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WILDLIFE – VEHICLE COLLISIONS IN URBAN AREA IN RELATION TO THE BEHAVIOUR AND DENSITY OF MAMMALS

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Key words: urban roads, vehicle collisions, wild animals, GIS.

Abstract

The aim of the study was to characterise the problem of road accidents involving selected species of wild-living animals present in the area of Lublin. Another aim of the investigations was to determine the relationship between selected behavioural elements of the annual life cycle of animals and the incidence of wildlife-vehicle collisions. The information about wildlife-vehicle collisions was obtained from the documentation held by the shelter for homeless animals in Lublin and veterinary services. The data are presented in a spreadsheet and analysis was performed in the GIS (ArcGIS 10.1) environment. Based on the ESRI Base Map-BING MAP HYBRYD, a vector database of streets where the incidents had taken place was compiled. Each street was assigned the number of incidents recorded in the period of 2009–2012. Animals were divided into three groups: large mammals, small mammals and bats. The compiled data indicate the highest road mortality among roe deer (132), foxes (63), and martens (33). The reported results show the greatest number of wildlife-vehicle collisions on exit roads leading from the city centre. Presumably, this may be associated with the lack of speed limits and possible faults in the infrastructure arising already at the design stage.

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WYPADKI DROGOWE ZE ZWIERZĘTAMI DZIKIMI NA OBSZARACH MIEJSKICH W ZALEŻNOŚCI OD ICH BEHAWIORU I ZAGĘSZCZENIA

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Słowa kluczowe: drogi miejskie, zdarzenia drogowe, zwierzęta dzikie, GIS.

Abstrakt

Celem pracy było scharakteryzowanie wypadków drogowych z udziałem wybranych gatunków zwierząt wolno żyjących, bytujących na terenie Lublina. Wykazano zależności między wybranymi elementami behawioralnymi rocznego cyklu życiowego zwierząt a częstotliwością występowania kolizji drogowych z ich udziałem. Informacje o wypadkach drogowych z udziałem zwierząt dzikich uzyskano z dokumentacji schroniska dla bezdomnych zwierząt w Lublinie oraz od służb weterynaryjnych. Dane zestawiono w arkuszu kalkulacyjnym oraz w środowisku GIS (ArcGIS 10.1). Na podstawie ESRI Base Mape-BING MAP HYBRYD przygotowano wektorową bazę danych ulic, których dotyczyły zdarzenia. Każdej ulicy przypisano liczbę zdarzeń zarejestrowanych w latach 2009–2012. Zwierzęta podzielono również na trzy grupy: duże ssaki, małe ssaki oraz nietoperze. Uzyskane dane wskazują, że najwyższa śmiertelność na drogach wśród zwierzyny dotyczyła saren (132), lisów (63) oraz kun (33). Na podstawie uzyskanych wyników można stwierdzić, że najwięcej wypadków wydarzyło się na drogach wylotowych z centrum miasta. Należy sądzić, że związane jest to z brakiem ograniczenia prędkości oraz możliwymi błędami w infrastrukturze już na etapie projektowania.

Introduction

Due to the intensive development of motorisation, transport routes are being continuously modernised, new expressways are being built, and the network of dual carriageways and motorways is being expanded. All these investments are aimed at improvement of the comfort of travelling and enhancement of the efficiency of road transport. However, the developing road infrastructure undoubtedly interferes with the natural habitat of animals. Fragmentation of biotopes by transport routes increases the risk of wildlife-vehicle collisions and accidents (JĘDRZEJEWSKI at al. 2006).

