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Ornis Hungarica 2023. 31(2): 192–202.
DOI: 10.2478/orhu-2023-0029

What is the size of the Western Barn Owl *(Tyto alba)* hunting range in a mosaic landscape?

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Received: October 21, 2023 – Revised: November 23, 2023 – Accepted: November 24, 2023

Presented at 3rd Hungarian Owl Research Conference held in Pécs on 8th September 2023

Szép, D. & Purger, J. J. 2023. What is the size of the Western Barn Owl *(Tyto alba)* hunting range in a mosaic landscape? – Ornis Hungarica 31(2): 192–202. DOI: 10.2478/orhu-2023-0029

Abstract Western Barn Owls hunt primarily small mammals in open areas, but they also hunt in urban, forest and wetland habitats. The landscape structure of their hunting range, therefore, affects the composition of their prey, knowledge of which can be a good starting point for estimating the size of their hunting range. Our goal was to estimate whether owls catch most of their prey within a circle with radius of 1, 2, 3, 4 or even 5 kilometres. In this study, we used five pellet samples of different size, collected between 2015 and 2019 from a settlement near the Drava River (Péterhida, Hungary). Our results showed that the annual distribution, diversity, and evenness of small mammal species detected from the samples was similar regardless of the sample size. The distribution of small mammal functional groups preferring urban, open, forest and wetland habitats was also similar. For this reason, the pellet samples were merged. Our results suggest that Western Barn Owls catch a significant part of their prey within a circle of 2-kilometre radius around its breeding or roosting site in the landscape, which consists of patches of habitat with a mosaic distribution. In a hunting range of this size, the proportion of small mammal functional groups preferring different habitats obtained from the pellets overlapped with the proportion of their preferred habitats.

Keywords: pellets, small mammals, habitat preference, landscape structure

Összefoglalás A gyöngybaglyok elsősorban nyílt élőhelyeken vadásznak, de urbán, erdős és vizes élőhelyeket preferáló kisemlősöket is elejtenek. A vadászterületük tájszerkezete tehát hatással van a zsákmányuk összetételére, aminek ismerete jó kiindulási pont lehet a vadászterületük nagyságának becslésére. Célunk az volt, hogy megbecsüljük, vajon a baglyok 1, 2, 3, 4 vagy esetleg 5 kilométeres sugarú körön belül ejtik-e el a zsákmányuk nagy részét. Ebben a vizsgálatban öt különböző méretű köpetmintát használtunk, amelyeket 2015 és 2019 között gyűjtöttünk egy Dráva menti településről (Péterhida, Magyarország). A mintákból kimutatott zsákmány évenkénti megoszlása, diverzitása és egyenletessége hasonló volt a minta nagyságától függetlenül. A zsákmányösszetétel a nyílt, urbán, erdős és vizes élőhelyeket preferáló kisemlősök funkcionális csoportjainak tekintetében is hasonló eloszlást mutatott. Az említett hasonlóságok miatt a köpetmintákat összevontuk. Az eredményeink arra utalnak, hogy a gyöngybaglyok zsákmányuk jelentős részét a költő- vagy pihenőhelyük körül egy 2 kilométeres sugarú körön belül ejtik el, amely mozaikos eloszlású élőhelyfoltokból áll. Ekkora nagyságú vadászterületen a köpetekből kimutatott különböző élőhelyeket preferáló kisemlős funkcionális csoportok aránya átfedésben volt a preferált élőhelyeik részesedésével.

Kulcsszavak: köpetek, kisemlősök, élőhely preferencia, tájszerkezet

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Introduction

The Western Barn Owl *(Tyto alba)* is a selective opportunistic predator that primarily preys on small mammals (Tores *et al.* 2005, Moysi *et al.* 2018). As a result, the small mammal community of the hunting range can be assessed more efficiently and precisely by analysing its pellets, compared to the trapping method (Torre *et al.* 2004, Heisler *et al.* 2016). Western Barn Owls breed in urban environments but mostly catch their prey in open habitats (Taylor 1994), consequently, insectivores and grassland rodents are oversampled in their pellets, and tree-dwelling and woodland rodents are underrepresented (Torre *et al.* 2004). The extent and arrangement of the habitats in the hunting range of the owls affects the probability that individuals of small mammal species will be caught (Horváth *et al.* 2023). However, the prey is not always dominated by small mammal species that prefer open habitats, as some species may permanently or periodically use other habitats. For example, among the small mammals that prefer forests, individuals of wood mouse *(Apodemus)* species live on the forest edge (Schlinkert *et al.* 2016), in agricultural areas (e.g. Tew *et al.* 2000, Todd *et al.* 2000, Tattersall *et al.* 2001, Heroldová *et al.* 2008), but are also present in urban habitats (Łopucki *et al.* 2013). The Harvest Mouse *(Micromys minutus)* associated with wetlands occurs in forests (Juskaitis & Remeisis 2007), agricultural areas (Bence *et al.* 2003), but also in various habitat patches in settlements (Dickman 1986). These examples show that few small mammal species can be considered habitat specialists, so the size of the hunting range can only be estimated based on the relative abundance of small mammal species detected in the pellets of Western Barn Owls.

