University of Sopron

Faculty of Forestry

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Doctoral (PhD) dissertation theses

CHARACTERISTICS OF HABITAT USE AND FEEDING HABITS OF RED DEER AND THEIR EFFECT ON BROWSING DAMAGE IN SOPRON MOUNTAINS

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1. Introduction, objectives

Of the large ruminant game species in Hungary, red deer can be called a "key" species because of its impact on forest ecosystems. Due to the distribution area and increasing population of red deer over the past few decades, the species plays a primary role in wildlife damage to forests. Therefore, possessing as much information as possible about the behavioral characteristics, diet characteristics, role in game damage, and the forest-related implications of red deer is essential. The author chose his dissertation topic based on the aforementioned statement, and examined the habitat use and dietary habits of red deer in highland areas using several methods to determine the role red deer play in the development of wildlife damage in forests.

At the beginning of the investigation, the author sought answers to following questions:

1. Can seasonal differences in the home range developement of red deer in the Sopron Highlands be detected, and if so, do any pecularities or differences exist according to sex?
2. Are there any observable seasonality differences in reforestations, or can the use of these areas for the purposes of feeding or sheltering be differentiated?
3. Which factors play a role in the use of reforestations / young forests? Does the edge effect occur?
4. While examining diet selection of the known vegetation, is it possible to determine the specificities of the forest management aspects, especially with the occurrence of browsing damage?
5. Do the different characteristics of forest regeneration exert any effect on the development and extent of browsing damage?

2. Materials and methods

The research was conducted in the Sopron Highlands and utilized several testing methods. Statistica13 and Past statistical software were used for the statistical analysis and graphical representation of the dissertation.

GPS telemetry - GPS signal collars were fitted onto 7 red deer hinds and 3 red deer stags from 03/03/2005 to 18/02/2011. The collars tracked the positions of the collared individuals hourly. Over the data collection period, the ten GPS collars recorded 99,314 positions over the course of 108 months. During map

processing, the data were classified yearly, seasonally, and monthly. The author analyzed the movement, habitat use, and preferences of the collared individuals.

Examinations of red deer diet – The stomachs of 32 individuals were collected to discover the diet of red deer outside the vegetation period. Of the collected individuals, 13 were young (calves) and 19 were adults (hinds). The rumen contents were macroscopically and microscopically processed to determine diet composition. In the macroscopic examination, the unit samples were washed with a 3.15mm sieve and then sorted. The author conducted an epidermical determination of the contents in the microscopic study after the samples had been washed. Components between 1 and 1.6 mm were destroyed, and after the staining of the epidermis was removed, a species determination was completed, followed by the determination of the consumption frequency of each plant.

Examination of forest regeneration use and damage characteristics - The investigation was conducted in 10 forest segments over three years. The most significant differences between the areas are seedling height, the size of the reforestation area, and the plant abundance characteristics. Red deer winter habitat use, the degree of browsing damage, and the vegetation abundance of the areas were determined with the aid of row transect surveys and measurements taken in sample surveys.

3. Results

The most important investigation results are presented in the form of responses to the five questions identified in the objectives.

1. Both seasonal differences and sex differences can be detected and justified in the development of red deer home range and habitat use in the Sopron Highlands. The size of home range areas lag behind in the rest of the country due to the high homogeneity of the area's resources and the low proportion of open habitats. Stags showed a higher degree of movement, and the seasonal development of the habitat did not play much more of a role than it did in the case of hinds where the effects of the sources could be well separated. Additionally, stags showed a greater degree of movement. Furthermore, stags used crop fields more intensively, while hinds largely preferred grasslands. This indicates that the two sexes used different parts of the Sopron Highlands for the majority of the year.

2. It can be established and proven with $\chi 2$ testing that 0-5-year-old red deer were active during the night, predominately for feeding, while 5-to-15-year-olds were active in the daytime and used the higher-situated places for sheltering. Seasonality differences occurred only within age groups and no

notable seasonality differences between the age groups was observed. Occurrence frequency was higher within the age groups during the vegetation period (spring, summer) than it was outside the vegetation period (autumn / winter). There was a significant difference between the summer and winter ($p = 0{,}000$) and summer-autumn ($p = 0.001$), the spring-autumn ($p = 0.004$), the spring-winter ($p = 0.028$), the summer ($p = 0.003$), and summer-winter ($p = 0.022$). The difference in density between spring-winter ($p = 0.009$) and summer-winter ($p = 0.001$) was justified. This can be attributed to the greater leafy coverage during the vegetation period and higher biomass amount produced by green leaf shoots in the vegetation period. This also implies that the number of positions in the ages for all age groups exceeded 34% beyond the vegetation period when the amount of food in the forest decreases and the danger of wildlife damage increases in reforestations.

