

**UNIVERSITY OF PÉCS**

**Biological and Sportbiological Doctoral School**

**The impacts of the weather and the landscape structure of the hunting area on the diet of the Northern Long-eared Owl (*Asio otus*) and the Common Barn Owl (*Tyto alba*) in the Transdanubian region of the Pannonian Basin**

*PhD Thesis*

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## INTRODUCTION

**Northern Long-eared Owl (*Asio otus*)** is a medium-sized owl, with a holarctic distribution. From late autumn to early spring, they usually winter in groups, mainly on trees in settlements. Thanks to this, large amounts of pellets can be collected underneath their resting places, so researchers can easily get a sample of the right size. Small mammals are the major part of the Northern Long-eared Owl's diet. So, they have an important role in the regulation of small mammal populations, since one of their main prey is the Common Vole (*Microtus arvalis*), which is a widespread agricultural pest in the Pannonian Basin.

Their prey capture can be influenced by a number of factors such as weather conditions, size and availability of prey, and landscape structure of the hunting areas. The Northern Long-eared Owls' hunting success and the availability of prey are influenced by meteorological conditions. Their winter diet is well known in most of its distribution area. In different geographical regions, climatic factors have various effects on diet composition, but this is even less explored. The distribution and mosaic patterns of habitats in their hunting areas influence the presence and availability of certain prey species, which may be reflected in the diet composition and the size of the home range. Radio telemetry studies of Northern Long-eared Owls found that the size of their home range depends on the sex of the birds, the urbanization around the nesting place and wintering or breeding season. Determining the size of the hunting area is not easy, because, if we start with the size of the owls' individual home range, they can be described with relatively small circles around the resting area. In contrast, the extended home ranges of Northern Long-eared Owls wintering in larger groups can, thanks to spatial separation, cover an area of up to a 3 km radius.

Due to the high consumption of Common Vole, the diet composition of Northern Long-eared Owls is less varied and, therefore, the relationship between the landscape structure of their hunting area and the relative abundance of prey species poorly understood. The owls living or wintering in cities it is difficult to find available prey locally, forcing them to fly across larger areas or to switch between prey species.

The **Common Barn Owl (*Tyto alba*)** with a palearctic distribution, prey mainly small mammals like the Northern Long-eared Owl, but their diet composition is much more diverse. The breeding and resting places of Common Barn owls in Europe are most often found in

church towers, attics of buildings and abandoned buildings. Based on the prey remains from their pellets, we can conclude the composition and abundance of small mammal fauna for the Common Barn Owls' hunting area. The extent and mosaicity of each habitat patch also undergo changes, which can also be detected through prey composition of owls due to the habitat preference of small mammals. Long-term Barn Owl pellet analysis can be used to detect spatial and temporal variation in the abundance of small mammal species or even changes in land use.

Common Barn Owls pellet analysis has a long tradition in both Croatia and Hungary, but this method has so far been used primarily to detect preyed small mammal species, i.e. faunistic surveys. Based on our comparison of the results from two surveys conducted at different times in the southern part of the Marcal Basin, we concluded that differences in the abundance of species detected in the pellets may also indicate distinct land use. The landscape structure of the Common Barn Owl hunting area has been studied in the past due to different literature data, in very different sizes, but mostly in small circles. Due to the significantly different sizes of hunting area, the question: what is the appropriate area of these different approaches that actually represents the owls' hunting area.

Common Barn Owls occur singly or in couples, which makes collecting large amounts of pellets not as easy as in the case of Northern Long-eared Owls. For this reason, we can find very different amounts of samples in the literature. If the sampling did not last for several years, the size of the samples from each sampling point is often very small. For this reason, the question often arises as to how large the pellet sample should be in order to adequately represent the small mammal community in the hunting area.

## **AIMS**

Owls play an important role in ecosystems in the regulation of small mammal communities' populations. Their prey capture can be influenced by the weather and the hunting areas landscape structure. Our knowledge of the effects of these factors is still incomplete, so the objectives of our studies were as follows:

1. To study the changes in the diet composition on the basis of the contents of the pellets collected regularly from wintering Northern Long-eared Owls, furthermore to show the effect of weather on the distribution and availability of prey species.

2. To determine the potential hunting area, by examining the hunting area corresponding to a radius of 1, 2 or 3 km, which distance reflect the habitat preference of the prey species. To study the effect of urbanization on predation through the prey composition of Northern Long-eared Owls wintering in three different-sized settlements. Study the size of the pellet sample required to represent the prey composition of owls.

3. To find correlations between the relative abundance of Common Barn Owls' prey species and the distribution of habitat types in the hunting area around the sampling sites. To examine how the abundance of preyed small mammal species reflects the differences in landscape structure between the hunting areas of the edge of Banskó Hill and the lowland region of Baranja.

