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Habitat use of Raccoon dogs, *Nyctereutes procyonoides*, in southern Finland

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Abstract

Habitat use of raccoon dogs (*Nyctereutes procyonoides*) was studied in southern Finland during the snow-free seasons of 1990–1992 using radio tracking. Habitat selection within the study area and habitat use within the home range were examined. Raccoon dogs favoured shore areas especially during early summer. Shore areas with dense undergrowth provide food (e. g. frogs) and shelter, and raccoon dogs often escape into water when attacked. During autumn, raccoon dogs favoured moist heaths with abundant berries, which serve as an important food source before entering winter dormancy. The habitat use of raccoon dogs is thus affected by the availability of food, shelter and suitable den sites. Two features are common to dogs in all areas: 1) the are very often found near water and 2) during autumn they are more or less dependent on fruits and berries, which affects their habitat selection.

Introduction

In Europe the raccoon dog (*Nyctereutes procyonoides* Gray, 1834) is an introduced canid which has rapidly colonized Finland since the mid-1950s (Helle and Kauhala 1991). Today its population density is rather high in southern and central Finland (Kauhala and Helle 1995), but very little is known of its effects on Finnish native fauna. Knowledge of the diet, home ranges and habitat use would provide background information on possible predation on or competition with native fauna. Home ranges of the raccoon dog in Finland have been studied previously (Kauhala et al. 1993 a), and a preliminary study of its diet in this country has also been published (Kauhala et al. 1993 b).

The aim here was to examine habitat selection within the overall study area, and habitat use within its home range in southern Finland. Habitat use between seasons, mainly early summer and autumn, was also compared.

Material and methods

Habitat types

The study area (about 30 km^2) is located in the boreal zone (25°10′E, 61°14′N) around Evo Game Research Station in southern Finland, and consists mainly of industrial forests, small pine swamps and many small lakes and streams. The forests were classified according to soil type as moist or barren heaths, and also by age: clear cuts (0–2 years), plantations (3–9 years), young forests (10–30 years) and old forests (>30 years). The basis for this classification lies in the undergrowth of each forest type. Moist heaths (including spruce swamps) are more productive than barren heaths (including pine

swamps). Berries (mainly bilberries *Vaccinium myrtillus* and lingonberries *V. vitis-idaea*) grow abundantly in moist heaths, especially in those older than 30 years. Ferns grow abundantly in old spruce swamps, providing shelter for raccoon dogs, while grasses and some raspberries (*Rubus idaeus*) grow in plantations of moist heaths. Few lingonberries grow in barren heaths, where undergrowth consists mainly of lichens and heather.

In addition to forests, the study area includes shore areas, farmyards, a fisheries research station and small fields. Shore areas included all habitats within 50 m of water. I included seven habitat classes in most analyses and figures (for habitat classes, see Fig. 1).

Habitat use

Habitat use of 12 adult (>1-year-old) raccoon dogs was investigated during early summer, midsummer and autumn of 1990–1992, using radio tracking. These animals lived as three pairs (Pair 1: female 33 and male 26, Pair 2: female 30 and male 23, Pair 3: female 140 and male 139) and six single individuals (males 99, 116, 150 and 141 and females 19 and 51). These single raccoon dogs probably also had mates, but these could not be caught. Raccoon dogs were caught with live traps or hounds and fitted with radio collars. They were located several times per week at different times of the day and night during snow-free periods (for details of radio tracking, see KAUHALA et al. 1993 a).

The habitat of each fix (n = 961) was determined and its distance to the nearest lake, pond or stream was measured, while locations within 200 m of a known den were excluded. Harmonic mean home ranges (DIXON and CHAPMAN 1980) were also calculated and the proportion of each habitat type in the 60% core area (mean size 1.3 km^2) determined. Home ranges were calculated only for data sets with at least 35 independent locations (for testing independence, see KAUHALA et al. 1993 a). Thirty-five locations are sufficient for determining home range size (KAUHALA et al. 1993 a).

Although the habitat use of individuals may differ, I first combined the data for all individuals to obtain an overall picture of habitat use in different seasons. I compared the frequency distributions of observed locations (number of locations in each habitat) with that of 532 random fixes from the study area (G-test; SOKAL and ROHLF 1981). Random fixes were obtained by determining the habitat at cross-points of a 200-m grid map overlay. I calculated a selection index for each habitat type to determine which habitats were especially favoured. The selection index is a ratio of the percentage of locations (L) to the percentage of habitat available (H): log L/H (see STORCH et al. 1990). When I compared the proportion of locations in a certain habitat with the proportion of random fixes in that habitat (i.e. tested the significance of the selection index), or compared the proportion of locations in each habitat during different seasons, I used the t-test (comparison of percentages).

