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Habitat preferences of the Lesser Spotted Woodpecker *Dendrocopos minor*

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We analysed the habitat preferences of Lesser Spotted Woodpeckers *Dendrocopos minor* in deciduous stands relative to forest type, snag density, tree age, area of the stand and latitude. Data were collected in 1985–1988 in 104 census areas, each of 200 ha, in south and central Sweden. We compared the stands with and without observations of the species using log-linear modelling, with the area of the stands as a covariate.

We found that the Lesser Spotted Woodpecker preferred stands with many snags ($P = 0.0004$) and old stands ($P = 0.011$), while it avoided stands without snags ($P = 0.0011$) and with mixed coniferous / deciduous forest ($P = 0.00004$). Whether the area of the stand was less than or greater than the median size was less important ($P \approx 1$). The preferences were the same in all the different regions studied ($P \approx 1$).

We regard snag density, stand age and forest type as good indicators of the habitat preferences of the the Lesser Spotted Woodpecker. Since these variables are easily measured in the field, they may serve as a starting-point for preservation of the habitats of the species.

1. Introduction

Wiktander et al. 1992 described the factors influencing the occurrence of the Lesser Spotted Woodpecker in large heterogeneous, forest-dominated areas. They found that the species needed large expanses of deciduous woods to occupy an area. In this paper we are concerned with the factors determining which stands, within the home-range of the Woodpeckers, are utilised more than others. That is, the habitat preferences at a local level.

The habitat preferences of the Lesser Spotted Woodpecker have been described in some earlier papers. Alatalo (1978) concluded that the species preferred deciduous forests and particularly birch-dominated woods in Finland. In Poland also, Wesolowski and Tomiałojc (1986), found a preference for pure deciduous woods. In Germany Spitznagel (1990) showed that the Lesser Spotted Woodpecker preferred oak-elm and willow woods, particularly on wet land. He also concluded that forestry — thinning or clear-felling of natural forests and plantation of exotic species

— had a negative impact on the Lesser Spotted Woodpecker.

Our aim in this study is to specify the variables that reflect the home-range habitat preferences of the Lesser Spotted Woodpecker, in the hope that our findings can serve as a starting-point for the preservation and creation of habitats important to the species.

2. Methods

2.1. Fieldwork

This study is based on the same material as was used by Wiktander et al. (1992), and for the basic description of the fieldwork the reader is referred to that paper.

This study includes only those 104 census areas in which Lesser Spotted Woodpeckers have been observed at least once. In total, 1453 deciduous stands were defined in these census areas. Each stand was referred to a specific forest type and classified by age, snag density and latitude (Table 1). The median stand area was 2 ha (range 0.1–129 ha). The stands were categorised as smaller than the median and equal to or greater than the median (Table 1).

The census areas were searched for Lesser Spotted Woodpeckers three to nine times in winter — early summer, between November and June. All the defined stands were searched at a constant rate per hectare.

2.2. Analysis

When analysing the habitat preferences of the Lesser Spotted Woodpecker, we used log-linear modelling (e.g. Norusis 1990), which is in effect

Table 1. The variables used in the analysis and their abbreviations and descriptions.

Variable	Abbreviation	Description
Occurrence		No occurrence: No observation in the stand during any visit Occurrence: One or more observations on at least one visit
Forest type	NEM	Nemoral deciduous wood and pasture; mainly dominated by oak *Quercus robur / petraea*, but also containing beech *Fagus sylvatica*, ash *Fraxinus excelsior*, lime *Tilia cordata*, elm *Ulmus glabra*, maple *Acer platanoides* and hornbeam *Carpinus betulus.*
	NON	Non-nemoral deciduous wood and pasture, dominated by tree species other than nemoral deciduous, mainly birch *Betula verrucosa / pubescens* or aspen *Populus tremula.*
	RIP	Riparian wood; wet forest adjacent to lakes or streams
	MAR	Marsh wood with alder *Alnus glutinosa / incana* and birch *Betula verrucosa / pubescens*
	MIX	Mixed wood with coniferous (25–60%) and deciduous (40–75%) trees
Stand age		Mean tree age in stand <30 years Mean tree age in stand 30–75 years Mean tree age in stand >75 years
Snag density		No deciduous snags ≥15 cm DBH 1–10 deciduous snags ≥15 cm DBH / ha >10 deciduous snags ≥15 cm DBH / ha
Area		<2 ha (i.e. less than the median) ≥2 ha (i.e. greater than or equal to the median)
Latitude		56–58°N 58–59°N 59–62°N

