Acta Theriologica 35 (3–4): 289–298, 1990.
PL ISSN 0001–7051

Preference of different habitats and age classes of forest by roe deer

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Aulak W. and Babińska-Werka J. 1990. Preference of different habitats and age classes of forest by roe deer. Acta theriol. 35: 289–298.

Using the method of pellet density the preference was studied of roe deer *Capreolus capreolus* (Linnaeus, 1758) for forest habitats and tree stand age classes in a small forest (ca. 200 hectares) surrounded by arable fields. The forest provided for the roe deer a cover and partly food. The animals were more numerous in the mixed forest providing better cover and more variable food than in the mixed coniferous forest. The deer preferred older tree stands: in the mixed coniferous forest those aged 41–60 years and in the mixed forest those aged 61–80 years.

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Key words: habitat preferences, *Capreolus capreolus*

Introduction

The roe deer *Capreolus capreolus* (Linnaeus, 1758) living in Poland represents two ecotypes: wood and field roes. In the areas with preponderance of fields and only small forests the wood roe deer utilize in a considerable degree the fields adjacent to the forest as a source of additional food (Pielowski 1984). The forest provides cover for the roe deer but frequent sallies into the fields provide for at least a part of the population reach and easily available green fodder from the fields (Aulak and Babińska-Werka 1990a, W. Aulak and J. Babińska-Werka, in prep.). The use of additional source of food from the fields is a cause of high density of roe deer population in small forests: from about 45–62 (W. Aulak and J. Babińska-Werka, in prep.) to 100 animals per 100 hectares of the forest (Pielowski and Bresiński 1982). Forests as well as fields are not homogenous and roe deer use different parts of both ecosystems fairly selectively.

Several methods are available for determination of the preference for and use of habitats by roe deer. These methods may be divided into two groups: (1) direct observation of roe deer, (2) indirect tracing of their presence there. The first group includes battue driving of the animals from certain parts of a forest (Pucek *et al.* 1975, Fruziński *et al.* 1983, Aulak and Goszczyński 1986) or assessment of the time spent by roe deer in certain parts of a forest based on telemetry (Cederlund 1983). The indirect methods include evaluation of the density of roe deer population by tracks left in snow (Pekka 1980, Goszczyński 1981) or by frequency of gnawed twigs etc. observed in an area (Bobek *et al.* 1972) or by the density of pellets left by roe deer in a forest (Riney 1957, Julander *et al.* 1963, Neff 1968, Downing *et al.* 1965, Collins and Urness 1979, 1981, Staines and Welch 1984). The last methods is used most frequently because of its

Table 1. Percentage of age classes of tree stands in the particular habitats of the study area. Stand age: I – 1–20 years, II – 21–40 years, III – 41–60 years, IV – 61–80 years. MFCF – mixed fresh coniferous forest, MFDF – mixed fresh deciduous forest, FDF – fresh deciduous forest.

Habitat	Age classes of tree stands				Total
	I	II	III	IV	
MFCF	48.35	14.49	32.41	4.75	44.29
MFDF	34.62	42.76	9.48	13.14	48.52
FDF	0.00	14.66	11.86	73.48	7.19
Total	38.21	28.22	19.81	13.76	100.00