3. Study results point to a moderate – negative correlation between the size of the reforestation area and red deer pellet groups; that is, smaller reforestations were used more intensively. This implies two aspects that both play a role: smaller afforestations can be safer and the microclimatic exposure is more favorable for deer in these restricted areas, especially during winter when thermoregulation plays a particularly important role. No verifiable correlation between the other two factors – seedling height and plant abundance – was found. The explanation for this could be partly the forest segments that formed the study area where the occurrence of feces was dependent on the "amount of nutritive vegetation" and partly by the "sheltering – seedling height," which created conditions where the two effects equalled each other out. This assumption is supported by the multivariate regression, which also showed a moderate correlation, with the greatest factor being area size, followed by seedling height, and the plant abundance.

For each pellet group discovered, the minimum distance measured from the forest edge was determined, which was closely related to the reforestation area and increased linearly with the growth of the forests. Reforestations were grouped according to size (0-1 ha, 1-3ha, 3-5ha, 5-10ha). The differences were statistically justified; that is, the greater the reforestation, the greater the average of the smallest margins of the feces. Based on this, the grouping of pellet groiups in the immediate vicinity was not observed in larger areas. This is evidenced by the frequency of the pellet groups depending on the distance from the forest edge. A steep flow curve can be observed in the case of 0-1 ha, and then the slope decreases according to area size and becomes uneven for the largest area size. Based on these

observations, it can be stated that the edge effect decreases with the size of the reforestation area for red deer.

4. The macroscopic study results found that 23% of the nutrition in the highland habitat was found in grasses in all samples. Shoots and leaves produced 57% and yielded 20% in the samples. Within the group of shoots and leaves, the highest proportion (74%) was represented by the leaves of dicotyledons; the shoots followed far behind (16%) because leaves have better digestibility properties than shoots. The evergreens lagged behind the leafy species, but the proportion of leaves (8%) was higher than the proportion of shoots (2%), with the former being 37% and the latter being 28%. Based on this, from the point of view of nutrition, the three basic components are the leaves and shoots of monocotyledonous and dicotyledonous plants. On the other hand, as long as a sufficient amount of grazing surface (shrubs, woods and dicotyledonous herbs) is present in the habitat, the browsing damage to shoots may remain low, but if consumption is delayed or limited by long-lasting snow cover, the seedling browsing can increase. Moreover, this process can be triggered if consumption of available crops is reduced because their 20% level of consumption is significant.

Blackberry was found in all samples in the microscopic examination, while the main tree species were 70% in pine, 52% in oak, and 40% in beech. The most common species were the linden (81%), followed by the hornbeam (75%), and birch (72%); all other tree species were below 30% of the samples. In comparison with all epidermis, the highest value was produced by the blackberry (35%), followed by hornbeam, linden, and birch, followed by only the three main trees, in the order of pine, oak, and beech, and the other tree below 1% left. This shows that blackberry is the primary form of nutrition in the diet of red deer, followed not by the dominant tree species of the area, but rather by the admixed tree species. The statistical tests conducted showed no differences in consumption frequency among the dominant species, while the consistency of the admixed species and blackberry was more common than the dominant species, compared to the difference between blackberry and admixed species consumption. Based on this, it can be assumed that as long as there are sufficient quantities of blackberries and secondary tree species, red deer will consume the dominant species to a lesser extent, meaning that these dominant species are less exposed to browsing damage.

