



SEASONAL AND DAILY CHANGES OF ROAD COLLISIONS INVOLVING FOREST ANIMALS

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Summary

Development of road infrastructure and growing number of vehicles on the roads increase the probability of road collisions with wild animals (fallow deer, stag, moose, roe deer or wild boar). In order to improve the safety and decrease the number of wildlife vehicle collisions, it is justifiable to determine the time intervals in which the probability of road accidents involving animals occurs, including seasonal, monthly and daily changes over the whole year.

The research comprised an analysis of the structure of road collisions involving wild animals in the years 2001-2011, including the division into seasons, monthly and daily intervals. The data of the number of road traffic collisions involving animals were obtained through an analysis of the data base of Police Headquarters in Warsaw.

The identified structure of seasonal and daily road collisions involving animals revealed that the highest number of accidents happened in autumn (29.36%) and spring (26.60%). Almost 10.88% of the analysed accidents happened in October and c.a. 10.62% in May. In the daily structure, the highest probability of collision was after the sunset. These changes are related to daily and seasonal migration due to animal behaviour and the traffic density.

Key words: road, road collisions, mortality, forest animals

INTRODUCTION

Each year thousands of road collisions caused by various factors happen on public roads (Seiler 2003, Symon 2012). Development of road infrastructure contributes to a better safety of travellers, but at the same time leads to the environment fragmentation (Forman et al. 2003), which makes difficult animal migration and may affect a decrease in alleles frequency leading to a genetic drift and genetic changes in subpopulations (Solomon et al. 2000). Extension of road infrastructure increases the probability of wild animals appearance on the roads, which may cause serious road collisions resulting in material losses, most frequently deadly hit of an animal, or even a wildlife roadkill (Tyburski, Czerniak 2013). In 2001-2010 the number of road accidents involving animals in Poland doubled from 8423 in 2001 to 17 678 in 2010 (Czerniak, Tyburski 2011).

To improve the safety and diminish the number of game accidents which cause the greatest material losses, it is justifiable to determine the time intervals in which the probability of road collisions involving animals increases, considering seasonal, monthly and daily changes occurring over the whole year.

METHODS

The presented research involved an analysis of the structure of road accidents involving animals in the years 2001-2010, including the division into seasons of the year, monthly and daily intervals. All kinds of road collisions which happened during the investigated 2001-2011 period were compared with the number of road accidents involving wildlife which took place on public roads in Poland. Pearson's correlation coefficient was computed for these data to determine the level of correlation. The data referring to the number of road collisions involving game were obtained through an analysis of database of the Police Headquarters in Warsaw.

For simplification reasons it was assumed that:

- the springtime comprised March, April and May,
- the summertime: June, July and August
- the autumn time: September, October and November
- the wintertime : December, January and February.

Analyses covering the number of collisions in one-hour intervals for each month were conducted for the years 2002-2011. Year 2011 was omitted because of the problems with accumulating detailed data for this year, due to filling systems used at Police Headquarters. The obtained data concerned the number of accidents involving animals at individual hours in a month, e.g. in January 2011, fifty one collisions occurred between 15.00 and 15.59. A boxplot was

made illustrating minimum and maximum values during the analysed period in hourly intervals.

The data were compared with the sunrise and sunset hours in order to analyse the importance of the day length for animal migration. The information about sunrise and sunset time originated from hunting calendar available on web page www.lowiecki.pl. On the basis of conducted analyses it was determined at which hours the risk of road collisions involving animals increased.

