The Little Owl Population dynamics, Behavior and Management of *Athene noctua*

Dries Van Nieuwenhuyse Ronald van Harxen David H. Johnson

Illustrated by Joris De Raedt



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Chapter 0. Executive Summary



This book synthesizes the substantial literature and knowledge base on the Little Owl Athene noctua and detaild the current understanding of its rangewide ecology, genetics and subspecies, its population status by country, and offers a conservation management strategy and a monitoring program for its conservation. The update of this volume after two decades of international co-operation, aided by standardized methods for data collection, management, analysis and dissemination led to doubling of species publications, almost exclusively in English across the entirety of Europe and gradually expanding over most of its distribution range. Technological advances like PDF, GIS, advanced statistics, international standardized databases of geocoded and time-stamped picture, sound recordings led to realtime exchange of papers, data, advice, images, sound recordings and maps, facilitating analysis and editing. The major difference was definitely the digital artwork. Drawings were custom made, as ordered by the authors, adapted, standardized and optimized, leading to excellent, tailor-made plates and illustrations. This state-of-the-art contribution aims at perfecting the knowledge and understanding of the species, its study methods,



proven conservation and management approaches across the entire distribution range of the Little Owl. The ambition of this book is to serve as yardstick for advanced citizen science and conservation management.



Chapter 1. Introduction – Framework



The framework of this book reflects the complexity of the situation of the species at different scales. To position the Little Owl in the cultural context we look at the history and cultural traditions connected to the species. We describe the taxonomy and the races to settle some taxonomic discussions of the species based upon major genetic, morphological and biogeographical findings. The distribution of the different subspecies and recent population estimates for the Western Palearctic are given to illustrate the geographic diversity. The habitat is next described and its relationships with the species. Food as principle biotic factor delivers the crucial energy input for the birds. Abiotic factors such as breeding cavities and perches show their importance for breeding and foraging efficiency to minimize the energetic cost. Next we focus on the breeding season discussing clutch size, hatching and fledging success in relation the age of the birds. We then describe the behavior mainly based upon two decades of webcam observations. Next we zoom in on limiting factors that influence populations in a given geographic environment e.g. immigration, re-introduction, or supplementation and mechanisms that interact between local



populations such as migration, meta-populations and sinks/sources. After describing the main causes for declines in the species, we summarise the knowledge into a conservation and management strategy. We conclude this book with an overview of the key points raised with an overview of the most important open questions and suggestions for future studies.



Chapter 2 History and traditions



With its large distributional range across Europe, the Middle East, and Asia, and an ability to co-exist as a commensal with many human habitations, not surprisingly, the Little Owl has figured prominently in many cultural beliefs, and in a variety of ways. The common names given to this species across the countries are linked to its activity, to its voice, to its morphology, to its food, to the beliefs, to its habitat, and to mythology. In Greek mythology, Athena was the daughter of Zeus and originally a Mycenaean palace goddess, guardian of cities, war goddess, patroness of arts and crafts, and promoter of wisdom. A particularly interesting situation on the cultural use of Little Owls comes from Crespina, Italy which was a centre for the rearing of owls in captivity to be used for hunting small passerines. They were sold on the Little Owl market while tied up on a roost. The nobility (upper-class people) hunted commonly in the countryside using the Little Owls as bait. The history and traditions of the Little Owl are truly long, rich, and varied, and grow with additional recoveries of artefacts from archaeological sites, as well as evolving cultural views. In closing this chapter, we urge reviewers of owl myths, traditions, and lore to closely scrutinise the



information they assemble, to determine whether the ideas and symbolism described in text and artefacts still apply in contemporary societies, or whether they are part of the colorful but quaint past.



Chapter 3. Fossil Evidence, Taxonomy and Genetics



Different owl species and subspecies were defined in the early days of taxonomy uniquely based upon morphological features like size and color in specific geographical regions across the world. Recently more differentiators are taken into account to define new species to avoid upgrading them from a subspecies based upon limited aspects. We consider the biological species concept that takes biological characteristics into account, the morphological concept studies especially morphometrics and coloration of the bird, the phylogenetic concept using mitochondrial DNA studies to establish a lineage that eventually leads to a common ancestor, complemented with fossil evidence for the evolution of species. Vocalisations of Little Owls across the range are increasingly documented and taken into account as well. Last approach is considering the geographical distribution and the use of validated, geocoded high quality photographic input. In this chapter we present the current fossil evidence of ancestors of the species. We describe the historical context in which subspecies have been defined. We illustrate the way the subspecies were described for which we now have evidence for their relevance. We



consider 14 subspecies of Little Owl where we have found substantial evidence for. This means that we have one more subspecies.