5. Several factors have had an impact on damage; the habitat use results and nutrition testing have also shown that this is a multi-factor link system, which has been verified by the main component analysis. Two main components

were distinguished during the process, the first being the quantitative and qualitative characteristics of the nutrition provided by the reforestation, supplemented by the vertical coverage provided by the hiding place. The other factors were ranked in the second. Based on the results of multivariate regression using the two main components (r = 0.801, R2: 0.612, p = 0.000), the examined factors show a close correlation with the development of browsing damage, the first of the two main components (PC1-b *: -0, 71), which has a greater effect than the second (PC2-b *: 0.379). That is, the nutrition and hiding places provided by the regenerations have the greatest impact on the development of browsing damage. For this reason, the kinds of vegetation left in area during forestry work are significant, apart from the dominant tree species because either the main cause (see siskanadtippan or little vegetation) or the limiting factor (admixed species, blackberry).

4. Dissertation theses

In the light of the results and answers described above, I have formulated the following theses as new scientific results:

T_1: Sexual and seasonal differences can be detected in the home range and habitat use of red deer in the Sopron Highlands. The habitat use of red deer hinds in this area - homogeneous at the source - is greatly influenced by the spatial and temporal changes of available resources. Accordingly, hinds show greater seasonality than stags, whose behavior does not show a strong seasonality due to their larger areas of mobility, their spatial diversity, and the uniformity of their habitat use.

T_2: Forests in the Sopron Highlands play a significant habitat use role for red deer all year round. Young red deer (0-15 years) use this habitat most intensively. Within this group, 0-5-year-olds use forests most intensively at night for feeding and nutritional purposes while 5-to-15-year-olds utilize forests in the daytime for hiding and sheltering. There is a demonstrable difference between the use of these areas within and outside the vegetation period, although 33% of the prevalence of young deer falls outside the vegetation period, but it can be estimated from the point of view of winter wildlife damage.

T_3: Pellet group density decreases as reforestation areas increase, while seedling height and vegetation cover does not influence pellet group density. The occurrence of red deer in small-area afforestations enclosed with stands is to be expected.

T_4: The increase in the extent of afforestation revealed the increase in the distance between the pellet groups and the incidence of pellet groups decreased near the forest edges with the increase in area size. Based on this, it can be stated that in

the case of red deer, the size of the area decreases the forest edge effect, which affects the habitat.

T_5: Based on the results of macroscopic nutrition studies, the shoots and leaves of shrubs and oak trees play a prominent role in the winter food of the red deer in the Sopron Highlands. It follows that browsing damage remains low as long as a suitable grazing surface is available to the red deer. The consumption of dominant tree species can increase in the event of long-lasting snow cover or forestry maintenence work that could render the leaves of the shrub and admixed tree species shoots unavailable.

T_6: Based on the results of the microscopic dietary studies, it can be concluded that blackberry plays a primary role in the winter diets of red deer, followed by the secondary, admixed tree species, followed by the dominant tree species of the area. On this basis, it can be stated browsing damage on dominant tree species in a given area remains low if red deer find enough blackberry and secondary tree species. From the point of view of browsing damage reduction, the role of secondary, admixed tree species can be particularly important, as the excessive presence of blackberry can be disadvantageous for seedlings (due to shading, root competition, and snow pressure).

T_7: Based on the results of the main component analysis involving 8 factors in the examination of browsing damage risk, it can be stated that the occurrence of browsing damage is largely determined by the supply of nutrition and sheltering sites in vegetation found in reforestations. In the light of this, it the appropriate design and implementation of forestry work (maintenance work, selecting the size of the cutting area) could offer protection against browsing damage.

5. List of Publications

Book sections

NÁHLIK, A., DREMMEL L., SÁNDOR GY. AND TARI T. (2012): Effect of browsing on timber production and quality, The Impact of Urbanization, Industrial, Agricultural and Forest Technologies on the Natural Environment p.107-116., Nemzeti Tankönyvkiadó, Budapest

TARI, T., SÁNDOR, GY. AND NÁHLIK, A. (IN PRESS): Gímszarvasok viselkedésének jellemzői a Soproni-hegységben, in: Kárpáti, L. (szerk): Soproni Tájvédelmi Körzet - Monografikus tanulmányok a Soproni-hegység természeti és kulturális értékeiről, Szaktudás Kiadó Ház; Budapest

Journals, texts, publications

NÁHLIK, A., TARI, T. ÉS NACSA, J. (2003)*:* A gímszarvas és őz téli erdősítéshasználatának jellemzői Vadbiológia 10: 15-25.

NÁHLIK, A., ÉS TARI, T. (2006): A gímszarvas és az őz téli erdősítés-használatára és csemeterágására ható tényezők vizsgálata az erdei kár csökkentése céljából, Gyepgazdálkodási közlemények, 2006/4: 75-79.