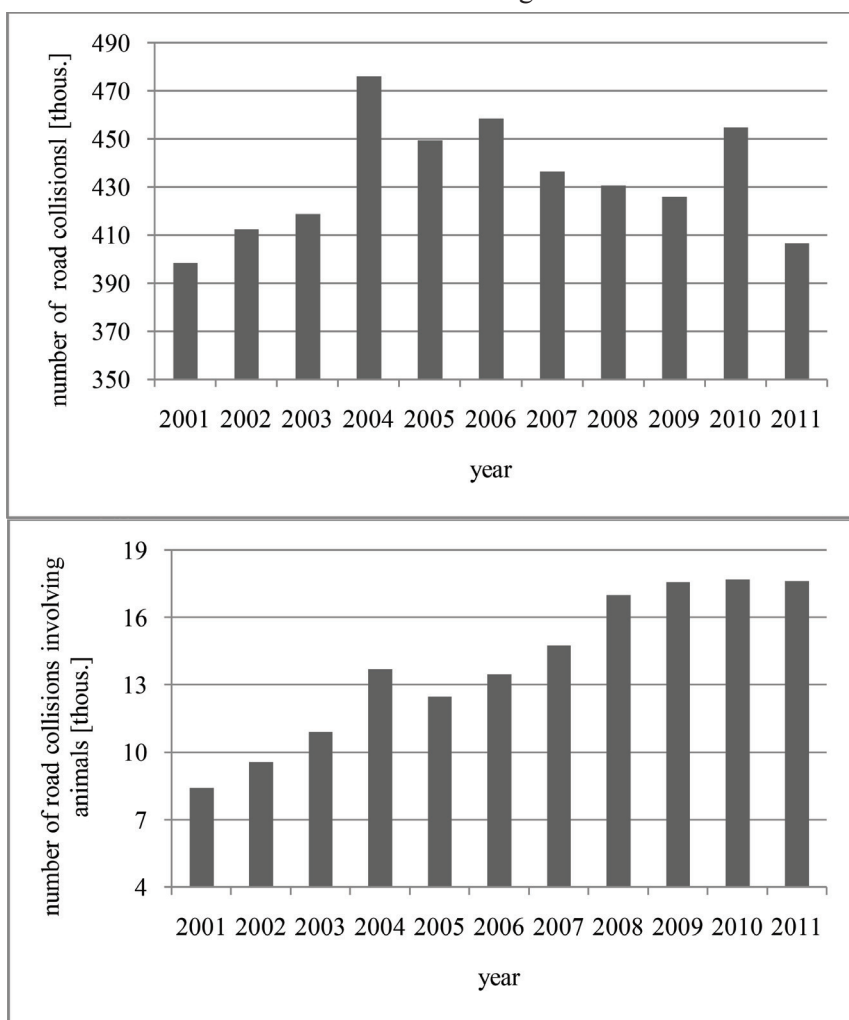


Figure 1. Comparison of the number of collisions on public roads in Poland with road collisions involving animals in 2001-2010

RESULTS AND DISCUSSION

The compilation of a total number of road accidents which took place on public roads in Poland and the number of road collisions involving animals shows that the number of game accidents was revealing a continuous upward trend. A total number of accidents revealed a changeability from c.a. 400 thousand collisions in 2001 and 2011 to over 470 thousand in 2005 (Fig.1). The relationship between the total number of road collisions and game accidents in the years 2001-2011 is weak, as determined by Pearson's correlation coefficient: 0.29.

Analysis of the distribution of road collisions involving animals in seasons of the year demonstrated that in 2001-2011 the highest number of analysed accidents (29.36%) happened in autumn (September, October, November), whereas the fewest were registered in winter (21.06%), whereas slightly more in summer (22.98%) (Fig.2).