Chapter 4. Morphology and Body Characteristics



This chapter gives an overview of the embryonic development and morphological characteristics of the Little Owl. We first look at how the egg is developing, with special attention to the temporary asymmetric ears, then zoom in on owlet development as they grow and the plumage of adult birds and how moult is taking place. The eyes are special and the species has retina cells similar to diurnal birds of prey. While Little Owls can differentiate several colors, the species does not see infra red rays. It has an audible sensitivity to locate small rodents with an accuracy of up to 1%. The bill is yellowish and its color functions as a signal for the fitness of both juveniles and adults. The Little Owl has differential biometrical measures (such as length of wing, tail, tarsus) according to the subspecies or according to the sex (such as weight - females are heavier close to the breeding time). We finally examine the voice. The species has a large vocal repertoire including 40 acoustic signals and combinations with regional specificities. The chapter concludes with specific characteristics of the flight and the anatomy.



Chapter 5. Distribution, Population Estimates and Trends



In this chapter, we examine aspects of distribution and population in the Little Owl for its global range which overlaps with 78 countries. Recent publications give an overview of population numbers and short and long term breeding population and breeding distribution trends for the EU28 and for continental Europe. The European Union (EU28) Red List assessments were based principally on the official data reported by EU Member States to the European Commission under Article 12 of the Birds Directive. In addition, population status and trends are assessed at the EU level. The reporting period 2006-12 of BirdLife International (2015) and Keller et al. (2020) and 2013-18 of European Environment Agency (2021) was used. Data outside the European continent were obtained from individual publications. In very general terms, all cumulative data suggests that the global distribution of the Little Owl increased in 12 countries, decreased in 10, remained unchanged in 25, or was insufficient for determination in 31 countries. For population numbers, the data suggests that the number of owl increased in 12 countries, decreased in 10, remained unchanged in 23, or was insufficient for determination in 33 countries. The global distribution and some limiting factors like latitude and elevation, are mapped as well as European population numbers and short and long term trends. For each



country we focus on the population estimates for currently existing populations and present distribution maps when available.



Chapter 6. Habitat



In this chapter we review the parameters that are of importance for the species, its prey species, and its predators. The favoured habitat for the Little Owl varies from the natural landscapes of steppe and arid deserts to anthropogenic areas. The common features are open areas with low grass, perches and cavities in the ground, rocks, trees or buildings. The species avoids forests, fallow land, and large parcels of arable land. A mosaic effect seems to be important for the species, due to the use of habitat edges, in particular for the richness in prey found there. The relations between the landscape factors will determine local owl densities and demographics. All quantitative studies available were done on anthropogenic habitats. Of natural habitats, only qualitative descriptions were available. We first discuss natural habitats in general terms, then we give an overview of different types of occupied anthropogenic habitat, followed by the actual preference of the species toward certain habitat typology studies consider only occupied habitats.



Chapter 7. Diet



The Little Owl has a generalist diet and takes a high diversity of small prey. It eats a diversity of small-sized prey across its entire distribution area. The diet varies with the season and the geographical area. From north to south and from winter to summer, an increase in the numbers of insects in the diet has been observed. However, small mammals remain the key prey category by biomass and energetic yield contributing significantly to the ecology and welfare of the species. For insect-eating owl species it is difficult to get a true picture of its diet by only studying its pellets or prey remains in nestboxes, because they catch lots of prey of which the remains are hard to find and identify in pellets. We present their relative proportion. In this chapter we look at this prey diversity through time and space, and focus on the hunting method of the owl, as well as caching behavior in larders. We offer a thorough review of the owl's diet and individual prey species, with attention given to the importance of micromammals. Pellet contents are described in detail and comprehensive results of camera observed breeding seasons are presented principally stemming from own research during 17 breeding seasons by camera observation, 2002-20 totalling 34,916 prev items.



