Habitat Selection of Eurasian Scops Owl Otus scops on the Northern Border of Its Range, in Europe

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Habitat selection of Eurasian Scops Owl *Otus scops* on the northern border of its range, central Slovenia

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Habitat selection of the Eurasian Scops Owl *Otus scops* was studied in Ljubljansko barje (central Slovenia, 180 km^2) where abiotic conditions, especially climate, could be considered suboptimal for this xerothermophilic species. Data on the number and distribution of calling males were gathered in May and June 2004–06 using the playback method. A total of 137 calling males were counted (29 in 2004, 66 in 2005, 42 in 2006). To avoid pseudo-replication, 72 non-overlapping sites were selected for habitat analysis. Habitat within 250-m radius plots surrounding owl sites was compared with 136 unoccupied and non-overlapping sites. Within plots, 14 habitat variables were measured. Discriminating variables between occupied and non-occupied sites were identified with stepwise logistic regression. Scops Owl occupation was positively associated with the number of tree lines, and slightly negative with the surface area of woodland and settlements. Scops Owls preferred sites with a higher than average proportion of traditional orchards, tree lines, scrub, unimproved meadows, and tree plantations. Tree plantations were only used by owls during 2005, when the number of calling males was highest. All males were unpaired, perhaps indicating inexperienced or late-arriving males outcompeted to marginal habitat. Conservation actions needed to maintain this population of Scops Owl at the northern border of its breeding range include: (1) preserve and rejuvenate traditional orchards and isolated trees in farmyards, (2) encourage renovation of old houses and their farmyards and discourage high density housing, (3) protect and restore tree lines and copses, (4) enlarge the proportion of unimproved meadows, and (5) limit the increase of cropland and the use of biocides.

Key words: Scops Owl, *Otus scops*, Slovenia, habitat selection, surveys

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INTRODUCTION

In 1995, the number of breeding Eurasian Scops Owl *Otus scops* in Slovenia was estimated at 500–800 pairs (Geister 1995). The greater part of this population breeds in the Karst region (southwestern Slovenia, estimated at 300–600 pairs in 2000; Trontelj 2003) and in Goričko (northeastern Slovenia, 210 calling males in 1997; Štumberger 2000). A population of 41–59 calling males was counted on Ljubljansko barje (central Slovenia) during 1998–2003 (Denac 2003). Habitat selection in the Scops Owl has been studied in core breeding areas in Italy (Galeotti & Gariboldi 1994) and in Spain (Martínez *et al.* 2007), elsewhere only anecdotally (Arlettaz 1990, Samwald & Samwald 1992, Sárossy *et al.* 2002). Ljubljansko barje is an atypical breeding site situated on the northern border of its breeding range in Europe. The local climate is continental with higher precipitation and lower temperatures compared with areas of high Scops Owl densities in the Mediterranean. The objectives of this study were to examine habitat selection of Scops Owls in the Ljubljansko barje area and to propose measures for its conservation.

METHODS

Study area

Ljubljansko barje (180 km^2) is part of the Natura 2000 network in Slovenia and is a potential Site of Community Interest (pSCI) and a Special Protected Area (SPA). Scops Owls were surveyed on a 138.3 km2 study area in Ljubljansko barje, centred at 45°59'N, 14°26'E. The area consists of isolated hills within a surrounding plain; average elevation is 290 m a.s.l. The average annual precipitation is 1400 mm with a peak in autumn. There are regular, short-lasting floods mainly in spring and autumn. The highest average temperatures are recorded in July (19°C), the lowest in January (–2°C) (Lovrenčak & Orožen Adamič 1998). Fourteen habitat variables were quantified in this study. The percent of the entire study area, given as land use data, category descriptions (MKGP 2001) and letter codes used in this study were:

