

## Home Range Dynamics and Habitat Selection by Roe Deer in a Boreal Area in Central Sweden

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This study describes spatial and temporal distribution of roe deer (*Capreolus capreolus* Linnaeus, 1758) in south central Sweden expressed as by home-range dynamics and habitat preference during the course of the year. Roe deer were monitored by telemetry at least one day a week during 1975 to 1977. Daily home-range varied between animals as well as between season (1—120 ha). The yearly mean daily area was significantly larger for males than for females (25.9 ha vs 18.9 ha). Males also covered a larger part of their seasonal home-range each day. Daily as well as seasonal home-ranges changed during the course of the year, the ranges in spring being largest. Home-range during the territorial season averaged about 95 ha for both sexes. No roe deer used the area uniformly. Instead, the animals selected small local areas a few hundred metres apart. At least 80% of all radio locations of each animal in all seasons were counted within a range of 400—500 m from the overall activity centre. Seasonal centres of activity were close to one another implying that spatial overlap from season to season was considerable as was the case between years. Examples from a buck and a doe showed that seasonal aerial overlap averaged about 50%. Overall habitat selection was found to be non-random and shifted between seasons. Bogs and clear-cuts were typically avoided in both 1975 and 1976 while occupancy of plantations, pole-sized stands and mature forests differed between the two years.

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### 1. INTRODUCTION

During the last century the roe deer (*Capreolus capreolus* Linnaeus, 1758) population in Sweden has drastically increased and extended its range north of the arctic circle (Siivonen, 1976), which is far north of its former distribution (Ekman, 1919). Though the roe deer is considered to be of great economic and recreational importance, little is known about their behaviour. So far, no data have been presented in Fennoscandia about spatial and temporal distribution. This information is fundamental when setting up future management policies and for understanding of today's intensive forestry practices and other large scale alterations of the environment.

In southern countries roe deer home-range studies have primarily been

focused on the territorial season. Most data on areas of occupancy was based on estimations through observations during certain periods of the year (e.g. Cumming 1966 and 1974; Kurt, 1968; Loudon, 1978 and Robin, 1978). A similar method was used for a year-round study of the roe deer population at Kalø in Denmark (Strandgaard, 1972) and an enclosed population in West Germany (Ellenberg, 1978).

The use of radiotelemetry has created opportunities for the continuous monitoring of animal activity and provide a large volume of useful data which can be used to assess factors influencing habitat preference. The technique has been used for home-range studies on roe deer for nearly a decade (Bramley, 1970 and 1977; von Berg, 1978; Sempéré, 1979 and 1980; Cederlund, 1982). However, most data presented so far are collected from rather few animals and refer to the territorial season or a limited part of the year. Little information is available on quantitative and qualitative habitat use. With the exception of ordinary nutritional analyses, available information is normally provided by visual data, which is primarily collected in areas more or less influenced by agriculture (Klötzli, 1965; Strandgaard, 1972; Borowski & Kossak, 1975; Reichholf, 1980 and Zejda & Homolka, 1980).

The main objective in this study is to describe the spatial and temporal distribution of telemetrically monitored roe deer in a boreal habitat in south central Sweden during the course of the year. Special interest is devoted to home range dynamics and habitat selection of resident roe deer.

## 2. MATERIAL AND METHODS

The study was conducted from January 1975 to December 1977. In total, 15 males (4 juveniles) and 17 females (3 juveniles) were radiolocated during this period. Juveniles were incorporated in the material only when the accompanying doe was untagged. 13 animals were tracked for two or more years. The most comprehensive data was achieved in 1975 and 1977. In 1975 yearlong tracking was focused on one doe (No 013) and one buck (No 015). One or several positions a week on each animal was recorded for 191 roe deer weeks in 1975, 165 in 1976 and 251 in 1977.

The different seasons include following months: Winter=Jan.—March; Spring=April—June; Summer=July—Sept.; Autumn=Oct.—Dec. The roe deer were caught during winter in special box traps baited with artificial fodder. Trap sites were distributed over the entire research area and usually in proximity to feeding stations. Each animal was aged by tooth eruption and wear, sexed, weighed to nearest 0.1 kg and finally eartagged and radiocollared.

Transmitters were constructed for use on 150 MHz and moulded together with a battery in an epoxy resin and attached to PVC-plastic collars in different colours. The assembly weighed 250—300 g and was adjustable to the animals' neck size. Signals were pulsed and received at 5 km from the fixed antenna system.

A detailed description of the fixed antenna system and the field technique at Grimsö was published by Cederlund *et al.* (1979).