In several studies, the hunting range of this owls species was considered to be the area of circles with different radii (between 1 and 5.6 km) starting from their breeding or resting site (e.g. Martinez & Zuberogoitita 2004, Meek *et al.* 2009, Milchev 2015, Torre *et al.* 2015), but the area of circle with 2 km radius seemed the most likely (e.g. Lovari *et al.* 1976, Horváth *et al.* 2005, Meek *et al.* 2009). Within hunting ranges of this size, significant relationships were found between the proportion of habitats and the relative abundance of small mammal species detected in Western Barn Owl pellets (Szép *et al.* 2017, 2018, 2019, 2021). However, by tracking the movements of owls, it was found that they hunt much further away than 2 kilometres (e.g. Taylor 1994, Guerra *et al.* 2014, Hindmarch *et al.* 2017, Cain *et al.* 2023), but it is still not known where they catch most of their prey. Upon a large pellet sample, it was shown that the hunting range of owls in the landscape dominated by open agricultural areas corresponds to a circle with a radius of 3 km (Purger & Szép 2022). Unfortunately, it was not tested how the result of the estimation would have developed if the assumed hunting range were further increased.

In this work, we sought answers to the following questions: 1) Can smaller pellet samples be merged to obtain a representative sample? 2) How large is the hunting range of Western Barn Owl (radius of 1, 2, 3, 4, or 5 km) supposed in a landscape where the arrangement of habitats is mosaic?

Materials and Methods

In the southern part of Hungary, the settlement of Péterhida is located on the Drava Plain, where Western Barn Owls regularly breed in nesting boxes placed in the attic of an abandoned cattle barn (Purger 2019, Sipter 2021). Between 2015 and 2019, a total of 1,018 pellets were collected from the nesting box and the attic, and the faunistic results, except for the year 2019, have already been published (Purger 2016, 2019). Most of the prey of Western Barn Owls were shrews and rodents, and were classified into four (urban, open, forest or wetland) functional groups based on their habitat preferences (Szép *et al.* 2018, Purger & Szép 2022). To estimate the size of the hunting range of owls, we used relative abundance of each functional groups.

The 2019 map of the CORINE Land Cover Project was used to characterize the landscape structure of the hunting range. Circles with 1, 2, 3, 4 and 5 km radius were marked around the nesting place located in Péterhida. We estimated the distribution of the habitat types in QGIS v2.12 (QGIS 2013). These various landscape structures were classified into 4 habitat types: urban, open, forest and wetland. According to the map of the national scale CORINE Land Cover Change 2012–2018, the land use change was estimated between 2015 and 2018. During this period the landscape changed only slightly: in a radius of 5 km circle 20 hectares of broad-leaved forest was replaced by transitional woodland-shrub. Based on Google maps, no significant intervention in the landscape took place in 2019 either.

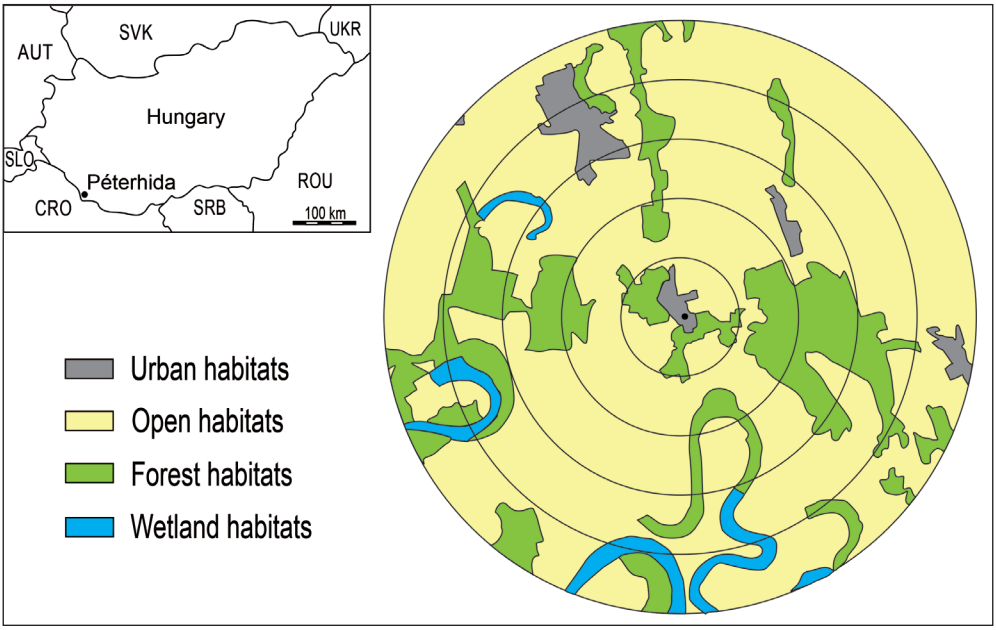

Figure 1. Distribution of four habitat types (urban, open, forest and wetland) in 1, 2, 3, 4 and 5 km radius circles (presumed hunting area) around the nesting place of the Western Barn Owl in Péterhida