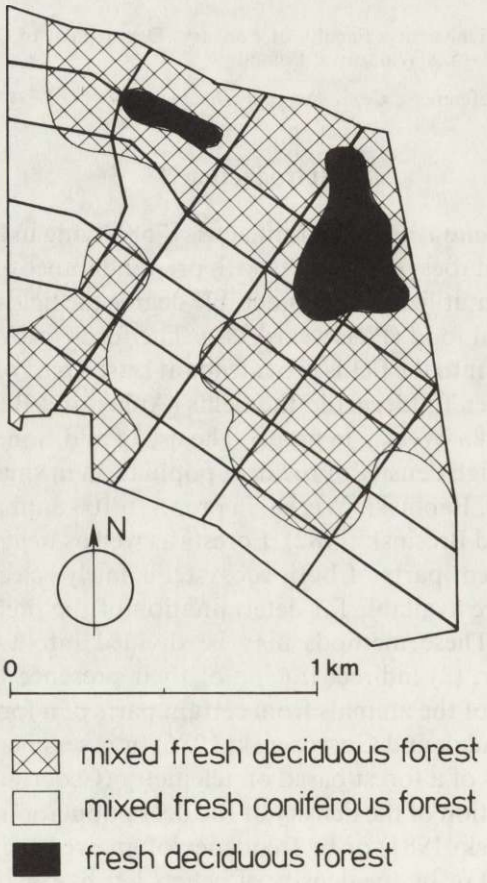

Fig. 1. The map of the forest habitat distribution in a study area.

simplicity and precision of the results. The method assumes, that the amount of pellets is proportional to the time spent by animals in a given area (Papageorgiu 1978).

The purpose of the present study was to determine the preference of a dense population of roe deer for various habitats and age classes of tree stands in a small forest surrounded by fields. The method used was based on determination of pellet density.

Study area

The study was carried out in the Experimental Forests of the Warsaw Agricultural University in Rogów in Central Poland (51°48'N, 19°53'E). The forest under study covered about 200 hectares and was surrounded on all sides by fields. Three forest types were present there: mixed fresh coniferous forest (MFCF, *Pino-Quercetum typicum* Kozł., 1925), mixed fresh deciduous forest (MFDF, *Tilio-Carpinetum calamagrostietosum* Tracz., 1962) and fresh deciduous forest (FDF, *Tilio-Carpinetum typicum* Tracz., 1962). The last covered only a small area of the forest, the remaining two types covered each over 40% of the whole area (Table 1). The richer sides (FDF, MFDF) covered mainly the northeastern part of the forest (Fig 1).

The prevailing tree in the tree stands was the Scots pine (*Pinus silvestris* L.). This species prevailed even in the unsuitable for it but richest dry ground forest (FDF). Pines influenced the composition of the ground cover providing a fairly homogenous cover in all three forest habitats.

The age distribution of tree stands in the study area (Table 1) indicates a predominance of the youngest age class (1 – 20 years). This class includes: forest young plantations (older in the studied area) and thickets. About one – third of the study area was covered by young pole stands and pole stands (aged 21 – 40 years). Older age classes of the tree stands (41 – 80 years) covered about 30% of the forest area. Tree stands aged over 80 years were absent in the studied forest. The spatial distribution of different tree stands indicates prevalence of the older age classes mainly in the northern part of the forest (Fig. 2).

The study was conducted in the years 1980 – 1982. According to spring inventories the population of roe deer in the forest in this period ranged from 89 to 124 animals (W. Aulak and J. Babińska-Werka, in prep.).

Material and method

In the whole area of the forest 30 study plots were randomly selected. Their areas were 2 – 3 hectares and they were covered by homogenous tree stands of similar age and habitat type. The plots represented all habitats and all age classes of the tree stands. Only in the fresh deciduous forest (FDF) with tree stands aged 21 to 60 years the study was not carried out since this forest type was very sparse in the study area. This habitat was represented only by the oldest tree stands aged 61 to 80 years. The number of plots of a given age class and habitat type ranged from 2 to 5, depending on the size of the forest area covered by them. In each part of the forest only one plot was chosen to prevent a close vicinity of two similar tree stands. The total area of the forest studied in these years was 75 hectares that is 40% of the whole forest area.

During three years of the study in spring, summer and autumn faeces of roe deer (single pellets) were counted in each plot in 30 randomly scattered circular sample areas of 1 m^2. Data from 900 sample areas were thus available in each season.

In accordance with Papageorgiou (1978) it was assumed that the number of roe deer pellets was proportional to the length of stay of animals in a given plot. This assumption seems to be justified since the number of defaecations of these animals in 24 hours is very high (Padajga 1970, Mitchell *et al.* 1985).

During three years of the study 40,628 pellets were collected; in 1980 the number of these pellets was 23,490 and in the last year only 6,401 were collected.

