



The range use of red deer (*Cervus elaphus*) hinds in a forest-agricultural land habitat-complex

Ph.D thesis

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## **1. Introduction**

### ***1.1. Theoretical and practical background***

The investigation of individual habitat use with radio tracking became possible in the last three-four decades. However many studies were carried out including numerous species, only few, generally accepted theories were established. One of the most important questions is the determination of individual home range sizes and the clarification the movements on a large scale (migrations). The theory of optimal behavior (Krebs and Davis 1978) and the relation between the body weight and home range size (McNab 1963, Harestad and Bunnel 1979) can help in answering the question, but other factors as the habitat quality, heterogeneity, productivity, the seasonal changes of these factors, the feeding strategies, the mating system (Clutton-Brock et al. 1982, Clutton-Brock and Albon 1989, Ford 1983) and the theory of ideal free distribution (Fretwell and Lucas 1970) also can play role. Further problem is that the results deriving from the investigations of different species or in different biotopes are often controversial and their applicability in our research is restricted. It is particularly true for those special biotopes like the forest-agricultural land habitat-complexes. These kind of habitat-complexes are interesting because of their increasing expansion, and because their two components differ significantly for example in resource supply, in stability, in predictability of changes etc., which factors are important for habitat use of large herbivores. Moreover the red deer has outstanding importance in game management. The deer hunting can produce big incomes, but, due to the habitat changes, the deer population is increasing and expanding. These process results increasing game damages and a resolvable conflict.

We started a long term research program by the support of Ministry of Agriculture to develop an ecologically based red deer management. As the leader of this research work I show some results in this thesis.

## ***1.2. The aims of the study***

I selected the following aims for my thesis:

- to describe the seasonal range use intensity of red deer population in a forest-agricultural land habitat-complex;
- to determine the characteristics of seasonal home range (HR) changes of red deer hinds to distinguish the HR expansion and HR shift;
- to study the factors acting on the seasonal HR sizes of hinds;
- to investigate the flexibility of HR shift in time and space;
- to study the possible causes of HR shift: the effect of food supply and selection;
- to recommend alteration in red deer management.

## **2. Material and methods**

### **2.1. The study area**

The studies were carried out on the southern part of the area between Danube and Theiss River between 1993 and 2001. The size of the study area was approx. 100000 ha, and it was divided into two different parts. The afforested part (forest) was 20000 ha large, dry, sandy, hilly area. The other was a 15-20 km wide, agricultural land on the former floodplain of Danube dissected by channels. The forest is composed of settled black locust (*Robinia pseudoacacia*, 44%) and pines (*Pinus silvestris* and *P. nigra* 18%). Bush coverage in black locust forest was 20% and it was dominated by hawthorn (*Crataegus monogyna*). The agricultural land was covered by cultivated fields (89%), and by small patches of willow-poplar forests (4%). Reed (*Phragmites communis*) was common along channels. The most frequent cultivated plants were the wheat (*Triticum aestivum*, 36%) and the corn (*Zea mays*, 32%). Smaller alfalfa (*Medicago sativa*), sunflower (*Helianthus annuus*), barley (*Hordeum vulgare*) fields and meadows covered the remaining parts.

Red deer spread to the area from southward in the fifties. The estimated population size was 1200 individuals in 1993.

### **2.2. Methods**

#### **2.2.1. Footprint and bed site density estimation**

Footprint and bed site density estimation were carried out to assess the seasonal distribution of deer population between the two habitat types. Two crossing lines were chosen for footprint density estimation in both habitats (forest: 28.95 km, agricultural land: 25.56 km). The counting was repeated three times a season. We recorded the number of the individuals which had used the track (intensity of use). We continued the estimations from 1995 to 2000.

The bed site density estimation was used to complete the previous method. The footprint density depends not only on the number of individuals but on their activity too. In

spite of this the bed site density represents a longer period and it is less affected by activity. We laid down 4 parallel lines in north-south direction in both habitats (total length in forest: 16.9 km, on agricultural lands: 31.3 km). The estimation were made in the time of footprint counts but only once a season from 1995 to 1998.

We used three-way ANOVA, one-way ANOVA, t-test and Welch-test, Duncan-range test and Pearson-correlation (SPSS 10.0) for statistical analysis.

### **2.2.2. Radio tracking and data analysis**

We captured the animals with blow net on 14 sites in the forest in 1993-2000. We endeavored to mark adult hinds belonging to different family groups. Consequently we marked only 36 hinds from the approx. two hundred captured deer. The captured animals were immobilized to decrease the stress. We estimated the age of every individual by tooth wear, and then tagged the small (150-170 g) radio collar (Televilt AB, Sweden).

