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Long-Term Stability of Harvest Mouse Population

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Abstract: The Eurasian harvest mouse (*Micromys minutus*) is a tiny rodent of the Palearctic and Indomalayan regions, with a distinct regional species status in Europe and irregularly varying local numbers. We analysed the population of *M. minutus* in Lithuania (Northern Europe) based on trapping data from 1975 to 2022 and owl pellet data from 1986 to 2009. Based on both datasets, the proportion of this species in the small mammal community was similar, 1.13% and 0.62%, respectively. The proportions have remained stable across all decades. Relative abundance was 1.19 ± 0.19 individuals per 1000 trap days, stable over the long term and across the country. Irregular fluctuations in abundance were observed in some of the sites surveyed. The highest average RA was recorded in open sedge habitats, meadows and marshes. The absolute highest RA was 88 individuals per 1000 trap days in floodplain meadows after a major flood. Although the negative impact of habitat anthropogenisation has been confirmed, *M. minutus* does not require special conservation measures in Lithuania.

Keywords: *Micromys minutus*; status; distribution; relative abundance; Lithuania

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1. Introduction

The Eurasian harvest mouse (*Micromys minutus*) is found in the Palearctic and Indo-Malay regions [1]. This species' range in Europe covers almost the entire territory, with the exception of Cyprus, Portugal, Ireland, Norway, Sweden and the central and southern parts of Spain and Italy [2]. This species may have been introduced into a small area between Sweden and Norway [3]. In montane regions, the limiting factor for distribution is altitude, with a maximum of 1700 m a.s.l. [2,4].

According to the IUCN Red List Criteria for Threatened Species, *M. minutus* is classified as LC (Least Concern) [5]. However, regional status varies: in the UK, it is NT (Near Threatened); in Scotland, it is C (Critical); in Wales, it is V (Vulnerable); but in England, it is still LC [6]. This species is not listed in the Appendices of the Bern Convention, CITES or the Habitats Directive.

No major threats to the species have been recorded [5], but numbers may fluctuate locally [7,8]. Extreme fluctuations in *M. minutus* numbers, up to five times per year, have previously been recorded in Russia and Great Britain [9]. No marked declines have been observed in Great Britain [10,11] and other countries [2,4,5]. However, declines in *M. minutus* populations have been observed in Switzerland and France following the loss of preferred habitats [12,13]. In Italy, *M. minutus* is the only rodent species whose threat of extinction has increased over the last decade [14,15]. In Japan, the conversion of grasslands into rice paddies or urban spaces is the main threat to the species [16].

The proportion of *M. minutus* in the small mammal community is not constant and has ranged from 63% of the total number of specimens caught in Finland in 1973 [17] and 58% in Khabarovsk, Russia, in 1937 [9], to values much lower than this in a large number of other captures [7,10,18,19].

Predatory mammals may be more effective in hunting *M. minutus*, as birds of prey and owls are less accustomed to hunting in dense and tall vegetation [20]. However, a high proportion of barn owl (*Tyto alba*) prey has been found containing this species:

23.3% in Italian farmland [21], 11.9% in Romanian marshes [22], and 9.7% in German wetlands [23]. The highest levels of *M. minutus* were lower in the barn owl (*Strix aluco*) prey composition, with 6.2% in Polish farmland [24] and 8% in a Slovakian wetland [25]. The highest proportion of *M. minutus* in the Long-eared Owl (*Asio otus*) assemblage was 10.4% in the Romanian urban environment [26], 22% in the Italian marsh [27] and 27.6% in agricultural land [28]. Short-eared Owls (*Athene noctua*) are very efficient hunters of *M. minutus*, with a peak of 18% in a Greek marsh ([29], 25% in an Italian marsh [30] and 42% in a Romanian marsh [31].

M. minutus habitats include a variety of natural and anthropogenic habitats with grasses, reeds and other tall vegetation [5] that provide cover, nesting sites and shelter, such as reedbeds, meadows, wetlands, grasslands, riparian zones, hedgerows and agricultural land [16]. Such habitat patches allow *M. minutus* to survive in urban areas [26,32]. Reedbeds are considered preferred habitats [33], especially those with low, thin and sparse stems [34]. Other monocotyledonous plant species could also be important [10]. In the rural landscape, patches of nettle (*Urtica dioica*) and American goldenrod (*Solidago gigantea*) in autumn and unmown areas in winter are particularly important [12].

On intensively managed agricultural land, small mammals generally have few resources. On the edges of arable fields, the main plants favoured by *M. minutus* were bramble (*Rubus fruticosus*), common hawthorn (*Crataegus monogyna*) and blackthorn (*Prunus spinosa*) [35]. Similarly, in Slovakia, the main nest-supporting plant species at field margins were *P. spinosa*, *R. fructicosus* and canary grass (*Phalaris arundinacea*) [36]. As shown by Hata, *M. minutus* adapts to the vegetation of its habitat when building nests [37]. It chooses plant species based on the greater number of stems and greater leaf cover [38]. In forest clearings, they may live sympatrically with the hazel dormouse (*Muscardinus avellanarius*) due to differences in the choice of plant species for nesting [39]. Significant differences in the proportions of plant species used for nesting have also been found in Slovakia in field margins, hedgerows and forest edges [4].

