Common dormouse (*Muscardinus avellanarius*) movements in a landscape fragmented by roads

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Abstract: The common dormouse (*Muscardinus avellanarius*) is widespread in Europe but populations have declined in some countries as a result of habitat loss and fragmentation. A population of common dormice living beside a dual carriageway road in southwest England was studied in 2007-2010 in order to investigate the impacts of roads on habitat fragmention at the local scale (tens of metres), i.e. the possible isolating effects of roads for a population. Each carriageway was eight metres wide with verges of two metres. Nest boxes and nest tubes were installed on each side of the road, and on the central reservation where areas of woodland or scrub existed. Animals were individually marked using implanted microchips (PIT tags). Common dormice were found in fragments of woodland or scrub as small as 0.2 ha and breeding was regularly recorded in fragments of 0.5 ha or larger. Common dormice were not present in all fragments in all years. Two individuals moved between the central reservation and the side of the road and there was indirect evidence of additional road crossings. This has implications for the conservation of dormice at the landscape scale where it is important to understand the extent to which roads are barriers to movement and the extent to which dormice will use fragmented habitats. It is also important to understand the extent to which dormice use habitats which are fragmented by roads when carrying out surveys for common dormice in connection with development and in mitigating the impacts of this development.

Keywords: *Muscardinus avellanarius*, dormouse, habitat fragmentation, metapopulation, road.

Introduction

The common dormouse (*Muscardinus avellanarius*) is a small arboreal rodent which is found throughout Europe, from southwest England and Brittany to northern Turkey and parts of central Russia and from southern Sweden to Sicily and central Greece (Juškaitis 2008). In many parts of its range (including the UK) it has declined in numbers in recent years (Verbeylen 2006) and is protected throughout the European Union as a consequence (Bright et al. 2006).

It has been suggested that the main reasons for its decline in the UK are loss and fragmentation of habitat combined with changes in woodland management practices which have led to a massive reduction in the practice of coppicing (Anonymous 2010). Juškaitis (2008) reviewed reports from several European countries citing similar impacts.

Common dormice are considered to be woodland specialists and it has been suggested that semi-natural ancient woodland where hazel is managed on a long rotation coppice cycle provides the best conditions for them (Bright et al. 1996). However, Eden & Eden (1999) have pointed out the importance of both hedgerows and scrub as habitats for common dormice in southern England and the Dormouse Conservation Handbook

(Bright et al. 2006) advises that all woody areas should be regarded as potential habitats for this species. Elsewhere in Europe common dormice are able to exploit a wide range of woodland habitats, including those dominated by spruce (*Picea abies)* and birch (*Betula pendula* and *Betula pubescens)* in Lithuania (Juškaitis 2008) and, as reviewed by Juškaitis (l.c.) dwarf pine (*Pinus mugo*) in the Tatra mountains (Miklós & Buchamerová 2004), former Czechoslovakia (Andera 1987) and former Yugoslavia (Kryštufek & Tvrtkovič 1988, Kryštufek & Petkovski 1990). In several countries, common dormice have been recorded in non-wooded habitats including Culm grassland (poorly drained, acid pasture dominated by *Molinia caerulea* and *Juncus* spp.) in the UK (Chanin & Woods 2003), and, again following Juškaitis (l.c.), wet meadow in Poland (Białas et al. 1989) and reedbeds in Germany (Berthold & Querner 1986).

Studies by Bright et al. (1994) in the UK and Mortelliti et al. (2010) in Italy have examined the effects of habitat fragmentation and isolation on common dormice at the landscape scale. Bright et al. (l.c.) reported that both isolation and woodland size affected distribution and also noted the effects of hedgerow prevalence on common dormouse incidence. They suggested that for isolated woodlands, 20 ha might represent the minimum size which could ensure the long term survival of a common dormouse population. Mortelliti et al. (l.c.), working in a very different landscape, demonstrated the independent importance of habitat loss and of habitat fragmentation in determining the distribution of common dormice and red squirrels (*Sciurus vulgaris*), showing that habitat loss has the greater effect. They also showed that hedgerows were a factor in determining the distribution of dormice but not of squirrels.