The faeces of roe deer collected in various seasons, were deposited in different periods. The faeces

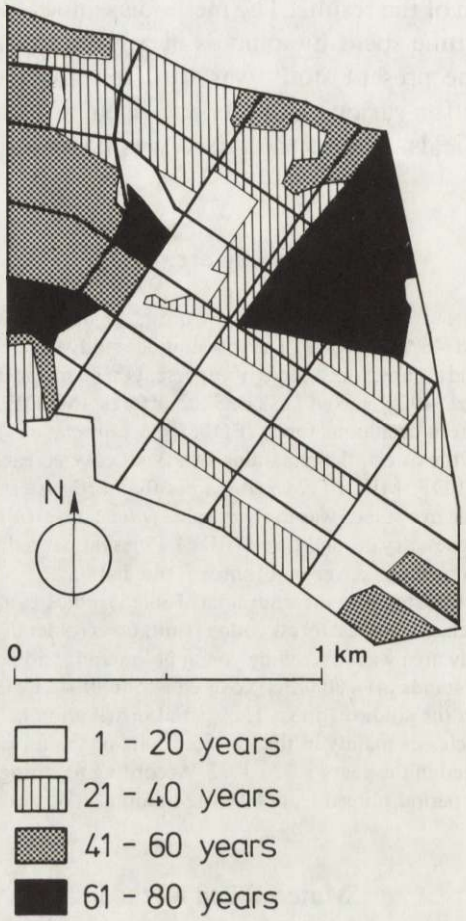

Fig. 2. The map of distribution of different age calsses of tree stands.

collected in spring included pellets accumulated from early winter to spring, in summer the pellets had accumulated in the period from spring to summer, and the autumn collection was composed of pellets accumulated from summer to autumn. The spring collection provided the largest material owing to the length of the accumulation period and low degree of mineralization of faeces. The summer collection was small due to rapid disintegration and to the fact that in the summer deer spend most of the time on fields.

Results

The density of roe deer faeces was estimated for each habitat type, and for each tree stand age class within this habitat. Average density of pellets per one circular simple was calculated as a mean from all the samples taken in a given habitat and tree stand age class. Considerable differences in the density of pellets between various years and seasons made impossible a graphic presentation of absolute values. Because of that, in

