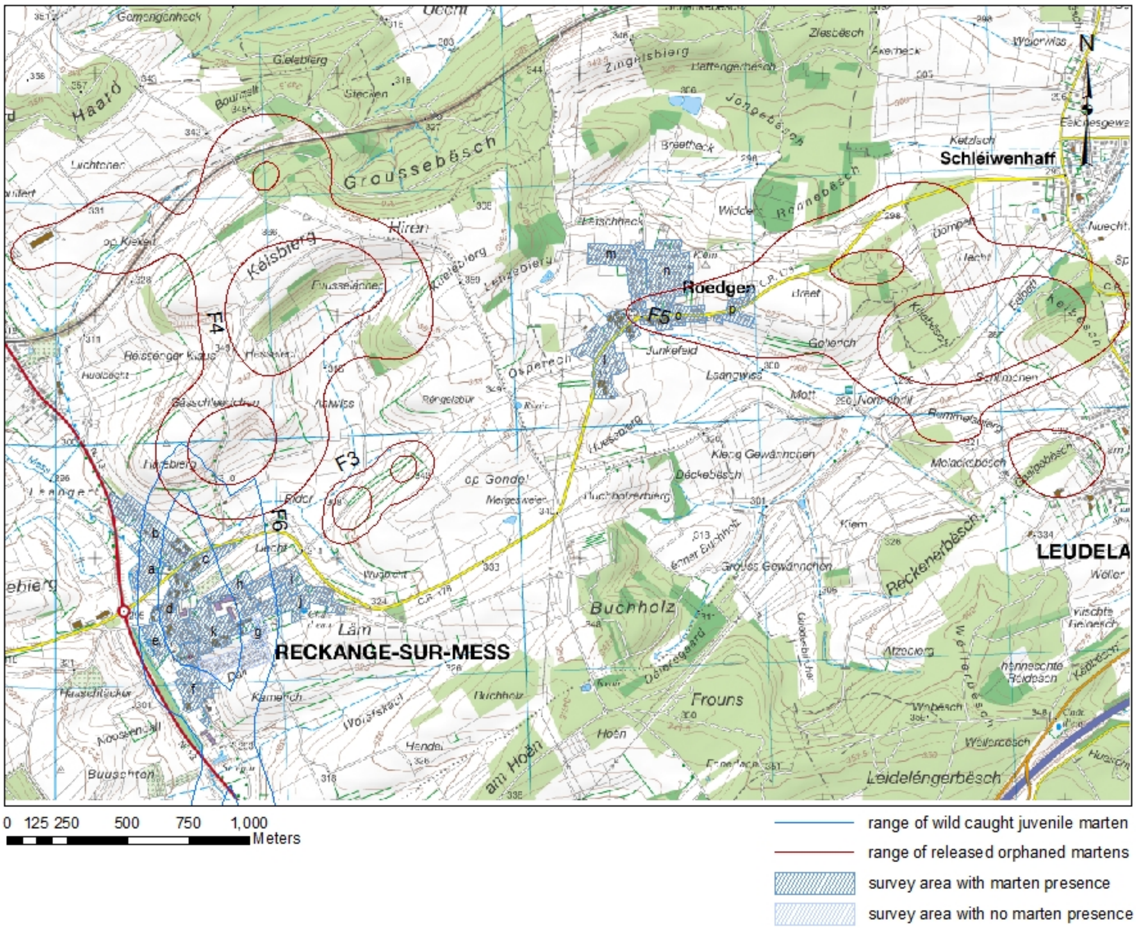


Figure 5.4
Map representing an overview of the situation during season 3, with the three released orphaned martens’ home ranges (F3, F4 & F5) represented by red lines; the home range of the wild caught juvenile marten (F6) that still lived within its mother’s home range represented in blue lines; and the survey areas in which marten presence had been established represented by dark blue striped boxes One street in Reckange-sur-Mess in which the survey suggested absence of martens is represented by a light blue striped box (g).

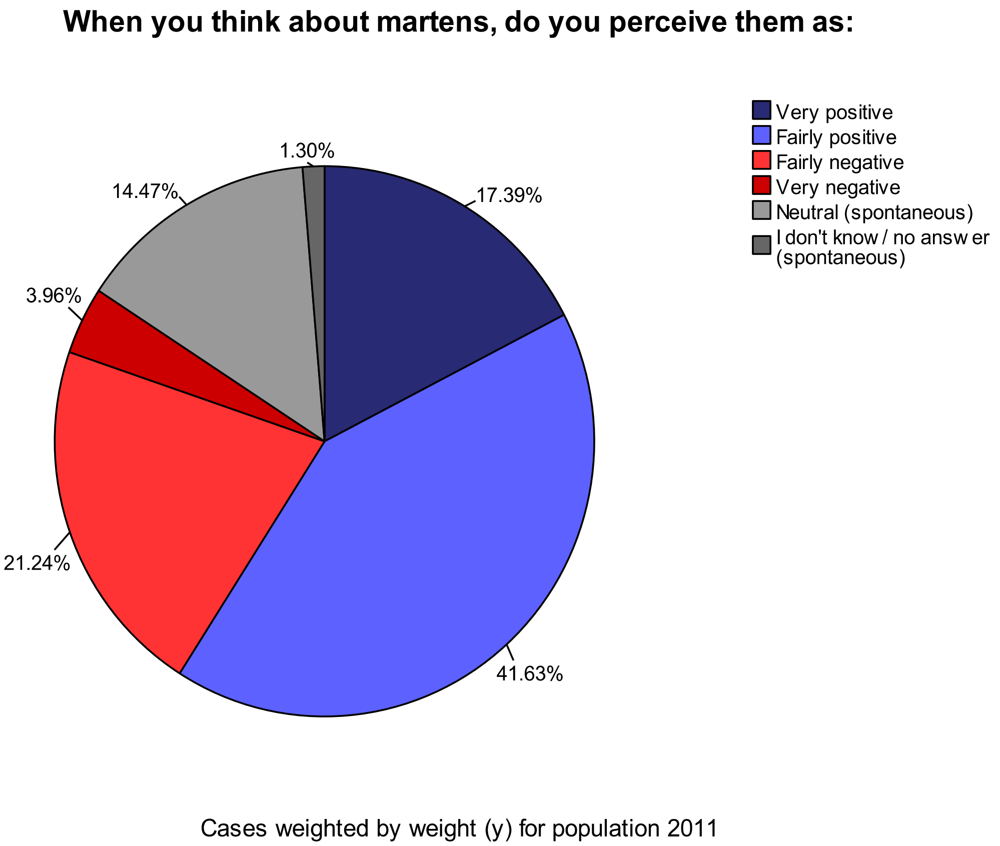


Figure 5.5
Interviewees' response to the question: 'When you think about martens do you perceive them as very positive, fairly positive, fairly negative or very negative?' Results were weighted by age composition of the commune of Reckange-sur-Mess in 2011

5.3.2.2 Influence of other factors on people's opinions about martens

5.3.2.2.1 Attitude towards the environment

94.74 % of people considered protecting the environment to be important (see Figure 5.6). There was no correlation between people's opinions on this subject and their attitude towards martens (r_s = 0.047, df = 196, P = 0.514). The results regarding the question on people's judgement of their own engagement with the environment were more varied (Figure 5.7); but again no evidence was found that this impacted on people's attitudes towards martens.

5.3.2.2.2 Damage caused by martens and opinion

43.65 % of all interviewees had experienced damage caused by martens within their household. The time of the most recent occurrence of these events ranged from two to three weeks ago to 35 years ago; and the events included killing chickens, stealing eggs, injuring a cat, and damage to roof insulation, cars and even a lawnmower. The financial cost ranged from zero to several thousands of euros.

People's negative experiences with martens did impact on their attitude towards martens. There was a significant association between people's opinions of martens and whether or not they had experienced damage in the past (χ^2=13.596, df=4, P=0.009). Amongst the people that had not experienced damage, 67.07% considered martens to be positive. However, in people that did experience marten damage, more than half (53.49%) still viewed martens positively. In addition, people who had not experienced marten damage stated more often that they had no opinion on martens (18.02%) than did people who had experienced damage (10.47%).

Looking at different types of damage more closely revealed a positive correlation between the cost of the damage and people's negative opinion of martens (r_s = 0.285, df = 47, P = 0.05). There was a clear threshold, in that if the cost of damage exceeded