We localized the marked animals at least once a week daytime. We used Televilt RX 900 B, C receivers and H-antenna. The duration of radio tracking (at least two years) in case of 28 animals from 36 were enough for data analysis. We collected 4131 localizations of these animals altogether. We estimated the seasonal HR sizes (90% kernel-estimation) and the core areas (60% kernel-estimation). The summer HR fidelity was investigated on 4 resident and 4 shifter individuals. All of them were older than 4 year. The year-by-year variability of the individual habitat use was characterized by the distance of the centroids and relative overlaps of summer HR-s. We used Tracker 1.1 software (Camponotus AB, 1994) for data analysis. The statistical tests were made by SPSS 10.0. We used paired t-test, one-way ANOVA, Tukey-Kramer post-hoc test and Kolmogorov-Smirnov test where it was necessary.

### **2.2.3. Analysis of food**

We made vegetation survey on the most intensively used areas by hinds to determine the food supply. We completed the digitalized forestry database with satellite images and field investigations. The coverage of dominant plant species and groups were estimated on 500 ha large sampling area in the forest and on 100 ha on agricultural land. In the forest 17, 10 m<sup>2</sup> large, on agricultural land 13, 0.25 m<sup>2</sup> large quadrates were assigned systematically. We

recorded every quadrat in every two weeks between 15<sup>th</sup> of June and 15<sup>th</sup> of July 2000, when the deer moved from the forest to the fields.

We could not exclude the possibility of daily movement between the two habitat types by the daily radio localizations. To eliminate this doubtfulness we investigated whether the indicator plant species (which occur exclusively one or the other habitat) can be found in the faeces samples collected in the other habitat type. The indicator plants had been chosen after a detailed vegetation survey. We chose the black locust (*Robinia pseudoacacia*), pines (*Pinus spp.*) and black horehound (*Ballota nigra*) in the forest and goat willow (*Salix caprea*), wheat (*Triticum aestivum*) and corn (*Zea mays*) in the agricultural habitats. We collected faeces samples for analysis in June of 1998 and from April to November 2000 in every two weeks ( $n_{\text{forest}} = 237$ ,  $n_{\text{fields}} = 149$ ).

The detection of indicator plants and the diet analysis were carried out with micro histological faeces analysis. Homogenized mix samples were made for every habitat and every date. 100 epidermis fragments were identified from every samples using reference collection (Mátrai et al. 1986). We estimated the proportion of plant species and plant groups on the basis of epidermis fragment number. We used  $\chi^2$  homogeneity and goodness tests and Bonferroni Z-test for statistical analysis.

We determined the food quality of red deer too. We collected a 300 g sample of those parts of plants which were really eaten. We collected those plants which were above 5% in the diet only. The sample collection was made in time of vegetation surveys. The samples were stored on minus 20°C. The samples were dried on 105°C for 4 hours and then the dry matter content was measured. After that the crude protein, the crude fiber, the crude fat, the crude ash and nitrogen-free extract content were determined by weendei-method (Church and Pond 1988). We analyzed not only the plant samples but the characteristic plant mixture consumed in given time and habitat. We used  $\chi^2$  homogeneity tests and Bonferroni Z-test for statistical analysis of differences between habitats.

### **3. Results**

#### ***3.1. Seasonal habitat use on population level***

The foot print densities differed significantly among years, seasons and habitats as well (3-way ANOVA:  $F(45, 326)=8.11$ ,  $p<0.001$ , for years:  $F(5, 326)=3.2$ ,  $p<0.01$ , for seasons:  $F(3, 326)=13.48$ ,  $p<0.001$ , for habitats:  $F(1, 326)=120.49$ ,  $p<0.001$ ). The seasonal values differed significantly in forest (one-way ANOVA:  $F(3, 134)=15.75$ ,  $p<0.001$ ). The values were smaller in summer than in autumn-winter (Duncan-range test,  $p<0.05$ ). We also found significant seasonal differences on the fields (one-way ANOVA:  $F(3, 230)=16.61$ ,  $p<0.001$ ). The values in spring were significantly higher than in winter but they were smaller than in summer and autumn (Duncan-range test,  $p<0.05$ ). The foot print density was significantly higher in the forest than on the agricultural land in winter (Welch-test:  $t=12.51$ ,  $df=82$   $p<0.001$ ), in spring (two sample t-test:  $t=9.77$ ,  $df=94$ ,  $p<0.001$ ) and in autumn too (two sample t-test:  $t=2.87$ ,  $df=94$ ,  $p<0.005$ ), however there was no difference in summer (Welch-test:  $t=-0.214$ ,  $df=92.86$ ,  $p=0.83$ ).