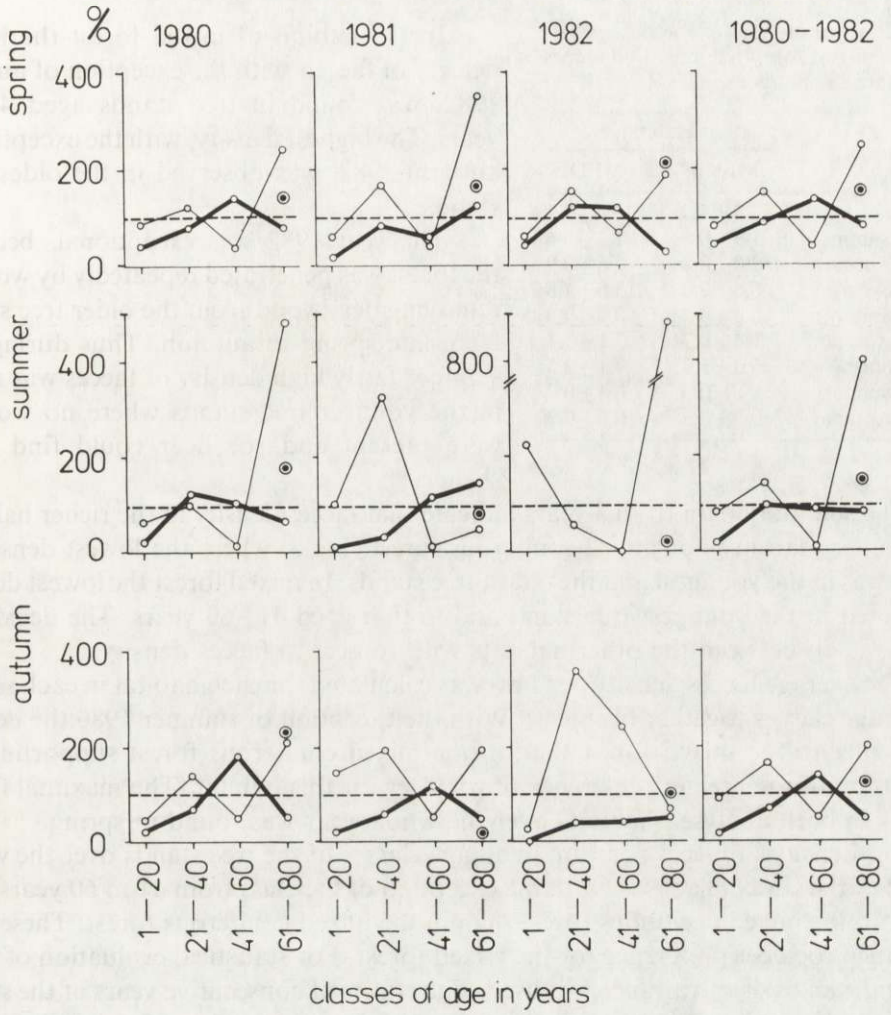

Fig. 3. Densities of roe deer pellets in different habitats and age classes of tree stands expressed as a percentage of mean density, 100% (broken line), found in a given season on the study area. Mixed fresh coniferous forest (solid line), mixed fresh deciduous forest (thin line) and fresh deciduous forest (open circle with dot inside) were analized.

each season the mean value for 30 areas was calculated, and the mean density was expressed in relative values, as per cent of the mean value (Fig. 3). The fresh forest (FDF) was characterized only by the value for the oldest tree stand (61 – 80 years) since no younger age classes were present there.

In the habitat of mixed coniferous forest the lowest density of pellets was found in the youngest age classes (thickets) (Fig. 3). In some seasons low density was observed also in the oldest age class of the tree stand in this habitat. In most cases the highest density was found in the tree stand of the middle age.

Table 2. Mean number of roe deer pellets per 1 m^2 of two forest habitats. Full names of the forest habitats as in Table 1.

Season		Habitat	
		MFCF	MFDF
1980	Spring	18.5±5.9	25.4±7.1
	Summer	1.9±0.8	1.3±0.6
	Autumn	2.0±0.8	2.6±0.9
1981	Spring	6.6±2.0	13.5±7.8
	Summer	0.6±0.2	0.9±0.5
	Autumn	1.4±0.7	3.1±1.1
1982	Spring	5.0±1.7	7.1±2.5
	Summer	0.0	0.4±0.2
	Autumn	0.2±0.05	0.6±0.3

In the habitat of mixed forest the lowest density of faeces, with the exception of autumn 1982, was found in tree stands aged 41–60 years. The highest density, with the exception of autumn 1982, was observed in the oldest tree stands.

The year 1982 was exceptional, because, the forest was penetrated repeatedly by workers removing deadwood from the older tree stands from late spring to autumn. Thus during this summer fairly high density of faeces was noted in the younger tree stands where no workers were present and roe deer could find quite shelter.

The summary data from 3 years indicate that faeces density in the richer habitats was higher than in poor mixed coniferous forest (Fig.3) where the lowest density of faeces was in the youngest and the oldest tree stands. In mixed forest the lowest density was noted in the youngest tree stand and in that aged 41–60 years. The deciduous forest was in-between the other habitats with respect to faeces density.

The average faeces density per 1 m^2 was calculated for each habitat in each season for all age classes together (Table 2). With the exception of summer 1980 the density was higher in the mixed forest than in the mixed coniferous forest supporting the conclusion of the greater preference of roe deer for this habitat. The maximal faeces density in both analysed habitats over the whole year was found in spring.

