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The use of nest boxes to survey marginally distributed Fat dormouse *Glis glis* in Latvia

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Abstract

The use of nest boxes in different studies of arboreal mammals, such as dormouse, is a widely accepted method. We examined the use of this method to survey a marginal population of Fat dormouse (*Glis glis*) living in a mixed, oldgrowth broadleaf forest in Gauja National Park. A total of 104 nest boxes and 15 nest tubes designed for dormice were set up in five study sites: both in areas with potential dormice presence and where likelihood of presence was only theoretical. Nest boxes were readily used by *G. glis* in two study sites. During a four-year period we obtained preliminary results also on dynamics of nest box use, habitat preferences, relative abundance and reproduction of *G. glis* living in the most northern part of the range. Altogether 41 dormice including 35 juveniles were captured. *G. glis* showed clear preference to areas with oldgrowth oaks having wide canopies. In this habitat type the abundance of *G. glis* was estimated to be two individuals per ha or 20 individuals per 100 nest boxes. Nevertheless, the species proved to be rare in Gauja National Park, probably due to scatter and isolation of suitable habitats.

Key words: *Glis glis*, marginal population, nest boxes, relative abundance, Latvia.

Introduction

The Fat or Edible dormouse (*Glis glis*), similar to other dormice species, is an arboreal mammal that uses tree holes as nest sites both for daily rest and rearing of young (Storch 1978; Airapetyants 1983; Rossolimo et al. 2001). *G. glis* is known also to use nest boxes set up for cavity-nesting birds. Therefore, the use of nest boxes is a widely accepted method to investigate the distribution and different aspects of ecology of Fat dormouse (e.g., Schlund et al. 1997; Juškaitis 1999; Burgess et al. 2003; Juškaitis 2003; Kryštufek et al. 2003; Milazzo et al. 2003; Bako, Hecker 2006). Long-term studies using nest boxes have shown the effect of climatic changes on *G. glis* populations (Koppmann-Rumpf et al. 2003). The National Dormouse Monitoring Programme in the UK is based on the use of nest boxes (Morris 2003).

In Latvia nest boxes for birds have been widely used already for a long time since the 1940s both to study and to monitor cavity-nesting birds (Vilka 1999) as well as to increase the abundance of cavity-nesting birds in managed forests in order to reduce populations of forest insect pests (Mihelsons, Vilka 1974). Common dormouse (*Muscardinus avellanarius*) is sometimes observed in nest boxes for birds if they are placed in habitats

suitable for this dormouse species (Štrauss 1959; Štrausa 1999). Nest boxes for birds were used successfully to identify the presence of *M. avellanarius* in a study (LIFE project) area (Pētersons 2003). The presence of the Forest dormouse (*Dryomys nitedula*) in Latvia was discovered by checking nest boxes (Kasparsons 1970). According to unpublished data of the Atlas of Latvian Mammals several cases are known when the Garden Dormouse (*Eliomys quercinus*) has been recorded in nest boxes for birds.

However, previously there are no records of Fat dormice in nest boxes in Latvia. One of the authors (V. Pilāts) recorded signs (faeces and nest material) which were identified as possibly left by *G. glis* in bird nest boxes set up in the Gauja valley in the mid 1990s. During 2000 to 2002 a study using altogether 70 bird nest boxes of various design were carried out by two secondary school students (Žagars, Rozenfelds 2003) in Daugava valley at Skrīveri, in an agricultural research centre, another well-known *G. glis* site (Fig.1). Dormice were found only in a few boxes that were set up inside the pavilion for agricultural studies. *G. glis* was known to inhabit this area since 1977 (Tauriņš 1982). Although in several cases students found food remains in nest boxes set up in a nearby forest and identified them as left by *G. glis* these records are doubtful. Neither students nor the authors of this study during the initial stage of the studies had practical experience on *G. glis* identification according to activity signs. Therefore we can not exclude misidentification of nestbox occupants, as several mammal species can use nest boxes (Juškaitis 1999).

