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Effects of Building a Highway and Wildlife Crossings in a Red Deer (*Cervus elaphus*) Habitat in Hungary

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Abstract – We examined how the movement of red deer (*Cervus elaphus*) was modified in an area that had a new fenced off highway built across it. The first step was the collection of data from the track marked for construction. We continued collecting data on wildlife crossings after the construction of the highway and the completion of the fences. After the completion of the highway, it was observed that only 5.9% of the original deer track counts remained, spread across the crossings. After the construction was finished, the wider crossing structures were used more often by deer for crossing to the other side of the highway than the smaller ones. During construction of the highway, a number of animals chose to walk tens of kilometres to get around the construction site instead of using the crossings. An existing highway, or a highway under construction not only changes the frequency of deer crossings, but affects their distribution as well.

Wildlife crossing structure / red deer / *Cervus elaphus* / linear constructions / fragmentation / barrier effect

Kivonat – Az autópálya építés és a vadátjárók hatása a gímszarvas területhasználatára. Vizsgáltuk, hogyan változik a szarvasok mozgása egy olyan területen, melyen megépült egy kerítésekkel kísért autópálya. Első lépésben adatfelvételezést végeztünk az épülő autópálya egy szakaszának nyomvonalán, majd folytattuk a felvételezést a megépült autópálya vadátjáróin, még az úttestet kísérő kerítés felállítása után is. Az autópálya építkezést követően a kezdetekben tapasztalható „szarvas-forgalomnak" csupán a töredéke (annak 5,9%-a) maradt meg és oszlott el a megépített vadátjárókon. Az, hogy melyik átjárót használják szívesebben, már rögtön a megépítést követően látszik, mint ahogy az is, hogy az egyedek nem használják az átjárókat, amíg akár több tíz kilométer árán is, de meg tudják kerülni az épülő útszakaszt. Az épülő ill. megépült autópálya nem csak a szarvasok gyakoriságát változtatja meg az egyes szakaszokon, hanem azok eloszlási arányait is.

vadátjáró / gímszarvas /*Cervus elaphus* / vonalas létesítmények / fragmentáció / barrier hatás

1 INTRODUCTION

Linear constructions have significant impact on the density of various wildlife species and diversity of the communities (Bissonette 2002). The impact can be direct (loss of habitat, population decline, etc.) and indirect (isolated population, deteriorating gene pool) (Bellis et al. 2007). These constructions (e.g. roads, railroads, waterways, forest fences, etc.) form a

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border line in both the ecological and the visual sense. The result is the "barrier-effect," which is the root cause of habitat fragmentation, and the most serious problem caused by linear constructions (Spellerberg 1998). The fragmentation effect is greatly affected by the width of the linear construction, its permeability, amount and speed of traffic and the existence of fences. Roads split up evenly distributed populations, forming smaller, sometimes completely isolated sub-populations (Forman – Alexander 1998). Fragmentation may inhibit species from spreading, reaching adequate food, mating and can lead to declining gene diversity due to smaller population size. These adverse effects can lead to further shrinking of the population, can cause serious depression of viability and fecundity and increase the risk of extinction (Standovár – Primack 2001).

The "border-effect" is another serious consequence of habitat fragmentation. Conditions along the borders of a fragmented habitat are different from those deep within the habitat. The micro-climate can change (light, temperature, humidity, wind speed) that can seriously affect community composition of the area, or the survival of the species. For example, the dense vegetation that grows along the borders of forests may lead to increased density of large herbivores. This may result in over-grazing of several sensitive plant species in a belt possibly several kilometers wide, reaching into the depths of the forest (Alverson et al. 1994).

Building fenced highways or similar structures creates a barrier that makes it difficult for wildlife to move from one side of the road to the other. Installing wildlife overpasses and underpasses allow animals to pass safely over or under the highway, mitigating these effects.

Building wildlife crossings requires a considerable amount of funds, so it is essential to know their effectiveness and to monitor how often they are used by different species. A number of methods are used to monitor the use of a wildlife crossing structure in wildlife management investigations – for example counting tracks, video recordings, and GPS-telemetry (Hardy et al. 2003; Cuperus et al. 1999; Dodd et al. 2004; Ford et al. 2009; Trombulac – Frissel 2000). These methods are useful not only for the examination of the use of wildlife crossings, but also for the study of the behaviour of wild animals when they are forced to approach artificial barriers that could otherwise be avoided or overcome.

In this study we collected data along the line of a highway before, during and after construction. According to earlier observations, the deer spotted the 2.4 m high fences protecting the highway from several kilometers away, and walked around them when possible (Alexander – Waters 2000; Mata et al. 2008). When deer could not find a by-pass, the animals were presumably "forced" to use the newly constructed overpasses and/or underpasses. Because of the increasing number of fences that fragment and limit the sizes of habitats, it is becoming more and more important to understand how these fences affect deer movements in these areas, and which type and size of crossings are more efficient.