Besides linear infrastructure and intensification of agriculture, other types of human activity, e.g. residential developments, land reclamation, and drainage of wetlands cause similar transformations and loss of animal habitats. Housing development is a factor that limits the surface area of habitats inhabited by wild animals, which have to change their living environment completely. This is especially evident on the outskirts of intensively expanding cities and towns. Synurbic species can be found in an urbanised landscape

more frequently. The occurrence of foxes and wild boars in close proximity to human settlements was a rarity several years ago but is nowadays common, also in urban areas. The ease of finding food and absence of natural enemies in the urbanised landscape exerts a considerable impact on the functioning of populations of these species in such different living conditions. This creates dangerous situations for both animals and humans (collisions with vehicles, noise or light stress, possibility of contracting diseases from domestic or livestock animals) (KLIMASZEWSKI 2011, MILCZAREK 1993). In addition, shrinking natural habitats and the increasing number of wild animals makes the move to areas where never before occurred In particular species which can travel long distances, therefore, they may be a vector that plays an important role in parasite transmission in the natural environment. Infections new species of parasites are very dangerous phenomenon which can lead to falls a large number of animals (BURLINSKI at al. 2011). The problem may be invasive species spread with human activity and posing a threat to already present fauna eg. american mink, raccoon dog, raccoon (GUGOŁEK at al. 2014).

The aim of the study was to characterise the problem of road accidents involving selected species of wild-living animals present in the area of Lublin. Another aim of the investigations was to determine the relationship between selected behavioural elements of the annual life cycle of animals and the incidence of wildlife-vehicle collisions.

Materials and Methods

Investigations of animal road casualties are difficult methodically and logistically. In Poland, many collisions are not reported and only fragmentary information about this type of incidents has been gathered by various institutions, e.g. national parks, forestry offices, and hunter associations. The police and institutions that arrive directly to the scene of a collision possess the most complete data. The information about wildlife-vehicle collisions was obtained from the documentation held by the shelter for homeless animals in Lublin and veterinary services. The data were available in the form of a paper notebook with tables presenting the animal species and the name of the street. Only a few records had an exactly specified address (80 cases of the total 930). The data from 2009–2012 were obtained from the veterinary clinic staff and those from 2011–2012 were provided by the animal shelter.

The data are presented in a spreadsheet containing the following fields: street name, animal species, number of incidents, and date of the incident. Further analysis was performed in the GIS (ArcGIS 10.1) environment. Based on the ESRI Base Map-BING MAP HYBRYD, a vector database of streets

where the incidents had taken place was compiled. Each street was assigned the number of incidents recorded in the period of 2009–2012. According to the number-of-incidents attribute, the streets were categorised in the form of a map. Red colour indicated streets with the highest number of incidents and a colour scale was used for the number of incidents assigned to each street (e.g. red – 27 incidents in one street; *n* – number of streets with 27 incidents). The lack of data on the exact localisation of incidents prevented compilation of a more detailed study.

Animals were divided into three groups: large mammals (mainly roe deer (*Capreolus capreolus*) and smaller numbers of red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*), small mammals (fox (*Vulpes vulpes*), marten (*Martes foina*), and others), and bats. The grouping followed the different behaviour patterns of the species and the periods of an increased number of collisions with animals from each group.

Results and Discussion

In 2009–2012, 930 wildlife-vehicle collisions were reported in the area of Lublin. Given the aim of the investigations, the results did not include data concerning dogs, cats, and pigeons.

The compiled data indicate the highest road mortality among roe deer (132), foxes (63), and martens (33). The proportion of other species was inconsiderable. These data confirm the information provided by other studies, which reported the greatest number of wildlife-vehicle collisions, i.e. ca. 75%, with roe deer (SAENZ DE SANTA MARIA and TELLERIA 2015, TAJCHMAN at al. 2010). This is most probably determined by two factors. The first one is related to the dynamic growth of the population of this species, estimated at ca. 50% of the initial number over the last decade (BUDNY at al. 2010). The other factor is, undoubtedly, the behaviour of this species consisting in long-distance migrations (KLIMASZEWSKI 2011). Field data from the area of Poland confirm the highest proportion of roe deer and wild boars involved in wildlife-vehicle collisions; the national data additionally include deer in this group (CZERNIAK and TYBURSKI 2011). Within the Lublin city limits, the number of killed deer (14 individuals) and wild boars (3 individuals) was relatively low.