Latvia lies at the northern limit of the *G. glis* range (Storch 1978; Pilāts 2003). Therefore, it is possible that dormice of the northern populations might avoid bird nest boxes for several reasons.

This study was aimed to examine the usability of dormice nest boxes in Gauja NP as a tool for detecting *G. glis* presence and for monitoring.

Materials and methods

Study areas

The study was conducted at five sites in four different areas of Gauja National Park (Fig. 1). A brief description on Gauja National Park is given in an earlier publication (Pilāts 2003) and detailed descriptions can be found in a monograph on the National Park (Pilāts 2007a). Study sites were established in natural undisturbed mixed woods with oak (*Quercus robur*) and hazel (*Corylus avellana*) in the understorey. Such forests are considered as suitable habitats for *G. glis* in the northern part of its range (Rossolimo et al. 2001; Juškaitis 2003; Pilāts 2003).

Site A is situated on a steep southern slope of the Gauja valley at the former farmstead "Paslavas". The height of the slope varies from 10 to 40 m, and there are small outcrops of sandstone. The slope is covered mainly by 60- to 140-year old, mixed broadleaf forest with oak (some of them up to 250-year old), lime (*Tilia cordata*), birch (*Betula pendula*), aspen (*Populus tremula*), pine (*Pinus sylvestris*), spruce (*Picea abies*) and shadbush (*Amelanchier* sp. – an alien species). Dry meadow is situated between the slope and the River Gauja. A 100-year old birch and pine wood is located to the North at the slope's upper edge. In that direction at a distance of 1.3 km where a dormouse (probably juvenile) was caught in a mouse-trap in October, 1995 at another farmstead "Cepļi" (Pilāts 2003).

Site B is situated on a steep southern slope of Gauja valley at the farmsteads "Klintis" and "Gūdas". The height of the slope is up to 50 m. In its eastern part rather large (up to 10

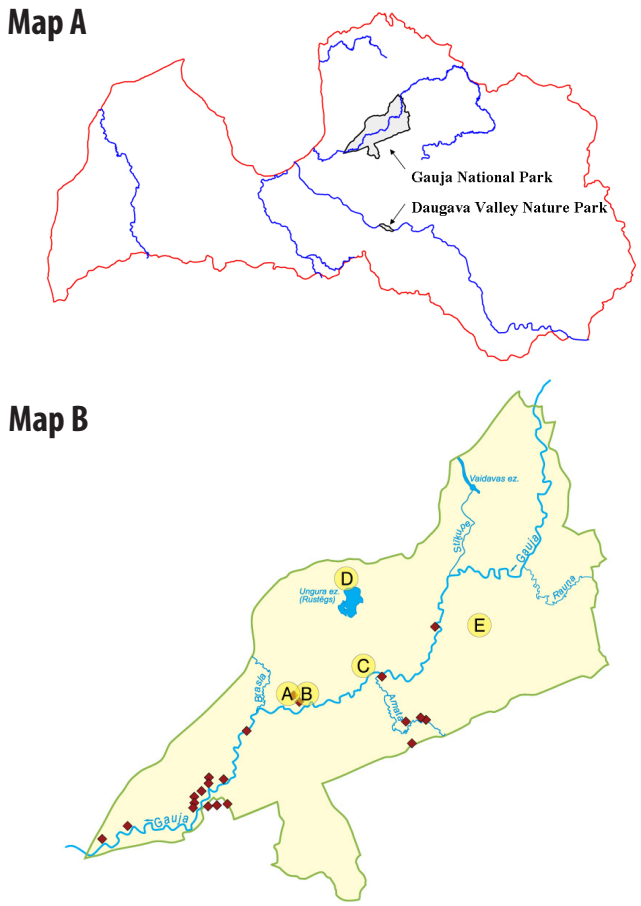

Fig. 1. Protected areas with Fat Dormouse in Latvia (Map A) and distribution of dormice records during 1937 - 2001 (♦) and study areas (A - E) during 2005 - 2008 (Map B).

