

Habitat Selection in the Common Dormouse *Muscardinus avellanarius* (L.) in Lithuania

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Abstract

The evaluation of habitat selection in the common dormouse *Muscardinus avellanarius* (L.) in Lithuania was based on comparisons between observed proportion of *M. avellanarius* localities in forest stands dominated by different tree species, and their proportion in the total forest cover of Lithuania. In Lithuania, most localities of *M. avellanarius* were situated in forests: 75% in forest stands and 21% in overgrown clearings and young Norway spruce (*Picea abies*) plantations. Among forest stands, 39% of localities were situated in stands dominated by Norway spruce, 20% in birch (*Betula pendula* and *B. pubescens*), and 13% in oak (*Quercus robur*)-dominated stands. In total, 39% of *M. avellanarius* localities were situated in conifer-dominated habitats with the majority of habitats also containing hazel (*Corylus avellana*). *M. avellanarius* preferred forest stands dominated by spruce and oak, but evidently avoided stands dominated by Scots pine (*Pinus sylvestris*). Additionally, forest stand selection in *M. avellanarius* was analysed at two dormouse study sites with nestboxes. The highest proportion of nestboxes used by *M. avellanarius* was found in spruce-dominated and oak-dominated stands, respectively. Indirectly, habitat selection in *M. avellanarius* is related to soil fertility: more suitable habitats for *M. avellanarius* are situated on more fertile soils.

Key words: common dormouse, habitats, forest stands, overgrown clearings, nestbox use, Lithuania

Introduction

The common dormouse *Muscardinus avellanarius* (Linnaeus 1758) is a woodland species living mostly in deciduous or mixed deciduous-coniferous forests with a well-developed understorey (Likhachev 1972, Storch 1978, Airapetyants 1983, Rossolimo *et al.* 2001). Habitats of *M. avellanarius* in different countries are described in many publications (see reviews in Likhachev 1972, Airapetyants 1983, Rossolimo *et al.* 2001), but very few analyses of habitat selection across whole countries were done. The frequency of occurrence of *M. avellanarius* in different forest types was analysed in Hungary (Hecker *et al.* 2003). In Wales, data on habitat type and dominant tree species in localities of *M. avellanarius* were analysed according to questionnaires (Bright 1995).

M. avellanarius is widely distributed across almost all Lithuania, but localities for this species are lacking in southern and south-eastern Lithuania, where Scots pine (*Pinus sylvestris*) forests prevail (Juškaitis 2003b). *M. avellanarius* is one of the most thoroughly investigated small mammal species in Lithuania (Juškaitis 2003c). However until now, the habitats of *M. avellanarius* in Lithuania were described only briefly in publications on dormouse distribution (Juškaitis 1994, 2003b).

The aims of the present study are: 1) to analyse habitat selection in *M. avellanarius* in their localities throughout Lithuania, and 2) to analyse forest stand selection by *M. avellanarius* at two study sites.

Study species

M. avellanarius (Rodentia, Gliridae) is a small arboreal rodent that climbs well along branches and twigs and, wherever possible, avoids moving on the ground surface. *M. avellanarius* is a nocturnal species, and spends the day time in ball-shaped nests made from vegetable material in thick tangles of woody vegetation or in closed cavities like tree holes and nestboxes. When the ambient temperature is low, especially in spring before noon, dormice can be torpid. The weight of adults is about 17–20 g in summer, but above 30 g in autumn when dormice accumulate fat reserves for hibernation. In Lithuania, animals spend 6–7 months in hibernation: from October until April – early May. Winter mortality is high and can reach 60–70%. *M. avellanarius* feed mainly on vegetative matter, and generative parts of plants (flower-buds, catkins, flowers, berries, seeds) are always preferred. In cases of scarcity of suitable vegetative matter, they use food of animal origin, primarily insects as well as bird eggs. Females can produce one or two litters per season. The numbers of juveniles in a litter fluctuate

from 1 to 7, litters of 3–5 juveniles being most frequent. Young-of-the-year females can breed when population density is low. The life span of *M. avellanarius* is up to 6 years in the wild, and it is a long-lived mammal compared to other rodents of similar size. Adult *M. avellanarius* are sedentary and have fixed home ranges, which can overlap partially. The mean range area for males throughout their active season is about 1.0 ha, whereas for females it is about 0.8 ha. Tawny owls (*Strix aluco*) are known to be one of predators of *M. avellanarius* in Lithuania (Juškaitis 2003c).