4. In Baranja, after 9 years, visit the previously visited area again and compare the results of the two surveys with the changes in the landscape structure.

5. To investigate in Zala County the effect of landscape structure and mosaic of the Barn Owls' hunting areas on their prey composition.

6. To find correlation between the proportions of the functional groups of small mammals in the diet and the proportion of their favoured urban, open, forest and wetland habitats in the Common Barn Owls' hunting areas in the Marcal Basin.

7. To determine the assumed hunting area of the Common Barn Owl, by examining how the prey species reflect a hunting area corresponding to a radius of 1, 2 or 3 km based on their habitat preference. Study the size of the pellet sample required to represent the small mammal fauna of the hunting areas and the prey composition of owls.

## **MATERIAL AND METHOD**

The study of the diet of Northern Long-eared Owls took place in Hungary in three settlements of South Transdanubia, Udvar, Mohács, and Pécs. The correlation between diet composition and weather conditons was conducted in Pécs, and the size of the potential hunting area and the effect of urbanization were studied in Udvar, Mohács, and Pécs. Udvar is a small village, Mohács is a small town, while Pécs is the fifth largest city in Hungary. In the cemetery of Pécs in the winter of 2014/15, we checked the roosting area 21 times. During the study, 6328 pellets

were collected. During our second study in the winter of 2016/17 in Udvar, Mohács, and Pécs we counted the owls and collected the pellets 6 times under the trees of the wintering places between December and March. A large amount of pellet was collected at all three sampling sites, and 1000 pellets was found to be sufficient for comparison based on our previous experience.

Landscape structure-dependent changes in the diet of Common Barn Owl were studied in Baranja, as well as in Zala County and the Marcal Basin. Baranja is a mostly flat region in the north-eastern part of Croatia, enclosed by the rivers Danube and Drava. The region is characterized as typical agricultural landscape. In the northern part of Baranja, BANSKO HILL stretches in an east-west direction, in which natural vegetation fragments can be found, as well as its cultivation differs from the surrounding lowland area. Altogether 2395 Barn Owl pellets were collected from 21 settlements of Baranja in 2007, from this there were 1211 pellets collected in the settlements from the edge of BANSKO HILL, and a similar number, 1184 pellets from the lowland area of Baranja. In 2016, repeating the previous survey of Baranja, we collected only 1466 pellets at 15 settlements. To examine changes in the prey composition of Common Barn Owls and the landscape structure of potential hunting areas, we highlighted the 10 collection sites where successful collections took place during both surveys. To investigate the correlation between the prey composition of the barn owls and types of the landscape structure within the hunting area, we used pellets collected in Zala County. The studied area is very diverse in terms of habitats, which it was seemed suitable for this research. The Zala Hills forms a large part of the county, almost one-third of its territory is covered by forests, but a significant part of its area characterized as mosaic agricultural landscape. As a result of the survey, 15 samples were collected at 13 sites, with an amount of 1106 pellets. Pellets collected in the Marcal Basin was used to study the proportion of functional groups of small mammals that prefer different habitats and the correlation between the proportions of their typical habitats in the Common Barn Owls' hunting areas. The small mammal fauna of this diverse area, which is rich in wetlands, is also poorly understood similarly in Zala County. We collected 1144 pellets in the Marcal Basin from 15 settlements in 2017. The collection of the Common Barn Owls pellets was carried out in the Udvar near to the Northern Long-eared Owls wintering site, so the hunting area of the two species presumably showed a large overlap. On March 16<sup>th</sup> 2017, we collected 1045 pellets in Udvar. The pellets were disassembled in a similar way for both owl species using dry technique. Small mammals detected in the pellets were identified on the

basis of skeletal parameters. Small mammals detected in the owl pellets were classified into four functional groups according to their preferences for urban, open, forest or wetland habitats.

To investigate weather conditions influencing the diet of Northern Long-eared Owls, the meteorological data were collected from the Jegenyés weather station near to the site. For landscape structure analysis we used the maps of the CORINE database from 2006 and 2012. On these maps we examined the distribution of CORINE land cover habitat classes as types of landscape structure, using the QGIS program. To our knowledge, Common Barn Owls hunt at a distance of about 1-3 km from its nesting or roosting place, but in most studies, the potential hunting range is considered to be a circle with a 2 km radius. As the potential hunting area of the Common Barn Owls, apart from the study of the potential hunting area size in Udvar, a circle with a radius of 2 km around the resting place was taken into account in all cases. To determine the size of the potential hunting area, we marked circles with a radius of 1, 2, and 3 km around the sampling site in the present study with Northern Long-eared Owls and Common Barn Owls. We studied the distribution of the various landscape structure types in these circles, and they were classified into 4 habitat types.

