sciendo

Ornis Hungarica 2023. 31(2): 217–225.
DOI: 10.2478/orhu-2023-0031

Investigation of roadkilled Western Barn Owls *(Tyto alba)* in Csanádi-hát region (SE Hungary)

András István Csathó[1], András János Csathó[1] & László Bozó[2]*

Received: August 24, 2023 – Revised: November 05, 2023 – Accepted: November 10, 2023

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

Csathó, A. I., Csathó, A. J. & Bozó, L. 2023. Investigation of roadkilled Western Barn Owls *(Tyto alba)* in Csanádi-hát region (SE Hungary). – Ornis Hungarica 31(2): 217–225. DOI: 10.2478/orhu-2023-0031

Abstract The Western Barn Owl *(Tyto alba)* is a common breeder in Hungary. It is a resident bird of open areas, staying near nesting sites in winter. Its population is strongly influenced by food availability, weather conditions and several anthropogenic activities. One of the most important factors of these in recent decades has been road mortality. In this work, we processed data of roadkilled individuals and field observation records in the Csanádi-hát region in south-eastern Hungary from the period 1995–2022. In Battonya, we have been recording roadkill individuals since 1995, while observations of Barn Owl individuals from Kevermes have been available since 2005. The species is a regular, but scarce breeder in the area, so both the number of roadkilled individuals and the number of field observations were relatively low. Nevertheless, we had the opportunity to examine how the number of individuals of the species that were killed in the traffic varied over time and within years. According to our data, more birds collided during the winter, and also between July and November. This can be explained mostly by the seasonal lack of food and the fledging time of inexperienced juveniles. The temporal distribution of field observations were different from the dynamics of the roadkills, as the species was mainly observed during the breeding season. The exact population size of the area can be difficultly estimated, as it breeds mainly in attics of stable, granary and church buildings. The breeding population of Kevermes was estimated at 3–4 pairs and did not change significantly in the studied period. Over the same 28-year period, using the same methods to the two other most common nesting owl species of the region, we found that the within-year roadkill dynamics of the Little Owl *(Athene noctua)* and the Northern Long-eared Owl *(Asio otus)* differed from that of the Western Barn Owls, which may be due to the different feeding habits of the species. We can conclude that the number of roadkilled birds was proportional to the local population of the species.

Keywords: roadkills, road mortality, animal-vehicle collisions, road ecology, agricultural landscape, Great Hungarian Plain, farmland bird, Strigiformes

Összefoglalás A gyöngybagoly *(Tyto alba)* Magyarországon elterjedt fészkelőfajnak számít. A nyílt területek madara, állandó faj, télen is a fészkelőhelyek közelében tartózkodik. Állományára az aktuális táplálékkínálat és az időjárás mellett különféle antropogén tényezők is jelentős hatással vannak. A faj esetében a közúti gázolások okozta elhullás az utóbbi évtizedekben az egyik legjelentősebb mortalitási faktornak számít. Munkánk során a Délkelet-Magyarországon elhelyezkedő kistáj, a Csanádi-hát területén gyűjtött elütési és terepi megfigyelési adatokat dolgoztuk fel. Az elütési adatok gyűjtésének központi települése Battonya, míg az állományfelméréseké Kevermes volt. Battonyán 1995 óta jegyezzük fel az elütött gyöngybaglyokat, míg Kevermesről 2005 óta állnak rendelkezésre megfigyelések. A battonyai adatsor mellett a Csanádi-hát más településeiről származó elütési adatokat is felhasználtunk. A faj a térségben rendszeres, de csak kisszámú fészkelő, ezért mind az elütött példányok, mind a terepi megfigyelések száma viszonylag alacsony. Mindazonáltal lehetőségünk volt megvizsgálni, hogy hosszú távon és éven belül hogyan változott a faj elütött egyedeinek száma. Az elütések szempontjából az éven belül bimodális eloszlást találtunk. Az egyik csúcs télen volt, míg a másik elhúzódott július és november között. Előbbi a téli táplálékhiányra, utóbbi elsősorban a tapasztalatlan fiatal példányok önállósodását követő időszakra vezethető vissza. A terepi megfigyelési adatok időbeli