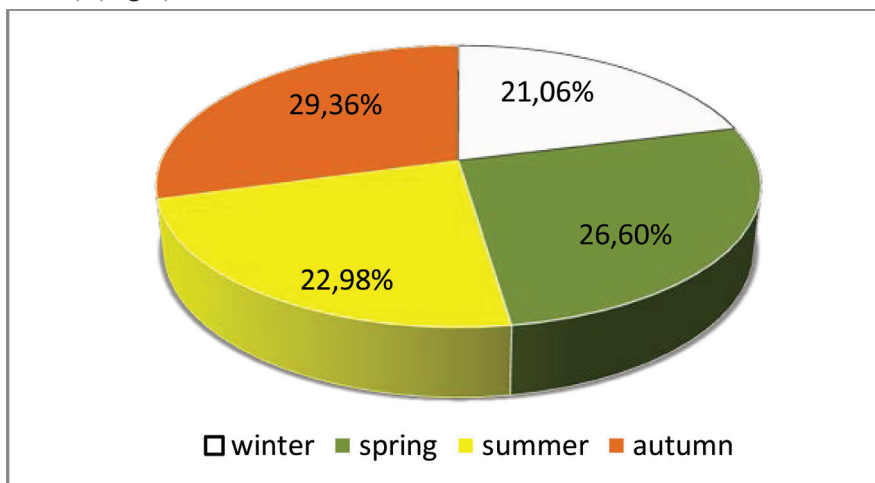


Figure 2. Percentage of road collisions involving animals on Polish roads in seasons of the year, in 2001-2011

The analysis of road collisions involving animals, including months reveals that the highest number of accidents took place in October and May – total 21.50% collisions. The fewest accidents – 8 885 (5.80%) were registered in February (Table 1). The average number of road accidents involving wild animals was 1 161 per month (Fig.3).

Table 1. The total number of road collisions involving animals on Polish roads in 2001-2011 in months

Month	Number of collisions	Percentage
January	10 205	6.66
February	8 885	5.80
March	10 839	7.07
April	13 663	8.91
May	16 275	10.62
June	11 372	7.42
July	11 315	7.38
August	12 529	8.17
September	12 402	8.09
October	16 676	10.88
November	15 921	10.39
December	13 187	8.60

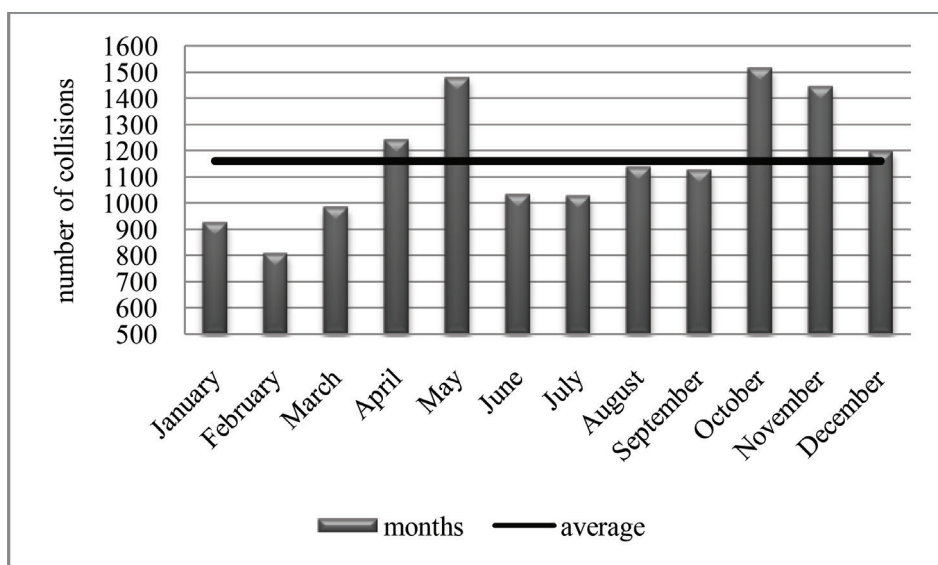


Figure 3. Average number of road collisions involving animals on public roads in Poland in 2001-2011, in individual months

Detailed data obtained from Police Headquarters in Warsaw allowed to conduct an analysis of the structure of road collisions involving animals happening in Poland, including one-hour intervals.

Figure 4 shows the structure of accidents in one-hour intervals in months, indicating the lowest and the highest values. The lowest value – zero was registered in January 2002 between 02.00 and 02.59. No collision involving animals was noted during this hour over the whole month on public roads in Poland. The highest value was registered in 2009 in May between 20.00 and 20.59, when the highest number of accidents (a total of 377) was registered for the whole analysed period (2001-2011). Analyses regarding one-hour intervals show that over the investigated period on average of 50 collisions involving animals happened on Polish roads at each hour of the month (Table 2).