m high) outcrops of sandstone appear on the slope. It is covered mainly by mixed 80- to 100-year old forest with lime, birch and aspen dominating and oak (some of them up to 250-year old), pine and spruce as minor species. A mixed 110- to 120-year old spruce-pinewood is situated between the slope and the River Gauja. An abandoned farmland is found to the North on the slope's upper edge. At that direction at a distance of 0.3 km a dormouse (probably juvenile) was caught by mouse-trap in late autumn, 1996 at farmstead "Klintis" (Pilāts 2003).

Site A and Site B are separated by a distance of 0.6 km. The side ravine with a small stream Draņķupīte, a tributary of the River Gauja, lies between the sites. The side ravine is covered by pine and birch woods of different age (mainly mature).

Site C is situated on a steep southern slope of Gauja valley at the farmstead "Ķūķi". The height of the slope is up to 40 m. Small outcrops of sandstone appear in lower parts on the bank of the River Gauja. The slope is covered by mixed, 130- to 150-year old forest where lime dominates and oak, birch, aspen and elm (*Ulmus glabra*) have minor proportion.

A farmyard is found on the slope's upper edge to the North. Historically the *G. glis* family has been found (Tauriņš 1982) on the opposite side of the River Gauja at a distance of approximately 1.3 km near the River Amata outflow.

Site D is situated on a flat area at a distance of 8.5 km from Gauja Valley at the former manor house "Ungurmuiža". The stand is 100- to 130-year old, almost solely oak. It is separated by a gravel road from a large park composed mainly of 200- to 300-year old oak.

Site E is situated on a steep southern slope of the Kazugrava valley at the farmstead "Mazceipi". The height of the slope is up to 40 m. The whole valley is situated in the area where dolomite is found on the slope almost everywhere. Important bat hibernation caves are situated nearby. The slope is overgrown mainly by mixed 60- to 110-year old forest with birch, aspen, oak, pine and spruce. The whole valley is surrounded by large crop fields and an abandoned meadow is situated in the valley bottom. Site E is located at a distance of 3 km from the Gauja valley. No *G. glis* records are known from the nearby sites D and E.

Methods

At all five study sites both wooden nest boxes and plastic nest tubes were used. Wooden nest boxes were composed of 25-mm thick planks, with internal dimensions 120 × 120 × 280 mm and with an entrance hole diameter of 40 mm. The design of the wooden nest boxes was similar to that introduced by Māris Čauns for small cavity-nesting birds in Latvia (for nest box design see Vilka 1999 and http://www.daba.gov.lv/public/files_uploaded/publikacijas/BRO_Putnu_burisi.pdf). The main feature of that nest box is the way how the box is fixed to the tree trunk: one side of the box is nailed to the trunk but the rest of the box is removable. This type of box is very good for inspecting the contents of the nestbox but it is not always easy to catch the dormouse found in the nestbox. In our study the entrance hole was in the side attached to the trunk, i.e. the nestbox entrance hole faced the tree trunk. The position of the nest box on the tree trunk was similar to that used for Common dormouse in Great Britain in 1982 (Morris et al. 1990) and is called a dormouse box.

Dormouse nest tubes, also designed in Great Britain (Morris, Temple 1998), are composed of two parts, a 300 mm long and 110 mm square plastic tube and a wooden tray.

Both wooden nest boxes and plastic nest tubes were positioned 3 to 4 m high on trees and arranged along transects throughout the wood. The distance between nest boxes and tubes varied from 15 - 20 m up to 60 - 70 m (Table 1).

