Oriolus

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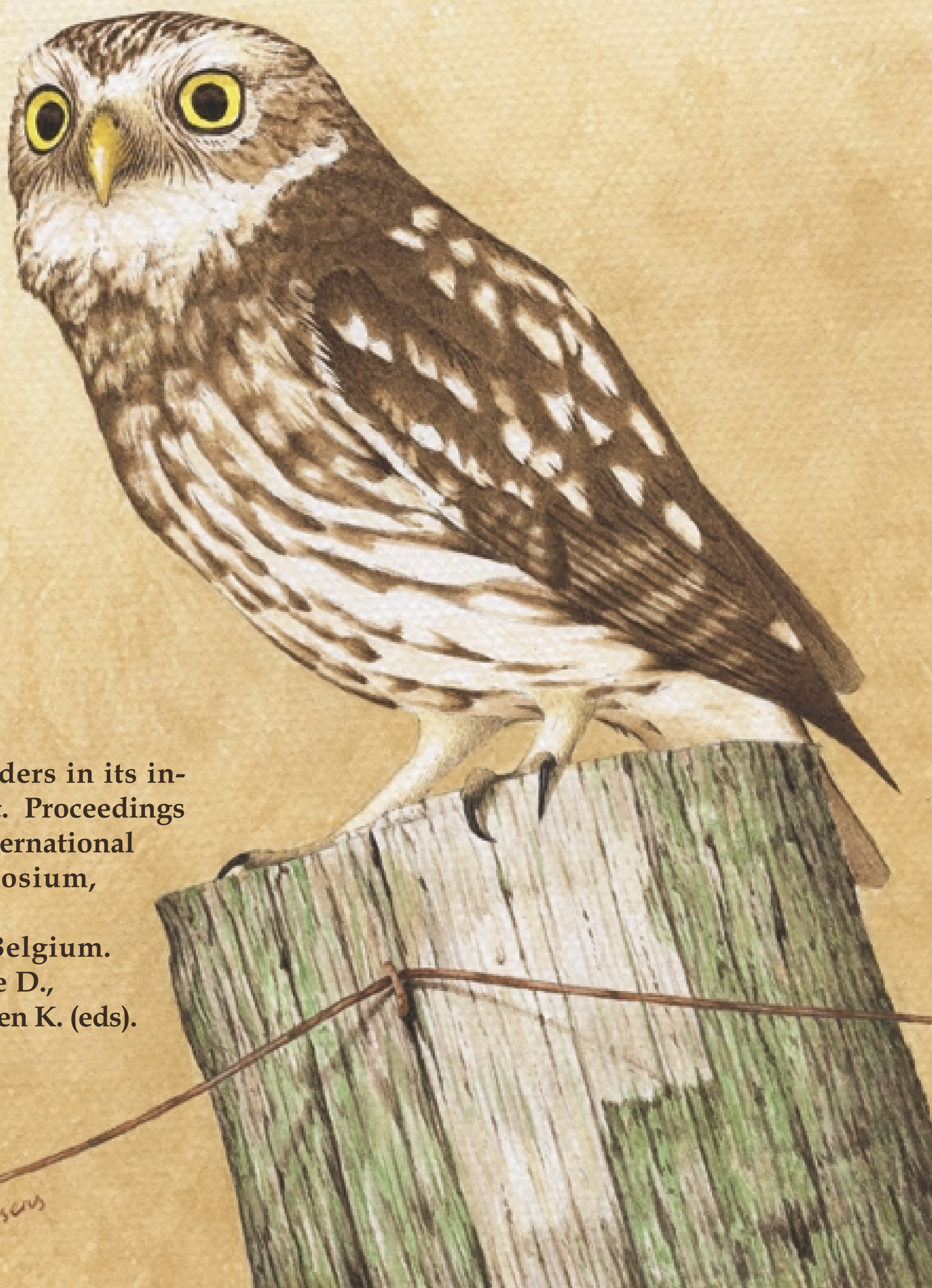

Little Owl in Flanders in its international context. Proceedings of the Second International Little Owl Symposium, 16-18 March 2001, Geraardsbergen, Belgium. Van Nieuwenhuyse D., Leysen M. and Leysen K. (eds). Oriolus 67 (2-3).

Oriolus

Vlaams Tijdschrift voor Ornithologie
Uitgegeven door Natuurpunt Studie vzw.

Oriolus verschijnt driemaandelijks en publiceert artikels en korte bijdragen, die nieuwe informatie bevatten betreffende de kennis en de bescherming van in het wild levende vogels, met nadruk op vogels in Vlaanderen, België en het West-Palearctisch gebied.
Oriolus publiceert tevens besprekingen van recente uitgaven en rapporten op dit terrein en mededelingen die voor de lezer van belang kunnen zijn.

Impressions of the Second International Little Owl Symposium, 16-18 March 2001, Geraardsbergen, Belgium

Left to right:
Roy Leigh, Peter Beersma, Wouter Mertens, Marc Leysen, Maarten Bekaert, Hubertus Illner, Harald Everard, Johan Lefebvre, Koen Leysen, Dries Van Nieuwenhuyse, Tom Van Muylem, Ingeborg De Leenheer, Paul Marié, Jacques Bultot, Christian Meisser, Jan van 't Hoff, Jean-Claude Génot, Cien De Roo, Koen Steenhoudt, Duccio Centili

How to refer to this volume?

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Example:

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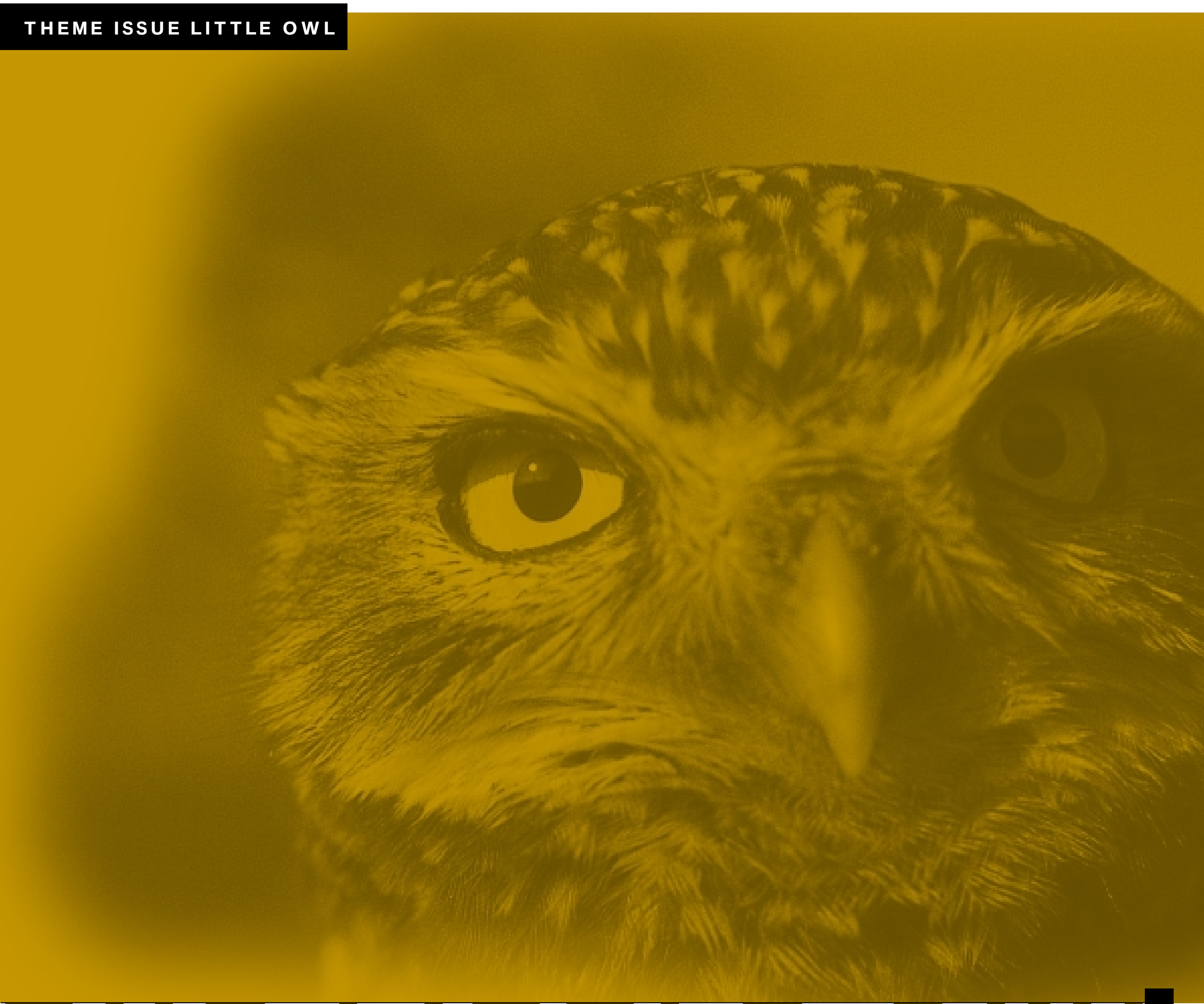
THEME ISSUE LITTLE OWL



THE LITTLE OWL

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THE LITTLE OWL

INHOUD

1. FOREWORD

The year 2001 was internationally dedicated to volunteers by the United Nations. Recognition and appreciation of volunteer work is also of crucial importance for nature conservancy in Flanders and the rest of the world. The Flemish Little Owl Project has proved this again by motivating over 400 volunteers to go and look for Little Owls in the freezing cold. The virtually unlimited input of volunteers during three years not only helped constructing a huge, standardised and reliable database, it also helped to broaden the social network of nature conservation. This way, nature conservancy is brought closer to the general public. The Little Owl hence forms a useful ambassador of the small-scaled half-open landscape. The species has a multitude of strategic features that might make it to the flagship of the rural environment: the species is very well known among the public, it is still present in reasonable amounts in Flanders so everyone has the opportunity to observe it and the Little Owl can deliver us some insights into the methods to implement nature restoration into practice. Due to its high cuddly effect it is furthermore a perfect vehicle to transfer nature conservancy ideas to the broader public.

Besides the educating role of the project, there is also the scientific knowledge that was obtained. The Flemish Little Owl Project demonstrated that private nature conservation organisations like Natuurpunt, surpassed the stadium of descriptive biology and are capable to cope with decision supportive nature conservancy biology. This project showed that a systematic monitoring is only possible using scientific methods in the field of inventory and the processing of the data. It was shown that existing digital data, readily available in Flanders, can be used perfectly for nature conservation. The approach to monitor population trends using modelled distributions over Flanders is promising for the future due to her scientific fundaments, her feasibility and durability. The identification of different types of habitat using objective statistical techniques allows furthermore to monitor into detail differences in habitat quality in the future. The presented methods are even very appropriate to process data of the currently run breeding bird atlas for species with similar active ranges.

The presented results of Flanders show that the Little Owl in our region and the knowledge about the species, deserve their international attention without discussion. The future of the Little Owl in Flanders and the rest of Europe, that's our business.

Koen De Smet
AMINAL Afdeling Natuur

1. VOORWOORD

Het jaar 2001 werd internationaal erkend als het jaar van de "Vrijwilliger" door de Verenigde Naties. Herkenning en erkenning van vrijwilligerswerk is ook van cruciaal belang in het natuurbehoud in Vlaanderen en de rest van de wereld. Het Vlaams Steenuilenproject heeft dit opnieuw bewezen door het enthousiasmeren van meer dan 400 vrijwilligers om in de vrieskou erop uit te trekken en Steenuilen te gaan zoeken. De tomeloze inzet van deze vrijwilligers gedurende drie jaar helpt niet alleen om op een haalbare manier aan een grote, gestandaardiseerde en dus betrouwbare gegevensbank te komen, maar evenzeer om het maatschappelijk draagvlak van natuurbehoud aanzienlijk te verbreden. Op die manier wordt de natuur dichter bij de bevolking gebracht.
De Steenuil is daarbij een zeer nuttige ambassadeur van het kleinschalige half open landschap. De soort heeft dan ook een aantal troeven in handen die ze tot vlaggenschip van dit ruderale landschap kan maken: de soort is zeer goed gekend in zowat alle lagen van de bevolking, ze is in Vlaanderen nog steeds in voldoende aantallen aanwezig zodat iedereen ze kan waarnemen, en ze kan ons een aantal inzichten bijbrengen rond methoden om het natuurherstel daadwerkelijk uit te voeren en is wegens haar hoge aaibaarheidsfactor een dankbaar vehikel om het ideeëngoed van natuurbehoud breed uit te dragen.

Naast de educatieve rol van dit project is er tevens de wetenschappelijke kennis die eruit voortvloeit. Het Steenuilenproject heeft aangetoond dat natuurverenigingen, zoals Natuurpunt, het stadium van beschrijvende biologie ruim zijn ontgroeid en daadwerkelijk beleidsondersteunende natuurbehoudsbiologie aankunnen. Dit project heeft dan ook aangetoond dat een gesystematiseerde monitoring slechts mogelijk is met behulp van goed onderbouwde wetenschappelijke werkwijzen zowel op het gebied van inventarisatie als van het verwerken van deze gegevens. Er werd aangetoond dat de bestaande digitale bestanden die Vlaanderen rijk is,
perfect kunnen gebruikt worden voor Natuurbehoudsdoeleinden. De aanpak om de evoluties van populaties te volgen via de gemodelleerde verspreiding over Vlaanderen is veelbelovend naar de toekomst toe wegens haar wetenschappelijke fundamenten en niet in het minst wegens haar duurzaamheid. Het onderscheiden van verschillende types habitat via objectieve statistische technieken laat daarenboven toe om naar de toekomst toe verschillen in habitatkwaliteit en hun evolutie nauwlettend te volgen. De voorgestelde methoden zijn daarenboven zeer goed geschikt om gegevens zoals bijvoorbeeld van broedvogelatlassen te verwerken voor soorten met een analoge territoriumgrootte.

De hier gepresenteerde resultaten uit Vlaanderen tonen aan dat de Steenuil in Vlaanderen en de kennis over de soort, hun internationale uitstraling in Europa ruimschoots verdienen. De toekomst van de Steenuil in Vlaanderen en de rest van Europa, daar maken we werk van.

Koen De Smet
AMINAL Afdeling Natuur

2.

THE CHALLENGES OF STUDYING LITTLE OWLS AT THE EDGE OF THE 20TH CENTURY

KLAUS-MICHAEL EXO

Since centuries, all across the world, owls and humans had a continuous love-and-hate-relationship. Owls are prominent in myth, superstition and folklore. On the one hand, owls were an omen of bad news, of doom and gloom - in Central Europe locally Little Owls are still associated with death -, on the other hand, the Greeks, for example, considered them wise, especially the Little Owl. Though the relationship between man and owls can be traced back to ancient Greece and beyond, our understanding of the basic biology of owls often is still rather poor compared to other bird species. No scientist interested in basic ecological principles would choose to study a nocturnal species breeding in low density, often in remote and inaccessible places. The situation changed mid of the 20th century, when ornithologists observed drastic declines in several owl species. Throughout Europe the decline of Little Owls is mainly caused by habitat destruction, especially due to the intensification and mechanisation of agriculture. These pronounced declines have attracted the attention of many conservationists and researchers. To set up a sound conservation and monitoring programme and to maximise the benefits for conservation, there is an urgent need to co-ordinate conservation actions in different countries. Now, at the turn of the 20th century, the International Little Owl Working Group (ILOWG) organized two international Little Owl symposia within less than half a year: the 1st International Little Owl Symposium in Europe "Little Owls and landscapes" took place in Champ-sur-Marne, France, in November 2000, the 2nd International Little Owl Symposium "The Little Owl in Flanders in its international context" in Geraardsbergen, Belgium, in March 2001. The next conference is already planned to be held at the Owl Centre in Cumbria, England, end of April 2002. Participants from eight European countries attended both meetings. However, the question arises, are there enough new initiatives for two international meetings within less than 6 months? Having both proceedings at hand, the special issue of Ciconia (Vol. 25/2, 2001) and the special issue of Oriolus (Vol. 67/2-3, 2001), the answer can only be yes!

There is a lot of progress in Little Owl research. Symposia such as these are extremely valuable in providing up-to-the-minute information on current research. The papers presented will help us to understand the ecology of the Little Owl, the species-specific adaptations, and therefore deliver the framework for a scientifically sound conservation strategy. This volume focuses mainly on habitat selection and factors affecting habitat selection. Besides that, the theme issue contains papers on survey methodology, the distribution of Little Owls in different European countries, analyses of population dynamics and about the main threats. Based on these studies a working structure for a European species conservation plan has been developed to standardise research and monitoring methods across Europe. The proceedings provide an excellent foundation for future co-operative studies and conservation.

A harmonised monitoring programme is essential for effective conservation and management, e.g. to follow the effectiveness of policy and mitigation measures. Though the aim of a monitoring programme is to elucidate also reasons for population changes, causal factors will not necessarily be obvious from monitoring data alone. In order to overcome these shortcomings, an indispensable tool, concomitant research, should supplement the monitoring programme. During the last decades many studies on the ecology of Little Owls have been published. However, the presented papers make clear that also in a "well studied" species as the Little Owl much deeper studies are needed to understand, for example, distribution patterns and especially the underlying ecological factors determining and affecting the distribution patterns as well as factors limiting and regulating populations. Both is essential to understand the biology of a species, its adaptation and therefore also to set up a monitoring and an effective conservation programme. The Little Owl theme issue you hold at hand provides examples on how to use data about bird distributions, relative abundance and habitat associations to set conservation priorities.

Along with this, the theme issue of Oriolus on Little Owls exemplifies in an excellent way

(a) the close link between amateur and professional ornithologists and (b) the overall importance of detailed large-scale and long-term studies by volunteers and their contributions to applied as well as to basic scientific research. The increase in knowledge during the last decades is largely through the efforts of non-professional ornithologists and NGOs. Most of the long-term studies on Little Owls as well as large-scale surveys of their distribution were carried out by volunteers. Modern software and modelling techniques provide the theoretical framework. In addition to their role as tools for describing distribution and patterns affecting them, for example, models can also provide the means for examining and generating hypotheses about causes and consequences of habitat changes. Models can show us which parameters are important and therefore should be recorded in the future, and hence make monitoring and conservation programmes more effective. To accomplish this, the integration of comprehensive empirical studies, technological advances to study the behaviour of nocturnal animals and mathematical modelling promises a lot of new insights. The understanding of population regulation and the spatial distribution, including the understanding of dispersal patterns will not only prove to be an interesting challenge for the next decade, it is also essential to set up an effective conservation plan. Generalisation of all available local insights and models across the entire geographical range of the species is another main point of attention for the future. The ILOWG and meetings such as these provide a fertile ground and deliver the necessary platform for co-ordinated studies across Europe. Congratulations to the editors that they managed to publish the proceedings immediately, within only 6 months after the conference!

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2. STUDIE VAN DE STEENUIL ALS UITDAGING VOOR HET NIEUWE MILLENNIUM

KLAUS-MICHAEL EXO

Sinds mensenheugenis bestaat een haat-liefde verhouding tussen uilen en mensen, vrijwel overal ter wereld. Uilen maken deel uit van mythes, bijgeloof en folklore. Uilen waren enerzijds een teken van slecht nieuws en verdoemenis -in centraal Europa wordt de Steenuil nog steeds geassocieerd met de dood-, of synoniem van wijsheid, zoals bijvoorbeeld de Steenuil bij de Grieken. Ondanks de lange duur van deze relatie blijft onze kennis van uilen nog steeds zeer beperkt vergeleken met andere vogelsoorten. Welke wetenschapper zou immers algemene biologische principes willen bestuderen op nachtdieren die in lage densiteiten voorkomen, meestal in afgelegen en weinig toegankelijke gebieden? Er kwam verandering in deze situatie halverwege de 20ste eeuw, toen ornithologen een gevoelige afname constateerden van meerdere uilensoorten. In geheel Europa gaat de Steenuil vooral achteruit door vernietiging van zijn habitat ten gevolge van de intensifiëring en mechanisatie van de landbouw.
Deze uitgesproken afname trok de aandacht van vele natuurbehoudmensen en onderzoekers. Om een effectief monitoring- en beschermingsplan op te starten dat de opbrengsten voor het natuurbehoud maximaliseert, is er dringend behoefte aan gecoördineerde beschermingsacties in verschillende landen.
Rond de eeuwwisseling organiseerde de International Little Owl Working Group (ILOWG) twee internationale Steenuilen-symposia op minder dan een half jaar tijd: het 1st International Little Owl Symposium "Little Owls and landscapes" vond plaats te Champ-sur-Marne, Frankrijk, in november 2000, het 2nd International Little Owl Symposium "The Little Owl in Flanders in its international context" in Geraardsbergen, België, in maart 2001. De volgende bijeenkomst is nu reeds voorzien in het Owl Centre in Cumbria, Engeland, eind april 2002. Deelnemers van acht Europese landen woonden beide meetings bij. Bij deze veelheid aan bijeenkomsten kan de vraag gesteld worden in welke mate genoeg initiatieven bestaan om twee internationale meetings op 6 maanden tijd te organiseren. Een blik op het Steenuilen-themanummer van Ciconia (Vol. 25/2, 2001) en van Oriolus (Vol. 67/2-3, 2001), toont aan dat er wel degelijk voldoende stof aanwezig is! Het Steenuilenonderzoek zit duidelijk in de lift. Dergelijke symposia zijn uiterst waardevol als communicatiemiddel voor bijzonder actuele onderzoeksresultaten. De artikels

helpen ons om de ecologie van de Steenuil en specifieke aanpassingen van de soort te doorgronden. Daardoor vormen ze het raamwerk voor een wetenschappelijk onderbouwde beschermingsstrategie. Dit themanummer richt zich vooral op habitatselectie en factoren die deze beïnvloeden, aangevuld met artikels rond inventarisatie-methodes, de distributie van de soort in verscheidene Europese landen, analyses van populatiedynamiek en de voornaamste bedreigingen. Op basis van deze studies werd een raamwerk ontwikkeld voor een Europees beschermingsplan om research en monitoring te standaardiseren in Europa. Beide themanummers vormen een excellente basis voor toekomstige internationale studies en beschermingsacties.

Een geharmoniseerd monitoring-programma is essentieel voor effectieve bescherming en beheer, bijvoorbeeld om de effectiviteit van het beleid te kunnen meten. Ondanks het feit dat monitoring als doelstelling heeft redenen voor populatie-evoluties aan te geven, zullen inzichten in oorzakelijke verbanden niet vanzelf komen uit monitoringgegevens alleen. Om deze tekortkoming te ondervangen blijft bijkomend specifiek overeenstemmend onderzoek absoluut nodig. Gedurende de laatste decennia werden talrijke studies over de ecologie van de soort gepubliceerd. Desalniettemin blijkt daaruit dat zelfs voor "goed bestudeerde" soorten zoals de Steenuil, diepgaander onderzoek noodzakelijk is om bijvoorbeeld meer inzicht te krijgen in distributiepatronen en vooral in de onderliggende ecologische factoren die deze verspreiding beïnvloeden of bepalen evenals factoren die populaties limiteren en reguleren. Beide inzichten zijn essentieel om een effectief monitoring- en beschermings-programma te kunnen uitvoeren. Dit Steenuilen-themanummer geeft voorbeelden van hoe gegevens rond de verspreiding van vogels, relatieve dichtheden en habitat associaties kunnen worden gebruikt bij het bepalen van prioriteiten bij de bescherming.

Daarnaast illustreert het themanummer van Oriolus rond Steenuilen op een uitzonderlijke manier (a) de nauwe band die bestaat tussen vrijwilligers en professionele ornithologen en (b) het algemene belang van grootschalige en toch gedetailleerde lange termijn-studies door vrijwilligers en hun bijdragen tot zowel fundamenteel als toegepast onderzoek. De toename van kennis van de soort van de laatste decennia is immers grotendeels te danken aan niet-professionele onderzoekers en NGO's. Moderne software en modelleringtechnieken bieden daarbij een theoretisch raamwerk. Naast hun rol als hulpmiddel voor het beschrijven van verspreidingspatronen en factoren die deze beïnvloeden, kunnen modellen ook dienen om hypothesen te genereren en te testen rond oorzaak en gevolg van habitatwijzigingen. Modellen kunnen ons tonen welke parameters belangrijk zijn en derhalve van nabij op te volgen in de toekomst. Op die manier kunnen ze monitoring en beschermingsprogramma's effectiever maken. De integratie van relevante proefondervindelijke studies, technologische vooruitgang om het gedrag van nachtelijke roofvogels te bestuderen en mathematische modellering is hierin beloftevol. Het begrijpen van populatie-regulerende factoren en de ruimtelijke verspreiding en dispersiepatronen zullen niet alleen interessante uitdagingen vormen voor de volgende decade, ze zijn ook essentieel voor het opzetten van een effectief beschermingsplan. Generalisatie van alle locale inzichten en modellen over de volledige geografische verspreiding van de soort, vormt een bijkomend aandachtspunt voor de toekomst. De ILOWG en bijeenkomsten zoals deze, bieden een vruchtbare voedingsbodem en vormen het noodzakelijk platform voor gecoördineerde studies in Europa. Felicitaties voor de samenstellers van dit nummer die er in slaagden om deze proceedings, slechts 6 maanden na het symposium, te publiceren!

Vertaling door Dries Van Nieuwenhuyse

3. ACKNOWLEDGEMENTS

AMINAL
Ministerie van de
Vlaamse Gemeenschap

First of all we wish to thank all the people that helped us collect a really huge data set on Little Owl, unprecedented in human history. Secondly we wish to thank the authors Duccio, Jean-Claude, Roy, Maarten, Ingeborg, Joris, Marco, Peter and Wies, Jan, Koen, Friedel, Jacques and Paul for sharing their valuable insights, both at the Second International Little Owl Symposium and in this volume. We thank the reviewers for their highly appreciated input: Michael Exo (Vogelwarte Helgoland), Erik Matthysen (University of Antwerp), Jenny De Laet, Jan Stevens (Province of Limburg), Anny Anselin (Instituut voor Natuurbehoud), Paul Van Sanden (Natuurpunt). For the Dutch translations we wish to pay tribute to: Ingeborg De Leenheer, Jacques Van Impe, Jenny De Laet and Anny Anselin.
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Special thanks go to Michael Exo who did most of the reviewing and even found the energy to write the preface.
The Flemish Little Owl Project was sponsored by AMINAL and Natuurpunt Studie. The Second International Little Owl Symposium was made possible by the input of the following people: Wouter Mertens (Vlaamse Gemeenschap), Koen Steenhoudt, Tom Van Muylem and Wouter Faveyts.

The editors

Dries Van Nieuwenhuyse wishes to thank his dear wife Trui, who had to endure more than a year of absent-mindedness and lack of attention. Without her motivation this volume and the symposium would not have been the way they turned out. He also dedicates this book to his two lovely and energetic twin-sons, Juul and Siel, hoping that they will share their fathers' passion someday. Thanks to Friedel Nollet who finally got us all into Little Owls instead of shrikes. Thanks to Maarten Bekaert and his family for their enthusiasm and persistence throughout this project. The prizes that Maarten wan, prove the quality of the delivered work. I am also very grateful to Johan Lambrecht for his excellent input as "sparring partner". He helped me discover hidden talents and made me believe more in my own capabilities. Thanks to Filiep Lammertyn for his moral support during our philosophical squash sessions.
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Dries

Marc Leysen wishes to dedicate his share in the making of this book to his late father Eric. He showed me things by learning me how to look, not by telling me what to see. Gianfranco De Grandi (JRC) continued this development by learning me to look around, and to come back and look again. My gratitude will always be with them for broadening my field of view and molding me into an engineer recognizing the essential force of inspiration. It's been a pleasant and enriching experience to be warmly embraced by the Natuurpunt crew and to be swiftly incorporated in the Study team, despite my principally technical background. No project of this scope can be carried through without strong personal backing and support. For providing me with the essential warmth and care, I am grateful to my family, Jessy, Bruno, Vera and Chiara. I also thank the many friends and fellow musicians who helped carrying my thoughts away from Little Owls from time to time, and directing my inspiration and energy to other aspects of beauty.
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Marc

As editor of Oriolus Koen Leysen would like to thank Dries Van Nieuwenhuyse on behalf of the editorial board of Oriolus. In organising the Little Owl Symposium and compiling this theme issue he has made an impressive achievement.
The co-operation with Dries and Marc was a very pleasant experience and has lead to a beautiful result. I believe this issue is a milestone in the history of our ornithological magazine. Furthermore I want to pay tribute to all the observers in the field that have made the Flemish Little Owl Project to a success. I'm sure this is not the end of our Little Owl story. This issue can provide the foundation of a brighter future for the Little Owl in Europe.

Koen

3. DANKWOORD

Vooreerst willen we iedereen danken die geholpen heeft bij het verzamelen van de meest indrukwekkende dataset over Steenuil ooit. Verder houden we er ook aan de auteurs te danken met name Duccio, Jean-Claude, Roy, Maarten, Ingeborg, Joris, Marco, Peter en Wies, Jan, Koen, Friedel, Jacques en Paul om hun waardevolle inzichten met ons te delen, zowel op het Tweede Internationaal Steenuilsymposium als in dit werk. Ook de referees willen we uitdrukkelijk danken voor hun gewaardeerde bijdrage: Michael Exo (Vogelwarte Helgoland), Erik Matthysen (Universiteit Antwerpen), Jenny De Laet, Jan Stevens (Provincie Limburg), Anny Anselin (Instituut voor Natuurbehoud), Paul Van Sanden (Natuurpunt). Voor de Nederlandse samenvattingen zijn we Ingeborg De Leenheer, Jacques Van Impe, Jenny De Laet en Anny Anselin erg erkentelijk.
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De uitgevers

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Robbrecht Guy
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Smets Philippe
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Spittaels Paul
Springael Wim
Spruyte Stef & Meersseman Marleen
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Steenkiste Ivan
Stessens J.
Stevens Jan
Stevens Mark
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Vanlommel Stef
Vanloo Eric
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Willemsen Alfons
Willockx Rudi
Wouters Frank
Wouters Johan
Wouters Leo
Wouters Rita
Wouters Wilfried
Wuyts Bert
Wybauw Erwin
Yskout Stijn

Al deze medewerkers hebben recht op een exemplaar van dit themanummer. Het is altijd mogelijk dat we toch iemand vergeten zijn. Gelieve ons hiervoor te excuseren. Als u dit signaleert hebt u uiteraard ook recht op uw gratis exemplaar.

4. TOWARDS A CONSERVATION STRATEGY FOR LITTLE OWL *ATHENE NOCTUA* IN FLANDERS.

VOORSTEL TOT STRATEGIE VOOR DE BESCHERMING VAN DE STEENUIL *ATHENE NOCTUA* IN VLAANDEREN.

DRIES VAN NIEUWENHUYSE*,
MARC LEYSEN, INGEBORG DE LEENHEER AND JORIS BRACQUENÉ

ABSTRACT

Despite its commonness in Flanders, specific conservational initiatives are suggested for Little Owls, mainly because of the high international importance of this local population for Western Europe.
The suggested conservation model entails five domains (i.e. people, knowledge, limiting factors, landscape and law) and four drivers (i.e. measuring the strategy, monitoring the evolution of dependent and independent variables, standardising methodology and storing and exploiting existing data on an international scale).

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"Birds are an 'ecological litmus paper'. Because of their rapid metabolism and wide geographical range, they reflect changes in the environment quickly; they warn us of things out of balance, sending out signals whenever there is a deterioration in the ecosystem..."
Roger Tory Peterson

INTRODUCTION

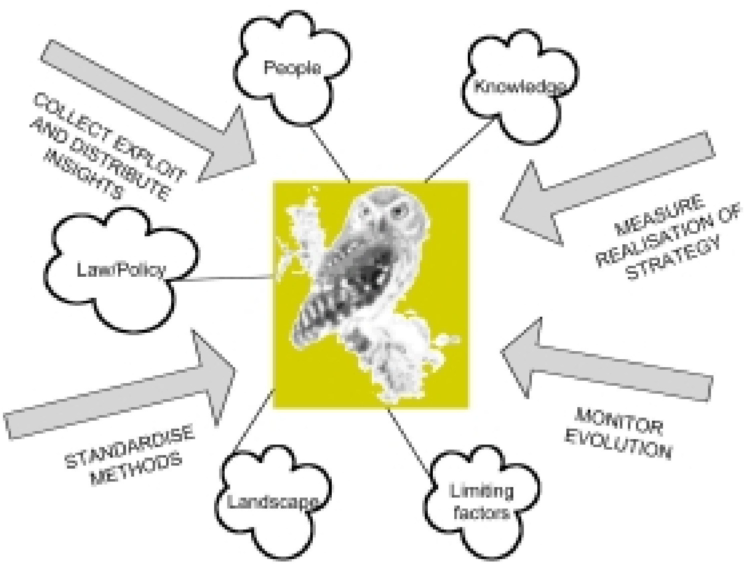
Conservation of Little Owl *Athene noctua* in Flanders might be considered redundant since the species does not seem to be endangered at all and not even threatened. The Little Owl is a common species in Flanders and has a widespread distribution with unusual strong populations (Van Nieuwenhuyse, Leysen and Steenhoudt 2001) compared to other Western-European countries (Génot et al. 1997). However, some threats emerge stronger and stronger and are observed as tree-lines that disappear unnoticed, further deterioration of high-stem orchards, further increase of the scale of the landscape, further increase of subsidised maize, possible bad impact of BSE and food and mouth-disease, further degradation of populations in neighbouring regions or countries (Génot et al. 1997). In Europe, Little Owl is considered as a Species of European Conservation Concern (SPEC) category 3 with a European Threat Status that is Declining (Tucker and Heath 1994). This means that the species is not of global conservation concern, has an unfavourable conservation status (declining) and its populations are not concentrated in Europe. For the arable land and improved grassland habitats, the species obtains a priority class B because of its SPEC3 status and because more than 75% of the European population occurs at any stage of the annual cycle in this habitat (Tucker and Evans, 1997). For the steppe habitats the species has a priority class C i.e. less than 25% occurs in this habitat. The unique situation in Flanders offers good opportunities for Little Owl conservation locally and for the rest of Europe. Hence the Flemish people and conservationists have large international responsibilities for this species.

To be able to maintain this population stronghold we wish to determine which strategy should be implemented and how this should be tackled? We think that a conservation strategy and a long-term vision are crucial before action is undertaken. Furthermore we believe that we do not have enough knowledge on the species and its limiting factors yet, to be able to manage the species for the future. In addition we wish to study the importance of our population in an international context to help determine the correct priorities. The aim of this paper is to present a discussion text for a possible strategy that guarantees the crucial knowledge about the species and the conservation of a healthy, sustaining Little Owl population in Flanders on the long term, offering a core source population for future international conservation activities.

CONSERVATION MODEL

Our conservation model entails five domains i.e. people, knowledge, limiting factors, landscape and law/policy and four drivers i.e. measuring the strategy, monitoring the evolution of dependent and independent variables, standardising methodology and storing and exploiting data on an international scale (Figure 1). We first zoom in on the domains followed by the drivers that act on the domains.

Figure 1. Flemish Little Owl Conservation Model.
Figuur 1: Vlaams beschermingsmodel Steenuil.



FIVE DOMAINS

1. KNOWLEDGE

We try to identify the gaps in the current knowledge of the species in Flanders (Tucker and Evans 1997). Therefore we first give an overview of what is already known and what needs to be known in the near future according to current insights of the species and its conservation status.

Available knowledge

The current knowledge of the Little Owl in Flanders is very limited despite its commonness. Habitat selection has been studied in Meulebeke, West Flanders by Van Nieuwenhuyse and Nollet (1990, 1991), in and outgoing movements were used to study foraging behaviour of one pair during one season in Meulebeke by Verhaeghe et al. (1996). Finally Smets (1999) published a short note on the breeding success of Little Owls from 1993 to 1999 in Hageland, Vlaams Brabant. At that time limited knowledge on the distribution was available from a few outdated national or regional breeding bird atlases.

Much more insights were obtained during the Flemish Little Owl Project of which this volume reports on the results. A scaled approach is followed to guarantee us the detection of different patterns that might occur at different scales (May 1994). We present our results on the macro scale (Flanders), on the meso scale (communities) and on the micro scale (individual territories).

• *Macro scale (Flanders)*
Van Nieuwenhuyse, Leysen and Steenhoudt (2001) present the results of their logistic regression model that explains the landscape elements that influence the presence of Little Owls in Flanders and its individual ecological regions.

• *Meso scale (communities)*
At the community level two studies were carried out. A longitudinal study was carried out by Van Nieuwenhuyse, Bekaert, Steenhoudt and Nollet (2001) re-using the data of Meulebeke of two earlier studies from 1988 (Van Nieuwenhuyse and Nollet 1990) and 1994 (Verhaeghe et al. 1996), together with new data obtained in 2000. In this study they present the observed fluctuations of the

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population numbers, the evolution in habitat selection and the distribution patterns of the species in function of increasing densities. In addition they study the relationship between the probabilities of occupation of sites obtained from their logistic regression model and the persistence in occupation by the species in order to confirm the relevance of the model. Furthermore Van Nieuwenhuyse and Bekaert (2001; submitted) yielded more insight into the habitat selection of the species in Herzele, East-Flanders using two different statistical techniques.

• *Micro scale (individual territories)*
Van Nieuwenhuyse and Leysen (2001) present a study of different habitat typologies of occupied Little Owl habitats in Flanders together with a habitat quality assessment based on current knowledge of the species as a base line for future monitoring of the species and a possibility to test the distinction between source areas and sink areas (Pulliam 1988).

Wanted knowledge
Apart from a small study on one research area and on breeding performance (Smets 1999), hardly any demographic knowledge currently is available for the region. More needs to be known about the occurring natural fluctuations of local populations. The only data available on long-term trends came from just one community (Meulebeke) and from three 6 years interval periods. However, plenty of ringing data exists among active ringers that has not been analysed nor published yet. To obtain a quick start on this topic, we suggest a maximal exploitation of existing ringing data on very short terms. A similar project of Walloon data is presented in Bultot et al. (2001) and shows that even non-experimental data can yield important knowledge of the species. This knowledge is crucial to assess the local context of breeding performance and health of the population. In addition we suggest an extension of the tasks of ringers towards a focused sampling of additional data e.g. feathers for genetic analysis and analysis of heavy metals, eggs for analysis of pollutants, dead birds for the study of mortality causes etc.. The study of dead animals and un-hatched eggs to analyse the impact of pesticides (Vogrin 2001) and rodenticides (Beersma et al. 2001) is also highly recommended because of the simplicity of the sampling. Collection of specimens is especially easy in Flanders because of the availability of the Marten-network currently collecting and dissecting dead *Mustelidae* across the region. Other opportunities to gather more crucial knowledge exist under the form of available Little Owls for release from the Flemish bird-care centres e.g. in 1995 one hundred and fifty-six birds (Van Nieuwenhuyse 1996). This allows us to use released birds as experimental samples using telemetry to study local emigration and settlement patterns in empty regions.

2. LIMITING FACTORS

Essential criteria for suitable Little Owl habitat are year-round prey availability, prey accessibility, vertical landscape structures with cavities and a limited predation pressure (Génot and Van Nieuwenhuyse, submitted).

We need to get a clear view on the relative importance of the different factors that influence the population dynamics of the species (Exo 1992). However, before we can test this, we first need reference data of the available resources.
Apart from a few anecdotic studies on Little Owl pellets, nothing is known about the food of Little

Owls in Flanders. If we want to study the food availability and the possible impact of it on population numbers, we need more information on the prey-choice of the species in Flanders and its variance in time and space. A Flemish database on micro-mammal distribution and especially densities is needed, as is a better view on the relative abundance of *Lumbricidae* and different beetle species. In function of local habitat optimisations by improved prey accessibility, we should study the impact of artificial perches on prey accessibility
similar to shrikes (Yosef 1993, Van Nieuwenhuyse et al. 1995). Better insight into the real importance of perches on habitat quality is also needed.
Now this is only indirectly confirmed by the Flemish results as the positive impact of edges on Little Owl presence. The impact of nesting cavities has been shown in other regions (Bultot et al. 2001, Exo 1992) but not in Flanders. We believe that at least 1000 nest-boxes are available in the region at present. Nest-boxes that are not known to researchers can influence the results. Therefore an inventory of these artificial cavities should be
carried out urgently and a nest-box database for Flanders should be made with a process to maintain this information. Finally, to get a better view on the possible impact of the predators, co-operation with existing initiatives are suggested e.g. with the Stone Marten (*Martes foina*) project. This might become important given the population increase of the species in Flanders (Van Den Berghe 1998) and its possible threat for Little Owls. The acrobatic skills of Martens are illustrated by Paul Marié and Leysen (2001) in this volume and possible measures to avoid predating by Stone Marten are suggested.

3. LANDSCAPE

The agricultural landscape is a key factor for the Little Owl since the species is typical for these landscapes (Tucker and Evans 1997). The impact of the changing landscapes is unclear at the moment for Flanders due to a lack of historical Little Owl data and historical landscape data. This kind of data however is crucial in the study of the causes of population trends e.g. as illustrated by van 't Hoff (2001) in The Netherlands. The Flemish Little Owl Project paid much attention to the set-up of a referential data base of soil data, land-use data, biological quality data, roads, rivers etc. (Leysen et al. 2001). This reference database will be used to follow the evolution of the landscape in a digital and exploitable way and made available in the planned European Little Owl Data Warehouse via the Internet. Contacts and co-operation between conservationist groups and official organisms e.g. Intra Eco Network Europe (IENE) need to be established because of the joint interests in the impact of habitat fragmentation on birds by roads and other infrastructure (IENE 1999).

4. LEGISLATIVE FRAMEWORK

An excellent overview of the opportunities for conserving the wider environment and indirectly the Little Owl, through the international and the European legislation is given in Tucker and Evans (1997). An important challenge remains to analyse these different instruments more into detail in function of the Little Owl and to translate the opportunities to a regional context. For Flanders specific local opportunities and challenges exist and were presented at the Second International Little Owl Symposium, Geraardsbergen, March 2001 by Joris Bracquené. The Flemish nature conservation legislation evolved from a species protection of ‘useful’ species towards a more territory directed conservation (e.g. Natura 2000). In recent years more attention went to species protection again due to the Biodiversity treaty. In Flanders the Little Owl is a protected species through the European Bird guideline 79/409 (Royal decree of 9/9/1981 changed by decree of the Flemish Government of 20/11/1985). Since 1998, the Decree on Nature Conservation (Belgisch Staatsblad 10/1/1998) offers different opportunities for Little Owl conservation. The fundamentals of the Decree are species protection, territory directed conservation, general basic ecological quality and a focused tackling of groups of interest. The decree offers some articles that can be used for species protection in general and Little Owl conservation in particular:
• art. 11: Planning the nature policy
• art. 50: Nature guidance plans
• art. 51: Measures for species

The implementation of these articles can be done through management contracts as mentioned in the EEC ordinance 2078/92. With these instruments farmers can get money to create or maintain certain elements in the landscape (wooded banks, pollard willows, ponds, field edges, …). These contracts are essential for safeguarding viable breeding places for the Little Owl. Despite the availability there is no systematic use of management contracts. Additional instruments are also subsidies for planting and maintaining pollard willows, high stem orchards, wooded banks and other small landscape elements in most communities through the GNOPs (Gemeentelijk NatuurOntwikkelingsProgramma, communal nature development plans). Despite some good and pragmatic initiatives, there remains a huge gap in the understanding of the link between economic and policy mechanisms and their impact on the species (Tucker and Evans, 1997) in Flanders too.

5. PEOPLE

People are another key-factor in the Little Owl Conservation Strategy. Up to 75% of the European Little Owl population occurs in agricultural and grassland habitats (Tucker and Evans 1997). Especially for this species, environmental protection and biodiversity conservation should be(come) an integral part of all uses of the environment, and of all policies of all socio-economic sectors (agriculture, forestry, tourism, etc.). On longer terms, sustainable use of the European environment will require substantial changes in society's use of natural resources, energy and transport. It is therefore essential that the public is aware of the implications of the current and increasing intensity of its uses of the European environment, and of the fact that everyone has a role to play in the conservation of biodiversity in the wider environment (Tucker and Evans 1997). The Little Owl might offer an excellent model to implement this in Flanders and Europe because of its high emotional impact on humans. We think that the species might become a flagship for agricultural landscapes in Europe.

Specific action-plans should be made to educate and influence the policy makers, landowners, land-users, conservationists and kids. Box 1 gives an overview of possible initiatives for different age classes and target groups.

BOX 1

Education programme for Little Owl in Flanders.

Adults

General
- Informative booklet on Little Owls in Flanders.
- Leaflet with the principal points
- Press text
- Lecture and oral presentation with additional excursion and instruction of the inventory methodology
- Lecture or training for volunteers
- Working books/trainings for teachers
- Leaflets
- Slide show
- Tapes with Little Owl recordings
- Film
- Interactive Little Owl CD-ROM
- Research material e.g. census maps, old radio tags, examples of nest-boxes
- Habitat management working days for volunteers (see Bultot et al., 2001)

Specific target group of adults (e.g. farmers, landowners, communities, schools, conservationists etc.)
- Farmers
- Active promotion of subsidised management contracts among farmers
- Creation of a clear link with organic farming, and try to promote Little Owl as their label
- Publication of articles in agricultural magazines and magazine of other land-users
- Conservationists
- Offer scientific consultancy to volunteers
- Publication of this theme issue of Oriolus similar to Génot et al. (2001)
- Larger public
- Excursions for the general public

Children

Kindergarten
- Booklet with plenty of drawings, illustrations etc.
- Active Little Owl Game during which the kids can actively play Little Owl and grow empathy with the species.

Primary school (6-10 years)
- Booklet with educational text and drawings, illustrations etc.
- Active Little Owl Game

10-12 years
- Informative booklet
- Little Owl Game focused on nature study

FOUR DRIVERS

The five domains that characterise the Little Owl Conservation Strategy are merely themes that need to be addressed. The four actors that we propose to act on these domains need to help to implement the initiatives that were suggested per domain.

1. MONITORING EVOLUTION

In van 't Hoff (2001) interesting insights are drawn from the historical data of the landscape and Little Owl distributions in Groningen, The Netherlands. Unfortunately for Flanders we have few historical data available. Freezing a digital version of the Flemish landscape at regular intervals is extremely important because we can then monitor the evolution of our independent variables in addition to the evolution of the dependent variable or the Little Owl population in one way or another. In Van Nieuwenhuyse and Leysen (2001) some starting principles of a long-term monitoring are suggested. Objective selection of representative independent and dependent variables (which landscape elements are causing habitat heterogeneity and what needs to be measured in function of Little Owl are proposed) and representative samples (which habitat typologies need to be followed at regular intervals identified). This suggested methodology is a good starting point. A similar distinction of habitat typologies in Bergamo, Italy is presented by Mastrorilli (2001) in this volume.

2. STANDARDISING METHODS

The inventory methodology is still not standardised across Europe. Some groups use rather stringent conditions (only simultaneous "ghuk"-calls) to accept a calling Little Owl as a territorial bird (Bloem et al. 2001) while the Flemish method accepts all different calls of the owls (Verwaerde et al. 1999) and registers only Little Owl presence. Further attention needs to go to study the reliability and reproducibility of playback methods. A good starting point for further analysis and optimisation of the method is presented by Centili (2001). Design of experiment techniques should be applied

- Lectures for classes and youth groups

Adolescents (13-18 years)
- Informative booklet on Little Owls in Flanders.
- Nature study adapted to the age
- Assistance to youngsters to participate in nature study contests (e.g. Prize for Biology Jacques Kets, Zoo Antwerp and ECYS). Maarten Bekaert his work was selected best Flemish biology study for the 13th European Union Contest for Young Scientists (ECYS) for his study on Little Owls on which he reports in this volume.
  He also received the 'Prijs voor Biologie Jacques Kets', a prestigious award given by the 'Koninklijke Maatschappij voor Dierkunde van Antwerpen'.
- Promotion of science for high-school students
- Lectures

General

Video (similar to the video on the Burrowing Owl *Athene cunicularia*) and study guide for teachers (http://web.orst.edu/~rosenbda/owlvideo.htm).
- The Natural History of the Burrowing Owl, a 3 minute film on the biology of Burrowing Owls intended for use at visitor centres and similar educational facilities.
- Going Underground: The Natural History and Conservation of Burrowing Owls, a 17 minute film for ages 12-adult.

Popular Little Owl book in Dutch (as part of the VUBPRESS series of "Vogels rondom ons", [Birds around us] and written by "Nobelgische Prijs voor Wetenschapspopularisering 1998"- award winning Jenny De Laet).

Construction of a European state-of-the-art website (similar to the Audubon Society site featuring initiatives to promote bird conservation through education, activism and citizen science featuring information on pesticides, a quiz, a watch-list, a bird conservation contest for kids, ask an expert, bird conservation news and links to specific species sites).

Currently there are several Little Owl web sites:
www.noctua.en-action.org
www.diomedea.org
www.steenuilgroningen.nl
www.ageulen.de
www.owlpages.com/species/athene/noctua

in the future when placing nest-boxes in research areas similar to what Paul Marié did in Soignies (Bultot et al. 2001). Even with voluntary activities, experimental set-up of actions should be attempted. Standardised guidelines for installation of nest-boxes at regular intervals hence are needed. Further research is also needed to better use releases of birds from care-centres as experimental samples to further improve the guidelines for release. Standardisation is also needed for the measuring of demographic data through Europe. A first proposal is given in Bloem et al. (2001). In addition it should be stressed that there is a strong need for simplification of the data collection methodology. Simple but useful methods can help to narrow the gap between scientists and volunteers. Furthermore they allow us to let larger groups of interested people and non-professional birders to contribute in the conservation of the Little Owl. This can help to close the gap between birders and the larger public. Optimal exploitation and publication of existing volunteer-data should be undertaken despite some methodological shortcomings to valorise the efforts of volunteers. An international standardisation is also suggested for the analysis of individual habitat data (similar to Van Nieuwenhuyse and Leysen 2001).

3. STORING AND EXPLOITING DATA USING DATA WAREHOUSING TECHNIQUES

The importance of good data storage cannot be overestimated. Even within this project there were some methodological shortcomings on data modelling and storage. Future research and international co-ordination should therefore emphasise the use of modern IT-methodologies. To avoid bad experiences we believe that all future Little Owl projects should have a mandatory data collection, storage and exploitation steering committee. To abuse all information available throughout the complete range of Little Owl, more literature overviews like Génot (2001), Mastrorilli (Italy), and Shergalin (Former USSR) should be made and published on paper or via the Internet. Initiatives in this domain are due by the end of 2001 and an International Little Owl Data Warehouse is in the making. This should guarantee a complete overview of literature, data, conservation insights and an easy access and distribution of available knowledge.

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4. MEASURE STRATEGY

A Little Owl Conservation strategy as such needs to be monitored too. We propose the set-up of a Little Owl Balanced Scorecard (Kaplan and Norton 1996) that contains all different key performance indicators that are needed to obtain a holistic view on the realisation of the strategy. This scorecard should contain measuring instruments to follow the degree of availability of needed knowledge and the progress of planned actions. It should contain an indicator for every domain of the strategy and the evolution specifying deadlines, actions and objectives. For the lack of knowledge we might monitor the number of topics that became and will become available, the number of people working on them and follow the number realised versus needed. For breeding data we might keep track of the number of sites, the preferable researched area as such and follow the actual breeding biological data in graphs comparing different research areas. This instrument should also allow us to track the realisation of the European Conservation Plan for Little Owl of which Leigh (2001) presents a working structure for the near future.

ACTIONS FOR FLANDERS

We believe that we have a clear view on the current status of knowledge of the species in Flanders. Now we need to prioritise what needs to be known when and why. A limited amount of sampling points (different habitat qualities with cluster analy-

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sis) should now be identified and volunteers found to monitor the species into more detail. We should create and exploit new databases extensively containing bird and resource data:

- existing and new breeding data
- existing and new genetic data
- existing and new emigration data
- existing and new mortality data
- the different landscape elements
- food choice and prey availability
- rodenticide and pesticide use
- nest-box availability
- predator distribution and impact
- weather impact

SPECIFIC STUDY

We believe that Little Owl in Flanders forms an ideal experimental population to study the spatial and behavioural dynamics of existing and new experimental populations using telemetry. Some experimental nest-box populations should be set up giving an added value to released birds of bird-care centres. The impact of rodenticides, pesticides and heavy metals on Little Owls should be studied or at least data collection should take place for later analysis.

More needs to be known on Little Owl demography and the food of Little Owl in Flanders. Finally local differences of limiting factors should be studied.

PUBLIC AWARENESS

We should distribute the knowledge that we already have on the species to all volunteers and make them aware of standardisation and guide them. We should also distribute the knowledge to the wider public and approach it with adapted means and tools to get the message passed.

CONCRETE ACTIONS

- Prioritise all initiatives
- Determine feasibility of different initiatives and zoom in on those under own scope of control
- Determine concrete action points for a species conservation plan
- Measure implementation of the strategy
- Creation and extensive use of scientific steering committee
- Work professionally, using all core competences of the available volunteers e.g. educationalists, IT-people, people managers, marketeers, engineers, etc.
- Believe in the strategy
- Go for it!

SAMENVATTING

De Steenuil, Athene noctua, komt algemeen voor in Vlaanderen en is er niet bedreigd. Toch worden beschermingsmaatregelen voorgesteld, vooral wegens het grote belang van deze lokale West-Europese populatie op internationaal niveau én omdat toch bepaalde bedreigingen de kop opsteken (bijvoorbeeld verdwijnen van hoogstamboomgaarden, toename van gesubsidieerde maïsvelden).

Het beschermingsmodel dat uitvoerig wordt besproken, behelst vijf domeinen en vier stuwers.

De vijf domeinen omvatten kennis, waarbij een overzicht wordt gegeven over de bestaande en de benodigde kennis; beperkende factoren, zoals beschikbaarheid van prooien, verticale landschapsstructuren met holtes en beperkte predatie; landschap, waarbij het agroculturele landschap doorslaggevend is voor de Steenuil; het legislatieve kader, waarbij de wettelijke omkadering besproken wordt en mensen, waarbij de nadruk ligt op het informeren en voorlichten van bepaalde doelgroepen (bijvoorbeeld landbouwers) en van het grote publiek.

De vier stuwers die inwerken op de domeinen zijn het monitoren van de evolutie van het landschap, waarbij wordt voorgesteld om op regelmatige tijdstippen een digitale versie van het Vlaamse landschap te "bevriezen"; het standaardiseren van de methodes, o.a. van de playback methodes, de installatie van de nestkasten, het vrijlaten van vogels uit vogelopvangcentra en het meten van demografische gegevens in Europa; het bewaren en exploiteren van data gebruik makend van 'Data Warehousing' technieken en van een data collectie, bewaring en exploitatie en begeleid door een begeleidingscommissie; het meten van de strategie gebruik makend van een Steenuil "Balanced Scorecard" dat een volledig overzicht zou moeten geven van de realisatie van de strategie.

De actiepunten voor Vlaanderen omvatten het inzetten van vrijwilligers en de creatie en exploitatie van nieuwe gegevensbanken met betrekking tot broeddata, emigratie, mortaliteit, landschapselementen, voedselkeuze en beschikbaarheid, gebruik van rodenticiden en pesticiden, beschikbaarheid van nestkasten, verspreiding en impact van predatoren en weersinvloed. Verder zou de Steenuil een geschikte soort zijn voor studie gebruik makend van telemetrie. Als laatste, maar niet in het minste, moet de huidige kennis verspreid worden naar het grote publiek en naar alle vrijwilligers. Daarbij is het essentieel dat de vrijwilligers ingelicht worden over de standaardisatie en dat ze goed begeleid worden bij hun werk.

Samenvatting door Ingeborg De Leenheer

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5. THE FLEMISH LITTLE OWL PROJECT: DATA COLLECTION AND PROCESSING METHODOLOGY

HET VLAAMS STEENUILENPROJECT: METHODOLOGIE VAN GEGEVENSVERZAMELING EN VERWERKING

MARC LEYSEN*,
DRIES VAN NIEUWENHUYSE AND KOEN STEENHOUDT

ABSTRACT

An extensive census of Little Owl (Athene noctua) was performed in Flanders (Northern Belgium) using a standardised inventory method. About 400 volunteers recorded the position of Little Owls responding to playback of territorial calls. The playback locations were positioned according to the systematic UTM grid. In a time span of three years (1998 – 2000), over 3000 square kilometre grid cells (or about 1/5th of the total area) were surveyed. The obtained data on the occupation by Little Owl is confronted with a numeric characterisation of its living environment as obtained from a Geographic Information System (GIS). The landscape description was extracted from a collection of digital map data: the Biological Valuation Map (30 variables), the Landscape Openness Map (6 variables), the Farming Parcel Map (10 variables), the Soil Texture and Drainage Map (22 variables). In addition, the six ecological regions of Flanders are used for stratification purposes.

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INTRODUCTION

Despite its rarity in Western Europe, important populations of the Little Owl *Athene noctua* still occur in Flanders and Belgium (Génot et al. 1997). Earlier local studies (Van Nieuwenhuyse and Nollet 1990, 1991) raised the impression that Little Owl populations in Flanders were much more important than in the neighbouring countries. In order to consolidate this observation we wanted to quantify this as good as possible and analyse why this unique situation was found here. The strategy adopted, focused on obtaining a large-scale overview rather than to study the local situation in detail. The role of volunteers in this type of project is crucial and indispensable in order to obtain a population inventory on a regional scale.

OBJECTIVES

The objectives of the Flemish Little Owl Project are to study where Little Owl can be found and what the driving factors behind the occurrence of the species are. This will serve the creation of a distribution map in support of a sustainable long term monitoring scheme.

