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AREA REQUIREMENTS OF PASSERINE BIRDS IN THE REED ARCHIPELAGO OF LAKE VELENCE, HUNGARY

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I studied the area requirement of reedbed breeding passerine birds on 109 reed islands in Lake Velence, Hungary, in the breeding seasons of 1993 and 1994. The size of the smallest occupied reed island for the observed 8 passerine bird species varied from 0.02 ha (Savi's Warbler *Locustella luscinioides*) to 4.14 ha (Bluethroat *Luscinia svecica*). Three species occupied reed islands which were 8–18 times larger than their territory sizes (Sedge Warbler *Acrocephalus schoenobaenus*, Moustached Warbler *A. melanopogon*, and Bluethroat), three species occurred on reed islands 4–4.5 times larger than territory sizes (Great Reed Warbler *A. arundinaceus*, Reed Warbler *A. scirpaceus*, and Reed Bunting *Emberiza schoeniclus*), and two species occurred on islands half the size of their territory sizes in continuous reedbeds (Bearded Tit *Panurus biarmicus*, Savi's Warbler). This may suggest that the latter two species can utilise groups of small patches within a territory. The incidence functions showed that the probability of occurrence of the Moustached Warbler and the Bluethroat was not 1 even on the largest reed islands (7–25.7 ha), while it was 1 for the other 6 species. The importance of landscape matrix type in determining minimum area requirements was demonstrated using data on the occurrence of bird species in reed marshes within an agricultural landscape in the Po Plain (Italy). In this landscape much larger minimum areas were found than at Lake Velence.

Key words: incidence function, area sensitivity, edge effect, landscape matrix

INTRODUCTION

The most effective way to conserve a species is to preserve it in original habitats. Different species need different areas of suitable habitat for survival, thus, conservationists should know the minimum area required for an individual of a given species to establish a territory. (Note that there are other definitions of minimum area, see e.g. BARKMAN (1989).) Several such studies have been conducted mainly for forest bird species (e.g. LYNCH & WHITCOMB 1978, HAYDEN *et al.* 1985, WILCOVE *et al.* 1986, THIOLLAY 1989, HINSLEY *et al.* 1994, VANCE *et al.* 2003, but see WINTER & FAABORG 1999 for grassland nesting birds), which led to the identification of area sensitive species. Several cases, however, have shown no clear relationships or different results on area sensitivity (HINSLEY *et al.* 1995, JOHNSON & IGL 2001). Nevertheless, identifying area sensitive species is useful in nature conservation; presence or absence of such species may indicate whether a habitat patch is over a required threshold or not (e.g. ZANETTE 2000).

Studies on minimum area requirements of birds assume that the minimum area is a continuous patch of habitat. However, birds can utilise more than one suitable habitat patches within their territories. The crossing of a gap of few ten meters can regularly occur, although it depends on species, landscapes and conditions (DESROCHERS & HANNON 1997, HINSLEY 2000, HARRIS & REED 2002). Therefore, minimum area requirement may also depend on the structure of the habitat.

An urgent task is to determine area requirements of birds in reedbed habitats, because reedbeds have seriously declined in most parts of Central and Western Europe (OSTENDORP 1989, POULIN 2001), as have the populations of many reed bird species (e.g. BIBBY & LUNN 1982, GRAVELAND 1998, TYLER *et al*. 1998, FOPPEN *et al*. 1999, MUSIL 1999).

In this study I present results on minimum area requirements of reedbed nesting passerine birds in a reed archipelago in Hungary, and I evaluate the "patchiness" of the minimum reed area required for the species.

STUDY AREA AND METHODS

I censused birds in the reed archipelago of Lake Velence, Hungary (24 km^2, 47°10'N 18°32'E) on 109 reed islands (average area: 1.74±3.2 ha; area range: 0.0025–25.7 ha) in April and May in 1993 and 1994, for a total of four visits per site (more details: BÁLDI & KISBENEDEK 2000). All reed islands, which were not on the lake bank were surveyed. The vegetation was homogeneous reed stands, standing in water. All birds seen on heard were recorded. I classified an island as occupied, if the species was recorded in both years on it. This restriction was necessary, because I tried to assess the area of 'typical' reed islands for each species, and this procedure reduced the variance resulting from ephemeral colonisation of marginal quality islands.

I investigated the minimum area necessary for the occurrence of species by comparing the smallest and the average area of occupied reed islands, and the territory sizes of each species. The latter was taken from the CD edition of the 10 volume comprehensive books on the birds of the Western Palaearctic (SNOW & PERRINS 1998). The necessary size for reed islands to provide habitat for each species was determined by the incidence functions (WHITTAKER 1998, p. 197). I grouped the 109 reed islands arbitrarily into 9 size classes, where the number of reed islands was similar: <0.024 ha (13 islands); 0.025–0.099 ha (14); 0.1–0.19 ha (12); 0.2–0.39 ha (15); 0.4–0.79 ha (10); 0.8–1.49 ha (18); 1.5–2.9 ha (11); 3.0–6.9 ha (11); >7 ha (5). The percent of occurrence in each size class was plotted against area.

