Conference Volume	5th Symposium for Research in Protected Areas 10 to 12 June 2013, Mittersill	pages 531 - 536

Owls in Floodplain Forests in Eastern Austria: Habitat Use and Population Density

Christina Nagl, Karl Reiter & Christian H. Schulze

Abstract

Due to their trophic position owls represent important indicator species for an intact environment. However, little is known about the population density and habitat preferences of owls in European floodplain forest ecosystems. Therefore, we mapped owl territories and analyzed the habitat use of the Tawny Owl in the largest remaining floodplain forests in Central Europe, located along Danube River and Morava River in Eastern Austria. The studied floodplain forests are embedded in an agricultural landscape matrix and are characterized by different flood dynamics, forest structure and forest management measures. Using a point-count methodology, owls were surveyed in March-May 2012 in an area covering approximately 100 km² along the Danube River east of Vienna (the largest part of this area belongs to the Donau-Auen National Park) and in an area of approx. 10 km² along Morava River, Lower Austria. The 188 observation points were located at a distance of >0.5 km from each other and covered the entire study area. Three owl species, Tawny Owl (*Strix aluco*), Long-Eared Owl (*Asio otus*) and Eagle Owl (*Bubo bubo*), were recorded in the surveyed floodplain forests with at total of 99, 7 and 5 identified territories, respectively. In regard to the Tawny Owl, the likelihood of occurrence at census points increased significantly with the increase of deciduous forest coverage (within a 200 m radius around census points). Apparently, the occurrence of Tawny Owl was not affected by flooding regime and the proximity of Eagle Owl territories. The high territory densities of Tawny Owl in the Nature Reserve March floodplain (1.6 territories/km²) and the Donau-Auen National Park (1.0 territories/km²) indicate a high habitat quality of the studied floodplain forests for owls.

Keywords

Tawny Owl, Long-Eared Owl, Eagle Owl, habitat use, habitat quality, population density, floodplain ecosystem

Introduction

The floodplain forests along Danube River and Morava River in Eastern Austria represent one of the largest remaining floodplain ecosystems in Central Europe and are characterized by one of the region's last free-flowing river stretches (MANZANO 2000). In this study we investigated the importance of this ecosystem for owls. Three owl species are known to breed in the region's floodplain forests: The Tawny Owl (*Strix aluco*), the Long-Eared Owl (*Asio otus*) and the Eagle Owl (*Bubo bubo*) (ZUNA-KRATKY et al. 2000). The Tawny Owl, a cavity-nesting and hence forest-dependent species, has a low ecological specialization (HIRONS 1985, MEBS & SCHERZINGER 2008). Long-Eared Owls prefer forest edge habitats and small woods surrounded by open country (MARTINEZ & ZUBEROGOITIA 2004, MEBS & SCHERZINGER 2008). They can strongly depend on old corvine nests for breeding and thereby avoiding Tawny Owl's territories (SCHUSTER 1996). After having almost vanished from large parts of its former distribution area due to the hunting and persecution by humans, the Eagle Owl has during the last decades successfully re-colonized in the Pannonian region, which includes the lowland floodplain forests along the Danube and Morava River (GRÜLL et al. 2010). Watercourses and an irregular topography combined with a heterogeneous landscape composition are preferred, whereas the species avoid areas with a high extent of human disturbance (ORTEGO 2007). The colonization of the Danube-Morava floodplains by Eagle Owls may lead to an increased intraguild predation on smaller predatory birds such as the Tawny Owl, which is frequently recorded as Eagle Owl prey (e.g. SERGIO et al. 2007).

The high hydrological dynamic of floodplain ecosystems creates a broad spectrum of habitats and has significant effects on the abundance of small mammals (WIJNHOVEN et al. 2005). Both most likely affect the value of floodplains as breeding and hunting habitats for owls. Beside natural flood dynamics, varied forest management measures affect forest structure, tree species composition and the availability of tree-cavities, which represent important nesting sites for tree hole-breeding owls. Due to their special breeding and food requirements high densities of owls can indicate high habitat quality (MEBS & SCHERZINGER 2008).