Various opinions have been published on the assessment of *M. minutus*' diet. Kryštufek et al. [5] describe this diet as consisting of green plant material, seeds, insects and bird eggs, but do not specify a trophic group. Fruits, seeds and insects have been identified as the diet of this species in Japan, with an average of 7.7% animal food [40]). C.R. Dickman classified *M. minutus* as omnivorous based on a diet consisting of seeds, fruits, grass leaves, fungi, mosses and insects [32].

We classified *M. minutus* as a granivore [41] and compared its diet with that of mice of the genus *Apodemus*. According to H. Ylönen [42], under limited-resource conditions, *M. minutus* exhibits interspecific competition with the bank vole (*Clethrionomys glareolus*). *C. glareolus* has been described as a mixture of herbivores and insectivores [43], but in Lithuania, at least in orchards, it was omnivorous [44].

The aim of this study was to review the status, distribution and abundance of *M. minutus* in Lithuania, based on long-term (1975–2022) trapping data and analysis of owl pellets (1986–2009).

2. Materials and Methods

2.1. Study Site

Trapping of small mammals was carried out in Lithuania, the southernmost of the three Baltic States, between 1975 and 2022. According to the National Land Service under the Ministry of Agriculture of the Republic of Lithuania, in 2018, agricultural land accounted for 52.3%, forests 33.2%, built-up areas 3.64% and roads 1.61% of the territory [45]. According to land cover data, between 2000 and 2018, the area of open areas increased by 16.42%, natural grasslands by 5.94% and artificial surfaces by 3.57% [46]. The area of arable land increased by 1.77%, the area of forests by 0.55% and the area of wetlands by only 0.02%. Between 2000 and 2018, the area of grassland decreased by 2.69% and that of water bodies by 0.11% [46]. Long-term trends in land use show an increase in the area of forests and built-up areas between 1971 and 2015, and a decrease in the area of productive lands, grasslands and wetlands [47]. A spatial representation of land use in Lithuania in 2018 is presented in Figure 1.