RESULTS

Altogether I have 2090 records of 8 reedbed passerine bird species at the Lake Velence reed archipelago (Table 1). Other recorded species were not reedbed breeding passerines. The minimum area of occupied reed islands varied two orders across species, from 0.02 ha to 4.14 ha. The average areas of occupied reed islands showed similar pattern (Table 1). I compared the smallest occupied reed island area with territory sizes for each species. This analysis revealed that the Great Reed and Reed Warblers, and the Reed Bunting used a reed island only if it was 4–4.5 times larger than the territory size. The Sedge and Moustached Warblers and the Bluethroat required even larger reed areas for territory establishment (Table 1). Surprisingly, the Savi's Warbler and Bearded Tit occupied reed islands of half the size of their usual territories. This may indicates that the territory of these two species can incorporate more than one reed islands, whereas other species did not tolerate fragmented habitat within a territory. This pattern is also present in the size of smallest occupied reed islands. For the Savi's Warbler and Bearded Tit the smallest reed islands were at least one order smaller than for other species (Table 1). The Bluethroat, and to a lesser extent Sedge and Moustached Warblers were found to be good indicators of large reed islands at Lake Velence (Table 1).

The incidence functions of six out of the eight species (i.e. except for the Bluethroat and the Moustached Warbler) reached 100% (Fig. 1). This indicates that these species occur always on large reed islands. The incidence of the Bluethroat and the Moustached Warbler did not reach 100%, therefore, their presence cannot expect for sure even on large reed islands. This result strengthen the validity of using these species to indicate area effect in reed habitats.

Table 1. Number of observations, number of occupied islands (No. isl.), area of the smallest reed island in which the given species occurred (Smallest), the average area of occupied islands (Average) and the smallest territory sizes of each species (Territory). (All areas are in ha.)

Species		Obs.	No. isl.	Smallest	Average	Territory
Great Reed Warbler	*Acrocephalus arundinaceus*	226	25	0.17	5.62±6.35	0.04
Reed Warbler	*Acrocephalus scirpaceus*	377	32	0.11	5.52±6.4	0.025
Reed Bunting	*Emberiza schoeniclus*	142	21	0.32	7.64±7.37	0.07
Savi's Warbler	*Locustella luscinioides*	337	18	0.02	6.4 ±7.32	0.038
Bearded Tit	*Panurus biarmicus*	423	37	0.03	4.49±6.14	0.05
Sedge Warbler	*Acrocephalus schoenobaenus*	460	27	0.75	5.59±6.24	0.09
Bluethroat	*Luscinia svecica*	73	5	4.14	12.52±4.59	0.45
Moustached Warbler	*Acrocephalus melanopogon*	52	5	0.64	7.89±6.09	0.035
Total		2090		0.0025	1.74±3.2	