The density of faeces per 1 m^2 in all age classes of the tree stands over the whole period of the study (Table 3) (with the exception of the class from 41 to 60 years) was higher in the mixed deciduous forest than in the mixed coniferous forest. These data confirmed roe deer preference for the mixed forest. For statistical evaluation of these results the analysis of variance was used. The effects of consecutive years of the study, seasons of the year, habitat type and age class of the tree stand, on the distribution of roe deer faeces were analyzed in two stages. In the first stage a three-factor analysis of variance of the first three factors was done. In the second stage a three-factor analysis

Table 3. Mean number of roe deer pellets per 1m^2 of different age classes of tree stands. The means are calculated for 3-year study period. Full names of the forest habitats as in Table 1. * I age class of FDF habitat were not present in the area, ** II and III classes of the FDF were not studied.

Habitat	Age classes of tree stands			
	I	II	III	IV
MFCF	1.7±0.5	6.0±1.5	6.0±2.0	4.0±1.5
MFDF	3.6±0.9	6.9±1.5	2.3±0.8	12.7±3.7
FDF	*	**	**	7.7±2.5

Table 4. Three-way analysis of variance of the roe deer pellets distribution in consecutive years, seasons and different habitats. Full names of the forest habitats as in Table 1. $*p<0.001$.

Source of variation	*d.f.*	Values of the F statistics
(A) Years 1980–82	2/52	29.74*
(B) Seasons: spring, summer, autumn	2/52	57.84*
(C) Habitats: MFCF, MFDF	1/26	1.73
Interactions		
AB	4/104	24.24*
AC	2/52	1
BC	2/52	1.05
ABC	4/104	1

of variance of the remaining factors, including the age of the tree stands was done for each year.

The results of this analysis revealed significant differences in faeces density between various years of the study and between seasons (Table 4). This was due to the highest density of faeces in summer 1980 and lowest in 1982, and in each year the density was greater in spring than in the remaining seasons (Table 2). The analysis of variance failed to disclose any statistically significant differences in faeces density between various habitats (Table 4), although the mean density of faeces per 1 m^2 was higher in the mixed deciduous forest than in the mixed coniferous forest (Tables 2 and 3).

In the second stage of the analysis (Table 5) a highly significant influence was demonstrated of consecutive seasons on the number of pellets. Some effects of the habitat was noted also but only in 1981. The effect of the age of the tree stands was highly significant in the years 1980 and 1981 but was not significant in the last year of the study when faeces density was lowest.

Many important pieces of information were obtained in the analysis of the interactions between the distribution of roe deer faeces and the season, the habitat and the age class of the tree stands. A significant correlation between faeces density in successive seasons and the habitat (interaction AB) was shown only in 1981 (Table 5). It was caused by much greater differences between the amount if faeces found in various habitats in spring and autumn than in summer (Table 2). In 1981 a statistically significant correlation was revealed between faeces distribution and the season of the year and age class of the tree stand (interactions AC). In spring and autumn this distribution was similar, with the maximal values in the oldest age class but in summer the maximal values were found in the age class 21–40 years (Fig. 3).

Even more complex correlations were noted in the BC interaction (between the habitat and the age class of the tree stand) and the ABC interaction (between the

Table 5. Three-way analysis of variance of the roe deer pellets distribution in consecutive seasons, different habitats and age classes of tree stands. Full names of the forest habitats as in Table 1. F – values of F statistics. $*p<0.05$, $**p<0.025$, $***p<0.01$, $****p<0.001$.

Source of variation	1980		1981		1982	
	d.f.	F	*d.f.*	F	*d.f.*	F
(A) Seasons: spring, summer, autumn	2/40	77.33****	2/40	48.95****	2/40	39.52***
(B) Habitats: MFCF, MFDF	1/20	1.03	1/20	7.36**	1/20	1.64
(C) Age of tree stands	3/20	5.23***	3/20	6.96***	3/20	1.32
Interactions						
AB	2/40	1	2/40	4.15*	2/40	1
AC	6/40	2.27	6/40	9.87****	6/40	1.51
BC	3/20	6.85***	3/20	3.77*	3/20	1.88
ABC	6/40	3.25**	6/40	3.48***	6/40	1.9

habitat, the age class and the season) which were significant in 1980 and 1981. These correlations were not significant only in 1982 when the amounts of roe deer faeces in the pooled samples were very low.