For this study radio tracking was primarily conducted from the fixed 3-antenna system and by a mobile unit. Each position was calculated by triangulation with three accurate bearings. All animals within range were located every 30th minute for a 24-hour interval each week. Information was immediately compiled and positions calculated and plotted on a map to location and to a grid system with square area of 1 ha (100×100 m). Accuracy of bearings within the central "telemetry area" was less than ±50 m for fair signals. Descriptions of home-range characteristics and habitat selection does not account for variation in accuracy of bearings.

Size of daily home-range area was calculated on data from the weekly 24-hour trackings. Seasonal and yearly home-range included all recorded positions during a specific period if more than 50 and distributed over the entire period. 50 positions account for 80–90% of the total seasonal area (Cederlund unpubl. data).

Following Burt (1943) home-range is here defined as the area which an animal occupies during a specific period including all types of behaviour necessary for normal living. Home-range was calculated by combining the outermost locations with the convex-polygon method (Mohr, 1947). Distribution of positions (in grid squares) within each home-range was indicated by calculations of geometric centre of activity (Hayne, 1949) and activity radii (Dice & Clark, 1953). Adams and Davis' (1967) method for index of home-range overlap was used but instead of estimating the animals time  $t_i$  for each grid square it was based on recorded positions expressed as percentage of total number of positions.

Habitat preference was determined by utilization — availability analysis (Neu *et al.*, 1974). Using the proportion of each habitat — type the observed number of locations was compared with the expected number of locations to test the null hypothesis that roe deer use the different habitat — types in relation to their occurrence. The quotient between observed and expected number of locations was used as an index. Areas were estimated with a planimeter as to nearest 0.1 ha based on forestry maps.

Following a general classification the forested part of the area was divided in four main types according to age of the stand, stage of succession and desired operations by the forest company (Svensson, 1980): (1) Clear cut areas. Age 1–10 years. (2) Young plantations. Age 10–25 years. (3) Pole-sized stands. Age 25–80 years. (4) Timber stands. Age > 80 years.

### 3. THE ROE DEER POPULATION

The roe deer population in the research area increased up to 1976 due to a series of mild winters causing a minimum loss. Track counts on snow in the central part of the area (1000 ha) indicated a winter population of 30–40 animals in 1976. The population was then considered to have reached its social carrying capacity (cf. Bobek, 1977). In the winter 1976–77 when snow accumulation was extreme with depth above 100 cm, mortality increased markedly and was estimated to 30–40% of the autumn population (Cederlund & Lindström, 1983). However, the number of resident animals was probably not affected.

## 4. RESULTS

Daily home-range varied considerably between animals as well as within season, the smallest being about 1 ha and the largest being about 120 ha (male No 28 in spring). The yearly mean daily area was significantly larger for males than for females, (25.9 ha vs 18.9 ha;  $t$ -test  $P < 0.01$ ). Data indicated that males regularly covered larger daily home-ranges though the differences were significant only in spring ( $t$ -test  $P < 0.05$ , Table 1). The reversed situation in autumn might be due to inadequate data. Both sexes showed a similar, general pattern in changing daily home-range area in the course of the year though it did not change significantly when including all seasons (analysis of variance;  $P > 0.05$ ). However, the small areas in winter were followed by a significant increase during spring ( $t$ -test; males:  $P < 0.05$ , females:  $P < 0.02$ ) after which areas were reduced again in summer (Table 1).

Table 1

Mean daily home range covered by roe deer at Grimsö during different seasons of the year in the period 1975—1977. The figures in parentheses indicate the number of individuals.

	Winter (Jan.—March)	Spring (Apr.—June)	Summer (July—Sept.)	Autumn (Oct.—Dec.)
<b>Males</b>				
Home range				
Mean $\pm$ SE, ha	17.5 $\pm$ 1.5	36.6 $\pm$ 3.5	20.3 $\pm$ 3.2	22.2 $\pm$ 3.4
% of seasonal area	19.2	27.4	21.0	23.4
N	69 (16)	73 (14)	17 (6)	22 (5)
<b>Females</b>				
Home range				
Mean $\pm$ SE, ha	15.0 $\pm$ 1.6	24.0 $\pm$ 3.2	12.3 $\pm$ 2.2	26.7 $\pm$ 2.9
% of seasonal area	13.9	24.0	13.0	20.8
N	64 (11)	45 (13)	7 (3)	10 (2)

Data on daily winter range were pooled for all included years. However, during the severe winter 1976—77 with large snow depth females reduced their daily range with nearly half the size compared to the other winters (11.9 ha vs 20.5 ha) whereas the males did not respond at all (20.6 ha vs 19.0 ha) (Cederlund, 1982).

In the territorial season, which is considered to include spring and summer there seemed to be no correlation between male age and daily range though insufficient data on birth year did not allow closer analyses. Two sedentary yearling males (No 035 and No 037) covered about the same area as the older males (mean: 24.3 ha vs 23.4 ha,  $N=17$ ).