On the basis of the analysis of road collisions involving wildlife in the assumed hourly intervals in a month, regarding the sunrise and sunset times, the highest increase in the number of game accidents in the morning was registered at sunrise hour or during the preceding hour. In the afternoon and early afternoon, the number of collisions was the lowest. An hour or two after sunset the highest number of accidents with animals happened during the whole day (Table 2).

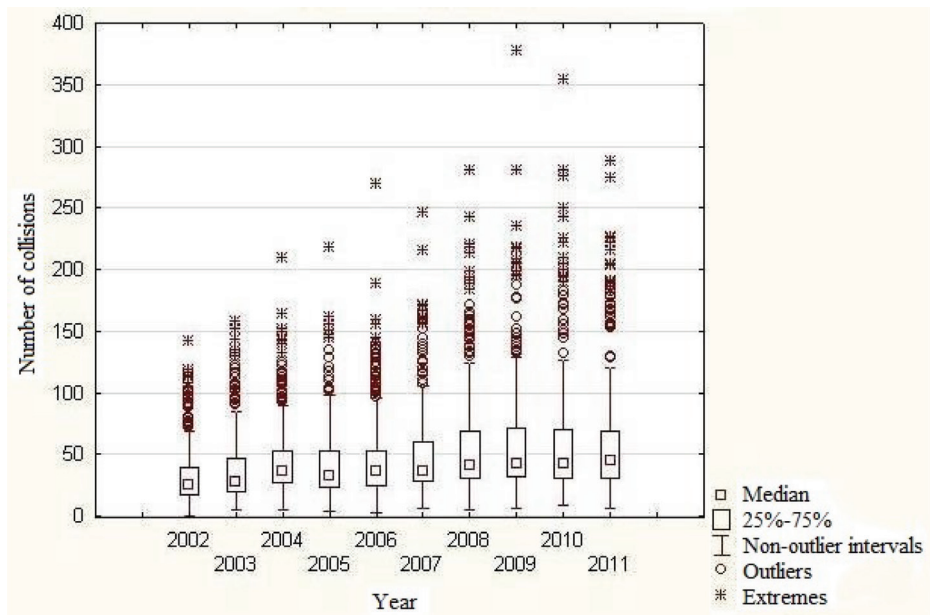


Figure 4. Chart illustrating the number of road collisions involving animals in 2002-2011 including the number of observations in the analysed one-hour intervals

Investigations conducted in other countries corroborate a higher number of road collisions involving animals in the morning and evening hours (Perrin and Disegni 2003), Litvaitis and Tash 2008). It should be taken into consideration, that researches conducted in various climatic and geographical conditions should not be compared, among others because of different animal behaviour resulting from postponed daily cycles. The investigations conducted in France and Spain reveal that March is the first month of the year when increased number of wildlife vehicle collisions happens (Morelle and Schlemaire 2005, Tenés, Cahill and Llimona 2007). In Poland this period falls in May.

The results of conducted analyses of road collisions involving wildlife on public roads in Poland are directly connected with animal migration during the days, months or year (Kamieniarz 2013). Animal migration is caused by seeking new feeding positions and reproduction periods. The morning and evening increase in the number of accidents involving animals is associated with their returning to or leaving their daily habitats and coincides with heavy traffic during rush hours. A diversification of the number of accidents on individual days of the week has been observed (Fig.5). The highest number of road collisions with animals takes place on Fridays, Saturdays and Sundays, which is associated with weekend getaways and vehicle movement in the afternoon hours – varied in time (Tyburski 2010).