Bright & Morris (1991, 1992) reported that radio-tracked common dormice were reluctant to descend to the ground to cross quite small gaps (a few metres) between blocks of continuous habitat. They noted that on some occasions dormice made quite substantial detours to avoid doing so. However, P.A. Morris (personal communication) has also found dormice on the central reservation of a dual carriageway in southeast England (the A21). Wouters et al. (2010) reported finding dormouse nests in a dense patch of bramble scrub, less than 100 m^2 in area which was isolated from other habitat by 15 m of tarmac. In central Germany dormice were found to inhabit a high proportion of traffic island at interchanges between a motorway and side roads (Schulz et al., in press). All 20 islands larger than 0.2 ha had signs of dormice whereas signs were only found at two of the four islands smaller than this. Moreover, Juškaitis (2008) reported several examples of common dormice crossing distances of 5 m to 50 m across the ground and Büchner (2008) reported six common dormice crossing 250-500 m across a treeless landscape between patches of woodland. These greater distances were probably made during dispersal but Juškaitis (l.c.) found one common dormouse using an isolated nest box which it had to cross 50 m on the ground to reach, suggesting that such distances may be covered in the

Figure 1. Location of the site in southwest England. The inset detail shows the route of the A30 (thick line) heading west from Exeter, past Bodmin (filled squares).

course of day to day activities.

Radio tracked common dormice in woodland rarely moved more than 70 m from their nest (Bright et al. 1991), while Naim (2010) observed movements up to 600 m within continuous woodland. In these cases dormice did not need to cross the ground.

We have detected common dormice crossing the ground over small distances (10-20 m) to use small fragments of habitat (<100 m^2) in the course of survey work in the UK (personal observations), but were unable to determine whether or not this was frequent behaviour.

Dormice are frequently present at sites where developments are planned in southern England (personal observation of the first author) and it is important to take their behaviour into account when planning mitigation for this (Bright et al. 2006). There is a clear need to understand the extent to which roads are a barrier to movement and to which dormice can exploit fragmented habitats. The discovery that dormice occurred on the central reservation of a major road in southwest England in 2003 (M. Pickard, personal communication) encouraged us to investigate this further. During 2006, a preliminary survey using nest tubes showed that dormice were still present and a larger scale study was initiated in 2007. The aim of the work described here is to determine the extent to which such movements might enable common dormice to exploit habitats which are fragmented by roads at the scale of tens of metres, creating fragments of habitat which are less than one hectare in size.

Methods

Our study site in southwest England, UK stretched along two kilometres of the A30 in Cornwall, and is five kilometres to the northwest of Bodmin (figure 1). The road is dual carriageway with narrow strips of woodland and scrub less than 20 m wide on the central reservation and adjacent road sides. The estimated Average Annual Daily Flow of vehicles

Table 1. Habitat description, area and number of nest boxes for each section.

Sections	Approximate area (ha)	No. of boxes	Habitat description
S1	0.5	11	Small young woodland plot. Mostly birch, pine and sycamore surrounded by gorse and bramble.
S2	0.4	9	Scattered scrub comprising gorse, bramble and pockets of hawthorn.
S3*	0.2	5	Dense scrub comprising tall gorse, hazel and hawthorn. This section is connected to a large area of gorse and blackthorn scrub over ten hectares.
S4*	10	3	This section is connected to S3 via habitat outside the highway boundary. Mostly young blackthorn thicket close to the road.
C1	0.3	6	Tree plot with ash and hazel predominantly, surrounded by gorse and bramble.
C2	0.9	20	Linear tree plot in central reservation with ash and sycamore being the main species and occasional oak, hazel and hawthorn. Gorse and bramble is found at localised areas throughout this plot.
C3	0.7	20	Long plot of linear willow, hazel and hawthorn with occasional gorse and pockets of bramble.
N1	0.3	13	A fairly open area at the eastern end of the plot with localised areas of gorse and scattered oak, willow, hawthorn and bracken changing to dense gorse and blackthorn/hawthorn thicket to the west.
N2*	0.7	13	Mature hazel, willow and stunted oak from a remnant hedgerow dominate this section together with occasional gorse, blackthorn, bramble and honeysuckle.