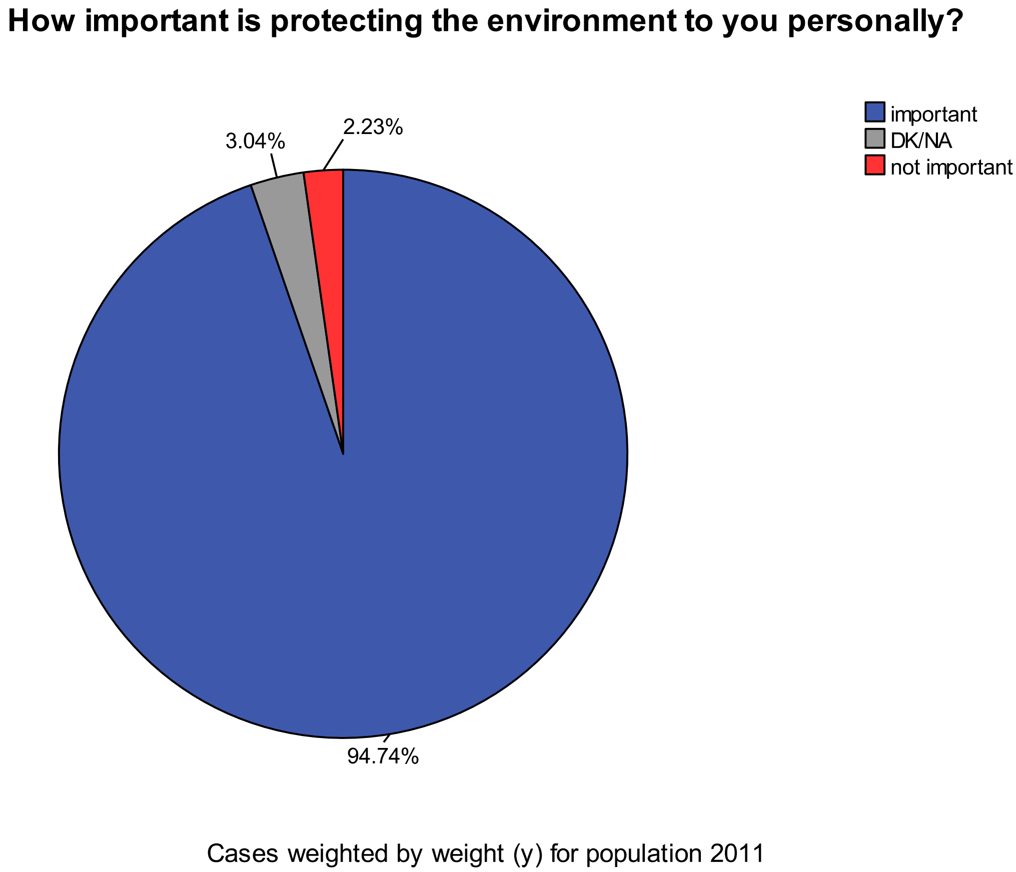


Figure 5.6
Interviewees' responses to the question: 'How important is protecting the environment to you personally?' Results were weighted by age composition of the commune of Reckange-sur-Mess in 2011.

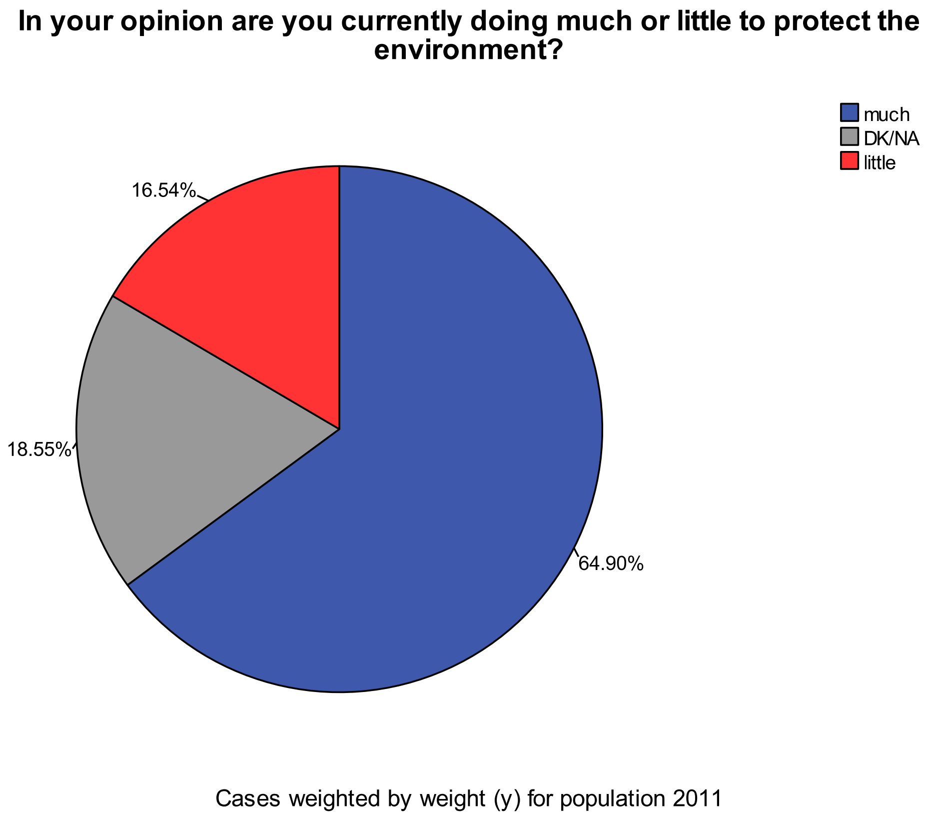


Figure 5.7
Interviewees' responses to the question: 'In your opinion are you currently doing much or little to protect the environment?' Results were weighted by age composition of the commune of Reckange-sur-Mess in 2011.

2000€, 100% of the interviewees in question considered martens as negative. However, this only represented 8.51 % of the cases for which costs were reported. The majority (74.47%) of incidents cost less than 250 €.

A significant association was found between people's opinions of martens and whether pet animals were killed or objects damaged (Fisher's exact test: F = 15.738, n = 88, P < 0.001). If domestic animals were involved, 80% of respondents considered martens as very negative, in contrast to 4.9 % if objects were damaged. It should also be noted that when domestic animals were involved, these were mostly chickens, and the events often dated back a few decades and were reported by elderly people.

The timing of the last incidence of damage had no impact on the opinion of people whose animals had been killed. This is in line with the results for all types of damage: there was again no correlation between the time that had elapsed since the last incident and people's opinion of martens (r_s = -0.121, df = 198, P = 0.087). Nor was any correlation found between the number of incidents and people's opinions (r_s = 0.122, df = 85, P = 0.262). However, in the very rare cases (four in all) in which damage had occurred more than 6 times in a single household, 100% of the interviewees in question considered martens to be negative.

5.3.3 Summary of results

Martens were present in the entire village and they were more popular than expected. Neither people's attitudes towards the environment nor their age impacted on their opinion towards martens. However, past experience with martens influenced how people perceived them: people who had had negative experiences with martens perceived them as more negative than those who had not. The timing of the last incident did not impact on people's opinion of martens, nor did the number of incidents. However, if pet animals were involved, or the damage resulted in high financial costs, people's opinions of martens were more likely to be negative.

5.4 Discussion

5.4.1 Marten Presence

Even though there is no guarantee that all interviewees had sufficient knowledge to identify martens, a number of measures were taken to exclude false sightings. Interviewees were asked a question to determine the reliability of their sighting and were shown flash cards with pictures of martens and marten traces. If the interviewer had doubts based on the description given, the sighting was excluded from the analyses. Finally, for each spatial unit in which marten presence had been detected there were at least two independent sightings.

This method does not allow determination of exact population densities, but marten presence was confirmed for the entire area surveyed, except for one street in one village in which martens were not observed but foxes were regularly seen. The foxes could have been the reason why this area was avoided by martens, as foxes and martens compete over the same food resources and there are records of foxes preying on martens (Lachat Feller 1993).

Combining the ranging data from the martens released during the third season (see Chapter 3) with the marten presence data yielded by the survey showed slight overlap. A small part of F5's outer range overlapped with units o and p from the survey presence data. However, there was no overlap with the core of F5's range and F5 only spent a small amount of time in the area in question. As there was temporal overlap between the release and the survey, it is possible that the marten that was reported in the survey was actually F5. However, no one mentioned having seen a radio-collar (though this could have been overlooked due to poor visibility at night) and there were earlier sightings in these areas, dating from before the releases. Thus even if some of the sightings were of F5 herself, there had been sightings of other martens too.

This could have a number of explanations. At the time, units o and p could have been occupied only by a male, in which case F5's presence could have been welcome.

However, F5 did not settle in this area even though it was suitable habitat. It is more likely, therefore, that the area in question was occupied by an adult female. Another explanation could be that as with the edges of F3's (captive-reared) and F6's (wild) ranges, that also overlapped, sharing of space could be a consequence of exploratory behaviour on the part of young martens that have not yet established an actively defended territory, together with tolerance of adult martens towards young martens passing through, as opposed to settling down (see Chapter 4).

The results are consistent with the idea that the released martens did not settle in the surrounding villages because these territories were already occupied. Even though young martens might be tolerated when crossing through or even occasionally feeding within the range of an adult, they do not seem to be allowed to stay. Conversely, evidence that the areas outside the villages had very low stone marten densities (see Chapter 4) could explain why most of the captive-reared martens settled in these areas.

5.4.2 Opinions about martens

Even though the results of this mini survey could not be generalised to the entire population of Luxembourg, valid statements could be made on people's opinions in the villages surrounding the final release site. The results regarding people's opinion on the environment confirmed what was found by the Eurobarometer survey (Anonymous 2011).

Overall, people viewed martens as positive, which seems counter-intuitive considering that martens generally have a bad press. However, since even carnivores that can cause human-wildlife conflict have had positive feedback in the past (Hunziker et al. 2001), and even foxes which can transmit potentially lethal zoonoses were relatively popular in some regions (König 2008), this result is not as surprising as it might seem at first sight.

43.66 % of interviewees had experienced problems with martens within their household. However, some of these problem incidents had occurred several years previously. Unfortunately I could not find previous studies of public attitudes towards martens, so it was not possible to see whether there had been a change in attitude towards martens over time, or how attitudes could have been influenced by any change in the image of the marten in the press.

The predictions made as to what would influence people's opinions about martens were only partly confirmed. Contrary to what was predicted, people's opinions were not influenced by age or by their attitude towards environmental protection. However, it was confirmed that opinions about martens were influenced by interviewees' personal experience with martens in the past. As predicted, people who had had a negative experience with martens in the past viewed them more negatively. Additionally, people who had had no negative experience with martens were more likely to have a neutral opinion towards them.