In site A all nest boxes were arranged in two more or less parallel transects: one along the slope's lower border (and partly along the forest edge), the other along the slope's upper edge, mainly on a trees growing on the top. The height difference between both transects was approximately 20 m. The lower transect runs through broadleaf forest and the upper– mainly through the birch and pine stands at their border with broadleaf forest. This is the only site where indirect evidence (droppings and nest material) of *G. glis* presence were found in some bird nest boxes set up in the mid 1990s. At site A nest tubes were set up between nest boxes or in the same tree as the box.

In site B and C boxes were set up in the upper part of the slope, partly along its upper edge which was is also the forest edge. Also in site D the transect was established partly along the forest edge. In site E the transect was arranged on the slope.

In sites A and B nest boxes and nest tubes were checked irregularly: during May to July

Table 1. The number of nest boxes and tubes as well as the pattern of their setup (in brackets the increase of box number with additional 10 in site A in 2008 are shown)

Site	Number of nest boxes	tubes	Month and year of set up	Distance between boxes (m)	Placement	Coordinates
A	40 (50)	7	November 2004	15 - 45	in 2 lines	57°14'55.33" N 24°59'5.73" E
B	15	-	July 2006	20 - 70	in 1 line	57°15'1.49" N 25°0'7.84" E
C	13	2	July 2006	30 - 50	in 1 line	57°16'35.52" N 25°6'26.19" E
D	12	3	June 2006	20 - 30	in 1 line	57°21'41.74" N 25°5'34.01" E
E	14	3	August 2005	30 - 60	in 1 line	57°19'53.28" N 25°21'35.81" E
Total	94 (104)	15				

usually once in a month, during August to October in some years up to once in a week. In sites C, D and E they were checked mainly once a year. The total number of nest boxes and nest tubes monitored was 104 and 15 respectively (Table 1).

During autumn of 2005 to 2007 in sites A and B food items (mainly apples, plums, chestnuts, acorns and bred) were placed in some nest boxes and nest tubes to test if this might promote dormice to visit nest boxes and nest tubes.

All nest box occupants (mammals, birds and eusocial insects, as well as in most cases other invertebrates) and signs of their activity (mainly nests and droppings) were recorded. The point of reference for data processing was the use of each nest box during the dormouse activity season. If an animal or its activity was recorded at least once a season the nest box was regarded as used. Repeated records of the same kind in the same nest box were not summed. One reason for this was that nest boxes have different visitation times during the season. We consider that occurrence of use of each nest box during the whole season can better characterize the association of dormice with nest boxes. Juškaitis (2000) also suggested that the percentage of nest boxes occupied during the season reflects dormice abundance more accurately than the number of animals found during a single nest box visitation.

Since 2007 rat and mouse ear tags (AgnTho's AB, Sweden) were used to mark dormice individually. Altogether 28 dormice, of them 22 juveniles, were marked during a two-year period (of 41 individual including 35 juveniles captured during four years).

In site A the number of individuals marked in 2007 and recaptured during nest box checks in 2008 was assumed as the minimum number of dormice living in the particular area. As reference area (area trapped) for density calculations we used both the area `covered` by nest boxes (distinctive narrow belt of mixed broadleaf forest on a steep slope which is delimited from two longer sides by unsuitable habitats: pine/birch forest and meadow) and an additional boundary strip. We extended the belt of slope on both sides by 100 m taking in account that one of our dormouse males had moved between nest boxes at a distance of more than 100 m; in Germany the medium diameter of *G. glis* home

range was estimated to be 200 m (Gaisler et al. 1977) and in Poland species home range size varied from 0.55 ha to 7.0 ha (Ścińsk, Borowski 2008). The size of the whole reference area was 3 ha.

We estimated population abundance as the number of individuals per 100 nest boxes, as in the study of Kryštufek et al. (2003). This might be regarded as a derivative of another abundance index – the number of animals caught per 100 trap-nights which is a standard method for estimating rodent number and was used in a study of *G. glis* by Ivashkina (2006).