Our main objective in this study was to examine if the animals were presumably „forced" to use the new highway crossings and in which degree, when they could not find another way. In addition, we examined whether there is a detectable drop in population size along the highway, when we compare track counts before and after the construction of the highway. Finally, we suggest methods to increase the use of the crossings

2 STUDY AREA

The study was conducted on the Hungarian M7 highway, in Somogy County (south of Lake Balaton) between the overpass north-east of the Road 68 crossing and the underpass with a water canal near to Balatonújlak. There were farm fields on both side of the highway, mostly corn and canola.

3 MATHERIAL AND METHODS

After marking the highway on the ground, but before commencing construction, the number of deer tracks that crossed the entire width of the planned highway was systematically recorded. The first recording took place in February of 2006, about one year before crossings were built with fences (January – February of 2007. The last recording was in November of 2008. We divided the planned trace into two sections. After the highway construction each section had two crossings built on it. After the completion of the crossings, we continued counting the tracks that crossed the entire length of the overpass and the underpasses.

Professional hunters employed by Somogyi Hunor Vt. (the association authorized to hunt in the area) helped us collect these data. There were four crossings constructed in the study area, one overpass (at the west end of this section) and three underpasses. The overpass (bridge S67 in highway segment 169 + 770) was 62 meters long and 27 m wide. The next underpass in the direction of Budapest was the S66 in highway segment 168 + 755. It was 25 m long and 16.3 m wide. There was a very similar underpass (called S64) in the same direction, in highway segment 166 + 996, 25 m long and 15 m wide. The last underpass is wider than the other underpasses, since there is a railway and a canal ("Nyugati-övcsatorna.") This was 25 m long and 132 m wide, located in highway segment 166 + 430. We calculated monthly averages from data collected on a weekly basis. To avoid duplicate counts, after each count, the tracks were covered by brushing over the soil with a tree branch. During, and right after construction, the ground where we counted the tracks was soft and tracks were clear, visible and easy to count.

The data did not match the normal distribution curve even after any transformation. For this reason, we decided to use the non-parametric Mann-Whitney test, the Kruskall-Wallis test, and the Spearmann rank-correlation.

4 RESULTS

According to the Mann-Whitney test which was applied to the data recorded before the construction between the two parts of the selected section, there was no difference in track density *($Z = -0.558$; $p = 0.577$)*. However, when we compared the results based on the data from two crossings in each of these two sections, we found a significant difference *($Z = -4.514$; $p < 0.001$)*. This definitely differs from the results before the construction *(Figure 1)*.

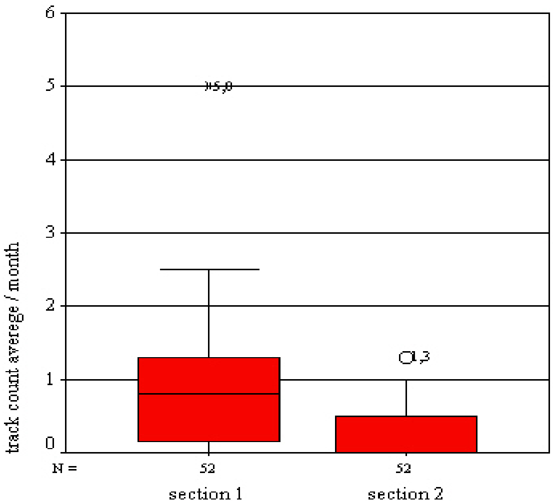


Figure 1. Comparison of two sections of the highway based on deer track counts recorded on two wildlife crossings at each section

This indicates that the number of red deer tracks was altered after the construction of the crossings. The section further away from the parts of highway still under construction had a higher frequency of use compared to the other section.

Comparing the conditions before and after the construction, the significant difference is evident not only in the altered proportion, but also in the entire recorded track density *(Figure 2)*.

