University of Sopron

Theses of doctoral (Ph.D.) dissertation

Conservation biological studies on the Little Owl *Athene noctua* (Scopoli, 1769) in the Kiskunság

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Sopron

2019

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E5 Program, Wildlife management

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1. Introduction

The agricultural intensification and, as a consequence, the large-scale habitat transformation have negatively affected the European Little Owl population by decreasing food availability, and number of nesting holes. The spatial distribution of the Hungarian Little Owl population is well documented but detailed data on temporal changes in population size in certain regions is lacking. In some of the Central-European countries the decreasing population trend has been found out, therefore it has become an urgent task also in our country to survey the process and emphasize the necessity of prevention. In the lack of natural nesting holes, the nesting possibilities are provided for the Little Owls by farms and agricultural buildings, however, there are considerable risk factors. International conservation biological researches have already been carried out and artificial nest box installations have been realized in order to preserve the different European populations but the nest box parameters, the habitat circumstances and the effects of these actions have only rarely been examined. Most of the research related to Little Owls was carried out in Western Europe therefore the ecological mechanisms described in these studies are not necessarily relevant to the Central and Eastern European populations. With the exception of the current study's content, no studies and nest box installation programs have been done in our country yet. The evaluation of the detailed occupation and reproduction data has a special importance because the breeding in artificial nest boxes may result lower reproduction success if they are not installed in suitable habitats. Besides, it is also important to study the habitats and parameters of nest boxes as they significantly influence the success of occupation and reproduction. For conservation reasons we should exactly know the population age classes, dispersion characteristics and the survival rate. Based on the demographic mechanisms we can conclude the stage of the habitats, as well as the effectivity of the Little Owls' nest box park. Nevertheless, the food availability is closely related to the Little Owl population trend, thus in order to support nature conservation strategies it is also essential to have detailed studies on feeding biology in our country.

In case of the Little Owl population discussed in the study, the primary conservative biological issue is, whether the narrowing of habitats or nesting possibilities is the main limiting factor.

The main questions of the study were the following:

- In the outskirts of Upper Kiskunság, what proportion of agricultural and other farm objects are suitable for occupation and what are the risk factors in these nesting sites?

- What is the value and how has the density of the Little Owl population changed in Upper Kiskunság?

- How do occupation rate, breeding and reproductive successes develop in artificial nest boxes in Upper Kiskunság?

- Based on comparative analyzes of randomly selected and unoccupied nest boxes, which factors influence primarily the success of breeding and nesting site selection in relation to the reproductive results and habitat parameters?

- On the basis of capture-recapture data, what values do the average dispersal distances, age-specific survival rates of the given Little Owl population, and the population growth rate determined on the basis of these age groups show?

- Based on the researches related to feeding biology, which animal species are preferred by the population in proportion to the number (% N) and to the biomass (% m)?

- What are the diversity characteristics of vertebrate and arthropod communities based on the Little Owl pellet analyzes?

2. Material and methods

2.1. Study area

The study area (70,000 ha) is located in the northern part of the Kiskunság National Park and partly in the southern part of the Danube-Ipoly National Park, in Bács-Kiskun and Pest county, south-east of Budapest. The entire study area is made up of the deployment points of artificial Little Owl nest boxes installed in 2003 and their outer boundaries of 2 km width. The additional nest box installations were located within this delimited 70000 acres. The various researches were basically based on the available data on the nest box survey and breeding biology of the Little Owl. The study of breeding and reproduction, the analysis of the parameters of the next boxes and their habitat characteristics, as well as the demographic and dispersion research based on the ringing data were carried out for the whole area, sometimes using random sampling. All further surveys and data collection (estimation of risk factors, density determination, feeding biology studies) were carried out in delimited habitats within this area.

2.2. Data collection and evaluation

Surveying the risk of the agricultural and other building types

A total of 326 objects were screened between 2003 and 2005 to assess the risk factors for potential anthropogenic nesting sites. A full visit to each part of the buildings took place once during the breeding season (May–July). For the assessment of each object, I have registered all the parameters for the nesting possibilities and the risk factors of Little Owl.

Methods of population survey for density estimation

The call-based population survey was based on the recording of the response call of the adult male Little Owls with already occupied territory. The designated 21 stations were surveyed between January and April of 2003, in 5 days. I played a 2-minute call tone with 1-minute pause at each survey point three times and recorded the number of responsive male individuals. In order to estimate the density, the maximum number of responding individuals were taken into account. Further density estimation for the Little Owl population was carried out during the breeding period in 2012–2018, in the entire research area with next boxes, thus ensuring representativeness. On the basis of the two data series, the minimum density values of the given year were determined, which were correlated to the number of installed nest boxes and the breeding success.