I studied the habitat use of the three pairs and the two single females in more detail (those cases with at least 35 independent locations per season). I combined the data of the male and female sharing the same home range (the pairs) because their habitat use did not differ (tested from frequency distributions of locations in each habitat, G-test). I compared the frequency distributions of locations of individuals/pairs with that of random fixes (G-test) and likewise the data for different seasons. I also compared the proportion of each habitat type in the 60% core area with the proportion of locations in each habitat in the home range. The snow-free period was divided into three seasons: early summer or pup-rearing season (May–June), midsummer when pups begin to forage with their parents (July) and autumn when the young disperse and raccoon dogs prepare themselves for winter (August–October).

Results

Combined data for all raccoon dogs studied

Habitat use of raccoon dogs differed between early summer and autumn (G = 52.5, df = 6, P < 0.001); raccoon dogs used more old moist heaths and less shore areas and young barren heaths during autumn than in early summer (Fig. 1). The frequency distribution of locations differed in all seasons from that of random fixes (early summer G = 225.7, df = 6, P < 0.001, midsummer G = 64.3, df = 6, P <0.001 and autumn G = 108.4, df =6, P < 0.001).
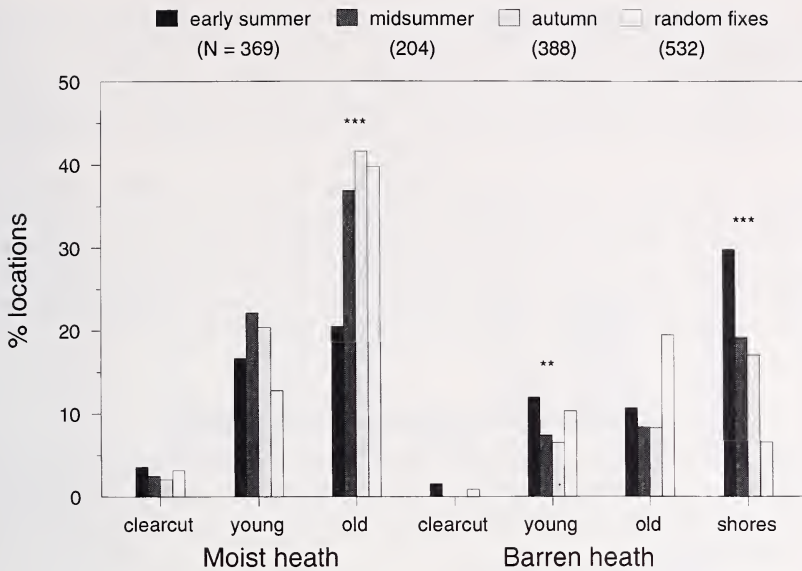
Fig. 1. Habitat use of raccoon dogs around Evo Game Research Station, southern Finland, during early summer (May–June), midsummer (July) and autumn (August–October) of 1990–1992. The statistical differences between early summer and autumn are indicated by asterisks (t-test; * P < 0.05, ** P < 0.01, *** P < 0.001). Random fixes were also obtained from the Evo research area. Clear cuts include 3-9-year-old plantations. Young forests are < 30 and old forests > 30 years old.
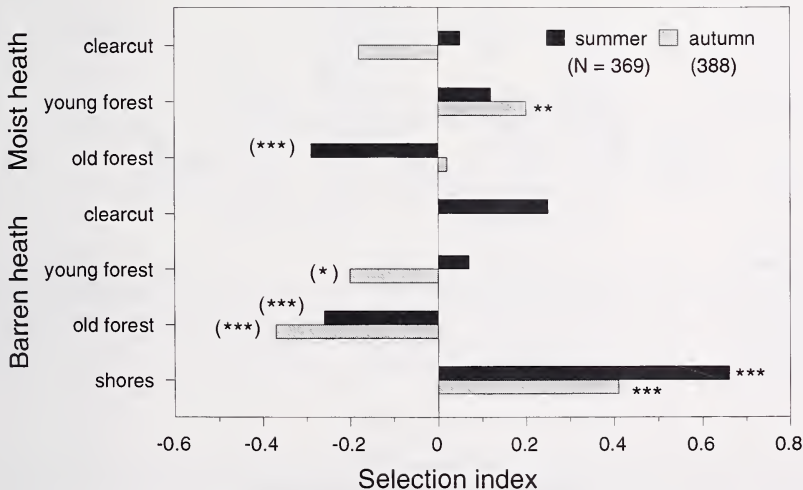
Fig. 2. Habitat use of raccoon dogs in Evo research area, southern Finland, during early summer and autumn of 1990–1992. The selection index is calculated according to STORCH et al. (1990). A positive selection index means that the habitat is favoured, negative values indicate that the habitat is used less frequently than expected. Habitat use is compared with the availability of each habitat which is esti-mated on the basis of the distribution of 532 random fixes from the Evo area. The statistical significance is indicated by asterisks (t-test; * P < 0.05, ** P < 0.01, *** P < 0.001). If the habitat was used less fre-quently than expected the significance is in parentheses (see text).