The analysis of the changes in the mean number of incidents with large mammals (Table 1, Figure 1) shows two periods characterised by an increase in wildlife-vehicle collisions, i.e. spring (May) and winter (December and January). In this group of animals, roe deer account for 97%, which in the spring period can be explained by the enhanced activity of roebucks establishing and protecting their territory (PIELOWSKI 1999, TAJCHMAN at al. 2010). In turn, the

Table 1

Number of wildlife-vehicle collisions in each month in 2009–2012 in the Lublin urban area

Month	Large mammals	Small mammals	Bats	Total
I	20	0	1	21
II	16	11	3	30
III	6	3	1	10
IV	13	9	4	26
V	32	31	9	72
VI	22	12	8	42
VII	6	13	13	32
VIII	9	11	20	40
IX	6	11	13	30
X	13	8	12	33
XI	14	5	4	23
XII	24	1	4	29
Total	181	115	92	388

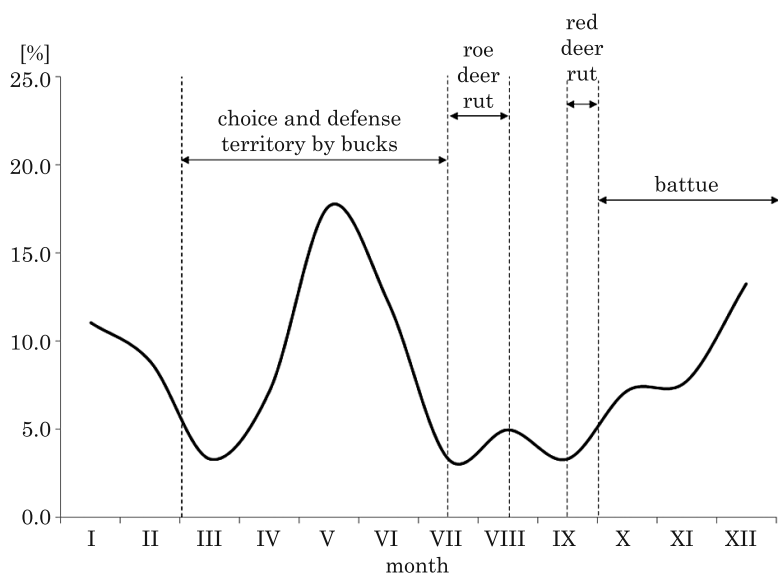

Fig. 1. Number of collisions with large mammals in each month in relation to their behaviour

increased number of wildlife-vehicle collisions in the winter period may be associated with the season for battues (between October 1 and January 15), in which wildlife animals are scared off and forced to flee, often cross transport routes. Additionally, during this period de-icing salt is applied onto roads as

a thawing agent, which may effectively attract animals close to transportation routes (BRUINDERINK at al. 1996).

The analysis of the number of vehicle collisions with small mammals (Table 1, Figure 2) in the respective months reveals that the number grows insignificantly during the vixen oestrus period (January – February). The lowest number of incidents is noted during the birth period (February/March). Next, a gradual increase in the number of collisions is observed in May, which may be associated with period of development of fox and marten offspring and increased activity of females questing for food for their young ones (GOSZCZYŃSKI 1995, GOSZCZYŃSKI at al. 1994, HERR 2008).