*connected with suitable habitat outside the study site.

Figure 2. View from section C1 looking west with C2 to the left, N1 and N2 to the right. *Photograph: Paul Chanin.*

Figure 3. Semi-natural woodland at N2 in early spring with oak and hazel predominating. *Photograph: Paul Chanin*.

Figure 4. C1 during the summer with ash, hazel and gorse in view. *Photograph: Paul Chanin.*

Figure 5. C2 in winter with ash and hawthorn visible. *Photograph: Paul Chanin.*

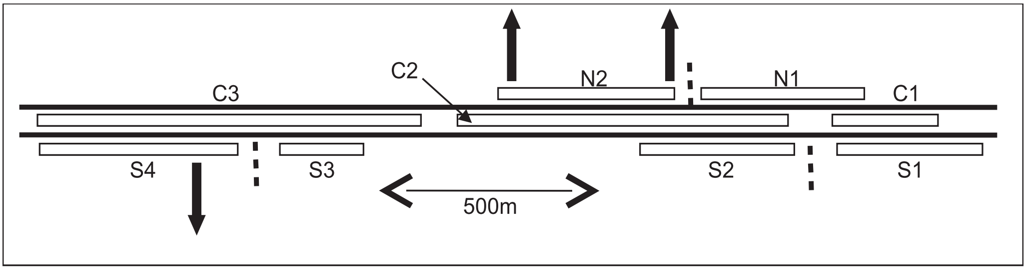

Figure 6. Schematic layout of sections with width not to scale. The study site is two km long and up to 75 m wide. Solid lines are carriageways, dashed lines are side roads, arrows indicate connections to off-site habitat.

was 23,143 between 2007 and 2010 (Department for Transport 2012). However this road is a major holiday route and traffic flows peak at summer weekends. The highest recorded flow on a single day in 2011 was 36,039 vehicles in August (O. Dash, personal communication). The study site was limited to land designated as highway, which was all within 20 m of the road edge. The maximum width across the site was 70 m.

The habitats in which common dormice were found consisted of semi-natural woodland, plantation (including broadleaved as well as coniferous species) and scrub, beside the road and on the central reservation (table 1 and figures 2-5). Some of this was close, or connected, to off-site vegetation which was suitable for dormice but there were several isolated fragments of potential common dormouse habitat which could not be reached without crossing the ground, including three separate sections on the central reservation. The fragments on the central reservation were separated from previously connected habitat when the road was upgraded from single to dual carriageway. They have been isolated for a minimum of 25 years. All isolated habitat fragments were less than 1 ha in size and all could be reached by crossing gaps no greater than twelve metres (of which eight metres was road surface and four metres grass verge). Gaps between some adjacent fragments along the length of the road were greater than this (maximum of 100 m on central reservation, 500 m on south side of the road) and some were less, across minor roads or tracks. Eight of the fragments were narrow (<20 m wide) and connections to nearby habitat were via hedges or trees and shrubs of a similar width. One, S4, was connected throughout its length to off-site habitat which was not surveyed.

Nine fragments of common dormouse habitat, referred to as ‘sections’, were numbered sequentially from east to west with a prefix letter referring to their location on the north side of the road, south side, or central reservation (N, S, C respectively) (figure 6). Nest boxes were distributed amongst them, approximately in proportion to the length of road along which they stretched, due to the linear nature of the habitat which did not permit a grid to be used. Within these, nest box density was fairly uniform (approximating to 20 ha^{-1}). In S4, where only a small proportion of the habitat was at the roadside, approximately 100 m of road was monitored but the density of boxes was very low (0.3 ha^{-1}).