Due to a lack of information on their occurrence and population density in Central European floodplain forests, we made extensive owl surveys in two protected areas along Danube and Morava River in Eastern Austria, where all three owl species occur. The Tawny Owl is the most abundant owl species in Austria (BERG 1992), followed by the Long-Eared Owl (MEBS & SCHERZINGER 2008). The Eagle Owl is continuously colonizing lowland floodplain forests in Eastern Austria (ZUNA-KRATKY 2000). Besides estimating the population densities for all three owl species in floodplain forests, we assessed the effects of landscape composition and flooding regime on the habitat use of the most abundant species, the Tawny Owl.

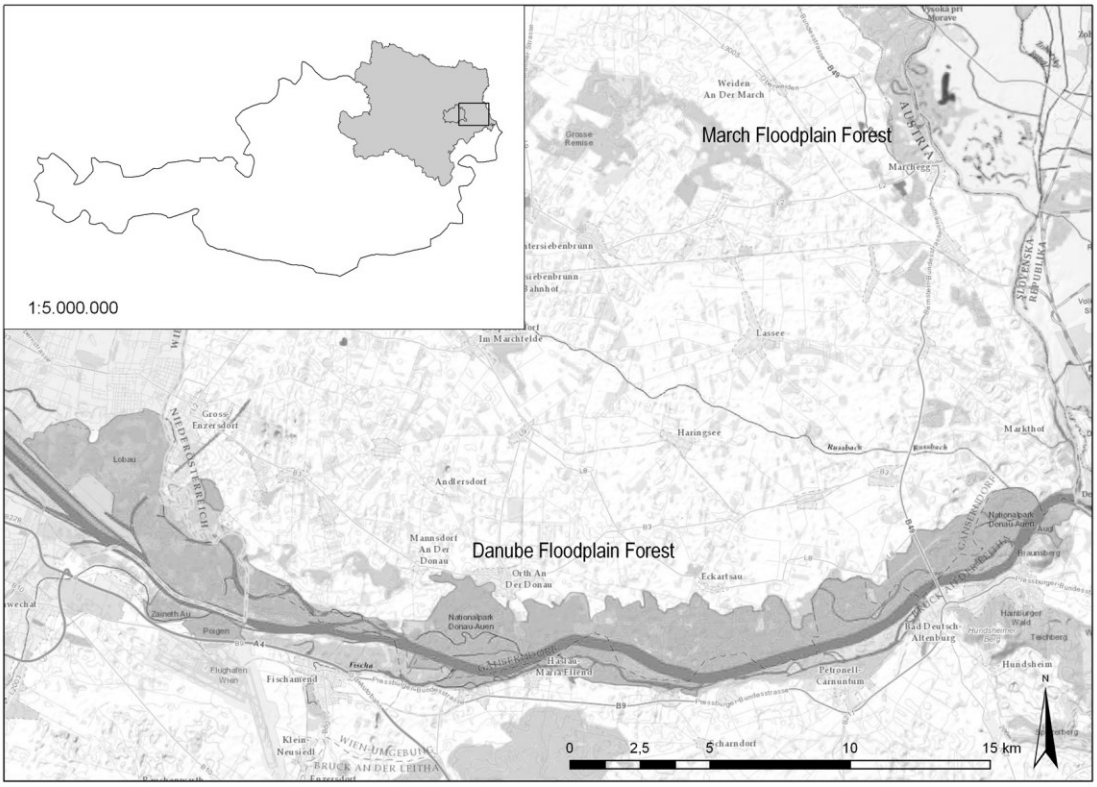

Figure 1: Study area along Danube and Morava River. Floodplain forest areas are marked dark grey. Source: Esri.