The objectives of this paper are to describe the independent and dependent variables that were used throughout the entire Flemish Little Owl Project analysis. The dependent variable, i.e. Little Owl presence, is the one we will try to explain in terms of the independent variables, which represent the physical living environment of the species. Establishing a model describing the relation between Little Owl population and the environment serves a double goal. In addition to revealing the owl's overall habitat preference, it also serves the population estimation. The data concerning the Little Owl presence was obtained through a dedicated field survey involving a multitude of volunteers. The environmental data was extracted from the readily available collection of digital reference maps of Flanders (www.vlm.be). An additional objective in this study was to assess the usefulness of the available data to explain the presence of the species.

STUDY AREA

The region of Flanders (50°41'-51°30' North – 2° 32'-5°54' East), the northern part of Belgium, is one of the most densely populated areas in Europe, counting nearly 6 million inhabitants on a total surface of 13.522 km^2 or on average 440 per km^2. Flanders is situated in the heart of the economical activity of the European Union: it encloses Brussels and is surrounded by industrial centres such as Randstad Holland, the Ruhr-area, and the Paris and London metropolis. With over 60.000 km of paved roads, Flanders has the densest network of roads and railroads in the Union.
According to the biogeographic division of Europe, Flanders is positioned in the Atlantic zone, characterised by a maritime climate with generally mild temperatures and a relatively high amount of precipitation (780 mm/year) equably spread over the year. In the context of nature conservation, the concept of ecological regions and ecological districts is used to describe the biogeography of the region (Antrop 1993). Ecological regions are natural geographic entities determined on the basis of very slowly varying abiotic factors such as geology, relief and water balance. Given the fairly homogeneous climatic conditions for the region, and its flat to undulating relief, the ecological regions mainly reflect the soil association sequence. When moving inland, the soil texture gradually becomes coarser, evolving from heavy clay soils in the western coastal polder area over loamy soils up to dry sands in the north-eastern Kempen.

The landscape developed to a large degree in harmony with the ecological potential of the area. The traditional landscapes are however further determined by their spatial association resulting from socio-economic activity. After World War II, many of the traditional landscapes were drastically modified through interventions such as land re-allotment schemes, urban and industrial expansion and the construction of residential and recreational quarters. Still over the past two decades, the built-up area increased from 10 to 15.5 % of the total area. The land use in Flanders is strongly fragmented. Industrial and habitation areas are scattered throughout the region; over 40% of the built-up zones are found outside the urban domain. Forests and nature reserves are generally small and isolated, and the quality as well as quantity of small landscape elements continually decreases (Kuyken 1999). Only two forests cover an area exceeding 800 ha while more than half of the forest area consists of entities smaller than 60 ha. Half of the nature reserves is smaller than 10 ha, one third is smaller than 3ha and only 6% larger than 100 ha. The dense linear transport infrastructure additionally results in a high degree of habitat fragmentation (Ministerie van de Vlaamse Gemeenschap 1998).

Since the start of the 20th century the agricultural activity underwent drastic changes; the proportion of the labour force active in agriculture diminished from 21.5 to 2.6 %. This evolution caused a general increase of the individual farm size as well as a high degree of scattering of their farmland. To remedy this counterproductive situation, a national land re-allotment programme was organised starting in the sixties. About 1/3 of the agricultural acreage was involved in this project. As a consequence of the grouping of neighbouring agricultural parcels by farming business, the landscape underwent another set of changes. Many parcels were physically joined to form larger entities. Linear landscape elements along the edges of the fields such as hedges and tree lines disappeared. In many cases over 70% of the linear landscape elements were lost in this process.
In recent years the Flemish authorities have undertaken several initiatives to consolidate the remaining valuable natural areas in the region, as well as to improve the situation where possible (Van Nieuwenhuyse, Leysen, De Leenheer et al. 2001). The region also participates in nature conservation initiatives in European context such as the Natura 2000 and EECONET networks.

RELATING LITTLE OWL TO ITS LIVING ENVIRONMENT

The Flemish Little Owl Project wants to obtain a method to be able to focus the attention of the volunteers and conservation in the future. It also aims at obtaining insight into the relation between the species and its living environment.

Describing occupied Little Owl habitats can easily be done using a Geographic Information System. Circles with a diameter of 300m can be drawn automatically around observation points and a numerical description of the landscape obtained. This information can be used to determine the variables that hold the highest heterogeneity and need to be followed in the future. Furthermore, it can be used to determine and quantify different habitat typologies (Van Nieuwenhuyse and Leysen 2001).

Establishing a model describing the relation between Little Owl population and the environment serves to reveal the owl's overall habitat preference and the creation of a distribution map for the whole region. We want to study to what extent the occurrence of the species is depending on the composition of the landscape. Therefore we call Little Owl presence the dependent variable. A statistical model can be seen as a formula that allows the calculation of the chance of finding a Little Owl using landscape (independent) variables. In order to make a model one needs to have information about the Little Owl and about its living environment. The information concerning the distribution of the thematic parameters over the census squares is extracted in terms of area, perimeter and number of parcels. Because of the approximate active range of 25ha of the species (Génot and Van Nieuwenhuyse, submitted) we work in squares of 500 by 500m.

Logistic regression allows determination of the formula that needs to be applied to calculate the chance of finding the species per square. It is crucial for this modelling to be successful, to obtain information of both occupied and unoccupied places. Extrapolation of the model can then be done for squares that were never visited but of which we have the independent variables. The extrapolations allow us to draw maps of the distribution of the species, which are useful as baseline for future monitoring (Van Nieuwenhuyse, Leysen and Steenhoudt 2001).

DEPENDENT VARIABLE

A standard method for the census of Little Owl is presented in Verwaerde et al. (1999). The method consists of a standardised playback protocol for the observation of the owls and a partially systematic sampling scheme for the location of the playback or broadcasting points.

The observation method exploits the response of Little Owls to conspecific territorial calls. A standard tape-recorded sequence is used, consisting of three 78 second call-tracks, separated by one minute of silence (Table 1). The track with different calls that was used, was taken from the CD 'Tous les Oiseaux de l'Europe', part 3, 'Coucous – Hypolaïs' – Jean Roché (Table 2). Playback stops as soon as a Little Owl responds. The observer waits 5 minutes after the last sequence. The position of the responding owl is indicated on a field map.

number of seconds	
78	call track
60	silence
78	call track
60	silence
78	call track
300	silence

Table 1. Standard tape-recorded sequence.
Tabel 1. Standaard sequentie van geluidsopname.

Seconds after start	Type of call
6	alarm
12	alarm
19	alarm
28	alarm
36	miauw
43	miauw
52	miauw
63	ghuk (song of male)
78	ghuk (song of male)

Table 2. Types of call on standard tape from CD 'Tous les Oiseaux de l'Europe', part 3, 'Coucous – Hypolaïs' – Jean Roché.
Tabel 2. Verschillende roepen van de Steenuil op standaard geluidsband van CD 'Tous les Oiseaux de l'Europe', part 3, 'Coucous – Hypolaïs' – Jean Roché.

Assumptions

We use this method for the compilation of the inventory under two basic assumptions. The species is considered to answer in a consistent way to territorial calls. Hence a single passage per year suffices and will yield representative results. We consider Little Owls faithful to their territories over the years and by consequence the use of consecutive observations over the three years is motivated.

Sources of uncontrolled variability

Standardisation of the playback volume is difficult to obtain due to differences in equipment quality and tuning. The positioning and orientation of the cassette player introduce further lack of homogeneity in the covering of the sample area. The landscape structure and eventual obstacles also intervene in this process. Unfavourable weather conditions such as heavy wind and rain have an impact on both the transmission range of the sound, the responsiveness of the owls and the audibility by the observer.

Further heterogeneity is induced by the different qualities of the observers. Different levels of field experience can yield differences in the detection of the animals, the determination of the exact answering locations and the type of answering call. It is therefore advised to do the fieldwork in teams of two observers. Although there is no grouping or interpreting of observations to be performed during the fieldwork, differences in reporting between observers is bound to occur. The moving of birds and the simultaneous calling of a breeding pair might also lead to different notations. The first reaction of responding birds is often short and non-persistent. Immediate stopping of the tape may lead to incomplete information.

Presence-absence versus densities

In the Flemish Little Owl Project we model Little Owl presence with logistic regression (Van Nieuwenhuyse, Leysen and Steenhoudt 2001) and not the local population density. The main reason for this choice is that presence-absence data is more robust in being less sensitive to sampling biases than measures of densities (Green 1979). In addition this allows us to bypass the impact of some of the uncontrollable variability.

Timing

The ideal surveying period is from mid February until mid April, which coincides with the period of courtship and territorial display. The pre-breeding population represents an ideal calibration point for monitoring. The best period of surveying is between sunset and midnight.

Sampling scheme

The selection of the sampling points is performed using a partially systematic scheme. The census unit covers 4 UTM km grid cells (2 by 2km) and can be chosen freely by the observer. Within this unit a systematic sampling scheme is mandatory. This assures the unbiased covering of both intuitively suitable and unsuitable habitats. In order to model

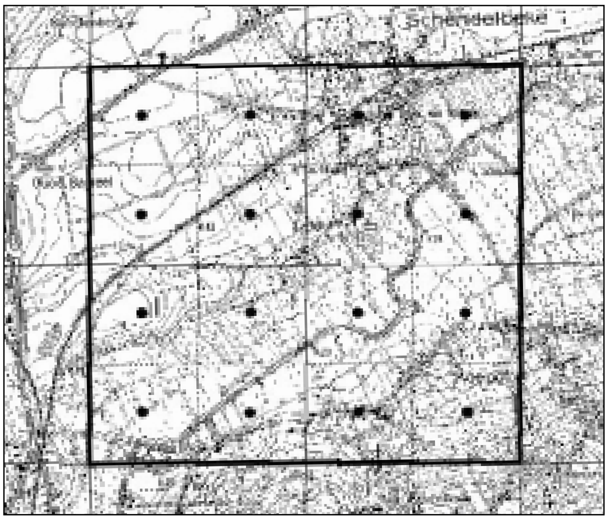


Figure 1. Census unit (2 by 2 km) divided in sixteen 500 by 500m quadrants, with an indication of the theoretical broadcasting points.
Figuur 1. Inventarisatie-eenheid (2 bij 2 km) onderverdeeld in zestien 500 bij 500m kwadranten met hun theoretisch afspeelpunt aangeduid.

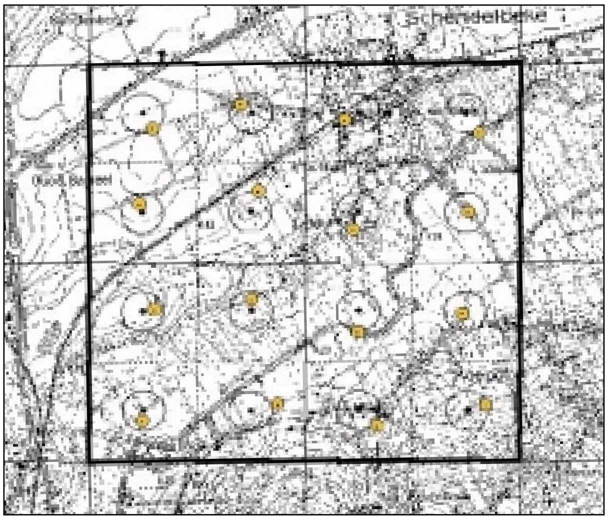


Figure 2. Census unit (2 by 2 km) divided in sixteen 500 by 500m quadrants, with an indication of the theoretical (black spots) and actual broadcasting points (yellow spots).
Figuur 2. Inventarisatie-eenheid (2 bij 2 km) onderverdeeld in zestien 500 bij 500m kwadranten met hun theoretische (zwarte punten) en werkelijke (gele punten) afspeelpunten aangeduid.

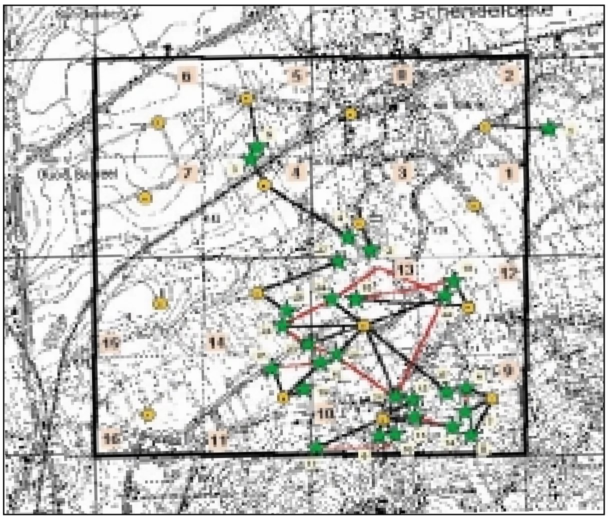


Figure 3. Census unit (2 by 2 km) divided in sixteen 500 by 500m quadrants, with an indication of the links between broadcasting locations and observations (black lines) and simultaneous observations (red lines).
Figuur 3. Inventarisatie-eenheid (2 bij 2 km) onderverdeeld in zestien 500 bij 500m kwadranten met aanduiding van de koppelingen tussen afspeelpunt en waarneming enerzijds (zwarte lijnen) en simultane waarnemingen anderzijds (rode lijnen).

habitat preference, observation of the absence of owls is as important as observation of presence. Each UTM km square is divided in 4 quadrants of 25ha (500 by 500m). The theoretical broadcasting points are situated in the centre of each of the 16 quadrants (Figure 1). The observer approaches these theoretical locations as close as possible in the field and marks them on the map (Figure 2). The observed Little Owls are marked in a standardised way including a link between the observation and broadcasting point as well as an indication of simultaneous observations (Figure 3).

INDEPENDENT VARIABLES

The independent variables are used to obtain a consistent insight into the driving forces behind the distribution of Little Owl. After a thorough quality analysis of all source data, the thematic legends of the different maps are combined to a level fit for statistical modelling and representing classes relevant for Little Owl living conditions.

Generalised data

Ecological complexes and degree of landscape openness are documented in Flanders in large scale maps representing generalised characteristics of the landscape or environment.

Ecological regions are natural geographic entities determined on the basis of very slowly varying abiotic factors such as geology, relief and water balance (Kuyken 1999). Ecological regions are further divided in ecological districts (Antrop 1993). These units are described by a set of ecological key factors, determining a unique combination of environmental characteristics. Within one ecological district, one distinctive vegetation type with the accompanying fauna is to be expected, given a relatively constant and stable land use. In addition it is assumed that ecological districts have a homogeneous sensitivity to environmental change factors such as acidification, excessive draining and manuring. The processes according to which these environmental problems develop, are bound to the components leading to the determination of the districts. The ecological regions were used to stratify the analysis of

Flemish Little Owl data

Total surface of Flanders: 14.582 UTM km squares, 58,328 UTM quadrants (25ha).

Total surface visited:
- 3020 UTM km squares with at least 1 visit (20,7% of Flanders)
- 2543 UTM km squares all 4 broadcasting stations (17,4% of Flanders)

Total number of (standardised) visits:
- 15386 in 3020 different UTM km squares
- 9512 visits in 1998
- 4132 visits in 1999
- 1742 visits in 2000

During the surveying period 1998-2000, a total of 10172 UTM quadrants have been visited at least once, using the standard surveying method yielding 8955 responding Little Owls in 3933 different occupied UTM quadrants. Overall probability of finding a Little Owl in a Flemish UTM quadrant: 39%.

For the statistical analysis, we used 8932 surveyed UTM quadrants with complete coverage by the Biological Valuation Map (5400 unoccupied and 3532 occupied quadrants). A quadrant was considered occupied when at least one year a Little Owl was observed.

Box 1. An overview of the Flemish Little Owl Project data.
Box 1. Overzicht van de gegevens bekomen tijdens het Vlaams Steenuilenproject.

random distribution of Little Owl habitat typologies (See Van Nieuwenhuyse and Leysen 2001). The ecological districts were used to quantify the occurrence of Little Owl in more detail (See Van Nieuwenhuyse, Leysen and Steenhoudt 2001).
The Landscape Openness Map represents the degree of visual and structural scale of the landscape in six classes (Table 3, Figure 4)

Code	Map	Description
open0	Landscape Openness Map	0 extremely open
open1	Landscape Openness Map	1 open
open2	Landscape Openness Map	2 medium open
open3	Landscape Openness Map	3 medium closed
open4	Landscape Openness Map	4 closed
open5	Landscape Openness Map	5 extremely closed

Table 3. Openness classes.
Tabel 3. Openheidsklassen.

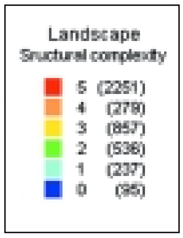
Detailed data

Thematic topics such as vegetation cover, agricultural land-use, soil texture and drainage are available in maps scaled at parcel level in Flanders.

Code	Map	Description
A	Biological Valuation Map	Lakes
b	Biological Valuation Map	Fields
c	Biological Valuation Map	Heather
d	Biological Valuation Map	Dunes
h	Biological Valuation Map	Grasslands
k	Biological Valuation Map	Other elements
kb	Biological Valuation Map	Tree lines
kh	Biological Valuation Map	Hedges and wooded banks
kj	Biological Valuation Map	High stem orchards
kp	Biological Valuation Map	Park
m	Biological Valuation Map	Swamps
f	Biological Valuation Map	Fagus forest
l	Biological Valuation Map	Poplar forests
n	Biological Valuation Map	Broad-leaved forest
p	Biological Valuation Map	Pine forest
q	Biological Valuation Map	Quercus forest
r	Biological Valuation Map	Ruderal forests
s	Biological Valuation Map	Thicket
u	Biological Valuation Map	Urban
un	Biological Valuation Map	Open with much green
ur	Biological Valuation Map	Rural
ud	Biological Valuation Map	Built-up areas
ua	Biological Valuation Map	Half open
ui	Biological Valuation Map	Industry
v	Biological Valuation Map	Valley
wat	Biological Valuation Map	River
weg	Biological Valuation Map	Roads
spoor	Biological Valuation Map	Railways

Table 4. Biological Valuation Map Vegetation Cover classes.
Tabel 4. Biologische Waarderingskaart vegetatieklassen.

The Biological Valuation Map is primarily used for its Vegetation Cover layer which is characterised by an extremely detailed thematic legend. The originally more than 200 thematic classes are combined into 30 relevant classes (Table 4, Figure 5).



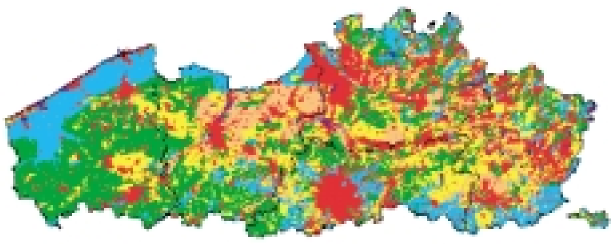


Figure 4. Overview of the openness map of Flanders.
Figuur 4. Overzicht van de openheidskaart van Vlaanderen.

The Farming Parcel Map depicts the results of the field level inventory of the land under agricultural practice. It provides extreme spatial detail and allows detailed determination of area, perimeter and number of parcels. Originally it contains numerous

Code	Map	Description
buildings	Farming Parcel Map	Area of farm buildings
rowcrops	Farming Parcel Map	Area of row crops
fruit	Farming Parcel Map	Area of orchards
grass	Farming Parcel Map	Area of grasslands
maize	Farming Parcel Map	Area of maize
braak	Farming Parcel Map	Area of fallow lands
other	Farming Parcel Map	Area of other parcels
cereals	Farming Parcel Map	Area of cereals
trees	Farming Parcel Map	Area of tree nurseries
pebuildings	Farming Parcel Map	Perimeter of farm buildings
perowcrops	Farming Parcel Map	Perimeter of row crops
pefruit	Farming Parcel Map	Perimeter of orchards
pegrass	Farming Parcel Map	Perimeter of grasslands
pemaize	Farming Parcel Map	Perimeter of maize
pebraak	Farming Parcel Map	Perimeter of fallow lands
peother	Farming Parcel Map	Perimeter of other parcels
pecereals	Farming Parcel Map	Perimeter of cereals
petrees	Farming Parcel Map	Perimeter of tree nurseries
nmbuildings	Farming Parcel Map	Number of farm buildings
nmrowcrops	Farming Parcel Map	Number of parcels of row crops
nmfruit	Farming Parcel Map	Number of parcels of orchards
nmgrass	Farming Parcel Map	Number of parcels of grasslands
nmmaize	Farming Parcel Map	Number of parcels of maize
nmbraak	Farming Parcel Map	Number of parcels of fallow lands
nmother	Farming Parcel Map	Number of parcels of other parcels
nmcereals	Farming Parcel Map	Number of parcels of cereals
nmtrees	Farming Parcel Map	Number of parcels of tree nurseries

Table 5. Farming Parcel Map classes and derived variables.
Tabel 5. Klassen van Landbouw-percelengebruikskaart en afgeleide veranderlijken.

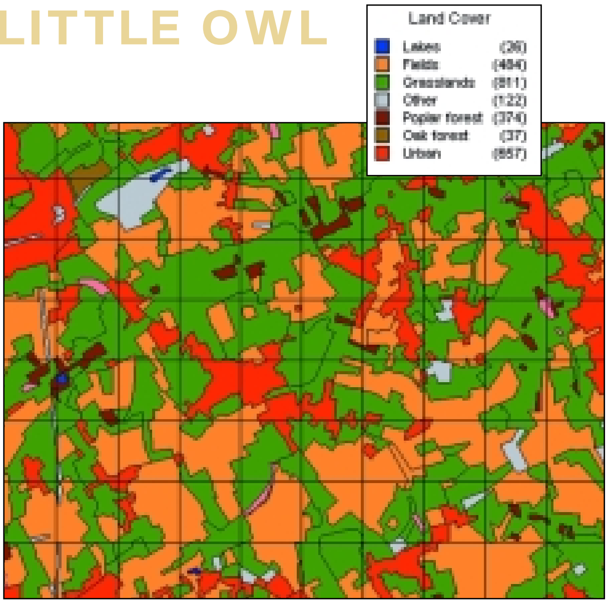
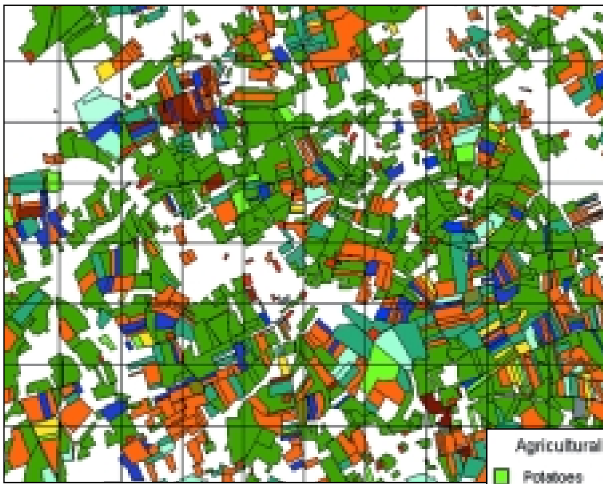


Figure 5. Extract from the Vegetation Cover layer of the Biological Valuation Map (after grouping of the thematic classes) with a 500m grid superimposed.
Figuur 5. Extract uit de Vegetatielaag van de Biologische Waarderingskaart (na groepering van de thematische klassen) met 500m rooster.



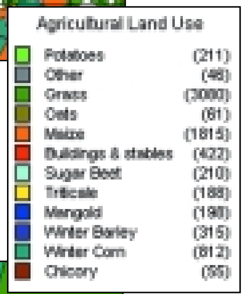


Figure 6. Extract from the Farming Parcel Map (original classes) with a 500m grid superimposed.
Figuur 6. Extract uit de Landbouw-percelengebruikskaart (originele klassen) met 500m rooster.

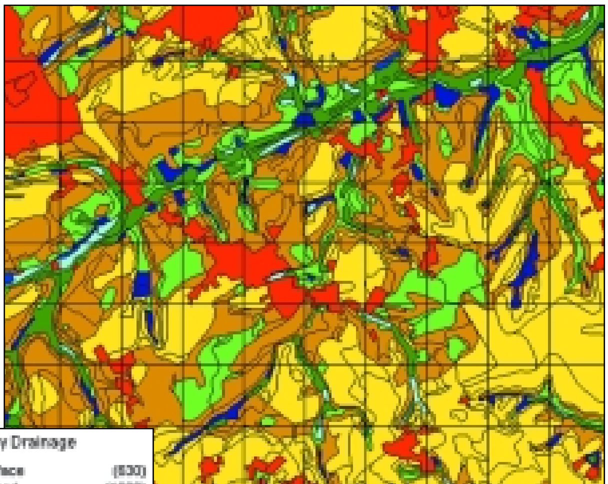


Figure 7. Extract from the Drainage layer of the Soil map with a 500m grid superimposed.
Figuur 7. Extract uit de Drainagelaag van de Bodemkaart met 500m rooster.

Figure 8. Examples of topological flaws of the Farming Parcel Map.
Figuur 8. Voorbeelden van topologische onvolkomenheden van de Landbouw-percelengebruikskaart.

agricultural land-use types (up to individual crop level) which we reduced to 9 classes (Table 5, Figure 6). The Soil Map is a highly consistent and detailed map representing an important element of the physical environment. Two thematic layers are considered relevant in terms of Little Owl ecology i.e. soil texture (particle size distribution) (Table 6) and soil drainage condition (water content behaviour) (Table 7, Figure 7).

Code	Map	Description
A	Soil Map - Texture	Loam
E	Soil Map - Texture	Light Clay or Clay
G	Soil Map - Texture	Stony Loam
L	Soil Map - Texture	Sandloam
P	Soil Map - Texture	Light Sandloam
S	Soil Map - Texture	Loamy Sand
U	Soil Map - Texture	Heavy Clay
Z	Soil Map - Texture	Sand
KU	Soil Map - Texture	Artificial Surface
PO	Soil Map - Texture	Polder

Table 6. Soil Map texture classes.
Tabel 6. Bodemkaart textuurklassen.

Photo by / *Fotograaf: Hans Hut ©*

Code	Map	Description
a	Soil Map - Drainage	Excessively drained
b	Soil Map - Drainage	Well drained
c	Soil Map - Drainage	Reasonably drained
d	Soil Map - Drainage	Insufficiently drained
e	Soil Map - Drainage	Badly drained
f	Soil Map - Drainage	Very badly drained
g	Soil Map - Drainage	Extremely badly drained
h	Soil Map - Drainage	Seepage

Table 7. Soil Map drainage classes.
Tabel 7. Bodemkaart drainage klassen.

Auxiliary data

Standard topographic maps at a scale of 1/10000 (Figure 1 to 3) are used as the field work base document and for positioning of the data on entry into the GIS system.

Quality considerations

A number of topological shortcomings of the vegetation maps (Figure 8) limit the accuracy of their application. Incomplete coverage of the mapped area, overlapping fields and gaps in between fields account for the appearance of false edges and erroneous area data. An additional consequence when combining different maps is that thematic and spatial coincidence may locally be problematic. The impact of these problems in the adopted approach (using 25ha grid cells as calculation unit) however proved to be within an acceptable range.

CONCLUSION

A true wealth of digital reference landscape data is available in Flanders. The most important thematic issues regarding Little Owl biotic and abiotic living conditions are readily available. A sound basis to undertake the effort of statistically modelling the relationship between Little Owl presence and its environment is therefore established.

On the other side of the comparison under study, the Little Owl presence in the region, a vast quantity of observations is made available with the help of a large number of volunteer collaborators. The Little Owl census is performed using a standardised protocol and the resulting inventory is spatially and qualitatively consistent and well spread over the project territory.

SAMENVATTING

SAMENVATTING

Een intensieve inventarisatie van de Steenuil (Athene noctua) werd uitgevoerd in Vlaanderen met behulp van een standaard methode. Ongeveer 400 vrijwilligers stelden de aanwezigheid van Steenuilen vast met behulp van een geluidsband met de roep van territoriale uilen. De afspeelpunten worden gekozen in functie van het systematisch UTM-rooster. Gedurende 3 jaar (1998 – 2000) werden meer dan 3000 vierkante kilometer (of ongeveer 1/5 van de totale oppervlakte) geïnventariseerd.

De bekomen gegevens over de aanwezigheid van Steenuilen wordt geconfronteerd met de numerieke beschrijving van de omgevingsfactoren zoals bekomen uit een Geografisch Informatie Systeem (GIS).

De beschrijvingen van het landschap zijn afkomstig van een verzameling digitale kaarten: de Biologische Waarderingskaart (30 veranderlijken), de openheidskaart (6 veranderlijken), de Landbouw-percelengebruikskaart (10 veranderlijken), de bodemtextuur- en bodemdrainagekaart (22 variables).

Daarnaast werden de ecologische regio's gebruikt voor het stratificeren van de gegevens.

Samenvatting door Dries Van Nieuwenhuyse

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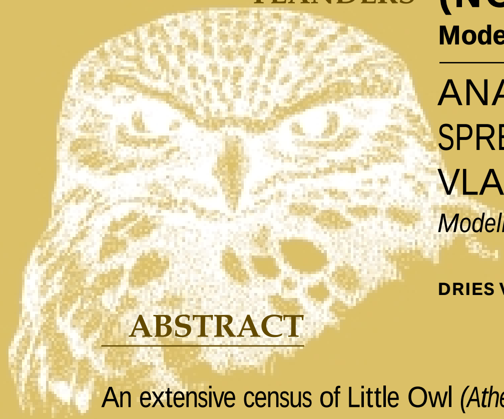

6. ANALYSIS AND SPATIAL PREDICTION OF LITTLE OWL *ATHENE NOCTUA* DISTRIBUTION IN RELATION TO ITS LIVING ENVIRONMENT IN FLANDERS (NORTHERN BELGIUM).

Modelling spatial distribution through logistic regression.

ANALYSE EN RUIMTELIJKE VOORSPELLING VAN DE VERSPREIDING VAN STEENUILEN *ATHENE NOCTUA* IN VLAANDEREN IN RELATIE TOT HUN LEEFOMGEVING.

Modelleren van ruimtelijke verspreiding met behulp van logistische regressie.

DRIES VAN NIEUWENHUYSE*, MARC LEYSEN AND KOEN STEENHOUDT

ABSTRACT

An extensive census of Little Owl *(Athene noctua)* was performed in Flanders (Northern Belgium) using a standardised inventory method. About 400 volunteers recorded the position of Little Owls responding to playback of territorial calls. The playback locations were positioned according to the systematic UTM grid. In a time span of three years (1998 – 2000), over 3000 square kilometre grid cells (or about 1/5th of the total area) were surveyed. The obtained data on the occupation by Little Owl is confronted with a numeric characterisation of its living environment. Establishing a model describing the relation between Little Owl population and the environment serves a double goal. In addition to revealing the owl's overall habitat preference, it also serves the population estimation. The model is computed using the data on the surveyed grid cells, and then applied to the remaining cells, thus producing a view on the situation for the complete region. The landscape description was extracted from a collection of digital map data: the Biological Valuation Map (30 variables), the Landscape Openness Map (6 variables), the Farming Parcel Map (10 variables), the Soil Map (11 variables) and the Drainage Map (11 variables). Stepwise logistic regression is used to extract from this set of independent variables those that have the stronger predictive power in terms of Little Owl presence. The sample set is split into 4 groups (four quadrants per square kilometre). Each group is used to calibrate a model while the other three groups serve the accuracy evaluation. In addition, the six ecological regions of Flanders are used for stratification purposes. We discuss the obtained models in terms of Little Owl ecology and present the resulting population estimation and distribution patterns with special attention to the accuracy of the models and estimates.

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INTRODUCTION

Currently available Belgian breeding bird atlases have been heterogeneous in their methodology and population estimates of common bird species. In 1972, Lippens and Wille reported for Belgium a total Little Owl population of 4000 pairs. The Atlas of Belgian Breeding Birds (Delmée 1988) reports up to 7300 pairs for the country between 1973 and 1977 and around 4300 in Flanders. Tucker and Heath (1994) report a national population of 4500-6600 between 1981 and 1990. Finally Vercauteren (1989) mentions around 2000 pairs in Flanders (approximately 40% of the Belgian territory) towards the end of the 80s. The different methods all work with partial data that are used to make estimates. Because the methods even yield different population estimates for the same time periods there is obviously a strong need for a standardised approach.

The aim of this paper is to present a baseline population estimate and distribution of Little Owl in Flanders and standardised, repeatable methods, using information on its living environment, allowing future population changes to be identified effectively. A baseline estimate is extremely important, providing a yardstick against which the effectiveness of current and future conservation measures can be assessed (Toms et al. 2000). This will be done using a statistical model describing the relation between Little Owls and their living environment (biotic and abiotic factors). Since the Little Owl uses distinct habitat types over the Flemish territory (Van Nieuwenhuyse and Leysen 2001) it may be necessary to create several submodels for the species' habitat (Christie et al. 1997). Therefore a scaled approach will be used, similar to Leftwich et al. (1997) by fitting a full model for Flanders and different stratified models per ecological region (De Blust et al. 1999).

Incorporating limited resource-based variables and more universal habitat component variables, was considered an attention point among owl biologists and managers during a workshop held at the 2nd International Owl Symposium in 1997 in Canada (Kearns 1997). Following this suggestion we test the usefulness of the different readily available digital data sets of Flanders for predicting Little Owl suitability of the landscape independently and combined. To allow for an objective screening of the available information we will use a stepwise approach despite some shortcomings of the method (Miles and Shevlin 2001). However, to compensate for the automatic variable selection we will control the obtained models rigorously for biological relevance. Beside automatic variable selection we want to test two specific hypotheses. We want to check if there is an optimal area of agricultural buildings for Little Owl since both a positive (Bretagnolle et al. 2001) and a negative (Van Nieuwenhuyse and Bekaert, submitted) impact of built-up areas have been described. We also test the impact of maize on the Little Owl because this culture has seen an explosive expansion across Flanders in the last decades.
We also wish to check the models for transferability across the ecological regions.

METHODS

The research area of Flanders and the different available digital sources (Biological Valuation Map (BVM, 30 variables), Openness Map (6 variables), Farming Parcel Map (FPM, 10 variables featuring number, perimeter and area of the parcels), Soil Map (11 variables), Drainage Map (11 variables)) are documented in Leysen et al. (2001) in this volume as is the Little Owl data set as obtained from the Flemish Little Owl Project. We used 8932 surveyed UTM-squares of 500 by 500m with complete coverage by the Biological Valuation Map into four groups, one per quadrant in a square kilometre. Figure 1 shows the distribution of the sampled 500 by 500m squares (5400 unoccupied and 3532 occupied squares).

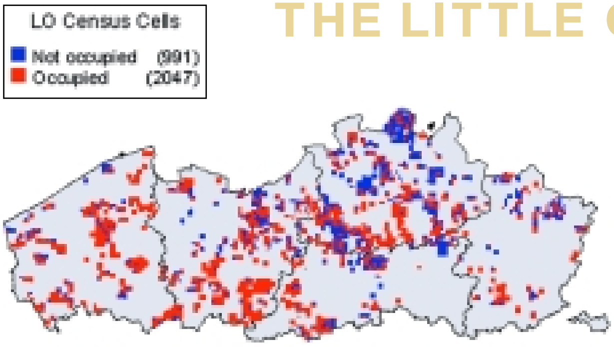

Figure 1. Distribution of sampled 500 by 500m squares during the Flemish Little Owl Project (1998-2000).
Figuur 1. Verspreiding van geïventariseerde 500 bij 500m hokken tijdens het Vlaams Steenuilenproject (1998-2000).

DATA ANALYSIS

We used SAS/STAT software version 8.0 (SAS Institute, Cary, NC, USA) for all statistical analysis. The habitat selection was modelled using logistic regression with PROC LOGISTIC (SAS Institute 1989). We used the stepwise option with a significance level of 0.05 to find parsimonious models that explain the most variance in the dependent variable containing the fewest number of independent variables (Miles and Shevlin 2001).

We used PROC FREQ (SAS Institute 1989) to construct classification tables to compare the predicted occupation in the squares with the observed occupation. We used a cut-point of 50% to split occupied (above or equal to 50%) from unoccupied squares (below 50%).

We used PROC CORR (SAS Institute 1989) to calculate the Spearman rank correlation coefficient between all available landscape elements for the whole Flemish territory.

To avoid biases due to using the same data to test the predictive accuracy of the models as to fit the model (SAS Institute 1995), we split our data into four groups (i.e. 11, 12, 21 and 22) using the four quadrants of the 500 by 500m per square kilometre UTM-grid cell. We therefore estimated each model four times and used each model per quadrant to predict the probability of occupation by Little Owl for the other quadrants. This gives us estimates for 75% (n=6656) of the known samples using 25% (n=2276) of the information each time which allows us to calculate the accuracy of each model (Table 1).

Observed Occupation	Predicted occupation		Total
	Unoccupied	Occupied	
Unoccupied	**3143**	874	4017
Occupied	1302	**1337**	2639
Total	4445	2211	**6656**
Accuracy =**(3143+1337)/6656**			0,67

Tabel 1. Analysis of the accuracy of a model using frequency tables of observed occupation versus predicted occupation (full model with all available variables for quadrant 11). The observed occupation is shown in the rows, the predicted occupation in the columns. There were 3143 unoccupied squares predicted correctly as unoccupied, 1337 occupied squares were predicted occupied, this makes 4480 squares predicted correctly in total which represents 67 percent of the sample set of 6730 squares.
Tabel 1. Analyse van de acuraatheid van een model gebruik makend van frequentietabellen van geobserveerde versus voorspelde bezetting (model met alle veranderlijken voor kwadrant 11). De geobserveerde bezetting wordt getoond in de rijen, de voorspelde in de kolommen. Er waren 3143 onbezette hokken voorspeld als onbezet, 1337 bezette hokken voorspeld als bezet, hetgeen neerkomt op 4480 correct voorspelde hokken of 67 percent van het staal van 6730 hokken.

Besides an automatic variable selection for the screening of the available data, we also tested two specific hypotheses i.e. that the area of agricultural buildings and of maize land-cover has a second-order effect on Little Owl probabilities. This would mean that small amounts would have a positive impact while large amounts have a negative impact. We calculated the square of agricultural built-up areas and maize from the Farming Parcel Map and fit a model using the built-up areas or maize and their square.

Population numbers were calculated using all grid cells of Flanders that have a full coverage of the Biological Valuation Map (n=48240) and belonging to the four main ecological regions of Flanders ("Dunes" and "Meuse"-region omitted). We used a cut-point of 50% to determine occupation.

		Sample				Predictive ability of model					Goodness of fit measure of model	Test if all estimates differ from 0		
Source	Quadrant	Occupied	Unoccupied	Observed Occupation ratio	Number of variables in Model	Concordant pairs	Discordant pairs	Ties	c	Accuracy of Model	Akaike Information Criterium (AIC)	Wald Chisq	DF	Pr>Chisq
Biological Valuation Map	11	893	1383	0.39	10	65.9	27.7	6.4	0.691	0.63	2800	187.11	10	<0.0001
Biological Valuation Map	12	860	1326	0.39	10	65	30.3	4.8	0.673	0.64	2705	171.77	10	<0.0001
Biological Valuation Map	21	928	1340	0.41	11	68.4	28.2	3.4	0.701	0.64	2752	227	11	<0.0001
Biological Valuation Map	22	851	1351	0.39	10	65.9	27.7	6.4	0.691	0.63	2687	189.11	10	<0.0001
Openness Map	11	893	1383	0.39	3	55	25.9	19	0.645	0.61	2863	153.54	3	<0.0001
Openness Map	12	860	1326	0.39	4	60.1	28.7	11.2	0.657	0.61	2758	154.92	4	<0.0001
Openness Map	21	928	1340	0.41	3	55.4	25.9	18.7	0.647	0.60	2905	136.72	3	<0.0001
Openness Map	22	851	1351	0.39	1	47.2	21.2	31.6	0.63	0.60	2800	155.8	1	<0.0001
Farming Parcel Map	11	893	1383	0.39	5	68.5	31.1	0.5	0.687	0.65	2826	205.78	5	<0.0001
Farming Parcel Map	12	860	1326	0.39	4	67.6	31.9	0.6	0.679	0.64	2743	178.35	4	<0.0001
Farming Parcel Map	21	928	1340	0.41	6	69.7	29.9	0.4	0.699	0.64	2822	227.58	6	<0.0001
Farming Parcel Map	22	851	1351	0.39	6	70.2	29.4	0.4	0.704	0.64	2694	219.27	6	<0.0001
Soil Map	11	893	1383	0.39	4	65.6	32.2	2.2	0.667	0.62	2851	170.49	4	<0.0001
Soil Map	12	860	1326	0.39	6	66.9	32.5	0.6	0.672	0.62	2735	165.9	6	<0.0001
Soil Map	21	928	1340	0.41	4	65.3	32.7	2	0.663	0.62	2873	169.13	4	<0.0001
Soil Map	22	851	1351	0.39	4	65.4	32.6	2	0.664	0.62	2750	162.04	4	<0.0001
Drainage Map	11	893	1383	0.39	5	62.1	36	1.9	0.63	0.61	2912	111.27	5	<0.0001
Drainage Map	12	860	1326	0.39	5	61.6	36.3	2.1	0.626	0.60	2808	99.34	5	<0.0001
Drainage Map	21	928	1340	0.41	4	62.1	35.4	2.5	0.634	0.60	2928	115.36	4	<0.0001
Drainage Map	22	851	1351	0.39	5	63	35.4	1.7	0.638	0.61	2804	114.86	5	<0.0001

Table 2. Multiple logistic regression model statistics of Little Owl presence in Flanders using the different biotic and abiotic individual data sets separately. All models were split in four, using the quadrants of square kilometres to calibrate the models. Accuracy was measured on the other quadrants. High c-values, high accuracy and low AIC-values represent better models (SAS Institute 1995).
Tabel 2. Meervoudig logistisch regressiemodel van de Steenuil in Vlaanderen met behulp van de verschillende biotische en abiotische gegevensbestanden apart. Alle gegevens werden in vier gesplitst, volgens de kwadranten per vierkante kilometer om de modellen te ijken. Accuraatheid werd gemeten voor de andere kwadranten. Hoge c-waarden, hoge accuraatheid en lage AIC-waarden duiden op betere modellen.

Transferability of the stratified models was tested with PROC FREQ (SAS Institute 1989) classifying per individual model the predictive accuracy of the cells in the other ecological regions (Leftwich et al. 1997).

RESULTS

When assessing models describing the relation between the Little Owl presence and the environment, one needs to focus on the quality of the estimated relationships and their predictive accuracy (Tables 2 and 3) and the biological relevance (Tables 4, 5 and 6). Application of the discovered relationships allows for a prediction of the population distribution (Table 7).

Assessment of the models: quality and predictive accuracy

All individual maps contain useful information to predict Little Owl presence and yielded significant models. The accuracy of the different models ranges between 60% and 65% for the individual sources (Table 2). When combining all sources together in the full model the accuracy of the different models range between 66% and 67% (Table 3). The stratification per ecological region only yields clear improvements of accuracy for the "Kempen" region ranging between 73% and 76% (Table 3). Despite the strong difference in number of significant variables for some data sets, the four models per set show a very similar accuracy and other statistics (Tables 2 and 3).

			Sample				Predictive ability of model					Goodness of fit measure of model	Test if all estimates differ from 0		
	Source	Quadrant	Occupied	Unoccupied	Observed Occupation ratio	Number of variables in Model	Concordant pairs	Discordant pairs	Ties	c	Accuracy of Model	Akaike Information Criterium (AIC)	Wald Chisq	DF	Pr>Chisq
	All maps	11	893	1383	0.39	13	73.1	26.7	0.3	0.732	0.67	2679	283.68	13	<0.0001
	All maps	12	860	1326	0.39	15	73.8	25.9	0.2	0.739	0.67	2561	286.24	15	<0.0001
	All maps	21	928	1340	0.41	17	74.8	25	0.2	0.749	0.67	2645	314.78	17	<0.0001
	All maps	22	851	1351	0.39	6	73.2	26.3	0.5	0.734	0.66	2581	269.6	6	<0.0001
All maps	Kempen	11	211	549	0.28	9	76	23.8	0.3	0.761	0.74	779	101.77	9	<0.0001
All maps	Kempen	12	203	499	0.29	7	76.6	23.1	0.2	0.768	0.76	722	104.18	7	<0.0001
All maps	Kempen	21	213	555	0.28	2	74	25.6	0.4	0.742	0.73	796	95.16	2	<0.0001
All maps	Kempen	22	199	581	0.26	3	75.9	23.8	0.3	0.761	0.74	765	103.29	3	<0.0001
All maps	Leemstreek	11	302	299	0.50	7	75.1	24.7	0.3	0.752	0.67	719	89.84	7	<0.0001
All maps	Leemstreek	12	290	294	0.50	8	74.5	24.4	0.2	0.755	0.65	693	88.45	9	<0.0001
All maps	Leemstreek	21	306	294	0.51	8	74.2	25.5	0.3	0.744	0.66	726	84.86	8	<0.0001
All maps	Leemstreek	22	278	289	0.49	7	79	20.8	0.2	0.791	0.65	647	100.62	7	<0.0001
All maps	Polders	11	48	66	0.42	1	68.2	31.3	0.6	0.685	0.60	147	10.6	1	0.0011
All maps	Polders	12	41	73	0.36	2	46	8.9	45.1	0.686	0.63	140	11.22	2	0.0037
All maps	Polders	21	46	66	0.41	3	75.4	24	0.6	0.757	0.62	130	16.6	3	0.0009
All maps	Polders	22	47	60	0.44	2	73.4	26.2	0.4	0.736	0.65	136	12.13	2	0.0023
All maps	Zand-Zandleemstreek	11	323	462	0.41	8	72	27.7	0.3	0.722	0.64	951	93.09	8	<0.0001
All maps	Zand-Zandleemstreek	12	318	448	0.42	7	73.3	26.4	0.2	0.735	0.63	928	94.26	7	<0.0001
All maps	Zand-Zandleemstreek	21	352	420	0.46	7	73.7	26	0.3	0.739	0.63	936	90.69	7	<0.0001
All maps	Zand-Zandleemstreek	22	317	414	0.43	6	70.9	28.8	0.3	0.711	0.64	899	75.92	6	<0.0001

Table 3. Multiple logistic regression model statistics of Little Owl presence in Flanders using all available biotic and abiotic variables in the full model. All models were split in four, using the quadrants of square kilometres to calibrate the models. Accuracy was measured on the other quadrants. High c-values, high accuracy and low AIC-values represent better models (SAS Institute 1995).

Tabel 3. Meervoudig logistisch regressiemodel van de Steenuil in Vlaanderen met behulp van alle beschikbare biotische en abiotische gegevensbestanden samen. Alle gegevens werden in vier gesplitst, volgens de kwadranten per vierkante kilometer om de modellen te ijken. Accuraatheid werd gemeten voor de andere kwadranten. Hoge c-waarden, hoge accuraatheid en lage AIC-waarden duiden op betere modellen.

Source	quadrant	Lakes	Other elements	Park	Swamps	Pine forest	Quercus forest	Open with much green	Rural	Built-up areas	Half open	Roads	River	High-stem orchards
Biological Valuation Map	11	-2.00E-05			-6.19E-06	-8.84E-06	-8.79E-06	-1.00E-05	-9.35E-06	-2.00E-05	-2.00E-05	-6.00E-05		1.60E-05
Biological Valuation Map	12			-2.00E-05	-1.00E-05	-1.00E-05	-8.65E-06	-8.60E-06	-9.88E-06	-2.00E-05	-2.00E-05	-5.00E-05		1.90E-05
Biological Valuation Map	21	-2.00E-05	-1.00E-05	-9.66E-06	-8.42E-06	-1.00E-05	-9.51E-06	-1.00E-05	-1.00E-05	-2.00E-05	-2.00E-05	-1.00E-04		
Biological Valuation Map	22	-2.00E-05		-1.00E-05		-1.00E-05	-1.00E-05	-9.69E-06	-1.00E-05		-1.00E-05	-1.00E-04	-3.00E-05	2.20E-05

	quadrant	Open0	Open1	Open4	Open5
Openness Map	11	-2.00E-05		-1.75E-06	-7.81E-06
Openness Map	12	-9.94E-06	-1.27E-06	-2.63E-06	-8.91E-06
Openness Map	21	-2.00E-05		-1.69E-06	-7.25E-06
Openness Map	22				-7.15E-06

Source	quadrant	Number of grassland parcels	Perimeter grass-land parcels	Area fruit parcels	Perimeter fruit parcels	Area rowcrop parcels	Number of rowcrop parcels	Perimeter rowcrop parcels	Number of cereal parcels	Perimeter maize parcels	Number of buildings	Area other land-cover	Perimeter other land-cover
Farming Parcel Map	11	4.65E-02	2.38E-04		2.19E-04	**7.165E-6**			7.48E-02				
Farming Parcel Map	12		3.05E-04				**6.68E-02**		7.74E-02			2.80E-05	
Farming Parcel Map	21		3.13E-04	1.10E-05			**6.10E-02**		7.81E-02	1.16E-04	9.33E-02		
Farming Parcel Map	22	6.09E-02	2.52E-04		3.07E-04			**1.42E-04**	7.25E-02				1.11E-03

Source	quadrant	Loam	Sand	Artificial	Other	Sandyclay	Loam Sand
Soil Map	11	2.134E-6	-4.79E-06	-1.00E-05	-9.27E-06		
Soil Map	12	4.165E-6	-2.68E-06	-6.66E-06	-2.00E-05	2.776E-6	2.475E-6
Soil Map	21	2.015E-6	-4.64E-06	-1.00E-05	-1.00E-05		
Soil Map	22	2.236E-6	-4.79E-06	-1.00E-05	-1.00E-05		

Source	quadrant	Excessive drainage	Bad drainage	Seepage	Artificial drainage	Other drainage	Polder
Drainage Map	11	-2.00E-05	-3.01E-06	3.654E-6	-1.00E-05	-8.93E-06	
Drainage Map	12	-2.00E-05	-4.49E-06		-8.74E-06	-1.00E-05	-1.97E-06
Drainage Map	21	-2.00E-05	-4.00E-06		-1.00E-05	-1.00E-05	
Drainage Map	22	-2.00E-05	-5.09E-06	3.947E-6	-1.00E-05	-1.00E-05	

Table 4. Multiple logistic regression coefficients of Little Owl presence in Flanders using the different biotic and abiotic individual data sets sparately. Positive signs (green cells) mean a positive impact of the variable on the probability of occupation of squares by Little Owl. Negative signs (red cells) mean negative impact. Small coefficients do not necessarily mean a small impact since each coefficient has to be interpreted in the scale of the original variable. Three interchangeable variables i.e. perimeter, area and number of row crop parcels, are marked in bold.
Tabel 4. Meervoudig logistisch regressiemodel van de Steenuil in Vlaanderen met behulp van de verschillende beschikbare biotische en abiotische gegevensbestanden apart. Positieve tekens (groene cellen) duiden op een positieve invloed van de veranderlijke op de waarschijnlijkheid om een Steenuil aan te treffen in het hok. Negatieve tekens (rode cellen) duiden op een negatieve invloed. Kleine waarden betekenen niet automatisch een kleine impact aangezien deze coëfficiënten moeten geïnterpreteerd worden in de schaal van de originele veranderlijke. Drie onderling uitwisselbare veranderlijken: perimeter, oppervlakte en aantal percelen staan in het vet.

Photo by / *Fotograaf: Ronald van Harxen ©*

Most sets of four models show the same variables with minor differences in the actual coefficients e.g. Soil and Drainage Map (Table 4). Since a stepwise approach was used to fit the four models per data set, the significant variables can be slightly different per quadrant for some data sets e.g. Farming Parcel Map. Some variables are similar and emerge in some of the four models and are replaced in other models e.g. area of row crops is significant in quadrant 11, number of row crop parcels in quadrant 12 and 21 and finally the perimeter of row crop parcels in quadrant 22. This is due to the fact that the variance in function of Little Owl presence is similar for the three variables but more significant in the respective models.
A check for multicollinearity (independent variables that correlate) was performed (data not shown) and yielded correlation between the BVM grassland variable and some FPM grassland related variables (perimeter, number of parcels). The final models that were used for the predictions of the distribution and the population numbers did not have the known correlating variables included together.

Description of the habitat selection models for Flanders: individual data sets

In addition to a good statistical quality, the habitat suitability models are also biologically meaningful in terms of Little Owl habitat preference.

The Biological Valuation Map for Flanders shows a negative impact on Little Owl presence for forests (Pine forest and Quercus forest), built-up areas (Open urban with much green, rural, built-up areas, half open urban areas, roads) and for other elements (lakes, parks, swamps) (Table 4). The species is positively associated with high-stem orchards.
The Openness Map allows prediction of Little Owl presence by a negative impact of extremely open landscapes (openness 0 = extremely open and 1 = open) and extremely closed landscapes (openness 4 = closed and 5 = extremely closed).
The Farming Parcel Map can be used to model the presence of the species via the presence of grassland, fruit trees, row crop parcels and cereal parcels.

Little Owls in Flanders are positively related to loam soil, while avoiding sand soil, artificial and other soils. The negative impact of artificial and other soils appears to be more related to urbanisation than to the influence of the real soils.

The Drainage Map shows a negative impact of artificial and other drainage classes which we think to be related to urbanisation too as for the soils. The negative relation with the natural drainage classes "excessive" and "bad" drainage might reflect the impact of moisture conditions for earthworms.

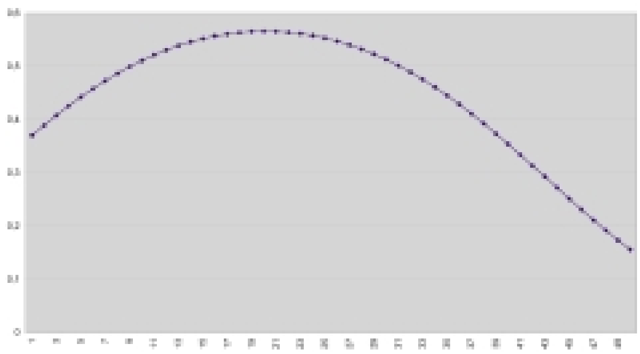

Figure 2. Second order effect of agricultural built-up areas on the probability of Little Owl presence in Flanders. Increasing areas have a positive impact on Little Owl up to an optimal coverage of 21a. Beyond this area the probabilities decrease again.
Figuur 2. Tweede orde effect van bebouwde zones voor landbouwgebruik op de waarschijnlijkheid op het aantreffen van een Steenuil in Vlaanderen. Toenemende oppervlakte heeft een positieve invloed op de aanwezigheid van de soort tot 21a. Verdere toename doet de waarschijnlijkheid terug dalen.

Source	quadrant	Open 2	Open 3	Open 5	Fields BVM	Grasslands BVN	Other elements BVM	Tree lines	High stem orchards	Area of maize	Number of parcels of buildings	Number of parcels of grasslands	Pine forest	Perimeter of buildings
All maps	11			-2.70E-06					1.30E-05					3.42E-04
All maps	12	1.43E-6	2.834E-6		7.171E-6	8.021E-6	1.30E-05		2.00E-05	-3.67E-06		5.66E-02		
All maps	21		1.307E-6		-9.77E-06			-4.00E-05			1.34E-01		-4.88E-06	
All maps	22			-3.66E-06								1.15E-01		

Source	quadrant	Perimeter of grasslands	Perimeter of maize	Half open	Built-up	Industry	Open with much green	Rural	Roads	Loam	Sand	Sandy Clay	Loam Sand	Other soil
All maps	11	1.91E-04		-1.00E-05	-9.55E-06		-4.72E-06		-6.00E-05	2.131E-6	-4.43E-06			
All maps	12					5.118E-6			-3.00E-05	4.241E-6		3.079E-6	3.299E-6	-9.06E-06
All maps	21	2.06E-04	9.40E-05	-1.00E-05	-1.00E-05		-6.29E-06	-9.47E-06	-1.00E-04	3.254E-6	-4.23E-06	1.594E-6		
All maps	22								-9.00E-05	3.2E-6	-3.97E-06			

Source	quadrant	Artificial drainage	Fairly drained	Badly drained	Insufficiently drained	Other drainage
All maps	11	-3.98E-06	2.393E-6			-4.55E-06
All maps	12			-2.59E-06		
All maps	21		3.897E-6		2.258E-6	
All maps	22					-7.27E-06

Table 5. Multiple logistic regression coefficients of Little Owl presence in Flanders using all available biotic and abiotic variables in the full model. Positive signs (green cells) mean a positive impact of the variable on the probability of occupation of squares by Little Owl. Negative signs (red cells) mean negative impact. Small values do not necessarily mean a small impact since each coefficient has to be interpreted in the scale of the original variable.

Tabel 5. Meervoudig logistisch regressiemodel van de Steenuil in Vlaanderen met behulp van alle beschikbare biotische en abiotische gegevensbestanden samen. Positieve tekens (groene cellen) duiden op een positieve invloed van de veranderlijke op de waarschijnlijkheid om een Steenuil aan te treffen in het hok. Negatieve tekens (rode cellen) duiden op een negatieve invloed. Kleine waarden betekenen niet automatisch een kleine impact aangezien deze coëfficiënten moeten geïnterpreteerd worden in de schaal van de originele veranderlijke.

Description of the habitat selection models for Flanders: full models

The combination of all maps into one data set (full model) (Table 5) confirms the association of the species with intermediate open landscapes (openness 2 = medium open and 3 = medium closed positive impact, openness 5 = extremely closed negative impact). Built-up and related areas (built-up, half open, open urban with much green, rural, roads, other drainage) all show a negative influence on Little Owl presence. High-stem orchards and grasslands have a positive influence on Little Owl presence. The same positive impact of loam soils and negative impact of sand soils is found in the full models.