Study areas

Lithuania is situated in the northern part of *M. avellanarius* distribution range (Mitchell-Jones *et al.* 1999). After World War II, forest coverage in Lithuania increased from 19.7% in 1948 to 32.5% in 2006 (Navasaitis *et al.* 2003, Anonymous 2006). Coniferous tree-dominated stands comprise 57.3% of forested areas. Most widespread are Scots pine stands (35.8%) and Norway spruce (*Picea abies*) stands (21.4%). Where deciduous trees prevail, most widespread are stands dominated by the birches *Betula pendula* and *B. pubescens* (21.1%). The proportions of stands dominated by other deciduous tree are much lower: 6.7% by black alder (*Alnus glutinosa*), 6.4% by grey alder (*Alnus incana*), 3.3% by aspen (*Populus tremula*), 2.5% by ash (*Fraxinus excelsior*), 2.0% by oak (*Quercus robur*), and 0.9% by other trees (Anonymous 2006). The average age of tree stands in Lithuanian forests is 53 years (Anonymous 2006). About 85% of Lithuanian forests are natural, the rest have been planted by humans (Navasaitis *et al.* 2003).

Study site A was situated in south-western Lithuania (Fig. 1), the Šakiai district (55°03'N, 23°04'E), occupied an area of 60 ha including about 3500 ha of forest and contained 262 nestboxes. In the most part of this site, forest was middle-aged (30–50 year-old), with diverse mixed tree stands. Within the study site, birch-dominated stands with spruce and black alder, ash-dominated stands with other deciduous trees and spruce, and spruce-dominated stands with deciduous trees were prevalent. Other forest stands occupied smaller areas. The understorey contained many hazels (*Corylus avellana*) and in some places glossy buckthorn (*Frangula alnus*).

Study site B was located in eastern Lithuania (Fig.1), Molėtai district (55°09'N, 25°21'E), occupied an area of 85 ha including about 500 ha of forest and contained 341 nestboxes. Mature (100–120 year-old) oak stands with spruce, in some places with aspen and birch, were prevalent on most of this site. Two more types of forest stands occupied comparatively large areas: the 40–50-year-old aspen-dominated stands with

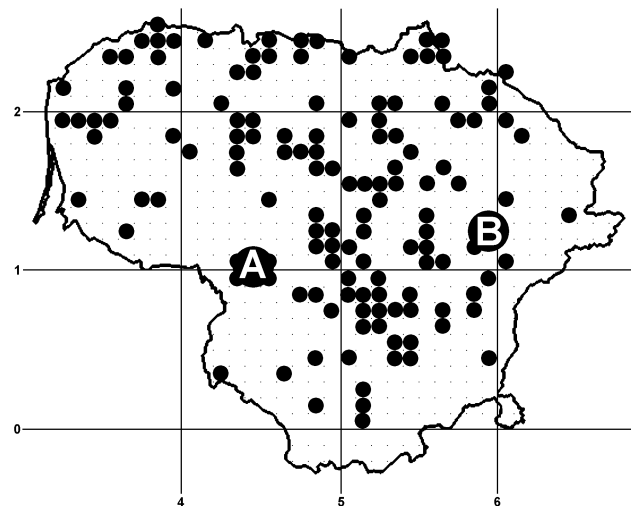


Figure 1. Localities of *M. avellanarius* in Lithuania, mapped on 10 × 10 km squares of the national grid “Lithuania-94”, and location of study sites A and B

spruce, oak and birch as well as spruce-dominated stands with oak and other deciduous trees. Hazel prevailed in the understorey.

Material and methods

Habitat selection in *M. avellanarius* in Lithuania was estimated using two methods: 1) analysis of habitats in most of the known localities of *M. avellanarius* in Lithuania, and 2) analysis of the proportion of nestboxes used by *M. avellanarius* in forest stands dominated by different tree species on two study sites.

The main data sources on habitats of *M. avellanarius* in Lithuania were:

- 1) author's field studies in different forests of Lithuania (*e.g.* Juškaitis 2004);
- 2) special searches for rare Lithuanian dormouse species using nestboxes, during which *M. avellanarius* were also frequently found;
- 3) interviews with professional and amateur naturalists;
- 4) records from publications on the fauna of some districts and protected areas (*e.g.* Maldžiūnaitė 1980, Malinauskas 1998, Baranauskas 2000).