Methods

Study area

The present study was conducted in lowland floodplain forests in Eastern Austria along the Danube and the Morava River (Figure 1). The study area covers 109 km². The largest part of 93 km² belongs to the Donau-Auen National Park and a further 6 km² of non-protected forest at Petronell-Carnuntum are attached to the southern margin of the national park. The remaining area of 10 km² is located in the WWF-Nature Reserve March-Auen. A detailed description of the tree species composition of the floodplain forests along the rivers Danube and Morava can be found in TIEFENBACH et al. (1998) and BAUMGARTNER et al. (1999), respectively. The Danube-Morava-floodplain is characterized by two different flooding regimes: spring floods along the river Morava and summer floods along the river Danube (ZUNA-KRATKY et al. 2000, TIEFENBACH et al. 1998).

Owl surveys

We used a point-count methodology to survey the owls in our study area. The 188 census points were located at a minimum distance of 0.5 km from each other and were more-or-less equally distributed over the total study area. All observation points were visited once between 1 March and 5 May 2012. Playbacks (duration: 1 min.; repeated 2-3 times) of male owls were used to stimulate the calling of territorial birds. The observation time at each census point was 30 minutes (REDPATH 1994).

Habitat variables

For each observation point the habitat composition was quantified within a radius of 200 m. A total of six habitat types were classified: deciduous forest, mixed forest, coniferous forest, grassland, agricultural area and area of water bodies. For each habitat type the percentage of area covered within the radius of 200 m around census points was measured. Therefore, we used landscape classifications according to WRBKA et al. (2003). For each observation point habitat diversity was quantified by the Shannon-Wiener index.

Data analysis

All owl records were plotted on maps of the study area to allow for a preliminary visual evaluation of the spatial distribution of the three owl species in our study area. Subsequently, population densities were calculated for the entire study area and, separately, for floodplain forests along Danube and Morava River. For the Danube floodplain system which was divided into flooded and non-flooded forest areas by a levee, we tested for differences in the occurrence frequency of Tawny Owl in both forest types by using a chi-square test.

Only the Tawny Owl was abundant enough to evaluate the importance of habitat composition on the species' occurrence. Due to strong multi-collinearity of habitat variables, we calculated a principal component analysis (PCA) on all variables. A generalized linear mixed model (GLMM) was calculated to evaluate the potential of our landscape variables (factors 1-3 of the calculated PCA), region (Danube and Morava floodplain forest), flooding regime and the presence of Eagle Owls for predicting the occurrence of Tawny Owls at census points. Occurrence probability predicted by the GLMM was then plotted against potentially important habitat variables. Furthermore, their effect on the occurrence of Tawny Owl was described by logistic regression functions.

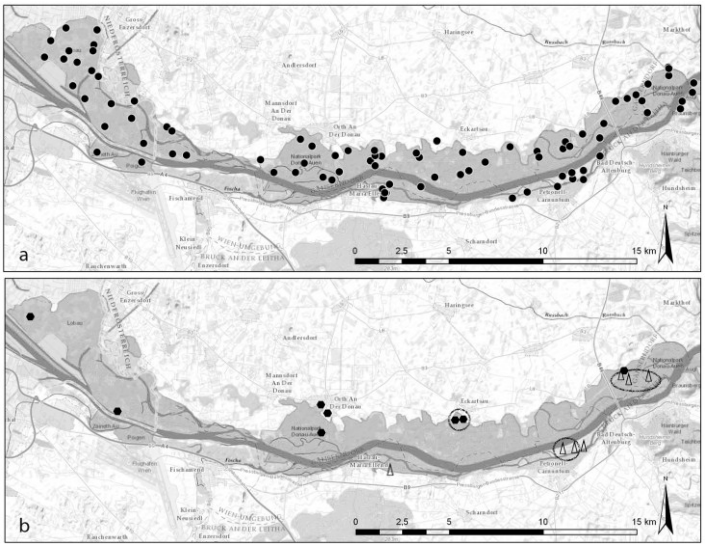

Figure 2: Occurrence of (a) *S. aluco* (●), (b) *A. otus* (⬢) and *B. bubo* (⍙) in the study area along Danube River in spring 2012. Circles merge observations most likely referring to one territory.