1. ábra A gyöngybagoly péterhidai költőhelye körül kijelölt 1, 2, 3, 4 és 5 km sugarú körökben (feltételezett vadászterület) a négy élőhely típus (urbán, nyílt, erdei és vizes) eloszlása

The comparison of the relative abundances of small mammal functional groups detected in the five samples, and the proportion of the habitats within the corresponding hunting ranges were carried out by a homogeneity test (Zar 2010). The diversity (H) and evenness (J) of the small mammal prey of Western Barn Owls was calculated using the Past program (Hammer *et al.* 2001).

Results and Discussion

In the pellets collected in Péterhida in the abandoned cattle stable between 2015 and 2019, we identified 2,346 individuals of 19 small mammal species (considering only the shrew and rodent species). The number of species varied between 15 and 18 in the samples, which differed in size and were collected in different years *(Table 1)*. The number of pellets collected in different years varied between 71 and 430 *(Table 1),* but the diversity (H) and evenness (J) of the preyed small mammal species were similar *(Table 2)*.

The prey composition of Western Barn Owls can be considered similar in the years of our study as significant differences could only be detected in three cases concerning the groups of small mammals that prefer certain habitats *(Figure 2)*. During the five years of our study, the importance and relative abundance of small mammal species preferring urban and open habitats in the diet of Western Barn Owls was similar *(Figure 2)*. However, the relative abundance of small mammals preferring forest habitats was significantly higher in 2019 (G=4.30, P<0.05) than in 2016 *(Figure 2)*. The change was caused by that Western

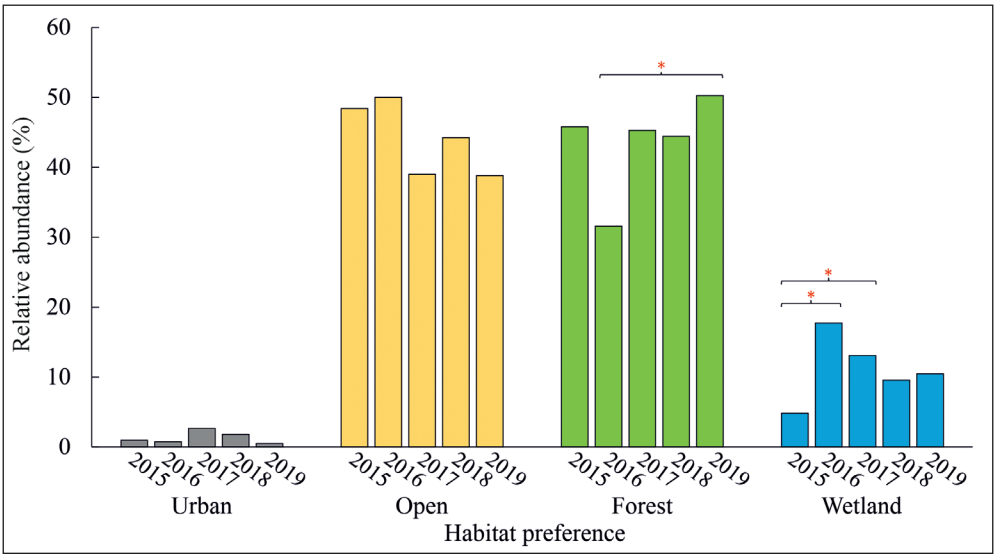

Figure 2. Changes in the relative abundance of functional groups based on the habitat preference of small mammals recovered from Western Barn Owl pellets between 2015 and 2019. (* P<0.05)

2. ábra A gyöngybagoly köpetekből előkerült kisemlősök élőhely preferenciája alapján kialakított funkcionális csoportok relatív gyakoriságának változása 2015 és 2019 között. (* P<0.05)

Table 1. Habitat preference (HP: U – urban, O – open, F – forest, W – wetland), relative abundance, diversity (H) and evenness (J) of small mammals (considering only shrew and rodent species) detected from Western Barn Owl pellets collected between 2015 and 2019.