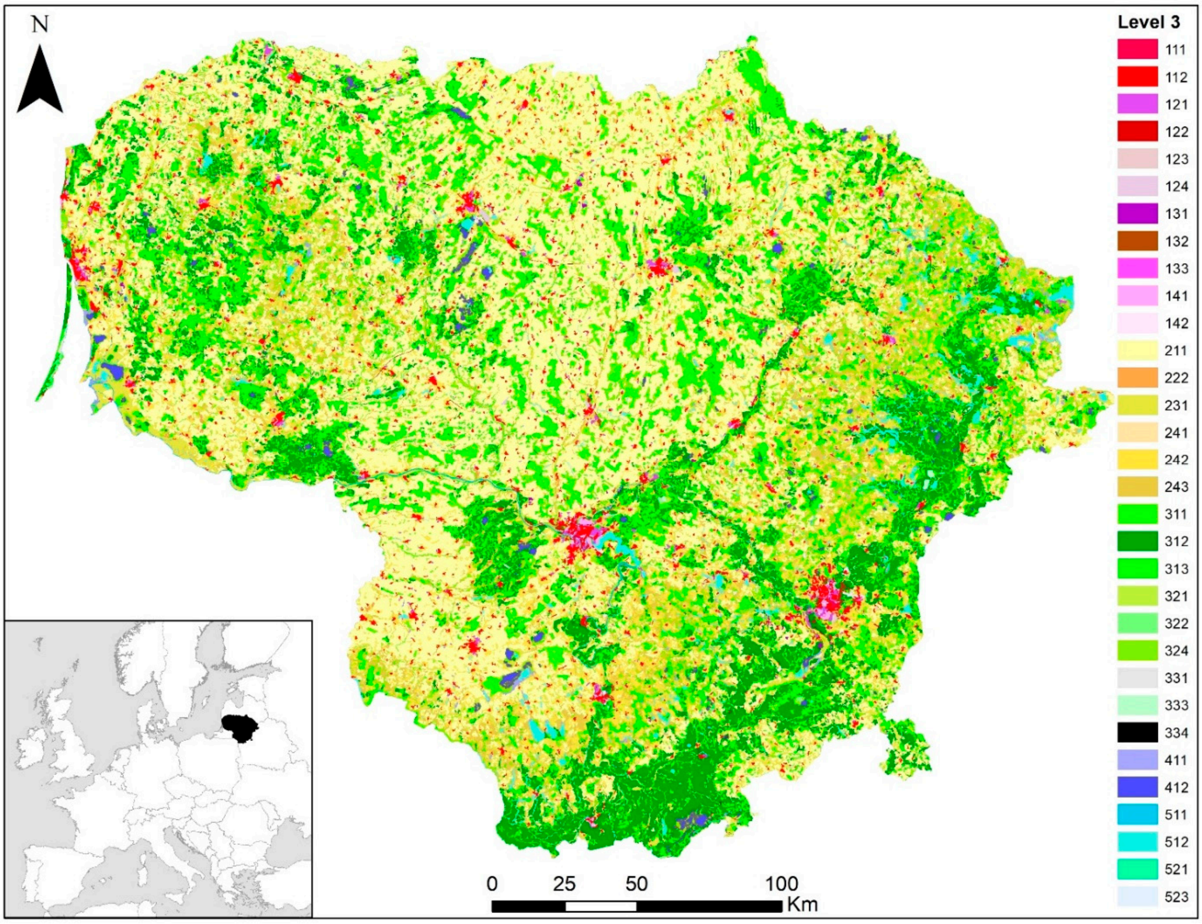

Figure 1. Land use map of Lithuania in 2018. Level 2 and Level 3 land cover classes are presented according to CORINE nomenclature. We list just Level 3 habitats, important to *M. minutus*. Urban fabric: 111–112; industrial, commercial and transport units: 121–124; mine, dump and construction sites: 131–133; artificial, non-agricultural vegetated areas: 141–142; arable land: 211—non-irrigated arable land; permanent crops: 222—fruit trees and berry plantations; pastures: 231—pastures; heterogeneous agricultural areas: 241—annual crops associated with permanent crops, 242—complex cultivation patterns, 243—land principally occupied by agriculture, with significant areas of natural vegetation; forests: 311—broad-leaved forest, 312—coniferous forest, 313—mixed forest; scrub and/or herbaceous vegetation associations: 321—natural grasslands, 322—moors and heathland, 324—transitional woodland-shrub; open spaces with little or no vegetation: 331–334; inland wetlands: 411—inland marshes, 412—peat bogs; inland waters: 511—water courses, 512—water bodies; marine waters: 521–523 [48].

Lithuania's climate is transitional between continental and maritime, with average January temperatures of −4.9 °C and July temperatures of +17.2 °C, and average rainfall of 570–902 mm. Some climate trends are shown in Table 1 [49].

Table 1. Climate trends in Lithuania 1961–2020: WIN—winter (December, January, February); SPR—spring (March, April, May); SUM—summer (June, July, August); AUT—autumn (September, October, November). OASMT—observed average seasonal temperature; OSP—observed seasonal precipitation.

Indices	**1961–1990**				**1991–2020**			
	WIN	**SPR**	**SUM**	**AUT**	**WIN**	**SPR**	**SUM**	**AUT**
OASMT	−5.13	5.79	16.2	7	−3.1	6.97	17.34	7.56
OSP	69.98	130.97	224.3	185.74	89.22	131.43	227.92	177.62

2.2. Data Collection

We analysed small mammal trapping material from the author's personal data and from data published by various authors in Lithuania. All the data we have used on owl diets have been published. A review of the sources is given in [50].

Trapping was carried out using 7 × 14 cm snap traps, set in rows of 25 traps spaced 5 m apart. The traps were baited with a brown bread crust containing unrefined sunflower oil. The traps were set for 3 days. In 1.3% of cases, this standard was not met due to the limited habitat area, which resulted in a lower number of traps, or due to heavy rainfall, which resulted in two days of trapping instead of three.

Four long-term small mammal trapping events are examined on a case-by-case basis: in the Ignalina Nuclear Power Plant region (1981–1990), in Žagarė Regional Park (1975, 2008–2012), in Rusnė floodplain meadows (2008–2020), and in two administrative districts of Lithuania covering grassland and forest succession (2007–2013). The trapping and pellet collection sites are shown schematically in Figure 2.