Results

Population densities

The most abundant owl species *S. aluco* was recorded in the whole study area at 56.7 % of all observation points (Figure 2a, 3a). The frequency of occurrence at census points was significantly higher at the Moravian than at the Danube floodplains (Chi-square test: $\chi^2 = 8.38$, df = 1, $p = 0.004$). In the Morava floodplain the Tawny Owl was recorded at 88.9 % of all observation points (N = 18), in the Danube floodplain it was found at 53.2 % of all observation points (N = 156). The density of territories estimated for the Nature Reserve March floodplain was 1.6 territories/km² (Table 1, Figure 3a), for the Vienna and Lower Austrian parts of the Donau-Auen National Park a density of 1.0 and 0.9 territories/km², respectively, was calculated (Table 1).

Table 1: Number of recorded territories and territory density of *S. aluco* in different parts of our study area.

Location	Area (km²)	Territories	Territory density/km²
WWF-Nature Reserve March-Auen	10	16	1.6
Donau-Auen National Park Vienna (Lobau)	22	22	1.0
Donau-Auen National Park Lower Austria	71	61	0.9

The Long-Eared Owl could not be recorded in the Nature Reserve March-Auen. In the Donau-Auen National Park a total of <0.1 territories/km² were found. A total of five Eagle Owl territories were recorded in the entire study area: one territory in the Nature Reserve March-Auen and four territories in the Danube floodplain forest (Figure 2b, 3b).

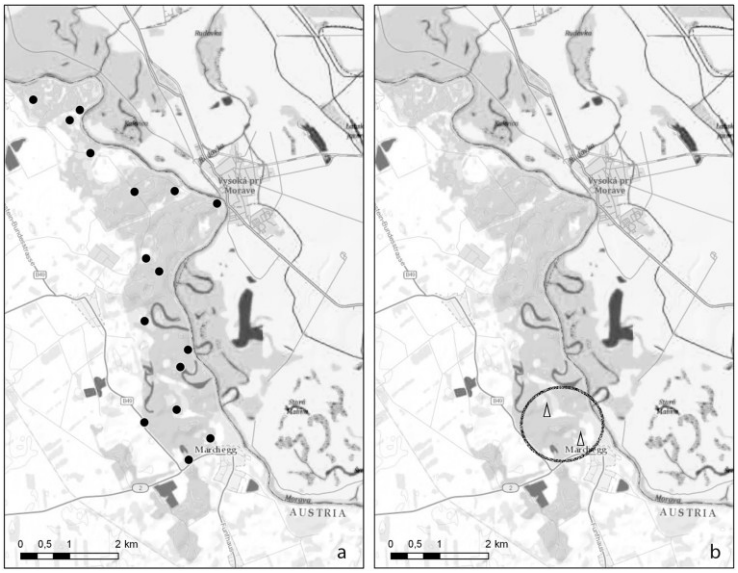

Figure 3: Occurrence of (a) *S. aluco* (●) and (b) *B. bubo* (⍙) in the WWF Reserve March-Auen in spring 2012. Circles merge observations most likely referring to one territory

Habitat use of Tawny Owl

The occurrence frequency of Tawny Owl in our study area did not differ between census points located in flooded forest areas, non-flooded forest areas and the transition zone between both forest types (Chi-square test: $\chi^2 = 1.70$, df = 2, $p = 0.427$). Also no significant differences were found when only comparing flooded and non-flooded forest areas and only considering the census points located in the Danube floodplain (Chi-square test: $\chi^2 = 1.40$, df = 1, p = 0.237).

Due to the strong multi-collinearity of landscape variables, we calculated a principal component analysis. The first three factors PC1, PC2 and PC 3 explained 39.15%, 25.48% and 14.23% of the total variance. PC1 predominantly represents the proportion of deciduous forest and habitat diversity. Habitat diversity has a negative factor loading, the deciduous forest cover is positively related to the PC1 values (Table 2) because habitat diversity declines when most of the area is covered by deciduous forest ($r = -0.84$, $p < 0.001$). The PC2 is highly related to variance in the cover of human-modified habitats (grassland, agricultural area, coniferous forest) and the area of water bodies. The proportion of mixed forest is the only variable with a high PC3 loading (Table 2).