eloszlása eltért az elütések dinamikájától, mivel a fajt elsősorban a nászidőszakban észleltük. Pontos állományának becslése nehéz a térségben, mivel elsősorban mezőgazdasági telepeken és padlásokon költ, ahol a fészkelő madarakat gyakran nehéz megtalálni. Kevermesi állományát ezzel együtt 3–4 párra becsültük, és az nem változott jelentősen a vizsgált időszakban. Azonos 28 éves időszakban, megegyező módszereket alkalmazva megállapítható, hogy a térségben a másik két legnagyobb számban fészkelő bagolyfaj, a kuvik *(Athene noctua)* és az erdei fülesbagoly *(Asio otus)* éven belüli elütési dinamikája jelentősen eltér a gyöngybagolyétól, ami elsősorban a fajok eltérő táplálkozási szokásaira vezethető vissza. A két különböző módszer eredményei alapján arra következtethetünk, hogy az elütött madarak száma arányos volt az adott faj helyi populációméretével.

Kulcsszavak: közúti elütések, állatgázolások, útökológia, agrártáj, Alföld, bagolyalakúak

[1] *Independent researcher, 5830 Battonya, Hungary*
[2] *Eötvös Loránd University, Department of Systematic Zoology and Ecology, 1117 Budapest, Hungary*
** corresponding author, e-mail: bozolaszlo91@gmail.com*

Introduction

The Western Barn Owl – *Tyto alba* (Scopoli, 1769) – is a polytypic species with 10 subspecies (Gill *et al.* 2023). Previously 30+ subspecies of Barn Owl were defined, which were lately divided into three groups, with the Western Barn Owl restricted to Africa and Europe (Uva *et al.* 2018, Marti *et al.* 2020). The species avoids colder regions such as high mountains, but is also absent from eastern Europe and Scandinavia (Almasi & Roulin 2020). Its density is the highest in southern and central Europe, decreasing eastwards as temperatures fall and the number of snowy days increase (Almasi & Roulin 2020). It feeds primarily on mice (*Apodemus* spp.) and voles (*Microtus* spp.) (Love *et al.* 2000, Bontzorlos *et al.* 2005, Kitowski 2013), which show significant fluctuations in their populations (Ylönen 1994). These fluctuations impact the Western Barn Owls, as the species does not leave their breeding area for the winter (Marti *et al.* 2020). In years when the density of rodents is high, and the winter is milder, up to 45% of pairs may breed twice, and occasionally even three times in Hungary (Bank *et al.* 2019, Haraszthy 2019). In food-poor years, both breeding occasions and egg production decrease, or pairs even may not breed at all (Haraszthy 2019).

Occasionally, major population collapses occur in certain periods (Altwegg *et al.* 2006, Chausson *et al.* 2014). Its European populations decreased before the 1990s and have been stable since, although local declines have been observed in several populations (Almasi & Roulin 2020).

In Hungary, two subspecies can be found, one is the *T. a. guttata*, which is a widespread breeder, and the other is the *T. a. alba*, which is only occasionally found (Bozó & Csathó 2022). The species occurs mainly in areas near grasslands, agricultural fields bordered by treelines, tree groups and open cultivated areas on which streams or rivers flow through, avoiding closed forests (Hadarics & Zalai 2008, Haraszthy 2019, Klein 2021). Its biggest populations occur in the Southern Transdanubia, the Marcal Basin, the Lake Fertő, the Hanság, the Bácska Plain, the North Kiskunság, the Borsod Plain, the Upper Tisza Plain, the Bodrogköz, the Szatmár–Bereg Plain, the Hortobágy and the Békés Plain (Klein 2021).

A significant portion of the population breeds in anthropogenic environments, especially in the attics of churches and agricultural buildings (Fenyősi *et al.* 1998, Haraszthy 2019), but may also use dovecotes and water towers.

Breeding is prolonged, taking place between March and October, but after mild winters breeding pairs may be present as early as February (Haraszthy 2019).

In addition to natural fluctuations in the food, the species' population is also affected by various anthropogenic factors. Road collisions are considered a particularly significant threat (Baudvin 1986, Percival 1990, Taylor 1994, Mátics 2000, Borza *et al.* 2021, Monoki *et al.* 2022, Tamás & Kőhalmi 2022). According to Borza *et al.* (2021), published data place the Western Barn Owl among the 10 most frequently recorded roadkilled bird species in Hungary. For this reason, bird–vehicle collisions mean a serious conservation problem for the species, which is extremely difficult to solve (Monoki *et al.* 2022).

