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Wood occupation and area requirement of the Great Spotted Woodpecker *Picoides major* in Rome (Central Italy)

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Abstract. This study was carried out in Rome city from 1991 to 1999. In a total of 47 urban parks and suburban woods, 22 wooded areas were occupied by Great Spotted Woodpeckers during the breeding period. All woods greater than 50 ha in area were occupied by woodpeckers. On a five year scale, territorial stability was positively correlated with woodland size. The requirement of wooded area per territory was slightly higher in urban parks (6.7 ± 2.7 ha, $n = 10$ wooded areas) than in suburban woods (5.7 ± 1.3 ha, $n = 5$), and was negatively correlated to the vegetation cover. The area of woodland per territory in Rome was higher than in neighbouring deciduous oak woods. This suggests that urban habitats are of inferior quality for breeding Great Spotted Woodpeckers, probably owing to features of their vegetation and their isolation from other woodland patches. Maintaining mature stands of natural vegetation with old and dead trees in larger urban parks could be useful to encourage the occurrence of Great Spotted Woodpecker in cities.

Key words: Great Spotted Woodpecker, *Picoides major*, distribution, breeding density, woodlot size, urban green areas

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INTRODUCTION

At a local scale, the typical habitat for a bird species appears as a mosaic of suitable patches scattered in an unsuitable landscape. Distribution and size of patches have been described as the main variables affecting bird distribution, breeding density, territory size, defence level, reproductive output, and feeding habits (e.g. Opdam & Schotman 1987, Galeotti 1994, Opdam 1994, Hinsley et al. 1996, Bellamy et al. 1998, Matthysen & Adriaenssen 1998). In rural landscapes, the effect of fragmentation on bird populations was studied especially using woodland Passerines as models (e.g. Matthysen et al. 1995, Hinsley et al. 1996, Bellamy et al. 1998, Jansson & Angelstam 1999, Jansson & Saari 1999). Urban landscape is considered a mosaic composed of several patches of different habitats (e.g. Gilbert 1989). The influence of fragmentation on city birds was rarely pointed out (e.g. Gilbert 1989, Hansson 1992, Galeotti 1994, Renman & Morberg 1994). The ecology of woodpeckers, typ-

ical wood colonisers, was extensively studied in Northern Europe, especially focusing on habitat quality, nesting site preferences, area requirement and wood size relationships (e.g. Wesolowski & Tomialojć 1986, Hansson 1992, Wiklander et al. 1992, Angelstam & Mikusiński 1994). The Great Spotted Woodpecker is a resident species inhabiting mixed deciduous forests and park-like anthropogenically formed habitats (Cramp 1985, Hansson 1992, Yamauchi et al. 1997) and poorly known in the Mediterranean basin (Flade 1997). In this work the Great Spotted Woodpecker distribution in urban Rome in relation to wood size and vegetation features was analysed.

STUDY AREA AND METHODS

Study area

The study was carried out in urban and suburban Rome ($41^{\circ}53'N$, $12^{\circ}28'E$) from March 1991 to July 1999. Vegetation of gardens and city parks

includes pines *Pinus pinea*, cypresses *Cupressus sempervirens*, cedars *Cedrus* sp., as well as isolated oaks *Quercus* spp. Suburban areas include open lands and small woodland patches, generally composed of mature stands of termophilous oaks (e.g. *Quercus ilex*, *Q. suber*). For details on the study area see Bruno & Blasi (1987), Attorre et al. (1998), and references therein.

Census methodology

To study the distribution (i.e. presence or absence) of Great Spotted Woodpeckers, 30 urban parks and 17 suburban woodlots were chosen. A 100 m-wide transect of variable length was established in each census plot (see Salvati & Manganaro 1999), following Jarvinen & Vaisanen (1977). At least 6 visits per transect were performed each year from April 1991 to June 1996 and from December 1991 to February 1996.