The bed site density changed significantly by years and habitats (3 way ANOVA:  $F(29, 105)=3.43$ ,  $p<0.001$ , for years:  $F(3, 105)=3.04$ ,  $p<0.05$ , for habitats:  $F(1, 105)=25.75$ ,  $p<0.001$ ), but it did not among seasons ( $F(3, 105)=1.23$ ,  $p=0.3$ ). There were significant seasonal differences in the forest (one-way ANOVA:  $F(3, 55)=4.07$ ,  $p<0.05$ ). The values were significantly higher in winter than in summer or autumn (Duncan-range test,  $p<0.05$ ). Controversially there were no significant differences on the agricultural land (one-way ANOVA:  $F(3, 72)=2.34$ ,  $p=0.08$ ). Here the smallest values were in winter, when no bed sites were found. The bed site density was higher in the forest than on the agricultural land in winter (Welch-test:  $t=5.24$ ,  $df=11$   $p<0.001$ ) and in spring (Welch-test:  $t=2.19$ ,  $df=21.07$ ,

$p<0.05$ ). There was no difference between the habitats in summer (Welch-test:  $t=-0.09$ ,  $df=27.76$ ,  $p=0.93$ ) and in autumn (two sample t-test:  $t=0.18$ ,  $df=33$ ,  $p=0.86$ ).

### ***3.2. The features of range use***

Our radio tracking showed that every marked hinds were in the forest in winter. However 9 individuals out of 28 shifted its HR from the forest to the agricultural land in summer (“shifter” strategy), while 19 hinds stayed in the forest whole year (“resident” strategy). The action radiiuses of seasonal HR-s were significantly smaller than the distance of their centroids ( $0=3.0$  km,  $SD=1.0$  in the forest,  $0=2.0$  km,  $SD=0.7$  on the agricultural land,  $0=8.9$  km,  $SD=2.1$  between the habitats, one-way ANOVA:  $F(2,52)=121.86$ ,  $p<0.001$ ). No indicator species of forest was found in the faeces collected on the agricultural land or vice versa.

### ***3.3. The stability of HR shift in time and space***

The year-by -year overlap of seasonal HR-s and core areas was relatively small in case of resident and of shifter animals as well. However the relative HR overlaps in consecutive years were one third higher in case of residents than in case of shifters but the difference is not statistically significant (two sample t-test,  $t=1.92$ ,  $df=33$ ,  $p=0.064$ ). But the overlap of core areas was nearly the half at shifters as it was at residents (two sample t-test,  $t=2.385$ ,  $df=33$ ,  $p=0.023$ ). The shift of HR centroids is a bit bigger at shifters, but it is not statistically significant (two sample t-test,  $t=-1.726$ ,  $df=32$ ,  $p=0.094$ ). We did not find any individual, which could change between the strategies.

### ***3.4. The seasonal HR size***

The winter HR-s were larger than the summer ones in case of both strategies (paired t-test: shifters:  $df=20$ ,  $t=-4.35$ ,  $p<0.001$ ; residents:  $df=41$ ,  $t=-2.95$ ,  $p<0.01$ ). We got similar result for core areas too (paired t-test: shifters:  $df=20$ ,  $t=-3.39$ ,  $p<0.01$ ; residents:  $df=41$ ,  $t=-$

2.49,  $p<0.05$ ). There were no differences nor in HR (two sample t-test:  $df=62$ ,  $t=-0.12$ ,  $p>0.05$ ), nor in core area sizes (Welch-test:  $df=28.76$ ,  $t=0.009$ ,  $p>0.05$ ) between strategies. But the shifters' HR (two sample t-test:  $df=70$ ,  $t=2.52$ ,  $p<0.05$ ) and also the core area size (Welch-test:  $df=30.56$ ,  $t=2.6$ ,  $p<0.05$ ) was significantly larger in winter in the forest.