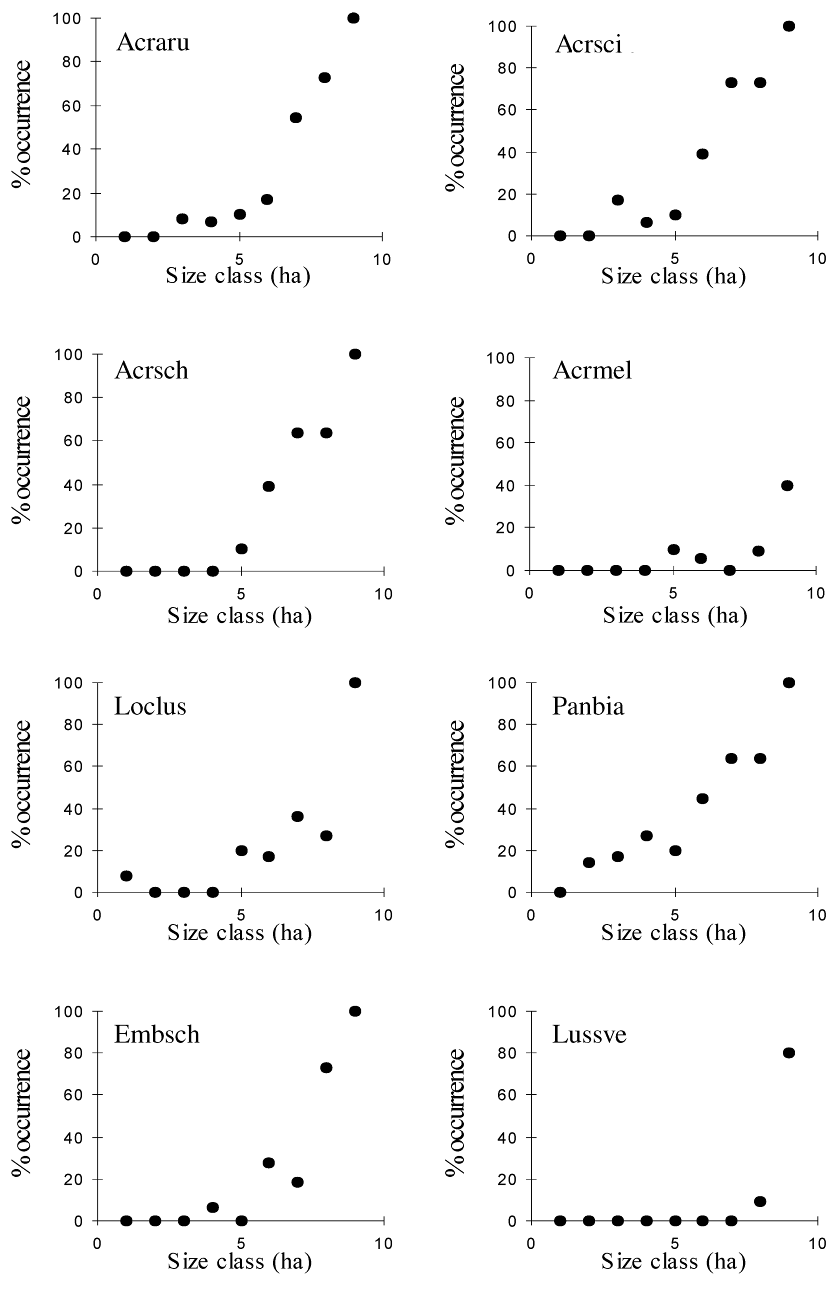

Fig. 1. Incidence functions of the 8 passerine bird species observed on the 109 reed islands at Lake Velence, Hungary. Abbreviations: Acraru = *Acrocephalus arundinaceus*, Acrsci = *A. scirpaceus*, Acrsch = *A. schoenobaenus*, Acrmel = *A. melanopogon*, Loclus = *Locustella luscinioides*, Panbia = *Panurus biarmicus*, Embsch = *Emberiza schoeniclus*, Lussve = *Luscinia svecica*

DISCUSSION

I found that the eight reedbed breeding passerine bird species required different minimum areas related to their territory sizes in the reed archipelago at Lake Velence. The Bluethroat was identified as the most area sensitive species, occurring on large reed islands (>4.14 ha), while the Bearded Tit and the Savi's Warbler occurred on rather small islands (>0.03 ha and > 0.02 ha, respectively). These differences may be due to an edge effect, which could play a major role in the archipelago via microclimate and vegetation edge effects (BÁLDI 1999). I found that reed edges support denser reed stands than interiors (BÁLDI 1999), which probably provide better nesting and foraging sites (HOI *et al.* 1995). This hypothesis is indirectly supported by the preference for the first few meters of reedbed edges by the Great Reed Warbler, Reed Warbler, Savi's Warbler, Bearded Tit and the Sedge Warbler (BÁLDI & KISBENEDEK 1999). However, Great Reed Warblers even preferred 3–6 m wide long strips of reeds in small channels, which seem to be edge-like habitats (MOSKÁT & HONZA 2000, 2002). Only the Bluethroat avoided edges, while the Reed Bunting did not show any preference (BÁLDI & KISBENEDEK 1999). (The Moustached Warbler was not included into the edge effect study due to small sample size.)

The reliability of area requirements found in this study needs spatial repetition. I used data of CELADA and BOGLIANI (1993 and pers. comm.), who studied reed marshes in the agricultural landscape of the Po Plain, Italy. The difference in minimum area requirements of the four common species (Great Reed Warbler, Reed Warbler, Savi's Warbler and Reed Bunting) at Lake Velence and the Po reed marshes were large: the average size of reed patches at the Po area was two times larger for the Great Reed Warbler and Reed Bunting, three times for the Reed Warbler, and four times for the Savi's Warbler. This may be a consequence of the landscape matrix around reed patches, and the edge between the two habitats. While at Lake Velence edge lines were sharp, in an agricultural landscape the reed stands gradually change to drier vegetation. Edge preferences are different if the edge vegetation structure is different; we showed that in gradual edge the Great Reed Warbler and Savi's Warbler avoided edges, the Sedge and Reed Warblers showed a weak edge preference, and the Reed Bunting also performed edge preference (BÁLDI & KISBENEDEK 1999). Therefore, a possible explanation for the different minimum reed patch area requirement of birds in the two different landscapes may be the different edge preference is due to different vegetation structure. While edges are attract birds in the lake ecosystem, in the agricultural system the attraction is weaker, and avoidance is also present. These results suggest that landscape characteristics influence the breeding of reed birds (e.g., MOSKÁT & HONZA

2000), therefore, landscape structure, the type of the matrix must also be included for the determination of area requirements (WIENS 1994, NORTON *et al*. 2000, JOHNSON & IGL 2001).

Which species are the best indicators for area effect in reedbeds? Based on the Lake Velence study, I could recommend the Moustached Warbler and the Bluethroat. If these species occur in a reedbed, then it should be considered as sufficiently large for territory establishment of other reedbed passerines, as well. However, minimum area requirements of birds seems to vary among habitats, species and landscapes (JOHNSON & IGL 2001), and may change in time, as well, thus the generalisation must be done with caution. Any minimum area requirement study is only reliable if it uses several methods to determine area requirements (e.g. evaluation of areas of occupied habitat islands, incidence functions), and if it controls for the landscape. Evaluation of the landscape structure should be an inevitable part of minimum area requirement studies.

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