As would be expected, the more expensive the damage caused by martens was, the more people disliked martens. If domestic animals were involved, people's attitudes towards martens were far more negative than if objects were involved. There are two possible explanations of this: either people could be more upset by the death of their animals than by a financial loss, or it could be an age effect, since the people who reported the death of domestic animals (mostly chickens) were all old. However, as there was no correlation between age and opinion, the first hypothesis seems more likely. Besides being more upset by the death of domestic animals, people apparently bore this grudge for decades.

This was consistent with another result, namely, that, in contrast to what was predicted, the timing of the last damage event did not impact on people's opinions of martens; nor did the number of incidents except in the very rare cases in which damage occurred more than six times in a single household. In these cases, all the relevant interviewees perceived martens as negative. An alternative hypothesis, that people could simply dislike martens regardless of their own experience, was not confirmed.

To summarise, the generally positive attitude of interviewees towards martens can be explained by the fact that people seem to like having wildlife around their homes and carnivores in general seem to be perceived as positive. Additionally, the two strongest factors that influenced people's opinions negatively, namely, high financial costs of damage and the death of domestic animals, only rarely occurred.

5.5 CONCLUSIONS

The survey proved to be a useful tool to detect marten presence in a village, given intra-species temporal and spatial overlap. Marten presence was confirmed for almost the whole survey area, which supports the hypothesis that the young released martens did not move into the villages because these territories were already occupied.

People's opinions of martens were influenced by their past experience: high financial costs of damage caused by martens, and incidents in which domestic animals came to harm, had particularly negative effects on opinion. Both these scenarios were relatively rare. Additionally generally people like having wildlife around their homes. Together, this could explain why, overall, people considered martens as more positive than was expected.

Chapter 6: Space use in martens: a comparison between two studies

6.1 Introduction

My original intention in this part of the study was to carry out a meta-analysis of the existing literature on space use in martens, in order to determine the effect of variables such as sex, age and habitat on home range size and movement patterns, and to see how my own data compared, quantitatively, with data from other studies. However, as I showed in Chapter 3, there has been no standardized method of recording or analysing data in the marten literature (see Table 3.1) and this lack of standardization makes a quantitative meta-analysis impossible. Thankfully, however, Jan Herr was so kind as to let me use the raw data from his study of stone martens (Herr 2008), for a direct comparison with my own data.

Herr's study involved adult martens living in an urban environment, so any comparison between his data and mine are confounded by differences in age (adult versus young) and habitat (urban versus rural). Nevertheless, in this chapter I compare Herr's results on space use and movement patterns with my own and attempt to explain similarities and differences.

6.1.1 Space use and movement patterns

6.1.1.1 Wild stone martens in an urban environment

As mentioned in Chapters 3 and 4, martens living within villages tend to have smaller ranges than outside of villages. 'Village' martens show less activity overall (Skirnisson 1986, Herrmann 2004), spend more time inside or close to their den (Skirnisson 1986) and seem to time their activity patterns so as to avoid human activity (Skirnisson 1986, Herrmann 2004). Most studies on martens in an urban or strongly urbanized environment have been conducted in the Netherlands (Broekhuizen et al. 1989, Lucas 1989, Hovens and Janss 1990, van Walree 1990, Bissonette and Broekhuizen 1995) but the study with the largest sample size was conducted in Luxembourg (Herr 2008). These studies have shown that as in other species [i.e., red foxes (Baker et al. 2000, Gloor et al. 2001), racoons (Michler et al. 2004, Prange and Gehrt 2004)], adaptation to an urban environment leads to a reduction in range size. However, it does not lead to a change in the marten social system which remains one of intrasexual territoriality (Bissonette and Broekhuizen 1995, Müskens and Broekhuizen 2005, Herr 2008).

As regards denning and movement patterns, Herr (2008) confirmed an increased use of anthropomorphic structures in an urban (medium-sized town) environment, as had previously been found in 'village' martens (Skirnisson 1986). However, he showed that even though urban martens had smaller ranges they were at least as active and mobile as rural or forest martens.

6.1.1.2 HOW SHOULD THE BEHAVIOUR OF ADULT URBAN AND CAPTIVE-REARED JUVENILE MARTENS DIFFER?

According to Genovesi (1997), young martens show longer travel distances than adult martens due to dispersal. My estimates of the sizes of the final home ranges of juvenile martens (see Chapter 3) lay within the range found in the literature, even if only those studies were considered in which more than half of the martens were adults (Table 3.1). Furthermore, Table 3.1 suggests no relationship between age and range size. Table 3.1 does, however, suggest a trend towards smaller ranges in urban habitats, and this effect has been claimed in a number of individual studies (see above).

My orphaned martens were released in a rural habitat and all but one settled outside of villages, so I expected them to exhibit rural behavioural patterns. If we accept that urban martens have smaller home ranges than rural martens but that there is no difference in home range size between young and adult martens, then adult urban martens should have smaller home ranges than young rural martens. Similarly, if there is no difference in travel distances between urban and rural martens (Herr 2008) but young martens move over longer distances than adult martens (Genovesi et al. 1997), then adult urban martens should show shorter movement distances than young rural martens. These predictions are summarized in Figure 6.1.

6.2 METHOD

6.2.1 METHODS USED BY HERR (2008)

The data with which I compared my own were collected by Jan Herr, for his PhD thesis, from June 2005 till May 2007. He trapped 14 wild martens, of which eight were adult females, three adult males, one a sub-adult female and two juvenile females. They were followed over periods ranging from 3 days to 9 months. All these martens lived within an urban habitat consisting of two medium-sized towns in southern Luxembourg, with a human population density of around 3600 inhabitants per km^2. Observations took place year-round. For my purposes I used only data from adult martens (N = 10) that had been followed for a minimum of four months and for which at least 10 nightly follows were recorded.

6.2.2 SUB-SAMPLING

Herr (2008) recorded fixes using the same method as me (see Chapter 2), except that he recorded fixes every 15 min whereas I did so every 30 min. To ensure a standardized sampling regime for comparability between the two studies, I sub-sampled Herr's raw data so as to extract fixes recorded at a half-hourly rate. Herr's

Summary of results of published studies:

Home range	**Urban < Rural** (Bissonette and Broekhuizen 1995, Herr 2008)	**Adult = Young** (for ref. see Chapter 3)
Travel distances	**Urban = Rural** (Herr 2008)	**Adult < Young** (Genovesi et al. 1997)

Predictions:

Home range	**Adult urban < Young rural**
Travel distances	**Adult urban < Young rural**

Figure 6.1
Relative sizes of home ranges and travel distances for stone martens depending on the habitat they live in and their age. Above: summary of results from published studies. Below: predictions arising from these results.

data were analysed using the same method as I used for my own data (see Chapters 2 & 3).

6.3 RESULTS

6.3.1 DIFFERENCES IN SPACE USE

Since I did not find a difference in home range size between the sexes in juvenile martens (see Chapter 3), I did not differentiate between the sexes in the comparison between adult and juvenile martens. As predicted (see Figure 6.1), adult urban martens had smaller home ranges ($U= 7$, $n_1= 8$, $n_2= 10$, $P=0.051$) (Figure 6.2) and core home ranges ($U= 7$, $n_1= 8$, $n_2= 10$, $P=0.076$) (Figure 6.3) than the released captive-reared orphaned martens. These differences were not significant but were suggestive of a trend.

6.3.2 DIFFERENCES IN MOVEMENT PATTERNS

Herr (2008) and I both found a significant difference between the sexes in marten movement patterns (see Chapter 3), so for the present analysis I looked at males and females separately. Contrary to what was predicted (see Figure 6.1), mean distances travelled per hour by captive-reared orphaned martens were significantly lower than those of wild adults, both in males ($U= 0$, $n_1= 7$, $n_2= 3$, $P=0.017$) and in females ($U= 8$, $n_1= 10$, $n_2= 5$, $P=0.037$) (see Figure 6.4).

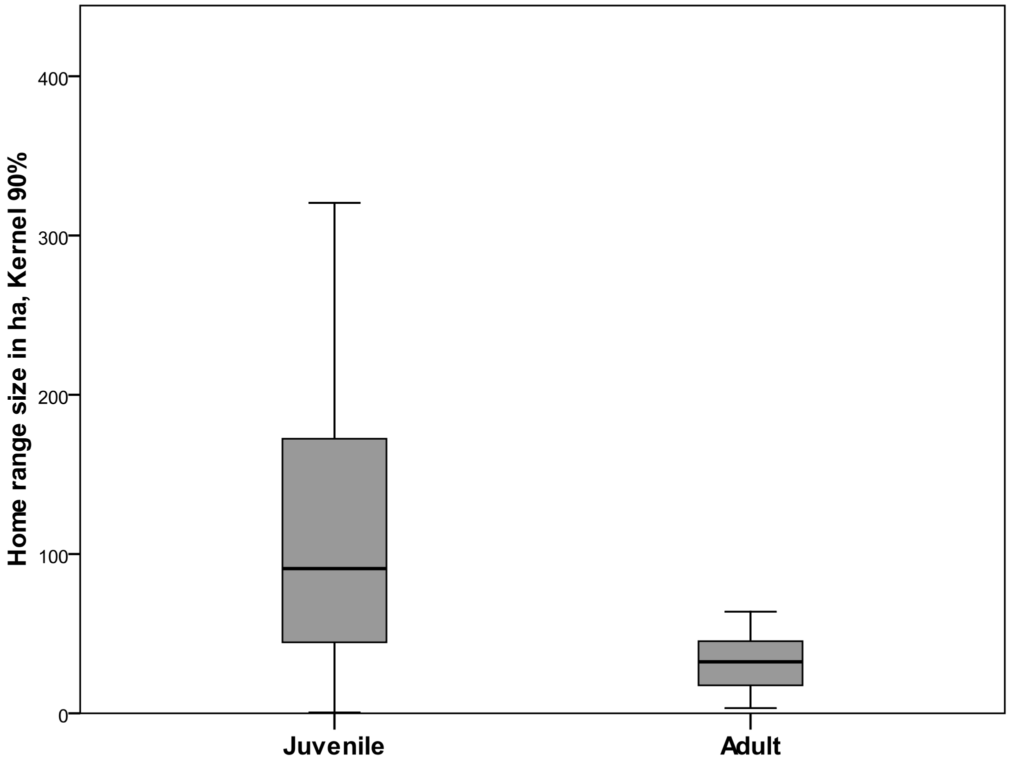


Figure 6.2
Home range size (Kernel 90%) in captive-reared orphaned juvenile martens and wild adult urban martens ($U= 7$, $n_1= 8$, $n_2= 10$, $P=0.051$).