Methods for surveying nest box occupation, breeding and reproduction

During the research period of 2003–2018, a total of 289 technologically uniform cylindrical artificial nest boxes were manufactured and installed. Considering all the sites, the next boxes were mainly fixed on wood (93%). In the year of the first establishment (2003), 39 nest boxes were settled, but over the years it has expanded from 4 to 13 new nest boxes as a potential breeding site. Installations were done every year during the post-flight period (August–March) in suitable habitats where it was expedient to place artificial nest boxes due to the lack of adequate breeding sites and the risk factors registered in farm buildings. The following parameters were recorded on the basis of the ecological and breeding biology characteristics of the Little Owl: location; placement height; direction of the flight opening; tree species; mounting position; visibility. The control of the entire nest box park took place during the incubation and rearing period (May–June), and possibly in the period of extra incubation period (July), after fledging (August to September). After 2015, nest boxes were controlled also during the pairing period (March). Data recording was done on the basis of a pre-compiled booklet for surveys. On the basis of the collected data, the occupation rate, the number of successful breeding, the success of hatching and the success of reproduction were determined at the end of the incubation period in each research year.

Evaluation of reproduction data, Little Owl nest box parameters and habitat characteristics

The analysis of the parameters associated with nest boxes discusses the data for the period of 2012–2016 taking into account the boxes fixed on trees. In the given period, all the boxes suitable for nesting were randomly selected, excluding those nest boxes that had been occupied by other species of birds at least once. Thus, the study involved 44 occupied and 44 unoccupied nest boxes. Based on the placement points, I have delimited the areas on the satellite aerial view based on the nesting range scale. Within these, I identified the land use categories, their boundaries, and determined their proportion within the designated areas. In the case of descriptive variables, the closest distance values of the determining environmental elements from the nest boxes were measured using Google Earth. For each breeding period, I also measured the distance to the nearest box in which Little Owl breeding was proven. Based on the average breeding success, the nest boxes were arranged into “low” and “high” categories. A t-test was used to examine whether there was a significant difference between the occupation rate and the breeding success among the two categories. Linear regression model was used to compare reproductive data and land use distribution. I used ANOVA model to determine the effect of environmental variables and nest box parameters on the occupancy. Principal Component Analysis (PCA) was used to study the breeding site selection of Little Owl, using the habitat data within the nesting range scale around the occupied and unoccupied nest boxes. The statistical analyzes was performed using SPSS vers. 20.

Methods for assessing dispersion and demographic changes of the population

The evaluation of dispersion and demographic changes (age-specific survival rate; population internal growth rate) of the examined population was carried out using the capture-recapture data of the period 2005–2017. Marking and recapture of the birds occurred primarily in artificial nest boxes placed in the study area or within their nesting range scale. During the ringing, we recorded the date, the age, sex and biometric data of the birds, the location of the nest box, or the exact location of the capture. No sex was determined for pulli and juveniles, we only identified the sex for birds aged 2y (2nd calendar year). When determining the dispersal characteristics of the fledged juvenile birds, the distance between the nest box where the bird was hatched and the territory newly occupied in the following year (2y spring-summer) were measured. The captur-recapture data were analyzed using the MARK software. I used the Jolly-Seber Open Population Method to model the survival rate of age-specific apparent survival rate. The model set included the models for age, year effect and their combination. For the model-selection the corrected Akaike information criteria (AICc) were used. When calculating the internal growth rate of the population, excluding permanent emigration, I took into account the number of adult breeders and the average annual apparent survival rate, as well as the average annual clutch size and average apparent survival rate of the fledged young individuals.

Method of pellet analysis and evaluation of samples

The pellet samples from 2005 were collected within three territories, from stations regularly used for dropping pellets, whereas in 2015 and 2016 the collection was made exclusively from the 20 nest boxes where successful breeding took place in both years. The analysis of the former samples was fully realized, i.e. the determination of arthropods and the presence of earthworms, in addition to vertebrates. From the latter pellet material, however, only the determination and analysis of vertebrates was realized. On the basis of the larger sample numbers, diversity measures for vertebrates were evaluated for the 2015–

2016 collection period, while the arthropod communities were evaluated in detail using the 2005 identification data.

The pellets were dried and then processed by standard methods. We have identified mammals by skulls, jaws and teeth, birds by skulls and beak, femurs and feathers, amphibians and reptiles based on forearms, femurs and skulls. The insect species were identified on the basis of the collection of the Hungarian Natural History Museum and the head, chews, legs, covers and other body part features. For determining biomass, weight of most of the prey species was derived from the literature, while biometric data and specific equations were used to calculate the weight of the remaining species. Since the significant part of the pellet material collected from the nest boxes were fragmented as a result of the young Little Owls' activity, the estimated pellet number of each sample was determined based on the measurements of undamaged pellets and on the basis of literature data. To evaluate the vertebrate and arthropod diversity of Little Owls' food, three different diversity measures were determined for each area: species richness, Shannon diversity index, and equitability. To compare diversity values of two assemblages a modified t-test was used. Rényi diversity profiles were applied for partial diversity ranking of the arthropod communities as reflected in the owl pellets. To evaluate the similarities of species composition, Jaccard's similarity coefficient and the Bray-Curtis index were calculated. All analyses were carried out with Past 2.17c.