Table 2: The first three factors (PC1-4) of a principal component analyses on seven habitat variables showing factor loadings.

Variables	PC1	PC2	PC3
Proportion deciduous forest	**0.95**	-0.22	0.03
Proportion mixed forest	-0.36	-0.01	**0.91**
Proportion coniferous forest	-0.56	**-0.65**	<-0.01
Proportion grassland	-0.24	**0.70**	-0.23
Proportion agricultural area	-0.47	**0.62**	-0.05
Proportion water area	-0.52	**-0.65**	-0.32
Shannon habitat diversity	**-0.92**	0.043	-0.06

To evaluate the importance of different subsets of habitat variables (PC1-3), region, flooding regime and the presence of Eagle Owls for the occurrence of Tawny Owls at census points, a GLMM was calculated. The resulting model only indicated a significant effect of PC1 on Tawny Owl occurrence (Table 3).

Table 3: Results of GLMM testing for effects of PCs combining habitat area and diversity variables, region, flooding regime and the occurrence of Eagle Owls on the occurrence of Tawny Owl. Significant effects are printed bold.

Variable	*F*	*P*
PC1	**11.54**	**0.001**
PC2	2.36	0.126
PC3	0.78	0.781
Region	1.13	0.339
Flooding regime	0.89	0.415
Eagle Owl territory	2.25	0.114

The likelihood of occurrence increased with increasing PC1, which explained predominantly the variance in deciduous forest cover and habitat diversity. Indeed, both variables are strongly related to the predicted probability of Tawny Owl occurrence, which increases with increasing forest cover (Figure 4a) and decreasing landscape diversity (Figure 4b).

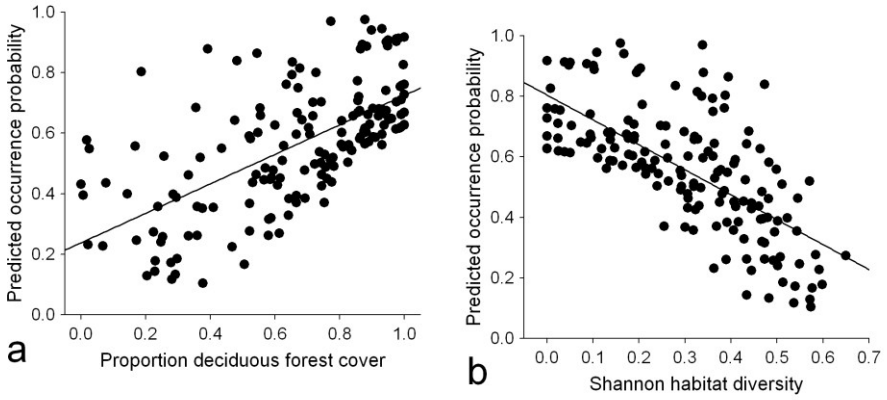

Figure 4: Relationships between the probability of Tawny Owls occurrence at census points and (a) the proportion of deciduous forest cover and (b) the habitat diversity. Probability occurrences were estimated by a GLMM evaluating effects of different habitat variables, region, flooding regime and the presence of Eagle Owls on the presence of Tawny Owls at census points.

Discussion

In lowland forests of Central Europe, the Tawny Owl usually represents by far the most abundant owl species. Its regional density varies, depending on the forest cover, between <0.2 and 2.75 breeding pairs/10 km². When considering only forest areas, higher densities between 5 and 10(16) pairs/10 km² can be found. Even higher densities are only reached in small forest fragments (GLUTZ VON BLOTZHEIM 1987). In Central European floodplain forests, the reported territory densities range between 8 and 11 territories/10 km². Our study documents an even higher density of 16 territories/10 km² for the WWF Reserve March-Auen (Table 4).