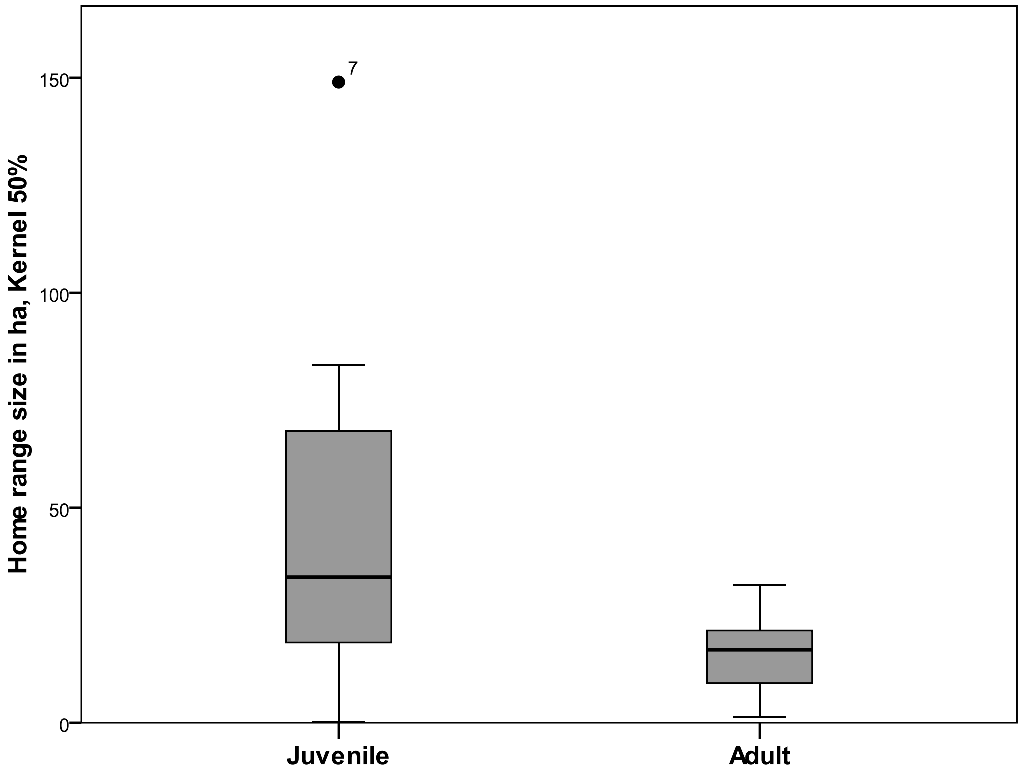


Figure 6.3
Core home range size in captive-reared orphaned juvenile martens and wild adult urban martens (U= 7, n_1= 8, n_2= 10, P=0.076).

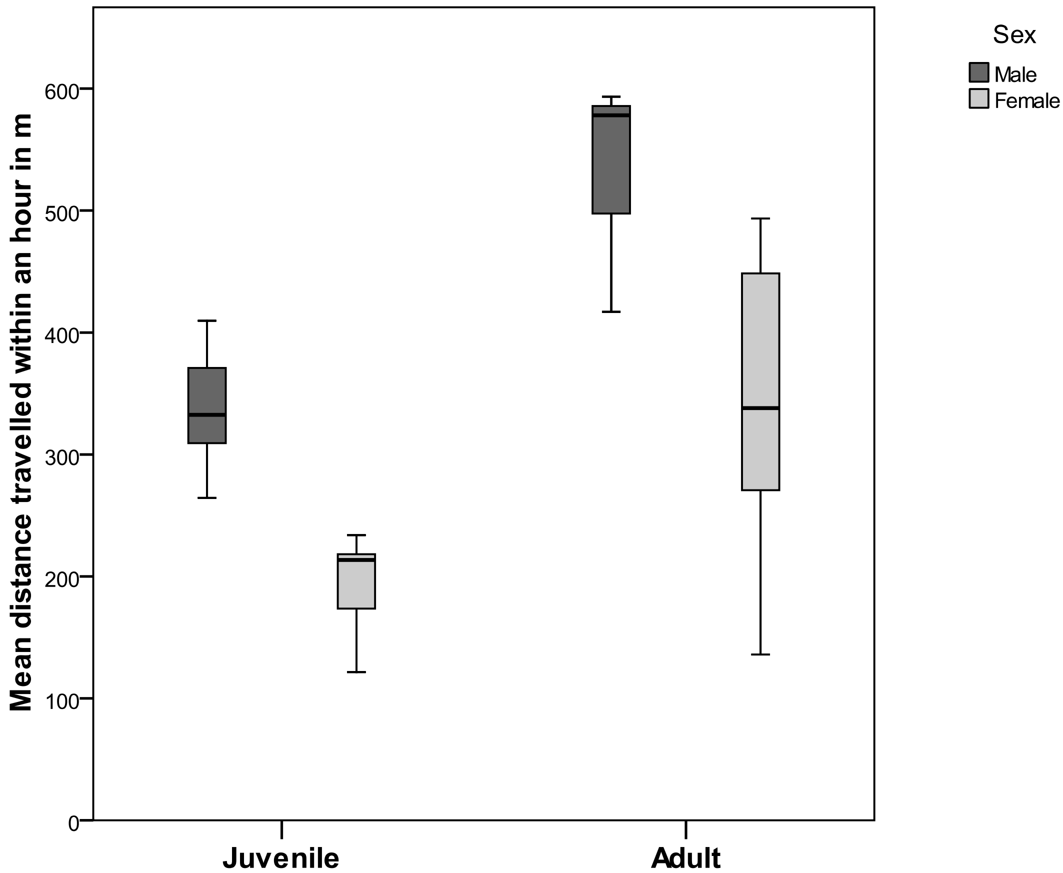


Figure 6.4

Mean distance travelled per hour by male and female juvenile orphaned martens after release in a rural area and by male and female wild caught, adult, urban martens. Wild adult males travel significantly faster than captive-reared orphaned males ($U= 0$, $n_1= 7$, $n_2= 3$, $P=0.017$). Wild adult females travelled significantly faster than captive-reared orphaned females ($U= 8$, $n_1= 10$, $n_2= 5$, $P=0.037$).

6.4 DISCUSSION

My predictions on home range sizes and core home rage sizes were confirmed: the released juveniles had larger ranges than the adult urban martens, albeit the differences were not statistically significant. However, contrary to my predictions, the released juveniles showed significantly slower travel speeds than the adult urban martens.

6.4.1 DIFFERENCES IN HOME RANGE SIZE

There are several possible reasons why the captive-reared juveniles tended to have larger ranges than the wild urban adults. One possibility is that since the captive-reared juveniles' data were skewed towards males and the urban adults' data towards females, the adults' home ranges could be underestimated and the juveniles' overestimated. However, my results showed no difference between the sexes in juvenile home range size (see Chapter 3). Additionally, even if the median of the adult home range size was underestimated, Figure 6.2 shows clearly that even the largest adult home range did not exceed the median of the juvenile home range sizes. The same was true for home range cores.

Another possibility is that the captive-reared juveniles' ranges were over-estimated because after release they were moving around extensively and did not have a stable, defined range. However, even if this possibility cannot be entirely excluded, it was largely eliminated by excluding data points collected at the beginning of the study and from areas the martens did not return to once they had settled (see Chapter 2).

Finally, and most probably, the difference in range sizes reflects the fact that the captive-reared juveniles were exhibiting rural marten behavioural patterns and for this reason had larger ranges than the adult urban martens. That is, the difference was owing to the difference in habitat (rural versus urban) rather than to differences in rearing condition or age.

One final piece of evidence consistent with this conclusion comes from the single wild-caught juvenile marten that I radio-tracked (see Chapter 4). This animal's home range size and core home range size were closer to the median range sizes of the adult wild martens than to those of the captive-reared juveniles. Given that the wild-caught juvenile was living in a village, this is consistent with the idea that smaller home ranges are attributable to urban habitat rather than to juvenile status.

6.4.2 DIFFERENCES IN DISTANCE MOVED PER HOUR

The fact that adult urban martens moved over longer distances per hour than the captive-reared juvenile martens is surprising considering that adults have smaller home ranges. Genovesi (1997) explained larger juvenile movement distances by the fact that juveniles disperse. However, the dispersal data available in the literature indicates that dispersing young tend to engage in bouts of increased movement: that is, individuals would move over large distances in a few hours followed by longer periods of lesser movement (Skirnisson 1986, Lucas 1989). I found similar patterns for the released martens (see Chapter 3). This sort of pattern should have little overall effect on mean values, and therefore had probably little effect on the results. The difference in travel speeds cannot be explained by the difference in habitat because Herr (2008) found no difference between urban and rural martens in this respect. Another possibility is that adult martens travelled over longer distances per hour because they had to defend (i.e., patrol and scent-mark) a territory. Yet another possibility is that the difference could reflect a physical constraint since, at the time these observations were made, the juvenile martens had not yet reached their full physical strength and so might not be able to move as rapidly as adult martens. Either way, it seems most likely that the difference in travel speed was a consequence of the difference in age between the two groups of martens, rather than to the difference in rearing condition or habitat.