- (F) Fields (cropland) and gardens, 59.4%.
- (UM) Unimproved meadows (fertilized once per year or unfertilized, cut once or twice per year, late first cut); (IM) improved meadows (fertilized and cut 3–4 times per year, early first cut, sown grass mixtures); (WM) wet meadows (high level of underground water, grasses, sedges *Carex* sp., rushes *Juncus* sp. and horsetail *Equisetum* sp. prevailing), 18.6%.
- (W) Woods (broad-leaved, mixed and wet woods); (TP) tree plantations (mainly *Populus* hybrids); (TB) groups of trees and bushes including tree lines; (SC) scrub (*Salix* sp., *Ligustrum vulgare, Sambucus nigra, Frangula alnus*),12.3%.
- (S) Settlements (mainly rural), 7.2%.
- (WA) Waters, 1.2%.
- (M) Moors (sedges, rushes, *Eriophorum* sp.); (OML) other marshland, including peat bogs, fens, reedbeds and other marshes, 0.9%.
- (TO) Traditional orchards (high trunk trees, 90–200 trees/ha, and no biocide application); (MO) modern orchards and highbush blueberry plantations, 0.4%.

After the Second World War, the surface area of arable land increased but crop diversity decreased. Nowadays maize is the bulk crop, alternated with some wheat, oilseed rape, barley, rye and oats (Čop *et al.* 2000). Unimproved meadows include all land covered with natural vegetation that is grazed or cut with low intensity. In contrast, improved meadows are characterized by repeated use of nitrogen fertilizers and early and multiple mowing with heavy machinery. The characteristic vegetation of wet meadows consists of different species of grass, sedges *Carex* spp. and horsetail *Equisetum* spp. They are frequently flooded and have a high ground-water level throughout the year (Seliškar 1986, 2001). Some small broad-leaved and mixed woods are located on isolated hills, while others lie in the plain and are more or less wet (e.g. periodically flooded *Pseudostellario europaeae–Quercetum roboris* woods and woods on peat bog fragments; Martinčič 1987, Seliškar 2001). Tree plantations mainly consist of hybrid poplars (Lah 1965). The landuse category TB (trees and bushes) mainly stands for tree lines along drainage ditches that separate land parcels. They are <15 m wide and belong to the *Carici elongatae–Alnetum glutinosae* association (Seliškar 2001), with Common Alder *Alnus glutinosa*, poplar *Populus* sp. and willow *Salix* sp. being the most common trees. Abandoned agricultural land is overgrown with different species of bush (Trontelj 1994). Settlements include all urban and rural areas, including roads. Peat bogs, fens and reedbeds have largely disappeared from the study area due to agricultural intensification. Traditional orchards, with a density of 90–200 trees/ha and no usage of biocides, are few and small in the larger part of the study area.

Playback surveys

The study area was divided into nine survey units; transects were chosen in each unit so that full coverage was guaranteed. Fixed points along transects were spaced 500–1000 m apart, depending on the openness of the terrain. At each point we first listened for spontaneously calling owls for 1 min, then broadcasted a playback of a male call for 1 min and waited for another 3 min for a response. Thus, a total of 5 min was spent at the survey stations (Samwald & Samwald 1992). Locations of calling males and females were marked on an aerial photograph 1: 5000. Every calling owl's location was numbered and its attributes (provoked or spontaneous calling, sex, perch, height, behaviour, time of observation) were recorded. Surveys were started in May and finished by the end of the first week of June, 2004–06. Surveys began after sunset at approximately 21:30 h and were conducted on nights with no precipitation, minimal cloud cover and little or no wind.

Analysis of habitat selection

Positions of calling males were entered into geographical information system software, and a 250 m radius was created around each point. This radius was based on published estimated territory size (Sacchi *et al.*

1997). To avoid pseudo-replication, I combined all occupied sites over the years and selected 72 non-overlapping sites. Habitats within a 250-m radius surrounding the location of calling males and of 136 unoccupied and non-overlapping sites were analysed using ground-truthed landuse data (MKGP 2001). Differences between occupied and unoccupied sites were analysed by logistic regression with PROC LOGISTIC (SAS Institute 1989). I used the stepwise option with a significance level of 0.05 to find parsimonious models that explained most of the variance in the dependent variable containing the fewest number of independent variables (Miles & Shevlin 2001). The original and squared variables were put into a model in order to test for second order effects. Differences between occupied and unoccupied sites relative to the importance of the different habitat components were analysed by discriminant analysis with PROC DISCRIM in SAS (Van Nieuwenhuyse *et al.* 2004). Proportional differences between the coefficients of the occupied (o) vs. the unoccupied (u) discriminant functions were calculated as $(o–u)/u$.