Observations of *M. avellanarius* in the wild, findings of dormice in nestboxes, characteristically gnawed hazel nuts, and summer nests found were considered to be evidences of the presence of *M. avellanarius* (Ulivičius and Juškaitis 2005). However in most localities, habitats of *M. avellanarius* were described only qualitatively (*i.e.* only tree and understorey species composition, dominant species). In some cases, habitat descriptions were absent, and also habitat descriptions presented by different authors could not be unified.

In order to standardize data on the habitats of *M. avellanarius*, forest stands where dormice were found were classified according to dominant tree species, *i.e.* according to classification, which is used by the foresters in Lithuania (Navasaitis *et al.* 2003, Anonymous 2006). The following tree stands were identified from forestry district maps according to dominant tree species: pine, spruce, birch, oak, ash, aspen, grey alder, black alder and other deciduous trees. Areas with early successional stages of forest stand formation up to an age of about 10 years were classified into a separate category. The last category of habitats includes: 1) overgrown clearings, usually with planted young spruce trees, and 2) young spruce plantations. When *M. avellanarius* were found in several forest stands dominated by different tree species within the same forest, all the cases were included in the analysis. In total, the data on 186 sites occupied by *M. avellanarius* from localities scattered throughout all the country (Fig. 1) were used in the present study.

Additionally, habitat selection in *M. avellanarius* was also analysed on two dormouse study sites (Fig.1), where long-term studies of two populations of *M. avellanarius* were carried out (*e.g.* Juškaitis 2003a). The data on the use of nestboxes by *M. avellanarius* in mixed forest stands dominated by different tree species from 1984–1989 were used for this aim. On both study sites wooden nest-boxes with internal dimensions of 12 × 12 × 23 cm and an entrance hole of 35 mm, normally used for small hole-nesting birds, were spaced in a grid system with 50 m intervals between boxes (density = 4 boxes/ha). They were checked from April till October monthly with additional controls in May and September. Nestboxes containing dormice, their nests or other signs of activity (*e.g.* droppings, gnawed hazelnuts) were considered to be used by *M. avellanarius*. The average proportion of nestboxes used by *M. avellanarius* in a particular forest stand was considered to be an index of forest stand suitability for *M. avellanarius*.

Fisher's exact test for the analysis of the difference between two proportions (Uitenbroek 1997) was used to evaluate differences in the observed proportion of *M. avellanarius* localities in forest stands dominated by different tree species and their proportion in the total forest cover of Lithuania (Anonymous 2006). The data on nestbox use by *M. avellanarius* in different forest stands were analysed using chi-square tests. Contingency tables (Fowler and Cohen 1990) were used for calculation of differences between the observed and expected number of nestboxes used by *M. avellanarius* in different forest stands on two study sites. Yates' corrected chi-squares were calculated using 2 × 2 tables for evaluation of differences between

two forest stands. Calculations of chi-squares were performed with STATISTICA 6.0 (StatSoft 2001).

Results

In Lithuania, almost all localities of *M. avellanarius* were situated in forests: 75% in forest stands and 21% in areas with early successional stages of forest stand formation (16% in overgrown clearings and 5% in young spruce plantations). Among forest stands, 39% of the localities of *M. avellanarius* were situated in forest stands dominated by spruce, 20% in birch-dominated stands and 13% in oak-dominated stands. Other tree stand types, in which *M. avellanarius* were found, comprised less than 10% each (Fig. 2). Differences between the observed and expected proportion of *M. avellanarius* localities in several forest stands were statistically significant. *M. avellanarius* preferred forest stands dominated by spruce ($z = -2.22$; $p = 0.027$) and stands dominated by oak ($z = -2.82$; $p = 0.005$), but evidently avoided forest stands dominated by pine ($z = 4.38$; $p = 0.000$). Also, *M. avellanarius* tended to avoid stands dominated by black alder ($z = 1.86$; $p = 0.063$). The number of localities of *M. avellanarius* in stands dominated by grey alder was significantly higher than that in black alder-dominated stands ($\chi^2 = 7.14$; $df = 1$; $p < 0.008$).