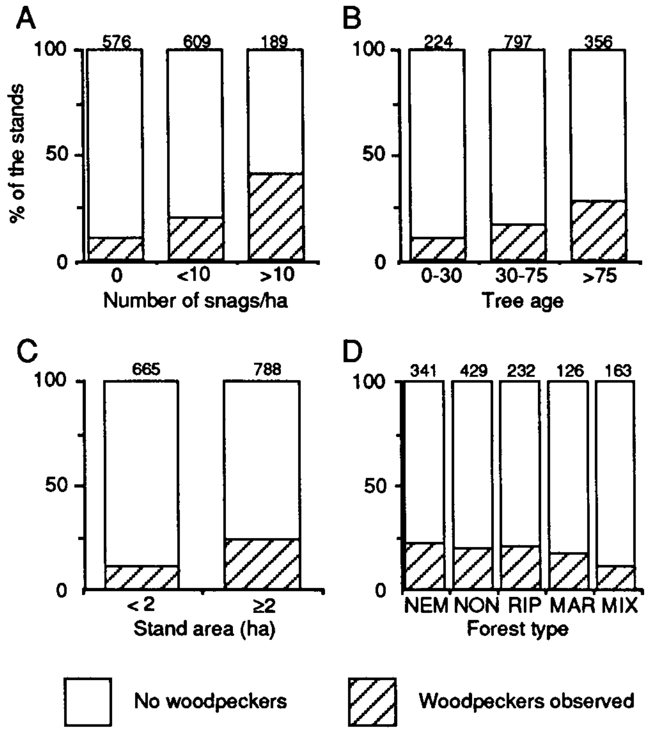

Fig. 1. The relations between occurrence of the Lesser Spotted woodpecker and the habitat variables. A: Number of snags/ha; B: Tree age; C: Stand area; and D: Forest type. The figures above the columns are the number of stands in the category

a multivariate χ^2-analysis. We adopted the, so-called, logit models, in which one variable is dependent and the others independent. In our case occurrence was the dependent variable. We thus compared stands with and without observations of the Lesser Spotted Woodpecker in respect of the stand characteristics.

The reason for including the region as an independent variable is that we suspected that it might interact with the other variables. For example, the value of a certain forest type might differ between north and south.

The field method includes a constant searching time per unit area. Thus, the larger the stand the more time the observer spends there, and accordingly, the more likely he or she is to observe a Woodpecker in that stand. As this does not necessarily have anything to do with habitat preferences, we compensated for it by using the area (continuous variable) of the stands as a covariate of occurrence. That is, the expected occurrence varies with the area of each stand. For example, a stand of 10 ha will be expected to have twice as high a probability of observation as a stand of 5 ha. We can then regard the remaining probability of observation as the Woodpeckers' true habitat preferences. We could not exclude the possibility that the Woodpeckers did in fact prefer larger stands, and also that area might interact with the other habitat variables. Therefore we included the area (greater or smaller than the median) as an independent variable as well.

Log-linear modelling, like other tests based on χ^2, is sensitive to too low expected values in a cell, and therefore we had to exclude some of our variables from the analysis to obtain a valid model. To determine which variables to exclude, we first constructed a model with all the variables present and then removed the least significant ones.

3. Results

Lesser Spotted Woodpeckers were observed in 263 of the 1453 deciduous stands. Figure 1 illustrates the relationship between occurrence of the Lesser Spotted Woodpecker and snag density, stand age, area and forest type. We do not present any univariate tests of these relationships, since they are likely to interact with one another.