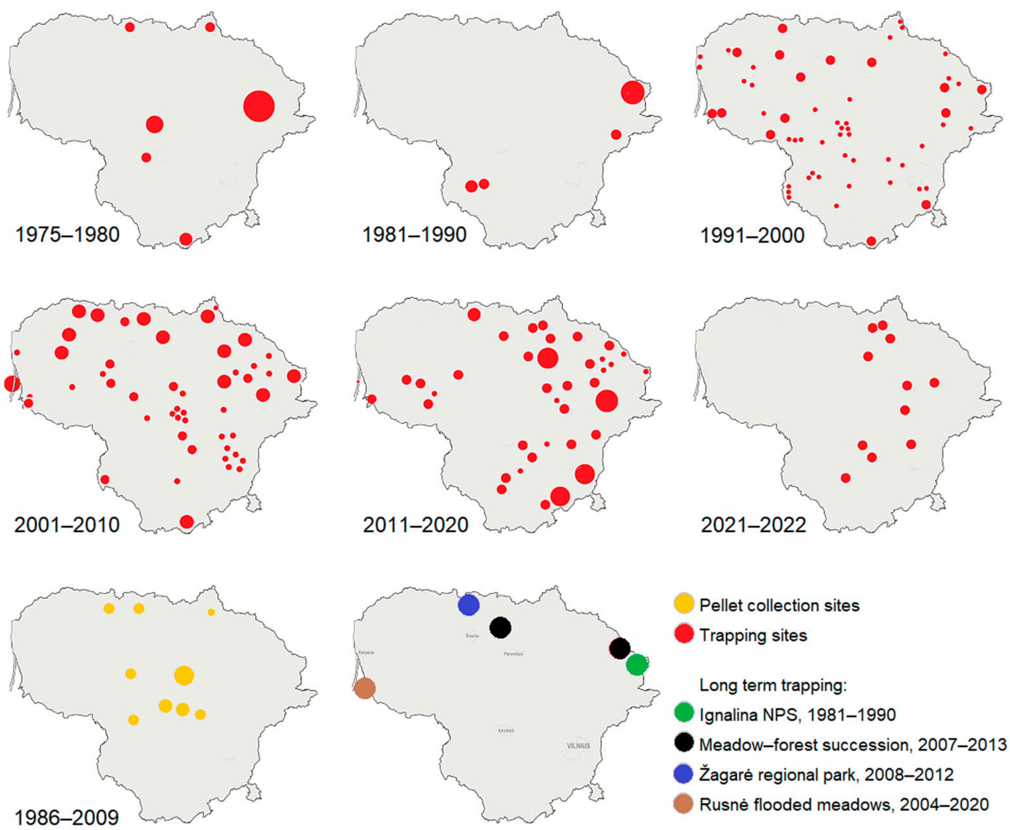

Figure 2. Schematic maps showing the locations of small mammal trapping, pellet collection and case study sites. Note: locations are not geo-tagged. Bubble size approximates sample size.

Trapping sample size: 170 sampling sites, 669 samples, 383,175 trap days, 51,975 small mammals trapped. All data were grouped into decades, covering 1975–1980, 1981–1990, 1991–2000, 2001–2010, 2011–2020, and 2021–2022.

Pellet sample size: 52 batches, 5775 small mammals identified. Both sets were not pooled. Prey of two owl species, the Tawny Owl (*Strix aluco*) and the Long-eared Owl (*Asio otus*), was analysed. In terms of the number of individuals described in the prey, the proportion of the latter species was 4.3%, with no *M. minutus* recovered.

The small mammal traps covered a wide range of habitats: wetlands (peatlands, bogs, fens and marshes), forests (deciduous, coniferous and mixed stands, young, middle-aged and mature stands), meadows and pastures, reedbeds, agricultural fields, gardens, farmsteads, riverbanks, lakeshores and islands. A large proportion of captures were made in mixed habitats, including grassland, woodland and wetland in almost equal proportions. More detailed information on trapping by period and habitat is given in [50].

Pellets of both owl species were collected mainly underneath the special nest boxes, while prey remains were collected in the nest boxes after the breeding season. The location of the nest boxes and observations of owls confirmed that their hunting grounds were not only in forest. The hunting grounds also covered open habitats, such as meadows and farmland in central and western Lithuania, wetlands and meadows in northern Lithuania. The above is confirmed by the composition of the prey, including numbers of common voles (*Microtus arvalis*) and striped field mice (*Apodemus agrarius*) in the diet of both owl species [50].

2.3. Data Treatment

The relative abundance (RA) of *M. minutus* was expressed as the number of individuals per 1000 trap-nights (usually 100 trap-nights, but this gives a very low RA for the species). Differences in RA between periods in different habitats were assessed using ANOVA, and the combined effects of period and habitat were assessed via main effects ANOVA.

The proportion of *M. minutus* in the small mammal community was expressed as a percentage. In addition, 95% confidence intervals were calculated using Wilson's method using the epidemiological software OpenEpi [51]. The Wilson method is accurate, suitable for small samples and provides better coverage of confidence intervals, especially when dealing with extreme proportions [52]. Differences in species proportions between time periods in different habitats were assessed using the G-test with an online spreadsheet [53], or with 2 × 2 tables, using the χ^2 test.

To investigate whether the sampling effort was sufficient to capture *M. minutus*, we analysed species' accumulation curves using rarefaction based on the individuals [54] with the log Gamma function and calculated in PAST version 4.13 (Museum of Palaeontology, Oslo University, Oslo, Norway). *M. minutus* was ranked 10th in terms of the number of captures [50]; therefore, the sampling effort was considered sufficient when at least 10 small mammal species were expected. We also performed a power analysis to calculate the required sample size to detect differences in the proportions of *M. minutus* between decades. Calculations were carried out for desired significance $\alpha = 0.05$ and power = 0.80, using an online calculator (https://www.stat.ubc.ca/~rollin/stats/ssize/b2.html, accessed on 15 October 2023).

3. Results

3.1. Harvest Mouse Numbers and Proportion in Small Mammal Communities

M. minutus accounted for 587 of the 51,975 small mammals trapped between 1975 and 2022, i.e., 1.13% (95% CI = 1.04–1.22%), while between 1986 and 2009, this species accounted for 0.62% (CI = 0.45–0.86%) of the total number of small mammals preyed on by owls, i.e., 36 out of 5775 individuals. Thus, the proportion of the species in the owl assemblage was significantly lower ($\chi^2 = 12.5$, $p < 0.001$) than in trapping.

The total number and proportion of *M. minutus* among other small mammals trapped are shown in Figure 3. Although the total number of small mammals varied significantly by decade (ANOVA, $F_{5,665} = 51.0$, $p < 0.0001$), the number of *M. minutus* ($F_{5,135} = 0.81$, $p = 0.54$) and the proportion of the species ($F_{5,605} = 0.94$, $p = 0.45$) remained stable.