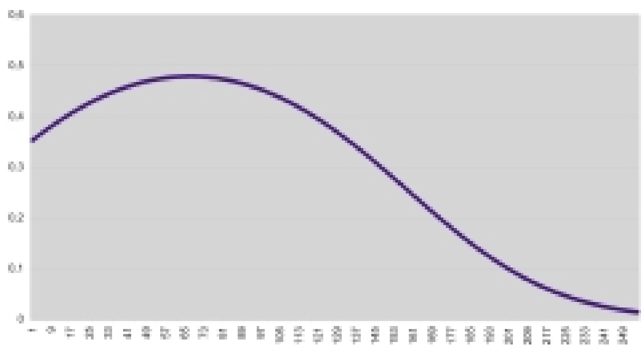

Figure 3. Second order effect of maize areas on the probability of Little Owl presence in Flanders. Increasing areas have a positive impact on Little Owl up to an optimal coverage of 65a. Beyond this area the probabilities decrease again.

Figuur 3. Tweede order effect van maïs op de waarschijnlijkheid op het aantreffen van een Steenuil in Vlaanderen. Toenemende oppervlakte heeft een positieve invloed op de aanwezigheid van de soort tot 65a. Verdere toename doet de waarschijnlijkheid terug dalen.

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Agricultural built-up areas are not retained in any stepwise regression model. A second order model however shows a positive impact of increasing built-up areas up to 21a, followed by a decline in probability (Figure 2). The same holds for maize areas for an optimum around 65a (Figure 3).

Description of the habitat selection models for Flanders: full models per ecological region

The stratified models per ecological region have the following characteristics (Table 6). Little Owl presence in the "Kempen" region is depending mainly on the absence of sand soils, the presence of intermediate openness (openness 1 = open negative, openness 3 = medium closed positive impact) of the landscape, the presence of grasslands and fields and fairly drained.

The species in the "Leemstreek" ecological region is associated with the presence of intermediate openness (openness 2 = medium open and 5 = extremely closed negative, openness 3 = medium closed positive impact) of the landscape. A negative impact of human concentrations (open urban with much green and roads) and swamps is observed and a positive impact of grasslands. Loam soils are indiscriminate in this ecological region since most of this region are characterised by this soil type ("Leem" = loam), the loamy sand soils in this region on the other hand do show a negative impact on Little Owl presence.

In the "Polders" ecological region the species shows a positive association with "Other elements" of the Biological Valuation Map and the perimeter of grasslands.

The species shows a negative relationship with larger human settlements in the "Zand-Zandleemstreek" ecological region (open urban with much green, artificial drainage and roads) while agricultural and hence smaller built-up areas have a positive impact which confirms the second order effect of human settlements. The perimeters of grassland parcels have a positive impact.

Population estimates

The estimates of occupied 500 by 500m grid squares

All maps

Ecoregion	Quadrant	Open 1	Open 3	Fields BVM	Grasslands BVM	Tree lines	Pine forest	Industry	Number of rowcrop parcels	Sand	Sandy Clay	Light Sandy Clay	Loam Sand	Other soil	Fairly drained
Kempen	11	-5.49E-06		1.20E-05	1.30E-05	1.31E-04	8.35E-6	1.40E-05	1.50E-01	-3.72E-06				-6.77E-6	
Kempen	12		2.597E-6	5.196E-6	7.238E-6						1.00E-05	4.327E-6	6.179E-6		3.626E-6
Kempen	21				9.451E-6					-5.63E-06					
Kempen	22				9.795E-6					-5.58E-06					6.511E-6

All maps

Ecoregion	quadrant	Open2	Open3	Open5	Fields BVM	Grasslands BVM	High-stem orchards	Park	Swamp	Open with much green	Quercus forest	Roads	Perimeter of grassland parcels	Number of built-up parcels	Area of row crops
Leemstreek	11	-2.97E-06		-5.66E-06					-2.00E-05		-2.00E-05	-8.00E-05	4.31E-04		
Leemstreek	12			-6.01E-06		5.311E-6	2.40E-05	-5.00E-05	-2.00E-05	-5.68E-06			1.65E-04		
Leemstreek	21				6.508E-6	1.00E-05						-1.10E-04	2.12E-04	2.11E-01	-8.71E-6
Leemstreek	22		3.083E-6						-1.00E-05	-7.55E-06		-1.10E-04			

All maps

Ecoregion	quadrant	Seepage	Number of grassland parcels	Loam	Light Clay	Loam Sand
Leemstreek	11					-1.00E-05
Leemstreek	12					-1.00E-05
Leemstreek	21	-1.00E-05				-2.00E-05
Leemstreek	22		2.05E-01	3.359E-6	1.30E-05	

All maps

Ecoregion	quadrant	Open2	Other elements BVM	Industry	Perimeter of grassland parcels	Number of Maize parcels
Polders	11				3.04E-04	
Polders	12	6.226E-6	1.05E-04			
Polders	21		7.70E-05	6.60E-05		3.00E-01
Polders	22		7.80E-05		3.47E-04	

All maps

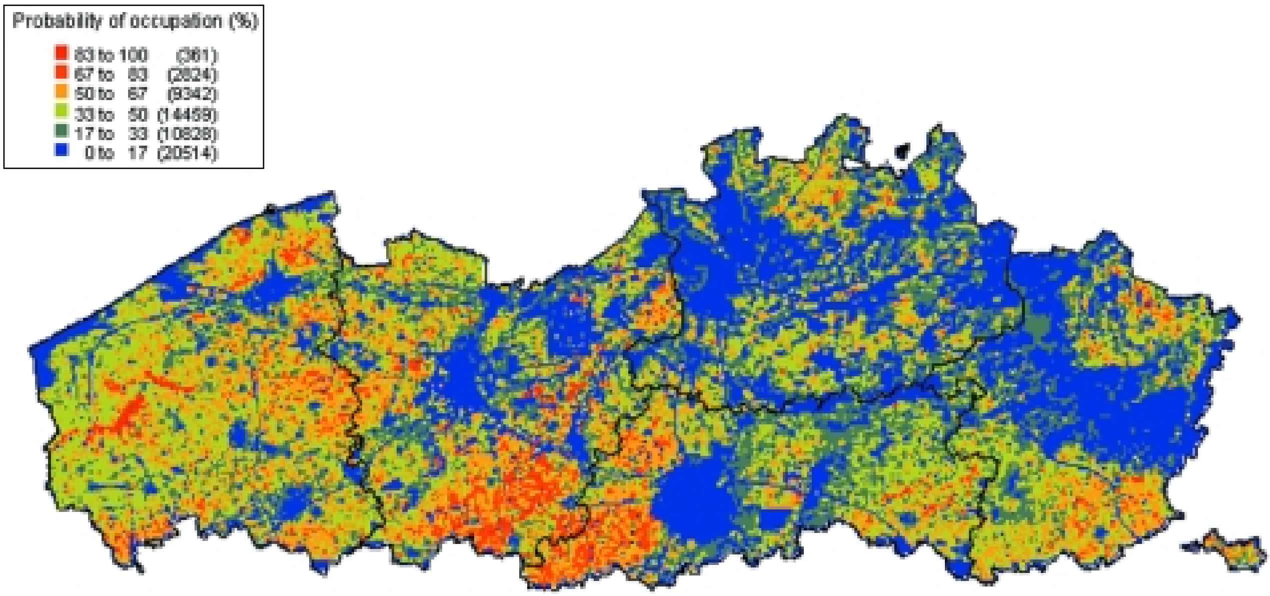
Ecoregion	quadrant	Open1	Open4	Open5	Open with much green	Other elements BVM	Number of built-up parcels	Number of grassland parcels	Perimeter of grassland parcels	Area built-up Number of row crop parcels	Perimeter built-up parcels	Heavy Clay	Sandy Clay	Light Sandy	Clay
Zand-Zandleemstreek	11		-2.19E-06		-9.11E-06			7.61E-02		3.90E-05			-2.00E-05		
Zand-Zandleemstreek	12		-3.80E-06	-5.34E-06					2.46E-04		5.50E-02				-2.73E-06
Zand-Zandleemstreek	21				-6.08E-06	-3.00E-05			2.61E-04		3.65E-02				
Zand-Zandleemstreek	22	-5.73E-06					1.41E-01		2.55E-04					2.527E-6	

All maps

Ecoregion	quadrant	Sand	Other soil	Artificial drainage	Fairly drained	Excessive drainage	Roads
Zand-Zandleemstreek	11	-4.84E-06		-9.28E-06	3.966E-6		
Zand-Zandleemstreek	12		-2.00E-05				-1.10E-04
Zand-Zandleemstreek	21			-1.00E-05		-3.00E-05	-1.10E-04
Zand-Zandleemstreek	22			-1.00E-05			-1.80E-04

Table 6. Multiple logistic regression coefficients of Little Owl presence in Flanders using all available biotic and abiotic variables and stratified by ecological region. Red cells indicate a negative impact, green cells a positieve impact.

Tabel 6. Coëfficiënten van het meervoudig logistisch regressiemodel van de Steenuil in Vlaanderen met behulp van alle beschikbare biotische en abiotische gegevensbestanden samen en opgedeeld volgens ecoregio. Positieve waarden (groene cellen) duiden op een positieve invloed van de veranderlijke op de waarschijnlijkheid om een Steenuil aan te treffen in het hok. Negatieve waarden (rode cellen) duiden op een negatieve invloed.



in Flanders (Table 7) range between 12527 (Figure 4) and 16046 occupied grid cells (probability of Little Owl presence >= 50%) for the models without regional stratification. When summing all the minimum and maximum estimates per ecological region respectively we obtain a range of 13646 to 17361 occupied cells. The percentage distribution of the Little Owl population among the different regions is calculated for the maximum and the minimum estimates and does not differ considerably (Table 7). Both estimates indicate two main regions in absolute numbers i.e. 40% of the Flemish Little Owl population situated in the "Leemstreek" ecological region and 46% in the "Zand-Zandleemstreek" region while the "Kempen" and "Polders" regions only have limited absolute numbers. Table 8 gives an overview of the detailed distribution of the predicted Little Owl occupations per ecological district (Figure 5). The highest average probabilities, calculated for each district, are observed principally in the "Leemstreek".

Transferability of the models across ecological regions

The four regional models that yielded the smallest total population estimate were used to test the transferability (Table 9). Highest scores are expected on the diagonal since these values illustrate the accuracy of the estimates of the model as calibrat-

Figure 4. Prediction of Little Owl probabilities of occupation of 500 by 500m grid cells as obtained from the full model, quadrant 22 and yielding a total of 12527 cells with a probability of observing Little Owls equal or over 50%.
Figuur 4. Voorspelling van de waarschijnlijkheden om Steenuilen aan te treffen in 500 bij 500m hokken op basis van het model met alle beschikbare veranderlijken, kwadrant 22 en resulterend in een totale schatting van 12527 hokken met een waarschijnlijkheid van >=50%.

Figure 5. Ecological districts of Flanders (after De Blust and Bauwens 1999).
Figuur 5. Ecologische districten van Vlaanderen (naar De Blust en Bauwens 1999).

	Source	Quadrant	Squares with Prob< 50%	Squares with Prob>= 50%	Squares with BVM < 25ha	Predicted Occupation ratio	% of Flemish minimum estimates	% of Flemish maximum estimates	% of Flemish samples
	All maps	11	33428	15335	9565	0.31			
	All maps	12	33203	15560	9565	0.32			
	All maps	21	32717	16046	9565	0.33			
	All maps	22	36177	**12527**	9565	0.26			
All maps	Kempen	11	13297	1666	1798	0.11		10	34
	Kempen	12	13380	1583	1798	0.11			31
	Kempen	21	13547	1416	1798	0.09			34
	Kempen	**22**	**13862**	**1101**	**1798**	**0.07**	**8**		**35**
All maps	Leemstreek	11	6496	6681	2117	0.51		38	27
	Leemstreek	12	7026	6151	2117	0.47			26
	Leemstreek	21	7397	5780	2117	0.44			27
	Leemstreek	**22**	**7665**	**5512**	**2117**	**0.42**	**40**		**25**
All maps	**Polders**	**11**	**3460**	**714**	**299**	**0.17**	**5**		**5**
	Polders	12	3419	755	299	0.18			5
	Polders	21	3058	1116	299	0.27			5
	Polders	22	2941	1233	299	0.30		7	5
All maps	**Zand-Zandleemstreek**	**11**	**9607**	**6319**	**1810**	**0.40**	**46**		**35**
	Zand-Zandleemstreek	12	9561	6365	1810	0.40			34
	Zand-Zandleemstreek	21	8145	7781	1810	0.49		45	34
	Zand-Zandleemstreek	22	9447	6479	1810	0.41			32
All maps	Flanders sum of ecoregions	max	30879	17361		0.36			
	Flanders sum of ecoregions	**min**	**34594**	**13646**		**0.28**			

Table 7. Population estimates of Little Owls in Flanders using presence of 500 by 500m grid cells with a predicted probability >=50% for different models using all available variables.
Tabel 7. Aantalschattingen van Steenuilen in Vlaanderen op basis van de voorspelde waarschijnlijkheid van aanwezigheid van >=50% voor verschillende modellen op basis van alle beschikbare veranderlijken samen.

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Ecological region	Ecodistrict	Number of grid cells per ecological district	Cumulative % of area	Average probability	Predicted cells occupied	% of Flemish population	Cumulative % of estimates
Leemstreek	Land van Oudenaarde-Zottegem	1599	3.31	**57.05**	**1094**	8.73	8.73
Leemstreek	West-Vlaams Heuvelland	275	3.88	**55.45**	201	1.60	10.34
Leemstreek	Pajottenland	1807	7.63	**54.89**	**1231**	9.82	20.16
Leemstreek	Vlaamse Ardennen	457	8.58	**54.79**	300	2.39	22.56
Leemstreek	Krijtland van Millen	423	9.45	**52.46**	251	2.00	24.56
Leemstreek	Voerstreek	137	9.74	**52.00**	79	0.63	25.19
Leemstreek	Land van Asse	519	10.81	49.24	312	2.49	27.68
Leemstreek	Leemplateau	1124	13.14	47.78	**478**	3.81	31.50
Leemstreek	Land van Hoegaarden	301	13.77	47.20	129	1.02	32.53
Polders	Oudland- en Middellandpolders	240	14.27	46.42	97	0.77	33.30
Polders	Zeepolders	2529	19.51	46.24	**895**	7.14	40.45
Zand- en Zandleemstreek	Centraal zandlemig Binnen-Vl.	2701	25.11	45.97	**1134**	9.05	49.50
Leemstreek	Leie-Schelde interfluvium van Anzegem	1088	27.36	45.43	**440**	3.51	53.01
Leemstreek	Vochtig Haspengouw van de Getevallei	389	28.17	43.58	129	1.02	54.04
Zand- en Zandleemstreek	Questa van Oedelem	212	28.61	43.29	81	0.64	54.69
Zand- en Zandleemstreek	Zandlemig Klein-Brabant	697	30.05	43.25	239	1.90	56.60
Zand- en Zandleemstreek	Westhoek	1938	34.07	43.21	**461**	3.68	60.28
Leemstreek	Zuidelijk Hagenland	778	35.68	41.28	179	1.42	61.71
Zand- en Zandleemstreek	Houtland	2810	41.51	39.67	**909**	7.25	68.96
Leemstreek	Haspengouw van St.-Truiden-Bilzen	1370	44.35	39.30	336	2.68	71.65
Zand- en Zandleemstreek	Land van Wetteren-Dendermonde	630	45.66	39.03	203	1.62	73.27
Zand- en Zandleemsrteek	Leiedal van Kortrijk-Deinze	882	47.48	36.90	245	1.95	75.22
Zand- en Zandleemstreek	Land van Waas	802	49.15	36.78	249	1.98	77.21
Kempen	Vlakte van Bocholt en Midden-terras van de	938	51.09	35.58	227	1.81	79.02
Zand- en Zandleemstreek	Beneden-Schelde	496	52.12	34.92	102	0.81	79.84
Zand- en Zandleemstreek	Vlaamse Vallei	3864	60.13	34.02	**796**	6.35	86.19
Zand- en Zandleemstreek	Rupelstreek en zandig Klein-Brabant	1000	62.20	31.60	137	1.09	87.28
Leemstreek	Beneden Dijlevallei	705	63.66	31.10	70	0.55	87.84
Leemstreek	Noordelijk Hagenland	1042	65.82	30.31	33	0.26	88.11
Leemstreek	Brabants Heuvelland	1163	68.23	30.26	167	1.33	89.44
Kempen	Land van Boom en Heist	1624	71.60	29.20	157	1.25	90.69
Kempen	Noorderkempen	2858	77.52	29.13	**438**	3.49	94.19
Polders	Scheldepolders	1101	79.81	27.65	97	0.77	94.96
Polders	Moeren en Meetkerkse Moeren	78	79.97	25.12	20	0.15	95.12
Kempen	Centrale Kempen	3801	87.85	24.16	318	2.53	97.66
Kempen	Demerland	2387	92.80	22.37	122	0.97	98.63
Polders	Nieuwlandpolders en Historische Polders	120	93.05	19.47	2	0.01	98.65
Kempen	Land van Keerbergen	219	93.50	19.42	7	0.05	98.71
Kempen	Limburgs plateau	3136	100.00	19.13	162	1.29	100.00

Table 8. Average probability of Little Owl presence and number of predicted occupied cells of Little Owls per ecological district for the full model, quadrant 22. Ecological districts with average probabilities equal or over 50% and those belonging to the ten highest absolute population numbers are indicated in bold.

Tabel 8. Gemiddelde waarschijnlijkheid om een Steenuil aan te treffen en het aantal voorspelde bezette hokken per ecoregio voor het model met alle beschikbare veranderlijken, kwadrant 22. Ecologische districten met gemiddelde waarschijnlijkheid >=50% en degene behorende tot de tien hoogste absolute aantallen staan in vet.

ed using information of the same region. The different models are not transferable except to the "Kempen" ecological region where all models perform best even when they were calibrated using information of another ecological region. When ignoring "Kempen" we find that the diagonal cells are higher than the accuracy for the other two remaining regions.

	Correct predictions of Kempen	Correct predictions of Leemstreek	Correct predictions of Polders	Correct predictions of Zand-Zandleemstreek
Model Kempen 22	75%	51%	58%	58%
Model Leemstreek 22	68%	66%	60%	62%
Model Polders 11	70%	55%	62%	61%
Model Zand-Zandleemstreek 11	71%	60%	58%	64%

Table 9. Transferability of Little Owl habitat suitability models for Flanders. Rows indicate the data set to calibrate the models, the columns indicate the percentage correctness of the predictions in the different ecological regions. High off-diagonal values indicate high accuracy and transferability.
Tabel 9. Overdraagbaarheidsmatrix van Steenuil-habitatvoorkeursmodellen voor Vlaanderen. Rijen duiden op de gegevensbronnen om de modellen te ijken, kolommen duiden aan welk percentage van de voorspellingen correct is. Hoge waarden die niet op de diagonaal gelegen zijn, duiden op een hoge accuraatheid en overdraagbaarheid.

DISCUSSION

Presence-absence versus densities

In this study we model Little Owl presence, not densities with logistic regression since presence-absence data is more robust to sampling biases than measures of densities (Green 1979). In addition this allows us to bypass some shortcomings in the available data. The method as used (Leysen et al. 2001) records all individuals that respond to playback without distinction of territorial males. This has the drawback that different calling individuals (consecutive or simultaneous) can come from the same bird or two birds belonging to the same breeding pair. To compensate for this, a grouping algorithm would be needed to cluster observations into unique territories. Since we do not model Little Owl densities, no such grouping is needed and the presence/absence indication per grid cell suffices.

Stratified approach versus full model approach

The use of stratified models allows for a larger efficiency and precision of the models (Toms 2000). On the other hand more general models might have better predictive abilities, allow transferability to other regions and could be useful in determining the overall similarity of the different sub-systems being studied (Leftwich et al. 1997). The relative importance of each variable as a limiting factor may vary considerably between sub-systems as has been shown above. A particular variable will only retain in a model as a limiting factor when its values cluster near the limits of the range of tolerance of the target species (Leftwich et al. 1997). Thus reduced or simple models may not transfer very well because key variables that explain species distributions in some sub-systems but not others can be removed. Our four fits of the full model have similar or even higher accuracy than most stratified models (only "Kempen" performs better in the stratified models) and therefore we see both approaches as complementary. We believe that the reason for the high transferability of all stratified models to "Kempen" is due to the fact that the extremes in the landscape elements between presence and absence for Little Owl in this region are more pronounced than elsewhere which might also be an explanation for the much smaller abundance of the species there. It could be that only the high quality habitats are occupied there.

Population estimates

Both the stratified approach and the full approach confirm the non-uniform distribution of the species in Flanders in concordance to existing breeding atlasses. Delmée (1988) mentions high densities around Oudenaarde and Oost-Brabant while very low densities were observed in the "Kempen". Vercauteren (1989) reports high densities in southern-West-Flanders, Limburg, East-Flanders around Gent, the Flemish Ardennes (southern East Flanders), around the Schelde-Leie rivers and in Hageland. We obtained similar results with high average probabilities for the "Leemstreek" and the "Zand-Zandleemstreek". Limburg on the other hand does not reveal important concentrations of the species in contrast to Vercauteren.

The difference in population estimates between the former sources and our study might be partly due to more detailed inventory and knowledge of the species across the Flemish territory, a better approach using statistical techniques and possibly partly due to a real increase in population numbers. We suspect a real population increase has taken place in Flanders similar to the observed increase of 92% between 1988 and 1994 in Meulebeke (Van

Nieuwenhuyse, Bekaert, Steenhoudt and Nollet 2001) but we cannot suggest any reasons for this.

Landscape elements and Little Owl ecology

Essential criteria for suitable Little Owl habitat are year-round prey availability, prey accessibility, vertical landscape structures with cavities and a limited predation pressure. Habitats will typically include open hunting ground rich in small prey, hunting perches, day-roosts, and nest-holes, and with benign climate and land management regimes which give reasonable long-term continuity without too drastic changes. This can be met within a wide diversity of natural and anthropogeneous landscapes and ecosystems (Génot and Van Nieuwenhuyse, submitted, Schönn et al. 1992, Van Nieuwenhuyse and Leysen 2001).

Gradients

The Little Owl in Flanders can be characterised along three gradients i.e. the gradient between open and closed landscapes, the gradient between dry and wet soils and the gradient between sand and loam soils.

Open-closed landscapes

Little Owls prefer landscapes with intermediate openness (class 2 = medium open and 3 = medium closed) while they avoid extremely open (class 0 = extremely open and 1 = open, e.g. lakes, dunes, large parcels) and extremely closed (class 4 = closed and 5 = extremely closed, e.g. forests, built-up and related areas) landscapes. Hence a mosaic-like landscape structure was found to be more important than the actual land-cover types in different studies. In Germany the species avoids villages with few large grassland areas and prefers those with a lot of small grassland plots (average plot size less than 0.6 ha) (Dalbeck et al. 1999). We found in almost all stratified models grasslands with a positive influence on Little Owl suitability and in most cases the perimeter of the grassland parcels or the number of parcels rather than the area. In Meulebeke, West-Flanders, the actual area of fields did not play a significant role while the amount of field edges did (Van Nieuwenhuyse, Bekaert et al. 2001). In Herzele, East-Flanders, a similar observation was made with meadow edges and not areas (Van Nieuwenhuyse and Bekaert 2001). In France, the distribution of the species is more related to the scale of the landscape than to the area components as such (Ferrus et al. submitted). This is further supported by the positive impact of parcel edges observed elsewhere. A correlation of Little Owl with linear elements i.e. hedges and walls, was observed in Germany (Dalbeck et al. 1999). Loske (1986) found a positive correlation between Little Owl population densities and the amount of fence-poles. Pollard willows are also used by the species in e.g. The Betuwe, The Netherlands (Fuchs 1986) to breed in. A positive relation is found between Little Owl density and the number of pollard trees with potential breeding cavities in combination with grasslands in Nord-Rhein-Westphalia, Germany (Loske 1986). Besides reflecting a limited scale of the landscape, transition zones between different habitats prove to be very diverse too e.g. road sides, meadow edges (Grimm 1986). The ecological relevance of tree lines as edges rich in biodiversity and as source of nesting cavities are illustrated in Van Nieuwenhuyse and Bekaert (2001). In general we can state that edges (e.g. hedges, walls, tree lines, grassland and field borders,…) offer higher diversity and density of potential prey species and offer nesting cavities and day-time roosts for the Little Owl.

The negative impact of roads that we observed in Herzele might be related to its correlation with built-up areas (Van Nieuwenhuyse and Bekaert, submitted). A positive relation between the species and sparsely built-up areas e.g. villages (Van Nieuwenhuyse and Nollet 1991) are probably masked by the negative impact of larger built-up areas e.g. towns. Farm buildings have a positive impact on Little Owls in France (Bretagnolle et al. 2001) and show a second order effect in Flanders i.e. in small numbers the presence has a positive impact on Little Owl occurrence, when the land-cover surpasses 21a per 25ha, the impact becomes negative. We have personal observations that Little Owl in Flanders is really attracted to farm buildings during winter and to breed in, in the absence of natural cavities. A negative impact of built-up areas was also observed in the larger built-up areas (towns) (Van Nieuwenhuyse and Nollet 1990). A correlation between agricultural buildings and high-stem orchards might also cause buildings to appear attractive while it might be only the orchards that are attractive for the species. This might play a role in Herzele where we found a positive relationship between built-up areas and orchards (Van Nieuwenhuyse and Bekaert 2001) but certainly not in Meulebeke where no such correlation was observed (Van Nieuwenhuyse, Bekaert et al. 2001). In Flanders however no significant correlation between orchards and the different built-up areas of the Biological Valuation Map nor between the area, perimeter and number of agricultural built-up parcels of the Farming Parcel Map could be found (data not shown).

The negative impact of forest is illustrated in Van Nieuwenhuyse and Bekaert (2001) in terms of the reduced openness of the landscape and in relation to Tawny Owl *Strix aluco* presence.

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Table 10. Spearman rank correlation coefficients (upper value) and probabilities (lower value) between high-stem orchards, loam soils, sand soils, excessive and bad drainage with the most important landscape elements. Only landscape elements with significant coefficients are given. Red cells indicate a negative impact, green cells a positive impact of the correlations that exceed 15%.
Tabel 10. Spearman rang correlatie coëfficiënten (bovenste waarde) en waarschijnlijkheden (onderste waarde) tussen hoogstamboomgaarden, leem- en zandbodems, extreme en slechte drainage met de meest belangrijke landschapselementen.
Enkel die elementen met significante coëfficiënten worden weergegeven. Rode cellen duiden op een negatieve associatie, groene op een positieve associatie boven 15%.

	high stem orchards	loam soil	sand soil	excessive drainage	bad drainage	
Area of fields	0.04664 <.0001	0.17134 <.0001	-0.2218 <.0001	-0.0503 <.0001	-0.17869 <.0001	Biological Valuation Map
Area of grassland	0.01086 0.0165	-0.01098 0.0153	-0.04571 <.0001	-0.11635 <.0001	0.3143 <.0001	
Area of high stem orchard		0.26801 <.0001	-0.13171 <.0001	0.02462 <.0001	-0.09016 <.0001	
Area of pine forest	-0.09056 <.0001	-0.1974 <.0001	0.47602 <.0001	0.22151 <.0001	0.11046 <.0001	
Area of Oak forest	-0.01182 0.009	-0.05345 <.0001	0.19536 <.0001	0.11433 <.0001	0.12263 <.0001	
Area of urban half open	-0.0383 <.0001	-0.09133 <.0001	0.20622 <.0001	0.1065 <.0001	0.13295 <.0001	
Perimeter of row cropparcels	0.04658 <.0001	0.19042 <.0001	-0.34511 <.0001	-0.10472 <.0001	-0.12491 <.0001	Farming Parcel Map
Perimeter of fruit-growing parcels	0.2351 <.0001	0.24638 <.0001	-0.17261 <.0001	0.0521 <.0001	-0.14162 <.0001	
Perimeter of grassland parcels	0.03246 <.0001	-0.04753 <.0001	-0.06411 <.0001	-0.1699 <.0001	0.2176 <.0001	
Perimeter of cereal parcels	0.12713 <.0001	0.36815 <.0001	-0.39603 <.0001	-0.02913 <.0001	-0.25983 <.0001	
Number of row cropparcels	0.05138 <.0001	0.19504 <.0001	-0.3549 <.0001	-0.1074 <.0001	-0.12178 <.0001	
Number of fruit-growing parcels	0.23562 <.0001	0.24682 <.0001	-0.17291 <.0001	0.05235 <.0001	-0.1415 <.0001	
Number of grassland parcels	0.04347 <.0001	-0.03842 <.0001	-0.06366 <.0001	-0.17042 <.0001	0.21391 <.0001	
Number of cereal parcels	0.13775 <.0001	0.38824 <.0001	-0.40391 <.0001	-0.02493 <.0001	-0.26153 <.0001	
Area of row crop parcels	0.06395 <.0001	0.17916 <.0001	-0.28251 <.0001	-0.07521 <.0001	-0.11589 <.0001	
Area of grassland	0.00867 0.0555	-0.07226 <.0001	-0.01927 <.0001	-0.14697 <.0001	0.19385 <.0001	
Area of cereals	0.09158 <.0001	0.27218 <.0001	-0.30663 <.0001	-0.0328 <.0001	-0.19439 <.0001	
Loam soil	0.26801 <.0001	1	-0.35755 <.0001	0.01656 0.0003	-0.1448 <.0001	Soil Map
Sand soil	-0.13171 <.0001	-0.35755 <.0001		0.22786 <.0001	0.21826 <.0001	
Excessive drainage	0.02462 <.0001	0.01656 0.0003	0.22786 <.0001	1	-0.09941 <.0001	Drainage Map
Good drainage	0.16948 <.0001	0.44317 <.0001	-0.00731 0.1063	0.17001 <.0001	-0.19299 <.0001	
Bad drainage	-0.09016 <.0001	-0.1448 <.0001	0.21826 <.0001	-0.09941 <.0001	1	

Loam - sand

Little Owls in Flanders are positively related to loam soil, while avoiding sand soil, artificial soils and other soils. This might be due to the link of the soil with some other factors. To assess this we calculated the correlation between the soil area and most important landscape elements (Table 10). Loam soils show a positive correlation with high-stem orchards while sand soils do not. Furthermore sand soils correlate well with oak and pine forests while loam soils show a negative correlation with forests. In addition areas, perimeter and number of parcels of fields (Fields BVM, row crops, cereals and fruit of the FPM) show a positive correlation with loam soils and a negative one with sand soils. Furthermore sand soils correlate well with excessive and bad drainage, while this is not the case for sand soils. Hence Little Owls might be related to loam soils indirectly because of these correlating factors that are favourable on loam soils and unfavourable on sand soils. Some favourable factors however do not correlate with either of the soils (e.g. grassland perimeter, area and number of parcels). Hence no firm explanation for Little Owl preference for loam soils can be deduced from this information, suggesting other factors involved. The relationships that we discovered with the soils might be related to the fact that loam soils are more favourable for earthworms than sand soils since sandy to gravely materials are avoided by earthworms (Edwards and Bohlen 1996). The negative impact of artificial and other soils seems to be more related to avoidance of urbanisation rather than the influence of these soils.

Wet - dry

A negative impact of artificial and other drainage classes was observed which appears to be related to urbanisation too as for the soils. The negative relation with the natural drainage classes "excessive" and "bad" drainage is probably also reflecting the impact of too limited and too much water for earthworms.
In general if the water has oxygen in it, worms can withstand very wet conditions, if the water has very little oxygen, worms will not be able to live in these soil areas. On the other hand dry soils will not contain enough moisture to allow the earthworms to thrive (Edwards and Bohlen 1996). Again the relationship between the Little Owl and the drainage classes might be indirectly related to another factor. Table 10 holds some evidence that other factors, such as earthworms might be involved. There is a positive correlation between grass and bad drainage while Little Owls are rather avoiding bad drainage classes. The only link that might exist between the two drainage classes and the absence of the species is the fact that forests correlate well with both drainage classes.

Earthworms

We believe there might be a further association between the Little Owl and earthworms through grasslands since the interaction of this land-cover with earthworm populations. Densities are always higher in grassland than fields (grassland 650 - 1100 kg/ha; arable crops 100 kg/ha, Russell 1973) because in fields there is a higher oxidation and hence reduction of organic material because of ploughing, less food for earthworms due to a lesser production of humus, a higher pesticide use, higher predation and mortality when ploughing. Densities in grassland depend on the fertility of the soil (a balanced nutrient influx yields higher densities than unfertilised grasslands), yielding higher densities with organic fertiliser than inorganic, due to direct intake of the first by earthworms (Edwards and Bohlen 1996).

Moderately drained grasslands on loam soil offer very favourable conditions for earthworms (R. Blakemore in litt.) which might be related to Little Owl abundance since the species was found to forage heavily on earthworms in plenty of cases (Juillard 1984). Some relations between earthworm densities and bird densities were described by Tucker (1992) who reported that the use of cultivated fields by invertebrate-feeding birds was greatest in those fields that received regular applications of farmyard manure. Woodcock *(Scolopax spp.)* feed preferentially on earthworms, and Granval and Muys (1992) even proposed the concept of controlled biostimulation of earthworm communities to create more favourable conditions for woodcock. Reynolds (1977) demonstrated that the habitat preference of the American woodcock *(Philohela minor)* was correlated positively with the biomass of earthworm populations in the habitat.

A causal relationship between earthworm and Little Owl abundance however is hard to investigate due to the absence of large-scale data of worm abundance in Flanders.

Nesting cavities

Orchards

Orchards can have a positive effect e.g. high-stem orchards in Herzele (Van Nieuwenhuyse and Bekaert, 2001) or a negative effect e.g. low-stem orchards in Meulebeke (Van Nieuwenhuyse, Bekaert et al. 2001). A special liking for old high-stem orchards is widely recognised (Juillard 1984, Fuchs 1986, Génot 1990). In densely populated areas in West-Flanders (pers. obs.) modern orchards with integrated fruit growing (reduced pesticide use) offer good habitat too (regularly mown and well-fertilised grasslands, with plenty of commanding perches) but only when nest-boxes are provided.

Possible shortcomings of the methods

Van Horne (1983) identified social interactions within wildlife populations as a potential habitat classification problem. For some population structures, dominant breeding animals exclude more numerous, sub-dominant, non-breeding animals from highest quality habitat. Classification of habitats based solely upon density of animals as results from aural census of Flammulated Owl *Otus flammeolus*, would result in a model which identifies sub-optimal habitat as critical at the exclusion of optimal habitat (van Horne 1983). Protecting only sub-optimal habitat would negatively influence the breeding success and overall stability of the population (Christie et al. 1997). For Flanders we found a spatial autocorrelation in the distribution of Little Owls suggesting social interactions as regulator in distribution patterns (Van Nieuwenhuyse and Bekaert, submitted). To study the impact of the species on its own distribution we should include spatial and temporal relationships such as nearest neighbour distance in future models (Kearns 1997).

We did not work with different years but used the cumulative distribution of the species, similar to our study at the community scale of Meulebeke (Van Nieuwenhuyse, Bekaert et al. 2001). Temporally static data (sampled from a single period in time) is a potential downfall of many habitat models (Pereira and Itami 1991, Hodgson et al. 1987). Data collection replicated through time is necessary for proper identification of annual and seasonal habitat differences and occurrence of periodic fluctuations which affect a species' choice of habitat. Vernier et al (1993) addressed the danger of classifying habitat based on 1 year's potential.

CONCLUSIONS

All readily available independent data sets of Flanders were useful to predict Little Owl presence. The full model using all variables together yielded a predicted accuracy that varied between 66% and 67%. The full model revealed a positive impact of intermediately open landscapes, loam soils and high-stem orchards and a negative influence of built-up and related areas and sand soils. The Little Owl in Flanders can be characterised along three gradients i.e. the gradient between open and closed landscapes, the gradient between dry and wet soils and the gradient between sand and loam soils. The species avoids extremely open and extremely closed landscapes, avoids soils with "excessive" and "bad" drainage and prefers loam soil to sand. A mosaic-like landscape structure was found to be more important than the actual land-cover types in different studies.

The most conservative base line population estimates (number of 500 by 500m grid cells with an occupational probability equal or above 50%) for the full model and the stratified model reach 12527 and 13646 respectively. The scaled approach and the followed methods presented here are easy to standardise. Models per ecological region were only transferable to predict the species presence in the "Kempen" probably because of the lower population numbers there and more extreme differences between occupied and unoccupied grid cells. We believe that the complete methodology as presented has proven capable of generating wildlife suitability models in Flanders using a set of readily available digital data. Application of the technique in the Flemish Breeding Bird Atlas, that is currently under construction, would be an excellent further test of the methods on other common species that occur in the agricultural landscape and have active ranges around 25ha.

The statistical approach using presence/absence data and logistic regression offers promising perspectives for monitoring purposes. The data collection can easily be carried out by volunteers since the observed densities do not matter, just presence/absence is taken into account. This parameter does not need professionally skilled and hence expensive co-operators to obtain reliable results. Once the sample distribution is known, modelling can easily be done using available digital data sets from the administration without additional cost. Furthermore the models as such allow for studies of the diversity of habitat selection of the species across a larger range. We believe that monitoring spatial distributions and not densities can serve as an effective measuring instrument to monitor the evolution of Little Owl populations and their living environments on longer terms.

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SAMENVATTING

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In de lente van 1998, 1999 and 2000 werd in Vlaanderen een inventarisatie uitgevoerd van de Steenuil met behulp van een gestandaardiseerde methode. In totaal werden 8932 hokken van 500 bij 500m (2233 km^2) geïnventariseerd. De bekomen gegevens werden geconfronteerd met een numerieke voorstelling van het landschap en het milieu waarin de soort voorkomt. Een model dat de relatie beschrijft tussen de Steenuil en zijn leefmilieu laat twee dingen toe. Naast het bieden van inzichten in de habitatvoorkeur van de soort, biedt het ook mogelijkheden om gefundeerde aantalsschattingen te maken. Modellen werden berekend, gebruik makend van de gegevens van de geïnventariseerde hokken. Dit model wordt dan toegepast op de ongekende cellen, hetgeen een relevant beeld oplevert voor het gehele grondgebied. De beschrijving van het landschap werd geëxtraheerd uit verschillende digitale kaarten: Biologische Waarderingskaart (30 veranderlijken), de Openheidskaart (6 veranderlijken), de Landbouwperceelskaart (10 veranderlijken), de Bodemkaart (11 veranderlijken) en de Drainagekaart (11 veranderlijken). Stapsgewijze logistische regressie werd gebruikt om slechts die veranderlijken te selecteren met een effectief voorspellend vermogen. De gegevensset werd in vier gesplitst (vier kwadranten per vierkante kilometer). Elke groep wordt gebruikt om een model te ijken terwijl de drie andere gebruikt worden om de kwaliteit van het model te controleren. Bijkomend werden de zes ecoregio's van Vlaanderen gebruikt om de gegevens op te splitsen. Alle beschikbare gegevensbronnen waren geschikt om de aanwezigheid van de Steenuil in Vlaanderen te voorspellen. Het model waar alle beschikbare veranderlijken werden gebruikt, voorspelde in 67% van de gevallen de aanwezigheid correct. Het model toonde een positief verband tussen de Steenuil en halfopen landschappen, leembodems en hoogstamboomgaarden. Een negatief verband werd gevonden met bebouwing en verwante thema's en zandbodems. De Steenuil in Vlaanderen kan gekarakteriseerd worden volgens drie gradiënten: tussen gesloten en open landschappen, tussen droge en vochtige bodems en tussen zand- en leembodems. De soort vermijdt extreem open en gesloten landschappen, vermijdt bodems met extreem goede en slechte drainage en verkiest leembodems boven zandbodems. Een kleinschalig mozaïeklandschap was belangrijker dan de landgebruiksvormen zelf.

De meest conservatieve populatieschattingen (aantal 500 bij 500 hokken met een kans op bezetting gelijk aan of boven 50%) schommelden tussen 12527 en 13646. De volledige werkwijze heeft bewezen in staat te zijn om modellen te leveren op basis van beschikbare digitale kaarten. Toepassing van de techniek op bijvoorbeeld de gegevens van de Vlaamse Broedvogelatlas zou een ideale test zijn van de methode voor soorten met een territoriumgrootte van rond de 25ha.

SAMENVATTING (vervolg)

De statistische werkwijze, gebruik makend van aan- of afwezigheid van de soort en van logistische regressie, is veelbelovend voor toekomstige monitoring. De gegevensverzameling kan gemakkelijk worden uitgevoerd door vrijwilligers aangezien de echte densiteiten niet echt meetellen, alleen aan- of afwezigheid. De vaststelling van aanwezigheid van de soort behoeft geen professionele mensen om tot aanvaardbare resultaten te komen. Eenmaal de inventarisatiegegevens gekend, kan gemakkelijk gemodelleerd worden op basis van bestaande digitale kaarten zonder bijkomende kost van datacollectie. Bijkomend kunnen de modellen op zich gebruikt worden voor de studie van habitatselectie van de Steenuil op grotere internationale schaal. We geloven dat monitoring van ruimtelijke verspreiding eerder dan van densiteiten, een effectief en duurzaam instrument is voor het opvolgen van de evolutie van Steenuilpopulaties en hun omgeving op langere termijn.

Samenvatting door Dries Van Nieuwenhuyse

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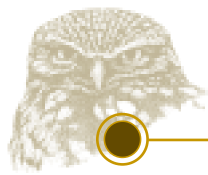

7. LONGITUDINAL ANALYSIS OF HABITAT SELECTION AND DISTRIBUTION PATTERNS IN LITTLE OWLS *ATHENE NOCTUA* IN MEULEBEKE (WEST-FLANDERS, NORTHERN BELGIUM).

LONGITUDINALE ANALYSE VAN HABITATKEUZE EN VERSPREIDINGSPATROON BIJ DE STEENUIL *ATHENE NOCTUA* IN MEULEBEKE (WEST-VLAANDEREN).

DRIES VAN NIEUWENHUYSE*, MAARTEN BEKAERT, KOEN STEENHOUDT AND FRIEDEL NOLLET

ABSTRACT

A Little Owl *Athene noctua* census was performed in the spring of 1988, 1994 and 2000 in Meulebeke (West-Flanders, Northern Belgium, 35 km²) using a standardised inventory method. One hundred and twenty grid cells were surveyed per census. The species showed an increase in population numbers, measured as calling individuals, of 92% between 1988 and 1994 and of 4% between 1994 and 2000. We found no indications for the cause of this population increase. The distribution of calling Little Owls does not show any stability, no significant association of the species in 25ha grid cells was found, not even between the two latter periods with similar numbers. The observed habitat selection of the birds, modelled using logistic regression, changed during the period. In 1988 no model was significant, in 1994 the area of meadows was the only significant predictor of cell occupation. In 2000, tree lines and field-edges had a positive impact on the occupation by Little Owl while low-stem orchards and roads show a negative impact. When using all grid cells occupied at least once during the three periods, built-up areas have a negative impact on Little Owl presence while tree lines and field edges have a positive impact. Spacing between the calling owls is regular, suggesting a high territoriality as determining factor for the spatial distribution. Furthermore the distribution patterns observed are random but tending to maximally spaced.

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INTRODUCTION AND OBJECTIVES

Populations of avian species tend to fluctuate more or less depending on the species. To obtain a better insight in the conservational status of the Little Owl *Athene noctua* in Flanders we want to know and understand the variation of the population in time and space as a reference for future monitoring work. Up to now hardly any longitudinal data are available on natural spatiotemporal variation in this species. This paper describes the evolutions observed in Meulebeke during three research periods i.e. 1988 (Van Nieuwenhuyse and Nollet 1990, 1991), 1994 (Verhaeghe et al. 1996) and 2000. We check if the spacing between calling individuals and their distribution pattern is constant or varying. We look at the reoccupation of 25ha grid cells to test the spatial stability. If the occupation of grid cells is

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similar between the years this might indicate the importance of nest sites and other relatively stable resources as limiting factors for the distribution of the species. If the distribution changes from year to year without obvious changes in the landscape, other determining factors for the settlement apparently are involved. We also assess the possible impact of the sampling method.

METHODS

Research area

Our research area, 3° 14' 00"E - 50° 55' 00"N to 3° 21' 30"E - 50° 58' 30"N, covers the whole territory of the community of Meulebeke (central West-Flanders, northern Belgium) ($35km^2$). The research area is situated in the centre of the province of West-Flanders in the "Sand-Sand-Loam" ecological region (De Blust and Bauwens 1999). The area was split into 500 by 500m (25ha) grid cells using the UTM grid. The Little Owl data were collected using two similar playback methods. The first two surveys were carried out using interval points of 600m (i.e. 300m radius circles were drawn, not selected on a grid) (Van Nieuwenhuyse and Nollet 1990), the latter using regular intervals of 500m (i.e. square grid cells of 25ha) (Leysen et al. 2001). The same tape and a similar protocol were used during the 3 surveys. Individuals were considered as one if observations were clearly originating from two birds belonging to the same pair or heard at very short distance and not heard simultaneously.

Landscape data

A digital representation of every grid cell was obtained by copying 12 mapped landscape elements onto transparencies using topographic maps of the Belgian National Cartographic Institute (update 1978) at a 1/25000 scale (map 22/5-6). We use the same landscape data for the three historical models because of the lack of historical landscape data. This way it remains impossible to look for causal relations between the evolution of the landscape and the response of the Little Owl populations as described by van 't Hoff (2001). Hence we assume that the landscape, as measured by topographic maps, did not change over recent times.

Meadows
Orchard
Fields
Forests
Built-up areas
Brooks
Tree lines
Forest edges
Meadow edge
Field edges
Road edges
Orchard edges

Table 1. Twelve landscape elements used in the analysis.
Tabel 1. Twaalf landschapselementen zoals gebruikt in de analyse.

Data analysis

The numerical representation of the 12 landscape elements of 120 surveyed 25ha grid cells was obtained manually (Table 1). The land-cover variables were divided by $2500m^2$ and the linear landscape parameters by 330m (one 10th of the maximum value of linear elements) to obtain values ranging between 0 and 10. The census was carried out in 140 grid cells and used for the study of the spacing and the distribution patterns.

SAS/STAT software (SAS Institute Inc., Cary, NC, USA) was used for all statistical analysis. Historical habitat selection was modelled using logistic regression with PROC LOGISTIC (SAS Institute 1989) to study the possible changes between the three different research periods. Logistic regression allows prediction of the probability of occurrence of binary response variables using binary, categorical and continuous explanatory variables. We predicted the occupation of each surveyed grid cell for the presence of Little Owl. The stepwise option with a significance level of 0.05 was used. The same analysis was done using the distribution of the grid cells occupied at least once during the 3 periods. PROC REG (SAS Institute 1989) was used to assess the latter model by testing for a linear relation between the predicted probabilities and the number of times the grid cells were occupied. The Spearman rank correlation coefficient (r_S) was calculated with PROC CORR (SAS Institute 1989) for all pairs of variables. The type of spacing (random or uniform) between calling individuals was analysed using the GMASD (Geometric Mean - Average - Square Distance) (Brown 1975). Distribution patterns

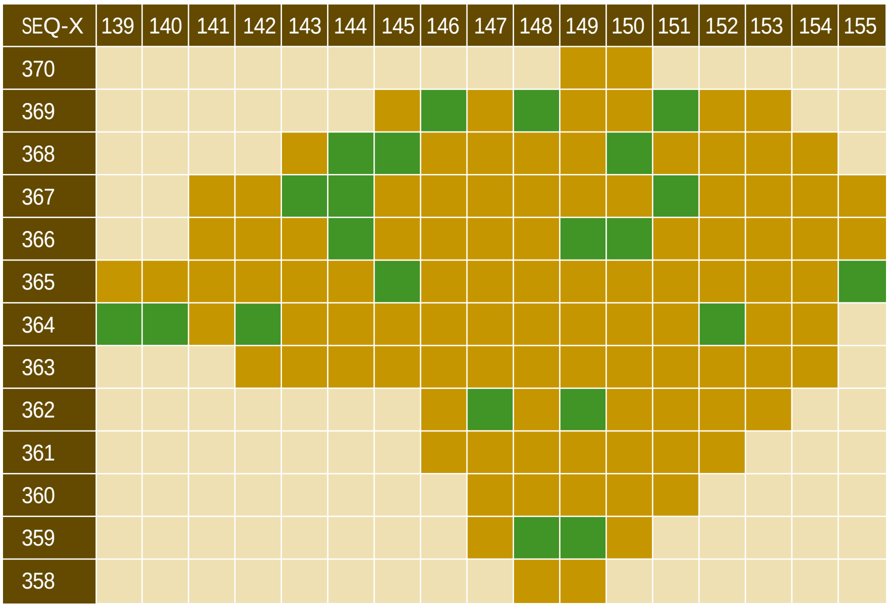

Figure 1. Little Owl nest box availability in Meulebeke (Belgium) per 25ha grid cell in 1994 (green ceels contained nest box).
Figuur 1. Beschikbaarheid van nestkasten voor Steenuil in Meulebeke per 25ha roostercel in 1994 (groene cellen bevatten nestkast).

(random, clustered or uniform) were analysed using the method of Clark and Evans (1954). The Phi coefficient (Siegel and Castellan, 1988) was calculated to test the association between the occupations of the respective grid cells, survey by survey using PROC FREQ (SAS Institute 1989).

Nest boxes

Between 1989 and 1994, twenty-nine nest boxes were placed in unoccupied areas (Figure 1) of which 7 were at least once occupied with a maximum of 5 occupations in one given year. In the breeding season of 2000, only 8 nest boxes were still usable by Little Owls, the others were worn out. The maximum impact of the nest boxes hence was never higher than 8. To exclude the impact of the nest boxes we estimated all our models with the grid cells containing nest boxes both omitted and included.

RESULTS

Distribution

In 1988, thirty-one cells out of 120 were found occupied (totalling 38 answering individuals, 1.3 calling individuals/km^2); in 1994 fifty-three were found occupied (totalling 73 answering individuals, 2.4 calling individuals/km^2) and in 2000 fifty-five cells were found occupied (totalling 76 answering individuals; 2.6 calling individuals/km^2) and 65 unoccupied.

Figure 2 shows the cumulative distribution of Little Owls in Meulebeke per 25ha square grid cell during the three research periods. The colours indicate the number of times that the grid cells were occupied (i.e. 0, 1, 2 or 3). In Meulebeke territory fidelity at 6 year-intervals is not observed for calling individuals. For all combinations between the three surveys (i.e. 1988-1994, 1988-2000 and 1994-2000), the degree of association between the occupied and unoccupied grid cells (Phi-coefficient) (Table 2) for each pair of years lacks a statistical significance (minimal Chi-square Probability > 0.07).
The average nearest neighbour distance decreases nearly perfectly linearly with increasing densities (average nearest neighbour distance = 675m - 3.65m per extra calling owl; $P < 0.02$; Adjusted R^2: 0.99. Spacing between calling males (Table 3) is

	1988	1994	2000
1988 PHI	1		
1988 CHISQ-PROB	1		
1994 PHI	0.167	1	
1994 CHISQ-PROB	0.07	1	
2000 PHI	0.002	0.106	1
2000 CHISQ-PROB	0.98	0.244	1

Table 2. Mutual comparisons between 1988, 1994 and 2000 grid cell occupation patterns by Little Owl with corresponding Phi-coefficients and Chi²-probabilities.
Tabel 2. Paargewijze vergelijkingen tussen 1988, 1994 en 2000 bezettingspatronen van rooster cellen door Steenuilen met overeenkomstige Phi-coëfficiënten en Chi²-probabiliteiten.

SEQ-Y	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155
370											1	2					
369							1	0	2	0	1	1	0	1	1		
368					2	2	2	2	3	0	3	2	1	2	1	2	
367			1	1	1	1	1	0	0	3	0	1	1	2	1	2	3
366			1	0	1	3	1	2	0	0	1	1	2	3	2	2	2
365	2	0	0	0	1	0	1	0	0	0	2	2	1	1	1	1	1
364	1	2	0	1	2	2	2	0	0	0	2	2	2	2	1	2	
363				1	2	1	1	1	0	0	0	2	2	2	0	1	
362								3	2	1	1	0	1	1	1		
361								2	2	1	0	0	2	2			
360									2	0	2	1	1				
359									0	2	2	3					
358										1	0						

Figure 2. Little Owl presence in Meulebeke per 25ha grid cell indicating the number of times occupied in 1988, 1994 and 2000.
Figuur 2. Het voorkomen van de Steenuil in Meulebeke per 25ha roostercel met het aantal bezettingen in 1988, 1994 en 2000.

Research period	Censused cells	Territories observed	Nearest neighbour distance					Density per m²	Expected mean nearest neighbour distance for a random distribution	Ratio Observed Expected	Distribution pattern Clark & Evans (1954)	G-ratio GMASD
			Min.	Mean	Max.	Standard deviation	In case of maximal spacing					
1988	140	38	238	536	1251	249	1031	0.00000109	480	1.117	random maximum spacing	0.68
1994	140	73	179	418	173	148	744	0.00000209	346	1.207	random maximum spacing	0.78
2000	140	78	826	393	811	161	720	0.00000223	335	1.173	random maximum spacing	0.73

Table 3. GMASD (Geometric Mean – Average – Square Distance) and distribution patterns according to the Clark and Evans method of Little Owl calling individuals in Meulebeke during the 1988, 1994 and 2000 survey.
Tabel 3. GMASD (Geometrisch gemiddelde - rekenkundig gemiddelde - kwadraat afstand) en distributiepatronen van roepende Steenuilen in Meulebeke tijdens de inventarisatie van 1988, 1994 en 2000, volgens de Clark en Evans methode.

Year															
1988	NO SIGNIFICANT MODEL														
1994	Model	-1.19	Intercept	+	0.42	Meadows									
1994	**Pr> ChiSq**	**0.0008**			**0.0015**										
1994	Odds ratio				1.52										
2000	Model	0.52	Intercept	+	-1.4	Orchards	+	-0.5	Roads	+	0.76	Tree lines	+	0.64	Field edges
2000	**Pr> ChiSq**	**0.42**			**0.027**			**0.008**			**0.017**			**0.008**	
2000	Odds ratio				0.25			0.6			2.1			1.9	
1988-1994-2000	Model	0.07	Intercept	+	-0.6	Built-up areas				+	1.2	Tree lines	+	0.53	Field edges
1988-1994-2000	**Pr> ChiSq**	**0.87**			**0.007**						**0.01**			**0.03**	
1988-1994-2000	Odds ratio				0.55						3.5			1.7	

Table 4. Logistic regression models of 120 surveyed grid cells of Little Owl occurrence in Meulebeke for the 1988, 1994, 2000 and the cumulative survey data.
Tabel 4. Logistisch regressie modellen van 120 geïnventariseerde roostercellen van het voorkomen van de Steenuil in Meulebeke voor de gegevens van 1988, 1994, 2000 en gecumuleerd.

regular throughout the whole research period with the highest G-value in 1994 despite the fact that this is not the year with the highest density. The spatial distribution of the Little Owl calling males is random but tends towards maximal spacing according to the Clark and Evans-statistic (Table 3).

Habitat selection models

The different logistic regression models are shown in Table 4. For 1988 no landscape elements were significant during the stepwise regression.

In 1994 the occupation of grid cells was best predicted by the meadow land-cover. When leaving the grid cells (n=22) out of the model where a nest-box was present, we obtain the same model with a slightly stronger relationship (data not shown).
In 2000, tree lines and field-edges have a positive impact on the occupation by Little Owl while low-stem orchards and roads show a negative impact. When leaving the grid cells out of the model where a nest box was still present in 2000 (n=8), we obtain a model with tree lines and field edges as significant independent variables (data not shown). When taking all ever occupied square grid cells into account in one model, we obtained an even better predictive model for Meulebeke. Built-up areas have a negative impact on Little Owl presence. Field edges have a moderately positive impact and tree lines have an extremely positive impact on the probabilities.

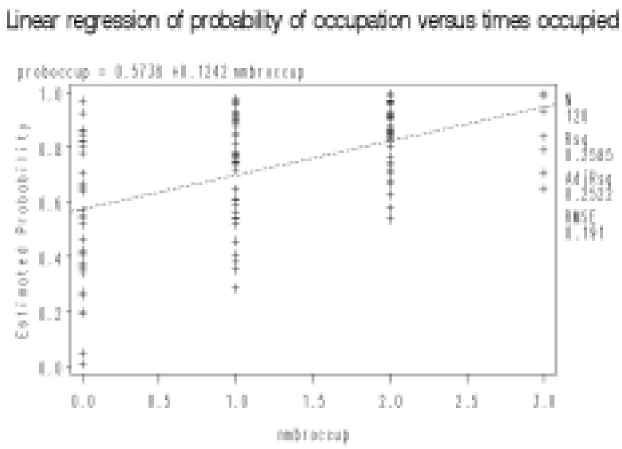

Figure 3. Linear regression of probability of occupation versus the number of times that a grid cells was occupied (nmbroccup).
Figuur 3. Lineaire regressie van de probabiliteit van bezetting versus aantal keer dat een roostercel bezet was (nmbroccup).

To test if the model reflects higher probabilities for more occupations we estimated a linear regression model. The number of times a grid cell was occupied (i.e. 0, 1, 2 or 3 times) has a linear relationship with the probability of occupation as obtained from the logistic model (Figure 3). We found a probability of occupation of a grid cell of 57% when no historical occupation was observed. Every time the grid cell was occupied in the past research periods, the chance of occupation increases with 12%, yielding 69% for once occupied, 81% for two occupations and 93% chance when all three periods were positive.