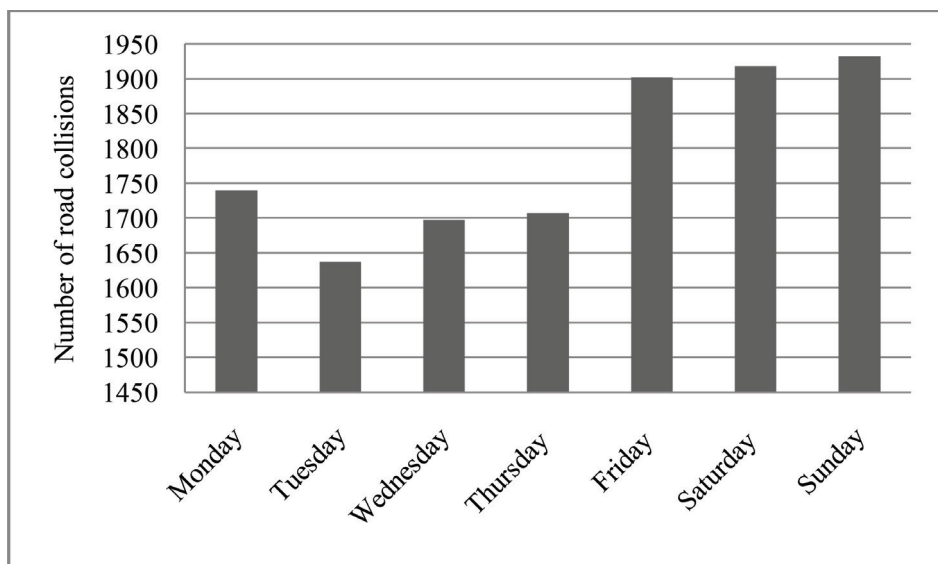


Figure 5. Average number of road collisions involving animals in Poland in the years 2001-2008 per the days of the week (Tyburski 2010)

Table 2. Average number of road collisions involving animals in the analysed months and hourly intervals

Hours	January	February	March	April	May	June	July	August	September	October	November	December	Average number of accidents per hour
	☀️ – sunrise ☾ – sunset, 🟡 – the highest number of road collisions in the morning 🔴 – the highest number of road collisions in the afternoon												
	☀️ 07.36	☀️ 06.53	☀️ 06.02	☀️ 05.38	☀️ 04.41	☀️ 04.15	☀️ 04.33	☀️ 05.19	☀️ 06.09	☀️ 06.53	☀️ 06.55	☀️ 07.36	
	☾ 15.53	☾ 16.46	☾ 17.54	☾ 19.33	☾ 20.54	☾ 20.56	☾ 20.47	☾ 19.58	☾ 18.50	☾ 17.32	☾ 15.44	☾ 15.25	
00.00 – 00.59	13	11	18	35	52	38	40	33	29	33	26	18	29
01.00 – 01.59	17	16	19	39	63	43	41	36	34	36	23	20	32
02.00 – 02.59	12	8	14	27	47	35	28	28	21	25	17	13	23
03.00 – 03.59	10	8	13	26	54	50	39	23	22	23	14	10	24
04.00 – 04.59	10	12	15	42	🔴 96	☀️ 48	☀️ 54	36	26	25	16	13	33
05.00 – 05.59	18	16	33	🔴 77	63	28	33	☀️ 54	51	43	29	21	39
06.00 – 06.59	36	☀️ 40	☀️ 42	55	42	30	30	46	☀️ 70	☀️ 103	☀️ 71	43	51
07.00 – 07.59	☀️ 53	37	31	39	48	30	32	39	47	85	63	☀️ 70	48
08.00 – 08.59	34	27	29	35	38	26	28	38	37	50	40	44	36
09.00 – 09.59	27	23	29	34	35	29	28	31	32	49	37	33	32
10.00 – 10.59	28	24	31	36	36	25	25	30	28	39	37	35	31
11.00 – 11.59	30	27	28	30	31	25	24	32	28	36	35	36	30
12.00 – 12.59	31	25	28	31	27	22	24	31	24	38	38	38	30
13.00 – 13.59	30	24	28	32	25	20	23	28	24	35	36	41	29
14.00 – 14.59	34	28	34	34	30	22	26	32	26	42	42	44	33