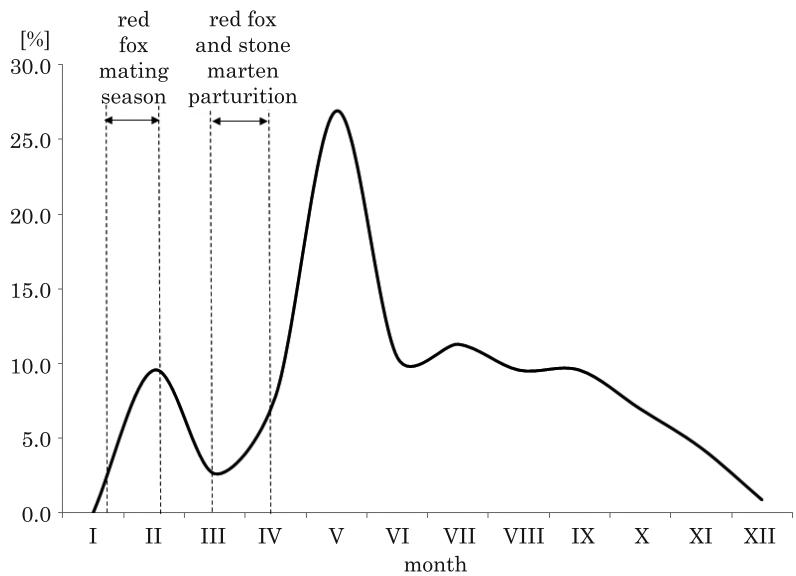

Fig. 2. Number of collisions with small mammals in each month in relation to their behaviour

In the case of bats, the increase in the number of wildlife-vehicle collisions in the summer period is evidently related to their behaviour (Table 1, Figure 3). The number of accidents involving bats is on the increase and is correlated with their greater post-hibernation activity. The peak of the number of incidents is noted in early autumn, i.e. at the beginning of the mating period (FUSZERA at al. 2010, RACEY 1982).

The analysed data on the localisation of the sites of wildlife-vehicle collisions indicate that exit roads were the most dangerous sites for animals, while roads in the city centre posed the lowest risk. The greatest number of wildlife-vehicle collisions was reported from Wincetgeo Witosa, Poligonowa, and Osmolicka Streets (Figure 4). Noteworthy, the land use along Wincentego

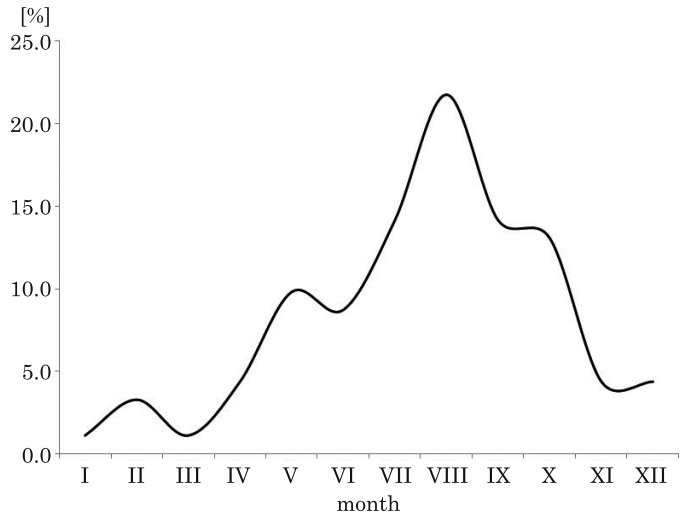

Fig. 3. Number of collisions with bats in each month in relation to their behaviour

Witosa Street has changed in recent years. Before 2012, the area was dominated by fields and fallows, while currently it has been turned into a commercial shopping centre area. Poligonowa Street is characterised by areas of uncultivated land and former allotments, which may serve as animal refuges. In turn, Osmolicka Street runs across Dąbrowa Forest, which is largely located in a protected landscape area with an artificial water reservoir, Lake Zemborzycki, on its right side. This promotes animal migration. Slightly fewer wildlife-vehicle collisions are noted in Spółdzielczości Pracy Alley, as it is a fenced road with acoustic screens and residential developments. These streets were also characterized by a relatively high intensity of movement especially in the mornings and evenings. These are the hours when the animals have greater mobility especially in autumn and winter when the day is short. The average intensity of traffic on Poligonowa Street is relatively low because it is in the range 300–500 (vehicles/hour), on Osmolicka over 1000 (vehicles/hour), and on Spółdzielczości Pracy and Wincentego Witosa Streets is very high because it varies from 1000 do1500 (vehicles / hour) and on some pieces on even higher than 1500 (Zarząd Dróg i Mostów w Lublinie).