Spearman Correlation Coefficients, N = 120 Prob > |r| under H0: Rho=0							
	meadows	fields	built-up areas	roads	tree lines	meadow edges	field edges
meadows	1						
fields	-0.6369 <.0001	1					
built-up areas	-0.25895 0.0043	-0.34432 0.0001	1				
roads	-0.31855 0.0004	0.05064 0.5828	0.35165 <.0001	1			
tree lines	0.28873 0.0014	-0.07525 0.414	-0.1954 0.0325	-0.03578 0.698	1		
meadow edges	0.2667 0.0032	-0.10312 0.2624	-0.17671 0.0535	-0.07993 0.3855	0.02627 0.7758	1	
field edges	0.19465 0.0331	-0.11746 0.2013	-0.16143 0.0782	-0.04073 0.6587	0.13742 0.1345	0.14614 0.1112	1

Table 5. Spearman rank correlation coefficients between numerical representations of 12 landscape elements of 25ha grid cells in Meulebeke. Positive correlation is indicated by green colour, negative by red colour.
Tabel 5. Spearman rang correlatiecoëfficiënten tussen numerieke voorstellingen van 12 landschapselementen van 25ha roostercellen in Meulebeke. Positieve correlatie wordt aangeduid in het groen, negatieve in het rood.

DISCUSSION

Population numbers of Little Owls showed an important increase in the study area and almost doubled in 6 years time. No obvious explanation for this was found. Breeding numbers of larger raptors normally show much more stability with on average fluctuations below 15% (Newton 1979). A similar increase after a dip in population numbers in the 80s was observed in Soest (North-Rhein-Westphalia, Germany) (Illner, pers. comm.).

Impact of the landscape on Little Owl presence

Some landscape elements correlate (Table 5). The significant variables therefore can be considered as mutually exclusive when they appear in the models. On the one hand meadows are the only predictive parameter in 1994. On the other hand, meadows are absent but tree lines and field edges enter into the model for 2000 and the cumulative model. This might simply be because tree lines and field edges correlate positively with meadow area and are better predictors in our two last stepwise models. These models give a more diversified view on the habitat preference of the species than the first one. The negative impact of roads (linear landscape element) in the model for 2000 is replaced by built-up areas (area landscape element) probably because of the correlation between the two landscape elements. In our study, field edges do not correlate with field areas (P>0.14) but correlate with meadow areas in stead. This is possible when fields are spatially arranged like a mosaic. Meadow edges only correlate with meadow areas. In our other research area (Herzele) the opposite was observed (Van Nieuwenhuyse and Bekaert, submitted). When leaving the grid cells with nest-boxes out of the model, the models either become more significant (e.g. 1994) or only keep the strongest predictors (e.g. tree lines and field edges in 2000). Hence the differences between the models might reflect a real change in habitat selection (models become better with higher densities) or might be related to the statistical model building. This illustrates that caution is needed in longitudinal research of habitat selection. Furthermore it is shown by Van Nieuwenhuyse and Leysen (2001) that the species features an important plasticity in its choice of habitats. Different types of occupied habitat might have a different impact on the models in different years. It should be kept in mind that our logistic regression models assume only one habitat type.

Fields versus meadows

Field nor meadow land-cover show any discriminating effect on Little Owl occurrence in 2000 which is in contrast to the observations made by Dalbeck et al. (1999) who found a positive association of the species with meadow areas. A certain adaptability of the species towards fields might be involved. The highly intensive agricultural landscape in Meulebeke, featured by industrial vegetable growing, apparently still offers enough possibilities for the species. Intensive vegetable-growing even might improve the local availability and accessibility of earth worms *(Lumbricidae)* and possibly other prey on the bare ground between row crops.

Orchards

Orchards have a negative impact on the occupation by Little Owl. This is in contrast to the situation in our second research area, Herzele, where this factor is clearly positively related to the species (Van Nieuwenhuyse and Bekaert, submitted). This difference is probably due to the fact that orchards in that area are characterised by old tall-standing trees, Meulebeke has only low-standing orchards which are not suitable for the species except when artificial nesting cavities are offered (Génot and Van Nieuwenhuyse, submitted).

Built-up areas and roads

A positive relation between the species and sparsely built-up areas e.g. villages (Van Nieuwenhuyse and Nollet 1991) is probably masked by the negative impact of larger built-up areas e.g. towns. In Herzele our logistic regression model also showed that built-up areas are avoided by Little Owls (Van Nieuwenhuyse and Bekaert, submitted). Van Nieuwenhuyse, Leysen and Steenhoudt (2001) showed that for Flanders the built-up areas have a second order effect i.e. the positive impact on Little Owl presence rises at increasing built-up areas till 21a and goes back down with built-up areas above that value. On the one hand smaller built-up areas

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have a positive impact while larger areas have a negative impact on Flemish regional level. Because the network of roads is very dense and correlated with built-up areas, we believe that it is more the latter factor that has an influence on the birds.

Tree lines

Tree lines have multiple functions for Little Owls in Meulebeke. They offer nesting cavities, perches and act as a gradient. Most tree lines consist of pollard willows *(Salix sp.)*. When pollard willows border two meadows, an additional unmanaged rough zone of 1m remains between the barbed wires attached to both sides of the willows. Pollard willows are also used by the species in e.g. The Betuwe, The Netherlands (Fuchs 1986). A positive relation is found between Little Owl density and the number of pollard trees with potential breeding cavities in combination with grasslands in Nord-Rhein-Westphalia, Germany (Loske 1986).

Edges and mosaic-like landscapes

Edges prove to be more important than areas in Little Owl habitat preference (Génot and Van Nieuwenhuyse, submitted). A correlation of Little Owl numbers was observed with linear elements i.e. hedges and walls (Dalbeck et al. 1999) and fence-poles (Loske 1986). In addition transition zones between different habitats e.g. road sides, meadow edges prove to be very diverse in prey composition (Grimm 1986). In our study, field areas have no direct impact on Little Owl presence, the amount of field edges do. As in France, the distribution of the species is more related to the scale of the landscape than to the actual land-cover as such (Ferrus et al., submitted). A mosaic of smaller parcels is preferred in Germany too where the species avoids villages with few large grassland areas and prefers those with a lot of small grassland plots (average plot less than 0.6 ha) (Dalbeck et al. 1999).

Differences between surveys

The differences that were observed between the surveys, which caused the absence of any spatial association, might be caused by sub-optimal inventory work or by a real change in the population. If only part of the whole population is detected with our census method, we might miss one year Little Owls somewhere, and somewhere else another year. One might have the perception that some individuals moved. Even then the analyses still make sense since the error in detection would be completely random. Similar statistical relationships would emerge but possibly with an inferior significance.
A limited quality of the census is however unlikely when looking at the observed spacing and distribution pattern. For the different densities we obtained a similar spacing and distribution pattern during the three periods. The fact that plenty of intra-specific interactions are observed (Exo 1987, 1992), makes a reaction and hence detection very likely at our observed densities in Flanders. With a similar survey-method, Exo and Hennes (1977) claim to detect 80-90% of Little Owls present.
We believe that the Little Owl distribution patterns are dynamically built up year by year in a way that is less linked to the landscape than generally believed. Our impression of a low fidelity might also be caused by using calling individuals and not breeding pairs. Fluctuations and movements however are also observed in studies that worked with breeding pairs. Adults changed territory regularly in Betuwe, 18 shifts/89 site fidelity cases, more often after severe winters i.e. 9/18 shifts (Fuchs 1986). In Groningen, The Netherlands, Little Owls show some important movements. The number of occupied territories in the 60s, 70s, 80s and 90s was 15, 21, 28 and 38 respectively with only 13 common territories during these four decades (van 't Hoff 2001).

One might argue that the use of calling individuals as indicators for habitat selection is faulty since it does not necessarily reflect the actual breeding habitats. On the other hand it is much more interesting to use all calling birds including non-breeding individuals (floaters) and not just nesting sites (Newton 1998). Floaters can play an important role in the population as a reserve pool to compensate for mortality of breeding individuals. In that case it is the evolution of the whole pool of Little Owls that needs to be understood and managed including breeding habitats and those occupied by floaters. Evidence of an important pool of floaters in a nearby region is offered by Bultot et al. (2001) who found extremely fast occupations of newly offered nest-boxes in Wallonia. In Italy 57 (48,3%) of 118 replies to playback did not originate from known territorial individuals; only 5 (8,8%) of such "unknown" replies came from locations where in a later year territorial Little Owls were found, perhaps representing undetected territorial individuals (D. Centili, pers. comm.).

Geographical distribution

The regularity in the spacing between the calling males of Meulebeke (G-statistic: 0.68-0.78) is similar or even higher compared to the nest-spacing of a population in the Netherlands (G-statistic = 0.72, Fuchs unpubl. In Nilsson et al., 1982). Higher regularity in spacing for nesting raptors was observed in *Accipiter nisus* (G-statistic > 0.93) (Newton et al. 1979), *Aquila chrysaetos* (G-statistic = 0.92) (Brown 1976), and *Falco subbuteo* (G-statistic = 0.91, Cronert unpubl., In: Nilsson et al. 1982). We believe that the regularity of the spacing in Little Owl calling birds in our research area is mainly due to intra-specific interference e.g. juvenile birds are attracted to conspecifics on the one hand (Exo in litt.), but on the other hand are pushed away from cluster centres due to territorial behaviour of territory-owners (Exo 1987, 1992). Equilibrium between attraction and competition might cause regular spacing between territorial owls even at lower densities. Such an equilibrium could be a driving force for clustered distribution patterns of Little Owls at lower densities and is also confirmed by the fact that important spatial autocorrelation for the species is observed (Van Nieuwenhuyse and Bekaert, submitted).

CONCLUSIONS

Changes in Little Owl population sizes are still difficult to understand. The number of calling males increased significantly between 1988 and 1994. After that period the population increased slowly. The distribution pattern within Meulebeke does not show a stable pattern, since there was no association of occupied grid cells between the periods. Some other factors might be involved in the distribution of the calling males than just the landscape. The spacing between the calling males is regular for all densities suggesting that territorial behaviour plays an important role in the positioning of the birds in the landscape. This is also confirmed by the random but tending to maximally spaced distribution pattern of the Little Owl calling birds in the area. The variance in territoriality and building up of a pre-breeding population (breeding birds and floaters) might explain the lack of spatial stability and the evolution in habitat selection, supporting the hypothesis of social behaviour as driving force for the spatial distribution of the species in Flanders. Fluctuations might not be as negative as they appear. In monitoring activities it remains very important to have a good view on overall habitat suitability on a larger time horizon than just a few years. The habitat selection was mainly determined by meadow areas in 1994 and in 2000 by parameters that correlate well with meadow area but that are more diversified, i.e. tree lines (positive impact), field edges (positive impact). A negative impact was seen as low-stem orchards and roads. The Little Owl in Meulebeke tends to avoid human concentrations since it is not found in high densities of roads and built-up areas. Tree lines have a positive impact on Little Owl presence since pollard willows offer nesting cavities, serve as perch and cause additional unmanaged prey-rich edges. Finally field-edges have a positive impact on the species since high amounts of edges indicate small parcels and a mosaic-like landscape which is highly preferred by the species. When taking the cumulative presence of Little Owl during the 3 surveys per grid cell in the model, we obtain an even more pronounced impact of built-up areas (negative impact), tree lines (positive impact) and field edges (positive impact). The probability of occupation of a grid cell showed a linear relationship with the number of times the cell was occupied, confirming the validity and usefulness of the model for quality assessment.

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In de lente van 1988, 1994 en 2000 werd een inventarisatie uitgevoerd van de Steenuil in Meulebeke (West-Vlaanderen, Noord-België, 35 km²) met een gestandaardiseerde telmethode. De bedoeling hiervan was om inzicht te krijgen in de variatie in tijd en ruimte van de Steenuilpopulatie. Zo kunnen we ook de status van de soort en de eventuele noodzaak van bescherming nagaan. In totaal werden 120 hokken van 500 bij 500m (25 ha) geïnventariseerd per inventarisatie. De onderzoeken werden uitgevoerd met behulp van een geluidsband. Bij de eerste twee onderzoeken was de afstand tussen afspeelpunten 600m, in het laatste 500m. Door voor elk hok twaalf gekarteerde landschapselementen op transparanten te zetten en op te meten, werden digitale weergaven van het landschap gemaakt. Dezelfde landschapsdata werden voor de drie historische modellen gebruikt bij gebrek aan historische landschapsgegevens. Dit maakt het onmogelijk om na te gaan of er een causaal verband is tussen de evolutie in het landschap en de aanwezigheid van Steenuilen. De gegevens werden statistisch verwerkt. In 1988 waren 31 hokken bezet, in 1994 53 en in 2000 55. Dit betekende een aantalstoename van roepende individuen van 92% tussen 1988 en 1994 en van 4% tussen 1994 en 2000. Omtrent mogelijke oorzaken voor deze toename tasten we in het duister. De 6-jarige interval liet niet toe om plaatstrouw van roepende individuen af te leiden. De verspreiding van roepende Steenuilen laat geen stabiliteit zien, er is geen significante associatie van de soort in 25 ha hokken, zelfs niet tussen de twee laatste periodes met vergelijkbare aantallen. De gemiddelde onderlinge afstand (675 m) bleek vrijwel lineair af te nemen met hogere dichtheden. De waargenomen habitatselectie werd gemodelleerd met logistische regressie en bleek veranderd te zijn in de loop van het onderzoek. In 1988 was geen enkel model significant, in 1994 was het areaal aan weide de enige significante voorspellende factor van aanwezigheid in een hok. In 2000 hadden bomenrijen en randen van akkers een positieve impact op de aanwezigheid van Steenuilen, terwijl laagstamboomgaarden en wegen negatief inwerkten. Indien we alle hokken die minstens éénmaal bezet waren in de drie onderzoeksperiodes in aanmerking namen, kregen we het beste voorspellend model voor Meulebeke. Bebouwing bleek negatief te zijn, terwijl akkerranden en vooral bomenrijen gunstig waren voor de aanwezigheid van de Steenuil. De verschillen tussen de verschillende jaren kunnen verklaard worden doordat sommige landschapselementen met elkaar correleren. Zo vertonen bomenrijen en akkerranden een positief verband met oppervlakte weide, het ene jaar weegt het ene door, het andere jaar het andere. Ook wegen en bebouwing zijn positief gecorreleerd. In ons onderzoeksgebied bleken akkerranden en oppervlakte aan weide positief samen te hangen. Dat heeft alles te maken met de gefragmenteerde landschapsstructuur. Verder mogen we ook niet vergeten dat de Steenuil een zeer ruime biotoopkeuze heeft, terwijl onze modellen van logistische regressie er van uitgaan dat er slechts één habitat-type is. Een positief verband met dun bebouwde gebieden wordt waarschijnlijk verhuld door de negatieve impact van grotere bebouwde zones en het hiermee samenhangende dichte wegennet. Het belang van knotwilgen voor de soort is duidelijk. Verder blijkt de Steenuil meer afhankelijk van de schaal van het landschap dan van de samenstellende delen op zich. De onderlinge afstand tussen de roepposten is gelijkmatig verdeeld. Dit laat een hoge territorialiteit vermoeden als bepalende factor voor de ruimtelijke spreiding. Jonge uilen worden enerzijds aangetrokken door soortgenoten en anderzijds ook op afstand gehouden door territoriale vogels. De vastgestelde spreidingspatronen waren daarenboven willekeurig met neiging naar een maximale spreiding

Samenvatting door Koen Leysen

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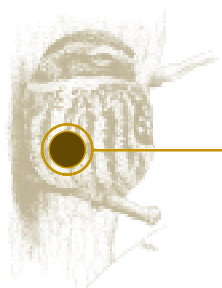

8. STUDY OF LITTLE OWL *ATHENE NOCTUA* HABITAT PREFERENCE IN HERZELE (EAST-FLANDERS, NORTHERN BELGIUM) USING THE MEDIAN TEST.

STUDIE VAN DE HABITATVOORKEUR BIJ STEENUIL *ATHENE NOCTUA* IN HERZELE (OOST-VLAANDEREN) MET BEHULP VAN DE MEDIAANTEST.

DRIES VAN NIEUWENHUYSE* AND MAARTEN BEKAERT

ABSTRACT

The community of Herzele, East-Flanders (43km^2) was surveyed for Little Owl using a standard inventory method of which 123 grid cells of 25ha were found occupied and 48 unoccupied. Ten mapped landscape elements were quantified per grid cell. Associations between the landscape elements were analysed with the median test. The same test was used to study possible associations between the landscape elements and the presence or absence of Little Owl. The species shows a positive association with the amount of field land-cover and field edge length and negative association with forest presence and the amount of road length. The use of the median test is discussed in relation to logistic regression.

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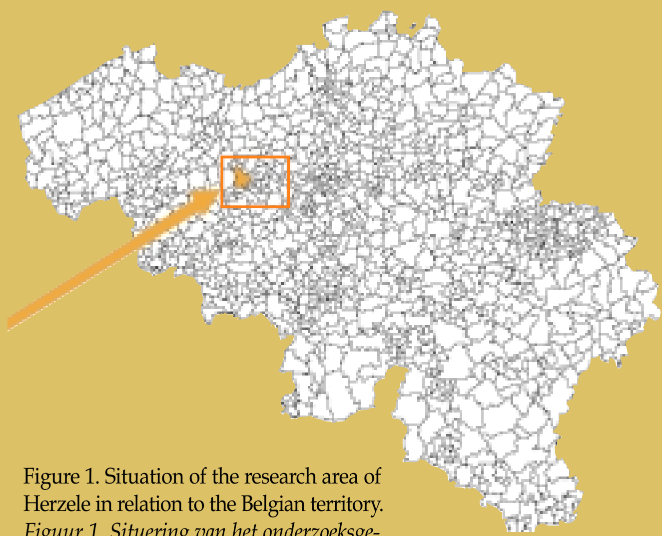


Figure 1. Situation of the research area of Herzele in relation to the Belgian territory.
Figuur 1. Situering van het onderzoeksgebied in Herzele in België.

INTRODUCTION

Habitat preference of owls has been studied in several ways, a first approach is to characterise occupied habitats (Van Nieuwenhuyse and Nollet 1990, 1991, Juillard et al. 1992). The difference between occupied and unoccupied habitats in Little Owl *Athene noctua* has only recently been studied using logistic regression (Van Nieuwenhuyse and Bekaert, submitted) or correspondence analysis and clustering (Ferrus et al. in press) while in Barn Owl *Tyto alba* canonical correlation analysis has been used (Andries et al. 1994).

The difference between occupied habitats and unoccupied habitats and hence the actual preference of the species, does not need to be too complicated to analyse. Therefore this paper wants to focus on a simple nonparametric test (the median test) by which simple calculations can reveal initial insights into the habitat preference of Little Owl. Further analysis however will always remain needed since this method has some fundamental shortcomings which we will highlight.

We have four aims:

- we want to look for associations among landscape features
- we want to obtain better insights into the driving forces of habitat preference of Little Owl in Herzele while analysing both occupied and unoccupied parts of landscapes,
- we want to illustrate that habitat preference can be studied in an extremely simple way without the need for too complicated statistical packages,
- finally we want to promote scientific research to non-professional ornithologists and lower the threshold for doing first basic analysis.

METHODS

Study area

Our research area, 3° 51' 30"E - 50° 54' 49"N to 4° 0' 0" E - 50° 50' 0" N (62km^2) covers the whole territory of the community of Herzele (south East-Flanders, Belgium) (Figure 1). The area was split into 500 by 500m squares (25 ha) using the UTM grid. A quantitative representation of every square was obtained by copying every mapped landscape element onto transparencies using topographic maps of the Nationaal Geografisch Instituut (update 1975) on a 1/25000 scale (map 30/3-4) and quantifying 10 categories of landcover and linear landscape elements (Table 1). 43 UTM-squares (43 km^2) of the research area were censused in 1998 and 1999 using a standardised inventory method for the Little Owl (Verwaerde et al. 1999).

Median test

The median test (Siegel and Castellan 1988) is a procedure for testing whether two independent groups differ in central tendencies. More precisely, the median test will give information as to whether

Landscape element	Median value of landscape element in Herzele (500 by 500 squares)	Measurement unit or Median used	Presence/absence
Meadow area	17.13	(ha)	Median used
Field area	5.22	(ha)	Median used
Road length	750.00	(m)	Median used
Tree lines length	300.00	(m)	Median used
Meadow edge length	962.00	(m)	Median used
Field edge length	500.00	(m)	Median used
Orchard area	0.00	(ha)	Presence used
Forest area	0.00	(ha)	Presence used
Built-up area	0.00	(ha)	Presence used
Brooks length	0.00	(m)	Presence used

Table 1. Median value of landscape elements in Herzele (500 by 500 m squares).
Tabel 1. Mediaan van landschapselementen in Herzele (500 bij 500 m hokken).

Chi-square: 3.11 Prob: 0.0778	Cells with meadow edge length below median	Cells with meadow edge length above median
Cells with meadow area below median	Number of cells with meadow area below median and meadow edge length below median **70 (28%)**	Number of cells with meadow area below median and meadow edge length above median **56 (22%)**
Cells with meadow area above median	Number of cells with meadow area above median and meadow edge length below median **56 (22%)**	Number of cells with meadow area above median and meadow edge length above median **70 (28%)**

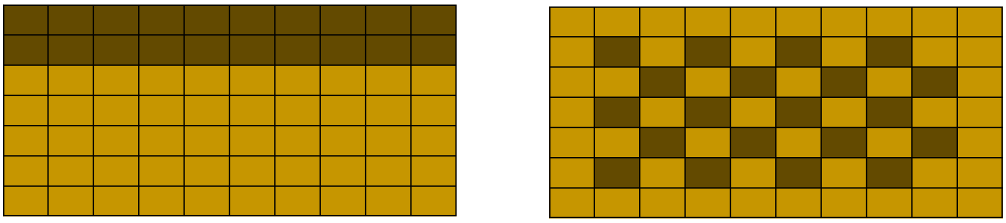
Table 2. Two by two matrix with cell frequencies of grid cells above or below the meadow edge length and grid cells above or below the meadow area. No association observed.
Tabel 2. Twee bij twee matrix met frequenties van onderzochte hokken boven of onder de mediaan van perimeter weiland respectievelijk oppervlakte weiland. Geen aantoonbare associatie.

Chi-square: 134.35 Prob: < 0.0001	Cells with field surface below median	Cells with field surface above median
Cells with meadow area below median	Number of cells with meadow area below median and field area below median **17 (6.75%)**	Number of cells with meadow area below median and field area above median **109 (43.25%)**
Cells with meadow area above median	Number of cells with meadow area above median and field area below median **109 (43.25%)**	Number of cells with meadow area above median and field area above median **17 (6.75%)**

Table 3. Negative association between meadow area and field area. Both landscape parameters are mutually exclusive.
Tabel 3. Twee bij twee matrix met frequenties van onderzochte hokken boven of onder de mediaan van oppervlakte weiland respectievelijk oppervlakte akker. Duidelijk negatieve associatie; beide landschapsparameters sluiten elkaar uit.

Chi-square: 6.38 Prob: < 0.0115	Occupied cells	Unoccupied cells
Cells with field area below median	Number of occupied cells with field area below median **29 (17%)**	Number of unoccupied cells with field area below median **48 (28%)**
Cells with field area parameter above median	Number of occupied cells with field area above median **19 (11%)**	Number of unoccupied cells with field area above median **75 (44%)**

Table 4. Two by two matrix with cell frequencies of occupied or unoccupied grid cells and grid cells above or below the median of the field surface.
Tabel 4. Twee bij twee matrix met frequenties van onderzochte hokken die al dan niet bezet zijn en die boven of onder de mediaan van oppervlakte akker liggen.



Field area = 50
Meadow area = 20
Meadow edge length = 24
Field edge length = 30
Field edge length associates with Field area
Meadow edge length associates with Meadow area

Field area = 50
Meadow area = 20
Meadow edge length = 40
Field edge length = 74
Field edge length associates with Field area
Meadow edge length associates with Field area

Figure 2. Two scenarios of equal area but different border lengths.
Figuur 2. Twee scenario's voor dezelfde oppervlakten maar verschillende lengtes randzone.

it is likely that two independent groups e.g. occupied and unoccupied cells of a landscape (not necessarily of the same size) have been drawn from populations with the same median value e.g. for a specific landscape parameter. The null hypothesis is that the two groups are from populations with the same median; the alternative hypothesis may be that the median of one population is different from that of the other. To perform the median test, we first determine the median score for both landscape parameters that we want to analyse. We then dichotomise both sets of scores at both median values and cast these data in a 2 x 2 table such as shown in Table 2. Before testing for habitat selection we investigated the statistical associations between different landscape elements using the median test.

The advantage of using the median to stratify is that half of all the observations are situated above the median and the other half below the median value. For two landscape parameters that have no association with one another an almost equal distribution of the observations over the four cells i.e. 25 % in each (Table 2) should be observed. If two landscape elements tend to occur together there should be larger numbers in the diagonal cells, if landscape elements rarely occur together there should be larger numbers in the off-diagonal cells (Table 3). Calculation of the median of every landscape parameter is trivial while the counts can be done manually.

Statistical test for association between rows and columns

All analysis were done first manually as described above and using PROC FREQ (SAS). This procedure serves two purposes (SAS Institute 1989). It is a descriptive procedure in the sense that it produces frequency counts and cross-tabulation tables, allowing to describe our data in a concise way (see supra). PROC FREQ is also a statistical procedure allowing analysis of the relationships among the variables. The test statistically tests the null hypothesis of no association between the row variable and the column variable. We used the Pearson chi-square statistic analysing the differences between

	Fields (m²)	Meadows (m²)	Built-up (m²)	Forest (m²)	Brook (m)	Roads (m)	Field edges (m)	Meadow edge (m)	Orchard (m²)	Tree lines (m)
Fields		134.3492 <.0001	n.s.	n.s.	n.s.	n.s.	63.004 <.0001	n.s.	n.s.	n.s.
Meadows			n.s.	n.s.	n.s.	n.s.	35.0657 <.0001	n.s.	n.s.	10.0633 0.0015
Built-up				n.s.	n.s.	7.6275 0.0057	n.s.	12.0714 0.0005	8.7671 0.0031	8.7671 0.0031
Forest					8.3161 0.0039	11.1083 0.0009	n.s.	n.s.	18.7538 <.0001	9.2841 0.0023
Brook						n.s.	n.s.	7.1429 0.0075	n.s.	16.3025 <.0001
Road							n.s.	8.3974 0.0038	n.s.	n.s.
Field edges								8.3974 0.0038	n.s.	n.s.
Meadow edges									10.0633 0.0015	7.1006 0.0077
Orchards										9.5764 0.002

Table 5. Chi-square values and level of significance of 2 by 2 frequency tests for independence of median values of all tested landscape elements in Herzele.
Tabel 5. Chi-kwadraat waarden en significantiegraad van 2 bij 2 frequentietesten voor onafhankelijkheid van mediaan van alle onderzochte landschapselementen in Herzele.

Positive associations *Positieve associaties* — Negative associations *Negatieve associaties*

the observed and expected frequencies. The observed frequencies are then compared to the expected ones and the probability for rejecting the null hypothesis is given and should be inferior to 0.05. We tested for associations between the landscape elements and between the landscape elements and the presence or absence of Little Owl.
We tested all possible combinations of every landscape parameter for association. To analyse the landscape parameters with a nearly overall presence in the cells we used the median value to split the observations (i.e. meadows, fields, roads, tree lines, meadow edges, field edges). When the median of a landscape parameter was 0, we dichotomised the samples splitting those cells with and without the landscape parameter present (i.e. for orchards, forest, built-up areas and brooks). The medians or the presence/absence as used in the median test of every landscape element is given in Table 1.

Habitat preference can be analysed similarly (Table 4) using the median of the landscape parameter as dichotomiser on the one hand and the occupation count of the cells by Little Owl on the other hand.

RESULTS

We first discuss the associations that we found between landscape elements themselves and then between the landscape elements and the Little Owl presence.
Table 5 shows all combinations of the landscape parameters. Chi-square values and significance levels are given for every combination.

Remarkable is that field surfaces and field edge lengths are positively associated while meadow edge lengths are not associated with meadow surface but positively associated with field edges. This can be explained by the following examples as illustrated by Figure 2. Both examples have the same surface of meadows and fields. The second example has a mosaic like distribution of the meadow surfaces in the fields. Hence both field edge length and meadow edge length are more associated with field surface than with meadow surface.
The importance of associations in landscape parameters is useful during the interpretation of the association of Little Owl presence with the individual

landscape parameters. If mutual association exists among landscape elements, then the interpretation should be made very cautiously.

Median tests of the 10 landscape parameters with Little Owl yield a positive association of Little Owl presence with field surface (Table 4) and field edge length (Table 6), while a negative association is seen with forest presence (Table 7) and road length (Table 8). Other landscape parameters show no association with Little Owl presence using the median test.

DISCUSSION

Earlier research on this dataset using multiple logistic regression (Van Nieuwenhuyse and Bekaert, submitted) predicting the probability of occupation of cells by Little Owl, revealed that forests and built-up areas have a negative impact on occupation. Multiple logistic regression of the principal components of a Principal Component Analysis (PCA) showed a positive relation with the meadow-edge-orchard-edge related dimension, a negative relation with the road-related dimension and the built-up area related dimension.

The median test of the same landscape parameters confirms the negative relation between Little Owl and roads and forest presence as found with logistic regression. The presence of built-up areas does not show any negative association with the species in the median test. Fields and field edges show a positive relationship with Little Owl using the median test in

Chi-square: 4.16 Prob: < 0.04	Occupied cells	Unoccupied cells
Cells with field edge length below median	Number of occupied cells with field edge length below median **27 (16%)**	Number of unoccupied cells with field edge length below median **48 (28%)**
Cells with field edge length parameter above median	Number of occupied cells with field edge length above median **21 (12%)**	Number of unoccupied cells with field edge length above median **75 (44%)**

Table 6. Two by two matrix with cell frequencies of occupied or unoccupied grid cells and grid cells above or below the median of the field edge length.
Tabel 6. Twee bij twee matrix met frequenties van onderzochte hokken die al dan niet bezet zijn en die boven of onder de mediaan van akkerrand liggen.

Chi-square: 4.16 Prob: < 0.04	Occupied cells	Unoccupied cells
Cells with forest absent	Number of occupied cells with forest absent **21 (12%)**	Number of unoccupied cells with forest absent **75 (44%)**
Cells with forest present	Number of occupied cells with forest present **27 (16%)**	Number of unoccupied cells with forest present **48 (28%)**

Table 7. Two by two matrix with cell frequencies of occupied or unoccupied grid cells and grid cells with forest present or absent.
Tabel 7. Twee bij twee matrix met frequenties van onderzochte hokken die al dan niet bezet zijn en waar bos al dan niet aanwezig is.

Chi-square: 4.06 Prob: < 0.04	Occupied cells	Unoccupied cells
Cells with roads below median	Number of occupied cells with roads below median **16 (9%)**	Number of unoccupied cells with roads below median **62 (36%)**
Cells with roads parameter above median	Number of occupied cells with roads above median **32 (19%)**	Number of unoccupied cells with roads above median **61 (36%)**

Table 8. Two by two matrix with cell frequencies of occupied or unoccupied grid cells and grid cells above or below the median of road length.
Tabel 8. Twee bij twee matrix met frequenties van onderzochte hokken die al dan niet bezet zijn en die boven of onder de mediaan van wegen liggen.

contrast to the logistic regression. Fields might be indirectly associated with Little Owl because of the association between fields and field edges in Herzele. Field edges on their turn might reveal the importance of borders for Little Owl in general and indirectly also show the importance of meadow edges since the latter feature a positive association with field edges. In the logistic regression built-up areas were negatively associated with Little Owl presence, while the median test shows no negative associations. Fields and field borders appear only in the median test and not in the logistic regression while meadow and orchard edges do. Roads appear in the median test as negative, not the built-up areas, while built-up areas and roads are discriminative in the logistic regression probably due to a positive association between the landscape parameters themselves. The negative association with roads is in contrast to the results of Hernandez (1988) probably because of the positive association of roads with built-up areas that might not be the case in Spain. Hence road density in Herzele is rather a reflection of the degree of buildings and hence a negative association with Little Owl is very logic. This observation illustrates the importance of a holistic view of the landscape rather than a univariate approach per landscape element.

Relevance to Little Owl

The species shows both positive associations with certain landscape parameters and negative ones. We discuss the ecological relevance of the associations as found in Herzele.

Positive associations

Borders

Borders of meadows and fields function as gradients between short and tall vegetation (ecotones or edge structures) and have special importance for the species (Génot and Van Nieuwenhuyse, submitted). A high proportion of edge structures relative to the surface is associated with smaller parcels and might increase the diversity in species of herbivores (e.g. cattle, sheep, goats, horses) which optimises heterogeneity in vegetation heights (Dalbeck et al. 1999); roads are preferred in Spain by the species due to their gradient nature (Hernandez 1988), pasture fences correlate positively with population densities in Germany (Loske 1986); a preference of the species is

Photo by / *Fotograaf: Marco Mastrorilli ©*

found for open fields surrounded by hedges in Spain (Zuberogoitia and Campos 1997) and the length of hedges in The Netherlands correlates with the species density (Visser 1977). Sometimes the boundaries of meadows and pastures (e.g. fences, ditches, roads) even correspond to territorial borders (Finck 1990). In pastures we see the lowest impact of over-fertilisation along the fences or parcel borders (Twisk et al. 1991). The importance of meadow borders and orchard borders for prey accessibility and prey availability is discussed in Van Nieuwenhuyse and Bekaert (submitted).

Negative associations

Factors decreasing prey accessibility, prey availability, cavity presence and increasing predator pressure or human influence have a negative impact on Little Owl densities (Génot and Van Nieuwenhuyse, submitted).

Increase of arable land has a negative impact on densities in Germany; furthermore trees are positively correlated with meadows and negatively correlated with arable land (Loske 1986). The fact that the species avoids larger forests, is illustrated by the spread of the species in Europe which occurred only after the principal deforestation period (9th-10th century) (Schönn et al. 1986). Abandoning agricultural exploitation reduces the availability of short vegetation (Juillard et al. 1992). The species also avoids traffic (Fajardo et al. 1998), forest (Schönn et al. 1991, Van Nieuwenhuyse and Bekaert, submitted); villages with few but large grassland areas (Dalbeck et al. 1999) and woods and closed meadow lands (Centili 1996). Avoidance of forest and forest edges can also be explained as a strategy of the species for

SAMENVATTING

De gemeente Herzele in Oost-Vlaanderen (43 km^2) is onderzocht op de aanwezigheid van Steenuilen gebruik makende van een gestandaardiseerde inventarisatiemethode. Dit leverde een totaal van 123 bezette hokken van 25 ha op, tegen 48 niet bezette. Het gebied werd onderverdeeld in hokken van 500 bij 500 m (25 ha) op basis van het UTM-raster. Van elk hok werd een kwantitatieve voorstelling van landschapselementen gemaakt (Tabel 1). De landschapselementen werden op transparanten gezet met de stafkaart (schaal 1/25000, 1975) als ondergrond en manueel opgemeten met millimeterpapier (oppervlaktes) en een koordje (lengtes). Hierbij werden tien categorieën van landgebruik en lijnvormige landschapselementen onderscheiden (Tabel 1). Associaties tussen de landschapselementen werden geanalyseerd met behulp van de mediaan test. De mediaantest (Siegel en Castellan, 1988) is een procedure om te testen of twee onafhankelijke groepen van elkaar verschillen in basiskenmerken. In dit geval kan deze test ons leren of bezette en niet bezette delen van een landschap geput zijn uit een verzameling met dezelfde mediaan, bijvoorbeeld voor een specifiek landschapskenmerk. De nulhypothese is dat de twee groepen een staal zijn uit een verzameling met dezelfde mediaan; de alternatieve hypothese zou kunnen zijn dat de mediaan van beide verzamelingen van elkaar verschilt. Om deze test te kunnen doen bepalen we eerst de mediaan van beide landschapskenmerken die we wensen te onderzoeken. We gieten dan de resultaten in een 2 bij 2 tabel (Tabel 2) met een opsplitsing in twee met name boven en onder de mediaan. Alle mogelijke associaties tussen landschapselementen enerzijds onderling en anderzijds met aan- of afwezigheid van de Steenuil werden getest. Om de vrijwel overal aanwezige landschapsparameters te analyseren werd de mediaan gebruikt als splitsfactor; indien die mediaan 0 was, gebruikten we echter gewoon de aan- of afwezigheid van dit element (Tabel 1). Ook habitatvoorkeur kan zo onderzocht worden (Tabel 4) waarbij enerzijds de mediaan van een landschapskenmerk als splitsingsfactor gebruikt wordt en anderzijds het al dan niet bezet zijn door Steenuil. Van alle mogelijke combinaties tussen landschapsparameters (Tabel 5) valt op dat de oppervlakte akker en de lengte akkerrand een positieve associatie vertonen terwijl de lengte rand van weiland niet geassocieerd is met oppervlakte weiland maar wel met lengte akkerrand. Hoe dit kan, wordt getoond in Figuur 2. De associatie tussen landschapsparameters is nuttig bij de interpretatie van de associatie tussen aanwezigheid van de soort en landschapselementen. Bij dit laatste is voorzichtigheid geboden indien wederzijdse associatie tussen landschapselementen voorkomt. De mediaantest van tien landschapsparameters bij Steenuil levert een positief verband op tussen aanwezigheid van Steenuil en oppervlakte akker (Tabel 4) en lengte akkerrand (Tabel 6). Aanwezigheid van bos en lengte wegen leverden een negatieve associatie op (Tabellen 7 en 8). De mediaantest van sommige landschapsparameters bevestigt het met logistische regressie (Van Nieuwenhuyse en Bekaert, submitted) aangetoonde verband tussen Steenuil enerzijds en aanwezigheid van bos en bebouwing anderzijds. Het positief verband met akker en akkerrand staat haaks op de resultaten van de logistische regressie. Het verband tussen Steenuil en akker kan in Herzele indirect zijn omwille van de associatie tussen akker en akkerrand. Akkerranden kunnen dan weer

predator avoidance. Apparently suitable but unoccupied habitat in Biscay (Northern Spain) has been found to occur within the distribution area of Tawny Owls. Attacks of Tawny Owl on Little Owl have been observed on three occasions (Zuberogoitia and Campos 1997). Mikkola (1983) reported the presence of Little Owls in Tawny Owls *Strix aluco* diet and Schönn (1986) found no overlaps of territories of the two species. Up to now there is no data available on the impact of the recent increase in population numbers of Tawny Owls towards the northern and western part of Flanders ("Project Vlaamse Broedvogelatlas 2000-2003" G. Vermeersch, pers. comm. (www.instnat.be/broedvogels/). The evolution of both species in relation to each other is of great concern for Flanders. Habitat selection in the UK showed that areas, composed of half-open landscapes intermingled with patches of forest is also used as hunting area by Tawny Owl (Redpath 1995).

CONCLUSION

Despite its shortcomings as far as repeatability is concerned, the median test is useful in general habitat preference studies. It is very easy to use and available in most spreadsheets and gives a good idea of habitat preference. In Herzele the results of both logistic regression and of the median test con-

de voorkeur van Steenuil voor alle randzones vertolken en onrechtstreeks ook de voorkeur van Steenuil voor randen van weilanden blootleggen gezien de positieve associatie tussen akkerrand en weiranden. De mediaantest levert geen negatieve associatie met bebouwing op en de logistische regressie wel. Akker en akkerrand duiken in tegenstelling tot weirand en boomgaardrand enkel in de mediaantest op. In deze test hebben wegen een negatieve invloed en bebouwing niet. Bij logistische regressie zijn wegen en bebouwing nadelig, vermoedelijk omdat de lintbebouwing er voor zorgt dat ze samenhangen. Dit laatste verklaart ook het negatief verband met wegen bij de mediaantest. Dit onderstreept het belang van een globale benadering van het landschap. Uit overige onderzoeken blijkt het belang van randzones in landbouwgebieden met hun overgang tussen lage en hoge vegetatie. Veel randen wijst op kleinschaligheid en brengt vaak ook meer variatie in begrazing en vandaar ook in vegetatiehoogte. Wegen zorgen ook voor meer overgangen en kunnen ook een positief effect hebben op de Steenuil. Afsluitingen van graslanden, velden omzoomd door hagen of de relatieve lengte aan haagkanten kunnen verspreid in Europa ook positief werken. De randzones vallen soms samen met de territoriumgrenzen en zijn vaak ook in verhouding minder intensief bemest. Overige onderzoeken leren ons dat factoren die het aanbod aan prooien en nestplaatsen doen afnemen en een hogere druk van predatoren en menselijke invloeden een negatieve impact hebben op de dichtheden van deze soort. Plaatselijk kan een toename aan akkers ook nadelig werken, zeker als blijkt dat bomen daar ook negatief gecorreleerd zijn met akkers. Ook landbouwgronden die niet langer bewerkt worden verliezen hun waarde voor de Steenuil omdat de begroeiing er te hoog wordt. Historisch hebben ontbossingen in het voordeel van de soort gewerkt. Niet alleen de bossen zelf zijn niet interessant voor deze soort, maar bosranden of de nabijheid van bos kan ook gemeden worden, eventueel ten gevolge van de aanwezigheid van de Bosuil. Gezien deze soort in Vlaanderen al geruime tijd aan een sterke expansie bezig is, lijkt die onderlinge relatie voor ons van erg groot belang.

In conclusie is de mediaantest vrij goed bruikbaar in studies rond algemene habitatvoorkeur. De relatieve eenvoud van deze test werkt drempelverlagend. In Herzele bevestigen de resultaten van de mediaantest en van logistische regressie de negatieve associatie met bossen en wegen. Logistische regressie laat een positieve associatie met randen van weiden en van boomgaarden zien, waar de mediaantest dat aantoont voor akkers en akkerrand. De duo's wegen/ bebouwde gebieden en akkerrand/ weirand zijn telkens positief geassocieerd met elkaar, los van de Steenuil. Logistische regressie en de mediaantest blijken dus ook complementair te zijn. De mediaantest kan gebruikt worden om plaatselijke studies met elkaar te vergelijken waar de mediaan van landschapselementen vergelijkbaar is. Gezien de soepelheid in habitatvereisten bij de Steenuil is de kans reëel dat de mediaan elders sterk verschillend is. Het aan- of afwezigheidscriterium is daarom veel bruikbaarder. De door de niet-parametrische mediaantest verkregen resultaten bevestigen grotendeels deze door de logistische regressie, een parametrische test.

Samenvatting door Koen Leysen

firm the negative association of Little Owl with forests and roads, logistic regression shows a positive association with meadow and orchard edges, while the median test show positive association with fields and field edges. Both roads and built-up areas respectively and field edges and meadow edges are positively associated with each other independently from the Little Owl. The logistic regression hence confirms partly other associations than the median test which makes both techniques complementary. The median test is useful to compare local studies where the median values of the landscape elements are comparable. Since the habitat requirements of Little Owl are general (Ferrus et al. in press) rather than selective, the chance of having different median values elsewhere is substantial. The presence/absence criterium hence is much better and should be preferred to the median. The results as obtained using the median test (non-parametric) mainly confirm the results as obtained by logistic regression (parametric).

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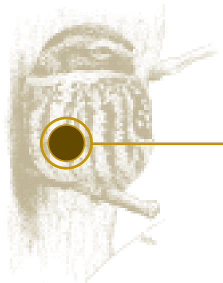

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9. HABITAT TYPOLOGIES OF LITTLE OWLS *ATHENE NOCTUA* TERRITORIES IN FLANDERS (NORTHERN BELGIUM)

Focusing on what really matters through Principal Component Analysis and Cluster Analysis

HABITATTYPOLOGIEËN VAN STEENUIL *ATHENE NOCTUA* TERRITORIA IN VLAANDEREN

Focussen op wat echt telt via Principale Componenten Analyse en Cluster Analyse

DRIES VAN NIEUWENHUYSE* AND MARC LEYSEN

ABSTRACT

A Little Owl census was performed in the spring of 1998, 1999 and 2000 in Flanders, northern Belgium using a standardised inventory method. A total of 8932 squares of 500 by 500m were sampled covering 2233 km^2. A random selection of 2344 non-overlapping observation points (300m radius) was analysed with Principal Component Analysis and Cluster Analysis. We used 57 variables of the digital Biological Valuation Map and the Farming Parcel Map. Eight principal components with an eigenvalue above 2 explain 45% of the variance. Of 20 clusters obtained after Cluster Analysis of the first eight principal components, 7 contained at least 50 observation sites and made up a vast majority of the samples. The different typologies are characterised and a possible degree of threat is determined based on Little Owl requirements i.e. prey availability, prey accessibility and presence of cavities. The cluster members were checked for a random distribution across the Flemish ecological regions to ascertain the validity of the coverage. Two clusters, with a limited number of members, were over-represented in two different ecological regions, the majority of the samples however are randomly spread over the Flemish ecological regions. The use of the habitat typologies is discussed as a tool in the definition of a sustainable monitoring scheme.

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INTRODUCTION AND OBJECTIVES

Birds are interesting bio-indicators for long-term monitoring programs of the environment (Furness and Greenwood 1993). When the objective of a monitoring program is to detect phenomena with slow rates of change, e.g. persistent organochlorides, decrease of food abundance, landscape and land-use changes, extended persistence of the program is critical. Little Owls *Athene noctua* constitute a simple and cheap bio-indicator for Flanders environmental and landscape quality because of some biological reasons e.g. its high abundance and its high trophic level and because of some logistic reasons e.g. the available expertise among dedicated volunteers makes this also inexpensive and more likely to persist. The main aim of this study is to identify habitat typologies of Little Owls in Flanders in order to prepare the basis for a focused and persistent long-term Flemish surveillance of habitats of different qualities of the species.
Therefore we wish to

- identify the principal heterogeneity that exists among the occupied sites
- identify different habitat categories in a straightforward and objective way
- assess the quality of the different habitat typologies using current conservation-biological insights to allow us to identify both optimal and sub-optimal habitats
- select representative sampling points for surveillance (repeated survey using standardised methods; Furness and Greenwood 1993) of Little Owl presence or absence and its limiting resources e.g. landscape elements, cavities, prey) in the future

The following questions will be answered in this paper: Which landscape parameters are really varying among occupied sites? What do we need to measure (which habitats and which landscape parameters)? What kind of plasticity is the Little Owl displaying in Flanders in function of the available landscapes? Are different typologies depending on the ecological region or randomly spread over Flanders?

METHODS

Study area

The research area of Flanders is extensively described in this volume (Leysen et al. 2001).
The six ecological regions of Flanders (Figure 1) are discussed in De Blust & Bauwens (1999).

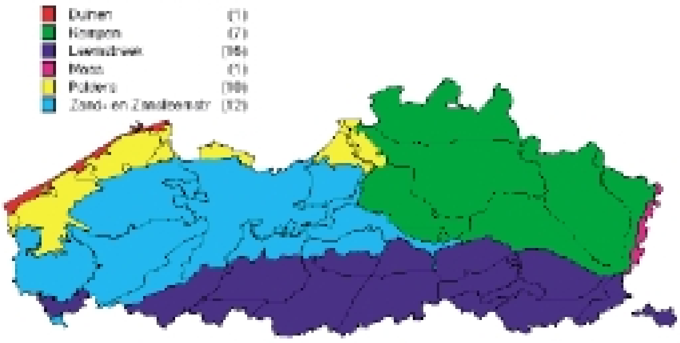


Figure 1. Ecological regions of Flanders (De Blust and Bauwens, 1999) (Zand-Zandleem streek = Sand-Sandy Loam region; Leemstreek = Loam region).
Figuur 1. Ecologische regio's van Vlaanderen (De Blust and Bauwens, 1999).

Data collection method

We used the presence/absence of the Little Owl as our measured variable in February-April using one passage per year with playback at fixed geographical locations at fixed intervals and registration of all answering individuals (Leysen et al. 2001). This method features a limited resource-consumption (time, equipment) yielding accurate and reliable results for Little Owl presence. The standard method imposes the inventory of at least 4 km^2 or 16 sample points in a time-span of approximately two nights. A total of 8932 squares of 500 by 500m were sampled (2233 km^2) yielding 9116 fixes. We selected arbitrarily 2344 (approximately 25%) three-hundred meter radius circles around observation points chosen at random out of the fixes or observations. Only non-overlapping circles were withheld in order to avoid pseudo-replication.
Fifty-seven available landscape parameters from two data sets i.e. Biological Valuation Map (BVM) and the Farming Parcel Map (FPM), were measured using MapInfo (See Leysen et al. 2001 for an extensive description of the data sources as used). Only circles with close to complete coverage by the Biological Valuation Map (at least 28ha or 99% of the area) were included in the analysis. Figure 2 shows a map of the distribution of the randomly sampled points.

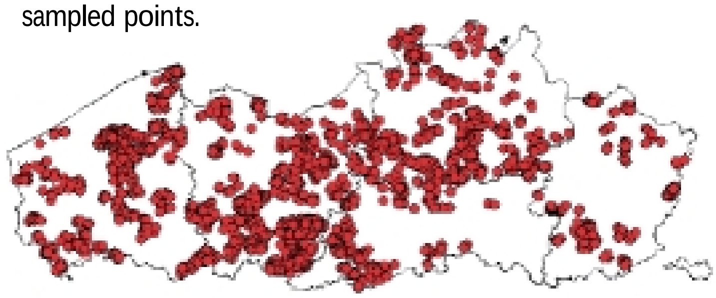


Figure 2. Geographical distribution of 2344 randomly selected Little Owl habitats in Flanders. The circles are disproportionate to the 300m radius and arbitrarily chosen for the graphic representation.
Figuur 2. Geografische verspreiding van 2344 willekeurig gekozen niet-overlappende Steenuil-territoria. De cirkels beantwoorden niet aan de schaal in functie van de grafische voorstelling.

Statistical methods

We used SAS/STAT version 8.0 software (SAS Institute Inc., Cary, NC, USA) for all statistical analysis. Fifty-seven descriptive variables underwent a Principal Component Analysis (PROC PRINCOMP, SAS Institute 1989) in order to reduce the number of variables to work with and in order to remove correlation that exists among the variables. The purpose of Principal Component Analysis is to derive a small number of linear combinations of a set of variables that retains as much of the initial information as possible. The principal components are perpendicular and no correlation exists between these new variables.
Disjoint cluster analysis on the basis of Euclidean distances (PROC FASTCLUS, SAS Institute 1989) is then used to place objects into groups or clusters suggested by the data such that objects in a given cluster tend to be similar to each other and objects in different clusters tend to be dissimilar. Either the

original variables are used or the principal components. We used the latter in our segmenting analysis of the sites.

Finally a frequency table (PROC FREQ, SAS Institute 1989) or contingency table is used to analyse the distribution of the samples and the resulting habitat types over different ecological regions and to check for over-representation of some types in some regions.

RESULTS

Principal Component Analysis

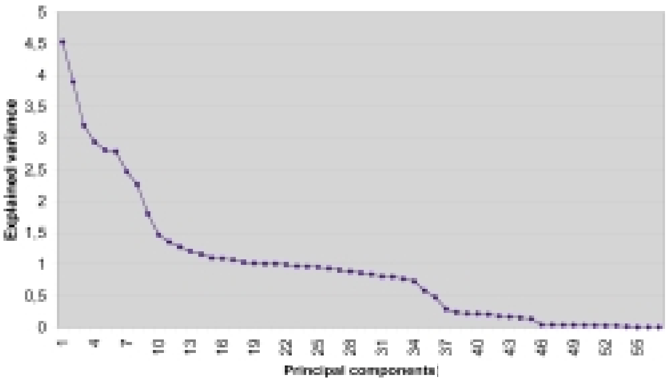


Figure 3. Scree plot of the principal components as obtained from a Principal Component Analysis of 57 landscape variables (Biological Valuation Map and Farming Parcel Map) of 2344 randomly selected Little Owl habitats in Flanders.

Figuur 3. Scree-plot van de principale componenten zoals bekomen uit de Principale Componenten Analyse van 57 landschapselementen (Biologische Waarderingskaart en Landbouwperceelskaart) van 2344 willekeurig gekozen Steenuil-territoria in Vlaanderen.

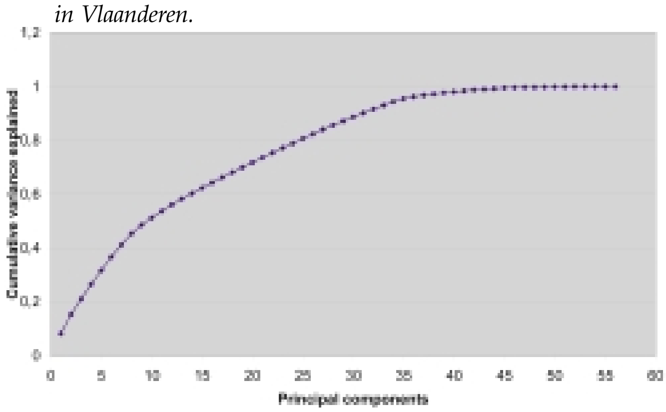


Figure 4. Cumulative explained variance of the principal components of 57 landscape variables (Biological Valuation Map and Farming Parcel Map) of 2344 randomly selected Little Owl habitats in Flanders.

Figuur 4. Cumulatieve verklaarde variantie van de principale componenten van 57 landschapselementen (Biologische Waarderingskaart en Landbouwperceelskaart) van 2344 willekeurig geselecteerde Steenuil-territoria in Vlaanderen.

PC1	
FPM perimeter cereals	0.31
FPM area cereals	0.31
FPM perimeter rowcrops	0.30
FPM area rowcrops	0.29
FPM number of cereal parcels	0.29
FPM number of rowcrop parcels	0.29
BVM Fields	0.28
FPM number of fallow parcels	0.12
FPM perimeter orchards	0.12
FPM area orchards	0.12
…	
BVM Urban with green	-0.03
FPM number of maize parcels	-0.03
FPM perimeter maize	-0.04
BVM Poplar	-0.04
BVM Pine forest	-0.05
FPM area maize	-0.07
FPM number of grassland parcels	-0.23
FPM perimeter grass	-0.26
BVM Grasslands	-0.27
FPM area grass	-0.28

PC2	
FPM perimeterbuildings	0.30
FPM number of buildings	0.30
FPM area buildings	0.29
FPM number of grassland parcels	0.25
FPM perimeter grass	0.25
BVM Fields	0.23
FPM number of rowcrop parcels	0.23
FPM perimeter rowcrops	0.22
FPM number of maize parcels	0.21
FPM perimeter maize	0.21
…	
BVM Half open	-0.09
BVM Quercus forest	-0.11
BVM Other elements	-0.12
FPM number of fallow parcels	-0.13
BVM Poplar	-0.13
FPM area fallow land	-0.13
FPM perimeter fallow land	-0.14
FPM number of orchards	-0.15
FPM area orchards	-0.16
FPM perimeter orchards	-0.16

Table 1. Contributions of the original variables to the respective principal components of 57 landscape variables (Biological Valuation Map -BVM- and Farming Parcel Map -FPM-) of 2344 randomly selected Little Owl habitats in Flanders. Only the 10 variables are shown with the highest positive and negative contribution respectively.

Tabel 1. Bijdragen van de originele veranderlijken tot de respectievelijke principale componenten van 57 landschapselementen (Biologische Waarderingskaart -BVM- en Landbouw-perceelskaart -FPM-) van 2344 willekeurig gekozen Steenuil-territoria in Vlaanderen. Slechts de 10 veranderlijken worden getoond met de hoogste positieve of negatieve bijdrage.

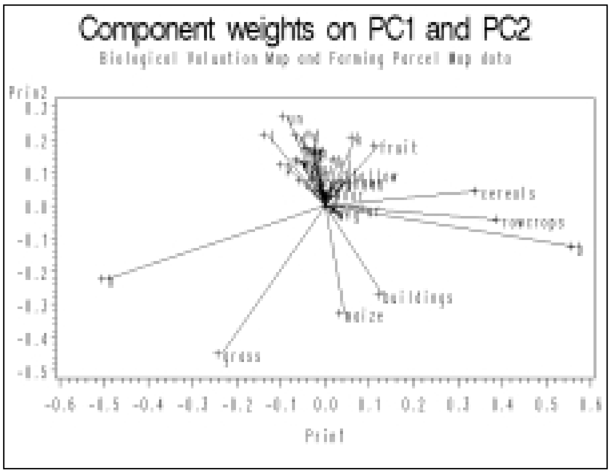


Figure 5. Graphical representation of the component weights on the first two principal components of 57 landscape variables of 2344 randomly selected Little Owl habitats in Flanders. (Legend: BVM=Biological Valuation Map; FPM: Farming Parcel Map; variable=data set description; b=BVM fields; d=BVM dunes; h=BVM grasslands; k=BVM other elements; f=BVM Fagus forest; l=BVM Poplar forests; n=BVM Broad-leaved forest; p=BVM Pine forest; q=BVM Quercus forest; un=BVM open with much green; ur=BVM rural; weg=BVM roads; spoor=BVM railways; buildings=FPM area of farm buildings; rowcrops=FPM area of rowcrops; fruit=FPM area of orchards; grass=FPM area of grasslands; maize=FPM area of maize; fallow=FPM area of fallow lands; cereals=FPM area of cereals).

