Evaluation of *Muscardinus avellanarius* population density by nest box and by trap checking

PETER VOGEL, ANOUK WEY & ELISE SCHUBNEL

Abstract

Population densities of marked common dormice *Muscardinus avellanarius* are generally based on nest box checks. As dormice also use natural cavities and leaf nests, we tried to answer the question 'what proportion of the population cannot be monitored by nest box checks', using parallel trapping sessions. We selected a forest of 1.7 ha where a 5-year nest box survey revealed an annual mean of 3.4 ± 1.4 dormice per check. The trap design (permanent grid of 77 hanging platforms) was developed in June. During July and August the traps were set every second week (4 sessions of two nights = 8 nights) resulting in a total of 75 captures with a mean of 9.4 dormice per night and the presence of 16 different individuals. The grid of 60 nest boxes was checked weekly (8 times) which allowed the recapture of 19 dormice with a mean of 2.4 dormice, per control day and the presence of 6 different individuals. Population density estimated by the calendar of capture and the minimal number of dormice alive methods gave for nest-box checks a value of 2.4 animals/ha and for trap checks 6.6 animals /ha with the conclusions that 63 % of the population were not being monitored by nest box checks.

Keywords: Common dormouse, population size, trapping device

1. Introduction

The common Dormouse *Muscardinus avellanarius* is essentially nocturnal and therefore rarely observed. Due to its arboreal lifestyle, its capture is rare in classical trapping devices. Therefore population studies are essentially based on nest box checks, either with specific boxes (Bright & Morris 1989, Bright & Morris 1990), but also with classical bird nest boxes (Juškaitis 2008). This technique gives data on reproduction, social behaviour and longevity, as well as interspecific competition and population densities [syntheses in Juškaitis (2008) and Juškaitis & Büchner (2010)].

In regard to the population densities the question arises whether nest-box checking reveals the presence of the whole population or only a part of the resident animals. As the hazel dormouse shelters also in natural cavities and also uses spherical leaf nest of its own construction, we do not know if some animals have a preference for one or the other nest type. The aim of our investigations was to compare by capture-mark-recapture studies the population size using small mammal traps and nest box check. The results should reveal the more effective method of a population estimation. After a small preliminary investigation in 1998 of just two days trapping, we used in the main study in 2003, during a period of two months, a technique that was developed especially for the hazel dormouse by Vogel & Duplain (2012).