Each day the roe deer normally traversed a minor part of the seasonal

home-range. Among both sexes seasonal mean daily range constituted the smallest part of total seasonal area in winter (and in summer) and the largest part in spring, the male areas ranging from 19.2% to 27.4% of total area while the female areas were smaller (13.0% to 24.0%, Table 1). The correlation between the changes in mean daily area and seasonal home-range was statistically significant only for males ( $r=0.986$   $P<0.02$ ; females:  $r=0.683$   $P>0.05$ ).

The resident roe deer at Grimsö Research Area exhibited some changes in their seasonal home-range areas during the course of the year (Table 2). However, there were too few observations in the summer and autumn to permit statistical analyses. The estimated winter and spring areas from 1977 were separated from the other winter and spring seasons because of the extreme snow depth as earlier presented by Cederlund (1982). In normal winters areas ranged from 48.4 ha (doe No 014) to 158.6 ha (buck No 004), while in 1977 a male (buck No 028) occupied an area of as much as 308.9 ha. His spring home-range was then estimated to 418.2 ha, mainly because of a daily travel of 3 to 4 km through the area from summer range to a winter feeding station. In the summer-autumn period areas ranged from 40.8 ha (buck No 035) to 202.8 ha (doe No 051). Males tended to establish the largest home-ranges in spring while females extended their home-ranges only under influence of a hard winter (Table 2). Even then their ranges were about 70% smaller than

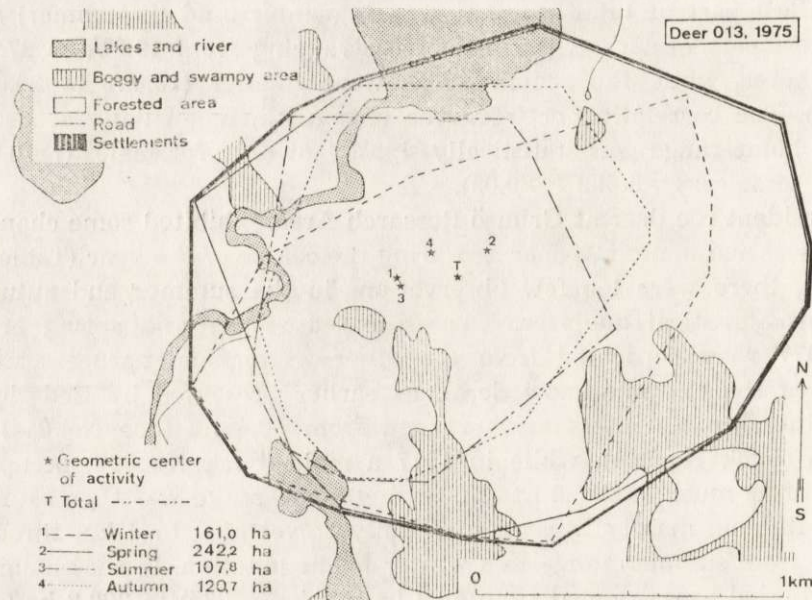
Table 2

Seasonal home range of roe deer at Grimsö during 1975 to 1977. Data from the severe winter and spring 1977 are separated from the other years (see text).

Season (months), year	Males	Females
	Mean±SE (n)	Mean±SE (n)
Winter (Jan.—March), 1975—76	91.3±14.0 (6)	107.9±11.5 (8)
Winter (Jan.—March), 1977	216.1±32.5 (4)	122.3±23.3 (4)
Spring (April—June), 1975—76	132.5±34.6 (6)	100.4±29.1 (6)
Spring (April—June), 1977	253.7±89.2 (3)	176.1±25.6 (4)
Summer (July—Sept.), 1975—77	96.8±17.1 (6)	94.6±33.4 (3)
Autumn (Oct.—Dec.), 1975—77	94.8±14.0 (3)	128.0±40.0 (3)

the males'. The extension of winter range was highly associated with movements to new feeding sites, which were then performed in the reversed direction in spring. Males traversed larger areas when searching for food and appeared, frequently at feeding stations, specially set up for roe deer near Grönbo village. On average both sexes seemed to occupy areas of similar size in summer and autumn (Table 2).

Once established in an area all radio tagged roe deer remained there throughout life or for as long as they were possible to locate. Size and



shape of home-ranges underwent insignificant changes between years except when heavy snow cover altered the food situation for the animals. For example doe No 002, which was 4 year old when radio-marked in November 1973, covered an annual area of about 150 ha until her death 1978 (car accident). Boundaries were almost the same every year. However, during the severe winter 1977 the doe performed a 2 km movement outside the ordinary home-range to feeding stations near Grönbo village.

Two radio-collared adult bucks (No 019 and No 028) living immediately outside the unmanaged research area left their home-range after a major part of the central home-range was logged during summer 1976. Buck No 019 moved intensively back and forth in an extended range, at the most about 1200 m from the former area, obviously without being capable of establishing a home site.