Figuur 5. Grafische voorstelling van de component gewichten van de eerste twee principale componenten van 57 landschapselementen van 2344 willekeurig gekozen Steenuil-territoria in Vlaanderen. (Legende: BWK=Biologische Waarderingskaart; LPK: Landbouw-percelengebruikskaart; veranderlijke=gegevensbestand beschrijving; b=BWK akkers; d=BWK duinen; h=BWK graslanden; k=BWK andere elementen; f=BWK Fagus bos; l=BWK Populierenbos; n=BWK Loofbos; p=BWK Naaldbos; q=BWK Quercus bos; un=BWK open gebied met veel groen; ur=BWK ruraal; weg=BWK wegen; spoor=BWK spoorweg; buildings=LPK oppervlakte landbouwgebouwen; rowcrops=LPK oppervlakte gewassen op rijen; fruit=LPK oppervlakte boomgaarden; grass=LPK oppervlakte graslanden; maize=LPK oppervlakte maïs; fallow=LPK oppervlakte braakliggend; cereals=LPK oppervlakte graangewassen).

The choice of the number of principal components to retain is arbitrarily and based on the scree-plot of the principal components (Figure 3). The graph visualises the amount of variance that is explained by every principal component or the so-called eigenvalues. The number of components selected for further analysis is arbitrarily set at 8 i.e. an eigenvalue of at least 2. The cumulative distribution of the explained variance is given in Figure 4. The eight principal components explain 45% of the total variance of the 57 variables for the combined data set. The PCA will transpose the data to emphasise the differences and to bundle the similarities between the habitat components. The relation between the new variables and the initial variables (Table 1) allows assessment of the contribution of every initial dimension on the new dimension. The variables that score high per principal component either positively or negatively have a high contribution to the latent variable. The first principal component bundles the variables that characterise cereal and row-crop presence and grassland absence (perimeter, area and number of parcels). Similar information coming from the two sources is also bundled i.e. the grassland area of the Biological Valuation Map (grasslands) and the perimeter, area and number of grassland parcels of the Farming Parcel Map (grass). The orientation of the initial variables that result in the principal components can also be represented in a graph (Figure 5) that shows the gradient between grasslands (h and grass; at the left of the plot) and fields (cereals, row crops and b; at the right of the plot). The second principal component (PC2) is mainly characterised by farm buildings and grasslands (the number of parcels, the perimeter and area).

A similar assessment was done for the 8 components and yields the following latent variables:

- PC1: FIELDS; Fields dimension with scarcity of grasslands
- PC2: FARMS; Farm buildings and grassland
- PC3: TREE ROWS; Orchards and tree nurseries
- PC4: MAIZE; Maize and scarcity of tree nurseries and farms
- PC5: TREE NURSERIES; Tree nurseries and scarcity of orchards and maize
- PC6: OTHER LANDUSE; Other land-use and scarcity of fallow-land
- PC7: FALLOW; Fallow-land and scarcity of tree nurseries
- PC8: CEREALS AND GRASSLAND: Cereals and grassland and scarcity of maize

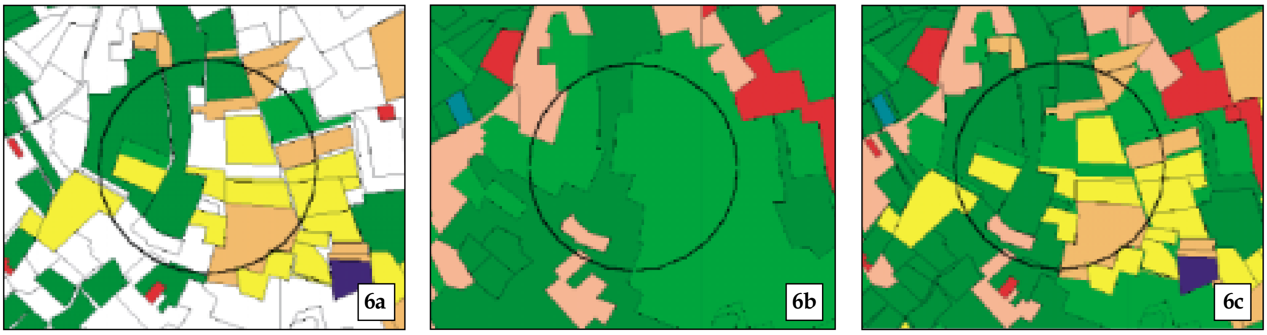
Cluster analysis

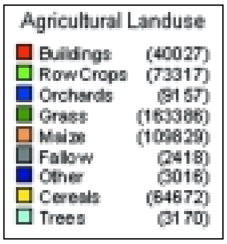
The projections of the original variables per site onto the principal component axes are used in the cluster analysis because they are not correlated and

contain most of the variance for a minimal number of variables. The observation sites were split in an arbitrary number of 20 clusters of which only the clusters with more than 50 sites were withheld, totalling 93% of the observation sites. The remaining clusters and habitats are true exceptions.
The number of cluster members per cluster illustrate the relative importance of the habitat type (Table 2). The cluster means allow us to assess the approximate standardised composition of habitat clusters in terms of the principal components. Furthermore, using the cluster allocation of every sample we can calculate the mean site composition of the original unstandardised variables (Table 3) e.g. habitat type 6 is mainly characterised by the scarcity of PC1 (i.e. FIELDS-dimension) as seen in the scarcity of fields (only 8.9ha), the abundance of grassland (15ha) and the presence of PC8 (i.e. CEREALS AND GRASSLANDS-dimension) seen as the presence of cereal fields (2ha) (Figure 6). Similar assessment of

		habitat type 11	habitat type 6	habitat type 15	habitat type 13	habitat type 2	habitat type 19	habitat type 12
Principal component 1	FIELDS	-0.09	-1.27	-0.47	3.01	1.01	3.82	-1.45
Principal component 2	FARMS	-1.12	0.71	1.29	2.17	-0.16	-1.26	3.80
Principal component 3	TREE ROWS	-0.68	-0.01	0.21	-0.70	0.23	0.65	2.54
Principal component 4	MAIZE	-0.34	-0.33	2.28	-0.78	1.73	1.12	-2.50
Principal component 5	TREE NURSERIES	0.12	-0.14	-1.96	0.84	1.41	-0.36	1.36
Principal component 6	OTHER LAND-USE	0.07	-0.59	0.41	-0.14	3.95	-2.34	0.48
Principal component 7	FALLOW LAND	-0.37	0.13	-0.32	-0.39	1.01	3.27	0.66
Principal component 8	CEREALS AND GRASSLANDS	-0.44	1.00	-0.98	-0.98	2.03	0.35	-0.36
Observation sites in cluster		843.00	703.00	245.00	215.00	83.00	58.00	54.00
Cumulative percentage		35.96	65.96	76.41	85.58	89.12	91.60	93.90
Percentage		35.96	29.99	10.45	9.17	3.54	2.47	2.30

Table 2. Cluster means, number of cluster members and cumulative percentage of the total sample of the 7 main clusters as obtained from the eight principal components of 57 landscape variables (Biological Valuation Map and Farming Parcel Map) of 2344 randomly selected Little Owl habitats in Flanders. Green cells indicate a relative abundance of the latent variable, red cells indicate a relative shortage of the latent variable.
Tabel 2. Cluster gemiddelden, aantal observaties per cluster en het cumulatieve percentage van het totaal staal behorende tot de 7 voornaamste clusters zoals bekomen uit de acht principale componenten van 57 landschapselementen (Biologische Waarderingskaart en Landbouwperceelskaart) van 2344 willekeurig gekozen Steenuil-territoria in Vlaanderen. Groene cellen duiden op een relatieve talrijkheid van de latente veranderlijke, rode cellen duiden op een relatief gebrek aan latente veranderlijke.





Randomly chosen Little Owl habitat (observation 1091) from habitat type 6 (GRASSLANDS AROUND FARMS TYPE).
Figure **6a**. Farming Parcel Map - Figure **6b**. Biological Valuations Map - Figure **6c**. Combination of Farming Parcel Map and Biological valuation Map.
Willekeurig gekozen Steenuil-territorium (observatie 1091) behorend tot habitat type 6 (GRASLANDEN ROND HOEVES TYPE).
Figuur **6a**. *Landbouw-perceelskaart - Figuur* **6b**. *Biologische Waarderingskaart - Figuur* **6c**. *Combinatie Landbouw-perceelskaart en Biologische waarderingskaart.*

variable name	data set	description	unity	habitat type 11	habitat type 6	habitat type 15	habitat type 13	habitat type 2	habitat type 19	habitat type 12
b	BVM	fields	square meter	79830.83	89201.75	150760.61	200917.35	112990.10	177503.50	139639.02
h	BVM	grasslands	square meter	116708.89	150938.94	100858.38	46313.21	113446.84	53318.43	77187.00
kb	BVM	tree lines	square meter	672.57	683.23	875.23	377.84	1918.29	1981.66	350.35
kh	BVM	hedges and wooded banks	square meter	63.12	53.52	83.62	21.15	669.99	581.33	0.00
kj	BVM	high stem orchards	square meter	3252.30	2156.74	883.33	475.09	1581.43	4591.21	1468.78
kp	BVM	park	square meter	2153.50	322.96	70.73	397.45	67.16	1421.22	330.19
		forest	square meter	18492.00	5603.51	7603.47	1462.73	10526.66	11724.02	3378.98
s	BVM	thicket	square meter	1052.06	795.42	168.20	151.79	387.71	228.74	149.31
un	BVM	open with much green	square meter	1526.00	293.73	632.51	0.00	1018.39	0.19	1167.28
ur	BVM	rural	square meter	16456.84	16979.56	8825.47	16554.71	15703.04	14467.53	31611.59
ua	BVM	half open	square meter	28007.60	7019.46	5982.75	9236.75	12487.11	4980.93	20777.02
weg	BVM	roads	square meter	203.40	150.76	144.28	425.48	81.63	76.60	235.94
buildings	FPM	area of farm buildings	square meter	1989.33	4384.47	2563.66	6716.96	3666.67	2423.76	21111.80
rowcrops	FPM	area of row crops	square meter	17570.83	12420.68	16317.14	94595.43	21930.93	29004.93	14365.93
fruit	FPM	area of orchards	square meter	1644.84	288.50	356.05	485.84	1890.65	3071.76	719.13
grass	FPM	area of grasslands	square meter	60398.02	135873.23	82490.83	58921.56	70746.65	46350.74	132345.06
maize	FPM	area of maize	square meter	28727.08	34335.60	104435.06	34138.69	45532.75	30223.83	38662.81
braak	FPM	area of fallow lands	square meter	26.10	21.28	8.82	11.90	146.46	6265.79	0.00
other	FPM	area of other parcels	square meter	78.94	114.82	118.36	86.13	11603.90	238.38	579.20
cereals	FPM	area of cereals	square meter	16636.56	20710.57	17099.44	38186.09	25603.99	64943.59	7001.19
trees	FPM	area of tree nurseries	square meter	338.54	294.56	214.62	187.35	622.61	226.47	395.72
pebuildings	FPM	perimeter of buildings	meter	150.07	323.82	177.04	449.36	266.96	153.16	1466.41
perowcrops	FPM	perimeter of row crops	meter	652.27	509.30	686.06	3366.81	951.20	1249.98	612.35
pefruit	FPM	perimeter of orchards	meter	64.44	11.31	11.76	18.50	58.30	134.07	24.26
pegrass	FPM	perimeter of grasslands	meter	2157.27	5007.87	3228.77	2385.96	2612.59	1795.38	5128.57
pemaize	FPM	perimeter of maize	meter	1076.28	1371.93	4222.20	1355.26	1793.54	1369.16	1547.70
pebraak	FPM	perimeter of fallow lands	meter	2.48	1.66	0.88	0.73	11.89	356.48	0.00
peother	FPM	perimeter of other parcels	meter	5.45	6.71	7.96	6.56	506.16	14.34	20.41
pecereals	FPM	perimeter of cereals	meter	618.04	849.98	741.29	1265.00	1049.53	2604.95	300.20
petrees	FPM	perimeter of tree nurseries	meter	13.29	14.88	10.12	12.55	24.12	12.62	17.24
nmbuildings	FPM	number of parcels of buildings	number	0.83	1.60	0.88	2.13	1.24	0.81	5.70
nmrowcrops	FPM	number of parcels of row crops	number	2.09	1.78	2.24	9.71	2.93	4.41	2.04
nmfruit	FPM	number of parcels of orchards	number	0.22	0.04	0.04	0.06	0.13	0.40	0.04
nmgrass	FPM	number of parcels of grasslands	number	5.92	13.05	9.76	6.81	7.24	5.14	13.13
nmmaize	FPM	number of parcels of maize	number	3.30	4.56	12.26	4.29	5.61	4.50	5.78
nmbraak	FPM	number of parcels of fallow lands	number	0.02	0.01	0.01	0.01	0.07	1.16	0.00
nmother	FPM	number of parcels of other parcels	number	0.04	0.03	0.07	0.04	1.52	0.09	0.11
nmcereals	FPM	number of parcels of cereals	number	1.96	2.83	2.49	3.68	3.10	8.12	1.11
nmtrees	FPM	number of parcels of tree nurseries	number	0.06	0.05	0.05	0.04	0.08	0.05	0.13

Table 3. Average composition of the original variables of the habitats belonging to the 7 main clusters as obtained from the eight principal components of 57 landscape variables (Biological Valuation Map=BVM and Farming Parcel Map=FPM) of 2344 randomly selected Little Owl habitats in Flanders. Only those variables are shown that have an uneven distribution across the clusters or habitat types. Green cells indicate a relative abundance of the variable, red cells indicate a relative shortage of the variable per cluster. Total surface 282743.34m^2 per map), variable name corresponds to label in Figure 5.

Tabel 3. Gemiddelde samenstelling van de originele veranderlijken van de habitats behorende tot de 7 voornaamste clusters zoals bekomen uit de acht principale componenten van 57 landschapselementen (Biologische Waarderingskaart en Landbouw-perceelskaart) van 2344 willekeurig gekozen Steenuil-territoria in Vlaanderen. Alleen die veranderlijken met een ongelijke verspreiding over de clusters worden getoond. Groene cellen duiden op een relatieve talrijkheid van de latente veranderlijke, rode cellen duiden op een relatief gebrek aan latente veranderlijke. Totale oppervlakte 282743.34m^2 per staal, de naam van de veranderlijke komt overeen met het label in Figuur 5.

		Ecological region				
	Cluster	Kempen	Leemstreek	Polders	Zand-Zandleemstreek	Total
Frequency	2	28	29	0	26	83
Row Percent		33%	35%	0%	31%	100%
Frequency	6	128	268	61	235	692
Row Percent		19%	39%	9%	34%	100%
Frequency	11	253	341	19	208	821
Row Percent		31%	42%	2%	25%	100%
Frequency	12	11	1	0	42	54
Row Percent		20%	2%	0%	**78%**	100%
Frequency	13	2	58	23	132	215
Row Percent		1%	27%	11%	61%	100%
Frequency	15	53	47	7	130	237
Row Percent		22%	20%	3%	55%	100%
Frequency	19	1	33	7	13	54
Row Percent		2%	**61%**	13%	24%	100%
Frequency	Total	476	777	117	786	2156
Row Percent		**22%**	**36%**	**5%**	**36%**	**100%**

Table 4. Distribution of the 7 main clusters as obtained from the eight principal components of 57 landscape variables (Biological Valuation Map and Farming Parcel Map) of 2344 randomly selected Little Owl habitats in Flanders and the 4 principal ecological regions of Flanders. The "Dunes" and "Meuse" ecological region are omitted.
Tabel 4. Verspreiding van de 7 voornaamste clusters zoals bekomen uit de acht principale componenten van 57 landschapselementen (Biologische Waarderingskaart en Landbouw-perceelskaart) van 2344 willekeurig gekozen Steenuil-territoria in Vlaanderen en de 4 voornaamste ecoregio's van Vlaanderen. De Duinen en Maas-ecoregio zijn buiten beschouwing gelaten.

the other clusters was done and yielded the following habitat typologies for Flanders:

- Habitat type 11(n=843; 36%): HALF OPEN GRASSLANDS TYPE: remote grasslands with few buildings, few fields and relatively many orchards and half open park landscapes and woods
- Habitat type 6 (n=703; 30%): GRASSLANDS AROUND FARMS TYPE: grasslands close to farms
- Habitat type 15 (n=245; 10%): FARMLESS CATTLE BREEDING TYPE: remote grasslands combined with many maize fields
- Habitat type 13 (n=215; 9%): HORTICULTURAL TYPE: horticulture habitats (row crops) close to farms
- Habitat type 2 (n=83; 4%): RURAL CATTLE BREEDING TYPE: rural cattle breeding areas with a balance between (maize)fields and grasslands, tree lines and woods
- Habitat type 19 (n=58; 2%): REMOTE CEREAL AND ORCHARD TYPE: remote cereal fields, tree-lines and high-stem orchards
- Habitat type 12 (n=54; 2%): URBANISED CATTLE BREEDING TYPE: urbanised cattle breeding with fields, grasslands and maize

Test for random distribution of habitat types over ecological regions

Habitat type 12 is over-represented in the Sand-Sandy Loam region ("Zand-Zandleemstreek") i.e. 78% of habitats of this type are situation in this region while only 36% of all habitats are situated there and habitat type 19 is over-represented in the Loam region ("Leemstreek") i.e. 61% of habitats (See Table 4 row percentage for cluster 12) of this type are situated in this region while only 36% (See Table 4 row percentage total) of all habitats are situated there. Other types are proportionally spread over the regions i.e. the number of observed sites per cell does not differ too much from the expected number (last row). Due to the occurrence of several cells with less than 5 observations, the chi-square test is not valid (SAS Institute 1989).The two disproportionately distributed clusters have the smallest number of cluster members (respectively 58 and 54).An indication of relative independence is offered by a graphical representation of the different clusters over the Flemish territory (Figure 7).

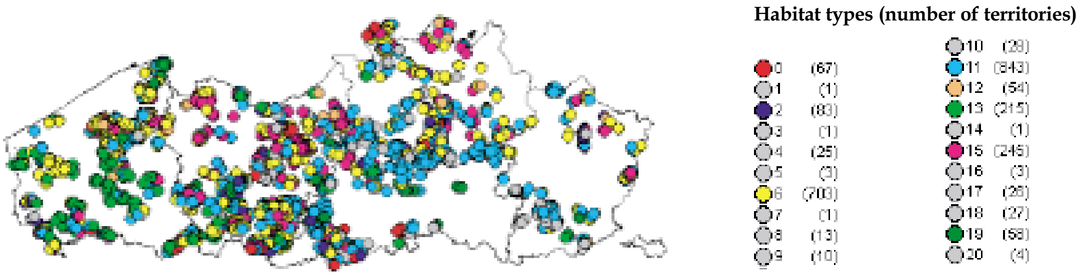


Figure 7. Distribution of 2344 randomly selected Little Owl habitats in Flanders in one of 20 clusters as obtained from a Cluster Analysis of the 8 principal components of 57 landscape variables (Biological Valuation Map and Farming Parcel Map).
Figuur 7. Verspreiding van 2344 willekeurig geselecteerde Steenuil-territoria in Vlaanderen volgens cluster zoals bekomen via een Cluster Analyse van acht principale componenten van 57 landschapselementen (Biologische Waarderingskaart en

DISCUSSION

Knowledge of different habitat typologies allows us to select representative sampling points for surveillance of the Little Owl in its living environment. We removed noise from the data since we only withheld the main clusters (with 2201/2344 observation sites or 93% of the samples). Based on the currently available independent variables we could consider the rest as outliers for Little Owl in Flanders. In terms of sustainability we believe we can dedicate most of the resources for future monitoring and conservation to these 7 habitat types. With these types we can assess the evolution in an objective, representative and optimal way since both optimal and sub-optimal habitats are included and distinguished. Hence it becomes possible to determine and track the extremities of the gradients in which Little Owls occur. The evolution of the habitat quality and existing populations in sub-optimal habitat is more likely to show the actual evolution than in optimal habitat since the resources are probably closer to their limits there. A focused surveillance in the future will allow us to confirm or reject the quality per type as assessed.

Quality assessment

Of the different typologies, habitat type 15 (10% of the habitats) is characterised by the presence of unfavourable or the lack of favourable landscape elements for Little Owls: i.e. an abundance of maize, few tree nurseries, few farms, few orchards. The abundance of maize has a negative impact on the species for areas beyond the optimum of 65a per 25ha (Van Nieuwenhuyse, Leysen et al. 2001). A limited number of farms has a positive impact on Little Owls in France (Bretagnolle et al. 2001). Farm buildings however have a second order effect on the species in Flanders i.e. in small numbers the presence has a positive impact on Little Owl occurrence, when the land-cover surpasses 21a per 25ha, the impact becomes negative (Van Nieuwenhuyse, Leysen et al. 2001). The complete absence of farm buildings has a negative impact on the species because of the lack of potential breeding cavities. The scarcity of grasslands probably also has a negative influence on the habitat suitability since this might reflect an absence of nesting cavities due to the possible lack of tree lines that mostly correlate with the abundance of grasslands (Van Nieuwenhuyse, Bekaert et al. 2001). Finally the relative lack of high-stem orchards is also negative for the species since a special liking for old high-stem orchards has been reported several times (Juillard 1984, Fuchs 1986, Génot 1990, Van Nieuwenhuyse and Bekaert 2001). About 10% of the random sample can be considered as sub-optimal and under threat in the near future.

The quality of habitat type 19 (2% of the habitats) is rather doubtful since it is dominated by an abundance of fields and fallow land, few farm buildings, few grasslands, few other land-use and few tree nurseries. Increase of arable land has a negative impact on densities in Germany; furthermore tree lines are mostly negatively correlated with arable land (Loske 1986, Van Nieuwenhuyse and Bekaert, submitted). The fallow land might have a positive impact on prey availability but it is doubtful that this kind of land-use will keep its destination for longer periods. The presence of tree lines, hedges and high stem orchards might offer nesting cavities. Tree lines were found to be important for the species in Flanders (Van Nieuwenhuyse, Leysen et al. 2001, Van Nieuwenhuyse, Bekaert et al. 2001). Willows are used by the Little Owl in The Betuwe, The Netherlands (Fuchs 1986). A positive relation is found between Little Owl density and the number of pollard trees with potential breeding cavities in combination with grasslands in Nord-Rhein-Westphalia, Germany (Loske 1986). The ecological relevance of tree lines as edges rich in biodiversity and as a source of nesting cavities are illustrated by Van Nieuwenhuyse and Bekaert (2001). Furthermore, habitat type 12 (2% of the habitats) might have a too large abundance of farms i.e. more than 2ha on average while the optimum built-up area for Little Owl is around 21a (Van Nieuwenhuyse, Leysen et al. 2001). A negative impact of built-up areas was also observed in the larger built-up areas (towns) (Van Nieuwenhuyse and Nollet 1990). Habitat type 13 (9% of the habitats) also shows a dependency on the agricultural buildings since it is featured by an abundance of fields, few grassland and plenty of farms. The presence of farm buildings can assure the species of sufficient nesting opportunities. Additionally the farm buildings can offer shelter and feeding opportunities during winter (pers. obs.). The situation for Little Owl in most habitats situated closely around farms however might deteriorate in the near future because of an intensification of the agriculture and a renovation of barns and stables. Habitat types 19, 12 and 13 account for 14% of the sample set and can be considered as having a doubtful quality on the long term.

The other habitat types are mainly dominated by favourable landscape elements for Little Owls e.g. habitat type 11 (36% of the habitats) with few farms, plenty of grasslands and an abundance of high stem orchards, parks and half-open landscapes, habitat type 6 (30% of the habitats) with few fields, plenty of grassland, few cereals, few maize and a lot of farm buildings for nesting, and finally habitat type 2 (4% of the habitats) with plenty of other land-use, plenty of grasslands, tree lines hedges and some forest. In Germany the species avoids villages with few large grassland areas and prefers those with a lot of small grassland plots (average plot size less than 0.6 ha) (Dalbeck et al. 1999). Van Nieuwenhuyse, Leysen et al. (2001) found that grasslands had a positive influence on Little Owl suitability and in most cases the perimeter of the grassland parcels or the number of parcels rather than the area. The habitats that are situated more remotely from the farms might be more secure for

this study	Van Nieuwenhuyse et al., 1991	Juillard et al. 1992	Mastrorilli, this volume	Centili (1996)
Flanders (North Belgium)	**West-Flanders (Belgium)**	**Causse Méjean (Lozère, France)**	**Bergamo (Northern Italy)**	**Tolfa mountain area (Italy)**
Habitat type 11: HALF OPEN GRASSLANDS TYPE	humid pasture areas with many pollard willows	pasturelands grazed by sheep with typical mounds of stones "clapas"	woods and zones with a particularly closed tree cover	open meadows
Habitat type 6: GRASSLANDS AROUND FARMS TYPE	large isolated meadows with very few trees	hay meadows and cereal fields with "clapas"	urban area including villages and industrial areas	woods
Habitat type 15: FARMLESS CATTLE BREEDING TYPE	field habitats at the backyards of the linear built-up areas along the roads	abandoned farms with ruined buildings	residential area with parks	covered meadows and cultivated (grass)land
Habitat type 13: HORTICULTURAL TYPE	fields at slightly higher altitude with many farm-buildings	active farms	gardens at the perimeters of the urban areas	cultivated (grass)land
Habitat type 2: RURAL CATTLE BREEDING		disused quarries	arable lands with or without irrigation and cultivated or uncultivated grasslands	
Habitat type 19: REMOTE CEREAL AND ORCHARD TYPE		linear habitats of coppiced trees (Fraxinus excelsior)		
Habitat type 12: URBANISED CATTLE BREEDING TYPE				

Table 5. Literature overview of the habitat typologies of the Little Owl in Europe.

the near future due to a lesser threat by human activity. The habitats labelled favourable based on current insights make up 70% of the random sample. The rest of the samples is not considered here since they are situated in the "Dunes" and "Meuse" ecological regions.

Plasticity of the species.

A certain plasticity of the species in Flanders can be suggested when interpreting the rows of Table 2. We observe that some dimensions can either characterise some clusters by their relative abundance and others by their relative scarcity. This illustrates the possible interchange of certain parameters and the flexibility of the Little Owl in its habitat choice. We find that the FIELDS, FARMS, MAIZE, OTHER LAND-USE-dimensions occur both either positively (in green) or negatively (in red) in different clusters. In addition, the multitude of habitat typologies of Little Owl in Europe (Table 5) clearly confirms the plasticity of the species in most of the European part of its range. Most typologies throughout Europe are featuring the essential criteria for suitable Little Owl habitats: year-round prey availability, prey accessibility, vertical landscape structures with cavities and a limited predation pressure which is met within a wide diversity of natural and anthropogeneous landscapes and ecosystems (Génot and Van Nieuwenhuyse, submitted).

Future

The time of survey for the Flemish Little Owl Project was selected at the pre-breeding population. A second time of survey still needs to be defined to be able to track the post-breeding population at a certain moment of the year (Safriel 1996). We suggest to measure the post-breeding population just before the winter. The dependent variable up to now has been Little Owl presence. We feel that this is a variable which is easy to measure (one passage, all answering individuals, fixed nearby points of experiment) and which can be recorded for longer periods by volunteers.

Own research in Meulebeke (West-Flanders) revealed important fluctuations of a local population in 1988, 1994 and 2000. It confirmed that the highest probabilities of occupation, resulting from a logistic regression model, were also the most frequently occupied habitats (Van Nieuwenhuyse,

Barthelemy and Bertrand 1997	Fajardo et al. (1998)	Loske (1986)	Ferrus et al. submitted	Ferrus et al. submitted	Ferrus et al. submitted
Garlaban hills (15 km from Marseilles city, southern France)	**southern Spain**	**Germany**	**Northern Vosges (North-East France)**	**Scarpe-Escaut Plain (north France**	**Causse Méjean**
suburban area with houses and gardens	marshland	orchard meadow	urban-type	pastures (20-40% of the area) and arable land in about the same proportions	arable land and pastures in equal proportions (40-60% of the area)
undisturbed hill area with low shrubs and rocky patches	grassland	grassland with pollard trees	mixed landscape	arable land, pastures and woodlands are intermingled	large proportions of pastures (60%-80%) and a clearly lower proportion of arable land (up to 20%)
	sunflower fields	borders around villages		arable land and pastures and built-up areas representing the built-up and related areas	
	olive tree plantations	grassland with solitary trees			
	orchards	isolated farms			
	urban areas	bridges			
	Eucalyptus plantations	churchyards "Lössgrube"			

Tabel 5. Literatuuroverzicht van habitattypologieën van Steenuil in Europa.

Bekaert, Steenhoudt and Nollet 2001). This shows that the persistent occupation of existing habitats might reveal the quality of the habitats. Therefore we suggest using the presence of calling individuals as a dependent variable both in the pre and post-breeding period because of the simplicity of the inventory method and the sustainability of the census work.

Furthermore we need to test whether the currently available digital maps of Flanders contain enough variance to distinguish different habitat qualities on longer terms, without a need for additional and hence time-consuming data collection of independent variables. Storage of the landscape description in a Geographic Information System (GIS) by the Flemish administration at least allows to take a snapshot of the actual historical status for later analysis without any considerable work for conservationalists. Further analysis will be needed however to determine if there is need for additional information and which variables should be added. Comparable data sources throughout Europe e.g. the Corine land-cover database (European Environment Agency) will allow a similar study on an international scale in the future too.

CONCLUSION

Principal Component Analysis proved to be a useful tool to reduce the number of variables used to characterise the habitats of Little Owls in Flanders. In addition Cluster Analysis allowed to identify different types of habitat that represent a significant part of all randomly selected samples. Five types of Little Owl habitat were found to be proportionally spread over the Flemish territory, the two types with the least members were over-represented in a different ecological region. Using currently available conservation-biological insights into the Little Owl we were able to assess the quality of each habitat type. The main habitat typologies can now be distinguished from the non-representative ones and a more dedicated surveillance can be set up. We can hence follow the evolution in the future in a stratified manner and suggest differentiated actions needed for the conservation of the species. It also guarantees us that we maintain a differentiated vision on the species in Flanders in an objective manner.

ACKNOWLEDGEMENTS

We wish to thank Michael Exo for his valuable comments and suggestions to an earlier version of this paper.

SAMENVATTING

SAMENVATTING

In de lente van 1998, 1999 en 2000 werd in Vlaanderen een inventarisatie uitgevoerd van de Steenuil met behulp van een gestandardiseerde methode. In totaal werden 8932 hokken van 500 bij 500m (2233 km²) geïnventariseerd. Een willekeurige selectie van 2344 niet-overlappende observaties werd geanalyseerd door de numerieke beschrijvingen van cirkels met 300m radius er rond aan een Principale Componenten Analyse en Cluster Analyse te onderwerpen. We gebruikten 57 variabelen van de Biologische Waarderingskaart en de Landbouwperceelskaart. Acht principale componenten met een eigenwaarde hoger dan 2 verklaren 45% van de variantie. Van de 20 clusters bekomen uit de Cluster Analyse van de 8 eerste principale componenten, bevatten er 7 minstens 50 observaties en waren goed voor de overgrote meerderheid van de observaties. Principale Componenten Analyse vormde een bruikbaar hulpmiddel om het aantal veranderlijken te verminderen om territoria van de Steenuil te beschrijven in Vlaanderen. Cluster Analyse liet daarenboven toe om de verschillende habitattypes te onderscheiden die het gros van de Steenuilen uitmaakt. De verspreiding van de bekomen groepen werd getest op willekeurige verspreiding over de ecoregio's van Vlaanderen. De twee kleinste groepen waren meer aanwezig in twee verschillende ecoregio's dan verwacht bij willekeurige verdeling. De vijf andere groepen en het grootste deel van de observaties vertoonden een willekeurige verspreiding over het grondgebied. Voor de verschillende typologieën werd een graad van bedreiging bepaald, gebaseerd op huidige kennis van de ecologie van de Steenuil. De belangrijkste landschapskenmerken en habitattypes kunnen nu worden onderscheiden van de minder representatieve en een gefocuste opvolging ervan kan worden opgestart en aangepaste beschermingsmaatregelen geformuleerd. De werkwijze garandeert ons tevens dat we een gedifferentieerd en objectief zicht kunnen blijven behouden op de Steenuil in Vlaanderen.

Samenvatting door Dries Van Nieuwenhuyse

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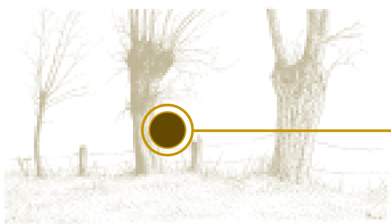

10. OVERVIEW OF LITTLE OWL *ATHENE NOCTUA* LITERATURE

OVERZICHT LITERATUUR OVER DE STEENUIL *ATHENE NOCTUA*

JEAN-CLAUDE GÉNOT

ABSTRACT

In this paper an analysis of 1357 Little Owl *Athene noctua* references is given. I focus on the temporal and geographic distribution, the topics dealt with and the format of the publications.

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INTRODUCTION

The author began to collect a bibliography on the Little Owl in 1984, before starting a research programme on the species in France. This bibliographical study went on from 1984 until 1989. Then it was published as a synthesis with 830 references (Génot 1989). Since then, the collection of bibliographical references has continued and today we reach 1357 references. In this article I present the analysis of these references similar to the one on the Burrowing Owl, *Athene cunicularia* (Millsap et al. 1997).

MATERIAL AND METHODS

The references were obtained by the following methods:

- consultation of the publications already dedicated to the Little Owl and syntheses like the one on the Owls of the world (Clark et al. 1978) which gave a good overview of the English bibliography,
- looking for references directly in libraries as the library of the zoological museum of Strasbourg, the library of the research centre on the biology of birds populations in Paris and mostly the library of the ornithological station in Sempach (Switzerland),
- access to the references located in all the European libraries thanks to the inter-libraries loan service of the national university library of Strasbourg.

The references were entered into a data base noting the author, the year of publication, the type of document (thesis, report, atlas,..), the title of book or article, pages, volume, subjects with key-words and the country.

RESULTS

Temporal distribution of literature

Most of the references appear after the sixties. The relative number of publications since this time is 72% (n=1344) and 47% for the period 1980-2000. Most of the publications from 1880-1940 come from Britain. They are linked to the status of the Little Owl after its introduction in this country at the end of the nineteenth century.

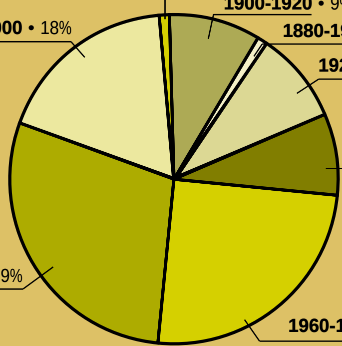

Figure 1: Temporal distribution of Little Owl literature.
Figuur 1: Temporele spreiding van Steenuil-literatuur.

Geographic distribution of literature

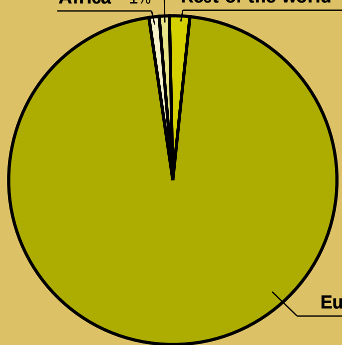

Figure 2. Geographic distribution of Little Owl literature.
Figuur 2. Geografische spreiding van Steenuil- literatuur.

Photo by / *Fotograaf: Marcel Vos ©*

A total of 1321 titles were assigned to geographic areas. 96,8% of references (n=1321) concern Europe. It can be explained partly by the distribution area of the species but mostly by an easy access to the European literature.
Western Europe (France, Germany, Belgium, Netherlands, Britain, Switzerland) account for 85,9% of the references (n=1279), Mediterranean Europe (Spain, Italy, Greece, Crete, Cyprus) 8,4% and eastern Europe (former Soviet Union, Poland, Czech Republic, Hungary, Romania) 5,7%. Even if France is partly considered as Mediterranean region, the majority of French references do not refer to this climatic area.

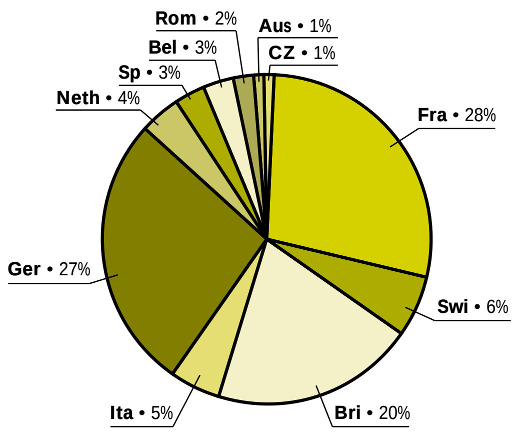

Figure 3. Geographic distribution of Little Owl literature in Europe.
Figuur 3. Geografische spreiding van Steenuil-literatuur binnen Europa.

France and Germany account for 49% of European references. If France shows the highest number of publications (315), it's due to the nationality of the author who had an easy access to the French bibliography. But Germany (312 references) is obviously the country where Little Owl was the most studied and which brought important knowledge.

In Switzerland, 26 citations on 67 are signed by only one author i.e. Michel Juillard.
Obviously, the majority of publications come from countries where the species is declining (France, Germany, Switzerland, Belgium, Netherlands, Austria, Luxembourg). It is confirmed by the chronology of studies whose 72% appear after 1960 which is the beginning of the Little Owl population decline across Europe.

Topical distribution of literature

Each reference has several keywords. This is why the results are not expressed in percentages. The most studied subjects are the following:

Distribution: 387
Food: 245
Habitat: 208
Breeding: 174
Density: 134
Behaviour: 130
Mortality: 126 with sub-topics as predation (25), road (28) or pesticide (39)
Population, abundance: 103
Nest-boxes: 102
Protection: 99
Generalities: 85
Population dynamics: 57
Taxonomy: 55
Vocalization: 25

Certain topics remain understudied as physiology (14), landscape (3), territory (8) or genetics (3).

Types of publication

TYPE OF DOCUMENTS	NUMBER	%
BIBLIOGRAPHY	2	0,15
THESIS	4	0,3
RED BOOK	9	0,65
MONOGRAPHY	11	0,8
PROCEEDINGS	40	2,95
ATLAS	51	3,75
REPORT	60	4,45
BOOK	112	8,25
JOURNAL	1068	78,7
TOTAL	**1357**	**100**

Table 1. Types of Little Owl publications.
Tabel 1. Verdeling van referenties volgens type.

78,7 % of references are journals. Among the other types of documents: books (112), reports (60) of which PhD theses, atlases (51), proceedings (40), monographs (11), red books (9) and theses (4).
Four PhD theses focused on Little Owl: Juillard (1984a) in Switzerland, Exo (1987) and Finck (1989) in Germany and Génot (1992) in France.
Among the monographs, 3 titles are very important: Cramp (1985) in English, Juillard (1984b) in French and Schönn et al. (1991) in German which is the most complete monograph at this moment.
These days an English monograph similar to Schönn et al.(1991) is necessary. An update of the Birds of the Western Palearctic was written recently by Génot and Van Nieuwenhuyse (submitted).

The most quoted journals are the following:

in Britain:	British Birds (127), Zoologist (19) and Bird Notes and News (14)
in Germany:	Vogelwelt (24), Journal für Ornithologie (23), Charadrius (16), Orn. Mitt. (14), Ökologie der Vögel (9), Vogelwarte (8)
in Switzerland:	Nos Oiseaux (24), Vögel der Heimat (18), Orn. Beob. (11)
in France:	Alauda (20), Ciconia (15), Héron (15), Lien Orn. Alsace (13)
in Belgium:	Aves (12), Gerfaut (5), Oriolus (5)
in Spain:	Ardeola (8)
in Italy:	Avocetta (9), Picus (6)
in The Netherlands:	Vogeljaar (12), Ardea (8), Limosa (5)

SAMENVATTING

In 1989 publiceerde de auteur reeds een eerste overzicht van 830 referenties over de Steenuil Athene noctua, bijeengebracht in het kader van eigen onderzoek naar deze soort. In voorliggend artikel geeft hij een analyse van 1357 referenties, verzameld in de periode van 1984 tot 2000. De gegevens werden bekomen door consultatie van gespecialiseerde bibliotheken en reeds gepubliceerde syntheses over de soort. Alles werd ingevoerd in een databank met naast vermelding van auteur, jaar, titel en bron, ook een aantal keuzewoorden. Uit de analyse van de publicaties in de tijd bleek dat de meeste (72%) verschenen na de jaren '60, waaronder 47% tijdens de laatste twintig jaar (Figuur 1). De meeste oude publicaties zijn afkomstig uit Groot-Brittannië. Bij de analyse van de geografische spreiding van de literatuur, konden 1321 titels aan een geografisch gebied toegewezen worden. 96,8% behandelt onderzoek in Europa (Figuur 2). Dit hoge cijfer is deels te wijten aan het feit dat het zwaartepunt van het Steenuilareaal in dit werelddeel ligt, maar ook door de betere beschikbaarheid van de literatuur over dit gebied. Binnen Europa is West-Europa goed voor 85,9%, het Mediterraan gebied voor 8,4% en Oostelijk Europa voor 5,7%. Wat betreft de verdeling over de verschillende landen, scoren Frankrijk en Duitsland het hoogst met samen 49% van de referenties (Figuur 3). Frankrijk heeft een hoog cijfer doordat de Franse auteur hier de literatuur zeer nauwkeurig heeft opgezocht. Uit Duitsland is het hoogst aantal referenties afkomstig. De soort werd en wordt er zeer goed onderzocht. Opvallend is ook dat de meeste publicaties verschijnen in landen waar de soort achteruit gaat. Ook de spreiding van de referenties per thema komt in dit artikel aan bod. Onderwerpen die veel onderzocht worden zijn o.a. verspreiding, voedselkeuze en habitatkeuze (elk in meer dan 200 artikels), terwijl o.a. bescherming, populatiedynamiek, taxonomie en geluid lager scoren (in minder dan 100 artikels). Thema's als genetica, territoria en landschapsrelaties komen nauwelijks aan bod (minder dan 5 artikels). De auteur onderzoekt ook het type van publicatie: 78, 7 % zijn artikels in tijdschriften, de rest is verdeeld over boeken, rapporten, thesissen enz.. (Tabel 1). De auteur stelt dat een Engelstalige monografie naar het voorbeeld van de meest complete maar Duitstalige monografie van Schönn et al (1991) nuttig zou zijn. Tijdschriften waarin de meeste artikels over Steenuil verschenen zijn o.a. British Birds (127), Vogelwelt (24), Nos Oiseaux (24) en Alauda (20). Het langste ooit over de Steenuil verschenen artikel is dat van Exo (1983) dat 40 pagina's telt. De auteur besluit met de mededeling dat zijn bibliografische lijst niet compleet is en blijvend moet aangevuld worden. Bovendien zou de lijst raadpleegbaar moeten worden voor de leden van de International Little Owl Working Group.

Samenvatting door Anny Anselin

The longest publication is the article of Exo (1983) published in Ökologie der Vögel with 40 pages. The publications published during the last fifteen years deal with modern scientific methods (radio-tracking, video system, statistical treatment software). Nevertheless, some descriptive publications of the past remain important because they provide information dealing with behaviour as in the article of Haverschmidt (1946) or Labitte (1951).

CONCLUSION

This bibliographical synthesis emphasises a big effort in studies and research since 1960, the start of the Little Owl decline in Europe. The countries which gave the most important contribution in literature are those where the decrease of Little Owl is the strongest (Germany, Switzerland, France, Belgium, Netherlands). We might improve the knowledge about the species (breeding biology, dynamics) in the Mediterranean distribution area. Likewise, there is a lack of information in the field of genetics, physiology of breeding, predator-prey-landscape relationships.
This bibliography is not complete. It must be continued and made accessible to the International Little Owl Working Group (ILOWG) members. It could be complemented by specific bibliographical investigations undertaken in different countries, as Marco Mastrorilli in Italy or Jevgeni Shergalin in the former Soviet Union.

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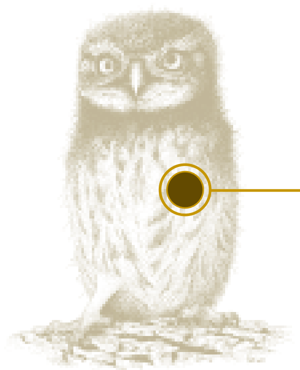

PLAYBACK AND LITTLE OWLS *ATHENE NOCTUA*: PRELIMINARY RESULTS AND CONSIDERATIONS.

GEBRUIK VAN GELUIDSBAND EN STEENUILEN *ATHENE NOCTUA*: VOORLOPIGE RESULTATEN EN BEVINDINGEN.

DUCCIO CENTILI

ABSTRACT

Efficiency of playback as a census tool has been assessed by recording the response rate of Little Owls *Athene noctua* at known occupied sites. Overall response rate between February and July was 49.6%. Response rate did not change significantly with month. There was no significant relationship between response rate and distance of playback station to occupied site within broadcast reach. This suggests that playback is as effective inside a territory as outside it in eliciting an owl's vocal reaction. Thirty-six percent of the replies came from occupied sites over 450m away from playback stations (max. distance 1100 m). Since a commonly used detectability radius around playback stations is 400 m, beyond which owl calls are considered not audible, it is suggested that caution be used in incorporating detectability radii in census schemes in order to minimise the risk of overestimating owl numbers.

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INTRODUCTION

Playback is a common method to detect secretive and vocally active raptors (Fuller and Mosher 1981, Cerasoli and Penteriani 1992). It is widely used to contact owls, whose elusive and nocturnal habits typically prevent a visual detection (Smith and Carpenter 1987, Bibby et al. 1992).
Playback is not a census method on its own: it is only a detection method that increases the chance of finding resident individuals by eliciting their territorial call. Playback must be used within the framework of an established census method (mapping, point count, point transect, look-see method; Bibby et al. 1992), with assumptions depending on the specific census method employed. Papers dealing with playback applications have not generally stressed the distinction between playback as a detection tool and the specific census designs within which playback may be employed; moreover, underlying census assumptions have been somewhat understated (e.g. Smith and Carpenter 1987, Sarà and Zanca 1989).
Few attempts have been made to quantify playback efficiency and to clarify which factors influence it (e.g. Bernard-Laurent and Laurent 1984 on Rock Partridge *Alectoris graeca*; Smith et al. 1987 on Eastern screech owl *Otus asio*). For Little Owls *Athene noctua* only Exo and Hennes (1978) provided circumstantial information on playback reliability.
In this paper I quantify the response rate of Little Owls to playback and analyse the relationships between response rate and 1) time of year; 2) distance to playback station. Moreover, some characteristics and limitations of census designs are discussed.

METHODS

During the breeding seasons of 1994 and 1995 a Little Owl census was performed in "Monti della Tolfa" (district of Roma, Central Italy) by means of playback and foot-surveys. Foot-surveys were made at daytime and investigated the areas where Little Owl calls had been heard and also remote areas outside of playback reach. Aim of foot–surveys was to locate the occupied sites being used by Little Owls, an occupied site being defined as a structure suitable for breeding where signs of Little Owl presence were found.

Playback was performed from March through July 1994 and from February through July 1995. Playback sessions typically started 30 minutes after sunset and ended at midnight, when Little Owls' calling activity decreases (Exo and Hennes 1978, Exo 1989). A portable cassette-recorder, amplifier and modified loudspeaker were employed for song broadcasting. Playback protocol was as follows: 2-3 minutes of listening; 20, 45, 90 seconds of calling with 1-minute intervals between them; finally 2-3 minutes of listening (modified from Exo and Hennes 1978). Taped call was the male advertising call "guhk" (Peterson Field Guide to the Bird Songs of Britain and Europe 1972). No playback was performed in conditions of rain or strong wind.
Response rate was recorded in each playback session as (number of Little Owls replying to playback) (number of occupied sites within playback reach). Only Little Owl calls coming from known occupied sites were included in the analysis. Duets of male and female owls were considered as 1 response.
An occupied site was considered within playback reach when distance to playback station was 500 m or less, with no obstacles to sound diffusion between them, or otherwise if a call was heard at least once, showing that audible contact was possible. If an occupied site was tried more than once in the same evening, only the first attempt was taken into account.
A critical value of α = 0.05 was used for all analyses.

RESULTS

Of the 39 occupied sites known, four were beyond reach of any playback station. The remaining 35 were within reach of 1 to 4 playback stations (x=1,86 ± 0,91 [±SD]). Occupied sites were stimulated 123 times in 88 playback attempts, and produced 61 Little Owl territorial responses. This adds up to a response rate of 61/123, that is 49.6% (both years combined). Results of single years 1994 and 1995 were almost identical with a response rate of 50.8% in 1994 (N= 63 stimulations) and 48.3% in 1995 (N= 60 stimulations). Difference between years was obviously not significant (χ^2=0.78, df=1, P>0.50).
Response rate might have been depressed by occupied site abandonment and consequent missed replies to playback at some time before the end of the study. To test for this hypothesis, only playback attempts were considered that had been made in the time between first discovery of occupied site and last check with positive occupancy. Response rate increased slightly at 54.7% (N= 53 stimulations, both years combined).
Response rate increased from February to April when it reached a peak of 69% (N=13 stimulations), while a minimum was found in July with 38% (N=21 stimulations). Difference in response rate among months was not significant (χ^2=0.50, df=5, P>0.95) (Figure 1).

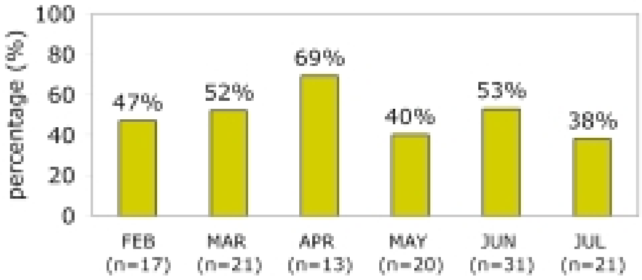

Figure 1. Response rate in each month. n = number of stimulations of occupied sites with playback per month.
Figuur 1. Antwoordbereidheid per maand. n= aantal bezoeken met geluidsband aan bezette territoria per maand.

Distance between playback station and stimulated occupied site did not apparently affect response rate. Response rate was highest at distances over 751m (60%) and 151-300m (59%). Lowest response rate occurred at distances of 301-450m (39%) and 451-600m (40%) (Figure 2). Differences of response rate among distance classes were not significant (χ^2=0.57, df=5, P>0.95).

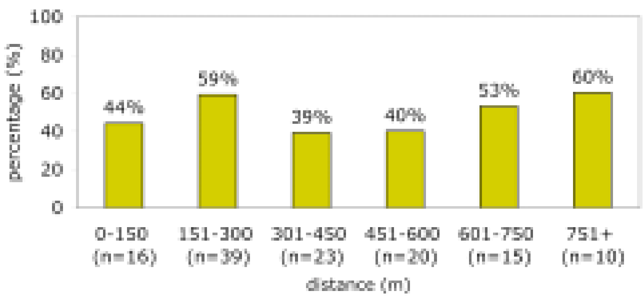

Figure 2. Response rate in each distance class between playback station and occupied site. n= number of stimulations of occupied sites with playback per distance class.
Figuur 2. Antwoordbereidheid per afstandsklasse tussen afspeelpunt en bezet territorium. n= aantal bezoeken met geluidsband aan bezette territoria per afstandklasse.

It is assumed that playback attempts performed within 300m of occupied sites were within the boundaries of an average 20ha Little Owl territory. Playback occurring at distance ≤300m from occupied site yielded a response rate of 54% (N= 55 stimulations) while response rate from distances ≥300m was 46% (N = 68 stimulations), the difference being not significant (χ^2=0.32, df=1, P>0.5). Thirty-six percent of replies obtained with playback came from Little Owls whose occupied site was more than 450m away from playback station (Figure 3).

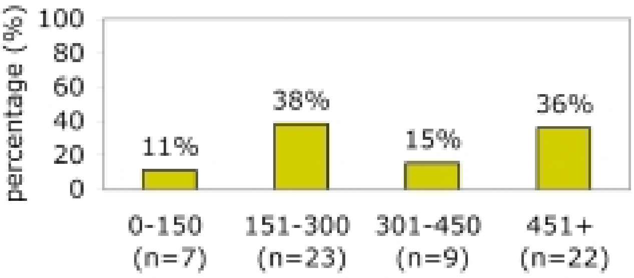

Figure 3. Response rate by distance class. n= number of replies from occupied sites by means of playback per distance class between playback station and occupied site
Figuur 3. Antwoordbereidheid per afstandsklasse. n= aantal positieve reacties van bezette territoria per afstandsklasse tussen afspeelpunt en bezet territorium.

Photo by / *Fotograaf: Francis Van Bauwel* ©

DISCUSSION

Censuses conducted only by means of playback rarely provide exact location of roosting and breeding sites. With no knowledge of owl locations, a playback session with no owls' reply may indicate that either owls are absent or they are present but did not reply. Assessments of response rate are usually expressed as (number of individuals heard)/(number of playback sessions performed). (Galeotti 1989, Sarà and Zanca 1989). These calculations yield rather low values of response rate because they cannot separate owl absence from owl silence, and the calculated response rate is inversely proportional to the number of playback stations with no owls around. The overall response rate of 49.6% obtained in this study places itself well below the 80-90% rate proposed by Exo & Hennes (1978), and above rates from other Italian studies: 24.9% (Galeotti and Morimando 1991), 28.2% (Mastrorilli 1997), 33.3% (Barbieri et al. 1978).

The overall spring response rate of 49.6% found in this study indicates that in spring-summer each territorial owl should be stimulated 3 times to have an 87% chance of obtaining at least one reply. Not much can be said about the relationship between response rate and month, because the monthly differences were not significant. More data are needed to investigate this relationship.

Analysis of response rate variation with respect to distance between playback station and stimulated occupied site didn't show any clear "optimal distance" of highest responsiveness. Distance between playback station and occupied site is thought to be important because playback effectiveness should be greatest from within the boundaries of an owl's territory (Sarà and Zanca 1989). My data do not support this view, since response rate does not significantly change with distance to occupied site. Moreover, response rate differences were calculated for distances ≤300m and ≥300m, 300m being the radius of a 20ha circular territory centred on the occupied site. These differences were not significant, suggesting again that being inside a territory is not necessary to obtain a satisfactory reply to playback: on the contrary, even at distances well beyond a Little Owl territory, playback can induce good levels of responsiveness.

Playback is often used within a transect method framework (Fuller and Mosher 1981). It is performed along transects defined by roads or paths and counts of responses result in an index of population abundance (Bibby et al. 1992). An important underlying assumption is that each calling bird can be heard at only one playback station.

If the assumption is not met, the result is an overestimation of the abundance. To avoid multiple counts of the same individuals, a detectability radius is established that is the maximum distance around stations allowing the researcher to hear the owls' calls. An owl replying to playback from beyond this detectability radius is not assumed to be audible. Playback stations are then spaced along the transect at double the detectability radius (Smith and Carpenter 1987, Sarà and Zanca 1989). Some Authors agree on a detectability radius of 400m for Little Owls (Galeotti 1989, Sarà and Zanca 1989). Actually detectability radius varies with local topography (Exo and Hennes 1978, Reynolds 1987) and Little Owls can be heard from great distances in favourable conditions. Génot (1990) affirmed that Little Owls can be heard at more than 800 m with calm weather. In this study a substantial fraction of recorded Little Owl calls came from occupied sites over 450m away, and up to 1100m (Figure 3). With a transect method there is then a risk of hearing the same individuals from adjacent playback stations if these are too close to each other, so that population estimates become inflated.

The assumption that a calling bird can be heard only at a single station does not apply to the mapping method. With this method, locations of singing owls are plotted on a map and outline the owls' home ranges (Bibby et al. 1992).

Playback stations are distributed so as to assure that their detectability radii encompass all or most of the study area (e.g. Cesaris 1988, Galeotti and Morimando 1991); some overlapping of detectability radii is beneficial because it increases the number of owl locations.

Establishing stations on a fixed grid allows standardising the census protocol but might not be very effective in hilly or mountainous landscapes. In these situations it might be better to place stations

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preferentially on vantage points to assure the best coverage of the surrounding area. A 500m detectability radius may be reasonable if there are no interposing obstacles to block sound diffusion. A grid size of 500m was also used in Flanders (northern Belgium) (Van Nieuwenhuyse et al., 2001).

CONCLUSIONS

Playback appears to be a reliable and robust method to locate Little Owls, providing fairly good response rates at least between February and July and regardless of distance of elicited owls to playback stations.

Audibility range of territorial calls appears to be variable, mostly depending on local topography around playback stations. This range variability could affect census results if not taken into account in the census design. A fixed audibility range of 400m is often employed: if each playback station is intended to locate different individuals, it might allow the same owls to be heard from several playback stations, leading to an inflated count. On the other hand, with a large audibility range some individuals will be more likely missed completely. A different approach, at the expense of standardization, might be to employ a mapping method with an audibility radius of 500m, so that overlapping audibility radii are not a problem any more.

SAMENVATTING

Nachtactieve soorten worden vaak met behulp van geluidsband vastgesteld. Van de effectiviteit van dergelijke methode is nog relatief weinig gekend. Ze moet dan ook voorlopig eerder gezien worden als een benaderende censusmethode. Aanvullende vormen van onderzoek blijven nodig. In dit onderzoek werd de doeltreffendheid van geluidsband als inventarisatiemethode bij Steenuil Athene noctua nagegaan door de responsbereidheid te registreren bij met zekerheid bezette broedplaatsen. Precies deze koppeling maakt het mogelijk om zinvolle uitspraken te doen over de antwoordbereidheid. Vaak wordt enkel een geluidsband-onderzoek uitgevoerd en kan er geen onderscheid gemaakt worden tussen plaatsen waar Steenuilen aanwezig zijn maar niet antwoorden en die waar de soort ontbreekt. Dat levert dan uiteraard veel lagere scores op.