We used 100 dormouse nest boxes (Heavy Duty Dormouse Boxes supplied by Alana Ecology Ltd, Totnes, UK) as our principle means of sampling the population, since we wished to monitor all aspects of common dormouse behaviour, including breeding (figure 7). These were spaced at intervals of 30 m and at heights up to two metres, attached by wire to trees or shrubs. In the hope that it would increase the probability of finding dormice we also installed 200 nest tubes, interspersed with the boxes at a spacing of ten metres and wired to horizontal branches (Chanin &

Figure 7. A nest box attached to a small tree by wire. *Photograph: Paul Chanin.*

Figure 8. A nest tube wired to a small sycamore. *Photograph: Paul Chanin.*

Gubert 2011) (figure 8).

Boxes and tubes were installed in March 2007 and checked monthly from April to October in 2007 and 2008. In 2009 and 2010 checking ended in September as no dormice had been recorded in October in the previous years. Most boxes were only checked once per month but on a few occasions, checks were spread over two days when a large number of animals had to be handled. When this occurred, small numbers of nest boxes and nest tubes which had been occupied on the first day were rechecked on the second to determine whether occupancy had changed overnight.

Dormice over 12 g in weight were marked on first capture with radio-frequency identification tags, also known as PIT (passive integrated transponder) tags (FDXB – 8 mm tags manufactured by pet-iD UK Ltd, Hassocks, UK) under the terms of annual licences from Natural England. Dormice which did not have an adult pelage (i.e. they had greyer fur) were classified as juveniles. One adult female dormouse was not tagged because she was heavily pregnant. Captured dormice were scanned with an 'iDentifier' (manufactured by pet-iD UK Ltd) weighed, sexed and their reproductive condition assessed.

Results

Captures and movements

Sixty-two common dormice were marked during the course of the study, and a few individuals escaped before marking. Nine juveniles were tagged (three females, six males) and of the 53 tagged adults, 37 (70%) were female. Animals which were not tagged (including the pregnant female referred to above) were discounted from analyses as we were unable to record their movements and they could have been subsequently recaptured and included in the marked population. 88% of all captures were in nest boxes. More detailed information, such as the number of

Table 2. Evidence for dormice crossing a carriageway.

	Common dormice	Between sections
Proven: *n*=3		
	Dm 02	S3 to C3
	Dm39	C1 to N1 N1 to C1
Strong evidence: *n*=5		
	Dm39 before first capture Dm03, Dm09, Dm45, Dm60	N1 to C1

males, females and juveniles (re)captured per patch and year, has been published elsewhere (Chanin & Gubert 2011).

Only four adult dormice were first 'caught' (i.e. found in a nest box or tube) on the south side of the road, 25 on the central reservation and 24 on the north side. Two animals were caught on the side of the road as well as on the central reservation. Twenty-two of the marked animals were caught more than once (including one juvenile), with the total number of captures reaching 103.

We observed three movements between sections. One adult female (Dm02) was caught first on the south side of the road (S3) in April 2007 and again 12 months later on the central reservation (C3) approximately 80 m away in a direct line. An adult male (Dm39), first caught in C1 in April 2009 was found a month later in N1, almost directly opposite - ca. 30 m away. The following day it was back in the original nest box on the central reservation. No evidence of breeding was recorded in C1 (no juveniles were found, no females showing signs of pregnancy, lactation or recent lactation). We therefore conclude that Dm39 must have crossed one additional time from the edge of the road (probably N1) to get to the central reservation before we first caught it.

We have no other direct evidence of movements between sections but noted that in addition to Dm39, four dormice were caught in C1 (two males, two females), despite the fact that we never recorded breeding in this small (0.2 ha) section. The only source of the dormice in C1 is that they crossed the road to get there and we consider this to be strong indirect evidence of further crossings. We therefore have strong or direct evidence for 8 crossings of the road during the four years of our study (table 2). We know that at least two male and four female dormice were involved.