In our work, we estimated the long-term changes in the total and annual number of roadkilled individuals in the area of the Csanádi-hát region (Békés County, SE Hungary).

The Western Barn Owl is a regular nesting species in the area with a small population (Bozó 2017), and roadkilled individuals are also regularly found (Csathó & Csathó 2009). Field observation data are available from one of the settlements in the area, which provide an opportunity to understand the within-season roadkill dynamics of the species and also provide a basis for population estimation. We also collected data of roadkilled individuals of the most common breeding owl species in the region, the Little Owl *(Athene noctua)* and Northern Long-eared Owl *(Asio otus)*, so we could compare our results with those obtained for the other two species.

Material and Methods

Between 1995 and 2022 we carried out roadkill surveys in the entire administrative area of Battonya town (14,577 hectares). The surveys were carried out by bicycle in most cases once a month during the whole year. There are four busy roads in the outer area of Battonya: Kovácsházi road (length: 8.4 km), Dombegyházi road (4.3 km), Tornyai road (5.0 km) and Mezőhegyesi road (3.4 km) (Csathó & Csathó 2009). All of the Western Barn Owls found roadkilled were recorded. Estimated date of the collision and the location along the road was recorded for each found individual. In most cases photos were also taken of the roadkilled Western Barn Owls.

We presented a graph on the between- and within-year distribution of the data. To create the database and the figures we used Microsoft Excel 2016.

Data from Battonya were compared with data from roadkilled individuals found in other areas of the Csanádi-hát region. In these areas, data collection was non-standard, with only occasional visits.

Field observations were carried out in Kevermes between 2005 and 2022 and the occurrence of the species was recorded. In total, observations were made on 2,465 different days during the study period. We considered data as one observation of the species per day. From these data, we estimated the local population of the species and the within year distribution of observations. This was then used for comparison with the date of the roadkills.

In the case of Little Owl and Northern Long-eared Owl, we used the same methods to collect the roadkilled individuals, with the same collection period (1995–2022), the location of the survey was also the administrative area of Battonya (without any data from other settlements of the Csanádi-hát).

Results

In Battonya, we found a total of 21 roadkilled individuals of Western Barn Owl during the 28 years of the data collection. In other settlements of Csanádi-hát region, we found additional 15 roadkilled birds *(Figure 1–2)*.

In Kevermes, 22 individuals were observed, one of which was found dead *(Figure 3)*. Based on our observations, there were at least 3–4 breeding pairs in the settlement during the studied period. The exact nesting sites were not known, but in one case, a nest of the

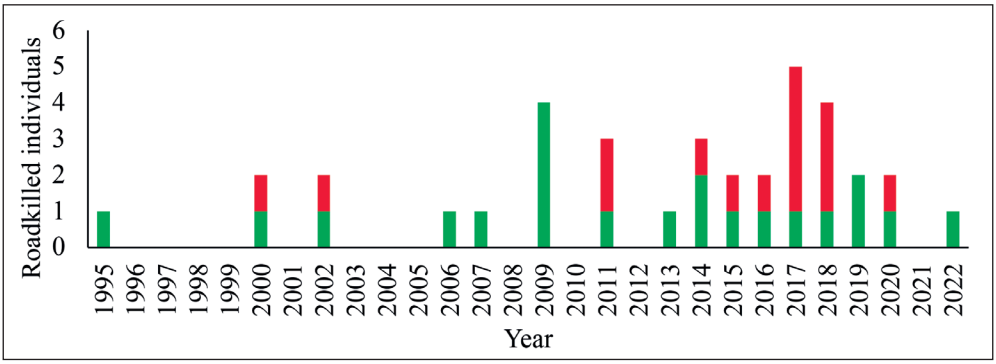

Figure 1. Annual distribution of roadkilled Western Barn Owls found in Battonya (green columns) and the other settlements of the Csanádi-hát (red columns) between 1995 and 2022

1. ábra A Battonyán (zöld oszlopok) és a Csanádi-hát egyéb településein (piros oszlopok) 1995 és 2022 között elütve talált gyöngybaglyok száma éves bontásban