A total of five Eagle Owl territories were found in our study area in 2012; four of them in the Donau-Auen National Park, one in the WWF Reserve March-Auen. A slightly higher number of territories (6-7 calling males) were found in the Danube floodplains in 2004/2005 (THOBY 2006). The breeding pair in the WWF Reserve near Marchegg has been continuously recorded since 1998 (ZUNA-KRATKY et al. 2000). During breeding season, Eagle Owls defend a territory of a size of 9-12 km², and during post-breeding season they use a home range of up to 100 km² (LEDITZNIG 1992, LEDITZNIG 1996). Therefore, the territory density documented for our study area most likely had already approached its summit.

The recorded density of 1 Long-Eared Owl territories/10 km² in our study area is almost certainly an underestimation. Due to its low territoriality and hence low response-probability to playbacks, a higher survey effort would have been necessary for assessing the species' territory density.

The fact that only forest cover proved to positively affect the occurrence of the Tawny Owl in our study area emphasizes its tolerance against other environmental factors. The remarkably high territory density in floodplain forests, not only in Eastern Austria, indicates the high habitat quality of this forest type for the Tawny Owl. In the studied floodplain forests along Danube and Morava River, forest management measures have decreased significantly during the last decades. This may have resulted in an increased density of available tree cavities (CARLSON et al. 1998) providing important nesting sites for *S. aluco* (SALVATI et al. 2002).

The Tawny Owl has a preference for old forests composed of large trees and a sparsely developed undergrowth layer, facilitating easy access to prey dwelling on the forest floor (GSTIR 2012). Besides infrequently feeding on birds, amphibians and insects, forest rodents are the main prey of Tawny Owls (JEDRZEJEWSKA et al. 1994), which should reach lower densities in regularly flooded forest areas (WIJNHOVEN et al. 2005). However, in our study area no differences in occurrence frequency of the Tawny Owl were found between regularly flooded and non-flooded parts of the forest.

Table 4: Territory densities of Tawny Owl in different forest types in Central Europe.

Study area	Landscape type	Study area (km²)	Territories/10 km²	Source
Bayrischer Wald (Germany)	mixed woodland	13.0	1.7	Mebs & Scherzinger (2008)
Grunewald West Berlin (Germany)	mixed woodland	31.0	6.0	Wendland (1972)
Badische Rheinebene (Germany)	floodplain forest	23.0	11.3	Glutz von Blotzheim (1987)
Fürstenwald/Ringelsdorf (Austria)	floodplain forest	8.5	8.2-9.4	Zuna-Kratky et al. (2000)
WWF-Nature Reserve March-Auen (Austria)	floodplain forest	93.0	9.0-10.0	present study
Danube floodplain east of Vienna (Austria)	floodplain forest	10.0	16.0	present study

Besides an underestimation of the density of Long-Eared Owl in our study area due to methodological reasons, the availability of suitable habitats may be limited. The species depends on open areas for hunting (SCHUSTER 1996, MARTINEZ & ZUBEROGOITIA 2004). Hence, large parts of the Donau-Auen National Park with a total meadow cover of <10 % (MANZANO 2000) may not fulfil the species' habitat requirements. Furthermore, Long-Eared Owls seem to avoid *S. aluco* territories (SCHUSTER 1996), which are densely distributed over most of our study area.

Conclusion

Our study confirms the high habitat quality of floodplain forests for owls, particularly for the Tawny Owl. Further studies will have to evaluate which resources (availability of nesting sites, abundance of prey etc.) are most important in explaining the high population densities of the Tawny Owl in floodplain forests.