Another cause of the increased number of accidents in the aforementioned streets can be related to the repair or reconstruction work carried out in these streets, which may have permanently altered the migration paths of wild animals. Approximately 50 km of roads in the Lublin urban area were reconstructed or built in 2010–2012. In this period, fragments of Zemborzycka Street (1150 m), Osmolicka Street (740 m), Spółdzielczości Pracy Alley

(878 m), and Smorawińskiego Street (1070 m extension of Spółdzielczości Pracy Alley) were reconstructed and Witosa Street (1150 m) was repaired (Zarząd Dróg i Mostów w Lublinie).

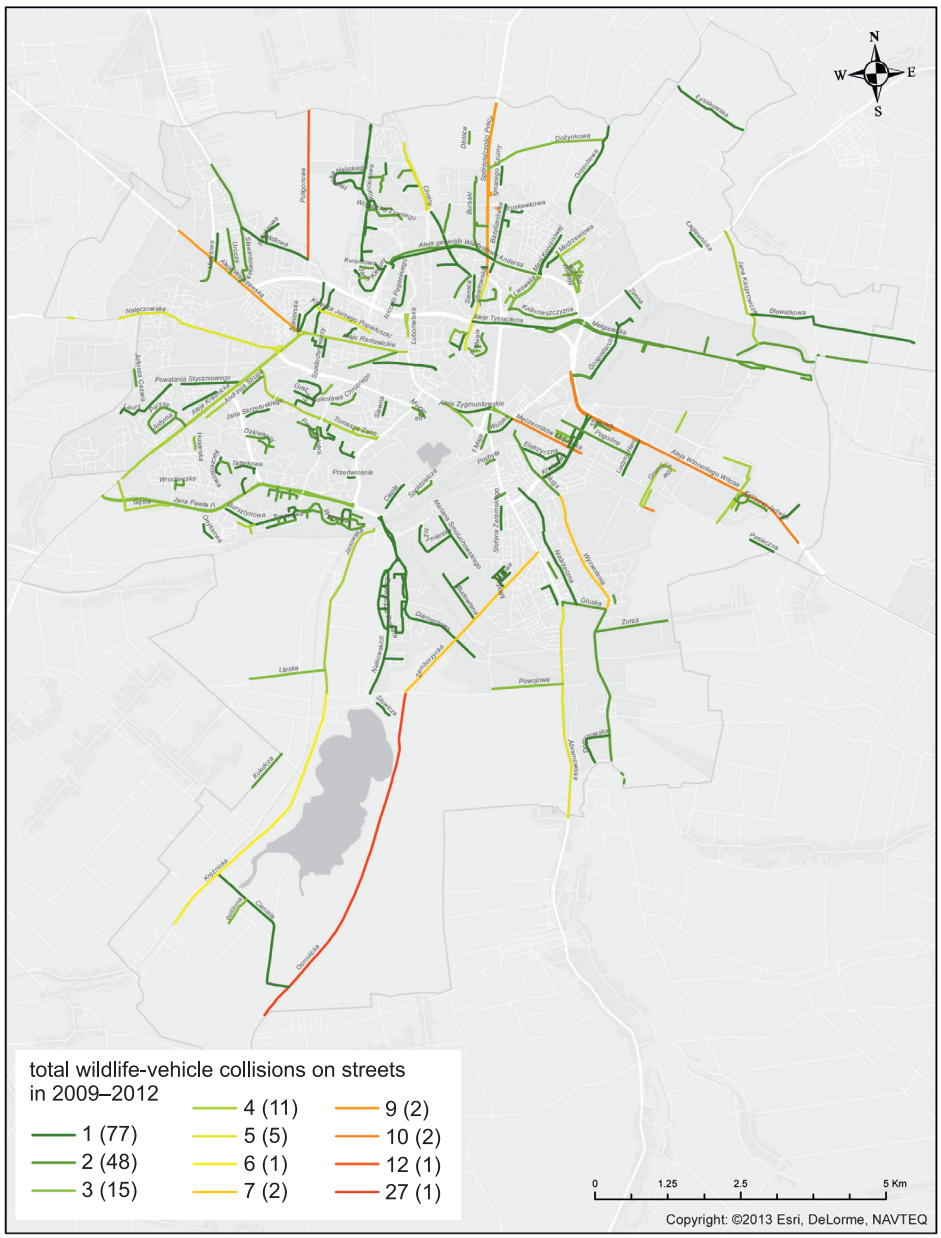

Fig. 4. Number of wildlife-vehicle collisions in the city of Lublin in 2009–2012

Conclusions

The reported results show the greatest number of wildlife-vehicle collisions on exit roads leading from the city centre (ORŁOWSKI and NOWAK 2006) – Figure 4. Presumably, this may be associated with the lack of speed limits and possible faults in the infrastructure arising already at the design stage.

There is a need for verification of the existing migration corridors in terms of their importance for the spatial and genetic permanence of populations and real long-term protection. The localisation of the corridors should be based on data of sites where animals cross public roads and spots of wildlife-vehicle collisions in urban areas, particularly in sites where the land along the roads will be transformed.

Animal populations have to adapt to the natural environment transformed by man. This is possible and effective in the case of some species (e.g. insects, rodents, predators), whereas other species such as large ungulates are not able to cope with the barriers created in the course of human development. From this point of view, the most important problem, i.e. degradation, loss, and fragmentation of habitats, it is not impossible to be solved, particularly in Poland, where the natural environment is relatively well preserved, in comparison with Western European countries. Therefore, the experience of other countries should be taken into account in the economic development in order to avoid the same mistakes and not to forget about the natural environment (INDYKIEWICZ at al. 2014, KLIMASZEWSKI 2011).