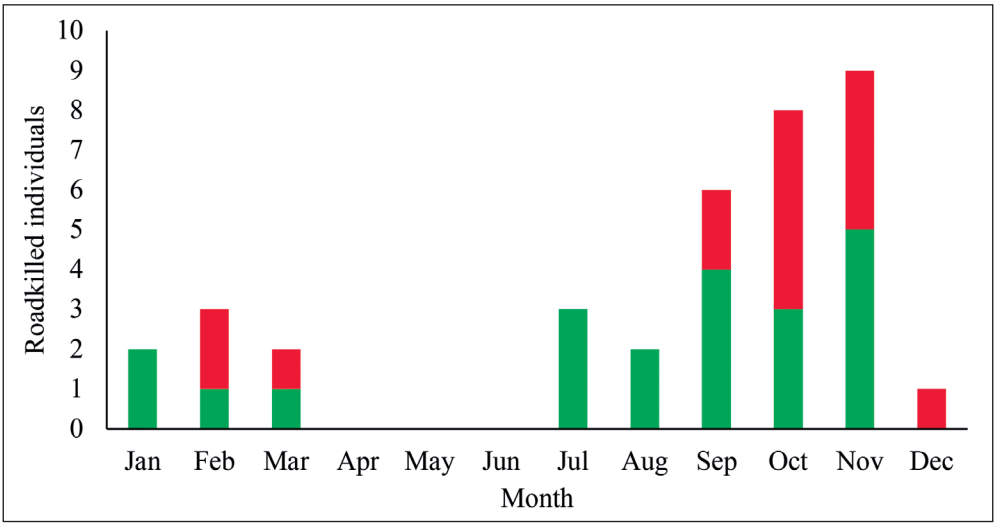

Figure 2. Monthly distribution of roadkilled Western Barn Owls found in Battonya (green columns) and the other settlements of the Csanádi-hát (red columns) between 1995 and 2022

2. ábra A Battonyán (zöld oszlopok) és a Csanádi-hát egyéb településein (piros oszlopok) 1995 és 2022 között elütve talált gyöngybaglyok száma havi bontásban

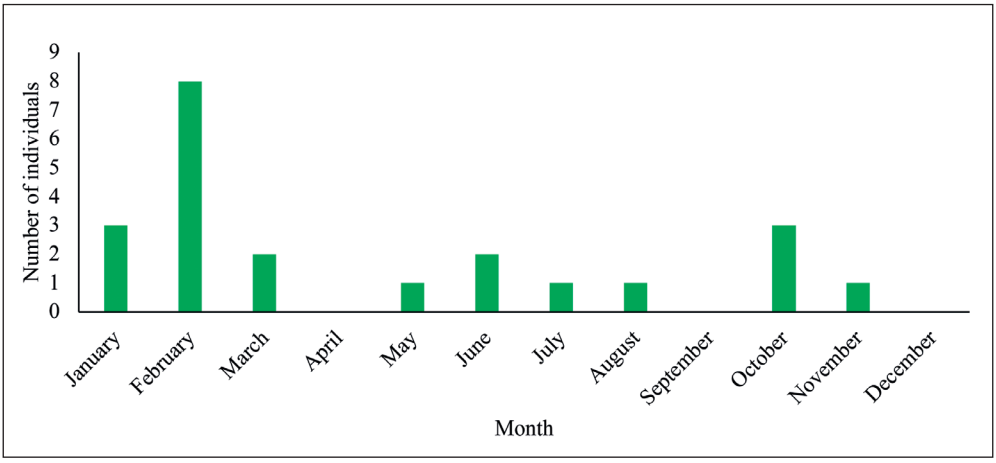

Figure 3. The within-year distribution of the Western Barn Owl observation from Kevermes between 2005 and 2022

3. ábra A kevermesi gyöngybagoly-megfigyelések éven belüli eloszlása a 2005–2022 közötti időszakban