Figure 3. Number of small mammals trapped, number of *M. minutus* and their proportion by decade in Lithuania 1975–2022.

There were no differences in the proportion of species across the country, ranging from 0.22% of the total number of individuals caught in south-eastern Lithuania to 1.78% in western Lithuania (ANOVA, $F_{9,605} = 0.97$, $p = 0.46$).

The proportion of *M. minutus* in the total owl prey assemblage increased from zero in 1986 to 0.54% (CI = 0.30–0.97%) in 1991–2000 and to 0.68% (CI = 0.46–0.99%) in 2001–2010, but the change was not significant (ANOVA, $F_{2,48} = 0.50$, $p = 0.61$).

During the ten years of trapping in the Ignalina NPP region, *M. minutus* represented on average 1.2% of all small mammals (Table 2). The variation in the proportion of the species between years is significant ($G = 21.4$, $p < 0.025$), but only in 1985 was the proportion significantly higher than the mean ($\chi^2 = 9.91$, $p = 0.002$). In the other two years, *M. minutus* was absent or present in only 0.3%, which is significantly lower than the mean ($\chi^2 = 26.0$, $p < 0.001$).

Table 2. Representation of *M. minutus* in the region of Ignalina Nuclear Power Station, eastern Lithuania, 1981–1990.

Year	All Species, N	*M. minutus*, n	*M. minutus*, %	*M. minutus*, % CI
1981	361	4	1.1	0.4–2.8
1981	361	4	1.1	0.4–2.8
1982	401	6	1.5	0.7–3.3
1983	261	6	2.3	1.1–4.9
1984	386	6	1.6	0.7–3.4
1985	455	14	3.1	1.8–5.1
1986	224	0	0	
1987	372	1	0.3	0.1–1.5
1988	357	4	1.1	0.4–2.9
1989	700	2	0.3	0.1–1.0
1990	303	4	1.3	0.5–3.3
Total	3820	47	1.2	0.9–1.6

In the north of the country, in the Žagarė Regional Park, only 1 *M. minutus* was snap-trapped in 1975 out of 493 small mammals, with a capture rate of 0.2% (CI = 0.04–1.1%), compared to 0.3% (CI = 0.2–0.5%) in the pooled sample from 2008–2013. There was no difference, even though the main habitat surveyed in the first period was forest, whereas in the second period, the main habitats surveyed were mixed forest, coppice, forest swamps, forest meadows, regenerating coppice, natural meadows, scrubby meadows and abandoned farmsteads.

In western Lithuania, specifically in the Rusnė environs of the Nemunas River delta, our surveys conducted in 2004 and 2005 yielded no sightings of *M. minutus* within flooded meadows and non-flooded meadows, despite the capture of 210 and 33 small mammals, respectively. In 2006, the presence of this species was detected at a proportion of 0.47% (CI = 0.06–3.90%) in flooded meadows and 0.69% (CI = 03.08–5.65%) in non-flooded meadows, with none found in the flooded forest habitat. From 2008 to 2020, the species proportions within a flooded meadow (as shown in Figure 4) exhibited significant fluctuations (G = 183.1, $p < 0.0001$), with an average of 5.95% (CI = 5.0–7.1%). Notably, there were no records of *M. minutus* in 2009, 2011, and 2013. However, in 2008, this species dominated the habitat, comprising 53 out of 161 individuals (32.9%, CI = 24.2–43.0%). In 2010, the proportion decreased to 10.5% (CI = 7.6–14.4%), followed by 5.4% in 2012, 5.2% in 2014, and 5.7% in 2017.

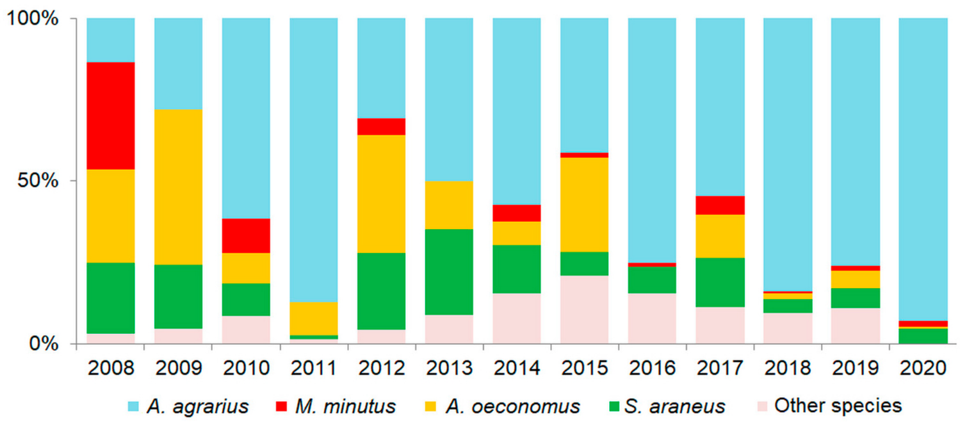

Figure 4. Representation of *M. minutus* in the flooded meadows of Rusnė, 2008–2020.