We know that Dm39 crossed the carriageway twice between 28 April and 28 May, 2009. Captures of Dm02 were a year apart but she was first recorded on the central reservation in May 2008. Three of the other four dormice caught in C1 were first captured in either April or May, one in July.

Use of sections

Dormice were never recorded in sections S2 and S4 but were present in the other sections for one to four years of the study (table 3). Breeding occurred in three out of four years in C2 and N2, less frequently elsewhere. The highest numbers of captures were also recorded in these two sections.

Although section S4 was considerably larger than others, much of this was away from the road side and outside the study site. Only three nest boxes (and four tubes) were installed along the carriageway here and the density of boxes much lower than in others. The absence of dormouse captures from this large block may be influenced by this. Excluding S4, breeding was more likely to occur in sections of 0.5 ha or greater (eight times out of a possible 16 opportunities - four sections for four years) than those smaller than 0.5 ha

Table 3. Pattern of use of each section by dormice during the four years of the study.

	2007	2008	2009	2010
N1	-	Present	Present	Present
N2	Breeding	Breeding	Breeding	-
C1	Present	Present	Present	Present
C2	Breeding	Breeding	Present	Breeding
C3	Breeding	Present	Present	Present
S1	-	-	Present	Breeding
S2	-	-	-	-
S3	Present		Breeding	Present
S4	-	-	-	-

(two out of 16 opportunities). Nevertheless one female dormouse produced a litter in the smallest section, i.e. 0.2 ha in extent (table 3). Excluding S4 there is a significant difference in the frequency that breeding was recorded in blocks less than 0.5 ha compared to those of 0.5 ha or greater ($\chi^2 = 5.24$, df=1, $P<0.05$)

Discussion

Our results do not contradict those of Bright et al. (1994) and Bright (1998) who stated that common dormice were ‘reluctant’ to cross gaps and populations were ‘less likely to persist’ in woods smaller than 20 ha. However, the results presented here do demonstrate that common dormice are more flexible in their use of habitats than may be implied by these authors. While dormice might be reluctant to cross gaps, they are clearly capable of crossing at least one carriageway of a major road which, during the summer, can be very busy. In addition, while isolated populations in small woods may be vulnerable to extinction, aggregations of very small fragments of habitat (<1 ha) might enable populations to persist over considerable periods of time, where they are sufficiently close to one another to permit recolonisation.

It is difficult to compare our results with those of Mortelliti et al. (2010) who worked in a very different landscape where arable land and land cultivated for vines, fruit and olive trees dominated the landscape. Much of southwest England is farmed as pasture with very small fields and a dense network of hedges. Their conclusion, that the distribution of common dormice is affected by habitat fragmentation, is likely to be dependent on the scale at which fragmentation is measured. We have shown that dormice were breeding in fragments of habitat isolated by roads at least 25 years after the road was constructed.

The area studied by Büchner (2008) in East Germany is more similar to ours, in that his habitat fragments were relatively small (0.66 ha to 4.25 ha), though more widely separated than ours. Capturing common dormice in both nest boxes and live traps, he marked 204 animals in a two year period. Of the 164 recaptures of dormice, six were of dormice which had moved between woodlands over distances ranging from 350-840 m. All these movements involved travelling on the ground through crops including clover, wheat and maize. The minimum distances crossed on the ground ranged between 250 m and 500 m.

Schulz et al. (in press), found considerable numbers of dormouse nests in some areas of roadside habitat. At one complex interchange they recorded 153 nests over a period of three years in 8.8 ha of woodland. Seventy-five percent of these were in fragments of habitat isolated by roads from the surrounding countryside. They concluded that dormice do not avoid the proximity of roads and suggested that roadside habitat might function as a good habitat for dormice, including as dispersal routes. However they also pointed out that as well as offering potential benefits to dormice, roads might have negative impacts resulting from noise, pollution and road deaths.