Results

Nestbox occupation

Up to present dormice have been recorded only in two (site A and B) of the five study areas. In a third study area (site C), a nest which might be made by *G. glis* was found in one nest box only once during the three year period. Neither dormice, nor their activity signs were recorded in sites D and E.

Besides the *G. glis*, the wooden nest boxes were occupied also by birds (*Parus major* and *Ficedula hypoleuca*), Yellow-necked mouse (*Apodemus flavicolis*), and eusocial insects (Vespidae) (Fig. 2).

Both the number of nest boxes used and number of *G. glis* found in boxes increased during the study period (Fig. 3). By the autumn 2008, the proportion of nest boxes visited by *G. glis* at least once during the four year period reached 55 %. Mainly the same nest boxes were visited by dormice both during one season and from year to year (Fig. 4). Some nest boxes most probably were visited by *G. glis* temporally – there either only droppings or only nest material e.g. leaves, but not well developed dens. In three cases we recorded two dormice older than one year sharing the same nest box.

Dormice were recorded in the nest boxes starting from late May until mid October. The older (reproducing) adults were recorded earlier and juveniles later in the season. At least a two week difference was observed between 2007 and 2008 in the date of the season's latest record of *G. glis* activity.

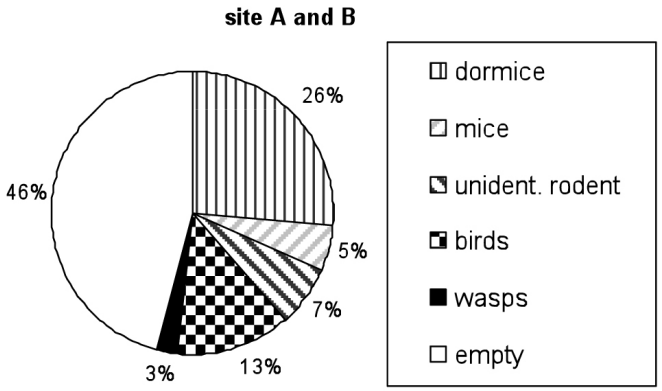

Fig. 2. Occupation rate of different nest-box inhabitants in 2008. Data from the two sites A and B were pooled in order to increase sample size.

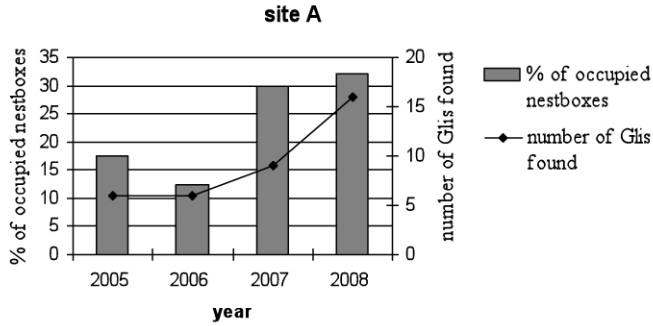

Fig. 3. Abundance dynamics of *Glis glis* according to nest boxes occupied and number of dormice found in nest boxes.

In site A a significant difference (chi-square = 8.29, p = 0.004) was found in nest box occupation rate when compared according to the topography and habitat where nest boxes were set up. During the study period 16 of the 23 nest boxes set up in broadleaf forest at the foot of slope were visited by *G. glis*, while three of 17 nest boxes were occupied at the upper edge of the valley slope (Fig. 4). Gestating females were recorded only in the lower transect of nest boxes.

Reproduction and abundance

Altogether 27 individuals of *G. glis* including one adult and five litters of three (one case), four (two cases) and five (two cases) juveniles were recorded in site A during the four year period (Fig. 5) and 14 individuals including two litters of four and six juveniles in site B during the two year period. In 2006 and 2007 we did not find any dormouse born in the previous year, in 2008 we recorded five in site A and three in site B. During late season 2007 we recorded also four juveniles (two per each site) born not in nest boxes. In 2006 and 2007 we did not find any dormouse born in the previous year, in 2008 five in site A and four in site B were recorded.