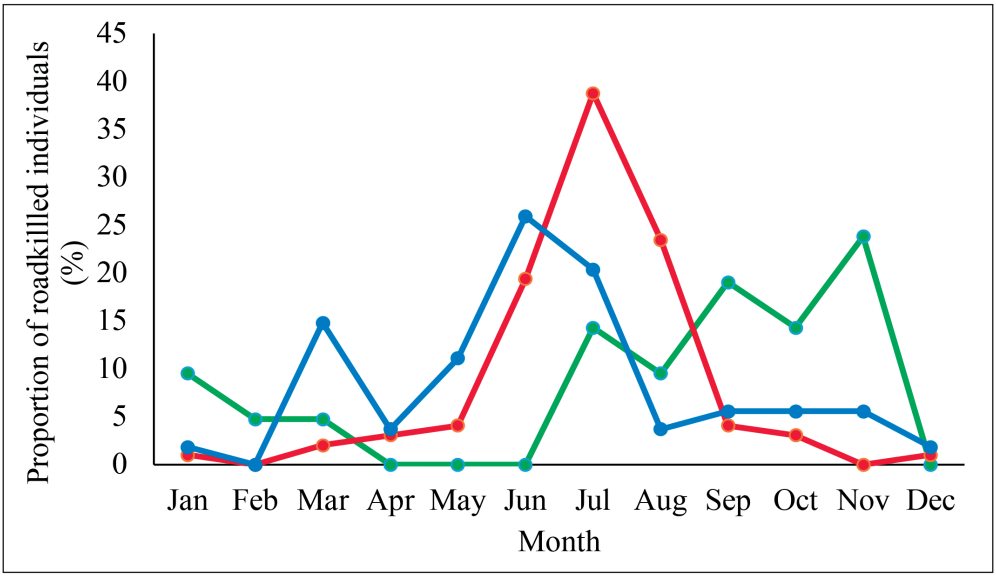

Figure 4. Proportion of roadkilled Western Barn Owls (green), Little Owls (red) and Northern Long-eared Owls (blue) found in Battonya by months between 1995 and 2022

4. ábra A Battonyán 1995 és 2022 között elütve talált gyöngybaglyok (zöld színnel), kuvikok (piros színnel) és erdei fülesbaglyok (kék színnel) éven belüli százalékos eloszlása

species was found in a bale pit of a farm in the countryside. Breeding was also observed in the centre of the settlement and in the surroundings of a former mill. No sightings have been made in recent years in the vicinity of the outlying granaries.

We found a total of 98 roadkilled Little Owls and 54 Northern Long-eared Owls in Battonya in the same 28-year period *(Figure 4)*.

Discussion

In the case of the Western Barn Owl, road collisions are a significant mortality factor. The road mortality of juveniles is much higher than that of adults, ranging from about 50–70% (Baudvin 1986, Percival 1990, Taylor 1994, Mátics 2000, de Jong *et al.* 2018). This may be due to the inexperience of the birds. In Mátics's (2000) study, only juveniles were affected by electrocution, drowning or mortality due to human hunting (birds could not find suitable shelter).

The following results support the conservation relevance of bird–vehicle collisions: in France, 73.2% of juveniles and 26.8% of adults (Baudvin 1986), in Great Britain 49% of juveniles and 48% of adults (Percival 1990), in Scotland 56.5% of juveniles and 22.7% of adults (Taylor 1994) died from being hit by a car. Nonetheless, it is important to mention that fatalities are over-represented because it is much easier to find individuals that became victims of traffic on roads, than those that have died naturally or from other causes, as Mátics (2000) pointed out. In contrast, a few years later, he found that the most important threat to the species in Hungary was road collision, with a mortality rate of 20.6% for juveniles and 13.5% for adults (Mátics 2004). These rates were much lower than those observed in western Europe at the time, most likely due to the relatively underdeveloped road network in Hungary. It should be noted that during the same interval, the rate of deliberate shootings dropped to almost zero. Similar results were obtained in Great Britain, where in the second half of the 20th century, road killings were increasingly responsible for the mortality of owls (Newton *et al.* 1997). In Jász-Nagykun-Szolnok County, Monoki *et al*. (2022) found a total of 424 roadkilled Western Barn Owls between 2005 and 2021.

Tamás and Kőhalmi (2022) found that the Western Barn Owl was the second most frequently roadkilled owl species after the Northern Long-eared Owl in their 7-year study in North Bácska region. In our survey, roadkilled Western Barn Owls were found regularly, but not in every year and this owl species was found in the highest numbers after the Little Owl and the Northern Long-eared Owl. This is in correlation with the population of these species in the area (Bozó 2017). The Western Barn Owl was never common in the area due to lack of suitable habitat, and its most important nesting sites here may be agricultural buildings. However, several of these have been renovated in recent years, which may explain why no roadkilled individuals have been found in Kevermes in the past few years.