They observed the presence of dormice in fragments smaller than any of ours (<0.2 ha) noting that in their sample, fragments large than this all had dormice present whereas not all of those smaller than this did. They did not catch or mark individual dormice and had no indication as to whether or not breeding occurred but pointed out that they recorded more than 20 instances where dormice had crossed a road at least once to colonise habitat which had been planted following road construction.

Bright et al. (1994) stated that their data imply a possible metapopulation model and our results, together with those of Büchner (2008) and Schulz et al. (l.c.) support that hypothesis. Bright et al. emphasised the importance of connecting hedges in this context but we have shown that dormice are willing to cross very open, exposed ground for short distances as have Schulz et al. while Büchner's data indicate that they may cross a few hundred metres over ground which has no trees or shrubs but does offer concealment in the form of agricultural crops.

A study by Macpherson et al. (2010) showed that both wood mice (*Apodemus sylvaticus*) and bank voles (*Myodes glareolus*) crossed small, single carriageway roads. In the absence of intervention, 7% of wood mice and 12% of bank voles crossed a six metre wide road, with 28% and 22% respectively crossing a road of 2.5 metres in width. Both species frequently travelled distances greater than these road widths in the course of their normal travels, suggesting that home ranges were normally confined to one side of the road or the other. Forty nine animals were translocated from one side of a road to the other and 16 (33%) of these crossed back again. In our study there is strong evidence that six (11%) of 53 adults crossed the road with no intervention. Given that common dormice are arboreal whereas wood mice and bank voles spend a considerable amount of time on the ground, this seems high, but may reflect the fragmented nature of the habitat in our study site such that dispersal movements of any dormice were likely to include a road crossing.

We were unable to determine whether or not the presence of the road has an impact on the mortality of common dormice. Of the 62 dormice marked, 10 were caught in two consecutive years and none in three or more years. However, our sample is very small and apart from the few juveniles that were marked we did not know the ages of the animals we captured. Therefore comparisons with the life tables presented by Juškaitis (2008) are very difficult to make. He showed that spring-born young had mortality rates of 60-70% in the first two years of life so the probability of finding dormice of three years or greater was small in our area with the sample size that was achieved.

Reasons for crossing

We only know the actual timing of crossing for one animal (Dm39), which crossed twice in April/May but there is a preponderance of first captures of dormice in S1 and C1 during these two months, not long after dormice have left hibernation and just before the onset of the breeding season. However we do not know whether these dormice had crossed the carriageway immediately before they were captured or in the previous autumn prior to hibernation. Crossing of the road might therefore be a dispersal movement or in connection with breeding.

A further possibility is that dormice crossed the road to gain access to food. Comparisons of the species present in the sections between which movements occurred or were inferred, show that ash (*Fraxinus excelsior*) is the main species present in C1 but not N1. One would expect ash to be particularly favoured when it is fruiting, later in the year than these movements. Bright and Morris (1993) found that common dormice did not favour ash trees and that fruit-bearing species, such as wayfaring tree (*Viburnum lantana*) and bramble (*Rubus fruticosus*), were taken in preference. Ash trees were visited most frequently during August and October in their study. The main difference between S3 and C3 (one movement recorded) is that willow (*Salix sp.*) is present in the latter. The timing of crossing is unknown but the animal was present in C3 in the spring not the fruiting season.

Juškaitis (2008) observed that 90% of first year common dormice were found in the same area in the spring as they had been the previous autumn suggesting that most dispersal on his study site occurred before hibernation although dispersal movements also occurred at the beginning of the year following birth, where young male dormice were found sharing nest boxes with adult males and subsequently moved away. The high proportion of females crossing the road in our study suggests that breeding may not be the primary motivation since there is good evidence that it is the males which move the greatest distances during the breeding season (Juškaitis 2008, Naim 2010). Our data therefore provide greater (though weak) support for movements across the road being related to dispersal rather than breeding.