In two sites undergoing meadow-to-forest succession in central and eastern Lithuania, the proportion of *M. minutus* was consistently low during the years 2007 to 2011, as shown in Table 3. There was a notable approximately fivefold increase in 2012, although it was not statistically significant (G = 6.65, NS).

Table 3. Representation of *M. minutus* in meadow–forest succession sites, central and eastern Lithuania, 2007–2012.

Year	All Species, N	*M. minutus*, n	*M. minutus*, %	*M. minutus*, % CI
2007	197	1	0.5	0.1–2.8
2008	136	0		
2010	378	2	0.5	0.2–1.9
2011	387	1	0.3	0.05–1.5
2012	284	7	2.5	1.2–5.0

3.2. Relative Abundances of Harvest Mouse

On average, the relative abundance of *M. minutus* in Lithuania was 1.19 ± 0.19 individuals per 1000 trap days over the period from 1975 to 2022. This implies that, on average, nearly 1000 snap traps needed to be set to capture a single individual. When examined by decade, the relative abundance remained stable (ANOVA, $F_{5,662} = 1.61$, $p = 0.15$), indicating no significant long-term increase or decrease in relative abundance. However, the maximum relative abundances varied significantly, as detailed in Table 4.

Table 4. Relative abundances of *M. minutus* in Lithuania, 1975–2022, by decade and irrespective of habitat.

Period	Samples, n	RA, Average ± SE/1000 Trap Days	Maximum RA/1000 Trap Days
1975–1980	6	0.25 ± 0.19	1.14
1981–1990	11	4.01 ± 2.11	23.33
1991–2000	111	1.82 ± 0.38	26.67
2001–2010	175	0.78 ± 0.23	33.80
2011–2020	278	1.24 ± 0.37	88.00
2021–2022	87	0.72 ± 0.38	26.67

The cumulative effect of two factors, decade and habitat, on the relative abundance of *M. minutus* was found to be statistically significant ($F_{15,428} = 2.78$, $p < 0.001$). However, the model's explanatory power is relatively weak, accounting for only 9.1% of the variation in RA. Specifically, the influence of the time factor appears to be insufficient ($F_{5,433} = 1.96$, $p = 0.08$), while that of habitat is significant ($F_{10,433} = 3.16$, $p < 0.001$). Consequently, we conducted further analysis to assess RA in various habitats.

Across the country, RA exhibited similar patterns, ranging from 0.33 ± 0.14 ind. per 1000 trap days in the southeastern part of Lithuania to 2.50 ± 0.52 ind. per 1000 trap days in the western part ($F_{9,605} = 0.96$, $p = 0.47$).

3.3. Harvest Mouse Habitats in Lithuania

The variation in relative abundance (RA) between habitats was statistically significant, although it accounted for only a modest 6.9% of the overall variation. While the average RAs of *M. minutus* were quite modest, substantial maximum RAs were observed in various habitats, including flooded meadows, wetlands, forests, open sedge habitats, and habitat mix (Table 5). These maximum RAs were typically obtained through occasional trappings. In the analysed long-term trapping examples, the maximum RAs of *M. minutus* closely approximated their respective averages.

Table 5. Relative abundance (individuals per 1000 trap days) of *M. minutus* in Lithuania, 1975–2022, by habitat and irrespective of time period.

Habitat	Samples, n	RA, Average ± SE	Maximum RA
Open sedge	1	13.33 ± 0.00	13.33
Meadow	58	4.69 ± 1.73	88.00
Wetland	18	2.95 ± 1.13	15.00
Agriculture	1	2.86 ± 0.00	2.86
Ecotone	4	1.25 ± 1.25	5.00
Commensal	26	0.14 ± 0.11	2.78
Mixed	180	1.19 ± 0.22	23.33
Forest	113	0.71 ± 0.24	20.00
Cormorant colony	31	0.45 ± 0.23	6.67
Island	1	0	0
Shore	1	0	0

3.4. Species Status and Distribution in the Country

M. minutus in Lithuania is not protected and has never been included in the national Red Data Book. It has not been considered a threatened species. Based on the available data, the species is distributed throughout the entire country but is not particularly common. Notably, there were no recorded trappings of *M. minutus* in four approximately 50 × 50 km areas (as indicated in Figure 5). However, it is essential to highlight that only one of these areas, located in the west, may not have been sufficiently covered by trapping efforts, as shown in Figure 2.