In total, 39% of *M. avellanarius* localities were situated in conifer-dominated habitats, *i.e.* spruce-dominated and pine-dominated stands and young spruce plantations. Spruce-dominated stands usually contained additional birch and aspen trees, less frequently oak or ash, but hazel was almost always present in the understorey. *M. avellanarius* occurred even in spruce stands almost devoid of deciduous trees, but with hazel in the understorey. However, *M. avellanarius* did not live in pure spruce stands that lacked hazel. Also, *M. avellanarius* did not occur in

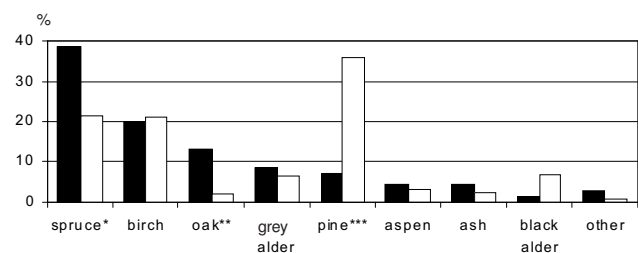


Figure 2. Proportion of *M. avellanarius* localities ($n = 140$) in forest stands dominated by different tree species (black columns), in relation to their proportion in the total forest cover of Lithuania (Anonymous 2006; white columns). Localities in overgrown clearings and young spruce plantations are not included. Statistically significant differences are marked with asterisks (* = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$)

pure pine stands, which prevail in eastern and southern Lithuania, but a few dormouse localities are known from pine stands with hazel and mixed stands dominated by pine. *M. avellanarius* were found second-most commonly in birch-dominated stands (Fig. 2). Such stands usually contained spruce trees and hazel in the understory.

Almost all forest stands where *M. avellanarius* occurred contained hazel, and hazel was an essential component for the presence of *M. avellanarius* in pure coniferous tree stands (except young spruce plantations). However, *M. avellanarius* were also found in several habitats without hazel: young spruce plantations, some overgrown clearings, willow *Salix* sp. scrub and overgrown peat-bog. In several cases, *M. avellanarius* were detected in homesteads and gardens situated near forests.

Differences between the observed and expected number of nestboxes used by *M. avellanarius* in forest stands dominated by different tree species were significant on site A ($\chi^2 = 16.20$; $df = 4$; $p < 0.003$) and site B ($\chi^2 = 6.79$; $df = 2$; $p < 0.034$). Among mixed forest stands of study site A, the highest proportion of nestboxes used by *M. avellanarius* was found in the 70-year-old spruce stand with birch and black alder (Table 1). This spruce-dominated stand was preferred by *M. avellanarius* compared with stands dominated by ash, aspen and birch ($\chi^2 = 8.01$ – 28.29 ; $df = 1$; $p < 0.000$ – 0.005) as well as the 30-year-old spruce-dominated stand ($\chi^2 = 11.57$; $df = 1$; $p < 0.001$). Also, *M.*

avellanarius used a higher proportion of nestboxes in ash-dominated stands compared to stands dominated by aspen ($\chi^2 = 5.98$; $df = 1$; $p < 0.014$) and birch ($\chi^2 = 15.32$; $df = 1$; $p < 0.0001$).

At site B, *M. avellanarius* used nestboxes spaced in a mature oak stand with spruce, aspen and birch most of all (Table 1). When *M. avellanarius* had a choice between oak-dominated and spruce-dominated stands in the same forest (Table 1), they preferred a stand dominated by oak ($\chi^2 = 11.73$; $df = 1$; $p < 0.001$), while differences between other stands were not significant.

Discussion

Analysis of habitat selection in *M. avellanarius* in Lithuania using two methods gave similar results: *M. avellanarius* preferred forest stands dominated by oak and spruce in both cases. Avoidance of pine-dominated forest stands by *M. avellanarius* could be confirmed by the results of nestbox controls in pure pine forests. *M. avellanarius* were absent in 10 localities with pure pine stands in Varėna, Tauragė, Jonava, Šilutė and Šakiai districts, where nestboxes were checked (R. Juškaitis, unpublished).