Acknowledgements

We are grateful to the team of Donau-Auen National Park, especially C. Baumgartner, C. Fraissl, H. Dolecek, J. Steiner, C. Manzano, G. Frank and A. Faltejsek for technical and financial support, and for providing invaluable information. Furthermore, we would like to thank G. Neuhauser for support in the WWF Reserve March-Auen and C. Abensperg-Traun for granting permission to survey owls in Petronell-Carnuntum. We also want to thank K. Zsak for GIS assistance, L. Gregor for English proof-reading, the University of Vienna for technical support and H. Frey, T. Zuna-Kratky, M. Noga and P. Korn for providing information about owls in the region, and of course many thanks to all of our field assistants (S. Vornegger, F. Rempt, M. Bartikova, G. Kalnina, K. Nagl, C. Mühlbacher, J. Panholzer, J. Braunisch, A. Hammerer, K. Palme, J. Primus, U. Stöger, B. Täubling, K. Heissenberger, B. Mertin, E. Pölz, C. Leutgeb, F. Kucera, M. Pintar, D. Mersmann, L. Huber-Eustachi, K. Neumayer, P. Surovec).

References

BAUMGARTNER, C., BRYCHTA, B., EDER, F., FINK, M., HANSY, H., HÖDL, W., KAPLAN, M., KELEMEN, J., KREMSMAYER, U., LAZOWSKI, W., MANZANO, C., NEUHAUSER, G., SCHLEDERER, R., SCHRATT-EHRENDORFER, L., SCHULTES, H., ŠEFFER, J., SIEBER, J., SPINDLER, T., STANOVÁ, V., TÄUBLING, A., UNGERMAN, J., VAŠIN, M., WEIGAND, E., WINTERSBERGER, H., WURZER, A., ZULKA, K. P. & T. ZUNA-KRATKY 1999. Fließende Grenzen – Lebensraum March-Thaya-Auen. Wien.

BERG, H.M. 1992. Status und Verbreitung der Eulen (Strigiformes) in Österreich. Egretta 35: 4-8.

CARLSON, A., SANDSTROM, U. & K. OLSSON 1998. Availability and use of natural tree holes by cavity nesting birds in a Swedish deciduous forest. Ardea 86: 109-119.

GLUTZ VON BLOTZHEIM, U.N. (ed.) 1987. Handbuch der Vögel Mitteleuropas. Band 9. Wiesbaden.

GRÜLL, A., PETER, H. & H. FREY 2010. The Eagle Owl *Bubo bubo* (Linnaeus 1758) in Burgenland, Austria: the process of colonization from 1971 to 2005. Egretta 51: 5-23.

GSTIR, J. 2012. Nest site selection of Tawny Owl *Strix aluco* in relation to habitat structure and food abundance in the Biosphere Reserve Wienerwald. Diploma Thesis, University of Vienna.

HIRONS, G. J. M. † 1985. The effects of territorial behaviour on the stability and dispersion of Tawny owl (*Strix aluco*) populations. Journal of Zoology 1: 21-48.

JEDRZEJEWSKI W., JEDRZEJEWSKI, B., ZUB, K., ANDRZEJ, L., BYSTROWSKI, R. & C. BYSTROWSKI 1994. Resource use by Tawny Owls *Strix aluco* in relation to rodent fluctuations in Bialowieza National Park, Poland. Journal of Avian Biology 25: 308-318.

LEDITZNIG, C. 1992. Telemetriestudie am Uhu (*Bubo bubo*) im niederösterreichischen Alpenvorland – Methodik und erste Ergebnisse. Egretta 35: 69-72.

LEDITZNIG, C. 1996. Habitatwahl des Uhus (*Bubo bubo*) im Südwesten Niederösterreichs und in den donaunahen Gebieten des Mühlviertels auf Basis radiotelemetrischer Untersuchungen. Abhandlungen der Zoologisch-Botanischen Gesellschaft Österreich 29: 47-68.

LEDITZNIG C., LEDITZNIG, W. & H. GOSSOW 2001. 15 Jahre Untersuchungen am Uhu (*Bubo bubo*) im Mostviertel Niederösterreichs - Stand und Entwicklungstendenzen. Egretta 44: 45-73.