Seasonal shifts of home-ranges are exemplified by data from buck No 015 and doe No 013 in 1975. These animals were living within the same area and with partially overlapping home-ranges and were intensively radiolocated in the course of the year. Totally, 1492 locations were recorded for the buck and 1395 for the doe. The home-range areas over the year were fairly similar as indicated in Fig. 1 a and 1 b (228.7 ha vs. 252.6 ha). Both animals extended their seasonal ranges most in spring, whereas the size covered by the doe was extreme

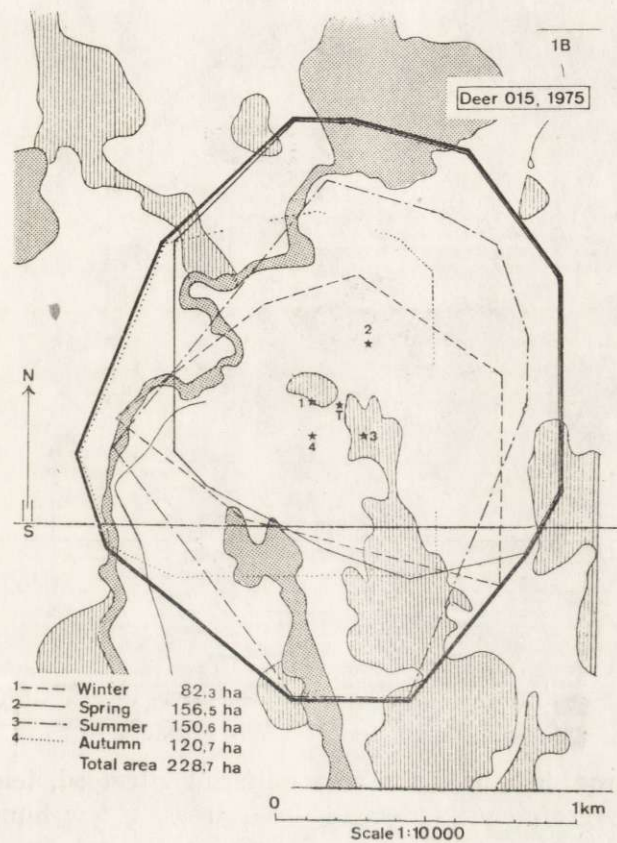
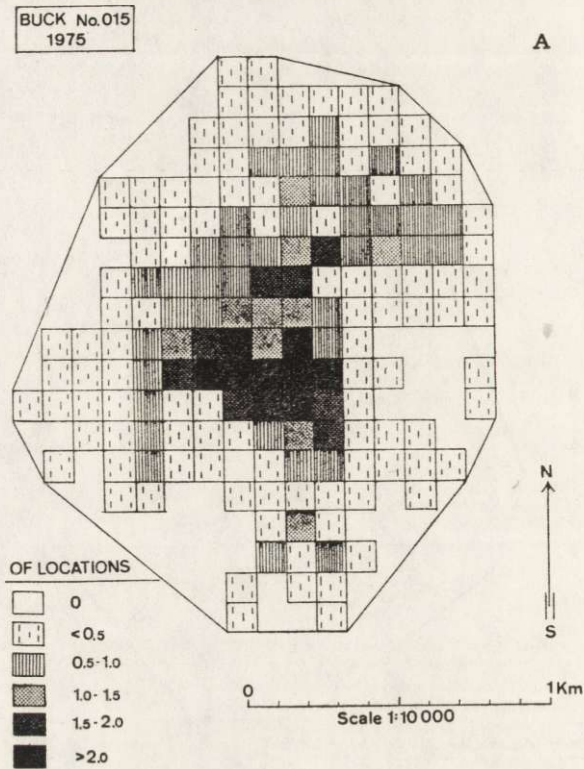


Fig. 1. Seasonal and total home range areas during 1975 of A. Doe No 013 and B. Buck No 015. Geometric centres of activity are also indicated.

compared to the mean (100.4 ha after normal winters, Table 2). Aerial overlap between consecutive seasons was high for both animals, in all instances exceeding 63%.

No precise data were available on inter-sex home-range overlap during the territorial season. Observations and radiolocations indicated that adults were evenly distributed over the research area. No detectable topographical or vegetational features were attributed to definite territorial or home-range boundaries. Instead, the boundary areas were commonly used by two neighbouring adults, though primarily at separate times. On one occasion in May 1976 buck No 004 and No 028 were located to the same area and so close that interaction was likely to happen. Buck No 028 visited the area only a few times in the following month indicating that the area was not actually incorporated in his



territory. No roe deer used the area uniformly. Instead, telemetry data indicated high preference for small, local areas, a few hundred metres apart. Thus the geometric centre of activity did not exactly coincide with the most frequented spots but rather indicated in what part of the home-range the animal was located most of the time. Most frequented areas were always near the centre of the total annual home-range. At least 80% of all the radio locations of each animal in all seasons were counted within a range of 400 to 500 m from activity centre, the majority being within 200 to 300 m. The outermost areas were visited at a lower frequency with no detectable regularity (Fig. 2 a and 2 b).