To study breeding density, we chosen 9 plots representing the widest size range of wood areas (3.5–83.8 ha) among all woodlots sampled. Territories were mapped within each plot from March to June throughout the study period, performing at least 4 visits per season in small woods (< 50 ha), at least 5 visits in larger woods (> 50 ha). All woodpecker observations were recorded on 1:10 000 maps. Territory occupation was confirmed by observations of territorial displays, and by listening to alarm calls, drumming and other vocalisations (Smith 1987). Some nests and drumming-posts, generally nearby nest-trees (Cramp 1985), were also located in each breeding period. A territory was regarded as occupied if a nest was found, or when two independent observations of at least one territorial bird in a limited area were made during the same breeding period (Tjernberg et al. 1993). Contemporary observations of two or more territorial woodpeckers allowed to confirm the occupation of different neighbouring territories. As distances of neighbouring woodpecker nests are sometimes extremely low, a census protocol based on territory mapping may give a biased estimation of breeding density. Although we did not search extensively the nest place in each territory sampled, the high density recorded in some suitable woodlots (Table 1) provide an indirect evidence that the census methodology we adopted reduces the likelihood that any territorial woodpecker was missed.

The maximum number of (independent) territories observed during the study period, irrespective of their breeding status (e.g. pairs or single birds), was used to calculate wooded area per ter-

Table 1. Requirement of wooded area per territory in nine woodlots of Rome. a — small urban garden, b — ancient park, c — termophilous wood (e.g. *Quercus ilex*), d — mesophilous wood (e.g. *Q. cerris*).

	Habitat	ha/n	n
Parco dei Fori	a	3.57	1
Villa Sciarra	a	5.97	1
Villa Celimontana	a	6.43	2
Villa Maraini	a	4.15	2
Villa Glori	b	7.11	3
Orto Botanico	b, d	4.36	3
Infernaccio	c	6.33	3
Torretta Massimi	c	6.02	3
Villa Pamphili	b, c	5.38	7
Villa Borghese	b	10.48	8
Acquatraversa	c, d	6.08	10

ritory defined as the wooded area divided by the total number of territories recorded. Considering that also in continuous woodlands some territories can be partially overlapping or there might be small areas not occupied by woodpeckers (e.g. Smith 1987, Tjernberg et al. 1993), wooded area per territory may not coincide with territory size. The occupancy level (i.e. the number of years during which the same territory was occupied) was measured on a five year scale (1992–1996) in 8 small woods supporting only one woodpecker territory. A territory was regarded as stable when occupied for at least 3 consecutive years.

Habitat variables

The following vegetation parameters were recorded on the whole area of the nine census plots in which breeding density was studied:

1) proportion of gardens (including stands of exotic or introduced species, such as *Eucalyptus* sp., *Robinia pseudoacacia*, and *Pinus pinea*);

2) ancient parks (mainly represented by stands of *Platanus* sp., *Tilia* sp., and mixed oaks *Quercus* spp.);

3) termophilous woods (e.g. stands of *Q. ilex* and *Q. suber*);

4) mesophilous woods (e.g. *Q. cerris*);

5) vegetation cover — a phytosociological rank index of tree density (see Bruno & Blasi 1987).

Vegetation data were obtained by inspections in each woodlot, and using vegetation maps (Bruno & Blasi 1987). Vegetation structure was measured within the nine woodlots within occupied territories. Vegetation plots were located at random, for a total of 27 plots sampled. The number of plots in each woodlot was determined according to the size of the woodlot itself. We

sampled vegetation using a modification of the circular sample-plot method (James & Shugart 1970). For each plot, we recorded the following information: tree (woody plants more than 2.0 m tall) density, height (using a clinometer), and diameter at breast height (using a dbh measuring tape) within a 20 m radius circular plot.