Het studiegebied situeert zich in de "Monti della Tolfa", district Rome, Italië. Het gestandaardiseerd onderzoek werd in 1994 en 1995 uitgevoerd van een half uur na zonsondergang tot middernacht. Gemiddeld leverde dit 49,6% antwoorden op tussen februari en juli. De methode bleek dus goed bruikbaar te zijn. Alhoewel april het beste scoorde was er geen significant verschil tussen de verschillende maanden. Ook de afstand tot de nestplaats speelde blijkbaar geen significante rol. Dit geeft aan dat geluidsband even efficiënt is in het opwekken van vocale respons buiten het territorium als erbinnen. Zesendertig procent van de antwoorden kwam van bezette plaatsen die meer dan 450m verwijderd waren van de afspeelplaats (maximale afstand 1100m). Vaak wordt echter een arbitraire straal van 400m gehanteerd als maximale afstand waarop een terugroepende uil nog kan gehoord worden. Daarom manen we aan tot voorzichtigheid bij het bepalen van dichtheden gebruik makende van maximale afstanden waarop een Steenuil zou kunnen vastgesteld worden. Een overschatting kan voorkomen aangezien de onderzochte afspeelplaatsen een groter bereik hebben dan de veronderstelde 400m.

Samenvatting door Koen Leysen

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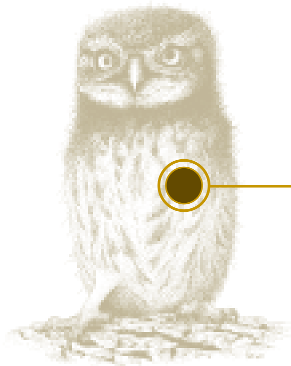

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12. LITTLE OWLS *ATHENE NOCTUA* AND BIOCIDES: REASONS FOR CONCERN?

THE LITTLE OWL INTERNATIONAL CONTEXT

STEENUILEN *ATHENE NOCTUA* EN BIOCIDEN: REDENEN TOT BEZORGDHEID?

PETER BEERSMA AND WIES BEERSMA

ABSTRACT

Little Owls have never been thoroughly analysed for the impact of rodenticides and insecticides. This paper presents evidence of rodenticide toxicity for different owl species in different degrees. An action plan is given to tackle the problem. Four pillars are distinguished: analysis of variance in demographic data and possible correlations with rodenticide use on the national scale at the community level, the promotion and use of a detailed sampling method using dedicated day-by-day monitoring to obtain samples within hours after death, comparative research of habitats with and without rodenticides and education of the larger public.

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INTRODUCTION

Of all the dead birds, including birds of prey, that were submitted for autopsy to the Institute of Animal Science and Health (ID-Lelystad) over the last ten years, there was a remarkable absence of owls in general and of the Little Owl *Athene noctua* in particular. This is due to the fact that owls are not deliberately hunted or poisoned which doesn't make them suspicious. Because of this probable biased sampling, possible side effects of biocides on owls have escaped our attention. With some authorities the impression even exists that if there are side effects, they are of little importance. They claim the diminishing numbers of the Little Owl to be caused by a number of different factors, poisoning not being one of them.
This opinion appears to be supported by the fact that the Barn Owl *Tyto alba* is doing so well, i.e. this mouse predator has increased significantly in numbers over the last few years (de Jong 1995) in The Netherlands.

The aim of this paper is

- to present a rational not to generalise the idea that the population increase of the Barn Owl suggests a lack of impact of biocides on Little Owl.
- to give some arguments why more attention needs to be given to the problem of biocides and their possible impact on the Little Owl in Europe.

Photo 1. Rodenticides as oat grains fed to rodents in open trays causing unselective spread of poison.
Foto 1: Rodenticiden aangeboden aan knaagdieren in open korven veroorzaken niet- selectieve verspreiding van het gif.
Photo by/*Fotograaf: Peter Beersma* ©

- to present an action plan for specific research into this topic of Little Owl biology and to improve sampling and increase public awareness with the suggested dedicated day-by-day monitoring method.

KNOWN FACTS ABOUT SENSIBILITY TO RODENTICIDES AND INSECTICIDES

After World War 2, Warfine was introduced to the market. This poison hardly caused any avian mortality. The second-generation anticoagulants, introduced in the 80s, seemed to be more powerful against birds too (Stone et al. 1999). Deadly poisoning of raptors in two Dutch zoos, proved the danger of rodenticides for secondary poisoning, even when the rodenticides are hidden well (Borst and Counotte, in press). In experiments with Barn Owls

using poisoned mice several anticoagulants proved to be toxic. Brodifacoum killed 5 of 6 owls, bromadiolon 1 of 6 and merely sublethal blood loss was observed for difenacoum (Mendenhall and Pank 1980). Despite larger doses Barn Owl did not seem susceptible to diphacinon that killed 2 of 3 Great Horned Owls *Bubo virginianus* and one Saw-whet owl *Aegolius acadicus*. This proves that rodenticide susceptibility is species specific and generalisations might be wrong.
Other experiments showed that the toxicity of the recently used rodenticides to Barn Owls is high. The risk of poisoning for this species in the wild however is low (Gray et al. 1994a). In 1998 two Barn Owls died in The Netherlands (Zoun 1999) and two in Georgia (USA) (Stone et al. 1999) from secondary poisoning by brodifacoum.
On an oil plantation in Malaysia Warfarin was replaced by brodifacoum followed by a mortality of 38 of 40 Barn Owls in 2 years time (Duckett 1984). Of the 145 dead Barn Owls collected between 1983 and 1989 in the U.K., at least 10% contained traces of brodifacoum and difenacoum. Four animals contained an accumulated amount and one was clearly killed by it (Newton 1990). To our knowledge no experiments on Little Owls have been carried out. One case of poisoning by brodifacoum of a free-living bird was documented in the U.K. (Zoun 1999).

The impact of insecticides on owls is even less documented than that of rodenticides. One case of parathion poisoning of a Little Owl in The Netherlands has been documented after the spraying of grasslands against so called leather jackets in order to get rid of the larval stage of the Long-legged Mosquito *Tipula paludosa* (Zoun, pers. comm.).

Photo 2. Dissection of Little Owl as a first inspection of causes of mortality.
Foto 2: Disssectie van Steenuil als eerste onderzoek naar doodsoorzaak. Photo by/*Fotograaf: Peter Beersma* ©

THE USE OF AND IMPACT OF RODENTICIDES ON RODENTS

Rodenticides are freely available legal substances and are distributed as the following components in The Netherlands: chloorfacinon, difenacum, brodifacum, bromadiolon and difethialon (Board of authorisation of Pesticides 2000). The placing of these kinds of substances in special feeding trays only accessible to rodents is however not guaranteed. Only animals with an affinity to eat the poisoned grains themselves, e.g. pigeons and gallinaceous birds, will be protected by feeding trays. Animals that transport food, also distribute the poison. Death occurs several days after the animal has eaten the poison. In the period between eating the poison and death the animal moves around in the surrounding area away from the feeding tray and outdoors in search of water and is therefore a danger for its predators. In France (Franche Comté) and in Switzerland, technicians of the crop protection services observed a much larger number of subterranean voles leaving their galleries and moving to the surface after poisoning *Arvicola terrestris* populations with bromadiolone. This altered behaviour makes poisoned individuals more accessible e.g. to avian predators. (P. Giradoux, pers. comm.). Similar deviant behaviour was observed by Prof. G. Verdoorn in South Africa among rodents. Impact was observed three days after intake of coumatetralyl. Before sunrise the rodents left their shelters and strolled around disoriented. Later on they were sunbathing as if they were hypothermic and died a few hours later.

SYMPTOMS AND POST MORTEM EXAMINATION

Coagulation of the blood of animals that have eaten the anticoagulant will take longer than usually, and microscopic tears in the blood vessels will keep bleeding. Severe anaemia then develops combined with a lack in osmotic power of the blood that can be fatal within a few days. Post mortem examination

Photo 3. Mechanical instead of chemical destruction of rodents harmless to Little Owl.
Foto 3. Mechanische in plaats van chemische vernietiging van knaagdieren, onschadelijk voor de Steenuil.
Photo by/*Fotograaf: Peter Beersma* ©

shows multiple bleedings around the mobile parts of their bodies such as joints and heart. This is known as the acute stage. If less of the poison is eaten then the process takes longer, the anaemia is less serious and the red blood cells that have left the blood vessels are broken down and transported away. If the animal does eventually die the bleeding may not be present, but the cadaver has an anaemic (pale) appearance, perhaps combined with secondary defects, which are a result of a malfunctioning oxygen supply. This is known as the sub-acute stage. The acute stage is seen in Barn Owls (Mendenhall and Pank 1980, Duckett 1984). It is not clear whether they also suffer from the sub-acute form of poisoning but there are indications. We wonder whether Barn Owls found dead in times when mice are plentiful and showing signs of thinness and anaemia (own obs.), are also possible victims of sub-acute poisoning. It is possible that birds that are anaemic do not hunt because the decreased oxygen supply to their muscles makes them weaker and therefore starve to death. They are also likely to be more susceptible to become traffic victims. Detection of the agent might be difficult too since it is doubtful whether several weeks after eating the anticoagulants the characteristic signs of the metabolites can still be found (Dr. G.H.M. Counotte, pers. comm.). Hence our data collection needs to be as fast as possible after death has occurred.
The actual situation of the Little Owl is presently unknown to us. Furthermore the Little Owl can ingest both anticoagulants and insecticides as a result of its diet. To obtain a better view on the possible impact of biocides on the species, we have drawn up a plan to investigate and examine dead Little Owls.

ACTION PLAN

Our action plan consists of four main pillars:
- Analysis of variance in demographic data and possible correlations with rodenticide use on the national scale at the community level
- Detailed sampling method using dedicated day-by-day monitoring
- Comparative research of habitats with and without rodenticides
- Education of the larger public

Analysis at the national scale

With the existing data of the National Ringing Centre it is possible to do an indirect analysis. The information from this Centre can indicate in which area the owls attain an age that is above average for their species. Hence regional variance in demographic data will be looked for, if found this will be matched with the amounts of local rodenticide application and looked for possible correlations. Similar to what has been proposed for Flanders, the acquisition of reliable information on the distributed rodenticides in a nation-wide database is urgently needed (Van Nieuwenhuyse 2000).
To tackle this problem there is also need for direct research of dead birds, preferentially sampled in a completely random way on a national scale. The public can play a significant role in this as collectors of specimens, similar to the Flemish Marten-network (K. Van Den Berghe, pers. comm.) with more than 45 sampling points throughout the country and sponsored by the Flemish Community.

Since the tracing of dead Little Owls is a rather tedious task, the analysis of their pellets might be a good alternative. Two studies showed that 25% of anticoagulant intake was excreted via pellets in Barn Owls (Gray et al. 1994b). How long those agents remain detectable in pellets still needs to be determined.

Additionally, the collected specimens might be used for studies of genetic variability in The Netherlands and Europe.

Dedicated day-by-day monitoring

The main problem with the former analysis is that direct causality at such a large scale cannot be proved. Correlations do not mean real causal relationships. In order to test direct causality, more detailed information is needed. Therefore we started with our specific monitoring method which allows us to keep track of individual birds on a day-by-day basis in the hope of getting hold of the dead specimens faster than usual i.e. within hours.
We have started this method of investigation under the supervision of prof. G. de Zeeuw and dr. G. Counotte.
We are using nest boxes with a balcony consisting of the walls/floor and roof continuing about 15 cm from the front-panel. The owls use this sheltered spot in front of the opening of the nest-box for sunbathing if the box is placed in a south-east direction (Photo 4). From inside his house the landowner can see whether the owl is standing on the platform and using a telescope or binoculars it can be seen on which leg the owl is ringed. With the use of coloured rings, whereby each year a different colour is used, it is possible to see from a distance how old the bird is and the individual characteristics. When the bird has disappeared and presumed dead we can look for the body in a matter of days. Especially during cold periods of the year, dead owls will remain for weeks in a good condition for examination. Using the current working method with nest box inspections in spring, it will only be possible around April to see whether a different female is sitting on the eggs in which case the chance of finding her predecessor in good condition for examination will be virtually nil. This approach will take many years to yield a sample set large enough to get statistical representative numbers. It will demand extensive information from the nest box owners and is fully dependent on their co-operation to sound the alarm. The advantage of this approach is also that an emotional involvement and increasing awareness of the landowners will hopefully develop over the years. The only drawback that this sampling method has is a bias towards habitats around houses, where the use of rodenticides presumably will be most pronounced. This way we will have a clear view on the worst cases of this assumed cause of mortality.

Comparative research

We are also doing comparative research on a small scale, by investigating locations where rat and mice poisons are and are not applied, especially during the winter months.

Education of the larger public

Finally we believe that the larger public needs to be convinced of the importance of rodenticides for the Little Owl. The species has features that make it cute and hence popular. This should be maximally used in function of the conservation activities. Presentations for all kinds of socio-cultural organisations are being given with great response.

CONCLUSIONS

If we want the species to survive then the following points are essential.

- We should get a detailed view on the possible impact of biocides in general and rodenticides in particular on the Little Owl on a national scale and on the community level and on a local scale via our day-by-day monitoring method.
- The public needs:
  - to get involved in Little Owl conservation, especially in rural areas in order to increase awareness.
  - to be motivated to use minimal amounts of poison in order to get rid of unwanted rodents, and they should definitely not use feeding trays outdoors to get rid of rats in cattle food. Also mice know how to find these trays.
  - to chose mechanical instead of chemical methods to kill rodents (Photo 3).
  - to be motivated to avoid using insecticides as the Little Owl also eats insects.

Photo 4. Sunbathing of Little Owl in winter on a specially designed platform in front of a nest-box allowing daily observations.
Foto 4. Zonnebadende Steenuil in de winter op een speciaal ontwikkeld platform voor een nestkast dat dagelijkse waarnemingen toelaat.
Photo by/*Fotograaf: B. Stoltenborg* ©

- to make it impossible for mice to enter their homes by blocking all gaps and by placing grids in ventilation holes.

• We should try to make sure that mice can survive the winter on the land by making dry spots available for it near its sources of food (acorns, walnuts etc).

Further we would advise:

- To study the possible impact of feeding the owls in severe winters to decrease winter mortality due to starvation.
- Create more secure and dry roosting and nesting holes for the owls. Little Owl pairs prefer to roost separately.
- Improve prey accessibility and optimal foraging by making sure that there are enough perches along the edges of fields, meadows and ditches etc.

SUMMARY

Whether the Little Owl in the wild is sensitive to biocides or not has not yet been investigated systematically. We present evidence why more attention needs to go to this problem. We also prove the potential danger of rodenticides and insecticides for the species. We therefore propose a national inventory and database of rodenticide and insecticide use at the community level and its possible impact on Little Owl demography. We also think that a national collection and research programme should be carried out at local level using our proposed dedicated day-by-day monitoring. To better assess the impact of the agents some comparative investigations are needed of areas with and without rodenticide and insecticide input.
Furthermore there needs to be an increase in public awareness to decrease the use of poison.
If we want the Little Owl, who in ancient times protected us with its wisdom, to continue to survive, we should start using our wisdom and pay more attention to the possible impact of biocides in its food.

ACKNOWLEDGEMENTS

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SAMENVATTING

SAMENVATTING

Warfine, het eerste bloedstolling remmende bestrijdingsmiddel tegen knaagdieren, was voor vogels weinig giftig. Na het optreden van resistentie werd rond 1980 de 2de generatie anticoagulantia geïntroduceerd. Deze blijkt helaas veel giftiger te zijn voor vogels, al zijn er grote verschillen tussen de componenten onderling. In Nederland worden uilen niet systematisch onderzocht op residuen van biociden, zodat neveneffecten van rodenticiden aan de aandacht ontsnappen. In Engeland is dit bij de Kerkuil Tyto alba tussen 1983 en 1989 wel gedaan. Van de 145 dood gevonden uilen had ruim 10% resten van anticoagulantia in het lichaam. Vier vogels toonden een verhoogd gehalte en één was duidelijk het slachtoffer van vergiftiging door deze middelen (Newton et al., 1990)

Dat in de praktijk het aantal Kerkuilen dat sterft t.g.v. nevenwerking van rodenticiden laag uitvalt (Gray et al., 1994) en het met de Kerkuil in Nederland de laatste jaren zo goed gaat, wil niet zeggen dat ook de Steenuil Athene noctua nauwelijks last zou hebben van biociden. Deze soort jaagt het hele jaar veel dichter rond en ook in gebouwen. Bovendien staat hij ten gevolge van zijn voedselkeuze ook nog bloot aan het opnemen van insecticiden. Tevens blijkt uit proeven in de V.S. (Mendenhall en Pank, 1980) dat de ene uilensoort gevoeliger is voor bepaalde middelen dan andere soorten. Waakzaamheid is dus bevolen.

In Nederland zijn 5 soorten anticoagulantia toegelaten, waarbij enkele uitsluitend binnen gebouwen mogen worden uitgezet wegens de kans op doorvergiftiging van niet doeldieren. Ook al wordt het lokaas goed afgeschermd, dan nog blijken ongewenste nevenwerkingen op te treden, zoals de vergiftigingsgevallen in twee dierentuinen in Nederland laten zien. In proeven met Kerkuilen in de V.S. blijkt Brodifacoum de meeste sterfte te veroorzaken. Ook van de ongewenste vergiftigingsgevallen in het vrije veld was daar meer dan 80% aan Brodifacoum toe te schrijven, een anticoagulant dat onder de naam KLERAT in de handel is. De situatie voor de Steenuil is nog onbekend, daarom is een onderzoek gestart in samenwerking met de terreineigenaren om meer zicht te krijgen op de doodsoorzaken van deze uilensoort. Het toepassen van speciale nestkasten, die vanuit huis goed zichtbaar zijn, bieden de mogelijkheid om de uilen vrijwel dagelijks zonder veel tijdverlies in het oog te houden (day-by-day monitoring). Het toepassen van kleurringen maakt individuele herkenning mogelijk, zodat verdwijningen snel opvallen.

Verder wordt systematisch geïnformeerd naar het merk ratten- of muizengif dat ter plekke wordt gebruikt. Gestorven dieren worden onderzocht.

Tevens wordt een reeks suggesties gedaan om de soort meer overlevingskansen te bieden.

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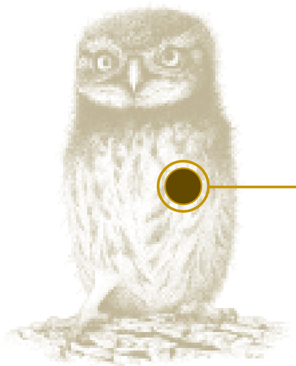

13. BALANCING ON THE EDGE.
THE CRITICAL SITUATION OF THE LITTLE OWL *ATHENE NOCTUA* IN AN INTENSIVE AGRICULTURAL LANDSCAPE.

BALANCEREN OP HET RANDJE.
DE PENIBELE SITUATIE VAN DE STEENUIL *ATHENE NOCTUA* IN EEN INTENSIEF GEBRUIKT AGRARISCH LANDSCHAP.

JAN VAN 'T HOFF

ABSTRACT

As a result of a more intensive agricultural land use, the scale of the landscape has increased greatly in the past four decades in The Netherlands. This has had many negative consequences for farmland bird species between 1960-2000, among which the Little Owl *Athene noctua*.
In this study we quantified the changes in a number of habitat characteristics in the theoretical home range (in a square of 25ha and 1km^2 around the nest) of Little Owls in the province of Groningen in the Netherlands. Furthermore we analysed the differences in habitat and isolation variables between the occupied and abandoned territories after 1995. Since the 60s the area of "extensively" managed grassland, the length of ditches and unpaved roads, and the number of high-stem orchards have strongly declined.
During the 80s the number of Little Owls started to decrease and this decline was even more rapid in the 90s. The decline of the Little Owl between 1980-1995 might be the consequence of a deteriorating habitat quality. After 1995 the increasing fragmentation of a decimated population had a great influence on the Little Owl. The main difference between the occupied and abandoned territories, is the average nearest neighbour distance, which is significantly larger for the pairs that disappeared. The difference in habitat quality is either negligible or to some extent even more favourable in the abandoned territories.
Measures to protect the Little Owl are focussed on rapidly improving the habitat quality in an extensive area in the surroundings of the last two fragmented populations, and on educating the general public.

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INTRODUCTION

The Little Owl population has declined by more than half in the Netherlands since 1992 (Van Strien and Van der Meij 2000). This alarming situation motivated the Little Owl Working Group Groningen to undertake extensive protection measures as soon as possible. Part of the plan is to obtain sufficient crucial conservation biological insight into the causes of this negative trend. We studied the changes in habitat quality of the occupied and abandoned territories, the type of nesting places and the extent of isolation to find out which factor influences the Little Owl populations most in Groningen. By doing so we hope to be able to save the last fragmented Little Owl populations in Groningen. Because of the dramatic evolution LOWGG has titled its provincial protection plan for the Little Owl "It is now or never ….." (Van 't Hoff 1999). This large scale-plan has been the basis of a concrete project that LOWGG and the Foundation of Landscape Management have started for a period of four years, from 1999 till 2003, with the assistance of the Province of Groningen.

METHODS

Study area

The study area comprises the entire territory of the province of Groningen (2499 km^2). It is one of the 12 Dutch provinces and is situated in the north of the Netherlands (Figure 1). It is a sparsely populated province. The majority of the Little Owls are

Figure 1. Map of The Netherlands with Groningen situated in the North-East.
Figuur 1. Kaart van Nederland met situering van Groningen in het noordoosten.

found in northern Groningen, mainly in open agricultural landscapes, dominated by modern agriculture, such as arable land or grassland. Traditionally Little Owls are very scarce in the peat-colonial southern part of Groningen. The favourable landscapes of the Little Owl are (very) open with scattered farms and villages situated on mounds.

Bird data

The LOWGG was established in 1996 as a result of alarming signals about a severe decline in the Little Owl population. Since then we have annually investigated new areas on the occurrence of Little Owls, placed and checked up to 195 nest-boxes in 2000 and monitored annually both the pairs in the areas with the remaining populations and the known isolated pairs. By means of calls for co-operation in the media and by making systematic inquiries on the presence of Little Owls by farmers and private landowners we acquired additional records, mainly of pairs on rather isolated locations. In the same way we also gathered new information on the historical occurrence of the species in the past decades.

Habitat and isolation data

To analyse the quantitative changes in habitat quality in the theoretical home ranges of Little Owls between the 60s and 90s we measured a number of habitat characteristics from topographical maps with scale 1/10000 For the 60s, revised maps were available from 1968 or 1969, for the 70s from 1978 or 1979 and for the 80s from 1987 or 1989. The habitat data of the 90s are collected via own field observations since 1998.

We used a Geographical Information System (GIS) to measure the landscape elements in squares of 25ha and 1 km^2 around the nesting places.

The number of measured occupied territories in the 60s, 70s, 80s and 90s was 15, 21, 28 and 38 respectively with 13 common territories during these four decades.

The following habitat characteristics were measured for the 13 common territories: the grassland area, the size of the grassland-lots, the area of "extensively" managed grassland (= meadows < 1ha), the size of "extensive" grassland-lots, the length of ditches and unpaved roads, the number of (high-stem) orchards and farms. Historical data are available on maps for these variables.

We measured the changes in the size of the "extensively" managed grassland parcels in an indirect way. This kind of information is not available on maps. Therefore we distinguished a special category of grassland parcels smaller than 1ha, assuming that these are managed less intensive.

Part of the data concerning changes in the landscape has unfortunately been lost forever e.g. old pollard trees, the size- and age of high-stem orchards and the length of permanent fencing. This kind of information is not present in topographical maps and the only way to gather it is by means of field observations. Because of the drastic changes that have taken place in many of the landscapes of Groningen, due to a lot of land re-allotment projects between the 60s and 90s, many of these habitat elements of the Little Owl have disappeared.

Between 1998 and 2000 we measured and analysed three additional non-mapped habitat variables of 43 territories (the number of pollard willows, the length of permanent fencing and orchard remnants), and three fragmentation- or isolation variables (the nearest neighbour distance, the number of pairs within a distance of 2.5 km and 5 km). These variables were used to analyse the differences in habitat and isolation between the occupied Little Owl territories and those abandoned since 1995. The variables of the abandoned territories were measured in the last year of presence.

Analysis

We tested the trend over the entire period (1960-2000) and the differences between the decades of the habitat variables for the 13 common territories by means of a repeated measures model. For the years 1995-2000 the differences in habitat and isolation between occupied (n=16) and abandoned territories (n=27) were tested with an F- and t-test. Little Owls of which the nesting place could not be located, were excluded from these tests. The trend in the number of Little Owls between 1995-2000 has also been tested with a repeated measures analysis.

RESULTS

Population changes

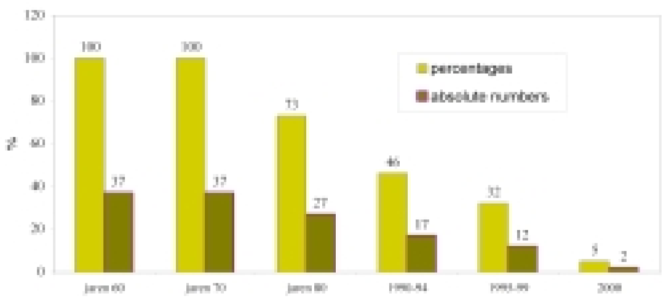

Figure 2. Decrease of the number of Little Owls since the 60s in terms of percentage. The changes are based on a number of territories (n=37) from the 60s of which the period of abandoning is known rather well.
Figuur 2. Afname van het aantal Steenuilen sinds de jaren '60 (in %). De veranderingen zijn gebaseerd op een aantal territoria (n=37) van de jaren '60 waarvan de periode van verlaten vrij goed bekend is.

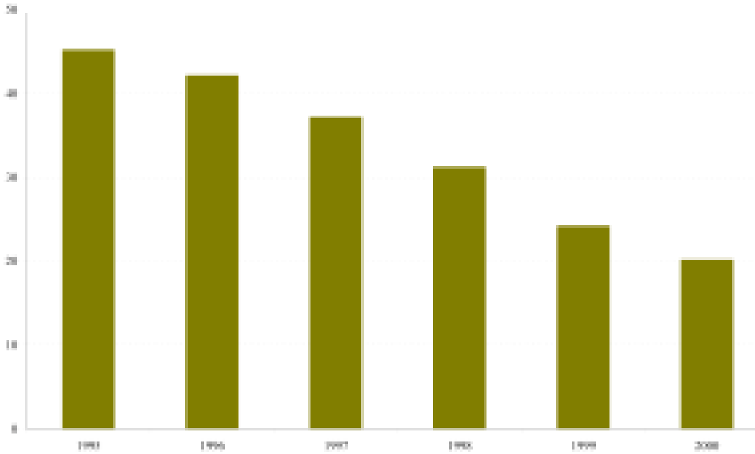

Figure 3. Changes in Little Owl numbers between 1995-2000.
Figuur 3. Veranderingen in het aantal Steenuilen tussen 1995-2000.

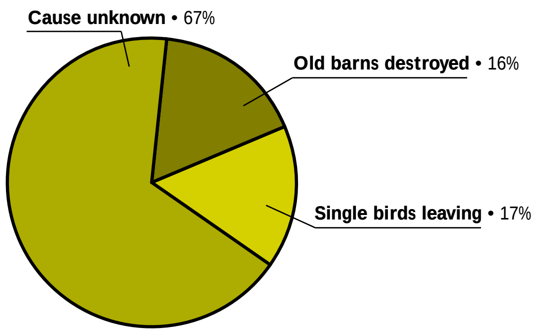

Figure 4. Causes of abandonment of Little Owl territories.
Figuur 4. Oorzaken van verlaten van Steenuilterritoria.

The population of Little Owls in the province of Groningen was probably stable until far in the 70s. In the first half of the 80s the number of Little Owls began to decline, but decreased rapidly in the second half of the 80s and in the 90s (Figure 2). During the 70s the population was estimated at about 300-400 pairs. In the short period between 1995 and 2000 alone the number of Little Owls declined by more than half (58%), from 48 to 20 territories in 2000 (Figure 3).
We gathered more accurate information on the numbers and trend in breeding pairs, the choice of nesting places and possible causes of loss from the second half of the 90s onwards. We know the location of at least 57 pairs from the period 1995-2000, and we know the exact nesting place of 43 pairs. 27 of these territories were abandoned in the last 6 years.

We have some information on the probable causes for abandoning territories in 33% of the cases (Figure 4). Sixteen % of the losses were directly caused by a physical loss of old barns that had been

	n	60's	70's	80's	90's	p
Surface of grassland (ha)	13	8.0	8.6	**7.9***	**8.7**	ns
Parcel size of grassland (ha)	13	0.7	0.8	0.7	0.8	ns
Surface of "extensively managed" grassland (ha)	13	2.9	**2.5***	**2.1**	2.2	ns
Parcel size of "extensively managed" grassland (ha)	13	0.4	**0.4***	**0.3**	0.3	0.003
Number of "extensively managed" grasslandparcels	13	7.4	5.9	6.0	6.5	ns
Number of farms	13	2.6	2.6	2.6	2.6	ns
Ditches (m)	13	**3040***	**2478****	**2096*****	**1832**	0.001
Unpaved roads (m)	13	**606****	**316****	**306***	**260**	0.009
Total of ditches and unp. roads (m)	13	**3646***	**2794*****	**2452*****	**2142**	0.003
Number of high-stem orchards	13	2.0	1.5	**1.3****	**0.2**	0.000

Table 1. Changes in habitat variables since the 60s in a 25ha-area around the nesting places. A code (*, ** or ***) at the figures-in-bold indicates a significant difference with the next decade; * = p<0.05, ** = p<0.01, *** = p < 0.001. In the last column the significance of the trend over the whole period 60s - 90s is pointed out (by means of repeated measures analysis).
Tabel 1. Veranderingen in habitatvariabelen sinds de jaren '60 in een gebied van 25 ha rond de nestplaatsen. Een code (,** of ***) bij de vetgedrukte cijfers geeft een significant verschil aan met de volgende decade, *= p<0.05, ** = p< 0,01, *** = p< 0,001. In de laatste kolom vinden we de significantie terug van de trend over de gehele periode tussen de jaren '60 en '90 (door middel van analyse van herhaalde metingen).*

replaced by new ones or, in a single case, newly built houses. Seventeen % of the cases were territories that were abandoned by non-breeding single birds. The increasing number of single birds may have been caused by increasing distances between the Little Owls. We don't have a direct idea of the cause of 67% of the losses, but it could be due to isolation (see below).
The changes in Little Owl-numbers in Groningen are remarkably similar to those in the entire country since the early 90s (Van Strien and Van der Meij, 2000).

Long term changes in habitat characteristics between 1960 and 2000

Compared to the 60s, habitat quality in the Little Owl territories has strongly declined. From the ten measured habitat variables, in a square of 25ha around the nest, a significant negative trend has been observed in the length of ditches, unpaved roads, the size of "extensively" managed grassland-lots and the number of high-stem orchards (Table 1). Only the smaller average size of these "extensively" managed grassland-lots (from 0.4 to 0.3 ha) can be explained as a possible positive change. This cannot be said of the loss of ditches, unpaved roads and high-stem orchards. In a period of 40 years the average length of ditches has declined from 3040m to 1832m with approximately 1200m per 25ha (i.e. more than 5km of ditches per km²). The length of unpaved roads has declined by more than half, from 606m to an average of 260m per 25ha. The length of ditches and unpaved paths has significantly decreased every decade. The number of high-stem orchards has declined remarkably from an average of 2.0 in the 60s to 0.2 in the 90s per 25ha and from 3.7 to 0.8 per km² respectively.
Compared to the 60s, the area of "extensively" managed grasslands declined, though not significantly so, from an average of 2.9ha to 2.2ha in the 90s per 25ha, as well as the number of "extensive" grassland-parcels from 7.4 to 6.5 respectively. In view of the strong decline in the Little Owl, the slight increase in the area of grasslands is not significant.

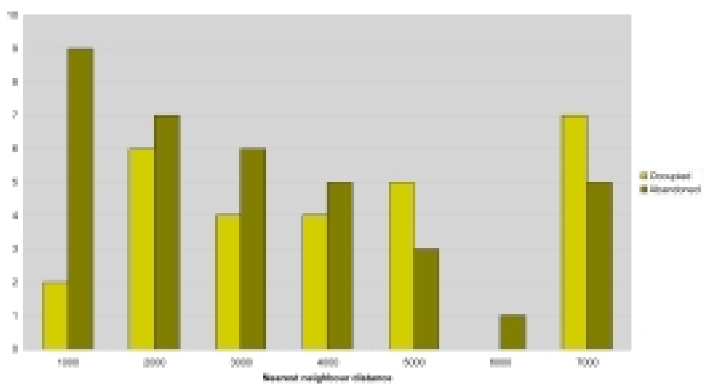

Figure 5. Histogram of the nearest neighbour distances of Little Owl territories occupied after 1995 and before they were abandoned between 1995-2000.
Figuur 5. Histogram van de afstanden tot de dichtsbije Steenuilterritoria bezet na 1995 en vooraleer ze verlaten werden tussen 1995-2000.

Short term changes in isolation and habitat between the occupied and abandoned territories from 1995 to 2000

A number of isolation and habitat variables of the occupied and abandoned territories is compared since 1995 (Table 2 and Table 3). The nearest distance between the neighbours shows the most remarkable difference. For the abandoned territories the nearest distance between neighbours is, with an average of 3.3km, significantly higher than that for the still occupied Little Owl territories (Figure 5) (2.9km).

	Occupied	Abandoned	p
Distance to nearest pair (km)	**2.9**	**3.3**	0.006
Number of pairs within 2.5 km	1.1	1.0	ns
Number of pairs within 5.0 km	2.0	2.4	ns

Table 2. Changes in isolation variables between the occupied and abandoned Little Owl territories during the years 1995-2000. Bold: a significant difference (t-test).
Tabel 2. Veranderingen in isolatievariabelen tussen bezette en verlaten territoria van de Steenuil gedurenden de jaren 1995-2000. Vetgedrukt: een significant verschil (t-test).

The average nearest neighbour distance of all territories has also significantly increased from 2.7km in 1995 to 3.5km in 2000. In the same period the number of breeding pairs within a distance of 5.0km has decreased from an average of 3.7 to 1.9. There is, however, no significant difference between the average number of Little Owls within 5km of the abandoned territories (2.4) and of the occupied territories (2.0). The two last remaining population clusters consist of 6 territories each at most.

It is remarkable that only one habitat variable improved in the occupied territories, namely the smaller parcel size of the "extensively" managed grasslands, both in the 25ha- and 1km²-areas (Table 3). Four of the 12 measured habitat characteristics in the abandoned territories even improved significantly, in the 25ha- or 1km²-samples. In the 1km²-areas the areas of grassland and "extensively" managed grassland increased significantly, in the 25ha-areas of the abandoned territories the length of ditches and the total length of bordering zones showed a similar increase. Table 3 also illustrates the great lack of high-stem orchards and old pollard trees in both the 25ha- and 1km²-areas of all territories.

DISCUSSION

In the study of the evolution of habitat quality we have limited our analysis to the habitat features in the nearest surroundings of the nesting places. We have concentrated on the scaling-up of the landscape since the 60s and its consequence for Little Owl ecology, the evolution of the quality of meadows, the importance of nesting places and the impact of increasing isolation and fragmentation on the Little Owl population in Groningen.

Scaling-up of the landscape

Radical changes in the habitat of the Little Owl have particularly taken place since the 60s and 70s.

	25ha			1km²		
	Occupied	Abandoned	p	Occupied	Abandoned	p
	n = 16	n = 27		n = 16	n = 27	
Farms	1.8	2.2	ns	4.1	4.1	ns
Orchards	0.6	0.7	ns	0.9	1.1	ns
Pollard trees	0.7	3.4	ns	1.6	4.3	ns
Surface of grassland (ha)	10.6	11.7	ns	**39.6**	**43.4**	**0.05**
Parcel size grassland (ha)	1.3	1.0	ns	1.5	1.3	ns
Surface "extensively managed" Grassland (ha)	1.2	2.6	ns	**5.2**	**7.1**	**0.017**
Parcel size "extensively managed" grassland (ha)	**0.3**	**0.4**	**0.0026**	**0.37**	**0.39**	**0.019**
Ditches (m)	**1840**	**2172**	**0.0079**			
Unpaved roads (m)	501	457	ns			
Total of ditches and unp. roads (m)	**2341**	**2629**	**0.01**			
Permanent fencing (m)	1151	1081	ns	2171	2524	ns

Tabel 3. Changes in habitat variables between the occupied and abandoned Little Owl territories during the years 1995-2000, both in the 25ha and 1km²-area around the nesting places. Bold: a significant difference (t-test).
Tabel 3. Veranderingen in habitat-variabelen tussen bezette en verlaten Steenuilterritoria gedurende de jaren 1995-2000, telkens in gebieden van 25 ha en 1 km² rond de nestplaatsen. Vetgedrukt: een significant verschil (t-test).

The habitat changes (Table 1) are mostly related to the scaling-up of the size of grassland-lots and mechanisation in agriculture. On a landscape level this development has led to a big reduction in length of ditches and the paving on a large scale of the unpaved roads and paths to make them more suitable for heavy machines. This ever continuing development in agriculture has created larger plots with smaller amounts of bordering zones which are ecologically more important for Little Owls than areas (Génot and Van Nieuwenhuyse, submitted). Many high-stem orchards have also been removed, disappeared or replaced by low-stem orchards.

The decrease in the Little Owl population during the 80s and in the first half of the 90s appears to be caused by a deteriorating habitat quality as a consequence of these developments in agriculture and landscape. Ditches, paths, permanent fences and rows of pollard trees are linear landscape elements that are often used by the Little Owl to hunt along since they function as excellent gradients (Loske 1986, Van Zoest and Fuchs 1988). Finally, old high-stem orchards also function as nesting places (Fuchs 1982, Génot and Van Nieuwenhuyse, submitted).

Intensification of grassland management

Besides the enlargement of grassland parcels, and with that the loss of bordering zones, there is the problem of the intensification of grassland management. Not only the area of "extensively" managed grasslands has significantly decreased (particularly between the 70s and 80s), but also the prey availability, e.g. voles, insects and earthworms (Duffey et al. 1974). The average area on extensive grasslands in the Little Owl territories has decreased from 2.7ha in the 70s to 2.1ha per 25ha in the 90s, i.e. extrapolated respectively from 10.8ha to 8.4ha per km^2. In the occupied and abandoned territories we measured an average area of respectively 5.2 and 7.1ha per km^2. This average area of extensive grasslands appears to be in a range Génot and Wilhelm (1993) have found. They discovered, by means of telemetry, that Little Owls were hunting over 80% of their time in areas, within their home ranges, that varies on average from only 3.5ha in the summer to 6.0ha in the winter.
The question of the minimally required area of (extensive) grasslands is still hard to answer, because of the lack of information on prey availability and the lack of knowledge about the year-round minimum food supply requirements by Little Owls.
Grasslands, and we presume especially the "extensively" managed grasslands and their borders, are the main hunting areas for Little Owls. Unlike arable land grasslands also are suitable hunting areas during the breeding season and fiercely defended by Little Owls (Finck 1989).
According to Dalbeck et al. (1999) there is a positive correlation between the density of Little Owls and the area of grasslands with fruit trees and pastures. The average area of grassland in the Little Owl territories in Groningen even increased slightly, but not significantly so, from 7.3ha per 25ha to 10.9ha (i.e. extrapolated 29.2 and 43.6ha per km^2 respectively) in the past four decades. Dalbeck et al. (1999) also found a strong preference of Little Owls for small grassland parcels, especially smaller than 0.6ha. In Groningen the average parcel size of extensive grasslands even significantly declined from 0.4ha to 0.3ha between the 60s and 90s (Table 1).

Food

An increasing input of dung and fertilisers, and especially the higher proportions of nitrogen, have a negative effect on the average size of insects in the grasslands. Already at a level of 50kg nitrogen per ha the average size of insects reduces to 4mm. And this size becomes even smaller at higher nitrogen levels. Hence for most of the Dutch grasslands that have an average dung level between 50-200kg nitrogen per ha (Beintema et al. 1995) insect production is almost absent.

The number of earthworms on the other hand is influenced by both the level of dung (more dung, more earthworms), the reduction of water levels and the type of soil. The density of earthworms is significantly lower on clay than on sand and peat soil (Van Eekeren 2000). Unfortunately, the home ranges of most of the Little Owls are on the clay soil of northern-Groningen.

The negative impact of a higher nutrient input in meadows in Groningen apparently outweighs the possible positive impact of the earthworms. Furthermore, the widespread use of heavy pesticides in the last four decades is generally known as having a negative impact on raptors and owls. Prey availability seems to be more strongly affected by the intensification of agriculture (i.e. loss of insects), while factors that improve prey accessibility, i.e. short extensive vegetation and bordering zones like commanding perches, pollard trees and ditches (Génot and Van Nieuwenhuyse, submitted), are reduced by the increase in size of plots.

Breeding places

Photo 1: Example of a typical breeding place of Little Owls in the province of Groningen.
Foto 1. Voorbeeld van een typische broedplaats van Steenuilen in de provincie Groningen.
Photo by / *Fotograaf: Jan van 't Hoff* ©

We do not believe that suitable nesting places are a limiting factor for Little Owl in Groningen for the following reasons. In Groningen farms are by far the most frequently used nesting places (Photo 1). 87% of the pairs breed under thatched-roofs of high farm buildings (on an average height of 12-15cm), 9% in small barns, 2% in high-stem orchards and another 2% in tree-cavities. These are farms that provide Little Owls with plenty of suitable both roosting and nesting places. These farms have been important nesting places for very long in the northern part of The Netherlands. Farms and barns were already mentioned as a main nesting site at the beginning of 1900 in the neighbouring province of Friesland (Van der Ploeg et al. 1977). The Little Owl is mainly a breeding bird of buildings on the edges of villages and in scattered farms in northern Germany (Schleswig-Holstein, Lower Saxony) (Loske 1986). The number of farms has not decreased in the past decades. There is no difference in farm-density (n=4.1 per km^2) between the still occupied and the abandoned territories.

Furthermore since 1977 we have placed a surplus of nest-boxes in the wide surroundings of the two last population clusters. Within one area we placed on average 32 nest-boxes in a radius of 5.0km around the occupied territories and in the second area an average of 7 nest-boxes. Up until now none of these nest-boxes have been occupied by Little Owls.

Isolation and population fragmentation

For the early 80s, Loske (1986) estimated an average nearest neighbour distance of 1434m in Germany. In areas with high densities, such as Central Westfalen, this distance was as low as 435m. In East-Flanders Van Nieuwenhuyse et al. (submitted) have even found an average nearest neighbour distance of 210m for calling Little Owl males.

Increased population fragmentation (with increasing distances between the pairs), as a consequence of a declining habitat quality and lower population densities, is probably the best explanation for the decline in the Little Owl population since the (mid-) 90s. The nearest neighbour distances of 2.9km and 3.3km at the occupied and abandoned territories by far exceeds the audible distance of Little Owl calls of 650m mentioned by Finck (1989). Maybe we could consider this as a critical distance between the territories to maintain a stable population. Nowadays the increased isolation has become of more importance than a relatively better habitat. This conclusion is very similar to the results of a recent study on Little Owls in East-Flanders, Belgium (Van Nieuwenhuyse and Bekaert, submitted). They found that the vicinity of conspecifics had better predictive power on Little Owl presence than landscape elements. The vicinity of the last population clusters in Groningen is more attractive to Little Owls than the quality of the actual habitats. Some favourable regions in Groningen, such as Westerwolde, Zuidelijk Westerkwartier and Gorecht, featuring seemingly excellent Little Owl habitat but situated far from the existing population clusters, remain more or less unoccupied. The same was apparent in the early 90s when large areas of arable land were transformed into set-aside with long-term grassland which was very attractive to many breeding, migrating and wintering raptors and owls, except the Little Owl (Koks and Van 't Hoff 1991, Voslamber et al. 1993). This may be mainly due to the poor dispersal rate of both the juveniles and adults. According to Fuchs (1987) about 50% of the juveniles settled less than 6km from their birthplace. Dispersal after the first breeding season is negligible. Exo and Hennes (1980) found that about 55% of the juveniles had settled within 10km of their birthplace. About 74% of all adults are recovered within 10km from the ringing place and only 9% at a distance of over 100km.

CONSERVATION STRATEGY

In 1999 LOWGG started a Little Owl project in Groningen. This project, in which the working group is closely co-operating with the foundation on Landscape Management Groningen, is a concrete result of the Protected Species Policy for the Little Owl of the Provincial Council and is funded by the Council to an amount of about 82.000 €. The money is being spent on practical protection and managing measures, and for educational purposes. The educational activities consist of a special Little Owl folder, the set up of an information centre on the Little Owl and agricultural nature management (in an old farm inside one of the population clusters which was opened in the summer of 2001), the set-up of a website and close co-operation with committees of inhabitants in the areas of the two last population clusters.

Landscape management that tries to decrease the scale of the landscape, decrease the intensity of agricultural use and improve the availability and accessibility of prey and nesting cavities is done according to the following guidelines.
All the management measures are performed in the areas of the two last population clusters. These agricultural areas, an open landscape of dikes and an open landscape of mounds, have an area of about 30 and 70km^2 respectively. The managing measures are performed on a large scale. In this project we do more than just use the subsidy of the Province, we also co-operate with other participants like local authorities, nature conservation organisations and local nature protection associations.

The main goal is to create favourable conditions in both areas, for a stable population of at least 10 Little Owl pairs.

Photo by / *Fotograaf: Christian Fosserat ©*

The management measures consist of overdue trimming of high-stem orchards and pollard willows, planting new ones, especially on favourable, historical locations and the introduction of new nestboxes in the area. Place names like Oosterwijtwerd and Westerwijtwerd (the meaning of Wijtwerd is willow mound) indicate that (pollard-) willows must have been characteristic elements in the past. Nowadays this indication has completely disappeared. Other management measures consist of agreements with farmers to implement more special strips in arable land and grassland with an adapted nature management. For that purpose we have drawn up a special Little Owl management arrangement giving farmers involved in this project financial compensation. Furthermore we are preparing a new arrangement for farmers to encourage alternative management of small meadows near the farms. The State also provides special management arrangements for dikes. In co-operation with the executive Service of State and the involved landowners we plant pollard willows or place permanent fences in order to create more perches for the species to hunt along the dikes and hence improve prey accessibility (Loske 1986, Génot and Van Nieuwenhuyse, submitted).

Important information, for example on increased grassland use with greater use of dung, fertilizers and insecticides, higher cattle densities, lowering the levels of ground and surface water, the use of fast growing grass-species and the regular sowing of new grass, is not available on this scale. We are fully aware of the impact of the lack of this kind of information, which has probably played a major role in the loss of diversity and food supply (voles, earthworms and a rich terrestrial fauna) in grasslands

(Duffey et al. 1974). Therefore it is extremely important to collect as much additional biotic and abiotic data of Little Owl territories as possible for future analysis.
The real limiting factor(s) for the Little Owl in Groningen is still rather difficult to fathom and should be dealt with at the level of the individual territory and at the population level. The measured quantitative habitat characteristics of the 60s and 70s give us a clue, but we lack every kind of long term reference for other important habitat variables, such as old pollard trees, the length of permanent fences and the area of extensive managed meadows.
Therefore, comparable quantitative habitat analyses from other good Little Owl areas would be valuable. More knowledge on the minimum quantitative habitat and food supply requirements is urgently needed in order to implement effective protection measures.
More comparable pellet-analyses from other areas with higher Little Owl densities or stable populations is also needed.
Hopefully we will succeed in our efforts to save the Little Owl as a characteristic breeding bird of the farmland and as a symbol for the diversity in our modern agricultural landscapes. However we are convinced that it will take a long time to succeed.

CONCLUSION

The direct consequence of the intensification of agriculture is observed in Groningen as the important cause for the decline in the Little Owl population and is seen to cause a reduction of gradients in the landscape (e.g. ditches, unpaved roads, pollard trees, permanent fences), with a decrease in the

SAMENVATTING

In de afgelopen 40 jaar hebben veranderingen in het agrarisch beheer geleid tot schaalvergroting, een intensiever grondgebruik en grote landschappelijke veranderingen. Met negatieve gevolgen voor veel vogelsoorten van het platteland, waaronder de Steenuil.
Van een aantal belangrijke habitatkenmerken zijn de veranderingen gemeten die zich tussen 1960-2000 in Steenuilleefgebieden in de provincie Groningen (Nederland) hebben voltrokken. Tevens zijn de verschillen in habitat- en isolatiekenmerken onderzocht tussen de theoretische leefgebieden (resp. 25ha en 100ha rond de nestplaatsen) van de nog aanwezige- en de na 1995 verdwenen paren.
Sinds de jaren 60 zijn de oppervlakte aan kleine, extensieve graslandpercelen, de lengte aan sloten en onverharde paden, en het aantal hoogstamboomgaarden sterk afgenomen. Hetzelfde geldt ongetwijfeld voor de lengte aan oude knotwilgenrijen en vaste afrasteringen (belangrijke zitposten) in graslanden. Dit alle zijn wezenlijke habitatkenmerken van de Steenuil.
In de loop van de jaren 80 begint het aantal Steenuilen in de provincie Groningen af te nemen om vervolgens in de jaren 90 in een glijvlucht te raken.
Lijkt de achteruitgang van de Steenuil in de periode 1980-1995 het gevolg van een sterk verminderde habitatkwaliteit, na 1995 speelt vooral de opgetreden versnippering in gedecimeerde populaties de soort parten. Het grootste verschil tussen de verdwenen- en nog aanwezige Steenuilen zit in de toegenomen afstand tot het dichtstbijzijnde paar (resp. 3.3 en 2.9km). Sinds 1995 is het verschil in habitatkwaliteit nog minimaal en steekt bij de verdwenen paren voor een aantal kenmerken zelfs gunstiger af. Aangezien de meeste Steenuilen in Groningen onder de rieten daken van boerderijen broeden, lijkt een gebrek aan nestgelegenheid geen fundamentele rol van betekenis te spelen. De slechte bezetting van nestkasten lijkt dit vermoeden te bevestigen.
Beheer- en beschermingsmaatregelen voor de Steenuil zijn gericht op een omvangrijke en snelle verbetering van de habitatkwaliteit in de gebieden met de laatste restpopulaties, en voorlichting (o.a. via een brochure, website en informatiecentrum). Financiële steun van het provinciale bestuur maakt dit alles mogelijk en in nauwe samenwerking met de Stichting Landschapsbeheer, boeren en particuliere grondeigenaren worden de maatregelen gerealiseerd.

Samenvatting door Jan van 't Hoff

area of "extensively" managed grassland and loss of old high-stem orchards. Furthermore the input of fertilizer and insecticides has caused an important reduction in prey availability for the Little Owl. From the 70s to the 80s the main impact was found to be the scaling-up of the landscape and intensification of agriculture. From the mid-90s onwards we also see that an increasing isolation and fragmentation of populations plays an important role. This is seen as melting crystals, since occupied territories closer to conspecifics are the last to be abandoned in spite of the sometimes lower habitat quality.

Our conservation strategy is mainly to secure the two remaining local population clusters, reduce the scale of the landscape by introduction of permanent fences, pollard willows, improve prey availability using strips with special management, improve nesting places using nest boxes, improve prey accessibility by mowing in strips of set-aside lands and add perches. Data collection of unmapped relevant landscape elements was started in 1995 and remains crucial. Finally international comparative research of landscapes and pellets is being carried out and will be extended in the near future.

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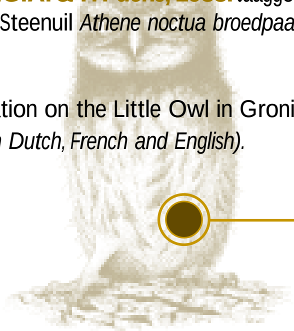
More information on the Little Owl in Groningen: *www.steenuil-groningen.nl (in Dutch, French and English).*



14. POPULATION DYNAMICS OF LITTLE OWL *ATHENE NOCTUA* IN WALLONIA AND ITS DRIVING FORCES. EVIDENCE FOR DENSITY-DEPENDENCE.

POPULATIEDYNAMIEK VAN DE STEENUIL *ATHENE NOCTUA* IN WALLONIË EN HAAR DRIJVENDE KRACHTEN. BEWIJZEN VOOR AFHANKELIJKHEID VAN DICHTHEID.

JACQUES BULTOT*, PAUL MARIÉ AND DRIES VAN NIEUWENHUYSE

ABSTRACT

Since the end of the eighties, 'Groupe Noctua', started a large-scale conservation action for Little Owl *Athene noctua* in Wallonia (southern Belgium). Nest-boxes were installed in 23 research areas spread over the territory. Occupation rates, breeding results, laying dates, clutch sizes and densities are described. This paper analyses the dynamics of the population as a whole and of two sub-populations in particular. For every extra pair/km^2, the average laying date is 8 days earlier. The average laying initiation dates for Wallonia are 6 days later per 100 l/m^2 precipitation in March, so bad weather postpones laying in Little Owl. Little Owls breeding in High Belgium (South of the Sambre-Meuse line) start breeding 5 days later on average than their conspecifics in Middle Belgium. Finally we analysed the average of the laying dates and clutch size and their variance for Ransart and Neufville. The average laying initiation dates differed significantly between isolated and clustered pairs i.e. in Neufville in 1995 (clustered pairs: 23/04; isolated pairs: 13/04) and 1998 (clustered pairs: 14/04; isolated pairs: 02/04). For the clustered pairs the clutch-sizes are significantly smaller than for isolated pairs illustrating density-dependence (1994: clustered pairs 2.5; isolated pairs 3.5 and 1999: clustered pairs 3.3; isolated pairs 4.0 in Ransart and in 1998: clustered pairs 3; isolated pairs 4.3 in Neufville). We found for Ransart in 1997 Little Owls starting to lay 1 day later on increasing distance with 100m to the nearest neighbour. In 1995 we found the species in Neufville laying 1 day later for every 100m closer they are situated to one another. Fledging success of Little Owl in Ransart shows a negative but non-significant linear relationship with the cumulative precipitation of May and June. For every 100 l/m^2 extra precipitation the number of fledglings tends to decrease with 0.6. Finally we found the clutch size decreasing with progressing laying dates. The results of this study are interpreted in the light of density-dependence.

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INTRODUCTION

Since the end of the eighties, a handful of Walloon ornithologists decided to start conservation activities to counter the deteriorating evolution of the Little Owl *Athene noctua* decreasing over most of Europe since decades (Génot et al. 1997). The main objectives of the 'Groupe Noctua' are to find and offer solutions to help conserve the species while considerable populations are still present. A first step was to determine and assess local densities using the playback method (Petzold and Raus 1973, Exo and Hennes 1978). As a result of plenty of nocturnal excursions in different regions between mid February and the end of March, we obtained a good view on the number of calling males still present (Coppée et al. 1995). Densities ranged between 1 and 1.7 calling males per km^2 depending on the region ranging from 20 to 50 km^2 but showing no linear relation between the densities and the prospected areas. Even semi-urban sites near Charleroi were found occupied. As a result of the survey we found anecdotic evidence for different factors having a negative impact on the species in our research area.

- Habitat loss is undoubtedly the main factor of direct disappearance of Little Owl both in Wallonia and elsewhere in Europe (Exo 1983, Juillard 1984, Schönn 1986, Génot 1988), whether this is deliberately or by accident e.g. as the destruction of neglected pollard willows by storms (e.g. February 1990, Photo 1), or degrada-

Photo 1 Neglected pollard willows destroyed by a storm as an important cause for the decline of Little Owl in Wallonia.
Foto 1. Verwaarloosde knotwilgen verwoest door een storm als een belangrijke oorzaak voor afname van Steenuilen in Wallonië.
Photo by / *Fotograaf:* Jacques Bultot ©

Photo 2 Uprooting of old high-stem orchards as an important cause for the decline of Little Owl in Wallonia.
Foto 2. Rooien van oude hoogstamboomgaarden als belangrijke oorzaak voor de achteruitgang van de Steenuil in Wallonië.
Photo by / *Fotograaf:* Jacques Bultot ©

tion or uprooting of existing orchards (Photo 2).
- Road mortality has an important impact on the species (Fajardo 1998) and will be dealt with in this paper too.
- Natural predators e.g. Stone Marten *Martes foina*
- Feral cats and dogs
- Accidental mortality e.g. barbed wires, chimneys and drinking ponds for cattle.

To cope with some of these problems we looked for the most feasible actions that could be undertaken to counter the deteriorating evolution i.e. using nest boxes to tackle the problem of the disappearing nesting cavities. After some experiments with nest-boxes of the Juillard (1984) and the Schwarzenberg (1981) type we finally created a new type of nest box and started to furnish artificial nesting cavities on a very large scale.

Since 1989 a long-term research programme is carried out using the nest box data. The aim of this paper is to present the results of the nest-box project from a population dynamics point-of-view. We look at local population densities and occupation rates of nest boxes (local evolution), demographic data such as clutch size, laying dates, immigration (input), birth rates, mortality causes and emigration (output) and end with giving some practical examples of possible conservation activities in function of the species. Special attention goes to differences between isolated and clustered pairs.