The seasonal geometric centre of activity were close to each other as indicated by the examples from buck No 015 and doe No 013 (Fig. 1 a and 1 b). This implies that spatial overlap from season to season was considerably as was the case between years. Buck No 015 visited 56.8% of the total number of squares in both years. Overall index of overlap ( $I=76.0$ ) indicated high similarity in distributional pattern.

Despite the regular high aerial overlap the index of overlap may strongly differ between seasons (Table 3). Thus, if the animal was returning to the same "core area" in two different seasons it did not



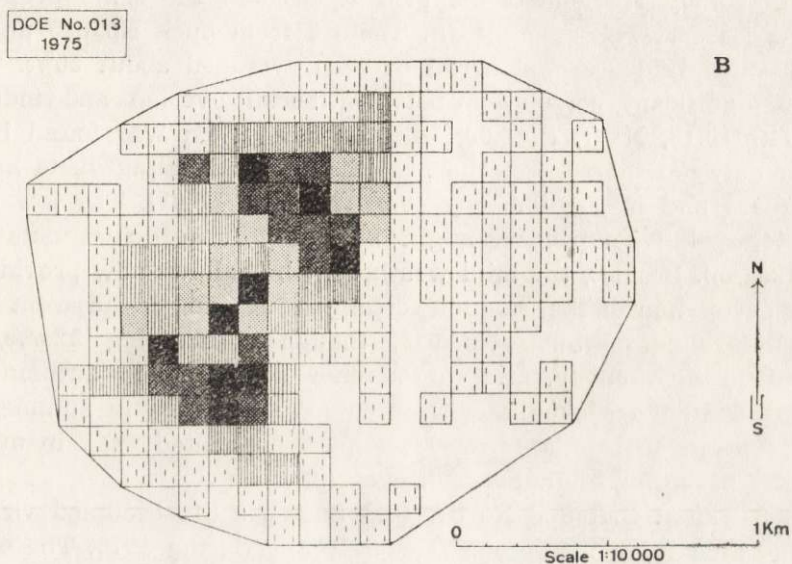


Fig. 2. Frequency of locations (in percentage) in separate 1 ha grid squares within each home range of A. Buck No 015 B. Doe No 013 during 1975.

Table 3

Aerial and index of home-range overlap between doe No 013 and buck No 015 and between seasons during 1975 and winter 1976.

		Home-range area, (ha)	Aerial overlap <sup>1</sup>	Correlation (r)	Sum of coinciding visits ( $\Sigma$ ) <sup>2</sup>	Index (I)
Roe deer No 013 and No 015						
Winter-Spring 1975	No 013	151.5	60.7	0.06	76.1	4.6
	No 015	77.9	46.2	0.22	109.9	24.2
Spring-Summer 1975	No 013	106.2	44.1	0.32	134.8	43.1
	No 015	109.6	52.6	0.27	127.9	34.5
Summer-Autumn 1975	No 013	88.2	69.1	0.36	165.9	59.7
	No 015	95.6	52.5	0.09	119.7	10.8
Autumn-Winter 1976—76	No 013	—	—	—	—	—
	No 015	70.9	54.9	0.18	162.7	78.1
Roe deer No 013 versus No 015						
Winter		78.9	46.2	0.18	73.9	13.4
Spring		152.1	58.7	0.51	159.3	80.6
Summer		97.8	57.0	0.28	134.0	36.8
Autumn		70.6	39.0	0.14	145.1	20.7
Total ( $\Sigma$ )		175.5	55.9	0.65	182.6	118.7

<sup>1</sup> % of total home-range area occupied by both animals.

<sup>2</sup> Sum of coinciding visits (%) in each grid square.

mean that they frequented the grid squares in the same proportion between seasons. The examples in Table 3 from buck No 015 and doe No 013 show that seasonal aerial overlap averaged about 50%. There was no significant correlation between aerial overlap and index of overlap ( $r=0.18$ ,  $N=7$ ,  $P>0.05$ ). A good correlation was found in the relation between the sum of the proportion of coinciding visits in each grid square and in the index ( $r=0.91$ ,  $N=7$ ,  $P<0.01$ ). The low index in winter-spring comparison might be due to insufficient data from winter season. Besides, the mild weather with shallow snow provided no regular occupation of the common feeding station and its adjacent areas. The home-range of buck No 015, though overlapping 52.5%, was occupied in different pattern in summer compared to autumn. The locations were more evenly distributed over the area in summer and highly concentrated to a formerly, almost nonvisited area in autumn and hence providing a low index of overlap.