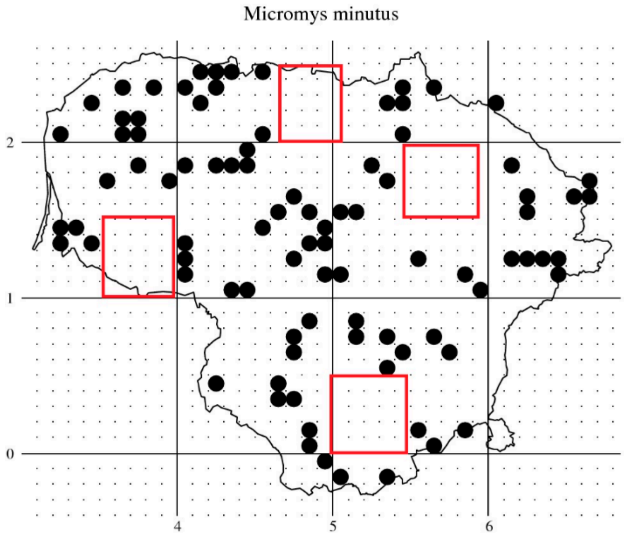

Figure 5. Distribution of *M. minutus* in Lithuania. Black dots represent the findings in 1999 (lines delineate 100 × 100 km squares); red squares indicate areas where the species was not present, based on data from 1975 to 2022. The remainder of the territory is represented by findings of the species within 50 × 50 km UTM squares.

Both the northern and western squares exhibit similar habitat compositions, as depicted in Figure 1. They are characterised by low patchiness, extensive agriculture, and the absence of wetlands.

In contrast, the southern square is not suitable to *M. minutus* due to its dominant habitats consisting of sandy and arid forests, interspersed with open spaces and sandy dunes. While mice nests were discovered in several locations within this square in 2002, no individuals were trapped. It is possible that the trapping effort may not have been sufficient [55].

However, the eastern square presents a different scenario, with a fragmented habitat comprising forests, wetlands, shrubby areas, and meadows. Notably, substantial trapping efforts were undertaken in this square from 2001 to 2020, as illustrated in Figure 2. Therefore, the absence of *M. minutus* in this square remains unexplained.

4. Discussion

To facilitate a meaningful discussion of the results, it is imperative to determine whether the prevalence of *M. minutus* in Lithuania can be attributed to inadequate trapping efforts. An examination of the species' accumulation curve (Figure 6) reveals that in order to capture no fewer than 10 different species, one should aim to trap until the total number of captured small mammals reaches approximately 300 individuals. Considerably higher numbers were sampled in each decade, even considering the two years within the 2021–2022 period. Moreover, when the sample size exceeds 1000 individuals, an impressive 14 to 18 small mammal species are typically trapped [50]. This emphasises the extent to which the trapping efforts were exhaustive.

In assessing the trapping effort, it is worth noting that there is a strong correlation between trap days and the number of trapped individuals (r = 0.75, $p < 0.001$). Similarly, a moderate correlation exists between trap days and the number of species trapped (r = 0.55, $p < 0.001$). Comparatively, from a much smaller sample in Lithuania, the respective correlations were 0.42 and 0.90, both with $p < 0.001$. It was evident that increasing the trapping effort beyond 1000 trap days did not significantly increase the number of registered species, which typically remained around 9–10 [56].

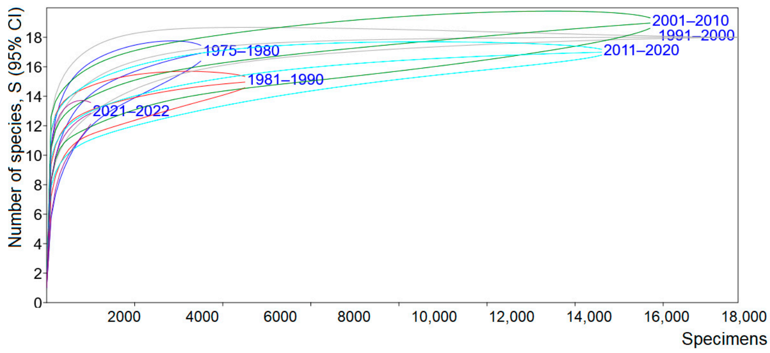

Figure 6. Species' accumulation curves in relation to the specimens trapped.

Of the 61 samples with more than 1000 capture days, *M. minutus* was recorded in 35 cases or 57.4% (CI = 44.9–69.0%). The proportion was 29.3% (CI = 24.5–34.6%) for more than 500 trapping days. When the trapping intensity was between 250 and 499 trapping days, individuals of this species were recorded in 11.2% (CI = 8.6–14.4%) of the cases, while in less than 250 trapping days, only 7.6% (CI = 5.1–11.2%) of the cases were recorded. Based on the above, the absence of the species in the two territories of northern and western Lithuania (see Figure 5) may be related to an insufficient trapping effort. However, insufficient trapping does not explain the absence of the species in the territories of central and southern Lithuania. Our results contradict those of Vecsernyés [12], who reported that *M. minutus* is "difficult to catch with conventional traps; with a sufficient trapping effort, there was no problem in recording the species. The use of snap traps to record the species and trapping in the wrong season, November and March–April, have been suggested as possible reasons for the low representation of these mice at Lake Neusiedl, Austria [7]. We appreciate an analysis of different trapping methods carried out in a tropical environment with very high vertical stratification [57]. However, in Lithuania, the use of methods other than trapping has been very limited.

A power analysis of the sample size required to detect changes in the proportions of *M. minutus* among other small mammals trapped over time showed that it was sufficient to detect temporal variation (Table 6), although the ANOVA analysis confirmed that the proportions of the species were stable.