The diversity of prey of the Northern Long-eared Owls and Common Barn Owls in each sampling site was characterised by Shannon's diversity index and by their evenness. The food niche breadth of the owls was calculated using the Simpson index and the food niche overlap was calculated using the Renkonen index. In Udvar, Mohács, and Pécs, the individual rareness was calculated on the basis of the individual numbers to determine the minimum required sample size of the owls. The cumulative species and taxon numbers were calculated, and then the saturation curve was plotted by adding the species lists of the pellets, that were processed by hundreds.

The comparison of the relative abundances of small mammal functional groups detected in the pellet samples and the proportion of their habitats within the corresponding hunting areas were carried out by a homogeneity test G, supplemented by canonical correspondence analysis in the survey of Marcal Basin.

Spearman correlation analysis was applied to reveal the relationship between weather conditions during the winter and the values of relative abundance of the particular species, as well as the relative abundance of the Common Vole and other small mammal species in the first study with the Northern Long-eared Owls. In Zala County and in the Marcal Basin the

relationship was studied between the proportion of each landscape structure, mosaic, relative abundance and diversity of small mammal species was analysed by Spearman's rank correlation.

In Baranja, the relative abundance and diversity of small mammal species, and the niche breadth of the owls were compared with Mann-Whitney U test between the edges of Banskó Hill and the lowland area between 2007 and 2016, as well as between the months in the study of the Northern Long-eared Owls.

## **NEW SCIENTIFIC RESULTS**

During the study the following new scientific results were obtained:

1. The relative abundance and the diversity of the small mammals identified in the Long-eared Owl pellets showed differences between the winter months. There was a negative correlation between the main species of prey, the Common Vole, and the relative abundance of several prey species. There was a correlation between the precipitation, the snow cover, the temperature and the relative abundance of some prey species.

2. In the prey of the Northern Long-eared Owls the distribution of the mammals according to their habitat preference and the distribution of their habitats was the most similar in the circle of a 3 km radius, although the size of the hunting area was influenced by the urbanization. As the size of the settlements increased, the functional groups of small mammals and the relative abundance of certain prey species also differed. In Pécs, lack of the open habitats and the main prey species Common Vole caused increasing importance of the alternative prey species, so the diversity of the prey was significantly higher than in Udvar or Mohács. Based on the saturation curves, 800 or 1000 pellets of the diet specialist Northern Long-eared Owl must be collected to investigate the diet spectrum, and a circle with a 3 km radius around the resting site is the most suitable for characterizing the hunting area.

3. We found differences between prey composition of the Common Barn Owls and landscape structure of the hills and typical flat areas in Baranja. There was a significant correlation between the relative abundance of seven small mammal species, the number of species, the equitability, the length of borders, and the proportion of particular landscape

structure classes. We found significant correlations between the small mammal species and the landscape structure, despite the dominance of the Common Vole.

4. The diversity of small mammals in the prey was similar in both years, while Common Vole dominated with over 60%. In pellets collected in 2016, we found significantly more Bicolored Shrews, Lesser Shrews, and Yellow-necked Mice, while the proportions of Harvest Mouse and Eastern House Mouse were significantly smaller than in the previous sampling. The landscape structure of hunting areas has hardly changed over the decade; therefore, the temporal variations in the owls' diet composition may have been caused by altered farming practices.

5. Among the 21 species that revealed in Zala County, there was the rare Parti-coloured Bat and a new species for the county the Steppe Mouse. Significant correlations were found between the relative abundance of some small mammal species and the number of landscape patches-, and the landscape structure of the assumed hunting area of owls that confirmed the consistency in habitat preference of some species. Our results proved that the prey-composition of Common Barn Owls reflects the land use through the distribution and abundance of small mammal species, therefore the pellet analysis is suitable for landscape ecological analyses.

6. In the Marcal Basin, small mammal functional groups represented by prey composition do not directly correspond to the proportion of their typical habitats. We conclude that the functional groups are not suitable for characterization of the landscape within the Common Barn Owl's hunting range.

7. In the prey of Barn Owls living in smaller settlements, the relative abundance of the species that prefer different habitats and the proportion of their habitats differed least within the 3 km radius. Based on the saturation curves, for faunistic and landscape ecological studies we recommend processing at least 400 pellets, and a circle with 3 km radius around the resting site to characterize the hunting area.



## PUBLICATIONS

### Publications related to the thesis

**Szép, D.**, Krčmar, S. & Purger, J. J. Possible causes of temporal changes in the diet composition of Common Barn-owls (*Tyto alba*) in Baranja County (Croatia). *Acta Zool Bulg*, beadvá 2020. január 17. No. 2407

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