METHODS

We worked on 23 different sites evenly spread over most available landscape types in Wallonia (southern Belgium) covering a total of 1641 km^2 (Figure 1; Tab. 1), Ransart (zone #1: 100km^2) and Neufville (16km^2 of zone #2:100km^2) have been investigated intensively since 1989 and 1993 respectively, and hence yield the bulk of the results. Every zone is investigated separately by people that had an on-the-job training of at least 1 to 2 years. 'Groupe Noctua' has an own ethical code: nest boxes are installed only when a regular follow-up (at least 3 times per year) is guaranteed. Durability of our

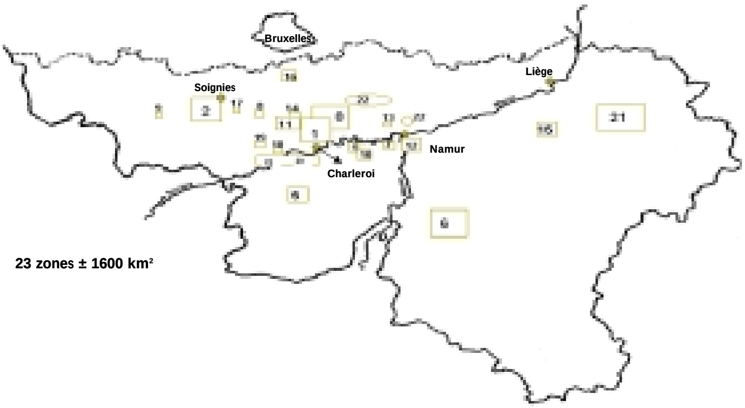

Figure 1. Location of 23 research areas in Wallonia and indication of the Sambre-Meuse border between High and Middle Belgium. The numbers of the zones correspond to the numbers in Table 1 (zone #1 Ransart; zone #2 Soignies, Neufville).
Figuur 1. Situering van 23 onderzoeksgebieden in Wallonië met weergave van de Samber-Maas grens tussen Midden en Hoog België. De nummers van de zones komen overeen met de nummers in Tabel 1 (zone #1 Ransart, zone #2 Soignies, Neufville).

* percentage of special anti-predator systems installed per zone.

Zone		Type of nestbox						
n°	Km²	wine box	ammunition box	modified ammunition box	Other type	Total	%	% SAP*
1	80	46	0	2	24	**72**	10	**10%**
2	100	51	53	0	2	**106**	14	**19%**
3	6	6	0	2	3	**11**	1	**9%**
4	10	4	0	5	0	**9**	1	**100%**
5	57	14	0	2	0	**16**	2	**100%**
6	625	39	0	45	4	**88**	12	**14%**
7	14	11	8	0	0	**19**	3	**100%**
8	76	1	0	0	42	**43**	6	**19%**
9	4	5	6	0	0	**11**	1	**27%**
10	15	8	0	8	0	**16**	2	**0 %**
11	80	40	0	5	5	**50**	7	**24%**
12	48	0	1	3	0	**4**	1	**0%**
13	5	2	0	1	0	**3**	0	**33%**
14	12	10	0	0	0	**10**	1	**0%**
15	15	12	0	0	0	**12**	2	**100%**
16	50	18	0	0	0	**18**	2	**0%**
17	18	1	7	0	3	**11**	1	**0%**
18	12	0	0	20	0	**20**	3	**0%**
19	30	21	0	0	0	**21**	3	**0%**
20	15	28	0	0	0	**28**	4	**100%**
21	276	61	0	0	0	**61**	8	**0%**
22	100	7	38	0	20	**65**	9	**1%**
23	8	15	0	0	0	**15**	2	**0%**
HZ	-	34	12	7	1	**54**	7	**4%**
Total	**1641**	**426**	**125**	**92**	**104**	**747**		
	%	**57**	**17**	**12**	**14**			**20%**

Table 1. Little Owl nest box availability data of 23 research areas in Wallonia. The numbers of the zones correspond to the numbers in Figure 1 (zone #1 Ransart; zone #2 Soignies, Neufville).
Tabel 1. Beschikbaarheid van nestkasten voor Steenuil in 23 onderzoeksgebieden in Wallonië. De nummers van de zones komen overeen met die in Figuur 1 (zone #1 Ransart, zone #2 Soignies, Neufville).

activities prevails, we favour less but better and more durable actions. We never install nest-boxes before a census has been carried out using the playback method as described by Petzold and Raus (1973). All nest boxes are installed on privately owned land in favourable habitats and a complete documentation set on the species is given to the landowner. This guarantees plenty of contacts with landowners that allow for transfer of knowledge and respect for the species, which is very stimulating for all volunteers and durable on the long term for Little Owl. Nest boxes are made, hung up and checked independently by the responsible per area, as is the general management and visits for ringing etc.. Standard forms are used, for registration of installation and follow-up of nest boxes, biometry and reproduction of the birds, and are collected during the regular meetings of the group. A yearly overview is published and distributed to all volunteers that co-operate, i.e. 25 persons assisted by many ad-hoc volunteers that form a pool for people to undertake the creation of new independent research areas.

Illustrations Nest box 'Groupe Noctua'

The nest boxes developed by us (Photo 3, Coppée et al. 1995) are made of recuperated wine bottle boxes measuring 50x33x18cm (LxHxB) and are

Photo 3. Nest box made of recuperated wine bottle boxes.
Foto 3. Nestkast gemaakt van oude wijnkisten.
Photo by / *Fotograaf:* Jacques Bultot ©

Model	Response variable		Intercept			Independent variable	P-value	Adj. R^2
#1	Log(density)	=	1	-	0.4	log(studied area)	<0.01	0.26
#2	Occupied nest-boxes	=	-26	+	0.37	available nest-boxes	<0.001	0.96
#3	Average calculated laying initiation date in Wallonia	=	21/04	-	8.44	density per year per zone	<0.0003	0.15
#4	Average calculated laying initiation date in Neufville	=	25/04	-	29.76	density per year in Neufville	<0.0053	0.78
#5	Average calculated laying initiation date in zone #3	=	12/05	-	33.125	density per year in zone #3	<0.0212	0.62
#6	Average calculated laying initiation date in 2000	=	23/04	-	17.12	density per zone per year	<0.015	0.35
#7	Average calculated laying initiation date in Wallonia	=	14/04	-	0.066	precipitation in March	<0.005	0.08
#8	Average calculated laying initiation date zone #6	=	11/04	+	0.16	precipitation in March	<0.049	0.49
#9	Average calculated laying initiation date in zone #8	=	14/04	+	0.08	precipitation in March	<0.003	0.89
#10	Calculated laying initiation date in Ransart	=	9/04	+	0.01	meter from nearest neighbour	<0.036	0.16
#11	Calculated laying initiation date in Neufville	=	27/04	-	0.01	meter from nearest neighbour	<0.03	0.36
#12	Clutch size in Ransart and Neufville 1993-2000	=	7.49529	-	-0.031	days after New Year	<0.0001	0.09
#13	Clutch size in Ransart and Neufville 1997	=	7.46054		-0.031	days after New Year	<0.0114	0.13
#14	Clutch size in Ransart and Neufville 1998	=	9.75909		-0.048	days after New Year	<0.0001	0.31
#15	Clutch size in Ransart and Neufville 1999	=	9.97033		-0.048	days after New Year	<0.02	0.08
#16	Clutch size in Ransart 1995-2000	=	8.14825	-	0.0338	days after New Year	<0.0001	0.09
#17	Clutch size in Neufville 1993-2000	=	7.81997	-	0.0353	days after New Year	<0.0001	0.15
#18	Clutch size in Ransart in 1997	=	7.93797	-	0.0329	days after New Year	<0.04	0.15
#19	Clutch size in Ransart in 1998	=	9.6826	-	0.0464	days after New Year	<0.017	0.19
#20	Clutch size in Neufville in 1998	=	10.52	-	0.0547	days after New Year	<0.0001	0.53
#21	Clutch size in Ransart in 1999	=	12.5739	-	0.0649	days after New Year	<0.015	0.16
#22	Clutch size in Neufville in 1999	=	14.4602	-	0.0865	days after New Year	<0.023	0.19
#23	Clutch size in Neufville in 2000	=	5.73235	-	0.0186	days after New Year	<0.02	0.2
#24	Average number of fledglings	=	3.26	-	0.0063	precipitation in May and June	<0.076	0.21

Table 2. Linear regression models for the covered research area elasticity on the observed density, the average calculated laying initiation date in relation to the observed densities and the precipitation in March, the calculated laying initiation date in relation to the nearest neighbour distance, the clutch size in relation to the laying date and the average number of fledglings in relation to the cumulative precipitation of May and June.
Tabel 2. Lineaire regressie-modellen voor de oppervlakte onderzoeksgebieden elasticiteit op gemiddelde in dichtheden, de gemiddelde datum van eerste eileg in relatie tot de waargenomen dichtheden en de neerslag in maart, de berekende datum van eerste eileg in relatie tot de afstand tot de dichtstbijzijnde buur, de legselgrootte in relatie tot de legdatum en het gemiddelde aantal uitgevlogen jongen in relatie tot de cumulatieve neerslaghoeveelheden voor mei en juni.

easy to obtain and to build, light but strong, very well accepted by Little Owl and practical during the visits. The majority of the nest-boxes are installed on private lands. Table 1 shows the total number of available nest boxes per area since 1989. During the research period several optimisations were carried out of which the most important was the transformation of the vertical chicane to a horizontal separation offering more space for the nestlings. To cope with the population increase of Stone Marten *(Martes foina)* special protective systems (SAP: Système Anti-Prédateur, Marié and Leysen 2001) were installed. In the current study we assume that the modifications have no impact on the breeding biological parameters of the population. The distribution of the nest boxes is in most areas in function of available Little Owl habitat. In Neufville however, an experimental design was used for installing nest boxes. On a surface of 16km², boxes were installed in a spiral around a central point with constant inter-box-distances of 250m.

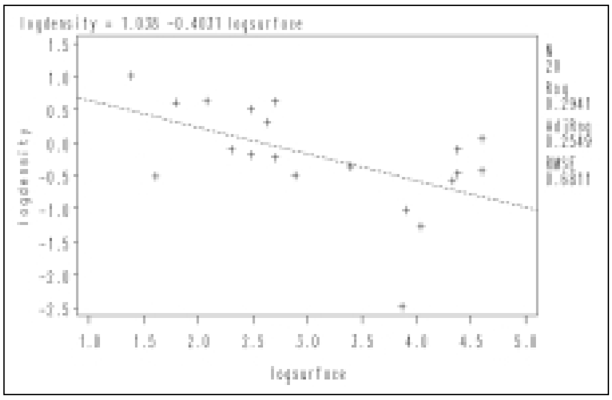

Figure 2. Covered research area elasticity on average Little Owl densities in Wallonia.
Figuur 2. Elasticiteit van oppervlakte onderzoeksgebied op gemiddelde dichtheden van de Steenuil in Wallonië.

THE LITTLE OWL

Data of precipitation for Ransart was obtained from the Royal Belgian Meteorological Institute (Gosselies), situated in research area 1 (Figure 1). We used the total precipitation in March to analyse the impact on the average laying dates of the first egg. We used the cumulative precipitation of May and June to test the impact on the number of fledglings per year. The impact of snow was not analysed since it is extremely rare.

DATA ANALYSIS

All analyses were done using the SAS-system (SAS Institute Inc., Cary, NC, USA). Hatching dates are calculated using the method of Juillard (1984) using the growing stage of the eight primary. This method, calibrated with 581 Swiss nestlings, yielded an accuracy of ± 2 days on 26 nestlings of the German Niederrhein area (Exo in Schönn et al. 1991). Laying initiation dates were calculated by subtracting 28 days from the calculated hatching date. The length of the incubation period varies between 22 and 28 days (Exo 1992). We tested with linear regression (PROC REG, SAS Institute 1989) if the average laying dates per year and per zone were related to the density of the species per year and per zone, and to the amount of precipitation in l/m^2 per month per year in Gosselies. Non-linear relationships were not tested since the remaining scatter-plots did not suggest this. First the analysis was done for Wallonia and next per zone. We tested if the average laying dates of the zones in High Belgium (south of Sambre-Meuse line) differed significantly from the average laying dates of the zones in Middle Belgium (Wallonia north of Sambre-Meuse line) using PROC NPAR1WAY (SAS Institute 1989). For Ransart and Neufville we tested laying date and clutch size in function of the nearest neighbour distance using PROC REG (SAS Institute 1989). Nearest neighbour distances were calculated with PROC FASTCLUS (SAS Institute 1989) for all occupied nest-boxes per year. For Ransart and Neufville we stratified our samples in isolated and clustered pairs using the nearest neighbour distance of 610m which is approximately the median value of Ransart (nearest neighbour distances of isolated pairs > 610m; nearest neighbour distances of clustered pairs <= 610m) and calculated average laying dates and clutch sizes and their variance using PROC

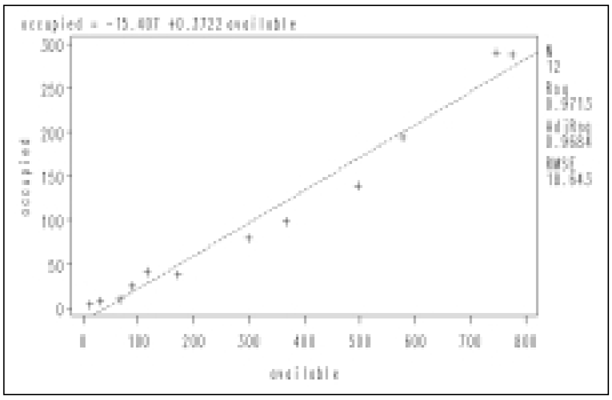

Figure 3. Linear relationship between the number of available nest boxes and the number of occupied nest boxes in Wallonia from 1989 to 2000.
Figuur 3. Lineair verband tussen aantal beschikbare nestkasten en aantal bezette nestkasten in Wallonië van 1989 tot 2000.

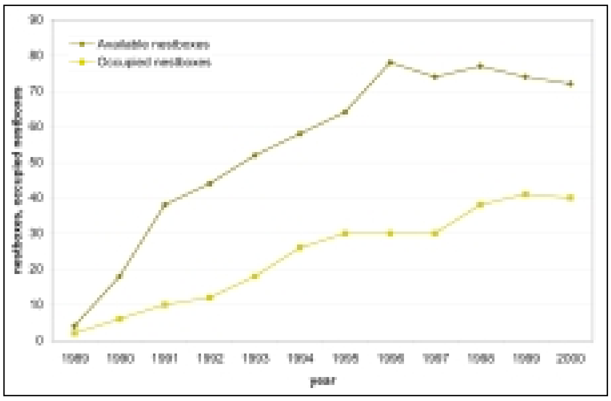

Figure 4. Evolution of available and occupied nest boxes in Ransart, Wallonia, since 1989.
Figuur 4. Evolutie van beschikbare en bezette nestkasten sinds 1989 in Ransart, Wallonië.

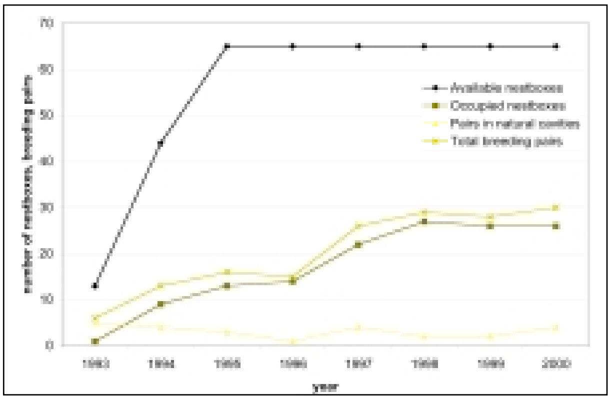

Figure 5. Evolution of available and occupied nest boxes and the number of breeding pairs in natural cavities in Neufville since 1993.
Figuur 5. Evolutie van beschikbare en bezette nestkasten en het aantal broedparen in natuurlijke holtes in Neufville sinds 1993.

	Years													
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total	Average
Available nest boxes	13	32	67	90	117	172	300	368	498	578	776	747		
Occupied nest boxes	4	8	10	25	41	38	79	98	139	194	288	290	**1214**	
%occupied	31%	25%	15%	28%	35%	22%	26%	27%	28%	34%	37%	39%		**29%**
eggs laid	17	28	29	85	149	118	253	340	440	644	955	949	**4007**	
average number of eggs	4.3	3.5	2.9	3.4	3.6	3.1	3.2	3.5	3.2	3.3	3.3	3.3		**3.3**
unhatched eggs	1	2	1	19	11	8	60	49	107	105	156	179	**698**	
average unhatched eggs	0.3	0.3	0.1	0.8	0.3	0.2	0.8	0.5	0.8	0.5	0.5	0.5		**0.6**
hatches chicks	16	26	28	66	138	110	193	291	333	539	796	770	**3306**	
average hatched chicks	4.0	3.3	2.8	2.6	3.4	2.9	2.4	3.0	2.4	2.8	2.8	2.7		**2.7**
dead chicks	3	4	7	13	12	28	43	45	38	69	81	108	**451**	
average dead chicks	0.8	0.5	0.7	0.5	0.3	0.7	0.5	0.5	0.3	0.4	0.3	0.4		**0.4**
fledglings	13	22	21	53	126	82	150	246	295	469	718	662	**2857**	
average fledglings	3.3	2.8	2.1	2.1	3.1	2.2	1.9	2.5	2.1	2.4	2.5	2.3		**2.35**
evaluation of breeding results	?	G	A	A	G	A	B	A	A	A	A	A		

G = Good - A = Average - B = Bad

Table 3. Overview of results of nest box occupation by Little Owl in Wallonia (1989-2000).
Tabel 3. Overzicht van de bezetting van nestkasten door de Steenuil in Wallonië.

	Years													
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total	Average
Available nest boxes	4	18	38	44	52	58	64	78	74	77	74	72		
Occupied nest boxes	2	6	10	12	18	26	30	30	30	38	41	40	**283**	
%occupied	50%	33%	26%	27%	35%	45%	47%	38%	41%	49%	55%	56%		
monitored pairs	2	6	6	12	15	19	29	30	28	33	41	36	**257**	
eggs laid	9	20	18	38	57	60	107	106	99	110	149	121	**894**	
average eggs laid	4.5	3.3	3.0	3.2	3.8	3.2	3.7	3.5	3.5	3.3	3.6	3.4		**3.5**
unhatched eggs	1	2	4	16	10	2	39	16	36	14	41	24	**205**	
average unhatched eggs	0.5	0.3	0.7	1.3	0.7	0.1	1.3	0.5	1.3	0.4	1.0	0.7		**0.8**
hatchlings	8	18	14	22	47	58	68	90	63	96	108	97	**689**	
average hatchlings	4	3.0	2.3	1.8	3.1	3.1	2.3	3.0	2.3	2.9	2.6	2.7		**2.7**
dead hatchlings	2	4	1	4	3	13	22	13	7	10	13	12	**104**	
average dead hatchlings	1	0.7	0.1	0.3	0.2	0.5	0.7	0.4	0.3	0.3	0.3	0.3		**0.4**
fledgelings	6	14	13	18	44	45	46	77	56	86	95	85	**585**	
average fledgelings		3	2.3	2.2	1.5	2.9	2.4	1.6	2.6	2.0	2.6	2.3	**2.4**	**2.28**
evaluation of breeding results	?	A	A	B	G	A	B	G	B	G	A	A		
Precipitation in l/m²**	34.3	58.8	42	76.6	87.1	99.3	161.1	53.8	71.2	169.2	122.4	114.7		

G = Good - A = Average - B = Bad

Table 4. Breeding results of Little Owl in Ransart from 1989 to 2000 (zone 1).
Tabel 4. Broedresultaten van de Steenuil in Ransart van 1989 tot 2000 (zone 1).

	Years								
	1993	1994	1995	1996	1997	1998	1999	2000	Total
Available nest boxes	13	44	65	65	65	65	65	65	**447**
Occupied nest boxes	1	9	13	14	22	27	26	26	**138**
Pairs in natural cavities	5	4	3	1	4	2	2	4	**25**
Total breeding pairs	6	13	16	15	26	29	28	30	**163**
%occupied	8%	20%	20%	22%	34%	42%	40%	40%	

Table 5. Breeding results of Little Owl in Neufville from 1993 to 2000 (part of 16km² of zone 2).
Tabel 5. Broedresultaten van de Steenuil in Neufville van 1993 tot 2000 (gedeelte van zone 2, 16 km²).

UNIVARIATE (SAS Institute 1989) per stratum per year. We tested if the clutch sizes and laying dates in isolated pairs was different from clustered pairs with ANOVA (PROC NPAR1WAY, SAS Institute 1989). To describe mortality causes of Little Owl in Wallonia, we compared our data with samples of Creaves (ex-CROH) bird-care centres during the last 10 years.

RESULTS

Densities

Most researchers tend to have a limited amount of time to spend on their Little Owl activities. This is partly reflected by the area elasticity on the local density that is observed. For every increase of 1% in the studied area, the observed density decreases with 0.4% (Table 2, model #1; Figure 2) after omission of the two extremely large research areas.

Occupation rate of nest-boxes

From the first year on, the results of our nest-boxes outperformed our expectations. The nest-boxes are occupied very soon and hence probably offer excellent nesting conditions as has been shown in many other studies (see infra). In some cases the nest box was visited or even occupied permanently only a few days after the placement. The most extreme case was a breeding pair discovered in June only after placing the box on April 2nd in Ransart and a breeding pair with eggs on April 28th after placing the box on February 18th in Neufville. The occupation rate of nest boxes by breeding pairs per year since 1989 is illustrated in Table 3 and ranges between 15% and 39%. The number of occupied boxes shows a nearly perfect linear relationship over the years with the number of available nest boxes (Figure 3). For every nest box that we additionally place 0.37 will be occupied i.e. one in three nest boxes (Table 2, model #2). A more detailed view on available nest boxes and their occupation rate is given for Ransart, zone #1 (Figure 4; Table 4) and Neufville, zone #2 (Figure 5; Table 5).
In Ransart we see a gradual increase of the number of nest boxes. This makes it impossible to split the impact of the nest boxes from the impact of the real evolution of the population i.e. the real population trend might be masked, more boxes might be occupied, simply because more nest boxes become available. After 1996 the number of nest boxes remained stable. From then on we see a gradual increase of the occupation rate which might indicate a real population increase or continuing destruction of natural cavities.
The identification of the owls in Neufville (Table 6), breeding in the additionally occupied nest boxes shows that 44% of the breeding females consists of first year birds and not adults suggesting a real population increase. Thirty-eight percent of the females of the new breeding pairs were actually born in the region and stayed there to breed. One female was born in a neighbouring research area 11.5km away.
In Neufville where the installation of nest boxes at regular intervals was finished within 2 years, we have indications of movements of existing pairs to nest boxes the first 3 years (number of pairs in natural cavities decreased while number of pairs in nest boxes increased slightly more). An actual increase in population numbers (number of breeders in natural cavities remained stable) was observed later on. Nevertheless we observed switches between nest boxes and natural cavities of the same birds frequently. Furthermore we see the curve of breeding pairs flattening i.e. a saturation effect is starting to occur. This might indicate that maximum densities are getting reached. The density of breeding pairs in Neufville (Soignies) was 1.875 breeding pairs per km^2 (total surface 16km^2).

age female Ransart	first occupations	% of all birds	% of birds with exact age known
>1	39	50	
>2	7	9	
>3	10	13	
>4	3	4	
>6	1	1	
>7	1	1	
2	10	13	59
3	5	6	29
4	2	3	12
TOTAL	78	100	17

age female Neufville	first occupations	% of all birds	% of birds with exact age known
>1	19	42	
>2	3	7	
>3	2	4	
>5	3	7	
1	1	2	6
2	7	16	39
3	5	11	28
4	1	2	6
5	2	4	11
6	2	4	11
TOTAL	45	100	18

Table 6. Age of Little Owl females at first occupation of nest box in Ransart and Neufville research area.
Tabel 6. Leeftijd van Steenuilvrouwtjes bij eerste bezetting van nestkasten in het onderzoeksgebied van Ransart en Neufville.

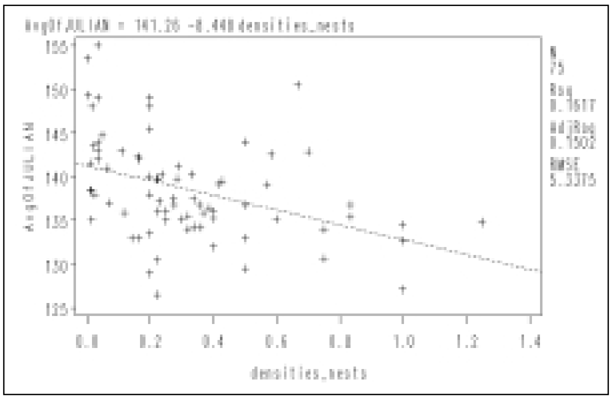

Figure 6. Linear regression of average laying initiation date and densities in Wallonia.
Figuur 6. Lineaire regressie van gemiddelde datum eerste eileg en dichtheden in Wallonië.

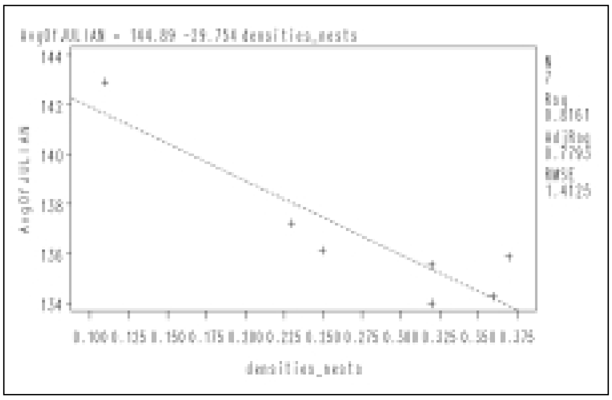

Figure 7. Linear regression of average laying initiation date and densities per research zone for zone #2, Neufville.
Figuur 7. Lineaire regressie van gemiddelde datum eerste eileg en dichtheden per onderzoeksgebied in zone #2, Neufville.

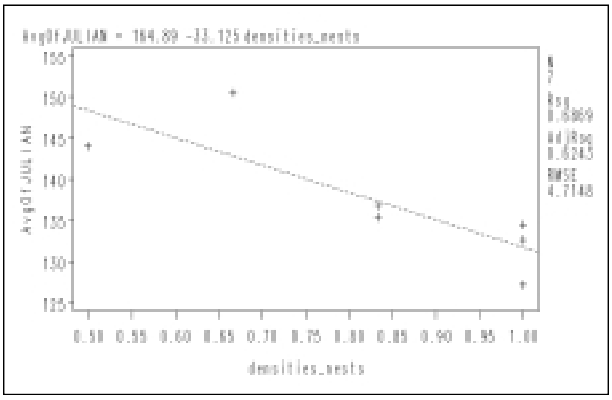

Figure 8. Linear regression of average laying initiation date and densities per research zone for zone #3.
Figuur 8. Lineaire regressie van gemiddelde datum eerste eileg en dichtheden per onderzoeksgebied in zone #3.

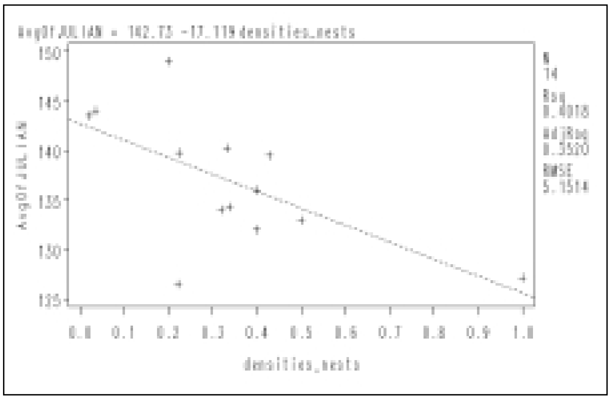

Figure 9. Linear regression of average laying initiation date and densities per year for 2000.
Figuur 9. Lineaire regressie van gemiddelde datum eerste eileg en dichtheden per jaar voor 2000.

Average calculated laying initiation dates

The mean calculated laying date of the first egg for 1989-2000 ranges from April 15th to 18th (n=283). The spread in laying initiation dates is within the possible error in the calculation method of the laying initiation date. We can consider the date as being stable. The earliest laying date ranges from March 25th to the 1st of April. The latest laying date ranged between June 3rd to May 23rd. Among the extremely late dates we have anecdotic evidence that some replacement broods are concerned. In 2000, two confirmed cases of replacement broods were recorded. Average Little Owl laying dates per year in Wallonia show a weak negative linear relationship with the local densities of breeding pairs (Table 2, model #3; Figure 6). For every increase of 1 pair/km^2 the laying date is 8 days earlier. When stratifying the data by individual research zone we find a significant model for Neufville (Table 2, model #4; Figure 7) and zone #3 (Table 2, model #5; Figure 8).

The other zones do not show any significant linear models. Analysis of the remaining scatter plots did not suggest non-linear relationships either. When stratifying the data by individual year we only find a significant model for 2000 (Table 2, model #6; Figure 9).

Average Little Owl laying dates in Wallonia show a positive linear relationship with the precipitation in March (Gosselies) (Table 2, model #7; Figure 10). For every increase of 100l/m^2 precipitation in March, the average laying date increases with 6 days. Clutch initiation is postponed in function of the amount of rain in March. When stratifying the data by research zone we obtain a significant linear relationship for zone #6 (Table 2, model #8; Figure 11) and zone #8 (Table 2, model #9; Figure 12). The impact of snow in Wallonia is marginal since there are on average only few days of snow-cover annually.

We also tested the hypothesis that the species breeding in High Belgium breeds later than in Middle Belgium. We found a significant difference between the mean laying dates in High Belgium (mean laying date: 22/04) and Middle Belgium (mean laying date: 17/04) (F-value: 20.9; Pr>F: <0.0001).

The average laying initiation date in Neufville differed significantly between isolated and clustered pairs in 1995 and 1998 using 610m as a threshold. The clustered pairs start laying 10 to 12 days later than

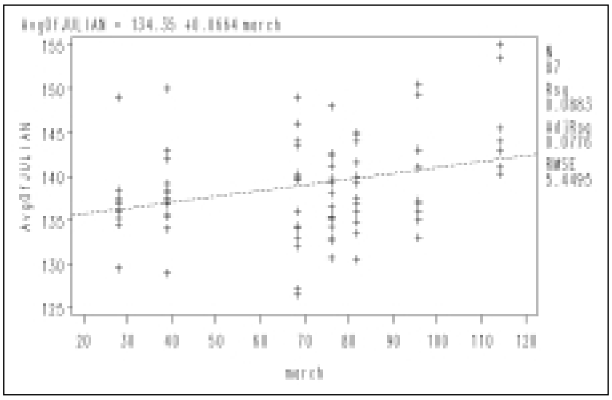

Figure 10. Linear regression of average laying initiation date and precipitation in Gosselies in Wallonia.
Figuur 10. Lineaire regressie van gemiddelde datum eerste eileg en neerslag in Gosselies, Wallonië.

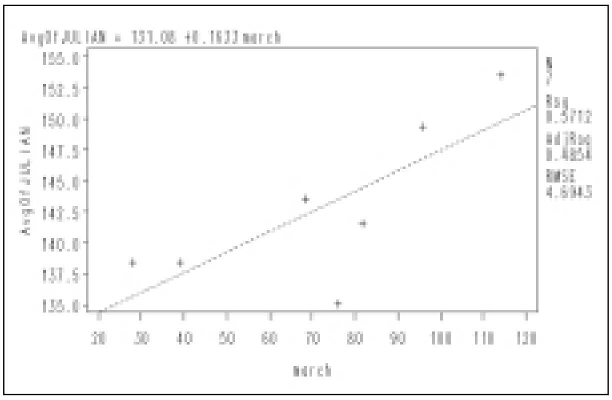

Figure 11. Linear regression of average laying initiation date and precipitation in Gosselies per zone for zone #6.
Figuur 11. Lineaire regressie van gemiddelde datum eerste eileg en neerslag in Gosselies per deelgebied voor zone #6.

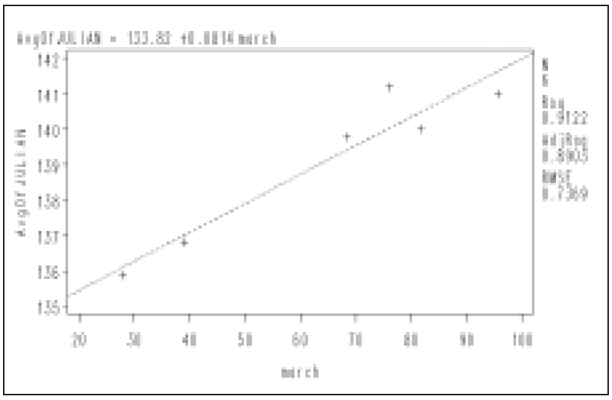

Figure 12. Linear regression of average laying initiation date and precipitation in Gosselies per zone for zone #8.
Figuur 12. Lineaire regressie van gemiddelde datum eerste eileg en neerslag in Gosselies per deelgebied voor zone #8.

the isolated pairs (1995; clustered pairs: 23/04; isolated pairs: 13/04 ; F-value: 7.1; Pr > F: 0.026; 1998; clustered pairs: 14/04; isolated pairs: 02/04; F-value: 4.51; Pr > F: 0.04; in Neufville). For the other years of the Neufville data and all years of the Ransart data a synchronisation between the two classes is observed.

Laying date in function of the nearest neighbour distance

The calculated laying initiation date was also checked in function of the nearest neighbour distances for Ransart and Neufville. We found for Ransart in 1997 Little Owls starting to lay 1 day later on increasing distance to the nearest neighbour with 100m (Table 2, model #10, Figure 13) while in 1995 we found the species laying 1 day later for every 100m that they are situated closer to one another (Table 2, model #11, Figure 14).

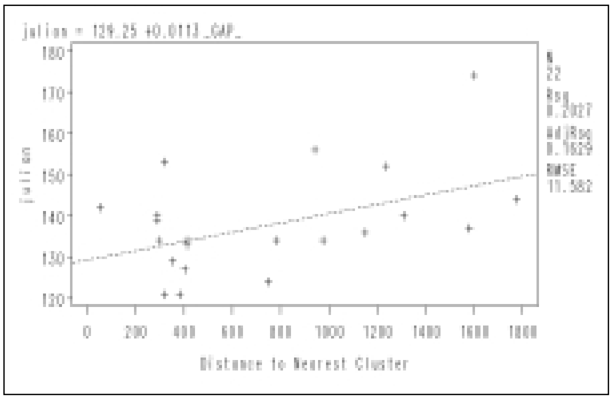

Figure 13. Linear regression of laying initiation date and nearest neighbour distance in Ransart in 1997.
Figuur 13. Lineaire regressie van datum eerste eileg en afstand tot dichtstbijzijnde buur te Ransart in 1997.

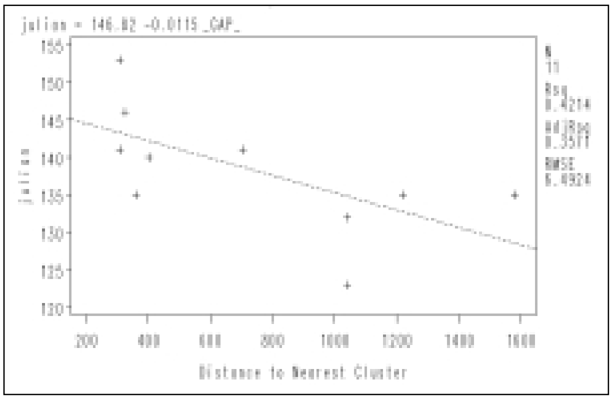

Figure 14. Linear regression of laying initiation date and nearest neighbour distance in Neufville in 1995.
Figuur 14. Lineaire regressie van datum eerste eileg en afstand tot dichtstbijzijnde buur te Neufille in 1995.

Clutch size

The average clutch size in Wallonia (3.3 eggs per nest, n=1214) is smaller than most average clutch sizes for Europe i.e. range of averages from 3.12 to 5.24 (Génot & Van Nieuwenhuyse, submitted, Schönn et al. 1991). Clutches of 4 eggs represent 36%, those with 3 eggs 32%. With an average of 3.3 eggs per nest and an average of 2.3 hatchlings per nest, our population seems to be at least stable or even increasing since new territories are occupied. The average clutch size in Ransart and Neufville differed significantly between isolated and clustered pairs using 610m as a threshold. The pairs breeding in clustered nest-boxes have a smaller clutch size than isolated breeding pairs. In Ransart in 1994 and in 1999 a significant difference between isolated and clustered pairs (1994: clustered 2.5 eggs; isolated 3.5 eggs; F-value: 5.34; Pr > F: 0.033; 1999: clustered 3.3 eggs; isolated 4.0 eggs; F-value: 5.91; Pr > F: 0.02) was found. For Neufville we obtain a similar result in 1998 (clustered 3 eggs; isolated 4.3 eggs; F-value: 8.75; Pr>F: 0.006).

Clutch size versus laying dates

Clutch sizes were tested in function of the laying date for all the years of the two zones (Ransart n=148; Neufville n=131), for the clutches of the individual years, for the clutches of the research areas individually and for the clutches per research area and per year (Table 2, models #12 to #23). Figure 15 clearly illustrates the reduction in clutch size on increasing laying dates for Neufville in 1998.

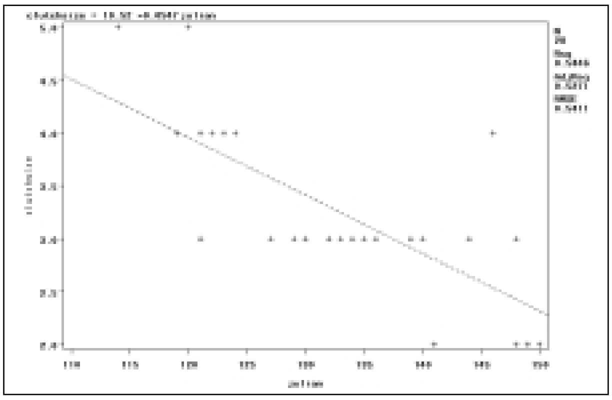

Figure 15. Linear regression of clutch size versus laying dates in Neufville in 1998.

Figuur 15. Lineaire regressie van legselgrootte ten opzichte van legdata in Neufville in 1998.

Breeding success

Figure 16 shows a negative but non-significant relationship between the average number of fledglings per nest-box and the precipitation in l/m² for Ransart in May and June (Table 2, model #24). For every 100l/m² extra precipitation in May and June, the average number of fledglings decreases with 0.6.

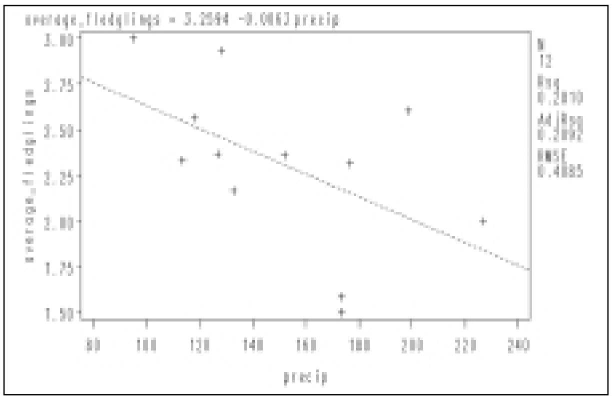

Figure 16. Linear trend between average number of fledglings in Ransart and amount of precipitation in May and June in Gosselies.

Figuur 16. Lineaire trend tussen gemiddeld aantal uitgevlogen jongen in Ransart en hoeveelheid neerslag in mei en juni in Gosselies.

Post-nuptial emigration

Fledglings show a very limited natal dispersal in our 2 main research areas with plenty of vacant nest-boxes available (average 2448m in Ransart, min = 1221m, max = 4443m, standard deviation = 1153m, n = 9 and 1189m in Neufville, min = 0m, max = 3187m, standard deviation = 920m, n=17) and migrate preferably to S and E of the region (Figure

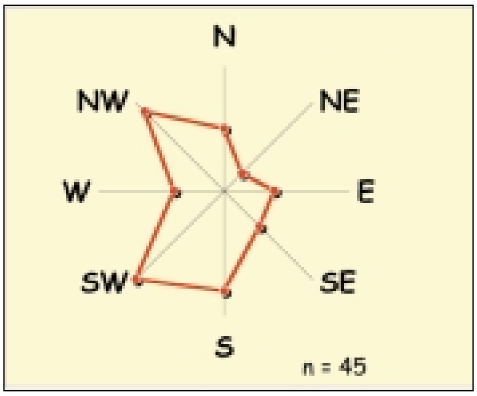

Figure 17. Post-fledging distribution of Little Owls born in Ransart (zone #1). Length of spoke is the number of individuals per respective direction.

Figuur 17. Dispersie van uitgevlogen Steenuiljongen geboren in Ransart (zone #1). Lengte van de spaak geeft het aantal exemplaren weer per respectievelijke windrichting.

17) in Ransart. We found no relationship between the density and the emigration distance, possibly because of the lack of recaptures outside the research area.

Age of settling birds

Circumstances are apparently favourable for the species since even first year birds can settle down and breed successfully e.g. Gosselies, in 1999 where six juveniles fledged successfully from a new breeding pair of which both partners were born in 1998. Table 6 shows the age of the birds when first found in a nest box in both research areas. Only females are considered here because of the lack of sufficient information on males. Both zones are featured by a relatively high percentage of young birds colonising the nest boxes, i.e. 59% and 45% per respective research area, indicating an important local settlement of local offspring. It also indicates however that some floating adult birds do occur and occupy new nest boxes too. For Neufville we have indications that floaters exist because almost half of all newly occupied nest boxes concern adult birds and the movement of individuals from natural cavities to nest boxes in the beginning of the research period is marginal compared to the occupation of new nest boxes by adults (see Figure 5 and Table 6).

In Ransart three visits per year yielded more than 400 controls with an average of 2.5 recaptures per bird (Max. recapture: 16 times for one female).

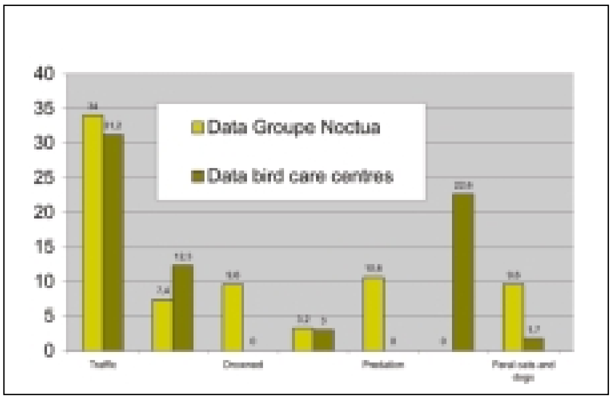

Figure 18. Causes of death of Little Owl in Wallonia, data Groupe Noctua compared to data collected in the Creaves (ex-CROH) bird-care centres.
Figuur 18. Oorzaken van sterfte van Steenuilen in Wallonië, de gegevens van de 'Groupe Noctua' vergeleken met die verzameld in vogelopvangcentra (Creaves).

The oldest ringed bird still alive has been ringed as nestling in March 1991 and is in its 11th year.

Mortality

Comparison of our own data with those collected by bird-care centres showed an extreme resemblance (Figure 18). The majority of found dead Little Owls are still killed by road collisions. This high number might be due to a bias in data collection, since victims of road collisions are easier to find than birds killed by other causes. Remarkable is also the fact that the bird-care centres have 22.6% of Little Owls that were reported to die from disease, while we did not find any victims of disease. Again this might be due to non-random sampling. Road victims are mainly juveniles without experience. On 89 casualties, 65% were birds less than one year of age, 35% were adults. Our data on mortality are only qualitatively and not sufficient to have a clear view on survival rates of the Little Owl population in our research area.

DISCUSSION

Logistic growth-curve

When a species establishes itself in a new area, its numbers usually grow rapidly for several years and then level off, roughly following a logistic pattern (Newton 1998). A similar saturation effect is seen in the Little Owl too in Heilbronn, Mittleres Albvorland, and Friederichshaften (Germany) (Hölzinger, 1987) and in our 2 research areas, Ransart and Neufville. As with the Goldeneye *Bucephala islandica* in Scandinavia (Eriksson 1982) once the shortage of nesting sites was rectified in Little Owl in Wallonia, using nest-boxes, other factors start to limit population numbers at higher levels. For Kestrel *Falco tinnunculus*, Village (1990) found that, after the installation of artificial stick nests, new limits were set by nest-sites, located far enough from existing pairs.

On the Walloon level no levelling-off is observed, probably due to the fact that conservation activities are still started up in new regions yearly and hence new experimental circumstances are set. Additional problems arise when, within one area, the number of nest boxes increases gradually. A real impact of the artificial nesting cavities on the population can only be tested once all nest-boxes are available. Whether the increase is due to a local population increase (response of the species) or due to a higher availability of nesting cavities as such (response to human interference) can only be analysed in Ransart after 1996 when the number of nest-boxes remained stable. From then on we see a gradual increase of the occupation rate which might indicate a real population increase. The possible masking of the real population trend is almost excluded in Neufville where the human interference was restricted to 2 years and even the number of pairs was known that breed in natural cavities.

Density-dependence

Experimental adjustments of breeding density is mostly undertaken with species that adopt nest boxes easily. Experiments have been conducted with Pied Flycatchers *Ficedula hypoleuca* in northern Europe (Virolainen 1984) giving evidence of reduced average breeding success at high densities due to the occurrence of non-breeding adults, more territorial behaviour and the occupation of sub-optimal habitat. As the number of Golden Eagles *Aquila chrysaetos* in the Swiss Alps increased over several decades, intrusions by single adults into the territories of breeding pairs led to fights which became a major cause of adult mortality and of breeding failure (Haller 1996). Average breeding success therefore declined as the numbers recovered and breeding performance was poorest in those pairs that experienced the highest rates of intrusions.

Limitation of breeding density among Little Owls was confirmed by Exo (1992) with a before/after comparison. The number and distribution of nest-sites were identified as 'ultimate' limiting factors determining population density across the breeding range of Little Owl in Central Europe. 'Overwinter loss' (losses occurring outside the breeding season, including mortality, immigration and emigration) was found to be a key-factor which influenced changes in annual breeding density. Losses during the breeding season were inversely correlated with subsequent overwinter loss, suggesting that a decline in overwinter losses compensated losses during the previous breeding season. Furthermore as the number of young fledged increased, overwinter loss increased too. Territorial behaviour was suggested to act as a 'proximate' regulating factor, whilst density was ultimately limited by suitable nest-sites. The number of intrusions also increased with density. Adult birds also intrude neighbouring territories especially in the fertile period (Exo 1987). This can add to the observed aggressiveness and its negative and hence regulating impact on breeding performance. For Wallonia, nest sites were observed as limiting breeding density.

Occupation of new nest-sites

In Neufville, we observed few movements of birds from natural cavities to nest boxes. More than half of the new occupants of newly furnished nesting cavities are adults and some nest boxes are occupied within a few days or weeks after installation even late in the season. This makes us believe that the studied population has a surplus of non-breeding birds or floaters that exploit new nest sites almost instantly. In some bird species, non-territorial ‘floaters’ live a mainly secretive and solitary existence in and around the territories of breeders (Newton 1998). In the Goshawk *Accipiter gentilis* in Gotland, Sweden 37% of males and 62% of females were floaters (Kenward et al. 1991). When the number of floaters is high due to high population densities, occupation of new nesting cavities might be very fast.

Density-dependence of laying dates

All significant models that were estimated to predict the average laying date using local or regional densities, revealed an advancing of laying dates on increasing densities. We think that the amount of sexual stimuli is higher at higher population densities, which might yield an earlier start of the egg-laying. Pirovano et al. (1999) found in Italy that the retention period between playback and answer by the species, increased with the nearest neighbour distance. When using the nearest neighbour distance between breeding pairs as a measure for density, we obtain an earlier laying date for Ransart when the breeding pairs breed closer to one another, confirming the density-dependence of the average laying date. In Neufville on the other hand we see the opposite situation where pairs breed

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earlier when they are situated further away. This is also confirmed when dichotomising the samples in clustered and isolated pairs. This difference might be related to the very high density in Neufville (1.85 pairs/km^2) compared to Ransart (0.4 pairs/km^2). At very high densities the aggressive behaviour might have the opposite effect and postpone laying.

The only cases of earlier breeding found in the Little Owl literature, were related to the food availability. Timing of breeding in Little Owls was found to be earlier in years with peak vole years in Germany (Illner 1979, Ullrich 1980). Experimental supplementation of food-supply in Burrowing Owl *Athene cunicularia* (Wellicome 1993) also caused the owls to lay earlier.

Laying dates are postponed on the other hand in years with unfavourable weather conditions, during late winter or early spring, egg-laying was delayed by a period of between 1 to 2 weeks in Germany especially in years with unusually long and snowy winter periods (Exo 1987, Finck 1988). Since the occurrence of snow in Wallonia, especially north of the Sambre-Meuse line, is hardly occurring, we believe that the impact of the precipitation (rain) on the average laying dates is somewhat different.

Density-dependence of clutch size

Clutch sizes were found to be up to one egg less in clustered pairs compared to isolated pairs. This might be related to food availability since several studies found a relationship between clutch size and food (Knotsch 1978, Illner 1979, Ullrich 1980, Exo 1983). The laying date that was found to be later in clustered pairs might also influence the clutch size (Ullrich 1980). We found for Ransart and Neufville too that later laying yields smaller clutches. We believe that the clutch size might also be reduced due to the many interactions and extensive territorial behaviour in clustered pairs.

Impact of weather on fledging success

The weather also puts constraints on the breeding performance of Little Owls. Fledging success is negatively related to the precipitation during the breeding season (May and June), though not significantly, while breeding is postponed in function of the rainfall in March. Rainy periods during the nestling period resulted in an enhanced nestling mortality in Germany (Glutz and Bauer 1980, Finck 1988). Olson and Olson (1989) also found a negative relationship between the number of days with rain in the breeding season and the breeding success for Peregrine Falcon *Falco peregrinus* in Australia.

CONCLUSIONS

Density dependence was observed in the Little Owl in Wallonia. Little Owl laying initiation dates depend on the observed density. For every extra pair per km^2 the average laying date is 8 days earlier. The breeding is postponed by rainfall in March. Clustered pairs start laying eggs later than isolated pairs in one of the most important research areas. The clustered pairs feature smaller average clutch sizes. Fledging success tends to depend on the cumulative precipitation in May and June. The population numbers show a logistic curve similar to populations that settle down in vacant areas in response to newly offered nesting cavities. We were able to lift the population to a higher level using nest-boxes, giving nesting opportunities to floating adults and to local offspring. This illustrates the importance of nesting cavities as limiting factor in Wallonia before the installation of nest boxes.

SUGGESTIONS FOR FUTURE CONSERVATION ACTIVITIES

To be able to trace the effectiveness of conservation activities it is recommended to obtain a baseline of existing breeding pairs and available floaters. This can be done by searching for occupied natural cavities and get a view on the number of territorial non-breeders using the playback method before starting with nest boxes. The efficiency of playback to detect non-breeding individuals still needs to be studied. It is very important to introduce the nestboxes in a very short period to avoid that results become too hard to interpret because of masked effects. If the number of available nest boxes increases gradually, one never knows whether the number of breeding pairs is caused by a real increase in bird numbers or just by an increase in sampled points. To understand the impact of population densities on the breeding biological parameters better, all birds that use the available resources i.e. breeding and also non-breeding individuals should be included in the analysis.

CONSERVATION

Landowners are not only prospected for nest-box placement but also for possible management of pollard willows, orchards or other types of management in favour of Little Owls. Most neglected trees are in bad shape and are tackled as fast as possible after a verbal approval of the landowner. Since 1990 we undertake management of Little Owl habitat from the end of November till half of March in all regions. Principally we manage pollard willows by coppicing the willows to compensate for the loss of this management by landowners due to modernisation and rationalisation of modern agriculture. Table 7 gives an overview of the activities that have been carried out since 1990.

ACKNOWLEDGEMENTS

The status of Little Owl has improved the last few years as a result of our conservation activities on a very large scale and with plenty of energy. After a daily combat since more than 10 years we start to see an increase in numbers. This is also reflected in an increasing popularity of the species among the human population. Besides protecting a species in danger, we also helped in the conservation of plenty of other species. The structure of our group permits to collect thousands of samples thanks to the teamwork joining different people for this ultimate goal. This intense co-operation catalyses our working efforts yielding such extraordinary results. Working together has also helped to forge links between each other. Gratitude goes to all the members of our splendid group S. Tombeur, M. Wauthy, M. Harvent, P. Tallier, S. Huybrechts, J. Annet, P. Lemmens, G. Bancu, A. Depelsmacker, M. Bariaux, P.J. Colette, J.P. & M. Charlier, M. Guillaume, N. Marres, E. Leprince, A. Herrent, P. Michaux, B. Hanus, O. Laus, J. & S. Finck, P. Goset, M. Lenaerts, T. Votquenne, C. Franc, C. Alphonse, F. du Sépulchre, D. Semin, G. De Voghel, S. Bertrand, B. Thirionet, B. Bourtembourg, D.&C. Rousseau, N. Delaunoy, C. Bayot, E. Ruelle, F. Payen, J-N. Lambinet, B. Pirson, R. Gottschalk, P. Denis, M. Huygebaert, V. Decamp, P. Bucquoy, P. Toussaint, J. Rouchet, B.&O. Poncin, J. Hautefenne, P. Nivelle. We also wish to thank the landowners that permitted us to visit their premises in search of Little Owls. Finally, we also wish to pay tribute to Michel Juillard and his work on the Little Owl in Switzerland. He was a source of inspiration and motivation for our study. Special thanks go to Michael Exo who gave valuable remarks on an earlier version of the manuscript.

More information on 'Groupe Noctua' can be found at (www.noctua.en-action.org).

	Activities	Willows		Plançons		Participants	
	Number of activities	Trimmed (pollard willows > 10 years)	Managed (pollard willows < 10 years)	Planted	Managed	Number	Worked hours
Total	89	237	111	1457	123	717	434
Average per year	15	40	18	243	20	120	72

Table 7. Activities carried out by Groupe Noctua in favour of Little Owls in Wallonia since 1990.
Tabel 7. Activiteiten door Groupe Noctua uitgevoerd ter voordele van de Steenuil in Wallonië sinds 1990.

SAMENVATTING

SAMENVATTING

Eind jaren tachtig is de 'Groupe Noctua', een groep Waalse ornithologen met een passie voor de Steenuil, gestart met een grootschalige beschermingsactie voor deze soort in Wallonië. In 23 onderzoeksgebieden verspreid over het gebied werden nestkasten opgehangen. De groep hanteert hier een strikte ethische code. Nestkasten worden enkel opgehangen als er op voorhand een census is uitgevoerd met behulp van playback en als de nestkasten jaarlijks met zekerheid minstens driemaal gecontroleerd kunnen worden. De nestkasten zijn gerecupereerde wijnkisten en zijn in de loop van het onderzoek geoptimaliseerd m.b.t. extra ruimte voor de jongen en veiligheid tegen predatoren (zie in dit nummer Marié en Leysen). In dit artikel worden de resultaten van deze actie op het niveau van de populatiedynamiek voorgesteld. Zowel bezettingsgraad, broedresultaten, legdata, legselgrootte als dichtheden komen aan bod. De dynamiek van de totale populatie en van twee deelpopulaties in het bijzonder met name in Ransart en Neufville wordt geanalyseerd. Voor elk extra paar per km² is de eerste eileg gemiddeld 8 dagen vroeger. Elke 100 liter neerslag per m² meer in maart zorgt ervoor dat de gemiddelde datum van eerste eileg 6 dagen later valt. Slechte weersomstandigheden zorgen dus voor een vertraging in het broedseizoen. In Zuid-België, met name ten zuiden van Samber en Maas starten Steenuilen gemiddeld 5 dagen later met broeden dan in Midden-België. Tenslotte is ook gemiddelde legdatum en legselgrootte en de variatie hierop berekend voor Ransart en Neufville. De gemiddelde datum van eerste eileg verschilde significant tussen geïsoleerde en geclusterde broedparen in Neufville, zowel in 1995 (resp. 13/4 en 23/4) als in 1998 (resp. 2/4 en 14/4). Legselgrootte bleek ook afhankelijk van de dichtheden. Geïsoleerde paartjes hadden gemiddeld grotere legsels. Ransart: 1994: resp. 3.5 en 2.5 eieren per nest en 1998: resp. 4.3 en 3; Neufville: 1998: resp. 4.3 en 3. In Ransart bleek voor elke 100m afstand tot het dichtstbijzijnde buurkoppel het broedseizoen één dag later te starten; in Neuville werd precies het omgekeerde vastgesteld. Uitvliegpercentages lieten een negatief maar niet significant verband zien met de cumulatieve neerslaghoeveelheden in mei en juni. Elke 100 l/m² extra hemelwater zorgde gemiddeld voor 0.6 minder uitgevlogen jongen. Als Steenuilen later aan het broedseizoen begonnen zorgde dat voor een afname in de legselgrootte. De resultaten van dit onderzoek werden telkens bekeken in het licht van de dichtheden.