Table 6. Sample size (N) required to confirm differences in *M. minutus* proportions between decades for desired significance α = 0.05 and power = 0.80. Confirming the proportion differences between some decades would require much larger samples, shown in bold.

Period	1975–1980	1981–1990	1991–2000	2001–2010	2011–2020
1981–1990	501				
1991–2000	1615	1769			
2001–2010	1439	2038	**333,854**		
2011–2020	632	**26,283**	3136	3816	
2021–2022	1922	1478	**171,997**	**58,371**	2462

The reason for the low representation of *M. minutus* may be related to irregular variations in relative abundance. For example, R. Feldmann states that in Germany, very low levels of RA of this species can be observed for up to six years [58]. Haberl and Kryštufek [7] therefore consider the possibility that this species is rare to be an artefact of a complex set of factors including unsuitable habitats, seasonal fluctuations in abundance and a low phase of RA fluctuations. In our study, at least one higher and one lower phase of *M. minutus* were observed in capture periods longer than 6 years (see Tables 2 and 3, Figure 4).

Our results also show that *M. minutus* inhabits a variety of habitats in Lithuania. Even in the intensively farmed landscape of our neighbouring country, Poland, this species can thrive in fragmented wetland patches and drainage ditches [34]. In other countries, information on this species' habitat is scarce [12]. This may be due to a lack of investigations. In the past, the paucity of information on this species in the UK has been attributed to a lack of competent researchers [10]. Nowadays, it may be due to different capture methods or a lack of favourable habitats.

The flexibility of *M. minutus* in the choice of nesting plants not only allows it to survive seasonal changes in the environment [38], but can also help it to acquire new biotopes. As their home range is only about 400 sq. m, a 500 m radius of habitat may be sufficient for population establishment [16]. Ground nests are not very common, but can help survival after grassland burning when it is not possible to build aerial nests [59]. However, this trait has only been studied in Japan.

M. minutus chooses certain plant species for nesting and therefore requires a special approach to protect its habitat [35]. Wetland management should take into account the affinity of this species to the American goldenrod (*Solidago* ssp.) in order not to compromise habitat quality [12]. The importance of goldenrod has also been demonstrated in Hungary [18]. However, in Lithuania, two species have been listed as invasive species, the giant goldenrod (*Solidago gigantea*) and the Canadian goldenrod (*Solidago canadensis*) [60]. As these species are also a food source for *M. minutus* [40], successful eradication of these invasive plants may result in a change in habitat suitability.

According to Perrow and Jowitt [61], *M. minutus* is an indicator of the general condition of the small mammal community due to its habitat dependence throughout the year. This species can reflect habitat changes. For example, in the former agricultural system, these mice were found in large numbers in corn ricks [19], but, nowadays, corn ricks are no longer available due to the use of modern harvesting techniques. The intensification of agriculture has had negative consequences, "almost certainly causing a decline in harvest mouse abundance, increasing population fragmentation and isolation" [9,10,35].

In the Lithuanian agrarian landscape, *M. minutus* has been caught in apple orchards [62], on the edges of arable land [63], on farmsteads [64,65], and in ecotones between forest and agricultural land [66–68]. The conversion of grassland to forest has been observed not to be beneficial for this species [69], as has the conversion of grassland to pasture [33]. However, *M. minutus* has been found even in intensively used irrigated meadows [70]. The determinants of the population status in Lithuania are not clear and need to be compared with long-term data from other countries. We agree with Ancilotto et al. [71] in that even for widespread species, "adaptation to local conditions can pose serious challenges to their conservation".

A further direction of our research is to investigate the spatial pattern and territory use of *M. minutus*, taking into account the different relative abundances and proportions in the small mammal community, as well as this species' relationship with other syntopically living small mammals. As shown by Haberl and Kryštufek [7], there was no spatial overlap of *M. minutus* with other small mammals living in mixed habitats, but the species' composition was different from that in Lithuania. A comparison of the ecology of species in different parts of their range is very important to avoid misguided conservation priorities across the species' range.

5. Conclusions

We found that *M. minutus* is widespread in Lithuania, but not abundant. The absence of this species at three sites in the northern, western and southern parts of the country could be due to inadequate habitat structure.

The proportion of *M. minutus* in the small mammal community is generally low, at 1.13%, as determined via trapping, and much lower, at 0.62%, in the owl prey. These proportions remain stable over the long period of 1975–2022. Proportions did not vary across the country, but irregular fluctuations were observed in places.

The relative abundance of *M. minutus* is low, 1.19 ± 0.19 individuals per 1000 trap days, has remained stable over the long term, and has not varied across the country. Differences in relative abundance between habitats were significant, with the highest mean RA observed in open sedge habitats and grasslands. Floodplain meadows were characterised by a maximum RA of up to 88 individuals per 1000 trap days after a high flood.

Our data confirm the negative impact of habitat anthropogenisation, but, in Lithuania, *M. minutus* does not require special conservation measures.

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Data Availability Statement: This is an ongoing study; therefore, unpublished data are not available publicly. All other data are available in the cited publications.

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