It was evident that doe No 013 and buck No 015 occupied virtually the same area though only 55.9% overlapping during 1975. The overall centres of activity were adjacent as was also indicated by a high index of overlap ( $I=118.7$ , Table 3). Seasonal areal overlap averaged about 50% with ranges from 39.0% to 58.7%. Index of overlap varied considerably. Again, the low figures in winter might be related to few data.

Preference of forest-types was calculated for 8 adults (2 ♂♂ and 6 ♀♀) on a 700 ha area in 1975 and for 14 adults (8 ♂♂ and 6 ♀♀) on a 1200 ha area in 1976. The area of 1975 was entirely included in that of 1976 but centred to the western part since most of the deer were caught and radio-tracked there. In all, 3173 locations were achieved in 1975 and 4275 in 1976. In all seasons in both years the overall habitat selection was found to be nonrandom ( $\alpha^2$  95% conf. interval,  $P<0.05$ ). Thus, the roe deers' relative preference between forest-types shifted within season while the preferences were fairly constant between seasons within the separate years (Fig. 3). In 1975 high preference indices were achieved for the mature forest type (type 4) while clear cuts (type 1) and bogs were consistently avoided (Fig. 3). The occupancy of forest-type 2 was not in any season significantly different from the expected figure (25.5% to 28.2% vs 27.6%;  $\alpha^2$ , 95% conf. interval). However, in 1976 this forest-type was preferred in all seasons while the mature type (type 4) was avoided. Again, low index were noted for bogs and clear cuts (type 1). Some of the deviations between 1975 and 1976 might be due to the eastward extension of the research area in the former year where the proportion of forests of type 2 and 4 was higher (46.8% vs 60.2%).

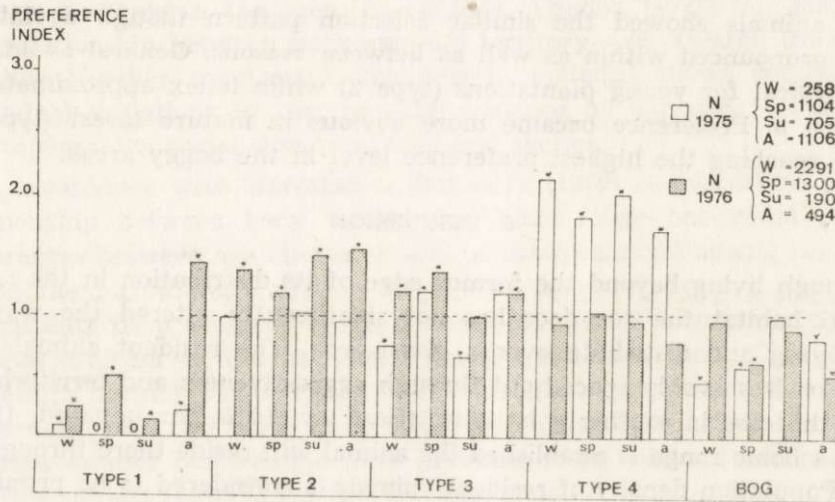


Fig. 3. Preference index for different forest types (including bogs) of roe deer at Grimsö Research Area during 1975—76. Seasonal sample size is indicated.

A habitat preference test during 1975 and 1976 was made within the ranges for buck No 015 and doe No 013 since they lived in almost the same area and were intensively radio-tracked throughout the period, which provided data for comparative analyses. Generally, both animals

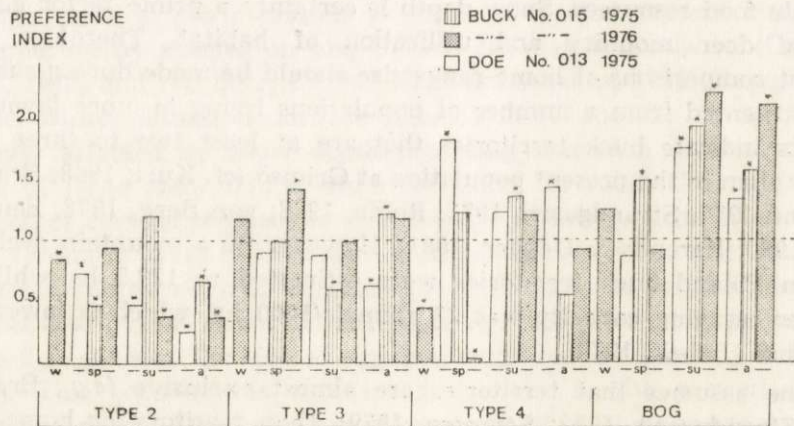


Fig. 4. Preference index for different forest types (including bogs) of Doe No 013 and Buck No 015 during 1975 and 1976. Significant deviation from 1.0 is indicated by (\*).