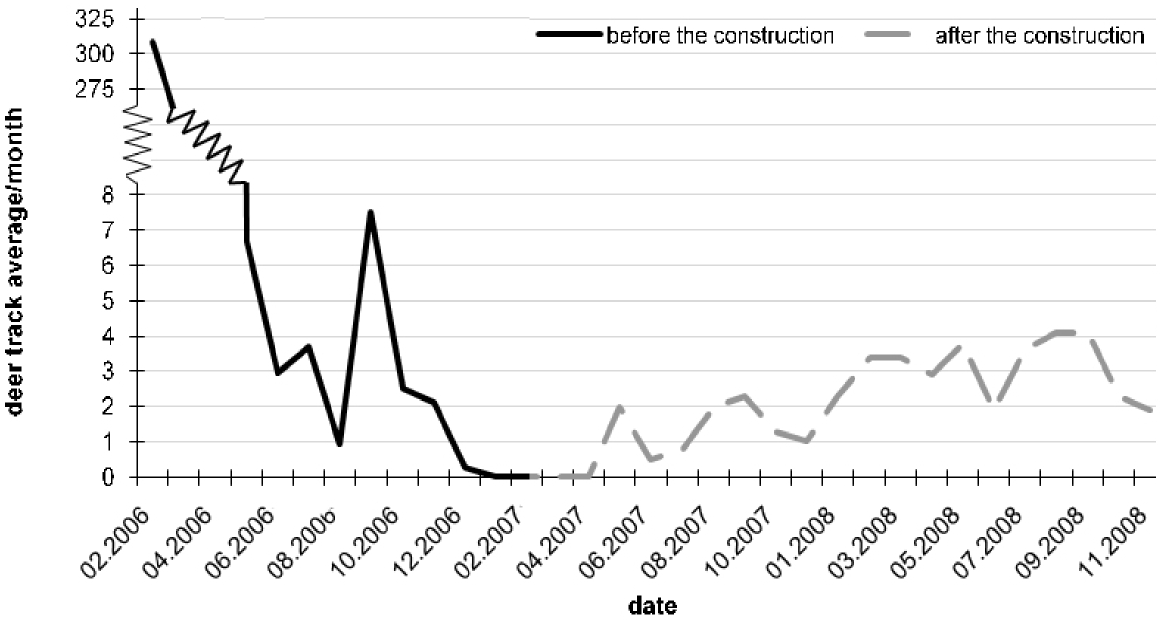
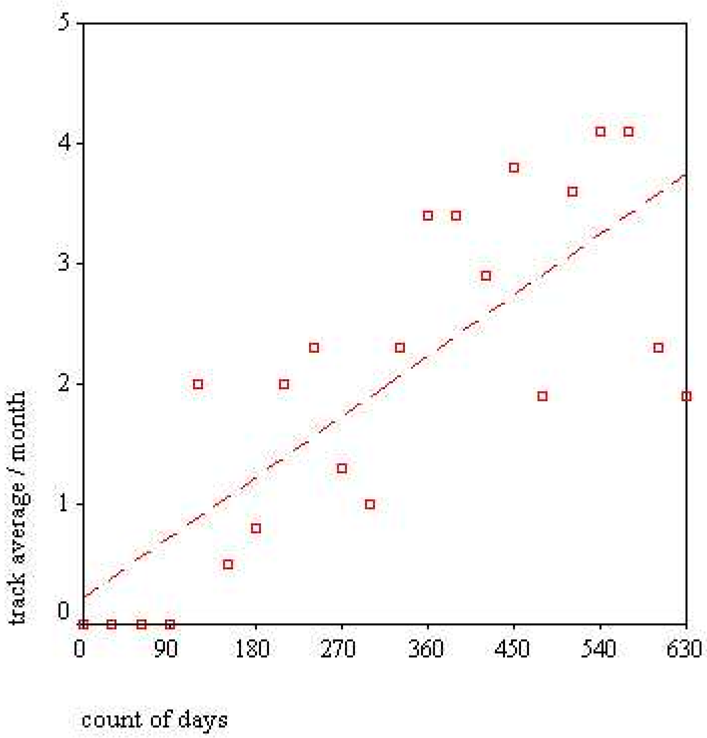


Figure 2. Comparison of deer track counts before and after the construction of wildlife crossings

Looking at monthly averages, before construction started, we observed more than 300 deer tracks for both sections each month. After the construction, this value at all crossings summarized was below 10, and often 0. The number of deer tracks was dramatically reduced after the highway construction *(*Mann-Whitney U test $Z = -1.755;\ p = 0.79$*)*

From the beginning of December, 2006, until end of January, 2007, the number of track counts of crossing deer was zero. This is the time period when the entire length of the road was closed off with a fence, with the exception of the uncompleted crossings. The second part of *Figure 2* shows that after this time, the presence of deer in the crossings was detectable again. Using Spearmann rank-correlation, we looked for a connection between the time and the track density. Based on the statistical analysis and the trend-line fitted on the scatter-type figure, there is an unambiguous correlation between the number of days that passed and the track density, so as time passes the track density in the crossings increases *(Figure 3)*.