6.5 CONCLUSION

As predicted, captive-reared orphaned juvenile martens had larger home ranges and home range cores than the wild urban adults. This was most likely due the different habitats they lived in rather than to differences in age or rearing condition.

Contrary to my prediction, urban adults moved further per hour than captive-reared juveniles. This difference is most likely due to the difference in age rather than the differences in habitat or rearing condition. However, further data are needed to confirm the differences in range size (which were not statistically significant) and to test hypotheses about the causes of the observed differences in range size and movement rate. Ideally, this would involve a study comparing the behaviour of individuals from different age categories living in both rural and urban habitats.

CHAPTER 7: GENERAL DISCUSSION

It is common practice, in Luxembourg (Herr 2008) and elsewhere (Robertson and Harris 1995, Sharp 1996), to bring orphaned wildlife into rescue centres where they are reared to independence and subsequently released back into the wild. However, little data is available on the success of such releases, for example in terms of the survival rate of the animals concerned once they are released and have to fend for themselves in the wild. The little data that do exist, derived from projects that involved following individuals after release, is generally sobering in that it usually reports high mortality amongst released individuals (Griffith et al. 1989, Wolf et al. 1996, Linnell et al. 1997, Massei et al. 2010).

The aim of my study was to evaluate some of the overall costs and benefits of raising and releasing captive-reared orphaned stone martens, putting special emphasis on the welfare of the released animals, their survival in the first months after release, and the potential for releases to result in human-marten conflict.

7.1 OVERVIEW OF MAIN FINDINGS

Chapter 3 showed that the releases resulted in hardly any potential for human-marten conflict, since only one of the captive-reared released martens settled in a village (i.e., in the type of environment most associated with conflict situations). The martens adapted to various kinds of foods, mainly non-anthropogenic in nature. The mortality rate was low at 0.33; and re-captured individuals, or individuals found after being killed by a car, were in good physical condition, suggesting that they had not had difficulty finding enough food. The final home ranges of released martens were within the size range reported by published studies, indicating that the animals managed to hold sustainable home ranges. There was no difference in range sizes between seasons or between males and females. However, males travelled further per hour than females. This indicates that in young martens, even if they are too young to show any reproductive behaviour, such as increased movement in spring or males monopolizing females, there is already some degree of behavioural sexual dimorphism.

In Chapter 4, I presented results from a wild-caught juvenile marten, which proved the existence of a local marten population in a village near the final year's release site. Even though the results did not allow conclusions to be drawn about the exact distribution of this population, they lent some support to the hypothesis that the captive-reared martens did not move into surrounding villages because these habitats were already occupied by resident adults. The wild-caught juvenile marten moved over shorter distances and her range size was small by comparison with those of most of the captive-reared juveniles, and close to that of the only captive-reared marten that settled in a village. This suggests that these differences were due to the difference in habitat (rural versus urban). In addition, the behaviour of the wild-caught juvenile was more goal-directed than that of the captive-reared martens. These behavioural differences could be due to lack of maternal care in captive-reared martens, to unfamiliarity with their surroundings, to the age difference between captive-reared and the wild caught juvenile marten or a combination of all three factors.

The results from a questionnaire survey, described in Chapter 5, showed that martens were present virtually everywhere in two villages close to the final year's release site, lending additional support to the hypothesis that the captive-reared martens did not move into the habitats within villages because these were already occupied. This is consistent with the idea that sub-adult martens are only tolerated within the territory of adults if they are genetically related to them. The opinion poll also showed that people's past experience could influence their attitude towards stone martens: in particular, and not surprisingly, opinions were more negative if martens had caused costly damage or if pet animals had come to harm. However, such events occurred rarely, and overall martens were considered as positive, regardless of human-marten conflicts. Thus it was unlikely that public opinion towards martens had affected the release project negatively.

In Chapter 6, I compared my results from captive-reared martens to results obtained from wild-caught urban martens in a previous study (Herr 2008). Captive-reared rural juveniles had larger home ranges than the urban adults studied by Herr, which was most likely due to the difference in habitat type. Surprisingly, captive-reared juveniles moved over shorter distances than urban adults, which could have been due to extensive patrolling of territories in adults or to physical constraints in juveniles. However, the data were not sufficient to enable these hypotheses to be evaluated.

7.2 Costs and benefits of releasing captive-reared orphaned martens

7.2.1 Welfare of released captive-reared orphaned martens

7.2.1.1 Habitat quality

The quality of the habitat into which a released marten settles will obviously have a strong impact on its survival. Since martens are found in rural as well as urban habitats, since the re-released martens were brought up by humans in a human dominated environment and since urban habitat is generally considered a higher quantity habitat than rural habitat, I assumed that the re-released orphaned martens would settle in villages surrounding the release site. But is rural habitat really of lower quality than urban habitat? This depends on a number of factors.

A number of studies have shown that urban environments support higher population densities than rural environments (Herr et al. 2009a) and this is prima facie evidence that urban habitat is of better quality. The principle advantages of an urban environment are believed to be year-round availability of food and well-insulated denning opportunities. In a rural environment, by contrast, not only is there seasonal variation in food resources but also, due to modern agricultural methods, these resources have become more scarce because of a reduction in the number of hedgerows and orchards and an increase in the use of pesticides (Gardner 1996). Additionally, there is no hunting pressure in an urban environment, although in Luxembourg generally there is little hunting pressure on martens (Herr 2008).

However, urbanised habitats have some negative aspects too. Higher population density could in principle lead to more diseases although there is no evidence for this. Martens are also more exposed to traffic in urban habitats and car accidents account for most of marten mortality. However, in the area in which my martens were release they were exposed to traffic regardless of whether they were within or outside villages, with traffic clearly being more dense inside the villages but at the same time more regulated too, e.g. by speed limits. Also, martens that are exposed to traffic on a regular basis are more likely to be aware of its dangers and to have learned how to avoid them. Altogether, then, it is not necessarily the case that traffic mortality is higher in urban than in rural environments and, indeed, the two martens that were killed by cars in my study were killed outside villages.

Food resources associated with human activity are not necessarily healthy, and this could decrease long term survival in urban populations. However, in contrast to other species such as badgers and raccoons, stone martens do not depend heavily on anthropogenic food in urban environments. Although they do to some extent feed opportunistically on waste, they also still hunt for rodents and birds and eat seasonally available fruits (see General Introduction).

To summarise, it is clear that rural and urban habitats are both suitable for martens and the only real evidence that urban habitats are superior is that they support higher population densities, with individual martens having smaller ranges (Herrmann 2004, Herr et al. 2009a). Although it seems reasonable to infer from this that urban habitats are richer in resources, this remains an assumption.

7.2.1.2 Behaviour

Since martens are a long-lived species with a prolonged k-selected life history and extensive maternal care (Herrmann 2004), the captive-reared orphaned martens were likely to have been impaired. They had no previous experience of their natural environment due to their prolonged period of captivity (Biggins et al. 1998, Sarrazin and Legendre 1999, Jule et al. 2008) and they lacked any input from adults including their mother. Additionally, my results indicate that their ability to adapt to their new environment was probably impaired by the presence of a local wild marten population. This is probably why the released juveniles did not enter villages and were consequently restricted to peripheral habitats.

The released juveniles moved more slowly than wild adult urban martens. As the wild-caught juvenile marten showed a similarly slow travel speed, this was unlikely to be related to the fact that the released juveniles were reared in captivity, and hence is unlikely to indicate impaired welfare. Rather, the slow speed of movement was most likely due to the young age of both the captive-reared and the wild-caught animals and, in particular, to the fact that they had not yet reached sexual maturity. Consequently, unlike adult males and females, they did not need to travel over long distances to extensively patrol and defend their territories from other breeding martens (Herr 2008); nor, unlike adult females, did they have to travel over long distances to provide for their young (Skirnisson 1986).

The finding that the captive-reared juveniles showed no sexual differences in home range size was probably also a reflection of their young age. Unlike adult males, that have to defend large territories to monopolize several females (Skirnisson 1986, Genovesi et al. 1997, Herrmann 2004, Broekhuizen et al. 2010), juveniles only need home ranges that offer enough to eat and sufficient hiding places. Like the relatively slow speed of movement, therefore, the lack of a sex difference in home range size is unlikely to be evidence of impaired welfare.

Even though their behaviour was less goal-directed than that of the wild-caught juvenile still cared for by her mother, the captive-reared orphaned martens seemed overall to succeed in establishing themselves. Their final home ranges were within the size range reported by previous studies of wild marten populations. Also, there is evidence that they adapted to various types of foods, including seasonally available fruit, eggs, rodents and birds, as is the case with wild martens that are able to adopt new food sources throughout their lives (Herrmann 2004). Altogether, then, the behaviour of the released juveniles, although it differed in some respects from that of wild adults, was not indicative of impaired welfare.

7.2.1.3 Survival rate and financial cost

The overall death rate of the released martens in my study was 0.33, which is much lower than the rate of 0.68 found for the first year of life in a wild population of martens in Alsace (Marchesi et al. 2010). Thus, there was good mid-term survival. In addition, all recaptured animals and road traffic victims were in good physical condition: they had shiny fur, hardly any ectoparasites, clear eyes, and were not starved, underweight or in any other way underdeveloped. This indicates good potential for long term survival. The actual financial cost for raising a surviving marten, at least in the mid-term, ranged from 214 to257 €, which was not excessively high.

As regards mortality, then, the results from my study again suggest that the welfare of the released martens was not seriously impaired. The high survival rate also means that the financial cost per surviving animal was moderate.