2. Material and methods

2.1. Study site

For this experimental study we selected a forest near Echichens (about 10 km west from Lausanne), at an altitude of 470 m asl with a total area of 1.7 ha. It is in part a humid gallery forest following a small stream with *Fraxinus excelsior*, *Quercus robur*, *Acer pseudoplatanus* and *Alnus glutinosa*, enlarged by a plantation of *Populus alba* and *P. nigra*. A section where the poplars were recently cut down was covered by young *Rubus* sp. Along the forest edge and at lighter places grow bushes of *Corylus avellana*, *Frangula alnus* and *Clematis vitalba*. Two sides of the forest are situated along an agricultural road and the other two sides are bordered by crop fields (Fig. 1). The rather small size should allow our investigation to cover the whole forest, avoiding estimations of boundary strips and its isolation certainly reduced exchange with other forests.
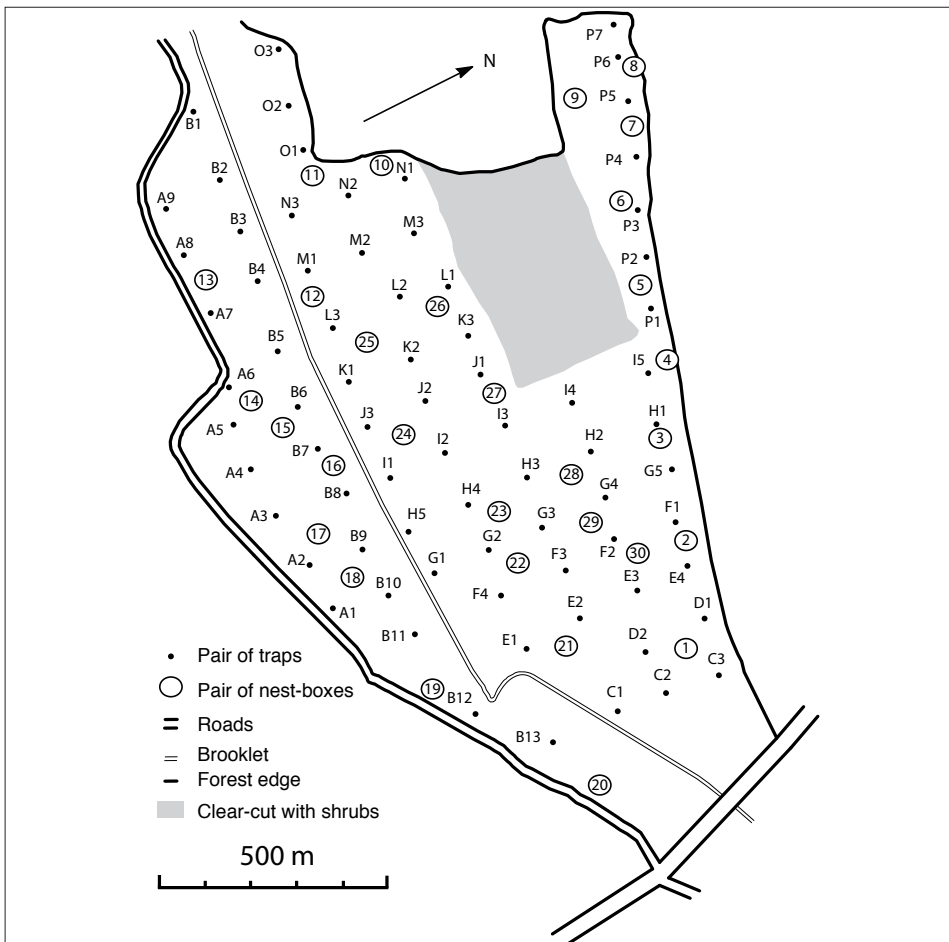

Fig. 1   Map of the forest of Echichens with the location of the pairs of nest boxes (1–20 in 1998, 1–30 in 2003). The location of the 77 platforms placed in rows is also indicated.

2.2. Nest-box device

Two types of nest boxes were used. The first is the one developed by specialists in Great Britain (Bright & Morris 1989) that we call the GB-type (Fig. 2). It is made in wood and looks like a nest box for birds, but with the entrance directed to the trunk. The inner dimensions are $12 \times 12 \times 20$ cm. The other is originally a German mousetrap produced by DeuFa® (DeuFa Fallen, article number 406006, Neuburg, Germany) that we call here the DE-type. It is a long wooden box with inner dimensions of $27 \times 4.5 \times 7$ cm. The top is covered with a wire-mesh and protected against rain and light by a moveable metal cover. It is placed without the entrance door in a hanging drainage pipe (Fig. 2).

Fig. 2   Example of a pair of nest boxes, left a GB type, right a DE type placed in a drainage pipe.

Originally, for a nest box preference study (Vogel & Duplain, 2012), twenty pairs of both types were set in autumn 1996 about 1 to 5 m inside the forest along the edge (nest-boxes 1–20 in Fig. 1) at a height of 2.5 m. With 3 to 6 checks between April and October, we got from 1997–2002 an annual mean per check of 3.4 ± 1.4 SD dormice (adults or subadults) with a maximum of 5.25 and a minimum of 1. The mean number of dormice per check (n = 27 checks) was 3.5 ± 2.5 SD with a maximum of 8 and minimum of 0 individuals.

A small preliminary capture-mark-recapture (CMR)-study in 1998 was done exactly in this situation. In spring 2003, judging that for the main investigation the number of nest-boxes may be too small, we completed the series by adding ten other nest-box pairs (number 21–30) inside the forest. The spatial distribution of the 60 nest-boxes is presented in Fig. 1.