NÁHLIK, A., TARI, T. ÉS SÁNDOR, GY. (2007): Az erdei vadkár keletkezésének okai és következményei. Vadgazdálkodásunk időszerű kérdései 7.: Vadkár, p. 12-40.

NÁHLIK, A., SÁNDOR, GY. ÉS TARI, T. (2008): Vadkárok az erdőgazdaságban, Alföldi Erdőkért Egyesület Kiadványa „Tudományos eredmények a gyakorlatban", Szeged

NÁHLIK, A., SÁNDOR, GY., TARI, T. ÉS KIRÁLY, G. (2009): Space use and activity patterns of red deer in a highly forested and in a patchy forest-agricultural habitat, Acta Silv. Lign. Hung., Vol. 5 pp. 109-118

NÁHLIK, A., SÁNDOR, GY. ÉS TARI, T. (2010): A bikák szemszögéből – felkészülés a bőgésre, Nimród 2010. szeptember, p. 6-9

NÁHLIK, A., DREMMEL L., SÁNDOR GY. ÉS TARI T. (2012) A csemetekori vadrágás következményeinek vizsgálata rudas állományokban, Erdészettudományi Közlemények 2.:163-172

NÁHLIK, A., SÁNDOR, GY., HEFFENTRÄGER, G., DREMMEL, L., HOPP, T., NYÚL, A. ÉS TARI, T. (2016): A gímszarvas mozgása, Nimród 2016 szeptember, p. 4-9.

VOLODIN, I., NAHLIK, A., TARI,T., FREY, R. AND VOLODINA, E. (IN PRESS): Rutting roars in native Pannonian red deer of Southern Hungary and the evidence of acoustic divergence of male sexual vocalization between Eastern and Western European red deer (Cervus elaphus), Mammalian Biology

Conference publications in Hungarian:

TARI T. (2008): Javaslatok az erdőfelújításokban bekövetkező rágáskár mérséklésére, Tavaszi Szél 2008 Konferencia, Konferencia Kiadvány p. 336-341

TARI T. ÉS VARJU J. (2008): Ökotonok hatása a gímszarvas és az őz területhasználatára erdei élőhelyen Tavaszi Szél 2008 Konferencia, Konferencia Kiadvány p. 335

TARI T., SÁNDOR GY. ÉS NÁHLIK A., (2009): A gímszarvas élőhely-preferenciája egy síkvidéki területen, NYME Erdőmérnöki Kar Tudományos Konferencia, Konferencia Kiadvány p. 256-261.

TARI T, SÁNDOR GY, NÁHLIK A. (2014): A gímszarvas táplálékfelvételének jellemzői In: Bidló A., Horváth A., Szűcs P. (szerk.) IV. Kari Tudományos Konferencia: Konferencia kiadvány. *pp. 303-307.* (ISBN:978-963-359-033-1)

Conference publications in a foreign language:

NÁHLIK, A., TARI, T, DREMMEL, L. AND SÁNDOR, GY. (2011): Home range size and use of open land by red deer in three different landscapes, Proceedings of the 30th IUGB Congress, p. 123-125

NÁHLIK A, HEFFENTRÄGER G, PÓCZA G, SÁNDOR GY, TARI T. (2014): Daytime movements of red deer disturbed by human activity In: Ma J, Zhang M, Halbrook R, Liu B, Zhang W (szerk.) Proceedings of the 8th International Deer Biology Congress and International Wildlife Management Symposium. *pp. 57-59.*

Presentations in Hungarian:

NÁHLIK A., TARI T. ÉS SÁNDOR GY. (2007): Az erdei vadkár keletkezésének okai és következményei. „Vadkárcsökkentés lehetőségei a vadászterületeken" Konferencia, Országos Magyar Vadászkamara, Vadgazdálkodási Bizottsága. Mezőgazdasági Múzeum-Budapest

NÁHLIK A., SÁNDOR GY., TARI T, KIRÁLY G. ÉS HEFFENTRÄGER G. (2007): A gímszarvas területhasználata. „Kutatási eredmények hasznosulása a szarvasfélékkel történő gazdálkodásban" Konferencia, VEAB – Zalaerdő ZRt., Nagykanizsa