MANZANO, C. 2000. Großräumiger Schutz von Feuchtgebieten im Nationalpark Donau-Auen. Kataloge des Oberösterreichischen Landesmuseums 149: 229-248.

MARTINEZ, A. & I. ZUBEROGOITIA 2004. Habitat preferences for Long-Eared Owls *Asio otus* and Little Owls *Athene noctua* in semi-arid environments at three spatial scales. Bird Study 51: 163-169.

MEBS, T. & W. SCHERZINGER 2008. Die Eulen Europas. Stuttgart.

ORTEGO, J. 2007. Consequences of Eagle Owl nest-site habitat preference for breeding performance and territory stability. Ornis Fennica 84:78-90.

REDPATH, S.M. 1994. Censusing tawny owls *Strix aluco* using imitation calls. Bird Study 41: 192-198.

REDPATH, S.M. 1995. Habitat fragmentation and the individual: tawny owls *Strix aluco* in woodland patches. Journal of Animal Ecology 64: 652-661.

SALVATI, L., MANGANARO, A. & L. RANAZZI 2002. Wood quality and the Tawny Owl *Strix aluco* in different forest types of central Italy. Ornis Svecica 12:47–51.

SERGIO, F., MARCHESI, L., PEDRINI, P. & V. PENTERIANI 2007. Coexistence of a generalist owl with its intraguild predator: distance-sensitive or habitat-mediated avoidance? Animal Behaviour 74: 1607-1616.

SCHUSTER, A. 1996. Bestandsdichte der Waldohreule (*Asio otus*) auf einer Probefläche im oberösterreichischen Alpenvorland. Vogelkundliche Nachrichten Oberösterreichs 4 (1): 33-36.

THOBY, A. 2006. Veränderungen der Greifvogelfauna in den Donau-Auen östlich von Wien, am Beispiel der Wälder im Gebiet des Nationalpark Donau-Auen. Diploma thesis, University of Vienna.

TIEFENBACH, M., LARNDORFER, G. & E. WEIGAND 1998. Naturschutz in Österreich. Wien.

WENDLAND, V. 1972. 14jährige Beobachtungen zur Vermehrung des Waldkauzes (*Strix aluco* L.). Journal für Ornithologie 113(3): 276-286.

WIJNHOVEN, S., VAN DER VELDE, G., LEUVEN, R.S.E.W. & A.J.M. SMITS 2005. Flooding ecology of voles, mice and shrews: the importance of geomorphological and vegetational heterogeneity in river floodplains. Acta Theriologica 50: 453-472.

WRBKA, T, PETERSEIL, J., KISS, A., SCHMITZBERGER, I., PLUTZAR, C., SZERENCITS, E., THURNER, B., SCHNEIDER, W., SUPPAN, F., BEISSMANN, H., HENGSBERGER, R. & G. TUTSCH 2003. Landschaftsökologische Strukturmerkmale als Indikatoren der Nachhaltigkeit - Projekt SINUS (Spatial INdices for LandUSe Sustainability). Wien, bm:bwk (CD-Rom).

ZUNA-KRATKY, T. 2000. Eagle Owl (*Bubo Bubo*) breeding in the lowland floodplain-forests in northeastern Austria. Crex 20: 43-47.

ZUNA-KRATKY, T., KALIVODOVÁ, E., KÜRTHY, A., HORAL, D. & P. HORÁK 2000. Das Klima der March-Thaya-Auen. In: Die Vögel der March-Thaya-Auen im österreichisch-slowakisch-tschechischen Grenzraum: 176-180. Deutsch-Wagram.

Contact

Christina Nagl
chrissi.nagl@aon.at

Christian H. Schulze
christian.schulze@univie.ac.at

Department of Tropical Ecology and Animal Biodiversity
University of Vienna
Rennweg 14
1030 Vienna
Austria

Karl Reiter
karl.reiter@univie.ac.at

Department of Conservation Biology, Vegetation - and Landscape Ecology
University of Vienna
Rennweg 14
1030 Vienna
Austria