The frequency of roadkills has increased compared to the 1990s, and the increase in traffic has certainly contributed significantly to this. There was no population increase during this period, so this seems the most likely explanation. However, the peak in 2009 can most likely be explained by high breeding success in that year, possibly due to colder and snowy weather. We were not able to investigate probable differences between age groups. According to Taylor (1994), the roadkilled birds were in poor condition and the roadkills typically occurred in winter. This is contradicted by a study in the Netherlands by de Jong *et al.* (2018), in which they found that hit Western Barn Owls were typically in good condition. The condition of the individuals in our survey was not assessed (partly because the condition of the individuals no longer allowed it), but the higher number of winter roadkills might be explained by the lack of food and weakening due to adverse

weather conditions. In contrast, inexperience may be the primary cause of roadkills in summer, when there was no significant lack of food. The inexperience of birds as main reason for roadkills most likely supported by the fact that the two most common owl species in the region, the Little Owl and the Northern Long-eared Owl, show only a single peak after the young have fledged, while in winter the number of roadkills is very low (Bozó & Csathó 2017, Bozó *et al.* 2020). In these two species, weather plays a much less important role in mortality than in the case of the Western Barn Owl, which is less adapted to cold temperature and thick snow cover.

For the seasonal pattern of mortality, Mátics (2000) obtained a bimodal distribution. One peak was in October, which was due to the high mortality of newly fledged individuals. The other peak was in January–February, in the coldest period. This, together with the fact that the seasonal mortality pattern of adult birds did not differ from that of young birds, suggests that weather is the most important factor influencing the pattern. Birds become weaker and thus die more easily from natural or also from anthropogenic causes. However, a few years later, Mátics (2004) concluded that, compared to the 1980s, the seasonal dynamics of the mortality in the 1990s had widened from a peak between August and February to a period between June and March, i.e. by three months. These results are in line with our results and supporting the idea that the dynamics of roadkills widened within a year. Monoki *et al.* (2022) found the highest number of roadkilled Western Barn Owls between November and March, especially between January and March in Jász-Nagykun-Szolnok County.

The within-year distribution of field observation data partly matches the pattern of the roadkills. Most observations occur in January and February, but there is a small peak in October. In contrast to the specimens found hit by a vehicle, the species was very rarely sighted in the second half of summer and early autumn, whereas it could have been more frequently seen in the first half of summer. The pattern of field observations is mainly related to the breeding biology of the species. Sightings occur mainly during the mating season when birds are actively calling. This is mainly in February, while in early summer the birds are likely to be more active due to second broods. The minor peak in October may be due to dispersal movements of juveniles.

The species is not considered common in the study area, and this is supported by both roadkill and field observation data. However, it is important to note that unlike in other parts of the country, the most important breeding sites are not church steeples but agricultural buildings and lofts even though in the late 1990s it also bred in the church tower of Kevermes (Pabar 2000) and in the recent in Battonya. Therefore, the exact population size remains unknown, but we can agree on that it is much rarer than the Little Owl and the Northern Long-eared Owl.

References

Almasi, B. & Roulin, A. 2020. Common Barn-owl *Tyto alba*. – In: Keller, V., Herrando, S., Voříšek, P., Franch, M., Kipson, M., Milanesi, P., Martí, D., Anton, M., Klvanová, A., Kalyakin, M. V., Bauer, H-G. & Foppen, R. P. B. (eds.) European Breeding Bird Atlas 2. Distribution, Abundance and Change. – European Bird Census Council & Lynx Edicions, Barcelona, pp. 410–411.

Altwegg, R., Roulin, A., Kestenholz, M. & Jenni, L. 2006. Demographic effects of extreme winter weather on Barn Owls. – Oecologia 149: 44–51. DOI: 10.1007/s00442-006-0430-3

Bank, L., Haraszthy, L., Horváth, A. & Horváth, G. F. 2019. Nesting success and productivity of the Common Barn-owl: results from a nest box installation and long-term breeding monitoring program in Southern Hungary. – Ornis Hungarica 27(1): 1–31. DOI: 10.2478/orhu-2019-0001

Baudvin, H. 1986. La reproduction de la Chouette Effraie *(Tyto alba)* [Reproduction of the Common Barn Owl *(Tyto alba)*]. – Le Jean-le Blanc 25: 1–125. (in French)

Bontzorlos, V. A., Peris, S. J., Vlachos, C. G. & Bakaloudis, D. E. 2005. The diet of Barn Owl in the agricultural landscapes of central Greece. – Folia Zoologica Praha 54(1–2): 99–110.