### ***3.5. The causes of seasonal HR shift: feeding***

The deer diet differed significantly between habitats in both years on the basis of plant groups ( $\chi^2$  homogeneity test:  $df=2$ ,  $\chi^2=43.15$ ,  $p<0.005$  in 1998;  $df=2$ ,  $\chi^2=27.3$ ,  $p<0.005$  in 2000). The diet was similar between years in both habitats, but it could be supported statistically for the forest only ( $\chi^2$  homogeneity test:  $df=2$ ,  $\chi^2=3.5$ ,  $p>0.05$  in the forest;  $df=2$ ,  $\chi^2=7.6$ ,  $p<0.05$  on the agricultural land). Deer consumed browses mainly and significantly fewer grasses or forbs in the forest ( $\chi^2$  test of goodness:  $df=2$ ,  $\chi^2=54.88$ ,  $p<0.005$  in 1998,  $df=2$ ,  $\chi^2=51.06$ ,  $p<0.005$  in 2000). The preference toward browses particularly black locust was notable ( $p<0.05$ ). The consumption on grasses and on browses was high on the agricultural land ( $\chi^2$  test of goodness:  $df=2$ ,  $\chi^2=22.1$ ,  $p<0.005$  in 1998,  $df=2$ ,  $\chi^2=13.52$ ,  $p<0.005$  in 2000). The preference of browses is positive here also but the preference of grasses is negative ( $p<0.05$ ). The consumption on cultivated plants was lower, than it was expected ( $\chi^2$  test of goodness:  $df=1$ ,  $\chi^2=178.57$ ,  $p<0.005$  in 1998,  $df=1$ ,  $\chi^2=229.36$ ,  $p<0.005$  in 2000). The proportion of alfalfa and wheat was 6% in 1998, but in 2000 only 4% for alfalfa. The consumption on corn was under the detectable level in both years.

The nutritive content of deer diet was similar in 1998 but differed in 2000 between habitats ( $\chi^2$  homogeneity test:  $df=4$ ,  $\chi^2=7.23$ ,  $p>0.05$  in 1998;  $df=4$ ,  $\chi^2=16.41$ ,  $p<0.005$  in 2000). The crude protein content was higher; the crude fiber content was lower in the forest diet. The crude fat, ash and nitrogen-free extract content were similar in 1998. However higher ash and lower in nitrogen-free extract content were measured in agricultural diet in 2000.

#### **4. New scientific results**

1. We pointed out, that the distribution of red deer population changed cyclically within the year: deer are concentrated in the forest in winter. Big number of deer appeared on agricultural lands at the beginning of summer. However our data did not confirm the hunters' opinion, that the forest is empty in summer. The deer density was similar in two habitats or a little bit higher in the forest.
2. We did not find any sign of long-distance migration, which concerns the big part of the population, that it was supposed earlier.
3. We distinguished two range use strategy: the “resident” and the “shifter” We rejected the hypothesis of “expander” strategy.
4. We revealed, that the strategy fidelity of adult hinds is high, namely the deer did not changed between the strategies.
5. We pointed out that the HR fidelity of red deer hinds is relatively high. The changes in habitat quality have only restricted effect on it.
6. We revealed, that nor the body size, nor the habitat productivity, nor did the habitat heterogeneity hypothesis not explain the seasonal HR sizes. According to habitat productivity hypothesis the winter HR-s were larger than the summer ones at both strategy. But the shifters had larger HR-s in the forest in winter than the residents.
7. We proved, that the HR shift could not be explained nor by the food supply nor by the differences in food quality. The deer did not feed on the cultivated plants principally on agricultural land, and the plant mixtures represented the deer diet on agricultural land were not better in nutrient content than the forest ones.

## **5. Conclusions**

### ***5.1. Seasonal habitat use on population level***

The results of footprint and bed site density estimation showed, that the distribution of red deer population changed cyclically within the year: deer are concentrated in the forest in winter. This result supported the observations of game keepers. Equalization was observed in summer, big number of deer appeared on agricultural lands at the beginning of summer. The deer density was similar in two habitats or a little bit higher in the forest. Consequently our data did not confirm the hunters' opinion, that the dry forest, which is poor in food, became practically empty in summer, and the majority of deer should use the rich agricultural land. Hence we think, that game keepers had good knowledge about the distribution of red deer population in hunting season (1<sup>st</sup> of September-15<sup>th</sup> of February), but it is not true in the remaining part of the year.

Similarly our observations do not support the result from North-America that the white-tailed deer density is one and a half-twice times higher on agricultural land, than in forest (Vander Zouwen and Warnke 1995, Osborn and Jenks 1998). The higher density is caused by the consumption of cultivated plants on the basis of their supposition. The deer density did not exceed the forest one on the agricultural land in our study, and the foraging on the cultivated plants was very low.