For checking the boxes, the entrance was closed with a cloth and the box was placed in a big plastic bag. Hazel dormice over 11 g were marked with a PIT tag and later read with an electronic reader (Trovan®, EURO I.D.®, Weilerswist, Germany). For the chip injection in the skin of the neck region, the dormouse was slightly anaesthetised with ether.

In the preliminary study in October 1998, nest boxes were checked only once (25th October). In the main study during July–August 2003, they were checked weekly (8 checks), but rainy conditions induced some small irregularity of visits.

2.3. Trapping device

We used two types of traps, the Longworth® trap (Penlon Ltd., Abingdon, UK) and the German mousetrap of DeuFa, the same model as for nest boxes. All traps were prebaited during three nights with a mix of seeds (sunflower seeds, etc.), shelled hazel nuts and a piece of apple. The Longworth traps were filled with hay as nesting material.

For the preliminary study, 20 pairs of the two trap types were set near the nest box positions on the ground and 20 other pairs were fixed on branches, giving a total of 80 traps. The traps were set on 19th October 1998 and checked twice, at 11 PM and at 8 AM next day. Then the traps on the ground were removed. For a second night from 23rd to 24th October, only the 20 pairs of traps on the branches were used.

For the main study the trapping design was the one developed by Vogel & Duplain (unpublished): One of each trap type were put together on a small wooden hanging platform placed at a height of about 1 m (Fig. 3) and set in prebaiting position during three nights. The hanging system is a filter against *Apodemus* species that are less likely to climb down to the 'feeder' along the suspension cord compared to *Muscardinus*. When fixed directly on the branches, in certain years up to 100 % of the traps may be occupied by *Apodemus* species. 77 platforms (with a total of 154 traps) were set in parallel rows forming a grid (Fig. 1). They were put out every two weeks and set to catch during two nights from 18 PM to 7 AM with a single control in the morning. Between trapping sessions, only the platforms remained in the forest to avoid the traps being used as nest boxes.
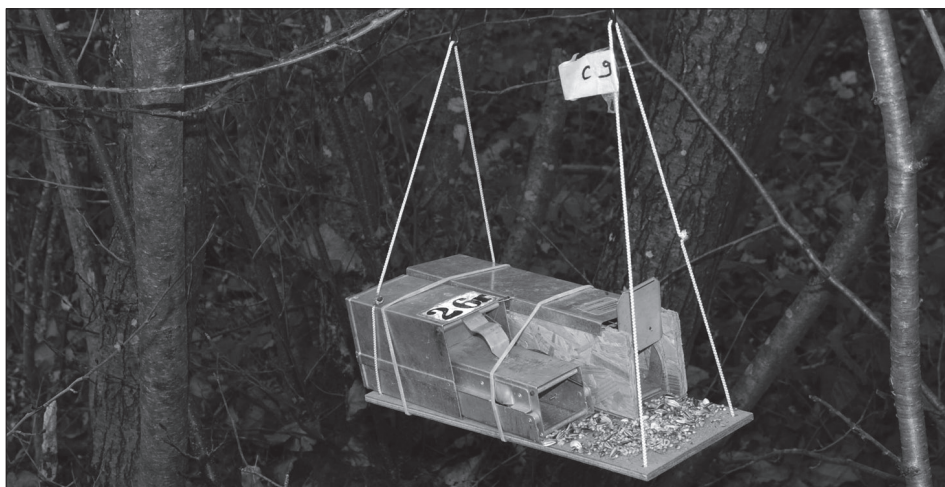

Fig. 3   Hanging platform with one Longworth and one DeuFa trap. Between trapping sessions, the platforms remain in place and help to set the traps at the same position.

Trapping was carried out at irregular intervals in June allowing us to mark a substantial part of the *Muscardinus* population. The experimental period considered here was limited to the summer months of July and August with most stable populations (Juškaitis 2008, Fig. 12) before the arrival of young from August litters.