Chapter 8 Breeding Season



This chapter covers the entire Little Owl breeding cycle. The breeding season is obviously a critically important period during which reproduction can be influenced by many different factors, such as weather, food, habitat, density, geographical location, parental experience. The season begins in January or February with the affirmation of territorial boundaries and onset of courtship. The Little Owl does not have high a productivity due to very few replacement clutches, moderate fledging success, and relatively high egg failure. According to the mortality rate of adults and juveniles, each pair should produce between 1.7 and 2.34 fledged young per year to compensate mortality and actually most of the long term breeding studies across Europe show results ranging between both values. Analysis of consistently organised long-term demographic data took place to enhance our understanding of Little Owl population dynamics. Further, this demographic data was linked to specific habitat conditions at the nest site, home-range, and landscape scales. We offer clarification in the terminology related to nesting success and reproduction due to its importance to provide an accurate and consistent foundation for the data that will be used to assess the reproductive performance of the owls, as well in long-term monitoring of status and trends.



Chapter 9. Behavior



New media such as internet-connected cameras in nestboxes can yield infrared images in the dark leading to new insights and knowledge. Substantial new information became available from the groundbreaking webcam project of Vogelbescherming Nederland Beleef de Lente that started in 2007 and continues to this day. Volunteers selected video clips revealing so far undiscovered remarkable behavior during fourteen entire breeding seasons day and night, from courtship to egg laying to the fledging of the young. Due to simpler and cheaper technology, more and more people decide to install such cameras in their nestbox which is expected to yield even more new knowledge in the future, opening unprecedented opportunities for citizen science. This chapter is complimented with a lot of information from the long-term research of Van Harxen and Stroeken (from 1986) in their study area in the Southeast Achterhoek in the Netherlands.



Chapter 10. Population Regulation



Little Owls have been shown to be directly and indirectly affected by habitat loss, vehicle collisions, limited availability of nest and roosting sites, pesticides (i.e., secondary poisoning) and heavy metals, entrapment in anthropogenic structures (i.e., hollow metal power poles and chimneys, and drowning in water troughs), predators, and weather. They are susceptible to parasites, diseases, and injuries too. While the Little Owl has co-evolved with a few of these (e.g., weather, predators, diseases, parasites), anthropogenic activities have substantially altered the landscape within which Little Owls exist(ed). When the population grows and owl densities become higher, density-dependent processes take place and serve to stabilise the population. In a metapopulation context, as populations become increasingly small, immigration helps to support them, extending the survival time of these population clusters. The mating system hypothesis, which predicts that the sex that establishes the territory should disperse shorter distances, was studied using the EURING data set containing 108,444 observations of ringing, re-capture and recovery data of 59,743 unique ringed birds. Little Owls ringed as young recovered at least one year later dispersed on average 14.69 km for females, 6.47 km for males and 11.61 km for



birds with unknown sex for live re-captures. Birds ringed as adult and then later recovered dispersed 2.33 km for females, 2.45 km for males and 2.42 km for birds with unknown sex for live re-captures.



Chapter 11. Management and Conservation



This chapter presents with a brief overview of the status of and threats to the Little Owl. We then offer a Conservation Strategy for the owl that involves five critical success factors: *Knowledge, Limiting Factors, Evolution of Landscape Conditions, Legislation and Policies,* and *People.* Thereafter, we describe four main drivers to implement this strategy, focused on *Monitoring, Management, Standardized Methodologies* and *Data Management.* The long-term conservation of the Little Owl is complicated as the species is largely linked to an agriculturally-dominated landscape. This landscape condition can change rapidly and significantly due to human demographics, changes in policies and management. The conservation strategy described in this chapter requires a multi-scale, multidisciplinary approach, with collaboration between different stakeholders (conservationists, scientists, different authorities, farmers), and additional research into the ecology of the species. This strategy must be applied at different levels: local, regional, national, and international. We encourage people involved in this conservation



management efforts that will benefit the broader array of species and environments of which the Little Owl is a part.



Chapter 12. Research priorities



This chapter deals with research priorities that were obtained during the writing of this book. We first illustrate the recent insights that were published since the publication of the first volume. New research topics are dealing with further exploring and identifying critical habitat components and the effect of land improvement initiatives. Demographics need to be studied in less covered areas using the method that were perfectioned in the typical highly researched countries. Examining responses of Little Owl populations to land uses and the effects of abiotic environmental factors should allow for more quantitative management and follow-up on the effectiveness of taken measures. The adoption of the information-theoretic approach, focus on process variation and searching for mechanisms will need more statistical background and thoroughness, leading to even more long term observational studies and focus on the cumulative effects. To do this in an optimal way more experiments are urgently needed, to enable controlling for certain parameters. Finally there is need for the expansion of the investigated geographic range and an increase in research and experiment maturity in emerging countries, hopefully enabled by high-mature research teams and international co-operation.