1. táblázat A 2015 és 2019 között gyűjtött gyöngybagoly köpetekből kimutatott kisemlősök (csak a cickány és a rágcsáló fajokat figyelembe véve) élőhelypreferenciája (HP: U – urbán, O – nyílt, F – erdei, W – vizes), relatív gyakorisága, diverzitása és egyenletessége

Mammal species	HP	2015	2016	2017	2018	2019
Crocidura leucodon	O	18.71	20.33	7.26	3.09	2.99
Crocidura suaveolens	O	13.55	15.07	7.26	10.26	9.45
Sorex araneus	F	17.10	9.81	18.40	20.32	22.89
Sorex minutus	F	11.29	4.78	4.60	3.78	11.44
Neomys anomalus	W	2.26	11.24	7.26	1.10	0.50
Neomys fodiens	W	-	0.48	-	0.10	0.50
Muscardinus avellanarius	F	0.32	-	-	0.10	0.50
Microtus lavernedii	W	0.97	3.35	3.87	7.37	5.47
Microtus arvalis	O	15.47	14.60	24.47	30.87	25.86
Microtus subterraneus	F	2.26	1.44	1.21	5.18	1.99
Arvicola amphibius	W	-	0.24	1.94	0.70	0.50
Myodes glareolus	F	2.90	3.11	2.91	5.18	3.48
Apodemus agrarius	F	9.03	8.14	7.26	4.98	2.98
Apodemus flavicollis	F	2.26	2.39	8.72	3.59	6.47
Apodemus sylvaticus	F	0.65	1.91	2.18	1.29	0.50
Micromys minutus	W	1.61	2.39	-	0.30	3.48
Mus musculus	U	0.97	0.72	2.42	1.49	-
Mus spicilegus	O	0.65	-	-	-	0.50
Rattus norvegicus	U	-	-	0.24	0.30	0.50
Number of species		16	16	15	18	18
Number of preys		310	418	413	1004	201
Number of pellets		100	185	232	430	71
Diversity (H)		2.24	2.33	2.32	2.17	2.20
Evenness (J)		0.59	0.64	0.68	0.49	0.50

Barn Owls preyed on more Common Shrews *(Sorex araneus)* in 2019 ($G=5.38$, $P<0.05$) than in 2016 *(Table 1)*. Compared to 2015, the relative abundance of species preferring wetlands significantly increased in the prey in 2016 ($G=11.27$, $P<0.01$) and 2017 ($G=3.93$, $P<0.05$) *(Figure 2)*. Despite that most of the species associated with wetlands showed an increasing tendency in the prey *(Table 1)*, only the Mediterranean Water Shrew *(Neomys anomalus)* was preyed by owls in 2016 in a significantly greater number ($G=6.52$, $P<0.05$) than in 2015 *(Table 1)*.

Several factors may have influenced the observed differences, for example, the number of pellets collected yearly, which in several cases was much less than what can be expected in an optimal case (at least 300 pellets) (Purger & Szép 2022). The other fact is that Western

Table 2. Comparison of the diversity (H) and evenness (J) of small mammals detected from Western Barn Owl pellets collected in different years. N.S. – non-significant

2. táblázat A különböző években begyűjtött gyöngybagoly köpetekből kimutatott kisemlősök diverzitásának (H) és egyenletességének (J) összehasonítása. N.S. – nem-szignifikáns

		2015	2016	2017	2018
2016	**H**	G = 0.001 N.S.			
	J	G = 0.002 N.S.			
2017	**H**	G = 0.001 N.S.	G = 0.000 N.S.		
	J	G = 0.006 N.S.	G = 0.001 N.S.		
2018	**H**	G = 0.001 N.S.	G = 0.005 N.S.	G = 0.004 N.S.	
	J	G = 0.014 N.S.	G = 0.028 N.S.	G = 0.040 N.S.	
2019	**H**	G = 0.000 N.S.	G = 0.003 N.S.	G = 0.003 N.S.	G = 0.000 N.S.
	J	G = 0.006 N.S.	G = 0.017 N.S.	G = 0.026 N.S.	G = 0.001 N.S.

Barn Owls can show prey preference during hunting (Yom-Tov & Wool 1997, Taylor 2009). However, we can also consider the weather, which can have a significant effect on the density and availability of small mammal species (Meek *et al.* 2012, Charter *et al.* 2017). In the period of our study, the differences can be explained primarily by meteorological conditions. In 2014 and 2015, large waterlogging areas formed as a result of the increased rainfall can also be seen on Google maps, but it is not represented on the CORINE maps we used. The waterlogging