RESULTS

A total of 137 calling males were detected in the study area (29 in 2004, 66 in 2005, 42 in 2006). Scops Owls on Ljubljansko barje inhabited both lowland areas and isolated hills. Their distribution was not uniform but showed three distinct aggregations with large annual fluctuations in the number of individuals recorded. The species was absent from highly urbanized areas alongside the highway Ljubljana–Vrhnika, dense woodland, and treeless areas with intensive agriculture.

The primary habitat within the 250-m circular plots surrounding 72 calling males consisted of fields (Table 1). Occupied sites were significantly different from unoccupied sites (Table 2). Tree lines had a positive impact on the probability of occupation by Scops Owls, in contrast to the area of settlements and woods (Table 2).

Table 2. Probability of occupancy by Scops Owl in relation to habitat within 72 non-overlapping occupied and 136 non-overlapping unoccupied survey plots (with a radius of 250 m); parameter estimates of the model with all original variables and their squares. Results are based on stepwise logistic regression.

Parameter	Estimate	*P*
Intercept	–0.4483	0.074
Settlements (S)	–0.00001	0.037
Trees and bushes (TB)	0.000027	0.0479
Woodland^2	–2.54 E–10	0.022

The discriminant analysis correctly predicted absence/presence of Scops Owls for 70.6% of the unoccupied sites and 65.3% of the occupied sites; the classification of the non-overlapping sites was correct in 68% of the cases. The variables that featured the largest difference in coefficient of the discriminant functions between occupied and unoccupied sites were mainly traditional orchards, trees and bushes including tree lines, scrub, tree plantations and unimproved meadows.

All traditional orchards were located next to houses. Within settlements, Scops Owls regularly called from large old trees in farmyards, which typically included Horse Chestnut *Aesculus hippocastanum*, Large-leafed Lime *Tilia platyphyllos*, Small-leafed Lime *T. cordata* and Common Ash *Fraxinus excelsior*. Approximately 50% of males were detected outside settlements and traditional orchards; these almost exclusively called from tree lines.

Table 1. Habitat components (as % of area) in 250-m radius circular plots centred on calling sites of 72 male Scops Owls (= occupied points) and 136 unoccupied points.

	Occupied plots				Unoccupied plots			
Habitat	Mean (%)	SE	Median (%)	Range (%)	Mean (%)	SE	Median (%)	Range (%)
Fields (F)	56.4	3.0	56.4	1.3–97.1	51.3	2.4	53.1	0.0–99.2
Meadows (UM, IM, WM)	20.6	2.6	12.4	0.0–93.8	19.0	1.5	14.7	0.0–90.8
Woods (W, TP, TB, SC)	13.6	1.5	9.6	0.0–47.4	14.7	1.4	9.4	0.0–69.2
Settlements (S)	7.2	1.3	1.4	0.0–44.7	12.6	1.3	5.0	0.0–78.8
Water (WA)	0.7	0.2	0.0	0.0–8.8	1.0	0.2	0.0	0.0–26.3
Wetlands (M, OML)	0.5	0.3	0.0	0.0–16.4	0.4	0.2	0.0	0.0–25.3
Orchards (TO, MO)	0.9	0.3	0.0	0.0–16.4	1.0	0.2	0.0	0.0–17.8

In 2004 (few calling males) and 2006 (medium number of calling males) no males were detected in poplar plantations. In 2005 (high numbers), several unpaired males were detected in poplar plantations surrounded almost entirely by cropland. I suspect that males calling in poplar plantations were inexperienced or late arrivals relegated to suboptimal habitats by intensive intraspecific competition during a high-abundance year.