Borza, S., Godó, L., Csathó, A. I., Valkó, O. & Deák, B. 2021. A közúti közlekedés természetkárosító hatása a magyarországi gerincesfaunára – Szakirodalmi áttekintés [Negative effects of traffic on vertebrate species – A literature review from Hungary]. – Természetvédelmi Közlemények 27: 1–17. DOI: 10.20332/tvk-jnatconserv.2021.27.1 (in Hungarian with English Summary)

Bourquin, J. D. 1983. Mortalite des rapaces de long de Tautoroute Geneve-Lausanne [Mortality of raptors along the Geneva-Lausanne highway]. – Nos Oiseaux 37: 149–169. (in French)

Bozó, L. 2017. Kevermes madárvilága [Birds of Kevermes]. – Dél-békési Természetvédelmi és Madártani Egyesület, Kevermes (in Hungarian with English Summary)

Bozó, L., Rutkai, T., Csathó, A. I. & Bozóné Borbáth, E. 2020. Winter diet and roosting site use of urban roosting Long-eared Owls *(Asio otus)*, and the change in the species' population size in Southeast Hungary. – Ornis Hungarica 28(2): 1–18. DOI: 10.2478/orhu-2020-0013

Bozó, L. & Csathó, A. I. 2017. The status and population changes of the Little Owl *(Athene noctua)* in the south of Békés County (Hungary). – Ornis Hungarica 25(2): 23–33. DOI: 10.1515/orhu-2017-0013

Bozó, L. & Csathó, A. I. 2022. A gyöngybagoly *(Tyto alba)* fehér mellű alakjának előfordulása Békés megyében [Occurrence of the white-breasted form of Western Barn Owl *(Tyto alba)* in Békés County]. – Heliaca 18: 124–127. (in Hungarian with English Summary)

Chausson, A., Henry, I., Ducret, B., Almasi, B. & Roulin, A. 2014. Tawny Owl *Strix aluco* as an indicator of Barn Owl *Tyto alba* breeding biology and the effect of winter severity on Barn Owl reproduction. – Ibis 156: 433–441. DOI: 10.1111/ibi.12148

Csathó, A. I. & Csathó, A. J. 2009. Elütött állatok Battonyán [Roadkills and the dynamics of the faunal casualties in Battonya (SE Hungary)]. – CSEMETE Természet- és Környezetvédelmi Egyesület, Battonya – Szeged (in Hungarian with English Summary)

de Jong, J., van den Burg, A. B. & Liosi, A. 2018. Determinants of traffic mortality of Barn Owls *(Tyto alba)* in Friesland, the Netherlands. – Avian Conservation & Ecology 13(2): 2. DOI: 10.5751/ACE-01201-130202

Fenyősi, L., Horváth, Z. & Pintér, A. 1997. Adatok a gyöngybagoly *(Tyto alba)* Somogy megyei elterjedéséhez az 1995. évi felmérés alapján [Data on the distribution of the Western Barn Owl *(Tyto alba)* in Somogy County based on the 1995 survey]. – Aquila 103–104: 131–133. (in Hungarian with English Summary)

Gill, F., Donsker, D. & Rasmussen, P. 2023. IOC World Bird List (v 13.1). – DOI: 10.14344/IOC.ML.13.1.

Hadarics, T. & Zalai, T. 2008. Magyarország madarainak névjegyzéke. Nomenclator avium Hungariae. An annotated list of the birds of Hungary. – Magyar Madártani és Természetvédelmi Egyesület, Budapest, p. 145.

Haraszthy, L. 2019. Magyarország fészkelő madarainak költésbiológiája. 1. kötet. Fácánféléktől a sólyomfélékig [Breeding Biology of Hungarian Nesting Birds, Vol. 1. Non-Passeriformes]. – Pro Vértes Nonprofit Kft., Csákvár, pp. 658–662. (in Hungarian)

Illner, H. 1992. Road deaths of Westphalian owls: methodological problems, influence of road type and possible effects on population levels. – In: Galbraith, C. A. & Percival, S. M. (eds.) The Ecology and Conservation of European Owls. – UK Nature Conservation No. 5, Peterborough, pp. 94–100.