### ***5.2. The features of range use***

The appearance of red deer on the agricultural lands is a well known fact (Petrak and Streubing 1985, Briedermann et al. 1989). However the individual behavioral mechanisms are not known in the background. We investigated this behavior.

We did not find any sign of long-distance migration, which concerns the big part of the population, that it was supposed earlier. The majority of the marked animals stayed in the forest whole year and used a definite, several ha large HR.

We investigated the seasonal habitat use. Our results came from two complementary studies. The individual radio-tracking and the detection of indicator plants characteristic for

one or other habitat allowed us to eliminate the problems, which derived from the detachment of feeding and resting areas in time and space. We supposed, that if the deer are resting in the forest at daytime and feeding on agricultural land at night (“expander” strategy), then we should localize marked animals in the forest, and we should detect agricultural indicator plants in feaces collected in forest. But it did not happen. The definite separation and big distance of forest and agricultural land HR fragments go against that as well. We can conclude that the long distance HR shift of several individuals from the forest is in the background of deer appearance on agricultural land in summer. There is no daily movement between habitats after shifting. So we distinguished two range use strategy: the “resident” and the “shifter”. We rejected the hypothesis of “expander” strategy. We suppose, that the HR expansion to both habitat type could result in a too big HR size, which could be too costly for the individuals. The costs probably exceed the benefits of a more heterogeneous and more diverse area (Ford 1983).

We revealed, that the strategy fidelity of adult hinds is high, namely the deer did not change between the strategies. As a consequence we suppose, that the individuals do not decide about the HR shift. Probably they continue that behavior, which they learnt when they were young (Georgii and Schröder 1983). So both behavioral strategies can hold up together in the population.

We know quite few about the differences of resident and shifter strategies and about the possible advantages and disadvantages of these kinds of behavior. Let's suppose, that the forest and the agricultural land is not equal in habitat quality. By the simplest assumption then, that the individuals use the available area according to the ideal free distribution hypothesis (Fretwell and Lucas 1970). In this case both strategies have equal increments. But we do not know what depend on the individual strategy selection. It is possible, that the individual rank in hierarchy plays important role. Clutton-Brock et al. (1982) and Clutton-Brock and Albon (1989) supposes that deer do not aggregate in better patches in high number (for instance around feeding sites) because the dominants occupy these sites and keep away dependants. According to those arguments we suppose that either the dominants shift to the agricultural land (it is better habitat than the forest in this case) or the dependants are crowded out from the forest (if the forest is better). Several data in the literature allude to the fact, that the agricultural lands provide better resources for deer (Andersen and mtsai. 1998, Faragó and Náhlik 1997, Osborn and Jenks 1998, Vander Zouwen and Warnke 1995). But we do not know accurately neither the differences in habitat quality from the view of deer, nor the ranks of the individuals following different behavior at present. Our results on nutritive content of

deer diet confirm that several important parameters of the forest diet (crude protein, crude fiber content) are similar or better, than the agricultural ones. Consequently it seems to be more probable that the dependants are crowded out from the forest. The considerably increasing population after kindling and the breaking up the big groups before the habitat change can be additional factors; consequently the strength of intraspecific competition can increase (Clutton-Brock et al. 1982).

The different explanations necessitate different game management and game damage prevention activities, so this knowledge has to be used in the professional management in forest-agricultural land habitat-complexes.

### ***5.3. The stability of HR shift in time and space***

There were no significant differences in HR and in core area sizes, or in centroid shifting comparing the residents and the shifters. The relative overlap of summer HR-s and core areas in case of shifters were smaller, than in case of residents. However the average HR overlaps were relatively small. Deer hinds seem to change their habitat use year-by-year in both habitats. They shift their HR a little, but the overlaps with the previously used area are considerable. The shift of the most intensively used area (the core area) is bigger on agricultural land, which is more variable year-by-year. These results suggest that the individuals answer the habitat changes, and adapt their habitat use to that. This answer is restricted and happens within 1 km. This corresponds to the results of Conradt et al. (1999a).

The habitat use of red deer is complicated behavior. It seems that it depends not only on the learning, but the environmental changes have restricted influence on it. We should use this knowledge in the manipulation of habitat change behavior, to direct it with the alteration of habitats. It would be useful to take these into consideration at in planning of game management and environment alteration.