One factor which may promote dispersal across roads in our study site is the fact that habitat fragments are small.

Conclusions

We have shown that common dormice are able to exploit small fragments of habitat (<1 ha) separated by roads where the distances to be crossed are no greater than twelve metres. These results have implications for the conservation of this rare species and in the practical implementation of legislation which affects it.

A recent review of national conservation efforts in the UK pointed out the need to "Enhance connections between, or join up, sites, either through physical corridors, or through 'stepping stones'." (Lawton et al. 2010). Local efforts to achieve this have been initiated, with common dormice considered a significant beneficiary (Nelson 2010, Al Fulaij 2010). Small fragments of habitat, which are partially isolated but not remote from each other may have an important role to play as such 'stepping stones', and medium sized roads (up to 12 m including verge) should not be seen as barriers to the movements of common dormice.

These factors may also be important in planning mitigation for common dormice where development might otherwise lead to fragmentation and loss of habitat. Consideration could be given to incorporating roadside planting in an effort to minimise the distances that dormice have to cross over open ground as an alternative to promising, although somewhat more complex, approaches using bridges over roads (Stride 2009, Morris & Minato 2012). Planting of even quite small areas of scrub or woodland may increase breeding opportunities for dormice provided the level of isolation is low and the areas are greater than 0.5 ha. Extensive planting of suitable habitat along roads will also promote dispersal and has the potential to link patches of habitat which would otherwise be otherwise isolated. Further studies to assess the risk of these patches creating a sink would be valuable.

We also believe that guidelines for ecological consultants who are considering whether or not habitat is suitable for common dormice, may need to be revised to take into account the fact that small fragments of habitat are readily used by them. For example, the Dormouse Conservation Handbook (Bright et al. 2006) states that "Dormice have been found in small woods (even down to two hectares where other suitable habitat is adjacent)". Clearly this value can be reduced by an order of magnitude.

In addition, the fact that dormice do not permanently inhabit some fragments means that surveys done in a single season and limited to one fragment may fail to reveal the fact that an area is used by dormice, though not on a permanent basis. Under such circumstances, where dormice are not found during surveys but are known to be present nearby, it would be prudent to act on the assumption that dormice could be present in subsequent years.

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Samenvatting

Verplaatsingen van hazelmuizen (*Muscardinus avellanarius*) in een door een weg verdeeld landschap

De hazelmuis komt in Europa op veel plaatsen voor. In sommige landen zijn de populaties afgenomen als gevolg van het verlies en versnippering van habitat. Wij bestudeerden een populatie hazelmuizen die leeft langs een autosnelweg in zuidwestelijk Engeland met als doel om op plaatselijk niveau na te gaan wat de invloed van die weg is in de vorm van versnippering van het habitat van de hazelmuis. Beide wegstroken zijn acht meter breed en hebben bermen van twee meter breed. Op plaatsen met wat bomen en struikgewas installeerden we nestkasten en nestbuizen, aan beide kanten van de weg en in de middenberm. Gevangen dieren werden met een microchip individueel herkenbaar gemerkt. We troffen hazelmuizen aan in bosjes met een omvang van minimaal 0,2 ha, in bosjes van minimaal 0,5 ha vonden we regelmatig nesten. Op de onderzochte locaties waren niet in alle onderzoeksjaren hazelmuizen aanwezig. Twee individuen verplaatsten zich van de middenberm naar de zijbermen van de weg en we verkregen indirect bewijs voor meer van dergelijke verplaatsingen. Deze waarnemingen hebben implicaties voor de bescherming van de hazelmuis op landschapsniveau, aangezien het daarbij van belang is om te weten of en in welke mate wegen barrières vormen voor verplaatsingen tussen dit soort snippers en daarmee voor de mate waarin deze snippers geïsoleerd zijn. Kennis van de versnipperende werking van wegen is ook van belang in verband met de ontwikkeling en het vaststellen van de effectiviteit van mitigerende maatregelen.

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