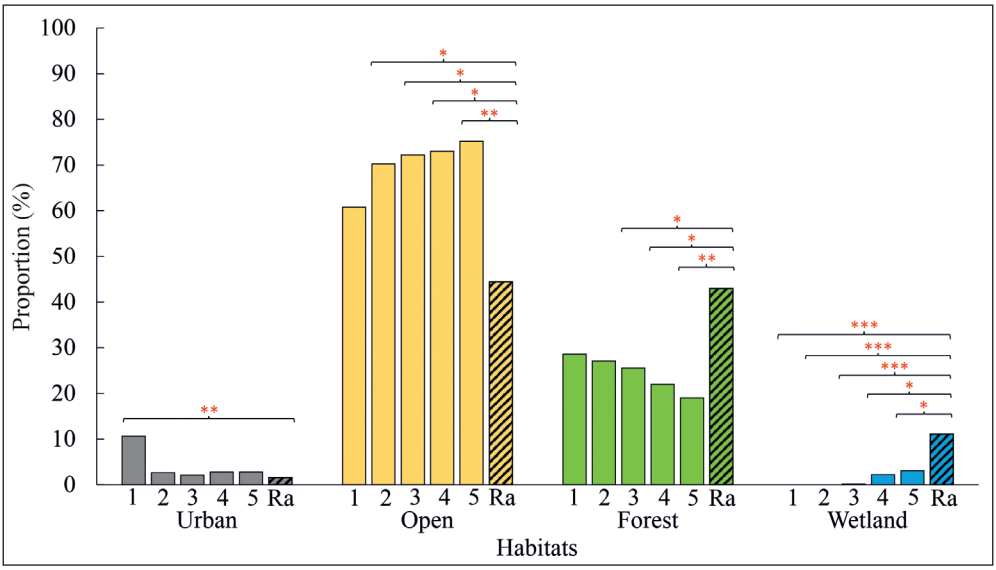

Figure 3. Comparison of the ratio of habitats and the relative abundance (Ra, striped bars) of small mammals that prefer them, in circles with a radius of 1–5 km (* P<0.05, ** P<0.01, *** P<0.001)

3. ábra 1–5 km-es sugarú körökben az egyes élőhelyek arányának összevetése az azokat preferáló kisemlősök funkcionális csoportjainak relatív gyakoriságával (Ra, csíkos oszlopok) (* P<0.05, ** P<0.01, *** P<0.001)

must have contributed to the fact that by 2016, species preferring wetlands were present with a higher density of individuals in the hunting ranges of the owls. As a result, in 2016 and even in 2017, the owls could more easily access and prey on individuals of species that prefer wetlands. In addition, the waterlogging also extended to the forests of the floodplains and bog forests covering the riversides of the Drava, so the density of individuals of species that prefer forest habitats may have decreased as a result, which can be confirmed by the fact that owls preyed fewer individuals of forest species in 2016 *(Figure 2)*. Weather changes can also be tracked through the small mammal prey of Wester Barn Owls (Meek *et al.* 2012, Charter *et al.* 2017). Despite the differences shown, to achieve a representative pellet number, it is advisable to combine or merge pellet samples from different years.

Moving away from the nesting and resting places of Wester Barn Owls, i.e., increasing the hunting ranges, the proportion of particular habitats changed *(Figure 3)*. Therefore, we examined the relationship between the relative abundance (Ra) of small mammals preferring different habitats and the proportion of habitats within the areas of circles with a radius of 1, 2, 3, 4, and 5 km *(Figure 3)*.

The proportion of urban habitats around the nest site, within a radius of 1 km was the highest *(Figure 3)*, nevertheless, the relative abundance of species associated with urban habitats in the prey of owls was significantly lower *(Table 3)*. This is expected since Western Barn Owls hunt primarily in open areas, therefore, the proportion of species preferring open habitats in the prey was similar as the distribution of open habitats within a radius of 1 km,

Table 3. Differences between the functional groups of small mammals detected from the whole sample of pellets of the Western Barn Owl, based on their habitat preference and the proportion of their preferred habitats within radii of 1, 2, 3, 4 and 5 km, using G test of homogeneity

3. táblázat Az egyes élőhelyek aránya és az azokat preferáló fajok relatív gyakoriságai közti különbségek a homogenitás G teszt alapján a gyöngybagoly feltételezett vadászterületén 1, 2, 3, 4 és 5 km-es sugarú körökben

Radius of circle	Habitat	Proportion of habitat (%)	Relative abundance (%)	G	P
1km	Urban	10.60	1.53	7.61	<0.01
1km	Wetland	0.00	11.08	15.36	<0.001
2km	Open	70.25	44.42	5.87	<0.05
2km	Wetland	0.00	11.08	15.36	<0.001
3km	Open	72.20	44.42	6.68	<0.05
3km	Forest	25.54	42.97	4.48	<0.05
3km	Wetland	0.14	11.08	14.02	<0.001
4km	Open	73.05	44.42	7.05	<0.05
4km	Forest	21.96	42.97	6.92	<0.05
4km	Wetland	2.20	11.08	6.48	<0.05
5km	Open	75.20	44.42	8.01	<0.01
5km	Forest	19.01	42.97	9.51	<0.01
5km	Wetland	3.03	11.08	4.88	<0.05

but significant differences were observed in circles with a larger radius *(Figure 3, Table 3)*. This result, however, suggests that owls do not have to move further than 1 km to catch their main food. Likely, the open agricultural habitats were rich in food sources, since Western Barn Owls living in such habitats exploited smaller ranges than individuals whose nests were established in habitats with lower prey availability (Séchaud *et al.* 2022).