There were relatively more observations of Lesser Spotted Woodpeckers in stands that were older or had a higher snag density (Fig. 1a–b). There were also more observations in stands which were larger than the median (Fig. 1c).

There was a tendency for more observations of Woodpeckers to be made in nemoral deciduous stands and riparian stands and fewer in mixed coniferous stands (Fig. 1d).

Figure 2 shows that there are relationships between forest type and some of the other variables. Nemoral deciduous woods are older than the other forest types, non-nemoral deciduous woods, riparian woods and marsh woods (χ^2 = 295, df = 8, P < 0.0001). The mixed coniferous / deciduous woods are intermediate. Snags are more common in the woods on wet land, riparian and marsh woods, less common in nemoral and non-nemoral deciduous woods and, again, intermediate in mixed woods (χ^2 = 44.6, df = 8, P < 0.0001). There seems to be no relationship at all between the forest types and stand area (χ^2 = 4.92, df = 4, P = 0.30). Stands of nemoral deciduous woods and marsh woods are more common in the southern and middle regions than in the northern region. In the northern region non-nemoral deciduous, riparian woods and mixed woods are more common than in the other regions (χ^2 = 52.3, df = 8, P < 0.0001).

In order to unravel the relationships between observation of the Lesser Spotted Woodpecker and all the independent factors simultaneously, we calculated a log-linear model. The first model with all five independent variables indicated that region (P corrected for multiple comparisons ≈ 1) was the least important variable for explaining differences in woodpecker occurrence. The second model contained the remaining four variables, of which area (P corrected for multiple comparisons ≈ 1) had the least significant interaction with occurrence. This model was not valid either, and area was removed as an independent variable, but remained as a covariate to the occurrence.

The remaining three variables are all highly significant and cannot be removed. Still, the

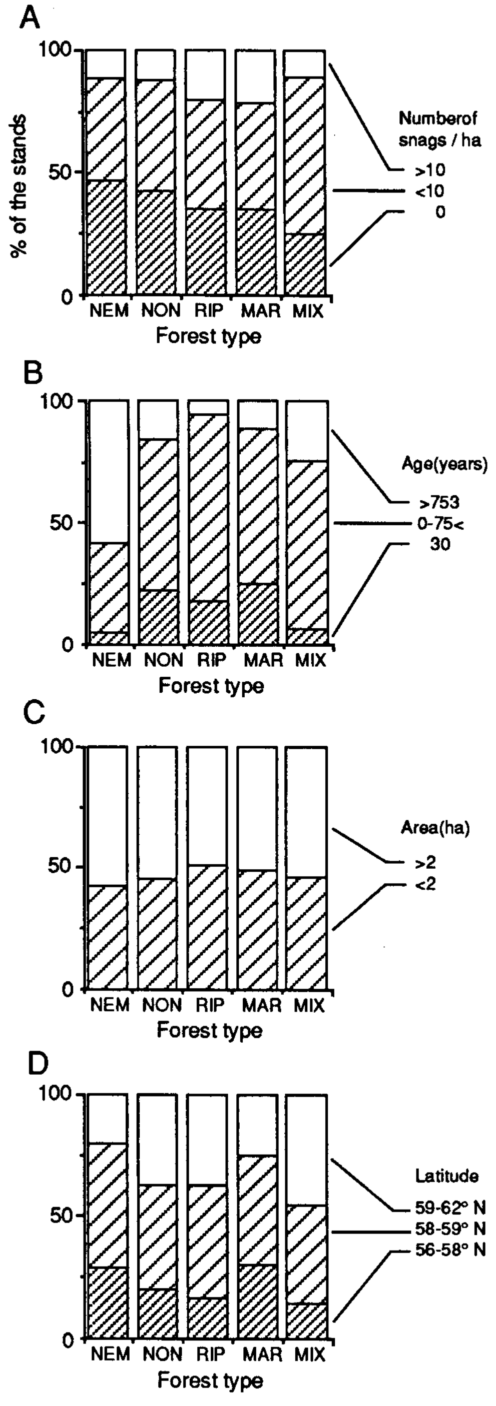

Fig. 2. The relations between forest type and the other habitat variables. The numbers of stands that each column represents are: NEM = 341, NON = 429, RIP = 232, MAR = 126, MIX = 163.