3. Summary of results, theses

1. The proportion of buildings considered suitable for nesting in the outskirts of Upper-Kiskunság is 63%, while 37% of those are not suitable for nesting. From the buildings not suitable for nesting 74% were closed or intermittently closed. Traces of Little Owls' presence or breeding were only found in 17% of the objects that could be considered suitable for nesting. The nesting Little Owls are constantly exposed to additional risk factors (e.g. beech marten, rodent poisoning, uninsulated mid-voltage power lines), which are significant risk factors for the success of breeding.

2. Based on the call-back survey, total Little Owl density was 0.9-1 pair/km^2 in 2003. On the basis of the number of breeding pairs in nesting boxes and other nesting sites, the minimum density of the study area increased from 0.986 pairs/km^2 (2014) to 1,629 pairs/km^2 (2018). The increased Little Owl density showed a strong correlation with the number of successfully fledged juveniles.

3. Taking into account the breeding results of the 2005–2018 period, notable increase in the occupation rate can only be observed after 2011, reaching a value of 42.86% in 2018. A total of 236 Little Owl incubations started in the installed nest boxes that of 203 were successful (86.02%). The number of successfully fledged juveniles was at least 842, with an annual average of 4.64 ± 0.27 SE. Reproductive success values markedly over-exceeded the literature value of 2.35 in each year.

4. Between 2012 and 2016, the average breeding success rate of the randomly selected occupied nest boxes with at least one successful breeding was 3.9 ± 1.1 SD. The occupation rate was 56.8% ± 25.1% and the hatching success rate was 84.5% ± 15.9%. Based on the analysis of factors influencing next box occupation and reproductive values, the Little Owls are more likely to occupy those nest boxes for breeding purposes that are closer to the farms/agricultural buildings and/or grazed and/or mowed grassland area. In relation to the land use, it can be demonstrated that the smaller the area taken out of cultivation,

the higher the expected reproductive success is. Based on the distance to the nearest occupied nest box, the number of eggs and the number of successfully fledged juveniles, it can be stated that the further the nest boxes are from each other, the more likely the higher the number of eggs and the higher the number of successfully fledged birds are. It can also be stated that the choice of nesting places is primarily affected by the proportion of meadows, pastures, areas taken out of cultivation and arable land. Mean scores of principal components mainly governed by the mentioned environmental variables showed significant difference between the occupied and non-occupied Little Owl nest boxes.

5. The average distance of the dispersal of young individuals from the hatching place is 9.67 km. In the case of breeding individuals, there were only 5 known cases of territory change, where the measured average distance was 8.9 km. In the case successfully fledged juveniles, the average apparent survival rate for the first breeding period is only 9.47% ± 2.99% SE, while it is 82.74% ± 8.46% SE for the already breeding and older individuals. Taking into account the average number of fledglings in the given period, the population's internal growth rate appears to be slightly positive (r = 0.006), thus the Little Owl population can be considered stable in Upper Kiskunság. Slight growth can be detected without taking into account permanent emigration.

6. The prey items identified from the 661 pellets represent 15 vertebrate species (1 amphibian, 2 reptile, 5 bird and 7 small mammal species) and 38 arthropod species. In addition, annelid presence has also been detected. In 2005, the consumption of common vole was found between 10.83% and 88.24%. Amphibians were represented by a single species, the common spadefoot, the quantity and proportion of which is remarkable. The Little Owl mainly consumed larger-sized beetles (Carabidae, Scarabaeidae) and orthopteran (Orthoptera) prey species. The proportion of arthropods did not approach, however, the proportion of mammals. The proportion based on number was 24.8–30.0%, while their weight share was very low, 0.14–0.34%. The total

number of species identified from the 4118 owl pellets in 2015–2016 was 21, including 12 mammalian, 1 amphibian, 4 reptile and 4 bird species. The proportion of mammals was 43.18–100%, while proportion of common spade foot ranged between 0–56.82%. Based on the number of individuals, common spadefoot dominated during the nesting period, while common vole was dominant based on the biomass. Until now, none of the European studies found such high values for amphibians in the food of Little Owls.

7. According to the pellets collected in 2015 and in 2016, the species richness of vertebrates was the highest in the Upper Kiskunság, while the Shannon diversity peaked in the Peszéradacs fields, which adequately reflects the characteristics of the particular territories. Based on the analyzes of the arthropod communities, the sites studied in 2005 didn't show distinct differences. Nevertheless, the particularities in the habitat mosaic structure and also in the farming activities are reflected in the arthropod communities. The highest arthropod diversities (species richness, Shannon diversity and equitability) were observed in the Kunpeszér site.

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