NÁHLIK A., TARI T., SÁNDOR GY. ÉS KIRÁLY G. (2007): A gímszarvas mozgásának és élőhely-használatának összehasonlítása két különböző élőhelyi adottságú területen. NYME Erdőmérnöki Kar Tudományos Konferencia, Vadgazdálkodási Szekció, Sopron

TARI T. (2008): Javaslatok az erdőfelújításokban bekövetkező rágáskár mérséklésére, Tavaszi Szél 2008 Konferencia, Agrártudományi Szekció, Budapest

TARI T. (2009): A gímszarvas összetett gyomrának vizsgálata, VII. Országos Interdiszciplináris Grastyán Konferencia, Pécs

TARI T., SÁNDOR GY. ÉS NÁHLIK A., (2009): A gímszarvas élőhely-preferenciája egy síkvidéki területen, NYME Erdőmérnöki Kar Tudományos Konferencia, Vadgazdálkodási Szekció, Sopron

NÁHLIK A., TARI T., SÁNDOR GY., KIRÁLY, G. ÉS NYÚL, A. (2010): GPS telemetria a gímszarvas kutatásban - a területhasználat hasonlóságai és különbségei különböző adottságú területeken, „Nagyvadkutatások eredményei a SEFAG ZRt. területén - országos kitekintés és tanulságok" – MTA VEAB Konferencia, SEFAG Zrt. Lábodi Vadászerdészet, Alexandra-puszta

NÁHLIK A., TARI T., SÁNDOR GY., KIRÁLY, G. ÉS NYÚL, A. (2011): GPS telemetria a gímszarvas kutatásban - a területhasználat hasonlóságai és különbségei különböző adottságú területeken, MTA VEAB Konferencia, Nyugat-magyarországi Egyetem, Sopron

TARI T, SÁNDOR GY, NÁHLIK A. (2013): Gímszarvas táplálékfelvételének jellemzői In: Bidló András, Szabó Zilia (szerk.) Nyugat-magyarországi Egyetem, Erdőmérnöki Kar, Kari udományos Konferencia: A konferencia előadásainak és posztereinek kivonata. Sopron: *p. 85.*

Presentations in a foreign language:

TARI T, SÁNDOR GY, NÁHLIK A. (2013): Analysis of game damages in forest regenerations In: Dejan Beukovic (szerk.) The 2nd International Symposium on Hunting: Book of Abstract "International Symposium on Hunting -Modern aspects of sustainable management of game population". *p. 123.* (ISBN:978-86-7520-178-3)

NÁHLIK A, HEFFENTRÄGER G, PÓCZA G, SÁNDOR GY, TARI T. (2014): Daytime movements of red deer disturbed by human activity 8th International Deer Biology Congress and International Wildlife Management Symposium.

NÁHLIK, A., SÁNDOR, GY., TARI, T., HEFFENTRÄGER, G., PÓCZA, G. (2016): Factors affecting diurnal activity of red deer, The 5nd International Hunting and Game Management Symposium, Book of Abstract, p.23.

Posters in Hungarian

TARI T., NÁHLIK, A. ÉS VARJU J. (2007): Erdőfelújításokban bekövetkező rágáskár mérséklésének lehetőségei. NYME Erdőmérnöki Kar Tudományos Konferencia, Vadgazdálkodási szekció, Sopron

TARI T. ÉS VARJU J. (2008): Ökotonok hatása a gímszarvas és az őz területhasználatára erdei élőhelyen Tavaszi Szél 2008 Konferencia, Agrártudományi Szekció, Budapest

Posters in a foreign language

NÁHLIK, A., TARI, T, DREMMEL, L., KIRÁLY, G. AND SÁNDOR, GY. (2011): Home range size and the use of unforested habitats of red deer in three different habitats, 30th IUGB Congress – Barcelona,

DREMMEL, L., SÁNDOR, GY., TARI, T. AND NÁHLIK, A. (2011): Long term effect of seedlings browsing as examined in pole stage., 30th IUGB Congress – Barcelona, 2011. 09. 5-9.

SÁNDOR, GY., NÁHLIK, A ., TARI, T. AND DREMMEL, L. (2012): Effect of browsing on timber production and quality, International Scientific Conference on Sustainable Development & Ecological Footprint, Sopron