model achieved has too many expected values that are too low to make it formally valid. To assess its robustness, we collapsed the independent variables into fewer categories, thus increasing the expected values. We did this in several different ways, but always came to the same qualitative result as when using the original categories, i.e. all three variables significant, but forest type the least important. Therefore we present the model with the variables categorised as in Table 1, since it gives the most detailed information.

The final model contains only two-way interactions (Table 2) and fits the data well ($\chi^2 = 28.3$, df = 33, P = 0.70). It shows that the Lesser Spotted Woodpecker prefers old forest stands and stands with many snags, and avoids mixed coniferous / deciduous forest (Table 3).

It seems that young forests are used if they contain many snags, but old forests are used little if there are no snags in them (Table 4).

4. Discussion

There is a possibility that the Lesser Spotted Woodpecker changes its habitat preferences during the period we have studied, since this period covers both wintering and breeding. However, any further division into shorter periods would

Table 2. Probability values for the significant interactions in the log-linear model. The P-values are corrected for three multiple comparisons. The predictions of the model fit the data well ($\chi^2 = 28.3$, df = 33, P = 0.70)

Occurrence	P-value
Snag density	0.002
Age	0.003
Forest type	0.015

Table 3. Probabilities for associations between occurrence of the Lesser Spotted Woodpecker in a stand and the categories of the significant variables in the log-linear model. The P-values are corrected for 11 multiple comparisons. " +" means that there is a positive and "–" that there is a negative association with occurrence.

Variable		P-value	Direction
Snag density (snags/ha)	0	0.0011	–
	<10	1	
	>10	0.0004	+
Stand age (years)	0–25	0.21	(–)
	25–75	1	
	>75	0.011	+
Forest type	NEM	1	
	NON	0.53	
	RIP	0.81	
	MAR	1	
	MIX	0.0004	–

Table 4. The percentages of stands with occurrence of the Lesser Spotted Woodpecker in each category of the habitat variables. The figures within parentheses are the number of stands in the categories.

	0 snags	<10 snags	>10 snags
NEM			
0–30 years	0 (13)	0 (4)	0 (1)
30–75 years	10 (60)	20 (54)	56 (9)
>75 years	17 (84)	31 (85)	53 (30)
NON			
0–30 years	11 (66)	14 (28)	100 (1)
30–75 years	11 (105)	18 (126)	39 (33)
>75 years	18 (11)	37 (38)	53 (19)
RIP			
0–30 years	10 (31)	13 (8)	67 (3)
30–75 years	14 (49)	19 (85)	38 (40)
>75 years	100 (1)	11 (9)	60 (5)
MAR			
0–30 years	0 (19)	20 (10)	33 (3)
30–75 years	4 (23)	18 (33)	30 (23)
>75 years	0 (2)	45 (11)	50 (2)
MIX			
0–30 years	0 (8)	0 (3)	0 (0)
30–75 years	4 (24)	15 (75)	8 (13)
>75 years	0 (9)	12 (26)	60 (5)
ALL			
0–30 years	7 (137)	13 (53)	50 (8)
30–75 years	10 (261)	18 (373)	35 (118)
>75 years	16 (107)	29 (169)	54 (61)

leave us with too small sample sizes to analyse. The preferences described here are thus the sum of the habitat preferences during the studied period.

With the field method used here, it is obvious that the probability of observing a Lesser Spotted Woodpecker is greater in a large than in a small stand (Fig. 1c). However, we are interested in the species habitat preferences and not in the likelihood of spotting it in the forest. The assumption of higher probability of observation in larger stands was thus included in our model by adding the area as a covariate.