A comparatively high proportion of *M. avellanarius* localities was situated in overgrown clearings, although clear-cut areas occupied only 1.9% of Lithuanian forest land compared to 95.0% occupied by forest stands (Anonymous 2006). The most suitable conditions for *M. avellanarius* are met in overgrown clearings situated on fertile soils, where hazels, glossy buckthorns, honeysuckles (*Lonicera xylosteum*) and raspberries (*Rubus ideus*) grow abundantly. Fruits of these plants are the preferred food of *M. avellanarius* (Juškaitis 1993). In such clearings, foresters usually plant young spruce trees, which are preferred nest sites for *M. avellanarius* in Lithuania (Juškaitis and Remeisis 2007). Later such overgrown clearings with planted spruce trees are rendered into young spruce plantations. *M. avellanarius* may still be found in such plantations, especially when they occupy small areas and are surrounded by other more suitable habitats. Also in other parts of its distribution range, *M. avellanarius* prefers the early successional stages of woody vegetation – overgrown clearings (e.g. Wachtendorf 1951, Lozan 1970, Likhachev 1972, Berg 1996) and coppices (e.g. Bright and Morris 1990, 1996, 2005, Bright *et al.* 2006).

The highest proportion of localities of *M. avellanarius* in Lithuania was situated in mixed forest stands dominated by spruce. This is a specific feature of habitat selection in *M. avellanarius* compared to the southern part of its distribution range. The southern border of Norway spruce distribution lies south

Table 1. Proportion of nestboxes used by *M. avellanarius* in the main forest stands dominated by different tree species at study sites A and B in 1984–1989

Forest stands	Forest stand age, in years	Number of nestboxes available	Nestboxes used by <i>M. avellanarius</i> , %
Site A			
Spruce-dominated stand with birch and black alder	70	120	75.8
Ash-dominated stand with other deciduous trees and spruce	30–50	456	61.4
Spruce-dominated stand with deciduous trees	30	174	55.7
Aspen-dominated stand with other deciduous trees and spruce	30	114	48.2
Birch-dominated stand with spruce and black alder	50	300	46.7
Site B			
Oak-dominated stand with spruce, aspen and birch	100–120	308	53.6
Aspen-dominated stand with spruce, birch and oak	40	120	45.0
Spruce-dominated stand with oak and maple (<i>Acer platanoides</i>)	90	114	34.2

of Lithuania, and in central and southern Europe, spruce grow only in mountain regions (Navasaitis *et al.* 2003). The development and diversity of understorey is a very important characteristic for habitats of *M. avellanarius* (Bright and Morris 1990, 1996). However, according to this characteristic, spruce-dominated stands seem to be not optimal habitats for *M. avellanarius*. In Lithuania, stands dominated by spruce usually grow on rather fertile soils, but they have one of the thinnest understoreys among Lithuanian forest stands, which may contain rowan (*Sorbus aucuparia*), hazel, glossy buckthorn, *Salix* spp. and other species (see Navasaitis *et al.* 2003) as understorey components. Older spruce stands have a richer understorey (Navasaitis *et al.* 2003), and this circumstance may explain why *M. avellanarius* preferred the 70-year-old spruce-dominated stand compared to the 30-year-old stand at site A.

Pine-dominated forests occupy the largest areas among Lithuanian forests (Navasaitis *et al.* 2003, Anonymous 2006). Pine trees do not demand good soils nor humidity, and can grow on barren sandy soils, which are not suitable for many other tree and shrub species (Navasaitis *et al.* 2003). However, *M. avellanarius* do not live in such pure pine forests and were found only in places where pine-dominated stands growing on fertile soils were mixed with other tree species, or at least contained hazel in the understorey. In Hungary, few localities of *M. avellanarius* were found in UTM squares dominated by Scots pine and none in squares dominated by black pine (*Pinus nigra*) (Hecker *et al.* 2003). In total, 39% of *M. avellanarius* localities were situated in conifer-dominated habitats in Lithuania. A similar situation was found in Wales, where 36.4% of dormouse sites were in conifer-dominated habitats (Bright 1995).

Oak-dominated forest stands were preferred by *M. avellanarius* in inverse proportion to their comparatively small occurrence in Lithuanian forests. Across its distribution range, *M. avellanarius* occurrence is related to broad-leaved forests and particularly to oak forests (e.g. Likhachev 1972, Airapetyants 1983). According to Likhachev (1972), *M. avellanarius* need the complexity of plant communities growing in oak forests. Among Lithuanian forest stands, oak-dominated stands have the second most abundant understorey and the highest density of hazel (Navasaitis *et al.* 2003). It should be noted that *M. avellanarius* is absent in some Lithuanian oak-dominated forests because of anthropogenic influence, e.g. earlier grazing in the largest in Lithuania Dūkštos oak forest near Vilnius (A. Žičkutė, pers. comm.). In Hungary, *M. avellanarius* was most frequently found in oak (*Quercus petraea* and *Q. robur*) -dominated forests (Hecker *et*

al. 2003). In Wales, 22% of dormouse sites were situated in oak (*Quercus* spp.) forests (Bright 1995), but according to this author, oak woods are likely to be poor-quality habitats for *M. avellanarius*.