During 2008 we recorded 16 individuals (eight juveniles) of *G. glis* in site A (Fig. 5) and 10 individuals (four juveniles) in site B. Among them 12 were recaptured, i.e. dormice marked in the previous year. This means that the relative abundance of animals that survived the winter 2007/2008 was 18 individuals per 100 nest boxes, when data from both sites are pooled. For site A this is equivalent to two individuals per 1 ha at the beginning of season.

Discussion

Use of nest boxes and nest tubes

In the study plots A and B, Fat dormice not only occupied wooden nest boxes readily but in site A used them also for breeding as early as the first summer (Fig. 4, 5). Animal recapture data indicate that adult dormice, male and female, can use several nest boxes in turn, but they prefer to occupy one and the same nest box. For example, we recorded one adult male that in mid-season changed between two nest boxes located at a distance of 140 m. A similar nest box occupation pattern was demonstrated also in other G. glis

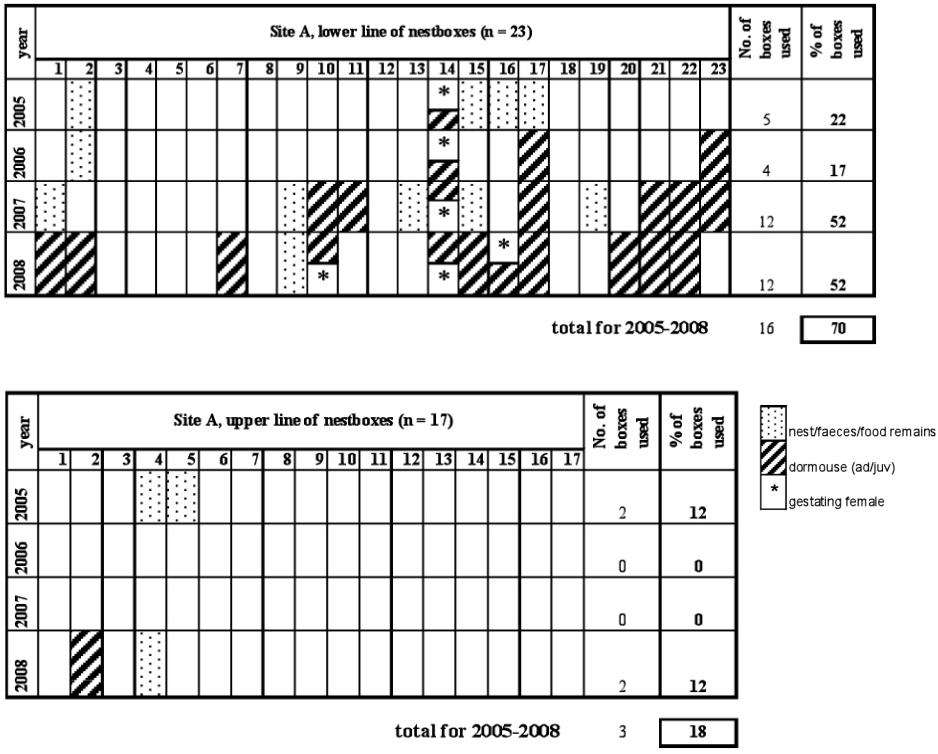

Fig. 4. Occupancy of nest boxes by *Glis glis* depending on nest box locality.