	January	February	March	April	May	June	July	August	September	October	November	December	Average number of accidents per hour
Hours	☀ – sunrise ☾ – sunset, ☐ – the highest number of road collisions in the morning ☑ – the highest number of road collisions in the afternoon												
	☀ 07.36	☀ 06.53	☀ 06.02	☀ 05.38	☀ 04.41	☀ 04.15	☀ 04.33	☀ 05.19	☀ 06.09	☀ 06.53	☀ 06.55	☀ 07.36	
	☾ 15.53	☾ 16.46	☾ 17.54	☾ 19.33	☾ 20.54	☾ 20.56	☾ 20.47	☾ 19.58	☾ 18.50	☾ 17.32	☾ 15.44	☾ 15.25	
15.00 – 15.59	☾ 40	32	36	36	30	24	23	33	29	39	☾ 57	☾ 58	36
16.00 – 16.59	77	☾ 38	42	36	29	27	28	36	35	61	158	142	59
17.00 – 17.59	115	96	☾ 56	38	39	30	34	40	42	☾ 91	175	128	74
18.00 – 18.59	89	101	143	51	43	32	40	51	☾ 62	169	137	110	86
19.00 – 19.59	75	74	121	☾ 81	56	39	42	☾ 60	126	169	128	98	89
20.00 – 20.59	60	60	92	202	☾ 138	☾ 51	☾ 63	129	139	134	116	90	106
21.00 – 21.59	53	46	65	142	254	139	139	150	98	103	93	71	113
22.00 – 22.59	49	41	50	84	166	172	139	97	78	85	69	58	91
23.00 – 23.59	26	28	35	61	94	87	76	67	56	65	45	36	56
Average no. of collisions	40	35	43	54	64	45	44	49	49	66	63	53	50
Average number of road collisions in month	963	839	1031	1300	1535	1070	1057	1178	1164	1574	1498	1263	

CONCLUSIONS

In order to reduce the number of road collisions involving wild animals it is necessary to provide the road users with full information about the most probable hours when forest animals may appear on the roads in the individual months.

Identified structure of seasonal and daily road collisions involving the animals revealed, that the highest number of the analysed accidents happened in autumn (29.36%) and in spring (26.60%). 10.88% of the investigated collisions happened in October and 10.62% in May. In the daily structure, the highest probability of the accidents was after the sunset. Changes in the number of accidents in the investigated hourly intervals and between the seasons of the year are strictly connected with the daily and seasonal migration resulting from the animal behavior and traffic density.

Considering the analysed period, the highest number of road collisions involving forest animals on Polish roads, regarding the hourly intervals in months, happened in May 2009 between 20.00 and 20.59 (337 collisions).

The highest probability of a road traffic collision involving big game was stated as follows:

- in January, in the morning between 07.00 – 07.59, in the evening 17.00 – 17.59,
- in February, in the morning between 06.00 – 06.59, in the evening 17.00 – 18.59,
- in March, in the morning between 06.00 – 6.59, in the evening 18.00-18.59,
- in April, in the morning between 05.00 – 05.59, in the evening 20.00-20.59,
- in May, in the morning between 04.00-04.59, in the evening 21.00-21.59,
- in June, in the morning between 03.00 – 03.59, in the evening 22.00-22.59,
- in July, in the morning between 04.00 – 04.59, in the evening 21.00-22.59,
- in August, in the morning between 05.00-05.59, in the evening 20.00-21.59,
- in September, in the morning between 06.00-06.59, in the evening 19.00-20.59,
- in October, in the morning between 06.00-06.59, in the evening 18.00-19.59,
- in November, in the morning between 06.00 – 06.59, in the evening 16.00-17.59,

- in December, in the morning between 07.00 – 07.59, in the evening 16.00-17.59.

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