Index=1.0; observed no. of observations=expected no. of observations  
 Index>1.0; " > "  
 Index<1.0; " < "

tended to select certain forest types in all included seasons (Fig. 4). Both animals showed the similar selection pattern though deviations were pronounced within as well as between seasons. General avoidance was typical for young plantations (type 2) while index approximated 1 in type 3. Preference became more obvious in mature forest (type 4) while reaching the highest preference level in the boggy areas.

#### 5. DISCUSSION

Though living beyond the former edge of its distribution in the north boreal habitat the roe deer has not significantly altered the way of occupying and distribute over a given area. The resident animals are more or less evenly spaced out through aggressiveness and territoriality as is the case in southerly latitudes (Bramley, 1970; Strandgaard, 1972). Once a home range is established the animal will reside there throughout life. Population density of resident animals is considered to be primarily related to food resources and when social carrying capacity is reached (Strandgaard, 1972; Bobek, 1977) the offspring have to emigrate; these conditions are typical in the Grimsö Area (Cederlund & Lindström, 1983; Cederlund in prep.).

Roe deer home-ranges at Grimsö are consistently larger than in southerly areas despite season. During the winter, ranges are at least twice that area found in other European countries (Cederlund, 1982). However, variations are considerable due to prevailing weather situation and available food resources. Snow depth is certainly a prime factor governing roe deer mobility and utilization of habitat. Therefore, most relevant comparisons of home-range size should be made during summer. Data presented from a number of populations living in more favourable habitats indicate buck territories that are at least two to three times smaller than in the present population at Grimsö (cf. Kurt, 1968; Bramley, 1970 and 1977; Strandgaard, 1972; Robin, 1978; von Berg, 1978; Sempéré, 1979; 1980; Barends & Dekker, 1981). However, in a mountain deciduous area in Poland buck territories were estimated to 128.5 ha while the summer carrying capacity was 23 animals/1000 ha, which is lower than at Grimsö (Bobek, 1979).

If one assumes that territories are almost exclusive (*e.g.*, Bramley, 1970; Strandgaard, 1972; Sempéré, 1979), then territory or home-range size will be inversely related to population density. This means that about 10 resident animals of each sex occupy every 1000 ha at Grimsö. However, data was achieved only from middle-aged deer (3–5 years old). Following Bobek (1977) these animals should have a larger territory or home-range than younger animals. Thus, by increasing hunting

pressure the mean age is lowered, enabling establishment of more and younger animals in the area. In contrast, Loudon (1978) did not find any relationship between buck age and territory size. Though too small to allow further conclusions, the present material shows pronounced individual variations in size, probably reduced by a number of factors like topography, social structure, food and shelter.

In accordance with Harestad & Bunnell's (1979) re-evaluation of the relationship between body weight and home-range one could expect differences between age classes as well as between sexes among roe deer. Using the formulated equation for the assumed relationship and field weight data from captured roe deer bucks occupy 6.6% larger areas than do does (67.5 ha vs 63.2 ha; Cederlund & Lindström, 1983). Considering the entire normal winter range the reversed situation was indicated by the present material while daily range was about 16% larger for males. Perhaps annual home-range data provides more relevant comparisons but this subject requires further investigations.

Suggestions by McNab (1963) and others indicate that the home-range concept is closely tied to energy requirement of a particular species. If one hypothesizes that a roe deer utilizes the minimum area than can sustain its energetic requirements, home-range would dynamically change throughout the year. The direction of change in size will depend on the relative amount of utilizable energy and energy requirements expressed as the "law of least effort" (Giest, 1977 cited in Georgii, 1980). This law then implies that roe deer require smaller home-ranges in summer than in other seasons as revealed by the present study. This is supported by studies on elk, *Cervus canadensis* Erxleben (Craighead *et al.*, 1973) and red deer, *Cervus elaphus* Linnaeus, 1758 (Georgii, 1978).

The winter situation for roe deer is more specific since they are strongly affected by snow depth providing extension of total range in times of large snow depth while searching for food (Cederlund, 1982). Like other cervids roe deer is then capable of lowering its basal metabolism (Weiner, 1975). Therefore, during winters when the amount of utilizable energy seem to decrease the deer occupies small home-ranges. For elk and moose, *Alces alces* (Linnaeus, 1758) the shrinkage was found to be 6 to 21% of the size of summer home-range (Harestad & Bunnell, 1979). This tendency is true for roe bucks in the present material regarding daily (14%) as well as seasonal (6%) home-range in normal winters.