Kitowski, I. 2013. Winter diet of the Barn Owl *(Tyto alba)* and the Long-eared Owl *(Asio otus)* in eastern Poland. – North-Western Journal of Zoology 9(1): 16–22.

Klein, Á. 2021. Gyöngybagoly [Western Barn Owl]. – In: Szép, T., Csörgő, T., Halmos, G., Lovászi, P., Nagy, K. & Schmidt, A. (eds.) Magyarország madáratlasza [Bird Atlas of Hungary]. – Agrárminisztérium, Magyar Madártani és Természetvédelmi Egyesület, Budapest, pp. 388–389. (in Hungarian with English Summary)

Love, R. A., Webon, C., Glue, D. E., Harris, S. & Harris, S. 2000. Changes in the food of British Barn Owls *(Tyto alba)* between 1974 and 1997. – Mammal Review 30(2): 107–129. DOI: 10.1046/j.1365-2907.2000.00060.x

Marti, C. D., Poole, A. F., Bevier, L. R., Bruce, M. D., Christie, D. A., Kirwan, G. M. & Marks, J. S. 2020. Barn Owl *(Tyto alba)*, version 1.0. – In: Billerman, S. M. (ed.) Birds of the World. – Cornell Lab of Ornithology, Ithaca, NY, USA. DOI: 10.2173/bow.brnowl.01

Mátics, R. 2000. A gyöngybagoly (*Tyto alba* Scop. 1769) mortalitása Magyarországon a gyűrűzési adatok tükrében [Mortality rate of Barn Owl (*Tyto alba* Scop. 1769) in Hungary based on ringing data]. – Aquila 105–106: 125–133. (in Hungarian with English Summary)

Mátics, R. 2004. A gyöngybagoly *(Tyto alba)* természetes és nem természetes mortalitása: nő az utakon történő pusztulás jelentősége [Natural and non-natural mortality of the Barn Owl *(Tyto alba):* increasing importance of road mortality]. – Természetvédelmi Közlemények 11: 517–524. (in Hungarian with English Summary)

Monoki, Á., Nagy, G. & Kiss, Á. 2022. A gépjárműforgalom bagolyfajokra (Strigiformes) gyakorolt hatása Jász-Nagykun-Szolnok megyében [Impact of road traffic on owl species (Strigiformes) in Jász-Nagykun-Szolnok County]. – Heliaca 18: 102–111. (in Hungarian with English Summary)

Newton, I., Wyllie, I. & Dale, L. 1997. Mortality causes in British Barn Owls *(Tyto alba)*, based on 1,101 carcasses examined during 1963–1996. – United States Department of Agriculture Forest Service General Technical Report Nc, pp. 299–307.

Pabar, Z. 2000. A gyöngybagoly *(Tyto alba)* állományának helyzete az Alföld keleti régiójában [Status of the Western Barn Owl *(Tyto alba)* in the eastern part of the Great Hungarian Plain]. – A Puszta 16: 288–303. (in Hungarian with English Summary)

Percival, S. M. 1990. Population trends in British Barn Owls, *Tyto alba*, and Tawny Owls, *Strix aluco*, in relation to environmental change. – BTO Research Report 57: 1–129.

Tamás, Á. & Kőhalmi, F. 2022. Az úthálózat hatása az Észak-Bácskában előforduló bagolyfajok (Strigiformes) mortalitására 2014 és 2020 között [Effect of road network on owl species' mortality in Northern Bácska region between 2014 and 2020]. – Heliaca 18: 94–101. (in Hungarian with English Summary)

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

Uva, V., Päckert, M., Cibois, A., Fumagalli, L. & Roulin, A. 2018. Comprehensive molecular phylogeny of Barn Owls and relatives (Family: Tytonidae), and their six major Pleistocene radiations. – Molecular Phylogenetics and Evolution 125: 127–137. DOI: 10.1016/j.ympev.2018.03.013

Ylönen, H. 1994. Vole cycles and antipredatory behaviour. – Trends in Ecology & Evolution 9(11): 426–430. DOI: 10.1016/0169-5347(94)90125-2