Discussion

The animals having the opportunity of choosing between habitats differing in various respects show preferences for those which provide food and shelter (Pekka 1980, Byron 1981, Cederlund 1983, Fruziński *et al.* 1983). The present study of three forest habitat showed only in 1981 a significantly higher faeces density in the mixed deciduous forest than in the mixed coniferous forest. This is due, most likely, to the pattern of the tree stands in the studied habitats. The prevalence of pines in all tree stands blurred the differences with respect to food types in these habitats.

The only superiority of the mixed deciduous forest with respect to the coniferous forest was in the type of understory layer which was richer both qualitatively and quantitatively, and provided not only better food but also a better cover for roe deer staying there. It seems that the cause of only slightly higher amount of faeces in the mixed deciduous forest in relation to the mixed coniferous forest could be a more rapid disintegration of faeces in the richer habitat (Aulak and Babińska-Werka 1990).

The preference for richer habitats shown by roe deer was stressed by Mooty (1979) and Padaiga (1970). In the latter study the density of pellets was greatest in deciduous forests and mixed forests, whereas it was lowest in mixed coniferous forest and pine forests.

The age of the tree stands was also important for roe deer. In mixed coniferous forest the maximal density of faeces was found in middle age class (41 – 60 years), while in mixed deciduous forest it was in the oldest class (61 – 80 years). This was again due to differences in the availability and quality of food (W. Aulak, in prep.) and the possibility of taking cover in various classes of tree stands. The initial stages of tree stand development were not attractive for roe deer, especially since the studied area

contained practically no forest young cultures, and thickets provided poor green fodder, and, probably, the animals had difficulties in moving in these areas with fairly densely growing and profusely branched young pines. The middle age classes of tree stands, particularly young pole stands and pole stands, seemed to provide good cover preferred by roe deer. The oldest age classes were probably a good refuge for animals but only if understorey there was well developed (fresh forest and mixed forest). The availability of green fodder was considerable in such age classes (W. Aulak, in prep.).

The preference for older age classes of tree stands resulted from the availability of food, adequate cover and the intensity of forest penetration by humans. The last of these factors, more intensive role in coniferous forests than in deciduous forest, caused that the density of pellets in the oldest tree stands in mixed coniferous forest habitats was usually smaller than in middle-age tree stands. Only exceptionally high pellet density was observed in tree stands aged 1 to 40 years. This was the case in 1982 when high intensity of work in the forest with older tree stands caused temporary migration of roe deer to the younger tree stands where they were not disturbed.

The preference shown by roe deer for older age classes of tree stands was stated by other authors, *e.g.* Dzięciołowski (1974, 1976) who found that roe deer preferred old tree stands. On the other hand, many authors believed that besides the oldest age classes roe deer chose also the youngest tree stands (Borowski and Kossak 1975, Cederlund 1983, Fruziński *et al.* 1983, Staines and Welch 1984). Our study demonstrated also that the highest pellet density was in the oldest age class but in the tree stands aged 21–40 years this density was in the second place. This preference might have been due to good cover in this forest.

The present study demonstrated a preference of roe deer for habitats with more abundant food and older tree stands. Roe deer sought areas with greater availability of food and cover. The forest chosen by us for the study probably differed from the wooded areas studied by others. The similarity of tree stands, despite different habitats, produced similar ground cover and was responsible for the similarity of food taken by the animals. The high density of the population of roe deer (45 to 62 animals per 100 hectares of the forest), suggested an even distribution of the population over the whole area. However, it was found that the various habitats in it were not equivalent for roe deer, due to differences of understorey providing shelter, differences (mainly quantitative) in the availability of food and age of the tree stands determining this availability. Penetration of the area by people was another important factor of habitat choice by deer.

Acknowledgments: The authors acknowledge gratefully the helpful criticism of Professor R. Andrzejewski in the preparation of this paper for publication. The study was done as part of the MR–II/19 programme, coordinated by the Warsaw Agricultural University.

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Received 19 April 1989, accepted 1 March 1991.