7.2.2 Human-marten conflict due to release

Out of the eight captive-reared martens followed for over 4 months, only one settled in a village; and this individual denned in a barn rather than in inhabited buildings. It might have damaged a car but, since it was never located at the exact spot at which the damage occurred, it may not have been the culprit. All other martens settled outside villages, where human-marten conflict situations are less likely to occur. One marten was seen stealing an egg but since this individual did not settle in a village, it is unlikely that this happened on a regular basis. It should also be noted that in some situations, martens can be beneficial. A farmer told me that he was happy to have a marten living in a barn in which he kept his animal feed, as it preyed on what he considered to be pest species (i.e., rats, mice and pigeons) (personal communication). One of the released martens was seen catching rats. In view of the fact that when they did use buildings these were usually associated with agriculture (e.g., barns, a biogas generator) rather than with human habitation, the released martens may overall have been useful rather than problematic.

7.3 Public opinion

As noted in Chapter 1, acceptance of the released species is essential for the success of any release project (Moore and Smith 1991, IUCN 1998, Fischer and Lindenmayer 2000). In extreme cases involving very unpopular species, such as wolves *Canis lupus* (Fritts et al. 1985) or lynx (Thali et al. 2007), released animals can even be subjected to deliberate persecution. In the case of the present project, martens do sometimes come into conflict with humans so deliberate persecution, although unlikely, was a possibility; and the rescue centre that cared for the martens was dependent on financial support from the general public in order to be able to do its work. Thus, it was important to investigate public attitudes towards martens,

The opinion survey that I carried out showed that people's attitudes towards martens were divided but positive overall. Whereas the opinions of interviewees were not influenced by their age or their general attitude towards the environment, they were influenced by having had negative experiences with martens. Perhaps surprisingly, however, opinions were not influenced by how long ago the last negative experience had occurred, nor by the number of negative experiences, except in a few very rare cases where problems reoccurred more than six times.

Martens are known to cause various types of damage (see Chapter 1). I found that when pet animals came to harm because of martens this had a much stronger negative effect on people's opinions than if objects were damaged. When objects were damaged, opinion was (not surprisingly) influenced by the financial cost involved: the more expensive the damage the less likely people were to perceive martens as positive. There appeared to be a clear cut-off point: if the cost exceeded 2000 €, all respondents perceived martens as negative.

Generally, people like wildlife around their homes (personal observation), even if the wildlife in question can cause problems (Hunziker et al. 2001). For example in Zurich, urban foxes are relatively popular even though they can transmit a potentially lethal zoonosis (König 2008). Martens are attractive animals and incidents that caused clear negative effects on people's opinion were rare. Overall, therefore, there is little risk that rescue centres would lose support (in the form of financial contributions and voluntary service) due to rescuing stone martens, even though martens can sometimes come into conflict with human interests. Nor is it likely that released martens would be subject to deliberate persecution.

7.4 Impact of my results on our knowledge of stone marten social system

One new finding that emerged from my study was that juvenile martens show no sex difference in home range size. As already noted, this is most likely because, since they are not yet sexually mature, males do not need to enlarge their home ranges in order to monopolize access to a number of females. Having larger ranges than are needed at the time would lead to additional energy expenditure with no compensating benefit.

The results also showed that most of the released martens did not settle in villages. This was contrary to expectation: I predicted that the martens would be likely to settle in anthropogenically dominated environments, partly because I had expected them to be habituated to humans and partly because villages are generally supposed to constitute a more resource-rich habitat than rural areas.

This failure of the released juveniles to settle in villages may tell us something about social relationships between adults and juveniles. Based on the literature I had assumed that sub-adult martens would be tolerated by adults (Lucas 1989, Müskens et al. 1989, Herrmann 1994). This hypothesis was further supported by results from previous release studies, showing that young released martens were more successful than released adults (Skirnisson 1986, Herr et al. 2008). However, the failure of my released juveniles to settle in villages suggests that adults do not always tolerate juveniles within their ranges. Live-trapping and the opinion survey proved the presence of a wild marten population in the villages surrounding the release site, whereas I did not manage to capture any stone martens outside villages. In addition, results from a study involving extensive trapping of pine martens showed that in rural Luxembourg, at locations near to my release sites, stone martens were rarely trapped outside villages by comparison with pine martens (one stone marten versus nine pine martens: personal communication Armin Liese). In principle this could just indicate that stone martens are harder to trap but the two species are attracted by the same baits and a study by Ruette et. al. (2003) showed no indication that either species was more likely to be trapped. Taken together, then, these observations are consistent with the hypothesis that stone martens are more common in villages than outside them, though this still needs to be confirmed given the overall low trapping success, despite the presence of martens, in my study. However, if adult martens are indeed more numerous in villages, I suggest that adult stone martens may tolerate related sub-adult individuals, which show no sexual behaviour, within their territories, but do not tolerate unrelated juveniles (which was the case for the released juveniles). This would be in line with a hypothesis proposed for pine martens by Balharry (1993).

If this hypothesis is correct it could shed some light on why there is such marked variability in the timing of dispersal in stone martens. There are records of mothers rejecting their young or denying them access to dens as early as at the age of 27 weeks

(Broekhuizen et al. 2010); but there are also records of young being tolerated within their parents' range up to age 10 months (Herrmann 2004); and even, in one case, for up to two years (this young male did not display any sexual behaviour yet) (Broekhuizen et al. 2010). The presence of a new litter does not seem to impact on this tolerance towards sub-adults, as Lucas (1989) observed a female marten being visited by an adult and a sub-adult male at her nesting site. This variation in dispersal time could therefore be due to variation in the timing of the onset of sexual behaviour on the part of the young (Herrmann 2004).

Suppression of reproduction may also be relevant in this context. In captivity, marten females seem able to suppress the reproduction of other females; and this behaviour is associated with a strongly despotic hierarchy (pers.com. Kugelschafter, in Herrmann 2004). In captivity, however, the suppressed female is unable to move away whereas in the wild this is an option. A possible explanation of the variation in the timing of dispersal is therefore that offspring might be tolerated within the parental territory, but not in other territories. If a suitable territory becomes available the young will move away; but if not the young will stay in its parents' territory but its reproduction will be suppressed, while it waits for a suitable territory to become available.

However, more work is needed to substantiate these hypotheses and to elucidate the underlying mechanisms.

7.5 CONCLUSIONS

Overall, the release of captive-reared orphaned martens can be considered a success. Even though the captive-reared martens showed less goal-directed movements than did wild-caught martens, and though most of them did not settle in high-quality habitats, their mid-term survival rate was high (0.66). In addition, those individuals that were recaptured were found to be in good condition, suggesting that the prospects for long-term survival were also good. Release did not, therefore, seem to be very detrimental to the welfare of the martens concerned.

People living around the final release site had a mostly positive attitude towards stone martens, even if they had had negative experiences with martens; and the kinds of incidents that impacted negatively on people's opinions were very rare. Overall, therefore, positive attitudes towards the presence of wildlife near to people's homes seemed to outweigh any negative effects of human-marten conflict. It is thus unlikely that public hostility towards martens would negatively affect either the success of marten releases or the popularity of rescue centres.

Finally, the high survival rate meant that the financial cost of rearing juvenile martens per successful release was moderate (214 to 247 €).

Overall, then, I conclude that rearing orphaned martens in captivity and releasing them in the wild is justifiable. As regards costs, the financial costs were modest, there was no evidence of serious welfare costs, and released martens were not likely to come into conflict with human interests. As regards benefits, the released martens were saved from either being euthanased or retained in captivity for the rest of their lives, and they may even have been beneficial in an agricultural context as predators of pests.

7.6 Further research

As regards the present project, more research with larger sample sizes, and over longer periods of time, would allow firmer conclusions to be drawn about the long-term survival of released captive-reared martens. This would also show whether released juveniles would eventually manage to establish themselves in a better habitat. These questions could potentially be answered using GPS technology, since collection of radio-telemetric data by hand (as was done in the present project) is extremely labour intensive. However, pilot studies would be necessary to determine whether GPS technology is suitable for stone martens, since they tend to spend extensive periods of time under cover or indoors, which could disrupt GPS signals.

Recapture rate for this study was low, so I was unable to remove all the collars at the end of the study. At the beginning of my study collars that would break away by themselves or with a remote controlled break-away mechanisms were not yet commercially available for animals as small as martens, so use of such collars was not an option. Future studies should try to resolve this problem to avoid unnecessary suffering for the animals.

As regards marten behaviour in general, most previous studies have been of short duration and have involved small sample sizes. To get a better understanding of the marten's social system, studies should attempt to follow martens of different age classes within the same habitats.

In addition, little data is available on natural mortality rates in wild populations. One possibility would be a road-kill survey, which would be relatively cheap and would involve fewer ethical issues than do studies involving handling and collaring of wild animals. Road kills can be particularly useful to determine death rates at different ages. Even though such a survey would examine only one cause of death, it would still give a relatively good picture of mortality in stone martens given that in my study, road accidents were the most frequent cause of death.

Finally, I suggest that future research would be facilitated by making raw data from published studies publicly available. This would allow researchers to make direct comparisons between their own work and previously published work using the most appropriate methods for their research question. It would also enable meta-analyses of previously published work to be carried out since the same analytical methods could be applied to data from different studies, thus overcoming the problem, that I encountered, of different researchers analysing their data in different ways. Additionally, adding data to a large data base would increase the value of research conducted with relatively small sample sizes, which is a notorious problem in species that are as difficult and labour intensive to investigate as the stone marten.