2.4. Statistics

A first analysis compares all the trap checks with all nest-box checks by the Mann-Whitney U-test for unmatched samples. For the main study, a calendar of capture was established and the population size at each control day (or night) was estimated by the method of the least number of *Muscardinus* alive (Krebs 1972). This means that an animal not checked at this day but captured before and again later was supposed to be present in the forest. We separated the calendar of animals present in the nest boxes from those present in the traps in order to evaluate the difference of the estimated population size by Wilcoxon's signed rank test. The preference between trap types was evaluated by a Chi² test.

3. Results

3.1. Preliminary study in 1998

The 80 traps in the first night resulted in 13 captures of dormice (11 different individuals). All were trapped on the branches, none on the ground. The 40 traps of the second night took 10 individuals, 8 recaptures and 2 new individuals, a total over the two nights of 13 different individuals. The trap success (number of catches compared to the number of traps) was 16% on the first night and 25% on the second night without traps on the ground. The nest-box check two days later showed the presence of 4 individuals, all marked from the preceding trapping period. The trapping session revealed 3 times more individuals present in the forest.

3.2. Main study in 2003

Presence of *Muscardinus* by nest box checking: During the two months, eight checks of the 60 nest-boxes were carried out. They revealed 19 positive events with 1 to 4 animals (mean 2.4) per check (Tab. 1) and a mean occupation of 4% of the nest boxes. The identified animals represented 5 different individuals. Considering the first 7 nest-box checks, the marked *Muscardinus* revealed a population size of 3 to 5 with a mean of 4.0 animals alive.

Presence of *Muscardinus* by trap checking: During the four trapping sessions of two nights, the total number of positive trap checks was 75 (6.1% trap occupation). Of these catches, 58 were in DeuFa traps, only 17 in Longworth traps, a highly significant difference (χ^2_1 = 21.3, P < 0.001). The mean number of captures was 9.4 animals per night. The first trap-night with a mean of 10.5 was always better than the second trap-night with a mean of 8.3 captures. The 75 captures were of 16 different individuals (Tab. 1). From these, 10 were never found in nest-boxes. In contrast, all checked individuals in nest-boxes appeared once or several times in the traps.

The main study as well as the pooled data from both investigations give a significantly better score for trap checking, e.g. the median number of *Muscardinus* in 10 trap sessions is significantly greater than in 9 nest box checks, Mann-Whitney U-test (U = 0, P > 0.05).

The population size estimation during July–August 2003 by the minimum number of animals alive by trap checking was 10 to 13 individuals (mean 10.9). Independent young individuals (5) arrived from the end of July, four of them appeared only once in the traps and had therefore a low influence on population size and density.

Tab. 1   Raw data on the nest-box and trap checks with the 16 common dormice. ID Tag = individual identification code. Nest box checks are signaled in bold with indication of position and type of nest box. Trap checks are signalled in non bold with trap position as indicated in Figure 1. Some data are summed up to show the numbers of animals checked and animals alive but not checked.