Statistics

The relationship between wood size and the presence of the Great Spotted Woodpecker was calculated by logistic regression analysis (Hinsley et al. 1996). Briefly, for each woodlot, the species was scored as 0 or 1 to represent the binary dependent variable (i.e. presence or absence). Wood size was the independent variable. The incidence function (i.e. the relationship between the probability of breeding and woodland area) was then constructed from the logistic equation.

The Mann-Whitney U-test (U values converted to a z score) was used to compare occupancy level in urban parks and suburban woods as well as to test differences in wooded area per territory between the two habitats. Spearman Rank Correlation tests were performed to identify habitat variables correlated to the wooded area per territory. A pairwise non-parametric correlation analysis was preferred to a multiple regression analysis due to the deviation of all vegetation variables from the normal distribution. In Spearman correlations we used the average value of tree density, height, and trunk diameter recorded in different vegetation plots in each woodlot. All statistics were performed by STATISTICA 4.5 (Statsoft Inc. 1993) PC package using a minimum probability level of $p < 0.05$. Results were given as mean \pm standard deviation (SD).

RESULTS

Out of a total of 47 study areas, 8 urban parks and 13 suburban woods were occupied by at least one woodpecker territory. The logistic regression analysis indicates an occupation probability of 1.0 for wood fragments larger than 50 ha (Fig. 1). The regression equation is

$$Y = e^{-1.28+0.11x} / 1 + e^{-1.28+0.11x}$$

On a five year scale, territory reoccupation was similar in urban parks (3.4 ± 1.8 years, $n = 5$ territories) and in suburban woods (2.2 ± 1.5 , $n = 4$).

Differences between parks and woods were not

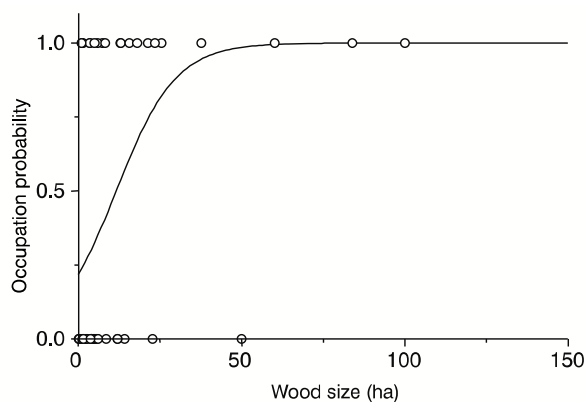


Fig. 1. Relationship between woodlot size and occupation probability in urban Rome from a logistic regression model during the breeding season. The regression equation is $Y = e^{-1.28+0.11x} / 1 + e^{-1.28+0.11x}$ (see methods for details).

significant (breeding season: $z = -1.1$, $p = 0.26$, $n = 9$; winter: $z = -0.3$, $p = 0.77$, $n = 11$). The relationship between occupancy level and wood size was highly significant ($r_s = 0.89$, $p < 0.001$, $n = 9$).

Wooded area per territory (Table 1), ranging from 3.5 ha to 10.5 ha, was low in both urban parks (6.7 ± 2.7 ha, $n = 10$) and suburban woods (5.7 ± 1.3 ha, $n = 5$). The difference between the two habitats was not significant ($z = -0.5$, ns , $n = 15$). Consequently, the breeding density calculated in a 1 km² area of continuous habitat was similar in urban parks (17.1 ± 6.3 territories/km²) and in suburban woods (18.6 ± 5.8 territories/km²). Wooded area per territory was negatively correlated to vegetation cover ($r_s = -0.84$, $p = 0.005$, $n = 9$), and not correlated to the proportion of gardens ($r_s = 0.60$, ns , $n = 9$), ancient parks ($r_s = -0.06$, ns , $n = 9$), termophilous woods ($r_s = 0.45$, ns , $n = 9$), mesophilous woods ($r_s = -0.07$, ns , $n = 9$), as well as to mean tree density ($r_s = -0.05$, ns , $n = 9$), height ($r_s = -0.47$, ns , $n = 9$), and diameter at the breast height ($r_s = -0.03$, ns , $n = 9$).