Of the factors we have analysed, those best describing the Lesser Spotted Woodpecker's habitat preferences are snag density, tree age and forest type (Tables 2, 3 and 4). The area of the stand and the region in which the stand is located (i.e. the latitude) both have little importance.

4.1. Area

As regards our conclusion that the stand area is unimportant, we wish to emphasise that the stands were defined by forest characters alone (cf. Wiktander et al. 1992). Most stands therefore probably do not form any functional units from the Woodpeckers' point of view. Thus, the present result does not mean that the area as such is unimportant when, for example, different stands are isolated from one another.

4.2. Snags and age

The Lesser Spotted Woodpecker uses snags both as a foraging resource (e.g. Alatalo 1978, Hogstad 1978) and for nest sites (e.g. Nilsson & Pettersson 1990) and these two factors may be the reason why it prefers stands with many snags. An additional explanation may be that in stands with a high number of snags there also tends to be a large amount of dead wood on live trees (unpublished data). This is probably because such stands are less intensively managed (cf. Spitznagel 1990). It is well known that dead wood on live trees is utilised by the species for foraging (e.g. Cramp 1985).

Old age is another factor that makes a stand preferred. We suspect that this is also associated with food availability and that an old forest contains more dead wood than a younger forest. But this idea has not yet been tested.

4.3. Forest type

The third factor involved in the habitat preferences of the species is mixed coniferous / deciduous woods, which are avoided in comparison to the other types. Though we must bear in mind that mixed woods are avoided only in relation to the other forest types in the analysis. We do not know what would happen if woods with less than 40% cover of deciduous species were included.

The Lesser Spotted Woodpecker is generally considered to prefer wet and nemoral deciduous forest for breeding (Wesolowski & Tomiałojc 1986, Spitznagel 1990, Wiktander et al. 1992). In this study we found that nemoral deciduous woods are generally older, and that riparian and marsh woods have more snags than other forest types (Fig. 2). They are thus preferred at the local level, but the reason may not be the forest type as such, but rather the association with the other habitat variables. Our results are not in contradiction with those of Wiktander et al. (1992). They found that Woodpeckers require a minimum area of nemoral deciduous and riparian woodland, probably due to adequate availability of food and / or nest sites. The result in the present study means that, given that the census area is occupied (i.e. the minimum requirements of the forest types are fulfilled), the Lesser Spotted Woodpecker occurs more often in old stands with many snags. And that it does this irrespective of whether the stands are in nemoral deciduous or riparian woods, but less often in mixed woods.

When we regard certain forest types as unimportant relative to tree age and snag density, we must be aware of the risk of making a type II error (e.g. Forbes 1990). Log-linear modelling, like other multivariate methods, can reduce the significance of one variable if it is associated with another slightly more significant variable. Thus, we must argue that we cannot be sure that nemoral deciduous and riparian woods are neutral. But we know that mixed coniferous / deciduous woodland is avoided and stands with many snags and old stands are indeed preferred by the Lesser Spotted Woodpecker.

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Sammanfattning: **Habitatpreferenser hos mindre hackspetten**

Vi har analyserat habitatpreferenser hos mindre hackspett i lövskogsbestånd med avseende på skogstyp, täthet av högstubbar, beståndsålder, beståndets areal samt latitud. Data insamlades under åren 1985 t. o. m. 1988 i 104 provrutor om vardera 200 ha i Syd- och Mellansverige. Varje provruta delades in i bestånd efter skogstyp och totalt ingår 1453 lövskogsbestånd i analysen. Mindre hackspett observerades i 263 av dessa. Vi fann att mindre hackspetten föredrar bestånd med hög täthet av högstubbar och bestånd av hög ålder medan den undvikar bestånd utan högstubbar och bestånd med blandskog (Tabell 3). Beståndets areal var av underordnad betydelse. Dessa preferenser gällde oberoende av latitud. Vi anser täthet av högstubbar, beståndsålder och skogstyp vara goda indikationer på mindre hackspettens habitatpreferenser. Dessa variabler är lätta att mäta i fält och kan fungera som en utgångspunkt när det gäller att skydda artens habitat.

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