N° final	ID Tag	Sex	7.7.	15.7	16.7.	22.7.	29.7.	30.7.	31.7.	8.8.	12.8.	13.8.	14.8.	22.8.	26.8.	27.8.	29.8.	Trap	Box
			BC1	TC1	TC2	**BC2**	**BC3**	**BC4**		**BC5**	**BC6**	TC5	TC6	**BC7**	TC7	TC8	**BC8**		
1	C3ET	m		B11	B11	x	x	x	B7	G1	x	x	A6	G2	x	G1		7	0
2	542T	f	**15DE**	A6	A6	xy	xy	xy	M1	**12DE**	**12DE**	B10	xy	**12DE**	B6	K1	**12DE**	7	5
3	8E8T	m	**11GB**	O2	B4	xy	xy	O1	A7	**12DE**	**12DE**	M3	x	x	N2	M2		7	3
4	6ADT	f		F4	B10	x	x	B13	x	x	x	E2	F3	**21DE**	B11			6	1
5	CCAT	f		B5	L3	x	x	B5	B5	x	x	N3	x	x	B3			6	0
6	0E4T	m	**19GB**	E4	F3	xy	**19DE**	**20DE**	E5	xy	E2	H2		**1GB**	C1	y	**1GB**	7	5
7	E69T	f		B3	x	x	x	A9	B4	x	x	O2	B6	x	A9	A9	**1GB**	7	0
8	ABDT*	f		x	x	x	x	A6	A6	x	x			x	A9			2	0
9	CE8T*	m	**4GB**	x	G5	**3DE**	**3DE**	xy	G5	**3DE**	xy	E4	G4	xy	F2	G3	**8GB**	6	4
10	609T	m		O1	A7	x	x	B2	A9	x	x	N3	B3	x	B2	A8		8	0
11	768T	m		A6	x	x	x	F2	H3	x	x	H3	G3	x	G1	H2		7	0
12	66FT	f						K3										1	0
13	21FT	m						B4										1	0
14	D7DT	?							P7									1	0
15	19FT	m								**12GB**		z	z	z	z	A6		1	1
16	2A3T	m										M1						1	0
																Total		**75**	**19**

* = present in June; x = present but not trapped; y = present but not checked; z = present combined

	7.7.	15.7	16.7.	30.7.	31.7.	8.8.	12.8.	13.8.	14.8.	22.8.	26.8.	27.8.	29.8.	Total	Mean	% of pop.
Number in box	4			1	2	1		2	3			3	3	19	2.4	21 %
Estimation box	4			4	4	4		4	5			4			4.1	38 %
Number in trap		9	8	12	11		12	13	11	7	10	11	10	75	9.4	84 %
Estimation trap		11	11	13	12		11	11	11	10	11	11			11.3	100 %
Combined estimation		11	11	13	12		11	12	12	11	11	11			11.2	100 %
First trap night	9			12									42	42	10.5	
Second trap night					11				7		7	33	33	33	8.3	
DeuFa	4	9	8	8	8		5	8	4	7	7	6		58		77 %
Longworth	0	0		4	3		3	3	3	3	3	1		17		23 %

A comparison between the population size estimation by nest box checking and trapping (Fig. 4), on the first 7 checks (using the 'minimum animals alive' method, the last value cannot be included) show a significant difference between the median number of *Muscardinus* of the two samples (T = 7, P < 0.02, Wilcoxon's test for matched pairs).

The combined total population estimation from nest box checks and trap checks was 10 to 13 individuals (mean 11.2). The overall population density with 11 *Muscardinus* for 1.7 ha over the two month period is equivalent to 6.6 animals per ha. Based on our nest-box check only, it is 2.4 individuals per ha.
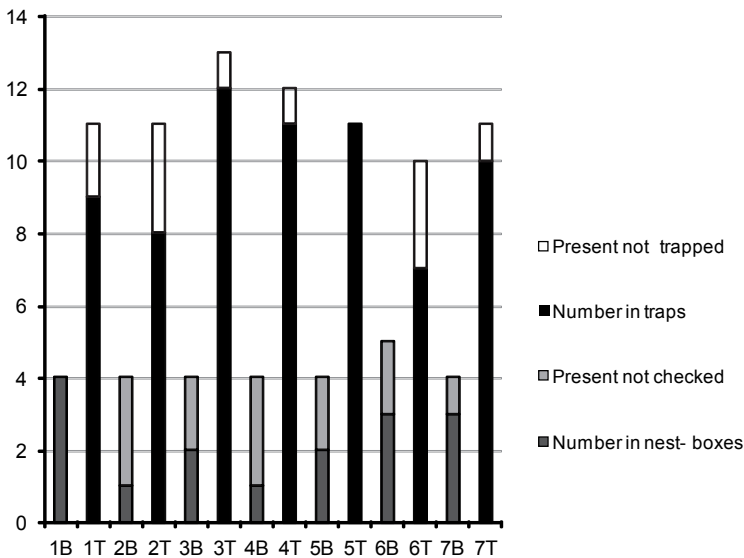
Fig. 4   Histogram of the animals checked in nest boxes (B) and trapped (T) in the sessions 1–7 as well as the animals present but not recorded in that inspection.