The proportion of forest species was similar to the proportion of forests within circles with a radius of 1 and 2 km *(Figure 3, Table 3)*. In the circles with a larger radius, the proportion of species preferring forest habitats was significantly higher in the pellets compared to the proportion of these habitats *(Figure 3, Table 3)*. In every year, except in the sample from 2016, the proportion of forest-preferring species was almost 50% of the total prey, which suggests that many forest species, such as the Wood Mouse *(Apodemus sylvaticus)* or the Striped Field Mouse *(Apodemus agrarius)* are also often preyed on outside the forest (e.g. Gliwicz & Kryštufek 1999, Tattersall *et al.* 2001). Wood mouse species are often caught by Western Barn Owls in smaller woody bushy habitats not shown on maps, such as around tree lines and hedges (Taylor 1994).

The relative abundance of species preferring wetlands was higher, in all cases, than the proportion of wetlands determined based on the maps *(Figure 3, Table 3)*. The smallest difference was observed in the radius of 2 km *(Figure 3, Table 3)*. The maps we used do not depict small watercourses and seasonal inland waters, so these habitats are usually underrepresented, which is why the established differences appear (Szép *et al.* 2019). The results of our present study indicate that Western Barn Owls caught their prey within a circle with a radius of 2 km since the habitat preference of the small mammal species detected in the prey in this case best reflected the distribution of different habitats. This result confirmed that this area size is acceptable to characterize the hunting range of Western Barn Owls (e.g. Lovari *et al.* 1976, Horváth *et al.* 2005, Meek *et al.* 2009, Szép *et al.* 2017). It is worthy to note that if the assumed hunting range is a typical agricultural landscape, the owls caught most of their prey within a 3 km circle (Purger & Szép 2022). The question, therefore, arises as to how accurate our estimation is, but it is perhaps possible to decide this if small mammal trapping is carried out in parallel with the pellet analyses, and only habitat specialist species from the pellets are included in the analyses. Unfortunately, this will require even larger samples, as the intensification of agriculture has negative effects on the density of rare and habitat specialist species (de la Peña *et al.* 2003).

Conclusion

It is worthy to note that the pellet samples can be merged to achieve a representative sample size if the ratio of each habitat type does not change significantly around the nesting site of the Western Barn Owls during the study period. Based on the assumption that most of the shrews and rodent species common in the prey of Wester Barn Owls show a certain level of habitat preference, the prey of owls can indicate the share of habitats found in the hunting range. The relative abundance of small mammal functional groups that prefer urban, open, forest, or wetland habitats in the prey in a hunting range of a certain size may overlap with the

proportion of the distribution of the habitats found there. Therefore, it is possible to estimate how large hunting range the Western Barn Owls can use to catch their prey. The result of the estimation can help reconstruct the proportion of each type of habitat within the presumed hunting range based on archive data of pellet analysis. It is conceivable that, despite the robustness of the method, it can be further refined, e.g., so that only the proportion of habitat specialist small mammal species are taken into account during the estimations.

Acknowledgements

We would also like to thank the anonymous reviewers for their work and Zsolt Csanád Sipter for his help in collecting pellets.

References

Bence, S. L., Stander, K. & Griffiths, M. 2003. Habitat characteristics of Harvest Mouse nests on arable farmland. – Agriculture, Ecosystems & Environment 99(1–3): 179–186. DOI: 10.1016/S0167-8809(03)00137-3

Cain, S., Solomon, T., Leshem, Y., Toledo, S., Arnon, E., Roulin, A. & Spiegel, O. 2023. Movement predictability of individual Barn Owls facilitates estimation of home range size and survival. – Movement Ecology 11(1): 10. DOI: 10.1186/s40462-022-00366-x

Charter, M., Izhaki, I., Meyrom, K., Aviel, S., Leshem, Y. & Roulin, A. 2017. The relationship between weather and reproduction of the Barn Owl *Tyto alba* in a semi-arid agricultural landscape in Israel. – Avian Biology Research 10(4): 253–258. DOI: 10.3184/175815617X15063340995365

de la Peña, N. M., Butet, A., Delettre, Y., Paillat, G., Morant, P., Le Du, L. & Burel, F. 2003. Response of the small mammal community to changes in western French agricultural landscapes. – Landscape Ecology 18(3): 265–278. DOI: 10.1023/A:1024452930326

Dickman C. R. 1986. Habitat utilization and diet of the Harvest Mouse, *Micromys minutus*, in an urban environment. – Acta Theriologica 31(19): 249–256. DOI: 10.4098/AT.arch.86-24

Gliwicz, J. & Kryštufek, B. 1999. *Apodemus agrarius*. – In: Mitchell-Jones, A. J., Amori, G., Bogdanowicz, W., Kryštufek, B., Reijnders, P. J. H., Spitzenberger, F., Stubbe, M., Thissen, J. B. M., Vohralík, V. & Zima, J. (eds.) The Atlas of European Mammals. – Academic Press, London

Guerra, C., García, D. & Alcover, J. A. 2014. Unusual foraging patterns of the Barn Owl, *Tyto alba* (Strigiformes: Tytonidae), on small islets from the Pityusic archipelago (Western Mediterranean Sea). – Folia Zoologica 63(3): 180–187. DOI: 10.25225/fozo.v63.i3.a5.2014

Hammer, Ø., Harper, D. A. T. & Ryan, P. D. 2001. PAST: Paleontological statistics software package for education and data analysis. – Paleontologia Electronica 4: 1–9.