DISCUSSION

The Great Spotted Woodpecker colonises gardens, parks, cemeteries and suburban woods in many European cities (Luniak 1990, 1996, Kostantinov et al. 1996, Flade 1997), but urban populations generally show lower densities than those recorded in rural woods (Flade 1997).

The requirement of mature stands of deciduous vegetation, used as optimal nest sites (Cramp 1985, Smith 1987), affects the distribution of Great

Spotted Woodpeckers in breeding season. Furthermore, territory reoccupation, although rather similar in both habitats studied, is correlated to the wood size, which should be regarded as an important variable affecting population stability of this woodpecker.

Wooded area per territory, ranging from 3.5 to 10.5 ha, is affected only by vegetation cover. Generally, high vegetation cover provides a more suitable habitat for woodpeckers, increasing population density and reducing mean territory size (Smith 1987, Rolstad et al. 1995). Wooded area per territory was slightly higher in urban parks than in suburban woods. This confirms that city gardens are generally low-quality habitats for woodpeckers. Interestingly, estimated wooded area per territory in Rome was comparable to the area requirement indicated for a woodpecker pair in Stockholm (5–10 ha, Renman & Mortberg 1994).

Woodpecker density was generally lower in Rome than in mature ash-elm-cherry and beech German forests — ca. 20 breeding pairs/km² (Flade 1997) and in mature lowland oak woods of central Italy — up to 30 breeding pairs/km² (Bernoni & Ianniello 1989). In those habitats, mature vegetation with old and dead trees may provide optimal resources for Great Spotted Woodpeckers (Smith 1987, Rolstad et al. 1995), generally not available in inner cities.

In conclusion, our results suggest that breeding conditions in urban areas are worse than in rural woods, whilst the former is likely a more suitable habitat for wintering. In fact, good wintering conditions may play a role in attracting birds to breed in sub-optimal habitats, as was observed for the Great Tit *Parus major* (Horak 1993). The occurrence of Great Spotted Woodpeckers in cities should be encouraged by maintaining natural vegetation with old and dead trees in larger urban parks. It should be tested if nest-box provision allows breeding woodpeckers in small urban gardens, where the lack of old trees seem to be a limiting factor for the species (Smith 1987, Rolstad et al. 1995).

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STRESZCZENIE

[Zależność między wielkością obszaru zadrzewionego a występowaniem dzięcioła dużego w Rzymie]

Badania prowadzono w latach 1991–1999. Zbadano łącznie 47 parków miejskich i podmiejskich lasów. W 22 z nich stwierdzono występowanie dzięcioła dużego w sezonie lęgowym. Wszystkie obszary zadrzewione większe niż 50 ha były wykorzystywane przez dzięcioły (Fig. 1). W skali pięcioletniej stwierdzono, że stabilność zajmowania terytoriów lęgowych była skorelowana z wielkością lasu. Wielkość obszaru zadrzewionego przypadająca na terytorium była podobna dla parków miejskich i lasów podmiejskich (Tab. 1). Przeliczając uzyskane wyniki na 1km² ciągłego lasu stwierdzono, że zagęszczenia dzięciołów były tylko nieznacznie mniejsze w parkach miejskich (17.1 ± 6.3 terytorium/km², n = 10), niż w lasach podmiejskich (18.6 ± 5.8 terytorium/km², n = 5). Zagęszczenia ptaków były mniejsze w Rzymie niż w okolicznych lasach dębowych, co sugeruje, że parki miejskie są dla dzięcioła dużego środowiskami o gorszej jakości, prawdopodobnie w związku z rodzajem roślinności i izolacją od innych płatów leśnych.

Utrzymywanie naturalnych zespołów roślinnych ze starymi i martwymi drzewami w większych parkach miejskich może być sposobem na zwiększanie częstości występowania dzięcioła dużego w tym środowisku.