4. Discussion

4.1. Trapping device

In general, *Muscardinus avellanarius* avoids traps on the ground as shown in the preliminary study. Trapping with prebaiting on tree branches gives a reasonable score, but may be hampered by other species living at higher population densities (*Apodemus* and even climbing *Myodes glareolus*). The device of hanging traps is therefore the best solution. The low trap success (6.1% versus 25% in the complementary investigation) is due to the high number of traps used to avoid saturation by other rodents. The significant and 4 times higher score of the DeuFa traps showed that this system was more attractive to dormice than Longworth traps. As the entrance tunnel of both trap types is of similar size, the wooden material may be responsible for the better score.

4.2. Nest box versus trap checks

Sixty nest boxes in a forest of 1.7 ha is a high density compared to other studies but close to 30 boxes/ha as recommended by Bright et al. (2006). Theoretically in an open system it

could in a normal situation increase the dormouse population (Morris et al. 1990). However, as our forest is rather a closed system with limited exchanges with neighbouring forests, an artificial increase of the population was not expected and did not take place. From the 16 marked dormice, only 6 individuals could be located in nest-boxes. Apparently, 2/3 of the population did not use the nest boxes. They sheltered either in natural cavities or in free nest constructions.

The preliminary investigation in October 1998, showing 13 different dormice in a two night trapping control and 4 individuals by nest-box checking, revealed similar proportions between the two independent studies.

4.3. Population size and density

According to Pollok et al. (1990), the often-used technique of the minimum number alive (Krebs 1972) is a bad population density estimator which does not take into account many factors such as age specific behaviour (e.g. our single catches of young dormice) and seasonality in trappability. However, for our situation in a short period of two months with a high recapture rate in the trap checks (84 %) it seems to us appropriate, and the best method for the comparison.

Literature on population densities shows different factors such as local climate, structural, food, predator and disturbance conditions. Most published data are essentially based on nest-box checking; only Berg & Berg (1999) published data from trapping with a maximal density of 6.7 individuals per ha. This is close to our trapped density of 6.6 animals per ha.

Overall population densities estimated from nest box checks in Great Britain was 2.2 adults/ha (Bright et al. 2006), but reached locally up to 15.6 adults/ha (Bright & Morris 1990). The most important evaluation of density results are presented by Juškaitis (2008), showing very low densities, e.g. 0.5–1.4 adults/ha in Lithuania (Juškaitis 2003), 3.4 adults/ha in Denmark (Vilhelmsen 1996), 0.5–4 adults/ha in Italy (Sorace et al. 1999), 4.6–8.2 adults/ha in Sicily (Sarà et al. 2001). According to Juškaitis (2008), certain densities in the literature are overestimated by different factors, e.g. an estimation without the addition of a boundary strip, a high density of nest boxes increasing the normal density of *Muscardinus* and the fact that most studies are executed in optimal habitats.

Our experimental test comes to a reverse conclusion, namely that nest box studies may underestimate the population density if a part of the population does not use the nest boxes as shown in our forest of Echichens. The difference may be strong, in our case about a three-fold underestimation. From all marked dormice caught by trapping, 37 % were also found in a nest-box, but only 25 % used them regularly.

5. Acknowledgments

6. References

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Authors' addresses:

Peter Vogel*
Department of Ecology and Evolution
University of Lausanne
1015 Lausanne, Switzerland

Anouk Wey
Sonnhaldenstrasse 6
3210 Kerzers, Switzerland

Elise Schubnel
222 C, Chemin du Hirzensteg
68000 Colmar, France

*Corresponding author: Peter Vogel (e-mail: Peter.Vogel@unil.ch)