Figur 3. Deer track density progress in time,
after the deflecting fences of the given section were set up

The number of tracks of deer using each of the four crossings is different. *Figure 4* shows how the use was divided between each of the crossings in the period when they were built. The non-parametric Kruskall-Wallis test proved that in the same time period, the widest crossing (marked as Nr. 1 on *Figure 4*) experienced a significantly larger traffic than the others *(Chi-square = 23.509; $p < 0.001$).*

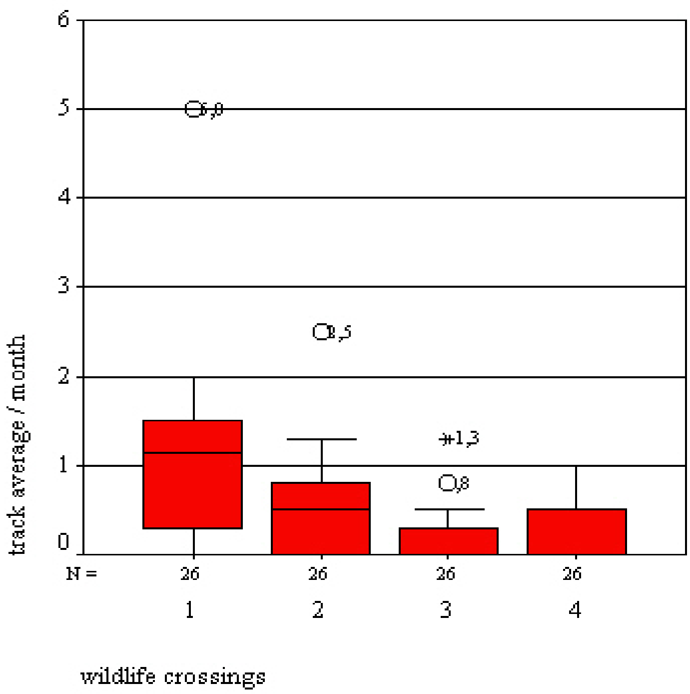


Figure 4. Comparison of monthly averages of deer track frequency
recorded in each of the crossings

We compared the only overpass with the underpass in the same section to have a comparison of two main types of crossings. As result of a Mann-Whitney U test, there is no significant difference shown between the frequency of the use of overpass (Nr. 4 on *Figure 4*) and underpass (Nr. 3 on *Figure 4*) in section two by deer. ($Z = -0.041$; $p = 0.967$)

5 DISCUSSION

A number of other investigations have examined the ecological implications of linear structures using track counts, just like our current study. Among their findings, they agree that the impact on wildlife is determined by the density of roads (Mech et al., 1988), and the size and speed of traffic (Gagnon – Dodd 2007; Clevenger et al. 2001).

Our results showed that shortly after the construction of the crossings, the animals did not use them, since they could still get around the fenced-off section in the near distance. This „getting around" behaviour was also observed when the fences were built in two parts. After the first section was built, the number of vehicle-wildlife collisions along the second unfenced section increased significantly.

Red deer used the "getting around" strategy as long as the energy invested was worth it. After that they were compelled to use the crossings. However, the construction work likely influenced their use. Servheen (2003) and Kusak et al. (2009) found positive correlation between disturbance and the use of wildlife crossings. In our study the crossings that were the furthest away from the construction site were the ones that were used first. As the construction moved away, and the disturbance affecting the animals decreased, the use of the crossing increased.

The above observations explain why the crossings on the first part of the section were used sooner. If the assumption is right, the difference should disappear with time after the completion of the entire M7 highway. If the phenomenon is caused by preference for one or two crossing types or locations, then the difference will remain detectable.

If a wildlife crossing has a low use, it does not necessarily mean that the location or its construction was wrong. Sometimes a few years are necessary for wildlife to get used to the crossing structures, and a few years with low use can be followed by sudden and significant increase (Clevenger – Waltho 2003). However, we must strive to decrease the "getting-around" behaviour due to the changed environment, since otherwise the number of car collisions with wildlife will increase. An animal won't consider a crossing that is 8-10 meters wide, since the animal won't even approach it, due to the presence of fences and the environment that was changed during the construction. Vegetation helps animals get used to it and increases the chances of it being used. Vegetation is especially important for an overpass because it makes the overpass more natural, and it will decrease the noise and light of the traffic as well, eliminating most of the disturbances.

To increase the effects of vegetation, it is advisable to equip the overpass edges with peg or noise reducing walls (Bekker – Vastenhout 1995). In addition to the vegetation, making the deflector fences cone-shaped can also help the animals to get used to the crossing. This form will not only lead the animals towards the crossing structure, but will make it more noticeable for the animals as well. This is important, as a deer might approach the fence at a given section, but won't see a 6-10 meter wide "hole" in it as a crossing point. Making these „holes" wider with deflector fences in a coned shape will give the animals a chance to carefully try and explore it before getting used to the new conditions.

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