Heisler, L. M., Somers, C. M. & Poulin, R. G. 2016. Owl pellets: a more effective alternative to conventional trapping for broad-scale studies of small mammal communities. – Methods in Ecology and Evolution 7(1): 96–103. DOI: 10.1111/2041-210X.12454

Heroldová, M., Tkadlec, E., Bryja, J. & Zejda, J. 2008. Wheat or barley?: Feeding preferences affect distribution of three rodent species in agricultural landscape. – Applied Animal Behaviour Science 110(3–4): 354–362. DOI: 10.1016/j.applanim.2007.05.008

Hindmarch, S., Elliott, J. E., Mccann, S. & Levesque, P. 2017. Habitat use by Barn Owls across a rural to urban gradient and an assessment of stressors including, habitat loss, rodenticide exposure and road mortality. – Landscape and Urban Planning 164: 132–143. DOI: 10.1016/j.landurbplan.2017.04.003

Horváth, G. F., Molnár, D., Németh, T. & Csete, S. 2005. Landscape ecological analysis of Barn Owl pellet data from the Drava lowlands Hungary. – Natura Somogyiensis 7: 179–189. DOI: 10.24394/NatSom.2005.7.179

Horváth, G. F., Mánfai, K. & Horváth, A. 2023. Relationship between landscape structure and the diet of Common Barn-owl *(Tyto alba)* at different distances from the Drava River ecological corridor. – Ornis Hungarica 2023(1): 88–110. DOI: 10.2478/orhu-2023-0006

Juskaitis, R. & Remeisis, R. 2007. Harvest Mice *Micromys minutus* and Common Dormice *Muscardinus avellanarius* live sympatric in woodland habitat. – Acta Theriologica 52(4): 349–354. DOI: 10.1007/BF03194232

Łopucki, R., Mróz, I., Berliński, Ł. & Burzych, M. 2013. Effects of urbanization on small-mammal communities and the population structure of synurbic species: an example of a medium-sized city. – Canadian Journal of Zoology 91(8): 554–561. DOI: 10.1139/cjz-2012-0168

Lovari, S., Renzoni, A. & Fondi, R. 1976. The predatory habits of the Barn Owl (*Tyto alba* Scopoli) in relation to the vegetation cover. – Bolletino di Zoologia 43(1–2): 173–191. DOI: 10.1080/11250007609434894

Martinez, J. A. & Zuberogoitia, I. 2004. Habitat preferences and causes of population decline for Barn Owls *Tyto alba*: a multi-scale approach. – Ardeola 51(2): 303–317.

Meek, W. R., Burman, P. J., Nowakowski, M., Sparks T. H., Hill, R. A., Swetnam, R. D. & Burman, N. J. 2009. Habitat does not influence breeding performance in a long-term Barn Owl *Tyto alba* study. – Bird Study 56(3): 369–380. DOI: 10.1080/00063650902937339

Meek, W. R., Burman, P. J., Sparks, R. H., Nowakowski, M. & Burman, N. J. 2012. The use of Barn Owl *Tyto alba* pellets to assess population change in small mammals. – Bird Study 59(2): 166–174. DOI: 10.1080/00063657.2012.656076

Milchev, B. 2015. Diet of Barn Owl *Tyto alba* in Central South Bulgaria as influenced by landscape structure. – Turkish Journal of Zoology 39(5): 933–940. DOI: 10.3906/zoo-1409-24

Moysi, M., Christou, M., Goutner, V., Kassinis, N. & Iezekiel, S. 2018. Spatial and temporal patterns in the diet of Barn Owl *(Tyto alba)* in Cyprus. – Journal of Biological Research – Thessaloniki 25: 9. DOI: 10.1186/s40709-018-0080-8

QGIS (Quantum GIS Development Team) 2013. Quantum GIS Geographic Information System. – Open Source Geospatial Foundation Project. Version 2.12 – http://www.qgis.org/

Purger, J. J. 2016. Adatok Somogy megye kisemlős faunájának ismeretéhez, gyöngybagoly *Tyto alba* (Scopoli, 1769) köpetek vizsgálata alapján [Date to the knowledge of small mammal fauna of Somogy county (Hungary), based on Barn Owl *Tyto alba* (Scopoli, 1769) pellet analysis]. – A Kaposvári Rippl-Rónai Múzeum Közleményei 04: 91–108. (in Hungarian)

Purger, J. J. 2019. A Barcsi Ó-Dráva holtág és környékének emlősfaunája [Mammalian fauna of the Old-Drava oxbow near Barcs and its surroundings]. – In: Purger, D. & Purger, J. J. (eds.) A Barcsi Ó-Dráva holtág élőhelyei és élővilága [Habitats and Wildlife of the Old-Drava Oxbow near Barcs]. – BioRes, Pécs, pp. 189–202. (in Hungarian)