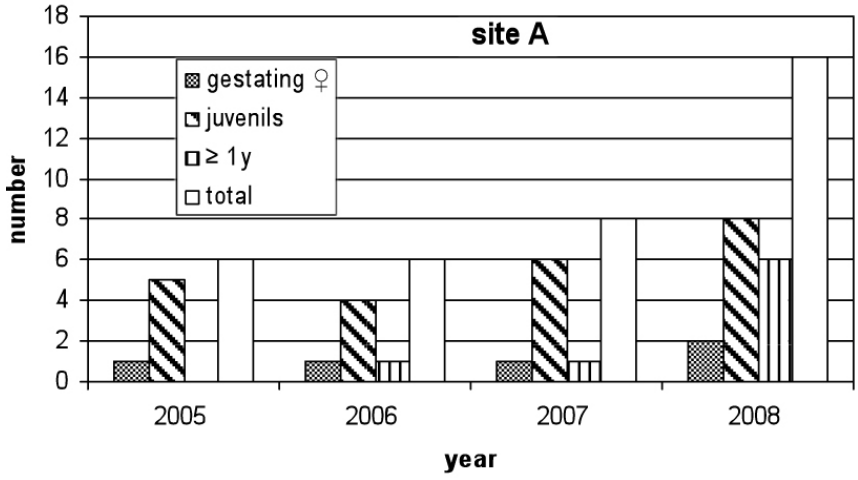

Fig. 5. Yearly number of *Glis glis* of different categories caught in site A.

studies (see Schlund et al. 1997; Rossolimo et al. 2001). Nest sharing by several, even up to six individuals have been reported (e.g. Airapetyants 1983) as a typical feature of Fat dormouse nestbox use, but we recorded only a few cases and up to two adults in one nest box. Similarly, we did not observe any competition/predation on bird nests in dormouse boxes, although elsewhere this is rather common (see Juškaitis 2006).

Although the greater part of nest boxes remained unvisited by *G. glis* during the study period, as in other dormouse studies (e.g. Morris et al. 1990; Schlund et al. 1997; Bako, Hecker 2006; Juškaitis 2008), nest boxes proved to be a good tool for dormouse monitoring, including marginal populations. However, plastic nest tubes were visited only in cases when food items were placed inside (Dzalba 2007). Avoidance of plastic nest tubes by *G. glis* was observed also in Hungary (Bako, Hecker 2006). We found that food items in wooden nest boxes did not promote their visitation, i.e. unvisited nest boxes kept this `status` also after food was put in. There was also no evidence that food in nest boxes would attract other dormice; i.e. animals which were not recorded yet in the area.

Different results on wooden nest box occupation were obtained in the study plot established in the Daugava valley. Nest boxes set up there in a forest evidently remained unoccupied as during 2000 to 2002 and later. In 2006 and 2008 the authors checked 20 nest boxes left there and found no evidence on dormouse presence. The reasons for *G. glis* absence in these nest boxes is most likely habitat suitability.

Distribution and dispersal of the Fat dormouse in Gauja National Park

This study proved the usefulness of dormouse nest boxes in survey of *G. glis* in the marginal population of Gauja National Park. The lack of dormice in many nest boxes can be considered as indicator for *G. glis* absence in an area if a sufficient number of nest boxes are established. Fifteen nest boxes set up in site B show that this number is sufficient to determine the presence of dormice. In sites D and E the Fat dormouse were probably absent even although suitable habitat was available. This indicates that the distribution of *G. glis* is restricted to the Gauja and Amata valleys (see also Pilāts 2003) despite suitable habitat availability in other parts of the National Park. Dormice absence in sites D and E might be explained by isolation of suitable habitats; they are too far one from other for dispersal of Fat dormice.