DISCUSSION

In this study, Scops Owls showed a clear preference for a mosaic of landuse categories. Unimproved meadows are important foraging sites for Scops Owls owing to a high abundance of orthopterans which constitute the major part of this species' diet (Sarà 1990, Arlettaz & Fournier 1993, Krištín & Sárossy 2002). Many former meadows have been turned into cropland or improved meadows (Božič 2005) which were avoided. Intensive management affects the structure of meadow vegetation, thus lowering the diversity, abundance and detectability of arthropods (Bastian *et al.* 1994, Opperman 1999). Horse breeding, which results in less intensive use of grasslands (Tome 2000), has regained its popularity on Ljubljansko barje. In Switzerland, extensive pastures and orchards with grazing cattle and horses are crucial foraging habitats of Scops Owls (Arlettaz 1990).

Table 3. Results of discriminant analysis to determine the proportional differences (prop-diff) between unoccupied (0) and occupied (1) plots.

Variable		0	1	Prop-diff
Constant		-9573	-9588	
TO	Traditional orchards	0.0984	0.0986	0.14
TB	Trees and bushes	0.0981	0.0982	0.13
SC	Scrub	0.0983	0.0984	0.13
TP	Tree plantations	0.0979	0.0981	0.12
UM	Unimproved meadows	0.0971	0.0972	0.11
WM	Wet meadows	0.0972	0.0972	0.08
F	Fields and gardens	0.0982	0.0983	0.08
IM	Improved meadows	0.0983	0.0983	0.07
W	Woodland	0.0983	0.0983	0.07
S	Settlements	0.0977	0.0977	0.06
M	Moors	0.0984	0.0985	0.06
OML	Other marshy land	0.1620	0.1621	0.05
WA	Water	0.0982	0.0982	0.01

In 2000, a Scops Owl nest was found in an apple tree hollow (T. Mihelič, pers. comm.). During this study, another six owl nests were located: two in traditional orchards and four in tree lines. The extent of traditional apple orchards, however, has declined from 268 ha in 1965 to 41.2 ha in 2001 (Lah 1965, MKGP 2001). People are replacing traditional orchard trees with trees that remain dwarfish and never develop tree cavities, resulting in the gradual disappearance of traditional orchards from Ljubljansko barje. Male owls outside settlements used tree lines as calling perches and as nesting habitat. Most of the once-common pollared willow tree lines have been cut and those remaining are in the final stages of decay. Many tree lines are being cut or thinned because of urbanization or for firewood. The loss of breeding habitat represents a serious threat to Scops Owls in Ljubljansko barje, as elsewhere (e.g. in Austria, Samwald & Samwald 1992).

Regarding abiotic (amount of precipitation, average annual temperature) and phytocenological conditions, Ljubljansko barje differs strongly from typical Scops Owl habitats in the Mediterranean, the latter represented by rocky slopes with xerothermophylic vegetation and extensively managed grasslands (Galeotti & Gariboldi 1994, Vrezec 2001, Marchesi & Sergio 2005). In the Mediterranean, the species reaches high densities (e.g. 2.4–3.3 calling males/km^2, Benussi *et al.* 1997). In my study area, habitat selection is more similar to that observed in continental Europe (Switzerland, Slovakia, Austria), where the species inhabits traditionally-farmed mosaic landscapes with numerous large trees and copses (Arlettaz 1990, Samwald & Samwald 1992, Sárossy *et al.* 2002). Densities are rather low in my study area (0.3–0.4 males/km^2, Denac 2003), which might reflect suboptimal breeding conditions.