Purger, J. J. & Szép, D. 2022. An attempt to determine the size of the Common Barn-owl's *(Tyto alba)* hunting area based on its prey composition. – Avian Biology Research 15(1): 41–46. DOI: 10.1177/17581559211066091

Schlinkert, H., Ludwig, M., Batáry, P., Holzschuh, A., Kovács-Hostyánszki, A., Tscharntke, T. & Fischer, C. 2016. Forest specialist and generalist small mammals in forest edges and hedges. – Wildlife Biology 22(3): 86–94. DOI: 10.2981/wlb.00176

Séchaud, R., Schalcher, K., Almasi, B., Bühler, R., Safi, K., Romano, A. & Roulin, A. 2022. Home range size and habitat quality affect breeding success but not parental investment in Barn Owl males. – Scientific Reports 2: 6516. DOI: 10.1038/s41598-022-10324-7

Sipter Cs. 2021. Gyöngybaglyok *(Tyto alba)* Belső-Somogyban [Barn Owls *(Tyto alba)* in Inner-Somogy]. – Paeonia 5: 131–144. (in Hungarian)

Szép, D., Klein, Á. & Purger, J. J. 2017. The prey composition of the Barn Owl *(Tyto alba)* with respect to landscape structure of its hunting area (Zala County, Hungary). – Ornis Hungarica 25(2): 51–64. DOI: 10.1515/orhu-2017-0015

Szép, D., Horváth, G. F., Krčmar, S. & Purger, J. J. 2018. Connection between prey composition and the landscape structure in the hunting area of Barn Owls *(Tyto alba)* in Baranja (Croatia). – Peridoicum Biologorum 120(2–3): 125–133. DOI: 10.18054/pb.v120i2-3.6650

Szép, D., Klein, Á. & Purger, J. J. 2019. Investigating the relationship between the prey composition of Barn Owls *(Tyto alba)* and the habitat structure of their hunting range in the Marcal Basin (Hungary), based on pellet analysis. – Ornis Hungarica 27(1): 32–43. DOI: 10.2478/ orhu-2019-0002

Szép, D., Krčmar, S. & Purger, J. J. 2021. Possible causes of temporal changes in the diet composition of Common Barn-owls *Tyto alba* (Scopoli, 1769) (Strigiformes: Tytonidae) in Baranja, Croatia. – Acta Zoologica Bulgarica 73(1): 87–94.

Taylor, I. 1994. Barn Owls: Predator-Prey Relationships and Conservation. – Cambridge University Press, Cambridge, UK.

Taylor, I. R. 2009. How owls select their prey: A study of Barn Owls *Tyto alba* and their small mammal prey. – Ardea 97(4): 635–644. DOI: 10.5253/078.097.0433

Tattersall, F. H., Macdonald, D. W., Hart, B. J., Manley, W. J. & Feber, R. E. 2001. Habitat use by Wood Mice *(Apodemus sylvaticus)* in a changeable arable landscape. – Journal of Zoology 255(4): 487–494. DOI: 10.1017/S095283690100156X

Tew, T. E., Todd, I. A. & Macdonald, D. W. 2000. Arable habitat use by Wood Mice *(Apodemus sylvaticus)*. 2. Microhabitat. – Journal of Zoology 250(3): 305–311. DOI: 10.1111/j.1469-7998.2000.tb00774.x

Todd, I. A., Tew, T. E. & Macdonald, D. W. 2000. Arable habitat use by Wood Mice *(Apodemus sylvaticus)*. 1. Macrohabitat. – Journal of Zoology 250(3): 299–303. DOI: 10.1111/j.1469-7998.2000.tb00773.x

Tores, M., Motro, Y., Motro, U. & Yom-Tov, Y. 2005. The Barn Owl – a selective opportunist predator. – Israel Journal of Zoology 51(4): 349–360. DOI: 10.1560/7862-9E5G-RQJJ-15BE

Torre, I., Arrizabalaga, A. & Flaquer, C. 2004. Three methods for assessing richness and composition of small mammal communities. – Journal of Mammalogy 85(3): 524–530. DOI: 10.1644/BJK-112

Torre, I., Gracia-Quintas, L., Arrizabalaga, A., Baucells, J. & Mario, D. 2015. Are recent changes in the terrestrial small mammal communities related to land use change? A test using pellet analyses. – Ecological Research 30(5): 813–819. DOI: 10.1007/s11284-015-1279-x

Yom-Tov, Y. & Wool, D. 1997. Do the contents of Barn Owl pellets accurately represent the proportion of prey species in the field? – The Condor 99(4): 972−976. DOI: 10.2307/1370149

Zar, J. H. 2010. Biostatistical Analysis (5th ed.). – Prentice-Hall, New Jersey, USA