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9 APPENDICES

9.1 APPENDIX 1:

Questionnaires (LU, FR, EN)

Stone Marten Survey

2012 (LU)

Bonjour Mme, M! Main Numm ass Lieke Mevis. Ech sin de Moment amgangen eng Dokteraarbecht iwert den Steenmarder ze schreiwen. Ech giff gären erausfannen ob ët hei zu Recken Mardern gët an wat d'Lait vun hinnen haalen. Géif ët Iech eppes ausmaachen mir dozou e puer Froen ze beäntwerten. Ët dauert just 5 Minuten

1) Hut Dir jee e Marder gesinn? Wann jo wou war dat?

Bei Iech am Haus	Bei Iech am Gaart	Hei am Duerf	Ronderem d'Duerf	Soss anzwousch	Nee
3	4	5	6	7	2

2) Hut Dir jee e Maarder héieren? Wann jo wou war dat?

	Bei Iech am Haus	Bei Iech am Gaart	Hei am Duerf	Ronderem d'Duerf	Soss anzwousch	Nee
	3	4	5	6	7	2
Ech hun Kaméidi héieren mee ech wees nët ob ët e Marder war	8	9	10	11	12	

3) Hut Dir jee Spueren vun engem Marder gesinn, zum Beispill: Kaka, Iersensreschter oder Pattenspueren. Wann jo, wou war dat? *(Kaart weisen!)*

Bei Iech am Haus	Bei Iech am Gaart	Hei am Duerf	Ronderem d'Duerf	Soss anzwousch	Nee
3	4	5	6	7	2

Wann op Fro 1), & 2) mat "Bei Iech am Haus " oder "Bei Iech am Gaart" geäntwert gin as: Weider maachen!
Wann op Fro 3) mat "Bei Iech am Haus " oder "Bei Iech am Gaart" geäntwert gin as fuer mat fro 5) weider!
Wa mat "Hei am Duerf" geäntwert gin ass dann looss Si ët op der Kaart weisen an fuer mat Fro 6) weider!
Wa mat "Nee" geäntwert gin ass dann fuer mat 6) weider!

4) Wéi Dir e Marder bei Iech am Haus oder am Gaart gesin oder héieren hut, ëm wat fir eng Daageszäit war dat?

Muejes	3	Owes	6
Mëttes	4	An der Nuecht	7
Am Nomëtten	5	WN/KA	99

5) Wéini war déi läschte Kéier, dass dir e Marder bei Iech am Haus oder am Gaart bemierkt hut?

Dës Woch	3	Firun 2-3 Méint	7
D'läscht Woch	4	Firun 3-6 Méint	8
Firun 2-3 Wochen	5	Firun ½-1 Joer	9
Firun engem Mount	6	Ët as schon méi wéi e Joer hir	10

		WN/KA	99

6) Wann Dir u Marderen denkt, empfand Dir se dann als:

Ganz negatif	6	Ganz positif	3
Eischter negatif	5	Neutral	88
Eischter positif	4	WN/KA	99

7) Fir Iech perséinlech, ass Emweltschutz:

Ganz wichteg	3	Guer nët wichteg	6
Eischter wichteg	4	Neutral	88
Eischter nët wichteg	5	WN/KA	99

8) Ärer Meenung no, maach Dir ganz vill, éischter vill, éischter wéineg oder ganz wéineg fir d'Emwelt ze schützen?

Ganz vill	3	Ganz wéineg	6
Eischter vill	4	Neutral	88
Eischter wéineg	5	WN/KA	99

9) Huet schon eng Kéier e Marder Iech e Schued gemaach? Wa jo, wat war dat?

Auto	3
Isolatioun vum Daach	4
Soss eppes:	5……………………………………………………………………………………………………..
Nee	2 *, wann mat "Nee" geäntert gin ass fuer mat 13) weider!*

10) Wéi oft hat Dir schon e Schued vun engem Marder? ……………………………………….

11) Wéini hat dir fir d'Läscht e Schued vun engem Marder?

Dës Woch	3	Firun 2-3 Méint	7
D'läscht Woch	4	Firun 3-6 Méint	8
Firun 2-3 Wochen	5	Firun ½-1 Joer	9
Firun engem Mount	6	Ët as schon méi wéi e Joer hir	10
		WN/KA	99

12) Wéi vill huet desen Schued Iech kascht?

0 €	3	2000-2999 €	8
< 250 €	4	3000-3999 €	9
250-499 €	5	>4000 €	10
500-999 €	6	WN/KA	99
1000-1999 €	7		

13) A wat fir engem Joër sid dir gebuer? …………..

14) Sid dir eng Fra oder e Mann?

Mann	1
Fra	2

Villmols merci fir är Matarbëscht! Awar Mme/M!

Stone Marten Survey

2012 (FR)

Bonjour Mme/M, je m'appelle Lieke Mevis. Je suis en train d'écrire ma thèse sur le sujet de la fouine et souhaite savoir un peu plus sur la présence de la fouine à Reckange et l'opinion des gens envers elles. Auriez-vous le temps de me répondre à quelques questions? Cela ne prendra que 5 minutes.

1) Avez-vous déjà vu une fouine? Et si oui, où s'était?

Chez vous à la maison	Dans votre jardin	Dans ce village	Dans les alentours du village	Quelle que part ailleurs	no
3	4	5	6	7	2

2) Avez-vous déjà entendu des fouines? Et si oui, où s'était?

	Chez vous à la maison	Dans votre jardin	Dans ce village	Dans les alentours du village	Quelle que part ailleurs	no
	3	4	5	6	7	2
J'ai entendu des bruits mais je ne suis pas sur si c'était bien une fouine	8	9	10	11	12	

3) Avez-vous déjà trouvé des traces de fouines? Par exemple: des excréments, des restes de nourritures, ou des traces de pattes. *(Montre la carte!)* Et si oui, où s'était?

Chez vous à la maison	Dans votre jardin	Dans ce village	Dans les alentours du village	Quelle que part ailleurs	no
3	4	5	6	7	2

Si les réponses aux questions 1) & 2) étaient "Chez vous à la maison" ou " Dans votre jardin", continues!
Si la réponse à la question 3) était "Chez vous à la maison" ou " Dans votre jardin", continues avec 5)!
Si les reposes étaient "Dans ce village", laisses leur te montrer l'endroit sur la carte et continue avec 6)!
Si les réponses étaient "No" continue avec 6!

4) Quand vous avez vu ou entendu la fouine dans votre maison ou votre jardin, à quel moment de la journée ceci s'est-il passé?

Le matin	3	Le soir	6
À midi	4	Pendant la nuit	7
Pendant l'après midi	5	NSP/PR	99

5) Quand vous êtes-vous, pour la dernière fois, aperçu la présence de la fouine dans <u>votre maison ou jardin</u>?

Cette semaine	3	Il y a 2 à 3 mois	7
La semaine dernière	4	Il y a 3 à 6 mois	8
Il y a 2 ou 3 semaines	5	Il y a un ½ à 1 an	9
Il y a un mois	6	Cela fait déjà plus qu'un an	10
		NSP/PR	99

6) Lors ce que vous pensez à une fouine est-ce que vous la considérez comme:

Très négative	6	Très positive	3
Plutôt négative	5	Neutre	88
Plutôt positive	4	NSP/PR	99

7) Considérez-vous, personnellement, la protection de la nature comme:

Très importante	3	Pas du tout importante	6
Plutôt importante	4	Neutre	88
Plutôt pas importante	5	NSP/PR	99

8) A votre avis faites-vous beaucoup, plus tôt beaucoup, plus tôt peu ou très peu pour la protection de la nature?

Beaucoup	3	Très peu	6
Plutôt beaucoup	4	Neutre	88
Plutôt peu	5	NSP/PR	99

9) Avez-vous déjà eu des dégâts causés par une fouine? Si oui, qu'est-ce que c'était?

Voiture 3
Isolation de la toit 4
Autres: 5…………………………………………………………………………………………………..
No 2 *<u>, si la réponse est no, continue avec 13!</u>*

10) Combien de fois avez-vous eu des dégâts causés par une fouine……………………………..

11) Quand a été la dernière fois que vous avez eu des dégâts causés par une fouine?

Cette semaine	3	Il y a 2 à 3 mois	7
La semaine dernière	4	Il y a 3 à 6 mois	8
Il y a 2 ou 3 semaines	5	Il y a un ½ à 1 an	9
Il y a un mois	6	Cela fait déjà plus qu'un an	10
		NSP/PR	99

12) Combiens ont coûté ces dégâts?

0 €	3	2000-2999 €	8
< 250 €	4	3000-3999 €	9
250-499 €	5	>4000 €	10
500-999 €	6	NSP/PR	99
1000-1999 €	7		

13) Quelle est l’année de votre naissance? …………..
14) Etes-vous une femme ou un homme ?

Homme	1
Femme	2

Je vous remercie beaucoup pour votre participation. Au revoir !

Stone Marten Survey

2012

Hello Ms/Mr. My name is Lieke Mevis. I am currently working on my thesis on stone martens. I want to find out whether there are martens present here in Reckange and what people think of them. Would you mind if I ask you a few questions? It will only take 5 minutes.

1) Have you ever seen martens? If yes, was this:

In your house	In your garden	In your village	Around your village	Somewhere else	No
3	4	5	6	7	2

2) Have you ever heard martens? If yes, was this:

	In your house	In your garden	In your village	Around your village	Somewhere else	No
	3	4	5	6	7	2
Heard noise but, not sure whether it was a marten	8	9	10	11	12	

3) Have you ever found traces of martens, for example faeces, food remains or tracks (show card!)? If yes, was this:

In your house	In your garden	In your village	Around your village	Somewhere else	No
3	4	5	6	7	2

If questions 1) & 2) & are answered with "in your house" or "in your garden" continue!
If question 3) was answered with "in your house" or "in your garden" go to 5!
If they answer with" in your village" or "around your village" let them point it out on map and go to 6)!
If they answer with "no" go to 6)!