The proportion of localities of *M. avellanarius* in birch-dominated stands almost coincided with the overall proportion of these stands in Lithuanian forests, but it was less than the proportion of localities in spruce-dominated stands (Fig. 2). On fertile soils, birch-dominated stands are similar to stands dominated by spruce in their species composition, but on barren soils, birch-dominated stands are more monotonous and less suitable for *M. avellanarius*.

Forest stands dominated by other tree species occupy a comparatively small proportion in Lithuanian forests. Among Lithuanian forest stands, those dominated by ash have the densest understorey (Navasaitis *et al.* 2003) and were among the most preferred stands of *M. avellanarius* on study site A (Table 1). Aspen-dominated stands grow on fertile soils and have one of the densest understoreys and the highest density of honeysuckle among Lithuanian forest stands (Navasaitis *et al.* 2003), thus creating favourable conditions for *M. avellanarius*.

Although the proportion of grey and black alder-dominated stands is very similar in Lithuanian forests (Anonymous 2006), the number of localities of *M. avellanarius* in grey alder-dominated stands was significantly higher. Black alders can grow in very wet places (Navasaitis *et al.* 2003), and this circumstance could determine the avoidance of such stands by *M. avellanarius*. Areas of forest stands dominated by grey alder have doubled in Lithuania during several last decades (Navasaitis *et al.* 2003). They have spread from forest edges into abandoned fields, meadows and pastures. Brambles (*Rubus caesius*), which are favoured by *M. avellanarius* as both a food source (Juškaitis 1993) and nesting site, grow on the edges of grey alder stands (Navasaitis *et al.* 2003).

In summary of this large-scale analysis it is possible to state that *M. avellanarius* is able to live in almost all Lithuanian forest stands except pure pine stands occurring on barren soils. The fertility and humidity of soils are very important factors determining the occurrence and distribution of different forest stand types in Lithuania (Navasaitis *et al.* 2003). Forest stands dominated by particular tree species growing on more fertile soils have a more diverse tree and understorey species composition and are, therefore, more suitable for *M. avellanarius* compared to the same tree species-dominated stands growing on less fertile soils. In such a way, habitat selection in *M. avellanarius* is related indirectly with soil fertility: more suitable forest stands and overgrown clearings for

M. avellanarius are situated on more fertile soils. Further analysis is necessary to determine a more accurate relationship between the occurrence of *M. avellanarius* and soil fertility across habitats.

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ВЫБОР МЕСТ ОБИТАНИЯ У ОРЕШНИКОВОЙ СОНИ (*MUSCARDINUS AVELLANARIUS*) В ЛИТВЕ

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Резюме

В Литве почти все места находок орешниковой сони (*Muscardinus avellanarius*) были в лесах: 75% – в древостоях леса и 21% – в зарастающих вырубках или саженных молодняках ели. Среди мест находок сони в древостоях леса, 39% приходилось на смешанные древостои, в которых преобладали ели, 20% – преобладали березы и 13% – преобладали дубы. 39% всех мест находок орешниковой сони в Литве приходилось на места обитания, в которых преобладали хвойные деревья. В большинстве древостоев, в которых были обнаружены сони, также росла лещина. Сравнение доли мест находок орешниковой сони в различных древостоях леса с площадью этих древостоев в Литве показало, что сони предпочитали ельники и дубравы, но избегали сосняков. Дополнительно выбор мест обитания орешниковой сони был исследован на двух стационарах, в различных древостоях которых были развешены искусственные гнездовья для птиц. По проценту заселенности этих гнездовий определялась пригодность различных древостоев для орешниковой сони. По этому показателю наиболее пригодными оказались смешанные древостои, в которых преобладали ели или дубы. Обобщая можно предположить, что выбор мест обитания орешниковой сони в Литве косвенно зависит от плодородности почвы: наиболее благоприятные места обитания для этого вида находятся в более плодородных участках лесных массивов.

Ключевые слова: орешниковая соня, места обитания, древостои леса, зарастающие вырубки, искусственные гнездовья для птиц, Литва