Our study is consistent with earlier records of *G. glis* dispersal pattern. In the autumn of 1995 and 1996 two individuals were trapped by mouse-traps in buildings of two farms situated near the study plots A and B (Pilāts 2003). The age of trapped animals is not known but according to the description given they probably were juveniles. The place of their birth is not known but obviously it was in the Gauja valley near sites A and B. There is no adequate habitat in between the Valley and both farms and in the other direction. The shortest distance between the valley and most distant farm is 1.3 km. Most probably both animals move within the forested areas as the Fat dormouse is considered as animal with pronounced arboreal lifestyle (Airapetyants 1983; Morris 2004) and avoids moving over open areas (Bieber 1995; Ivashkina 2006). Although *G. glis* can cross small treeless areas (at least up to 46 m; Bieber 1995) and disperse for even up to 2.8 km in a forested area (Rossolimo et al. 2001), this species is likely not able to colonize/recolonize the mosaic landscape in Gauja National Park. It should be also taken into account that formerly (before 100 - 300 years) the landscape in Gauja National Park was even more open, i.e. less forested (Pilāts 2007b) than today. The records of trapped individuals in farms confirms

another well-known habit of the *G. glis* – they readily enter buildings (Airapetyants 1983; Rossolimo et al. 2001; Morris 2004). However, cases are unique – *G. glis* was not seen in either farm previously nor afterwards. Fat dormouse in general is an unfamiliar species even for people living very close to *G. glis* habitats, both in the Gauja and Daugava valleys (see also Pilāts 2003). Thus these two records are an indirect indication on either low *G. glis* abundance or restricted distribution within the Gauja valley.

Habitat preferences

In the Gauja valley a significant and even surprising difference was observed in nest box occupation in association with topography and/or habitat quality (Fig. 4). The distance between the lower and upper transect (site A) is smaller than the distance between two nest boxes used by the one and same dormouse: 20 to 50 m and 140 m, respectively. Therefore, difference in topography is unreliable reason for the different nest box occupation rate, and most probably related to habitat quality. *G. glis* ignored not only nest boxes set up only some meters outside the broadleaf forest but even those situated in a particular habitat. It seems that the broadleaf forest in site A differs in quality for dormice, between the lower part and upper part of the slope. The lower part, mainly forest edge with more dense understorey and old oaks with big and broad branches (Dzalba 2007). This is the preferred type of trees for *G. glis* (Storch 1978; Juškaitis, Šiožinytė 2008). The upper part of the slope supports only a few thin oaks. Consequently, in site A dormice most likely inhabit a very narrow strip of forest where old oaks grow almost in a row. Also the study of Schlund et al. (1997) shows that Fat dormouse has clumped dispersion within one and the same habitat type.

Habitat quality might be reason for *G. glis* absence in nest boxes set up in the Daugava valley: there was no oak in the forest studied using nest boxes.

Additional studies are necessary to evaluate habitat quality within all our study sites to allow comparison with habitats in other *G. glis* localities including other parts of the species range.

Relative abundance

The abundance of *G. glis* varies from 0.6 to 50 individuals per ha (Rossolimo et al. 2001) depending of location within its range and habitats occupied. Our preliminary results suggest a density of two individuals per ha for site A, which is comparable with densities in other northern parts of the *G. glis* range, e.g., one to 11 individuals per ha in Poland (Jurczyszyn 1995), 2.3 to 6 individuals per ha in Germany (Schlund et al. 1997), 0.6 to 4.1 individuals per ha in England (Burgess et al. 2003).

However, density estimation may be biased for site A as the distribution of *G. glis* within the forest seems to be rather linear. Estimation of abundance by number of dormice per 100 nest boxes might be a better index. In 2008 the density of marked adults (animals older than one year) was 12 individuals per 100 nest boxes if we take in account both nestbox transects and even 20 individuals per 100 nest boxes when only nest boxes of the lower transect is considered. These density values are comparable even with densities estimated in southern parts of *G. glis* range, e.g. in Slovenia 23.5 and 25.8 individuals per 100 nest boxes in 1999 and 2000, respectively (Kryštufek et al. 2003).

We conclude that *G. glis* in the Gauja valley might be rather abundant very locally but is restricted to particular habitats and therefore is rare if a wider teritory is considered.

Dormice nest boxes proved to be useful tool for *G. glis* studies also in species in the northern part of its range but more data are necessary to verify most of our preliminary results and the ideas discussed above.

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