4) When you saw or heard a marten in your house or garden, at what time of day was this?

Morning	3	Evening	6
Midday	4	At night	7
Afternoon	5	DK/NA	99

5) When was the last time that you noticed a marten in your house or garden?

This week	3	2-3 months ago	7
Last week	4	3-6 months ago	8
2-3 weeks ago	5	6 months to a year ago	9
A month ago	6	More than a year ago	10
		DK/NA	99

6) When you think about martens do you perceive them as:

Very negative	6	Very positive	3
Fairly negative	5	Neutral	88
Fairly positive	4	DK/NA	99

7) How important is protecting the environment to you personally?

Very important	3	Not at all important	6
Fairly important	4	Neutral	88
Not very important	5	DK/NA	99

8) In your opinion, are you currently doing very much, fairly much, fairly little or very little to protect the environment?

Very much	3	Very little	6
Fairly much	4	Neutral	88
Fairly little	5	DK/NA	99

9) Have you ever had damage caused by martens on your property? If yes, what was damaged?

Car	3
Roof insulation	4
Other:	5…………………………………………………………………………………………….
No	2*, if "No" go to question 13!*

10) How many times did you have damage caused by a marten?

………………………………………………………….

11) When was the last time that you had damage caused by a marten?

This week	3	2-3 months ago	7
Last week	4	3-6 months ago	8
2-3 weeks ago	5	6 months- a year ago	9
A month ago	6	More than a year ago	10
		DK/NA	99

12) What where the financial costs of this damage?

0 €	3	2000-2999 €	8
< 250 €	4	3000-3999 €	9
250-499 €	5	>4000 €	10
500-999 €	6	DK/NA	99
1000-1999 €	7		

13) What year were you born? …………..

14) Are you a woman or a man?

Man	1
Woman	2

Thank you very much for you cooperation!

Goodbye!

9.2 APPENDIX 2:

Tables of survey results

Table 9.1

When you think about martens do you perceive them as: * age category Crosstabulation

			age category			Total
			15-29	30-54	55+	
When you think about martens do you perceive them as:	Very positive	Count	1	21	15	37
		% within age category	5.9%	21.2%	18.5%	18.8%
	Fairly positive	Count	9	39	31	79
		% within age category	52.9%	39.4%	38.3%	40.1%
	Neutral (spontaneous)	Count	5	11	13	29
		% within age category	29.4%	11.1%	16.0%	14.7%
	Fairly negative	Count	2	24	17	43
		% within age category	11.8%	24.2%	21.0%	21.8%
	Very negative	Count	0	4	5	9
		% within age category	.0%	4.0%	6.2%	4.6%
Total		Count	17	99	81	197
		% within age category	100.0%	100.0%	100.0%	100.0%

Table 9.2

How important is protecting the environment to you personally? * age category Crosstabulation

			age category			Total
			15-29	30-54	55+	
How important is protecting the environment to you personally?	Very important	Count	8	65	52	125
		% within age category	47.1%	65.7%	64.2%	63.5%
	Fairly important	Count	9	30	21	60
		% within age category	52.9%	30.3%	25.9%	30.5%
	Neutral (spontaneous)	Count	0	1	6	7
		% within age category	.0%	1.0%	7.4%	3.6%
	Not very important	Count	0	3	0	3
		% within age category	.0%	3.0%	.0%	1.5%
	Not at all important	Count	0	0	2	2
		% within age category	.0%	.0%	2.5%	1.0%
Total		Count	17	99	81	197
		% within age category	100.0%	100.0%	100.0%	100.0%

Table 9.3

In your opinion are you currently doing very much, fairly much, fairly little or very little to protect the environment? * age category Crosstabulation

			age category			Total
			15-29	30-54	55+	
In your opinion are you currently doing very much, fairly much, fairly little or very little to protect the environment?	Very much	Count	0	6	15	21
		% within age category	.0%	6.1%	18.5%	10.7%
	Fairly much	Count	9	62	38	109
		% within age category	52.9%	62.6%	46.9%	55.3%
	Neutral (spontaneous)	Count	4	10	21	35
		% within age category	23.5%	10.1%	25.9%	17.8%
	Fairly little	Count	4	20	5	29
		% within age category	23.5%	20.2%	6.2%	14.7%
	Very little	Count	0	1	2	3
		% within age category	.0%	1.0%	2.5%	1.5%
Total		Count	17	99	81	197
		% within age category	100.0%	100.0%	100.0%	100.0%

Table 9.4

When you think about martens do you perceive them as: * How important is protecting the environment to you personally? Crosstabulation

			How important is protecting the environment to you personally?					
			Very important	Fairly important	Neutral (spontaneous)	Not very important	Not at all important	Total
When you think about martens do you perceive them as:	Very positive	Count	28	7	0	1	1	37
		% within How important is protecting the environment to you personally?	22.4%	11.7%	.0%	33.3%	50.0%	18.8%
	Fairly positive	Count	50	27	1	1	0	79
		% within How important is protecting the environment to you personally?	40.0%	45.0%	14.3%	33.3%	.0%	40.1%
	Neutral (spontaneous)	Count	16	11	1	1	0	29
		% within How important is protecting the environment to you personally?	12.8%	18.3%	14.3%	33.3%	.0%	14.7%
	Fairly negative	Count	26	14	2	0	1	43
		% within How important is protecting the environment to you personally?	20.8%	23.3%	28.6%	.0%	50.0%	21.8%
	Very negative	Count	5	1	3	0	0	9
		% within How important is protecting the environment to you personally?	4.0%	1.7%	42.9%	.0%	.0%	4.6%
Total		Count	125	60	7	3	2	197
		% within How important is protecting the environment to you personally?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 9.5

When you think about martens do you perceive them as: * Have you ever had damage caused by a marten on your property? Crosstabulation

			Have you ever had damage caused by a marten on your property?		
			Yes	No	Total
When you think about martens do you perceive them as:	Very positive	Count	18	19	37
		% within Have you ever had damage caused by a marten on your property?	20.9%	17.1%	18.8%
	Fairly positive	Count	28	51	79
		% within Have you ever had damage caused by a marten on your property?	32.6%	45.9%	40.1%
	Neutral (spontaneous)	Count	9	20	29
		% within Have you ever had damage caused by a marten on your property?	10.5%	18.0%	14.7%
	Fairly negative	Count	23	20	43
		% within Have you ever had damage caused by a marten on your property?	26.7%	18.0%	21.8%
	Very negative	Count	8	1	9
		% within Have you ever had damage caused by a marten on your property?	9.3%	.9%	4.6%
Total		Count	86	111	197
		% within Have you ever had damage caused by a marten on your property?	100.0%	100.0%	100.0%

Table 9.6

When you think about martens, do you perceive them as: * What was damaged? Crosstabulation

			What was damaged?				Total
			Car	Roof insulation	Other	Pet animal	
When you think about martens, do you perceive them as:	Very positive	Count	17	0	0	1	18
		% within What was damaged?	21.8%	.0%	.0%	20.0%	20.9%
	Fairly positive	Count	28	0	0	0	28
		% within What was damaged?	35.9%	.0%	.0%	.0%	32.6%
	Fairly negative	Count	20	2	1	0	23
		% within What was damaged?	25.6%	100.0%	100.0%	.0%	26.7%
	Very negative	Count	4	0	0	4	8
		% within What was damaged?	5.1%	.0%	.0%	80.0%	9.3%
	Neutral (spontaneous)	Count	9	0	0	0	9
		% within What was damaged?	11.5%	.0%	.0%	.0%	10.5%
Total		Count	78	2	1	5	86
		% within What was damaged?	100.0%	100.0%	100.0%	100.0%	100.0%

Table 9.7

When you think about martens do you perceive them as: * What were the financial costs of this damage? Crosstabulation

			What were the financial costs of this damage?							
			0 euro	less than 250 euro	250-499 euro	1000-1999 euro	2000-2999 euro	3000-3999 euro	more than 4000 euro	Total
When you think about martens do you perceive them as:	positive	Count	9	13	5	1	0	0	0	28
		% within What were the financial costs of this damage?	75.0%	56.5%	71.4%	100.0%	.0%	.0%	.0%	59.6%
	DK/NA	Count	2	2	1	0	0	0	0	5
		% within What were the financial costs of this damage?	16.7%	8.7%	14.3%	.0%	.0%	.0%	.0%	10.6%
	negative	Count	1	8	1	0	1	1	2	14
		% within What were the financial costs of this damage?	8.3%	34.8%	14.3%	.0%	100.0%	100.0%	100.0%	29.8%
Total		Count	12	23	7	1	1	1	2	47
		% within What were the financial costs of this damage?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 9.8

When you think about martens do you perceive them as: * How many times have you had damage caused by a marten? Crosstabulation

			How many times have you had damage caused by a marten?									Total
			1	2	3	4	5	6	10	12	15	
When you think about martens do you perceive them as:	positive	Count	27	14	3	1	1	0	0	0	0	46
		% within How many times have you had damage caused by a marten?	57.4%	60.9%	50.0%	33.3%	100.0%	.0%	.0%	.0%	.0%	54.8%
	DK/NA	Count	5	3	0	0	0	0	0	0	0	8
		% within How many times have you had damage caused by a marten?	10.6%	13.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	9.5%
	negative	Count	15	6	3	2	0	1	1	1	1	30
		% within How many times have you had damage caused by a marten?	31.9%	26.1%	50.0%	66.7%	.0%	100.0%	100.0%	100.0%	100.0%	35.7%
Total		Count	47	23	6	3	1	1	1	1	1	84
		% within How many times have you had damage caused by a marten?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%