Samenvatting door Koen Leysen

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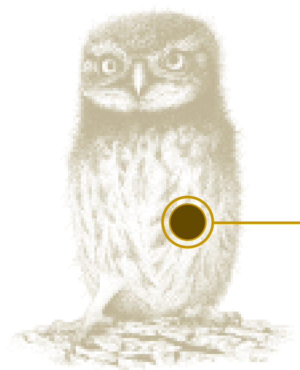

15. CONTRIBUTION TO THE DESIGN OF AN ANTI-MARTEN *MARTES FOINA* SYSTEM TO LIMIT PREDATION IN LITTLE OWL *ATHENE NOCTUA* NEST BOXES

BIJDRAGE TOT HET ONTWERP VAN EEN ANTI-STEENMARTER *MARTES FOINA* SYSTEEM TER BEPERKING VAN DE PREDATIE VAN STEENUILEN *ATHENE NOCTUA* IN NESTKASTEN

PAUL MARIÉ* AND MARC LEYSEN

ABSTRACT

The Marten *Martes foina* has always been an important natural predator for Little Owls *Athene noctua*. The breeding success of the species in nest boxes was often too low due to the accessibility for the Marten. An other type of nest box had to be developed. Observations on a Marten kept in captivity showed how he intruded into different types of nest boxes. The main objective was to find safe places to position a nest-box and nest boxes that were constructed in a way that would only allow Little Owls to enter and no Martens. It was especially interesting to start from existing nest boxes. The top of a smooth pole or the midst of a smooth wall, without obstacles within jumping distance, proved to be safe. Protective measures could also be integrated in the construction of the nest box. A Marten could not penetrate a nest box on the side of a trunk with a rubber penthouse (inner tube of truck around the hole). A balancing door that shuts down under the weight of a Marten can be very effective but it risks to be blocked by pellets. Another possibility was the use of plastic entry canals. Several possibilities are discussed. This paper might prove very useful in the future since the Marten is expanding its range in Flanders and other parts of Europe.

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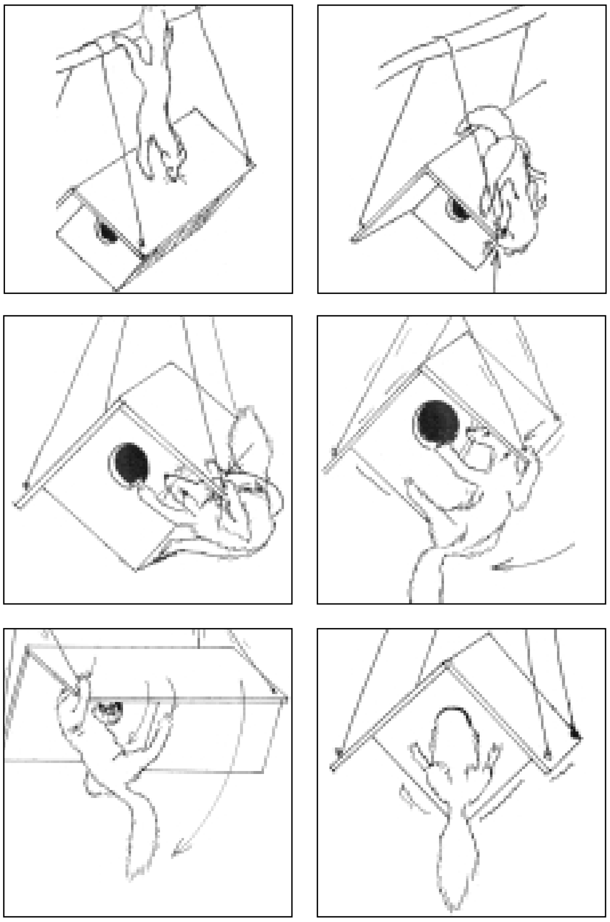
INTRODUCTION

An important mortality factor with the Little Owl *Athene noctua* is still to be attributed to natural predators, mainly Marten *Martes foina* (Schönn et al. 1991, Génot 2001). These mammals can seriously interfere with the Little Owl population dynamics by plundering the eggs or chicks from nest boxes and natural breeding places. In environments where the Little Owl is under threat and supported by nest boxes, a system protecting the Owls against this particular menace is called for. These systems might become increasingly important since the species is actually increasing significantly in Flanders (Van Den Berghe 1998) and elsewhere in Europe e.g. Austria (Ille et al. 2001).
Assessing the acrobatic capabilities of the predator and observing its methods of intrusion into nest boxes is difficult in a natural situation. It was therefore considered opportune to observe a Marten when confronted with different types of nest boxes

in captivity. Based on these observations it was possible to elaborate gradually more difficult tests taking into account their morphological as well as agility differences. It became quickly clear that a simple overhanging roof is not adequate to stop a Marten.

The initial starting question was: "can a shape and dimension for the entry hole be found, allowing all Little Owls to pass, and at the same time stopping all Martens?" After three weeks of testing with a young female Marten, and manipulating three frozen cadavers of Little Owls of different age, it was concluded that rather the opposite was true. One was building rather "anti Little Owl" nest boxes for Martens (using a rectangular entry hole of 40 x 60 mm) instead of Marten proof Little Owl nest boxes.



OBJECTIVES

The overall goal of the study is to conceive and construct reliable and affordable systems to protect Little Owl against predation by Martens. A first set of approaches attempt to prevent the Marten from reaching the nest box by simply positioning it in a safe spot.

The second part of the study was guided by the present-day (but maybe temporary) absence of Martens in the village where the experiments took place, and the fact that most of the occupied Little Owl nest boxes are simply fixed on top of pollard trees.

The goal was therefore set to the conception of a system that can be applied to an existing nest box, having all possibilities for the Marten to reach its entry and still stopping it from entering. Several approaches along this line of thought have been evaluated and will be explained and illustrated.

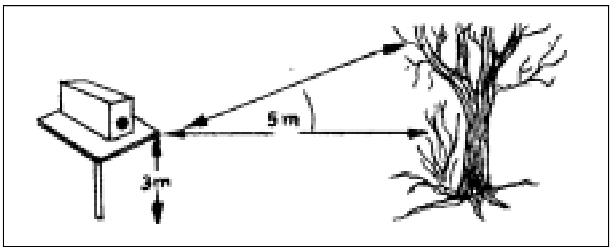
THE NEST BOX PROTECTION SYSTEMS

SAFE POSITIONING

Nest box on a smooth pole

- Pole in metal, concrete or smooth synthetic material.
- At least 3m from the soil (more on a tilting site).
- At least 5m away from any tree or shrub.
- Never underneath branches of trees even if their trunks are at more than 5m distance.

This system has the drawback that fledglings that are not capable of flying, can hardly reach any protected roost sites nearby. Additional attention needs to go to refugee opportunities for the fledglings after leaving the nest, since they spend a long period on the ground in bad circumstances before emancipation (Génot 2001).



Nest box attached to a building with smooth walls

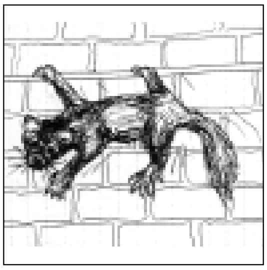
- Wall in concrete, plastic, sheet-iron, polished wood, glass or other materials with a smooth surface.
- As far as possible from windows, gutters, apparent electric wiring or construction ridges
- Exclude walls in old stones, stucco, unpolished wooden panelling, irregular bricks, uneven masonry or porous concrete blocks (a ridge or hole 3mm wide offers enough support for a Marten's claw to hook on to).
- Nest box should be at least 3m high and surrounded by 2m of smooth surfaced wall

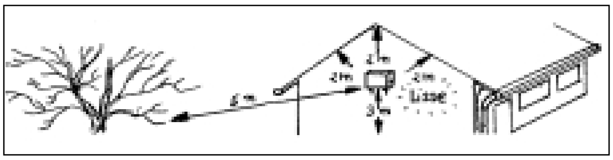
SELECTIVE DOORS

Nest box covered with a rubber penthouse

- Inner tube from truck or agricultural vehicle (or any other sheet of flexible rubber).
- Fixed to the sides of the box to form a penthouse that can be folded over the nest box entry hole. The rubber will fold down under the mam-

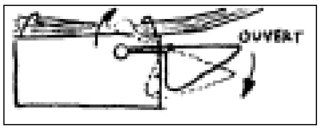
mal's weight and cover the entry hole.
- Nest box suspended or attached to a trunk, the entry hole pointing away from the trunk and no branches left up to 50cm underneath the box.





Basculating door

- A balancing door is constructed from aluminium or zinc sheet. It is held to the open position by counterweights in lead on either side. It will not hamper the Owl in entering the nest box, but will close under the Marten's weight and its smooth surface will cause it to fall off.
- The device could be traversed by all Little Owls (tested with a female weighing 220 grams) while stopping all Martens.
- These appliances however do carry a risk of being blocked (by pellets or prey) and thus shutting out the Owls.
- Solid, durable and efficient
- Not so easy to construct and not cheap



PLASTIC ENTRY SHIELDS

Next the study focused on the use of different constructions in plastic to be attached in front of the nesting cavities. These are well known for their smooth surface and rounding that particularly complicates the suspension of the Marten by lack of attachment possibility for its claws. The mammals are not at ease with such hard and smooth surfaces and the more dauntless ones will see their attempts to enter the nest box rewarded with a fall (more or less traumatising according to the height of the nest box and the way they fall down). In addition, the proposed devices can be adapted to protect natural cavities.

Tests

Several systems were constructed (see below) with real efficiency in preventing the Marten to enter the nest box when taking into account several precautions when setting them up in nature. Their respective attraction to the Little Owls however remains to be tested.

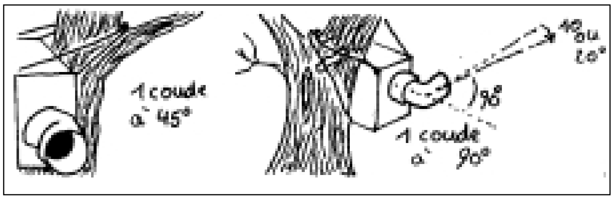
Precautions

Preferably to be positioned on a bare trunk with no branches within 50cm on each side of the box as well as 1m below it.
No trees or shrubs should be present in front of the nest box up to a distance of 5m (jumping).
To be installed as high as possible (the possibility of falling is more dissuasive).

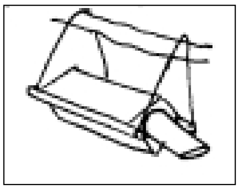
The systems

Elbow shaped plastic entry canal

- Diameter at least twice the diameter of the entry hole (i.e. 125mm or more), and as wide as the nest box front permits.
- Elbow elements of 45° or 90° can both be used
- Aperture as distant from the trunk as possible and to be tilted slightly downward (10-20° with respect to horizontal).
- In order to reduce the disfigurement of the tree, the elbow can be extended with one or several elements with a roughened interior surface (to help the bird to get through the canal). The outer element should however remain smooth on the inside and the outside, and be slightly tilted downward.
- The device can be fixed to the nest box using iron wire, eye-screws one into the other, or by means of a wooden board with a hole of the same diameter. To ensure solid fixation to each other and to the nest box, the tubes should be perforated and traversed over their full thickness by the fixation elements.
- Paint the canal in the same neutral colour as the nest box in order to blend in with the environment.



Plastic entry canal with slanted aperture



- The open ending of the plastic tube forming the entry canal, should be cut off to a slanting aperture facing downward by at least 45°. Slanting can be stronger when a larger tube diameter is used since this reduces the birds landing difficulty. In any case, the length of the shorter side of the canal should exceed its diameter.
- Diameter, fixation and precautions regarding vicinity of branches as indicated for the elbow shaped canal.
- When the nest box is fixed underneath a branch and parallel to it, placing the device in the centre of the box is to be avoided. In this case the canal can be slanted at both ends in order to place the aperture out of the axis of the supporting branch.
- Extend the canal length for a nest box to be used in a pollard tree.

The plastic can balcony

- A plastic container of 5 to 10 litres is worked up judiciously.
- Once cleaned, containers for demineralised water, motor oil or chemical products can be used.
- The top with the handle and plug is cut off and in the bottom a hole with a diameter corresponding to the nest box entry hole is made. The 4 corner edges are cut through over about their complete length such that 4 mobile and slithery flaps are

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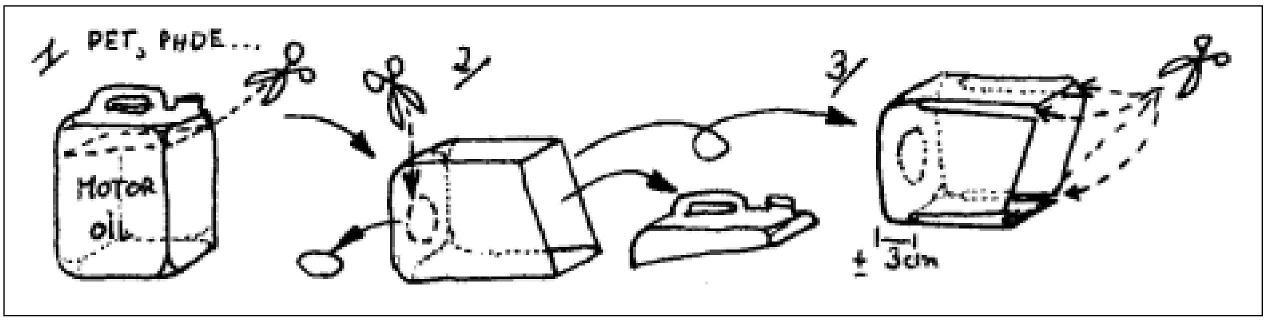
left. The resulting flexible balcony should be constructed with a slightly slanting opening, such that its top is longer than its floor. When necessary (according to the thickness of the plastic) the floor can be cut through once more over its length to make it more flexible.

- Fixation can be assured using eye-screws or a wooden board fixed with screws to the nest box from the inside of the balcony.
- The durability of the device depends on its thickness and exposition to UV radiation.
- This solution offers the best efficiency / price ratio of all proposed devices.

RESULTS

Taking the overall precautions into account, all three proposed plastic devices are generally well accepted by the Little Owls when they find themselves confronted with the unattended installation of one of the devices. The tilted and slippery elbow however seems to be the more discouraging especially when there are other nesting possibilities in



SAMENVATTING

Steenmarters vormen reeds lang een gevreesde vijand van de Steenuil wegens het leegroven van nestkasten. Beschermingsacties met nestkasten lijden dan ook sterk onder de predatie van dit roofdier. Om een beter inzicht te krijgen in de effectieve gedragingen van de Steenmarter werd een exemplaar in gevangenschap geobserveerd in de aanwezigheid van bestaande nestkasten. Deze studie had tot doel om veilige bevestigingsplaatsen te zoeken en om een aantal betaalbare en betrouwbare systemen te ontwikkelen die het de predator verhinderen om nestkasten binnen te dringen. De aandacht ging vooral naar systemen die konden worden bevestigd aan bestaande nestkasten. Veilige bevestigingsplaatsen bestaan o.a. uit een nestkast bevestigd bovenaan een gladde ijzeren of synthetische paal of midden een gladde muur, ver genoeg van voorwerpen van waarop de Marter zou kunnen springen. Dit systeem heeft als nadeel dat jongen die nog niet kunnen vliegen, niet terug in de nestkast kunnen klauteren. Verschillende systemen van beschermende structuren aan de ingang worden besproken zoals rubberen balkon, kantelende deur en plastic ingangsschilden. De laatste systemen baseren zich op constructies in plastic die te bevestigen zijn vooraan de nestkast. De plastic structuur is zeer glad en rond en maakt het voor de Marters onmogelijk om zich vast te hechten. Deze verschillende systemen werden succesvol getest, de impact op de selectie door de Steenuil na bevestiging van de systemen werd nog niet getest. De auteurs verwelkomen elke positieve en negatieve reacties op deze systemen.

Samenvatting door Dries Van Nieuwenhuyse

the neighbourhood. Bultot et al. (2001) report in this volume that about 20 % (155/747) of the Walloon nest boxes are equipped with an anti-Marten system. No systematic analysis of the impact on predation rate has been carried out yet up to now in Wallonia.

NOTE

Any experience or observation in favour or against one of the proposed devices, documented with photographs (frontal and profile) will gladly be welcomed by the authors.

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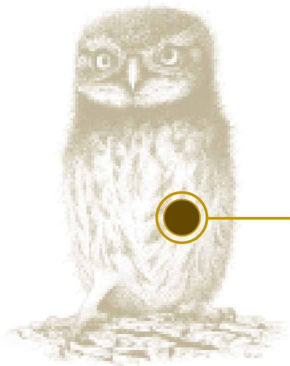

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LITTLE OWL *ATHENE NOCTUA* IN SLOVENIA: AN OVERVIEW

DE STEENUIL *ATHENE NOCTUA* IN SLOVENIË: EEN OVERZICHT

MILAN VOGRIN

ABSTRACT

In this paper I present the status and knowledge of Little Owl *Athene noctua* in Slovenia. Little Owls in Slovenia are distributed mainly in the south-western and north-eastern part of the country. As elsewhere in Europe, a strong decline has been noticed in last years, mainly in the sub-Pannonian region. The main reasons for this strong decline are probably loss of suitable habitats, i.e. traditional orchards, and the use of pesticides in large quantities.

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INTRODUCTION

Human activities have had a great impact on the European avifauna, and about 38% of the bird species occurring regularly in Europe are considered threatened (Tucker and Heath 1994). In particular, changes in agricultural practices during the twentieth century have resulted in population declines in many species, and about 60% of all species depending on lowland farmland areas are currently listed as threatened (Tucker and Heath 1994). The Little Owl *Athene noctua* has suffered large declines during the last decades in many European countries and it is thought that changes in agriculture and landscape structure are the main reasons (e.g. Exo 1992), though traffic may also have contributed to the decline (Génot et al. 1997).
The ecology and biology of Little Owl is being increasingly studied (see e.g. Exo 1992 and references therein); however, little is known about Little Owl in Slovenia. Here I present some data about our knowledge of Little Owl from Slovenia.

METHODS

The analysis is based on literature data (see references) and own unpublished data. Since some new surveys were performed on the same areas as earlier surveys some decades ago, local extinctions (present in the early survey, absent in the later survey) and colonisations (absent in the early survey, present in the later survey) of Little Owl between the two surveys can therefore be determined.
All statistical tests were performed with the SPSS 8.0/Windows statistical package. Data not normally distributed (tested by Kolmogorov-Smirnov test; e.g. Fowler and Cohen 1988) were analysed using Spearman rank correlation coefficient (r_S), otherwise Pearson correlation coefficient (r) was used. A probability of $P < 0.05$ was considered significant.
Figure 1 contains all localities referred to in Slovenia.

Figure 1. Map of Slovenia.
Figuur 1. Kaart van Slovenië.

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LITTLE OWL IN SLOVENIA

In the past

Data about Little Owl from the past and from the present time are scarce. First data about Little Owl in Slovenia date from the 19th century. According to Seidensacher (1858, 1864) Little Owl was breeding around Celje-town and in north-eastern Slovenia. It is interesting that about 100 years later Dolinar (1951) pointed out that the Little Owl could be found everywhere on the same area. At the beginning of the 20th century Reiser (1925) considered the species as common for the environs of Maribor and river Drava (NE Slovenia).

Present data

According to the Atlas of Slovene breeding birds (Geister, 1995) Little Owl occupies mainly south-western (Mediterranean) and north-eastern (sub-Pannonian region) Slovenia. According to own data it seems that Little Owls prefer pastures, environments of villages and traditional orchards. Breeding population estimates in 1995 range from 500 to 800 pairs with a strong negative trend dropping to only about 200-300 pairs nowadays, mainly in the Mediterranean region.

The most stable population is that in the Mediterranean region, where the decline is less pronounced. In north-eastern Slovenia the species is distributed, as elsewhere in Central Europe (e.g. Cramp 1985, Exo 1992), mainly in traditional orchards close to human settlements. Densities in a large area e.g. Dravsko polje (about 210 km^2) south of town Maribor were up to 0.48 pairs/10km^2 (Vogrin 1997), which corresponds to other central European areas (Exo 1992). However during the last years we noticed a decline of this species in this region too. From 1988 to 1999 I collected data for the whole region of Dravsko polje (see Table 1). Correlation between years is negative but not significant (r_S = -0.70 n = 6, P > 0.05). However I assume that in the last year only males were present since no nests or young were found.

Year	1988	1993	1996	1997	1998	1999
No. of pairs	10	4	3	1	4	3

Table 1: Evolution of Little Owl *Athene noctua* pairs in Dravsko polje (NE Slovenia) per year.
Tabel 1. Jaarlijkse evolutie van het aantal paar broedende Steenuilen Athene noctua in Dravsko polje (NO-Slovenië).

In Central Slovenia, on Ljubljansko barje in an area of about 160 km^2, Tontelj (1994) estimated the population of Little Owl at 5-10 pairs.

Other examples come from the Lower Savinja valley where the Little Owl was a common and abundant species about 50 years ago (Dolinar 1951). Today Little Owl is extinct in this region (Vogrin in press). The main reason is very probably the increase of intensive agriculture (hop fields) which completely changed the whole valley.

Little Owl is mainly a lowland species in Slovenia, below 400 m (Tome 1996), however some higher sites are also known, e.g. from 800 and 900 m. The first case comes from Mt. Pohorje in 1990 and the second one from the karst plateau Dobrovlje in 1995 and 1996 (pers. obs.).

In the last few years at least four Little Owls were found dead (on meadows or in orchards near houses) in north-eastern Slovenia where intensive agriculture is present, presumably because of pesticides. However no detailed examination, i.e. chemical analysis was performed on dead owls. Nevertheless pesticides were used in high quantities during the last decades (r = 0.73, n = 12, P < 0.01) (Figure 2) and the same holds for insecticides (r = 0.71, n = 12, P < 0.05). Since death from most chemicals is slow and preceded by lethargy, affected owls are most likely to die at their roosts or nests, where they would be unlikely to be found. Moreover, I assumed that the main reason for dead owls was rodenticides which are used around houses and farms where Little Owl also hunts (pers. obs.).

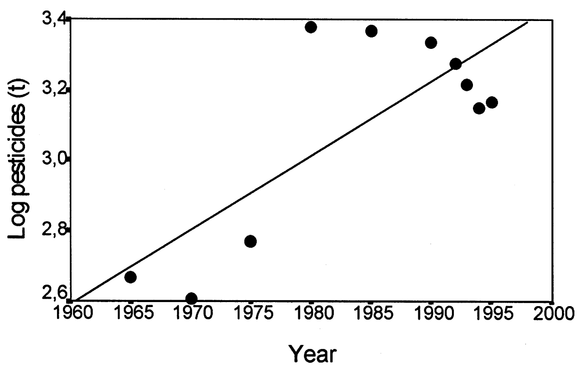

Figure 2. Evolution of pesticides in Slovenia during 1960 – 2000. Data source: Statistični urad Republike Slovenije (1996, 1997, 1998).
Fig. 2. Jaarlijkse hoeveelheid gebruikte pesticiden in Slovenië gedurende de periode 1960 - 2000. Bronnen: Statistični urad Republike Slovenije (1996, 1997, 1998).
X-as: Jaar
Y-as: Log pesticiden (in ton)

For Little Owl traditional orchards in Slovenia are an essential habitat constituent, hosting more than 30% of the entire national population (pers. obs.). Especially in the north-eastern part of the country the species almost exclusively breeds in old orchards. Nevertheless over the last 3 years only one occupied nest was found in an orchard in Dravsko polje. In the Mediterranean region Little Owls mainly use buildings for breeding.

Until recently every farm, country house and suburban garden had its own collection of fruit trees. Yet over the last few decades traditional orchards have disappeared in the wake of cheap imported fruit, the intensification of agriculture (e.g. intensive orchards) and pressures from land development. Slovenia, for example has lost more than 5000ha of its traditional orchards since 1990 (Statistični urad Republike Slovenije 1996, 1997, Vogrin and Vogrin 2000). Thus, this could be, besides pesticides, one of the reasons for a sharp decline of Little Owl in Slovenia. Moreover, the strong decline was noticed also in neighbouring regions, e.g. in Austrian Styria (Sackl et al. 1993).

Conservation measures were planned and still initiated for this endangered species. Since lack of appropriate breeding sites is one of the limiting factors for Little Owl in 1997, 50 nest boxes were installed in Dravsko polje and the nearest hills by members of DPPVN. Until now none of them has been occupied. However, in 1996 Little Owls already occupied modified nesting tubes model Heilbronn (pers. obs.).

ACKNOWLEDGEMENTS

Thanks to all institutions and persons who support the project "The Little Owl is endangered, let's help!" which was carried out by DPPVN - Society for bird research and nature protection from Race.

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SAMENVATTING

SAMENVATTING

Vanaf de 19° eeuw werden broedgevallen van de Steenuil Athene noctua in Slovenië vastgesteld. Volgens de broedvogelatlas (1995) van dit land was deze soort vooral te vinden in het zuidwestelijk (Mediterraan) en het noordoostelijk (Sub-Pannonisch) deel van de Republiek (Figuur 1). In Slovenië is de Steenuil voornamelijk een laaglandbroeder (< 400m); men kent enkele broedplaatsen op hoogten van 800-900m. De soort verkiest vooral weilanden, de omgeving van dorpen en oude boomgaarden die dicht bij nederzettingen gelegen zijn; dit laatste essentieel habitat herbergt meer dan 30% van de landelijke broedpopulatie. In het Mediterraan gebied verkiest de Steenuil vooral gebouwen als broedplaats.

Recent onderzoek heeft aangetoond dat de populatie over het gehele land een dalende trend vertoont, die minst is uitgesproken in het zuidwestelijk, Mediterraans deel. In een groot gebied van NO - Slovenië (Dravsko polje, ten zuiden van de stad Maribor), bereikt de soort dichtheden tot 0,48 paar per km², hetgeen overeenkomt met andere studies uit Centraal- Europa. Tijdens de periode 1988-1999 werd ook in dit gebied een afname vastgesteld (Tabel 1) en de auteur neemt aan dat hier alleen solitaire mannetjes aanwezig waren tijdens het laatste jaar van het onderzoek. In Centraal-Slovenië is de soort bijzonder schaars in de Ljubljansko barje, met slechts 5 à 10 broedparen voor een oppervlakte van 160 km2. In de vallei van de Beneden-Savinja, waar ongeveer 50 jaar geleden de soort nog een gewone verschijning was, is zij nu uitgestorven. In 1995 werd het broedbestand van het gehele land nog op 500-800 paar geschat, thans is het gedaald tot 200-300 paar.

In de laatste jaren zijn in NO - Slovenië ten minste vier dode Steenuilen gevonden. In deze streek wordt een intensieve landbouw beoefend met, zoals over het gehele land , een hoog gebruik van pesticiden (Figuur 2) en insecticiden gedurende de laatste decaden. Toch neemt de auteur aan dat de hoofdoorzaak van Steenuilensterfte in Slovenië moet toegeschreven worden aan het gebruik van rodenticiden in de omgeving van huizen en boerderijen, waar de soort graag jaagt. Daarnaast mag ook de verdwijning van oude boomgaarden als een belangrijke oorzaak van de sterke achteruitgang beschouwd worden, vermits de fruitteelt meer en meer beroep doet op goedkoop ingevoerd fruit. Sinds 1990 verloor Slovenië meer dan 5000ha aan oude boomgaarden.

Voor het behoud van de bedreigde Steenuil werden in Slovenië beschermingsmaatregelen gepland en reeds deels uitgevoerd. Vermits ook gebrek aan geschikte broedplaatsen een van de beperkende factoren is voor de instandhouding van de soort, werden in 1997 vijftig nestkasten geplaatst te Dravsko polje en omgevende heuvels en sinds 1996 maakt de Steenuil gebruik van aangepaste Heilbronn - nestkasten.

Samenvatting door Jacques Van Impe

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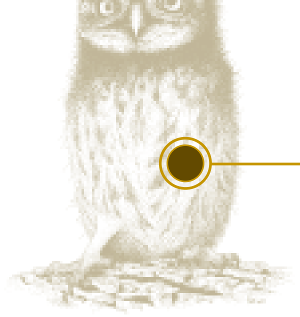

LITTLE OWL *ATHENE NOCTUA* STATUS AND HABITAT SELECTION IN THE TOWN OF BERGAMO (LOMBARDY, NORTHERN ITALY).

STATUS EN HABITATSELECTIE VAN DE STEENUIL *ATHENE NOCTUA* IN DE STAD BERGAMO (LOMBARDIJE, NOORD-ITALIË).

MARCO MASTRORILLI

Photo by / *Fotograaf: Marco Mastrorilli* ©

ABSTRACT

A census of nocturnal birds of prey, which was called Progetto Strigiformi Città di Bergamo was organized by the local division of LIPU (with more than 40 people joining it) in the town of Bergamo (Lombardia, northern Italy) during the years 1997-2000. It is an innovative research in Italy, previously performed only in the town of Pavia.

Bergamo (116000 inhabitants) lies at the foot of the Orobie Alps and its territory (38.76km^2) has different natural and anthropomorphized habitats located on the plain and on the hills. Here one can find historical and more modern urban areas and vast woods on the hills, parks and gardens in the Parco Regionale dei Colli, together with degraded areas in the southern part of the town.

The census of the Little Owl *Athene noctua* was performed using the playback method. We discovered this species as the most common bird of prey in this territory. During the two years of this research we went out to look for Owls for 95 times from October to May and for 310 hours of study. In the surveyed area (23.5km^2) we discovered 34 territorial couples of Little Owl or an overall density of 1.44 couples/km^2, a high average compared to other Italian towns.

In order to better define the environmental preferences of the Little Owl in Bergamo, we quantified the following environmental features per square grid cell of 500 by 500m. This allowed us to identify differences (even in density) of environments that were studied: historical centre, parks and gardens, industrial and sub-urban areas. In particular, it was very interesting to discover the presence of the Little Owl in the green areas of the town, often together with the Tawny Owl *Strix aluco* which usually has a higher density in this kind of environment. In conclusion, the Little Owl is the most widespread raptor found in the different environments of the territory of Bergamo where it often prefers nesting on the roofs of the historical centre, on the buildings of the new industrial areas and the old massive walls of the XVI century.

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Figure 1. Owl project in the city of Bergamo.
Figuur 1. Project uilen in de stad Bergamo.

INTRODUCTION

A census of nocturnal birds of prey was carried out in the town of Bergamo (Lombardy, Northern Italy) in the years 1997-2000. The project - denominated Progetto Strigiformi Città di Bergamo - was organized by the LIPU (Lega Italiana Protezione Uccelli - Italian Bird Protection League) local division and involved more than 40 people (Figure 1).

Such investigation is unusual for Italy, the only ones previously conducted having taken place in Pavia (Galeotti and Morimando 1991) and in Siena (Morimando et al.1995).

In the last years, some studies conducted in the Bergamo district dealt with the Little Owl *Athene noctua* (Mastrorilli 1997, 1998, 1999a).

Ornithological data, even general, concerning Bergamo are deficient and outdated (Guerra 1979, Galeotti et al.1985).

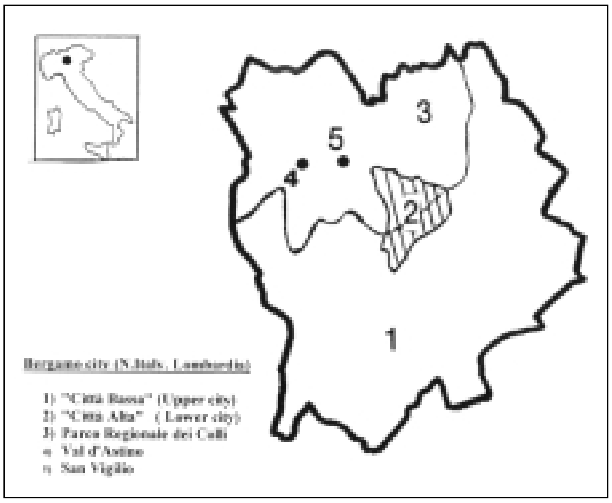
Photo by / *Fotograaf: Marco Mastrorilli ©*

STUDY AREA AND METHODS

Bergamo (116.000 inhabitants) lies at the foot of the Orobie Alps (Figure 2). The research area (38.76 km^2) is characterised by a mosaic of natural environments and built-up areas and includes plains and hills. The local difference in altitude rises up to 521m.
The town (Figure 3) is divided into two parts: Città Alta ("Upper City", the old and central one) and Città Bassa ("Lower City"). The former is surrounded by an ancient wall and lies on hills overlooking the land. Parks, gardens and large woods located on the hills and included in a protected area (Parco Regionale dei Colli) contrast with the historical and modern quarters. The southern portion of the research area is degraded because of its disharmonious development.

Figure 2. Bergamo situated in northern Italy near the Orobie Alps.
Figuur 2. Situatieschets van Bergamo in Noord-Italië, dichtbij de Orobie Alpen.

Figure 3. Map of Bergamo city indicating the distribution of the different habitats.
Figuur 3. Kaart van Bergamo stad met aanduiding van de verschillende habitats.



The census was carried out using a standardized playback recording technique (Galeotti 1991, Cesaris 1988, Sacchi 1994) which was not utilized in Città Alta (Upper City). The field nights took place between 19.30 and midnight. As suggested by investigations dealt with in Pavia (Sala 1988), we postponed the time in Città Alta (Upper City) - between 3 and 7 a.m. - because of the presence of many tourists and visitors.
During the first two years, the 95 field nights - 310 hours in all - took place between October and May.
In order to better define the Little Owls habitat preferences in Bergamo, the study area (23.5 km^2) was divided using a grid. Each square (0.25 km^2) was given a prevailing environment typology, as in Dinetti et al. (1995) and in Dinetti & Fraissinet (2001).
This technique enables an evaluation of the adequacy of Bergamo urban areas for Little Owl.

RESULTS

During the investigation, 5 species were censused: the Barn Owl *Tyto alba* (1 couple), the Little Owl *Athene noctua*, the Scops Owl *Otus scops* (3 couples) and the Tawny Owl *Strix aluco* (19 couples) are breeding birds, while the Long-eared Owl *Asio otus* winters in a small roost located at the border between Bergamo and the village of Gorle (Mastrorilli 1999b).

Typology	Km²	A.noctua breeding pairs	Density
Città Alta (Upper City)	4.75	4	0.84
Green areas urban parks. Parco dei Colli	6.75	10	1.48
Areas built-up after the Second World War	2	0	0
Rural areas. suburbs	3.25	7	2.15
Industrial areas. railway stations. former industrial areas	2.25	4	1.77
Monumental areas	1.75	5	2.85
Mixed urban areas and not defined areas	2.75	4	1.45

Table 1 Little Owl habitat selection in Bergamo
Tabel 1. Habitatselectie van de Steenuil in Bergamo.

Despite contacts during the breeding season, no evidence of nesting Long-eared Owls was found. A nesting couple of the Tengmalm's Owl *Aegolius funereus* (Guerra 1979) was recorded on Monte Bastia (521 m above sea level). No further data have been reported regarding this species.
During the study, 34 territorial Little Owl breeding pairs - average density 1.44 couple/km², close to the highest values reported in Lombardy (Galeotti and Sacchi 1996) - were recorded (Table 1).

The Little Owl is well distributed in the urban areas, except for the portions built up after the Second World War, characterised by high buildings, scanty vegetation and few cavities suitable for nesting.

DISCUSSION

Factors increasing prey accessibility, prey availability, cavity presence and decreasing predator pressure or human influence have a positive impact on Little Owl presence (Génot and Van Nieuwenhuyse submitted). We discuss the variability of occupied habitats in Bergamo according to these characteristics.

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In the Italian district capitals, the Little Owl shows adaptability in the choice of breeding sites (Dinetti and Fraissinet, 2001). It mostly occupies trees, bell towers, towers, and house roofs. In Bergamo, the suitable trees (Horse-chestnut *Aesculus hippocastanum* and Plane trees *Platanus sp.*) are located at the border of Città Alta (Upper City) and are mainly occupied by the Tawny Owl and, in the past, by the Scops Owl (Guerra 1979). Competition forces Little Owls to nest in garrets - especially in Città Alta (Upper City) -, in prefabricated sheds or in farmhouses (in the suburbs), in accordance with a trend recorded elsewhere in the Bergamo District (Mastrorilli 1999a).

The Little Owl is well distributed in the study area at different densities. The highest densities characterise the monumental portions of the town. The large and extended ancient wall, dating back to the sixteenth century and surrounding Città Alta (Upper City), provides the Little Owl with breeding sites while the nearby vegetable gardens and meadows supply trophic resources.
In the 60s and 70s, the importance of the ancient wall was pointed out by Guerra (1979), since it used to offer nesting sites for species nowadays missing, such as the Barn Owl *Tyto alba*, the Wall Creeper *Tichodroma muraria*, the Yellowhammer *Emberiza citrinella* and the Lesser Grey Shrike *Lanius minor*.

In the Parco Regionale dei Colli, the Little Owl and the Tawny Owl can co-exist. In other towns, the latter restricts the presence of the Little Owl (Galeotti in Bernini et al.1998).

The occurrence of many rural buildings at the borders of woods (Val d'Astino, S.Vigilio, Valverde, Monterosso) supplies suitable cavities, where Little Owls can find shelter and nesting sites. In the western part of the area, the landscape of Val

d'Astino is characterised by unusual and propitious features. In Val D'Astino, the occurrence of 4 nocturnal birds of prey was recorded: a Little Owl and a Barn Owl nest in Astino Monastery (XV century), while the Tawny Owl (2 pairs) and the Scops Owl (1 pair) occupy territories located at the border (data collected in 1999).
The industrial areas seem to be favourable for the Little Owl too. During the night, these habitats are not disturbed and the meadows located among sheds and factories promote the presence of micromammals. In Città Alta (Upper City), the Little Owl occupies the innermost portions, while the occurrence of some Tawny Owl couples at the border affect its potential breeding there. This disagrees with what was recorded in Pavia, where the town centre is not inhabited by the Little Owl (Galeotti in Bernini et al. 1998).

The Little Owl density recorded in the present study is higher than the Lombard average value (Galeotti and Sacchi 1996). In Bergamo, the proximity of the Alps, elsewhere affecting the occurrence of the Little Owl (LIPU 1998), shows no influence on the species.

In the next years, several public works (stadium, hospital) are planned. They will modify parts of the research area, threatening some areas vital for Little Owls. Therefore our presented results might become crucial information to assess the impact of the planned works.

CONCLUSION

The Little Owl shows a regular distribution in the town of Bergamo with a preference for monumental areas and suburbs. Thirty-four Little Owl breeding pairs (average density 1.44 couple/km^2) were recorded. The only places where the species experiences some difficulties of settlement are the areas built-up after the Second World war.
The lack of historical information relevant to the presence of the Little Owl in the town of Bergamo does not allow us to analyse the species trend. This research, however will offer a base-line to refer to in future research. As for the situation of the towns of northern Italy, Bergamo is one of the urban areas where Little Owl appears to be settled very well.

Photo by / *Fotograaf: Marco Mastrorilli* ©

ACKNOWLEDGMENTS

I thank all the people who took part to the tiring night fieldwork, especially E. Bassi, F. Galizzi, T. Sala, D. DeVecchi, M. Pavoni, G. Stefanelli, A. Barbagallo, G. Gandolfi. Many thanks to Dr. R. Sacchi (University of Pavia) for his suggestions in the field and to Dr. M. Guerra (Museo di Scienze Naturali di Bergamo) for historical data.
I would also thank Matteo Barattieri for the translation.

SAMENVATTING

SAMENVATTING

Tussen 1997 en 2000 liep in Bergamo (N.-Italië) een uilenproject, georganiseerd door de plaatselijke afdeling van de 'Italiaanse Vogelbeschermingsliga' waaraan veertig vrijwilligers deelnamen. Door het inventariseren van nachtroofvogels wilde men een idee krijgen over de status van o.a. de Steenuil Athene noctua in Bergamo.
Bergamo telt 116.000 inwoners en situeert zich aan de voet van de Orobie-Alpen, beslaat 38.76 km^2 en bestaat uit zowel natuurlijke als urbane habitats die zich in de heuvels en de valleien situeren.
Bergamo kan ingedeeld worden in een "upper city" of het oude centrale stadsgedeelte en een "lower city", een eerder door een disharmonieuze ontwikkeling gedegradeerd gedeelte.
Het onderzochte studiegebied (23.5 km^2) werd onderverdeeld in hokken van 25ha, ondergebracht in verschillende typologische klassen.
Tijdens het onderzoek werden vijf verschillende nachtroofvogels waargenomen: de Kerkuil Tyto alba met 1 koppel, de Dwergooruil Otus scops met 3 broedparen, de Bosuil Strix aluco met 19 broedparen, de Ransuil Asio otus werd wel waargenomen maar een nestplaats werd niet gevonden.
De Steenuil Athene noctua werd tijdens de onderzoeksperiode het meest frequent waargenomen met 34 broedparen of 1,44 broedparen/km^2. De Steenuil komt in het oude stadsgedeelte nog vrij goed aan bod (1,48 broedparen/km^2), in het naoorlogse stadsgedeelte daarentegen komt de soort helemaal niet voor. Hoge gebouwen voeren hier de boventoon en er valt erg weinig groen te bespeuren. Komt daar nog eens bij dat er een absoluut gebrek is aan nestholten. Dat alles maakt het voor de Steenuil allesbehalve aantrekkelijk.
De Steenuil heeft zich nochtans opmerkelijk aangepast en vindt in de meeste Italiaanse steden voldoende geschikte nestplaatsen. De Steenuil zoekt het vooral in het monumentale deel van Bergamo en de 16de eeuwse stadsmuren waar dichtheden van 2.85 broedparen/km^2 geteld werden. De bomen rond het oude stadsgedeelte bieden nestgelegenheid maar worden echter vooral ingenomen door de Bosuil en in het verleden ook de Dwergooruil.
In het Regionaal Park (Dei Colli) komen Steenuil (1.48 broedparen/km^2) en Bosuil naast elkaar voor.
Ook industriële gebieden schrikken de Steenuil niet af (1.77 broedparen/km^2). 's Nachts is het hier rustig, er zijn geschikte nestplaatsen en de uitgestrekte grasvelden zijn rijk aan kleine zoogdieren.

Samenvatting door Jenny De Laet

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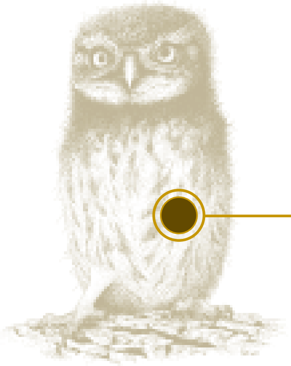

18. WORKING STRUCTURE OF THE EUROPEAN CONSERVATION PLAN FOR THE LITTLE OWL *ATHENE NOCTUA*: THE WAY FORWARD.

WERKSCHEMA VOOR HET EUROPEES BESCHERMINGSPLAN VOOR DE STEENUIL *ATHENE NOCTUA*: DE WEG VOORWAARTS.

ROY S. LEIGH

ABSTRACT

Across the continent of Europe the Little Owl *Athene noctua* exhibits varying degrees of abundance and threats. However the overall population trend in more than 80% of host countries appears to indicate declines in Little Owl numbers. This paper aims to provide the foundation of a species conservation plan that will be implemented on an international basis over the next five years.

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INTRODUCTION

In European Farming environments the Little Owl *Athene noctua* is an excellent flagship species to indicate the health of the environment. This is even more prominent when we consider its diverse prey range. From an ecological basis the Little Owl will indicate deficiencies in ecosystems and will prove to be a useful tool when monitoring improvements and management projects particularly in agricultural areas.

We are aware of the decline of the Little Owl across Europe and when the International Little Owl Working Group was established in 1999, one of the objectives of the group was to establish a conservation plan for Europe. This plan belongs to all members of the group and is an open working document that will be updated as the actions are implemented and further actions agreed and planned.

This document will only present the working structure of the plan, a more detailed plan will be circulated as the foundation elements laid out in this paper develop and are implemented.

The plan will use available methodology and best practises in conservation, which are already in use by ILOWG (International Little Owl Working Group) members in their countries, however some standardisation will be required. The plan will co-ordinate efforts on these areas and develop common methods for surveying, nest monitoring and data handling.

Conservation initiatives are more difficult to prescribe on an Euro wide basis. Therefore learning from established programmes and adopting "best practise" philosophy may be the best approach to the more practical issues regarding habitat management, nest box provision and predator control.

ACTION PLAN OBJECTIVES

The following will be the main objectives of the conservation plan:
Overall objective to stabilise 50% of declining Little Owl populations by the year 2006.

1. Work to same methodology when collecting population data
2. Use best practice where it exists in research, monitoring and conservation initiatives.
3. Develop a network of national co-ordinators to undertake national management of the plan.

4. Provide a structure and resources to aid implementation of the plan.
5. Undertake international agreement to co-operate in implementation of the plan.
6. Aid development of national, regional and local biodiversity action plans for Little Owls
7. Provide training and development for national co-ordinators and fieldworkers.
8. Make data available to conservation and scientific organisations.

CURRENT STATUS

The population has been declining in Europe for approximately 50 years. Loss of nest sites, urbanisation, increase in pesticides and rodenticides, changing farming practices have all impacted on the population across its range (Tucker and Heath 1994). Table 1 displays the population estimates and the trend of the population for a range of countries across Europe. We can see clearly that in most countries the population is shrinking. It is classified as a SPEC Category 3 in Birds of Europe, Their Conservation Status (Tucker and Heath 1994) this means that it has an unfavourable conservation status. However it is noticeable in some of the listed countries that the owl is on the brink of extinction i.e. Austria, Luxembourg, Switzerland. Some other countries show concerns enough to warrant Biodiversity Action Plans for the Little Owl, France (Lecomte et al. 2001) and Netherlands (Plantinga 1999) to name two. Despite its commonness in Flanders a conservation strategy was still developed for Little Owl to secure its favourable status and to support conservative actions in the neighbouring countries (Van Nieuwenhuyse et al. 2001). To take action we must act on an international basis and look at ways of conserving priority populations that are near to extinction as mentioned previously.

Country	Estimates and year	Trend	Reference
Albania	5 000-10 000 pairs 1962	?	Manez 1996
Austria	60 pairs 1997	Stable	Ille and Grinschgl 2001
Belgium	4 500-6 600 pairs 1981-1990	Declining	Manez 1994
Britain	7 468 pairs 1995		
	6 653 pairs 1996		
	6 253 pairs 1997		
	95% confidence intervals of 4 000-8 500	Declining	Toms et al. 2000
Croatia	6 000-8 000 pairs	Stable	Manez 1994
Czech Republic	300-350 pairs 1996 West-Bohemia	Declining	Schröpfer 1996
	700-1100 pairs in the whole country	Manez 1994	
Denmark	150 pairs	Declining	Manez 1994
Flanders	12 527 - 13 646 occupied cells 1998-2000	?	Van Nieuwenhuyse, Leysen and Steenhoudt, 2001
France	11 000-35 000 pairs 1998	Declining	Génot and Lecomte 1998
Germany	East Germany 250-300 pairs 1985-1986	Declining	Schönn 1986
	North Rheinland 1035 pairs 1999		Wink M. in litt.
	5 000-10 000 pairs 1985 in whole country		Manez 1994
Greece	5 000-10 000 pairs	Declining	Manez 1997
Hungary	1 500-2 000 pairs	Declining	Manez 1994
Italy	10 000-30 000 pairs 1996	Declining	Brichetti 1997
Luxembourg	80-150 pairs	Declining	Manez 1994
Moldavia	5 000-7 000 pairs 1988	?	Manez 1995
Netherlands	12 000 pairs 1997	Declining	Plantinga 1998
	4500-6000 pairs 2001		CBS and SOVON
Poland	1 000-3 000	Declining	Manez 1994
Portugal	10 000-100 000 pairs 1989	Stable	Manez 1994
Slovakia	800-1 000 pairs	Declining	Manez 1994
Slovenia	400-640 pairs	Declining	Vogrin 1997
Spain	50 000-65 000 pairs 1975-1995	Declining	Olea 1997
Spain	50 000-65 000 pairs		Manez 1994
Switzerland	70 pairs 1992-1996	Stable	Meisser and Juillard, 1998
	Genève 30-40 pairs		Meisser and Albrecht 2001
	Tessin less than 10 pairs		Meisser and Albrecht 2001
	Ajoie at least 17 pairs 2000		Meisser and Albrecht 2001

Table 1: Little Owl Population Trends across Europe (After Génot & Van Nieuwenhuyse, submitted)
Tabel 1. Populatietrends Steenuil in Europa (naar Génot & Van Nieuwenhuyse, in voorbereiding)

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CONSERVATION PLAN ORGANISATION

To deliver a plan of this order we require a multi-national steering committee and national co-ordinators to head the operational programmes in their countries.

The Steering Committee will be the following people:

Roy Leigh - Chairman
Jean-Claude Génot
Dries Van Nieuwenhuyse
Jan van`t Hoff
Niko Groen

The role and responsibilities of this committee will be as follows:

- To ensure that the plan is being implemented correctly.
- Hold regular reviews of the effectiveness of the plan and implement changes as required.
- To ensure that communication is good within the plan and to external agencies.
- Develop an Euro wide Datawarehouse for all of the data from the project.
- Develop a business plan to attract funding for the plan, talk to prospective sponsors.
- Review the plan at regular intervals to ensure that time-scales will be met.
- Develop training packages for co-ordinators and fieldworkers, and deliver them when required.

NATIONAL CO-ORDINATORS

A list of national co-ordinators is shown in table 2:

Country	Co-ordinator	Email address
Austria	Roland Ille	ille@kfungraz.ac.at
Belgium	'Natuurpunt'	Steenuil@wielewaal.be
Britain	Roy Leigh	RoySLeigh@aol.com
Czech Rep	Libor Schropfer	schropfer@oaplzen.cz
France	Jean-Claude Genot	Jean-Claude.Genot@wanadoo.fr
Germany	Hubertus Illner	h.illner&freenet.de
Hungary	Peter Elekes	epayba@freemail.hu
Italy	Duccio Centili	d.centili@inwind.it
Luxembourg	Patric Lorge	secretary@luxnatur.lu
Netherlands	Ronald Van Harxen & Nico Groen	Birdby@wxs.nl
Poland	Grzegorz Grzywaczewski	grzywacz@ursus.ar.lubin.pl
Portugal	Richard Thome	ricmocho@hotmail.com
Romania	Attilia D Sandor	Attilia@retezat.ro
Slovenia	Milan Vogrin	Milan.Vogrin@guest.si
Spain	Inigo Zuberogitia	Inigo.Zuberogitia@wanadoo.es
Switzerland	Christian Meisser	Meisser@viri.ch
Turkey	Edwin Vassen	RRRCT@about.com

Table 2. National Little Owl Co-ordinators.
Tabel 2. Nationale Steenuilcoördinatoren.

The role and responsibilities of the national co-ordinators will be:

- Act as point of contact for their country.
- Co-ordinate and organise censuses and nest monitoring using the same protocols across Europe.
- Supply information and data from their country.
- Figurehead all activities in their country.

Both the steering committee and co-ordinators will work very closely on implementing the plans in their country. Training workshops are to be held in 2002 to provide co-ordinators with standard methodology for inventory censuses of calling males. And a further workshop will be developed for the nest recording methodology.

METHODS

The aim of the plan will be to standardise research and monitoring methods employed across Europe. This makes sense because we can all compare data and send it into an Euro wide database which can be used in further conservation planning and analysis as required.

I understand that this will be the most difficult step for us all to take. However it will be a major step forward with the plan. When we achieve this by working from a set protocol we will have put in place a major foundation stone on which to build. Training workshops and fieldwork events will be planned to provide the skills and knowledge to undertake this element.

A fieldwork manual produced by Stone in the Netherlands (Bloem et al. 2001) will feature as a mode of communication and method standardisation in the nest recording protocol.

The Flemish project of Natuurpunt Studie has developed a population inventory census protocol, and data analysis methods, which have produced very positive results, therefore I propose that this methodology is used as standard and again the Flemish team will feature in the training programme in this element.

A programme of fieldworker exchanges will be developed to provide development opportunities and improve communications between national programmes.

Further development on a method to collect samples for DNA analysis will be addressed, as this is a very important element for our research to include.

DATAWAREHOUSE

A central datawarehouse will be developed and established to hold all of the data gained from the fieldwork and surveys. This will provide an opportunity to develop satellite systems which co-ordinators can access and input data directly into it.

This will act as the plan monitor and will provide annual population data. Data will also be available for organisations involved in the development of local and national action plans.

REFERENCE LIBRARY

Jean-Claude Génot has over the many years of Little Owl research built up a very extensive reference library, which under today's technology will be available to members participating in the plan who require references etc. Of course to help Jean-Claude with this we need to supply him with all our papers etc. to ensure the library is as complete as possible.

COMMUNICATIONS

It is important that the communications between all participants, funding organisation, nature organisations, and government offices are working optimally to keep them well informed of the progress and issues from the plan. This will be delivered in three methods, for everyone a web site will show the plan in whole to download, current status, results and other news.
An e-group will be developed, and a newsletter will be issued and distributed to participants of the plan.

TIME-SCALE

The statement "To stabilise 50% of declining national Little Owl populations by 2006" requires important work to be carried out within 2001. Therefore I am proposing that the Steering committee will meet in Q3 2001 to develop the training packages which ideally will by delivered in 2002, and develop a workshop to be held at the 3rd International Little Owl Symposium in England April 2002 to share best practise, to agree and prioritise the work. At the end of this workshop all delegates will leave with a strong belief in the way forward.

ACKNOWLEDGEMENTS

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So come on! Let's do it; let's get on and save the Little Owl.

SAMENVATTING

SAMENVATTING

In Europese landbouwgebieden is de Steenuil een ideaal vlaggenschip om de kwaliteit van het leefmilieu aan te geven. Zijn ruime voedselkeuze maakt de soort ecologisch gezien nog een interessantere graadmeter. In vrijwel geheel Europa gaat deze soort achteruit. Daarom is een internationaal beschermingsplan meer dan wenselijk. De belangrijkste doelstellingen van dit plan worden opgelijst. Hoofddoelstelling is 50% van de dalende Steenuilpopulaties te stabiliseren tegen 2006. Om hiertoe te komen is het noodzakelijk op Europees niveau dezelfde methodes te gebruiken bij het verzamelen, opslaan en verwerken van gegevens. De beste bestaande nationale initiatieven rond onderzoek, monitoring en bescherming moeten als model dienen voor de andere landen. Voor inventarisatie en analyse van de gegevens wordt de standaard aangereikt door het Steenuilenproject van Natuurpunt Studie. Voor communicatie en registratie van nesten stellen we het voorbeeld van de Nederlandse werkgroep "Stone" voor. Een netwerk van nationale coördinatoren moet dit plan op nationaal niveau uitwerken. Ter ondersteuning moet hiervoor een structuur uitgewerkt worden en fondsen verzameld. Uiteraard moeten internationale akkoorden de samenwerking rond de toepassing van dit plan consolideren. Nationale, regionale en lokale acties rond de Steenuil dienen ondersteund te worden. Voor de nationale coördinatoren en veldmedewerkers zal opleiding voorzien worden. De gegevens moeten beschikbaar gesteld worden voor natuurbehoud en wetenschappelijk onderzoek. Op basis van die krachtlijnen moet binnen de 5 jaar de planmatige internationale bescherming van de Steenuil een feit zijn.

Samenvatting door Koen Leysen

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NATUUR.ORIOLUS, AN INTRODUCTION

The two major nature conservation organisations in Flanders , De Wielewaal Natuurvereniging vzw and Natuurreservaten vzw, are merging into an new organisation from January 1st 2002 onwards. This new organisation is called Natuurpunt vzw. It has distinctive departments on membership, reserves, education and study (Natuurpunt Studie). The department study will have a specific ornithological magazine Natuur.Oriolus. This is a revised format of the former magazine Oriolus, edited by De Wielewaal. This renewed magazine will try to inform the Flemish ornithologists as wide as possible about the ornithological projects of Natuurpunt Studie and all its regional ornithological working groups. Other topics are scientific ornithological research in Flanders, recent sightings, new bird-trends, birding itineraries in Flanders and review of books and sites.
Natuur.Oriolus appears 4 times a year. A subscription will cost 26 euro. In order to subscribe send an e-mail to info@wielewaal.be and we will send you an invoice.
More info on www.wielewaal.be.

NATUUR.ORIOLUS, EVEN VOORSTELLEN

De twee grote natuurbeschermingsorganisaties in Vlaanderen, De Wielewaal Natuurvereniging vzw en Natuurreservaten vzw, fusioneren vanaf 1 januari 2002 tot Natuurpunt vzw. Deze nieuwe vereniging is onderverdeeld in verschillende afdelingen met name leden, beheer, beleid, educatie en studie. Natuurpunt Studie geeft een algemeen natuurhistorisch tijdschrift uit (Natuur.Focus) en een specifiek ornithologisch blad Natuur.Oriolus.
Dat laatste wil meer zijn dan zomaar de voortzetting van het vroegere Oriolus. Natuur.Oriolus wil de spreekbuis zijn van de meer dan 30 vogelwerkgroepen die binnen Natuurpunt actief zijn. Daarnaast willen we de lezer op de hoogte houden van alle vogelprojecten binnen Natuurpunt Studie: vogels voeren en beloeren, trektellingen, weidevogelbescherming, tellingen van roofvogels of wintervogels in het algemeen (PTT-tellingen)...
Verder willen we de resultaten van wetenschappelijk onderzoek in Vlaanderen op een vlotte manier presenteren.
Recente vogelwaarnemingen komen ruim aan bod in seizoensoverzichten en als er zeldzame vogels gezien zijn in Vlaanderen lees je dat in Natuur.Oriolus.
Uiteraard gaan we ook niet voorbij aan nieuwe ontwikkelingen en trends in het vogelwereldje.
Als bijkomende service voor onze lezers brengen we ook een aantal interessante vogelgebieden in Vlaanderen in kaart.
Natuur.Oriolus verschijnt driemaandelijks. Leden van Natuurpunt (lidmaatschap 17,5 euro) betalen 8,5 euro bovenop hun lidgeld als ze Natuur.Oriolus wensen te ontvangen (26 euro). Gecombineerd met Natuur.Focus komt dat op 32 euro (korting van 2,5 euro).
Inlichtingen hierover bij info@wielewaal.be of op de website www.wielewaal.be.

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