Georgii (1980), also considering findings for elk (Craighead *et al.*, 1973) and moose (Phillips *et al.*, 1973), postulated that increase in daily range during summer was primarily induced by increasing energy requirements during late pregnancy and lactation rather than by changes in forage

quality. For roe deer, activity is high (Cederlund 1982), and daily ranges are large prior to parturition in late May and early June. The patchiness of early green plant species in the onset of the vegetation period is probably another important factor governing the movement pattern. Important field layer food species have a quite scattered distribution, which certainly increases searching movements.

Among males, social activities associated with the establishment of the summer territory are high during spring (Ellenberg, 1978) as well as mobility (Cederlund, 1982), which might explain the large home-ranges during this period. The final territory size is obviously smaller and its establishment coincides with the time of maximum availability of high quality food.

Roe deer home-ranges are irregular in shape and size but become gradually spherical with time. Additive data might apply to circular (Mohr & Stumpf, 1966) or a bivariate (Koepple *et al.*, 1975) home-range model. Unfortunately no model incorporating size, shape and pattern is fully applicable for relevant comparisons between areas as well as between animals (Macdonald *et al.*, 1980 and Voigt & Tinline, 1980).

The similarity in annual home-range shape and size among resident roe deer is notable. There is no detectable changes in forest areas in normal succession. However, on clear-cutting of mature forests and in agricultural areas where alterations in farming policy might change the disposition of food and cover from year to year, drastic changes in home-ranges is noticed (Strandgaard, 1972).

Perhaps the residency might be altered in times of social stress and decease. For example a 8-year-old doe without fawns appeared unhealthy during late summer and was observed in an area about one kilometer from her ordinary home-range until she was shot in the autumn. During the summer a young doe with one fawn appeared in her former range.

One can hypothesize that an individual inhabiting a patchy environment utilizes its home-range selectively. If one consider that the roe deer is a selective feeder (c.f. Cederlund *et al.*, 1980) and requires high quality food, which is scattered in north boreal areas one would expect a definite preference for some subareas and avoidance of others. Other factors, such as topography, shelter and water might also affect the utilization. Evidently, roe deer of both sexes establish a home-range around a "core area", which is close to the geometric centre. The frequency of visits in each subarea declines gradually towards the home-range border.

Intensity of fraying and scraping was found to correlate to frequency of locations (Cederlund unpubl. data). In contrast, Sempéré (1980) found

a more peripheral pattern of territorial movements in spring providing a decentralized "core area".

Generally, the roe deer at Grimsö Research Area seem to avoid open areas like clear-cuts (type 1) and bogs, which provide little or no cover and quite small amounts of high quality food and are furthermore exposed to snowdrift and winds. For the other forest types there is no real consistency between years. It is doubtful if the differences in preference (Fig. 3) reflect an actual response to changes in the environment. It is more likely that data indicate the difference in constitution of the habitats within the home-ranges between years. If we consider resident roe deer to be uniformly distributed over the area and the fact that forest-types as defined in this paper are relatively large in relation to average home-range, the likelihood of finding the animals in the most common forest types is strong. For example, doe 013 and buck 015, both living in the same area with bogs covering a large part, showed similar high preference for bogs, which was avoided by roe deer in general. However, the deer were mostly located in proximity to the border of forest areas with higher amount of food and good shelter. These "transient" areas between different habitat types are certainly favourable to roe deer as well as other herbivores. Further information on this subject requires new definitions of habitat types compiled with more detailed analyses of the habitat.

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AREAL OSOBNICZY I WYBIÓRCZOŚĆ ŚRODOWISKA  
PRZEZ SARNY W CENTRALNEJ SZWECJI

## Streszczenie

Badania prowadzono od stycznia 1975 do grudnia 1977 roku. Sarny (15 samców i 17 samic) były śledzone telemetrycznie. Dobowy areal osobniczy (Tabela 1) był wyraźnie mniejszy niż areal sezonowy (Tabela 2). Samce miały średni areal dobowy większy niż samice (25,9 i 18,9 ha). Wykorzystywały one również w ciągu doby większe partie arealu sezonowego. Wielkość zarówno dobowych jak i sezonowych arealów zmienia się w ciągu roku, przy czym największe są one na wiosnę. Żadna badana sarna nie wykorzystywała swego arealu w sposób równomierny. Zazwyczaj wybierały one małe płyty terenu, odległe od siebie o kilkaset metrów. Przynajmniej 80% wszystkich lokalizacji poszczególnych zwierząt, we wszystkich sezonach, było odległych o 400—500 m od centrum obszaru największej aktywności (Ryc. 1). Sezonowe centra aktywności leżą blisko siebie, co wskazuje, że areały sezonowe jak i roczne nakrywają się w znacznym stopniu. Próby dla kozłów i kóz wykazują, że co najmniej połowa ich arealu nakrywa się (Tabela 3). Preferencja środowiskowa zmieniała się także w rytmie sezonowym. Zwierzęta unikały bagien i zrębów a wybierały uprawy, drągowiny i starodrzew (Ryc. 3, 4).