In Poland, there is only one universal warning sign with an image of a leaping deer "Caution, wild animals – A18b". The signs, however, are mounted routinely without consideration of local conditions, even if the probability of encountering a wild animal is relatively low. Due to its frequent presence, the sign is unnoticed by drivers. In 2008, for the first time in Poland, signs with images of a marten, roe deer, wild boar, hedgehog, or fox and the telephone number of a relevant service were displayed in the city of Łódź. In the first quarter of the year, a 20% decline in the number of wildlife-vehicle collisions was reported, compared with an analogous quarter of the previous year; additionally, aid provided to animals injured in an accident improved (BOROWSKA 2009). The success of the initiative proved the need for implementing such activity across the country. With knowledge of the routes and periods of migration of individual animal species, road administrators should be obligated to install warning signs at road crossings with migration corridors.

Wildlife-vehicle collisions (WVC) are a considerable problem in the transport route ecology due to their serious consequences for human life; they can result in economic losses and have a profound impact on many animal species (COFFIN 2007, CONOVER at al. 1995, FORMAN and ALEXANDER 1998, GROOT-

-BRUINDERINK and HAZEBROEK 1996). Therefore, prevention of the analysed incidents should be the major factor in designing and constructing roads and traffic management (ZUBEROGOITIA at al. 2014). This is usually accomplished through enforcement of national and international regulations for prevention of damage and for design of proactive actions in the most problematic sectors (IUELL at al. 2003). In this context, it is worth assessing the geographic distribution of WVC, determining the most problematic animal-human conflict areas, and strengthening preventive measures (FARELL and TAPPE 2007, GUNSON at al. 2010, MALO at al. 2004, ROSELL at al. 2013, ZUBEROGOITIA at al. 2014).

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