Shore areas were favoured in early summer and autumn, while young moist heaths were favoured in autumn (Fig. 2). Shores were favoured also in midsummer (P < 0.001). Information on which habitats were favoured is here considered crucial, because the proportions of locations in each habitat are not independent: if the animal spends much time in a certain habitat, it inevitably spends less time in other habitats (Aebischer et al. 1993).

The mean distance of the locations from water was 191 m (SD = 170.2, n = 961). During early summer the distance was 156 m (SD = 146.6, n = 369), in July 193 m (SD = 151.9, n = 204), and during autumn 223 m (SD = 192.6, n = 388). Random fixes were located a mean of 222 m (SD = 161.0, n = 100) from the water. The mean distance from water was significantly smaller during early summer than in the other seasons. During early summer the distance was smaller than that of random fixes (P < 0.001, ANOVA).

Habitat selection of different individuals/pairs

Habitat selection on the basis of frequency distributions of locations (number of locations in each habitat) during early summer and autumn differed from random in all cases studied (Tab. 1). Habitat selection also differed between seasons in the three cases in which it could be tested (Tab. 1)

Table 1. Results of the G-tests for habitat selection/use of different raccoon dog individuals/pairs during early summer (May–June) and autumn (August–October) in southern Finland during 1990–1992. Habitat use was compared with the frequency distribution of 532 random fixes from the study area.

Pair/ind.	Comparison to random	Comparison between seasons
Pair 1		
Summer	G = 58.3, df = 6, P < 0.001	G = 59.0, df = 6
Autumn	G = 51.6, df = 6, P < 0.001	P < 0.001
Pair 2		
Summer	G = 82.6, df = 6, P < 0.001	G = 13.8, df = 6
Autumn	G = 48.3, df = 6, P < 0.001	P < 0.05
Pair 3		
Summer	G = 64.7, df = 6, P < 0.001	
Female 19		
Summer	G = 84.8, df = 6, P < 0.001	G = 13.3, df = 4,
Autumn	G = 23.5, df = 4, P < 0.001	P < 0.01
Female 51		
Summer	G = 48.1, df = 5, P < 0.001	

Habitat use within home ranges

Habitat use of Pairs 1, 2 and 3 and females 19 and 51 was also studied by comparing the proportions of each habitat available within the home ranges (Fig. 3 a) with the proportions of locations in each habitat within the home ranges (Fig. 3 b). During summer, raccoon dogs frequented shore areas more than one would expect on the basis of the proportion of shore areas in the home ranges. Moist heaths were frequented more during autumn than summer, and barren heaths more during summer.
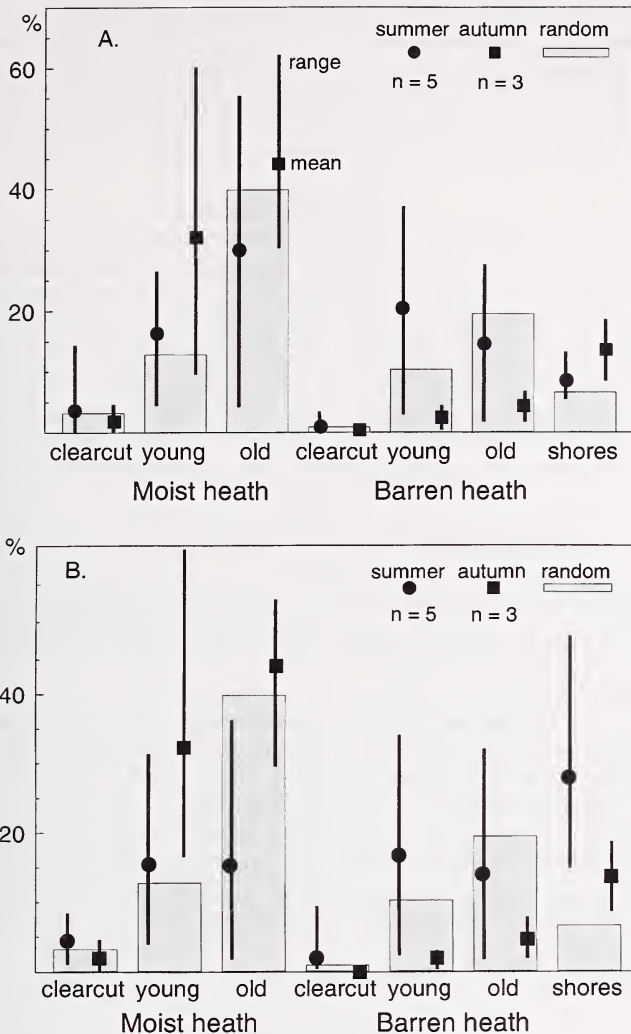
Fig. 3. Proportion (mean, range) of each habitat in the 60% harmonic mean home ranges of raccoon dogs (A) and the proportion of radio locations in each habitat (B) in the Evo research area, southern Finland. Random distribution indicates the proportions of habitats available, and was obtained from 532 random fixes from the research area.