In this study, woodland and settlements had a negative impact on occupation by Scops Owls. Males used groves on isolated hills as calling perches, and possibly as breeding sites, but they avoided wet forests and larger woods in the surrounding flat plains, possibly because of predation pressure from the Tawny Owl *Strix aluco* (Sarà 1990, Galeotti & Gariboldi 1994, Marchesi & Sergio 2005). Males were also recorded in settlements but only in parts with unpaved farmyards, with large trees, barns and small traditional orchards. Large trees in farmyards, prone to developing cavities (Sárossy *et al.* 2002), are often polled or removed due to their age and urbanization. Ljubljana, the capitol of Slovenia, is close to Ljubljansko barje and urbanization pressure is high. Most houses erected in the past 15–20 years are built close together with paved areas in

between and are landscaped with non-indigenous ornamental shrubs that are regularly trimmed. Scrubland is unsuitable as feeding or breeding habitat for Scops Owl but it might serve as occasional roosting sites (D. Denac, pers. comm.).

Management recommendations

Based on habitat analysis and observations made during this study, the following conservation measures for Scops Owls in Ljubljansko barje are recommended:

(1) Preserve and rejuvenate traditional orchards and isolated trees on farmyards.
(2) Promote renovation of old houses with their characteristic farmyards over building new ones.
(3) Prevent large habitat parcels from being divided into smaller ones and from being declared as building areas.
(4) Prevent the loss of tree lines and copses and revitalize pollared willows.
(5) Increase the proportion of unimproved meadows and decrease that of cropland and/or improved meadows.
(6) Diversify crops and limit the use of biocides.

The Scops Owl was assessed as 'Depleted' by BirdLife International because its European population has not yet recovered to the level that preceded its decline between 1970–90 and because it has further declined in some countries between 1990–2000 (BirdLife International 2004, Burfield 2008). Bird populations that live on the border of their breeding range are susceptible to any deterioration in breeding habitat (Hanski 1999). All suitable habitats used by Scops Owl in my study area are experiencing strong negative impacts which will likely reduce its population size in the near future. Based on the precautionary principle, we should implement the above conservation measures for this Natura 2000 species.

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SAMENVATTING

In het onderhavige onderzoek wordt de habitatselectie door de Dwergooruil *Otus scops* in het midden van Slovenië onderzocht, waar de abiotische omstandigheden voor deze warmte- en droogteminnende soort suboptimaal zijn. In mei en juni 2004–06 werden gegevens over het aantal en de verspreiding van roepende mannetjes verzameld door middel van het afspelen van de roep van deze uilensoort. In totaal werden 137 roepende mannetjes geteld. Het habitat binnen een cirkel met een straal van 250 m rond elke roepplek werd vergeleken met het habitat op 136 plekken die niet door uilen waren bezet. In elke cirkel werd het habitat op basis van 14 variabelen gekarakteriseerd. Het voorkomen van Dwergooruilen bleek positief gecorreleerd te zijn met het aantal windsingels en zwak negatief met de oppervlakte aan bosjes en bebouwing. De Dwergooruil had een voorkeur voor plekken met relatief veel boomgaarden die nog op een traditionele wijze worden bewerkt, windsingels, bosschages, niet-intensief bewerkte graslanden en productiebos. Aangelegd productiebos werd alleen in 2005 bezet, toen het aantal roepende mannetjes erg hoog was. In dit habitat werden alleen ongepaarde vogels aangetroffen. Mogelijk betrof het hier onervaren of laat aangekomen vogels die naar marginale plekken waren verdrongen. Als beschermingsmaatregelen die nodig zijn om de Dwergooruil langs de noordkant van het verspreidingsgebied te behouden worden genoemd: (1) behoud en onderhoud van traditioneel bewerkte boomgaarden en van losstaande bomen op erven, (2) renovatie van oude huizen en omringende boerenerven en het voorkomen van verdichting van bebouwing, (3) beschermen en herstellen van windsingels, (4) stimuleren van niet-intensief bewerkt grasland en (5) afremmen van het verbouwen van akkergewassen en het beperken van het gebruik van landbouwbestrijdingsmiddelen.

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