### ***5.4.. The seasonal HR size***

The affect of alternative habitat use strategies on HR size is hardly studied on deer. The red deer HR sizes in different habitats showed big variability (Mysterud et al. 2001). That is the reason why we studied the HR sizes of red deer hinds belonging to the same population

but using different habitats. We predicted the seasonal HR size on the basis of three general hypotheses. The body size hypothesis predicted similar HR sizes in both habitats and in every season for residents and shifters. However the habitat productivity and habitat heterogeneity hypothesis predicted different HR sizes in two habitats in summer but similar in winter.

The winter HR-s were bigger for both strategies than summer ones. This corresponds to the prediction of habitat productivity hypothesis (Harestad and Bunnel 1979). The HR sizes of shifters and residents were similar in summer in our study. It was predicted by body size hypothesis. But regarding to the habitat productivity hypothesis the similar HR size could show, that the forest and agricultural land can provide similar habitat in quality for red deer hinds. This could be adverse with the broadly accepted assumption, that the agricultural land provides significantly better resources for red deer in vegetation period than the forest do.

We expected larger HR-s on agricultural land because of the smaller heterogeneity, than in the forest. In spite of this we got similar HR sizes. The background of this contradiction can be a scaling problem. We can imagine that the heterogeneity does not affect on HR size by a continuous function but there are some threshold values. The too large patches, for instance, can act as barriers. Conradt et al. (1999) found that the yearlings and the young hinds leaving the family group do not diverge for more than several hundred meters, not even, if they could find noticeably better habitats within 1-2 km. Their comment is that the risk of this exploration could be too high. It is possible that the animals do not use the whole agricultural land. They can use only the edges of large fields. So the heterogeneity of the really used area can be bigger than the heterogeneity of the whole area and can be close to the heterogeneity of the forest. We can confirm or reject this assumption by the testing the distribution of localizations later.

Regarding that the predictions of two hypotheses based on habitat quality were contrary; we can suppose effect equalization. Theoretically it is possible that the less heterogeneity of agricultural land is compensated by the higher productivity. The food analysis goes against this. The detailed investigation of HR-s on agricultural land is necessary to answer the question.

Perhaps the most interesting result is that the shifters use larger HR-s than residents in the forest in winter. Considering that the prediction of habitat productivity hypothesis was confirmed previously, the bigger HR could show less productive habitat. It could mean that the shifters use worse patches in the forest.

None of the hypotheses explain the HR sizes in the forest-agricultural land habitat-complexes satisfactory. I think that one of the weakness of the tested hypotheses is that those do not take into consideration the individual differences and social factors. The dispersion of deer is not even on a given area, but the individuals assemble to smaller or bigger groups and use different areas. The social interactions (learning, aggression etc.) influence the habitat use (the separation of shifters and residents in space and the HR sizes) strongly.

### ***5.5. The causes of seasonal HR shift: feeding***

One of our assumptions was that the deer eat cultivated plants mainly in agricultural land. But this was not true. The cultivated plants were rather negligible than dominant in deer diet. It was true nevertheless the cultivated plants were available easily in big quantity on agricultural land. So we conclude that this does not cause the habitat change.

The comparison of the diet quality did not confirm our supposition that deer consume on plants with better nutritive content on agricultural land. There was no difference in food quality in the two habitats in 1998, but it was in 2000 when the forest diet quality was better. The significantly lower protein and higher fiber content of diet is disadvantageous for deer on the agricultural land. It is contrary to the supposition of Georgii (1980) Schmidt (1993) and Borkowski and Furubayashi (1998) which says that the cause of habitat change can be find in these parameters.

Another possible cause of habitat change could be the interaction among individuals. It was pointed out that these are the main factors affecting the habitat use of stags (Clutton-Brock et al. 1982). We can suppose that this factor can be important for the behavior of hinds too. The movement from the forest to the agricultural land can serve for decreasing the intrasexual competition. Moreover we can assume that there is not noticeable difference between the forest and agricultural habitat for the deer in summer. Consequently the habitat change (shifter strategy) is neither advantageous nor disadvantageous comparing to resident strategy. This could be in accordance with the predictions of ideal free distribution theory (Fretwell and Lucas 1970).

To summarize I think that the investigation of the social interactions and the profitability of different strategies could help to understand the causes of the seasonal habitat change in the forest-agricultural land habitat-complexes, and to accept or reject the theories explaining that behavior. We are not able to explain this phenomenon now. But the

professional game management needs more knowledge about the factors and causes of this behavior. It seems that the excessive simplification, which is very frequent, lead to false conclusions and management.

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