Discussion

Raccoon dogs used shore areas more frequently than expected in all seasons, and more during early summer than midsummer or autumn. This can at least be partly explained by the fact that raccoon dogs frequently prey on frogs which are abundant and easily caught in shallow water in early summer (Barbu 1972; Kauhala et al. 1993 b).

Shore areas were also favoured to some extent during midsummer and autumn. Forests near water are often damp with dense undergrowth which provides shelter for raccoon dogs. In addition, a very typical feature of the raccoon dog is its habit of escaping into water when chased or attacked; thus, raccoon dogs prefer to forage near water.

In Russia, raccoon dogs are also frequently found near water or in damp meadows, swamps and alluvial soil (NASIMOVIC and ISAKOV 1985). They especially favour shore areas with dense reed beds or bushes which provide abundant food, shelter and den sites. A study from the Voronez area showed that 50% of raccoon dog tracks found were located on river banks, although this habitat constituted < 10% of the area (NASIMOVIC and ISAKOV 1985). In Ukraine, 85% of raccoon dog observations were made near water (KORNEEV 1954).

In the present study, moist heaths were also favoured in autumn; raccoon dogs used old moist heaths more frequently during midsummer and autumn than early summer. Berries grow abundantly in moist heaths, and when ripe raccoon dogs frequently forage in this habitat. Berries are an important food source for raccoon dogs before entering winter dormancy. They accumulate large fat reserves. Half of the stomachs collected from southern Finland during August–October contained berries (KAUHALA et al. 1993 b).

In other areas, e. g. in northern Caucasus and in Japan, berries and fruits were found to be important for the raccoon dog in autumn (IKEDA 1985; NASIMOVIC and ISAKOV 1985; M. KISHIMOTO, pers. comm.). MOROZOV (1947) found that raccoon dogs eat large quantities of cranberries (*Vaccinium oxycoccos*) in swamps during autumn, and raccoon dogs have been found to migrate at this time to areas with abundant fruits or berries. If the home range consists of diverse habitats, raccoon dogs usually remain in the same area all year round (NASIMOVIC and ISAKOV 1985).

Some individuals favoured barren heath in early summer. Although fixes very near the den were excluded, the location of the den may have influenced the results. Most dens at the Evo research area are located under large rocks in barren heath. Raccoon dogs probably do not forage in barren heath where the undergrowth consists mainly of lichens and provides little food or shelter.

In conclusion, the habitat use of raccoon dogs is affected by the availability of food, shelter and suitable den sites. The raccoon dog is typically an opportunist, and also lives in European habitats, including coniferous forests, steppe and semi-desert, which are not found in its original distribution area in the Far East (NASIMOVIC and ISAKOV 1985). In the Russian Far East the raccoon dog favours open landscape, especially damp meadows and agricultural land, and avoids dark forests, except in the peripheral parts of its range (JUDIN 1977). A feature common to raccoon dogs in all areas, however, is that they are very often found near water. In autumn they commonly forage in habitats were they can find abundant fruits or berries.

Acknowledgements

Zusammenfassung

Habitatnutzung beim Marderhund, Nyctereutes procyonoides, im südlichen Finnland

Habitatnutzung beim Marderhund (*Nyctereutes procyonoides*) wurde im südlichen Finnland während der schneefreien Periode in den Jahren 1990–92 mit Radiotelemetrie untersucht. Die Habitatwahl innerhalb des ganzen Untersuchungsgebietes und die Habitatnutzung innerhalb individueller Aktionsräume wurden erforscht. Die Marderhunde bevorzugten Uferbiotope insbesondere im Frühsommer. Ufer mit dichter Untervegetation bieten Nahrung (z. B. Frösche) und Schutz. Marderhunde fliehen bei

Bedrohung oft ins Wasser. Im Herbst bevorzugten die Tiere feuchte Heidewälder mit reichlichem Bee-renangebot. Die Beeren sind wichtig in der Vorbereitung für die Winterruhe. Dementsprechend ist die Habitatnutzung des Marderhundes vom Nahrungsangebot, Schutz und auch günstigen Bauen abhängig. Zwei Eigenschaften sind bezeichnend für die Marderhunde überall: erstens befinden sie sich sehr oft an Gewässern und zweitens beeinflußt das Frucht- und Beerenangebot ihre Habitatwahl durch Abhängig-keit von dieser Nahrung.

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