Spatiotemporal Patterns of Ungulate-Vehicle Collisions in Lithuania

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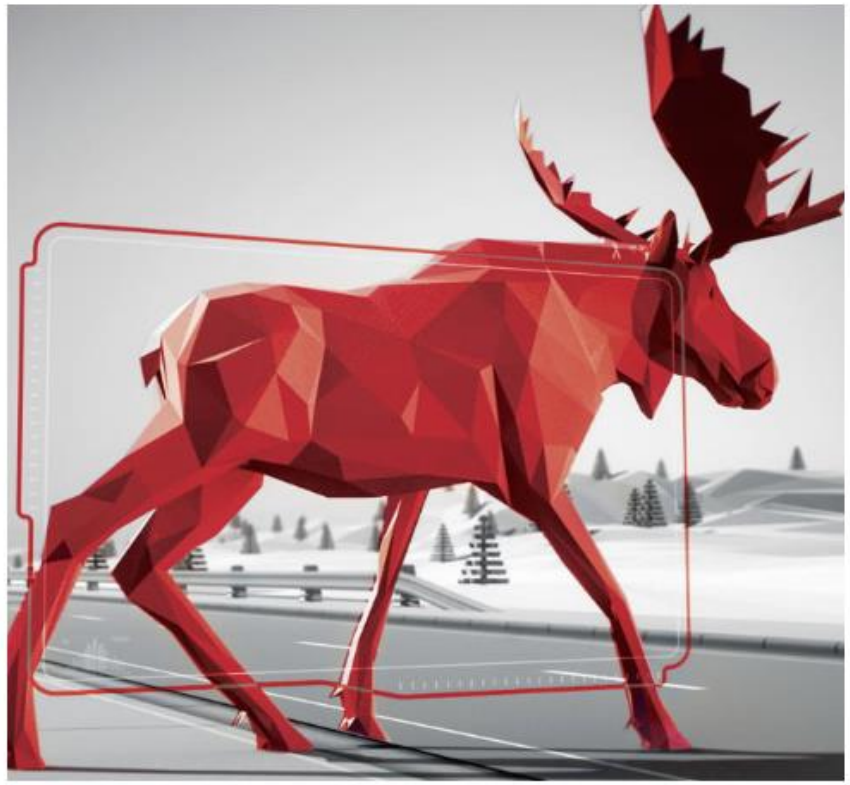
Background

- The **ecological effect of road traffic on wildlife populations**, which potentially affects every moving terrestrial species, **is of growing concern in numerous countries**.
- **Wildlife mortality caused by vehicles** is a serious conservation and economic problem as collisions with large mammals **are global, persuasive and increasing**.
- **Large mammals** that participate in UVC **are the most critical for drivers due to the animal body sizes** and the respective impact consequences.
- **UVC are responsible for majority of the economic losses and human injuries** associated with vehicle-wildlife collisions.
- To check whether ungulate-vehicle collisions indicate different seasonal and daily variation, **we analysed ungulate-vehicle collision time** for four major ungulate species (roe deer, red deer, moose, wild boar) **within the 2002-2017 period in Lithuania.**



Study area and collision data

Roads:

•1784 (21,471 km) of State owned main, national and regional roads.

Fences:

•1088 wildlife fences (804 km).

•The average length of fenced road section is about 739 metres.

•The most fenced road sections are on:

- 99 % of main roads;
- 50 % of national roads;
- 5 % of regional roads;

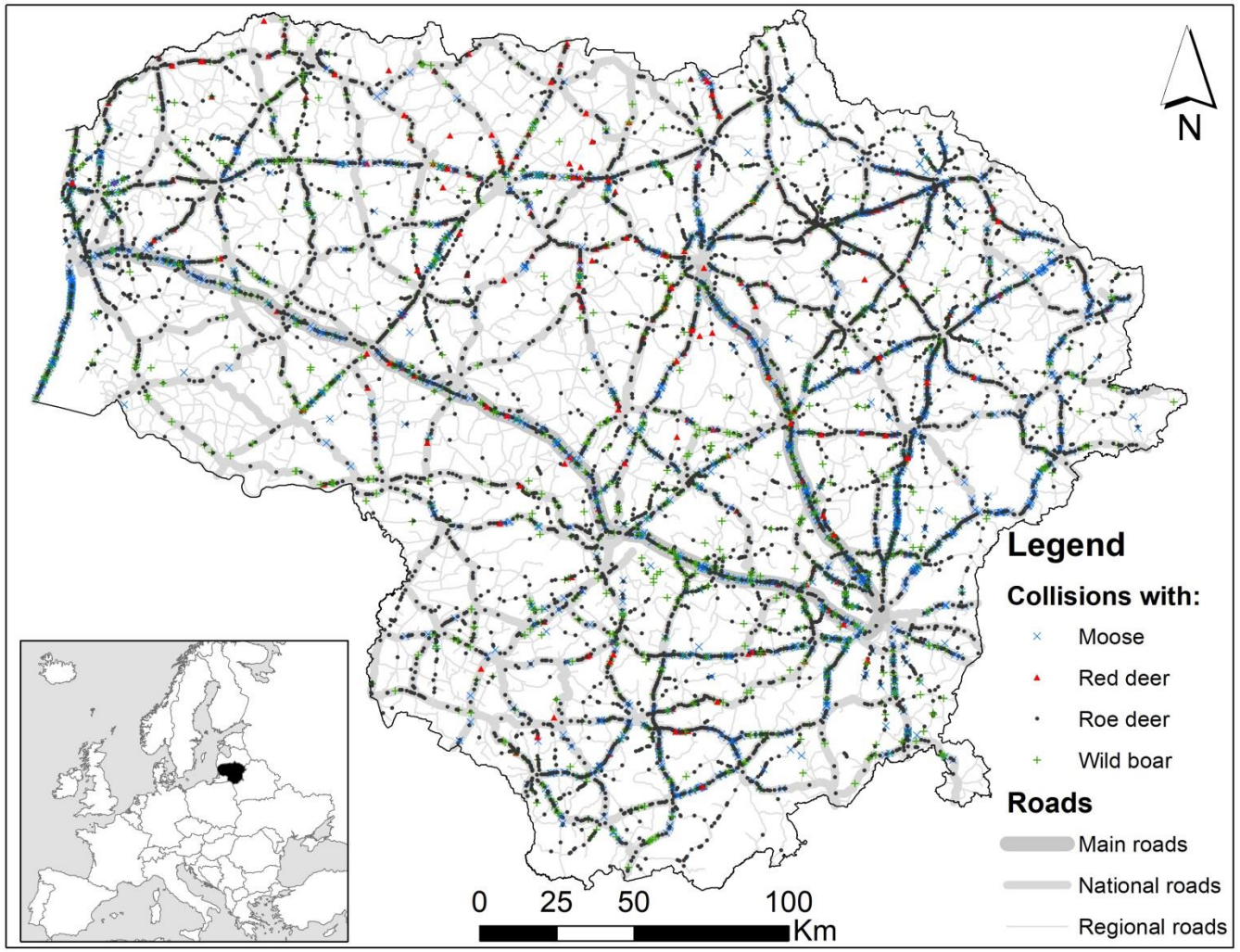
AADT:

•8 % of main (3,000-20,000 cars per day) roads/highways;

•23 % of national (500-3,000 cars per day) roads;

•69% of regional (up to 500 cars per day) roads.

14,989 UVC reports



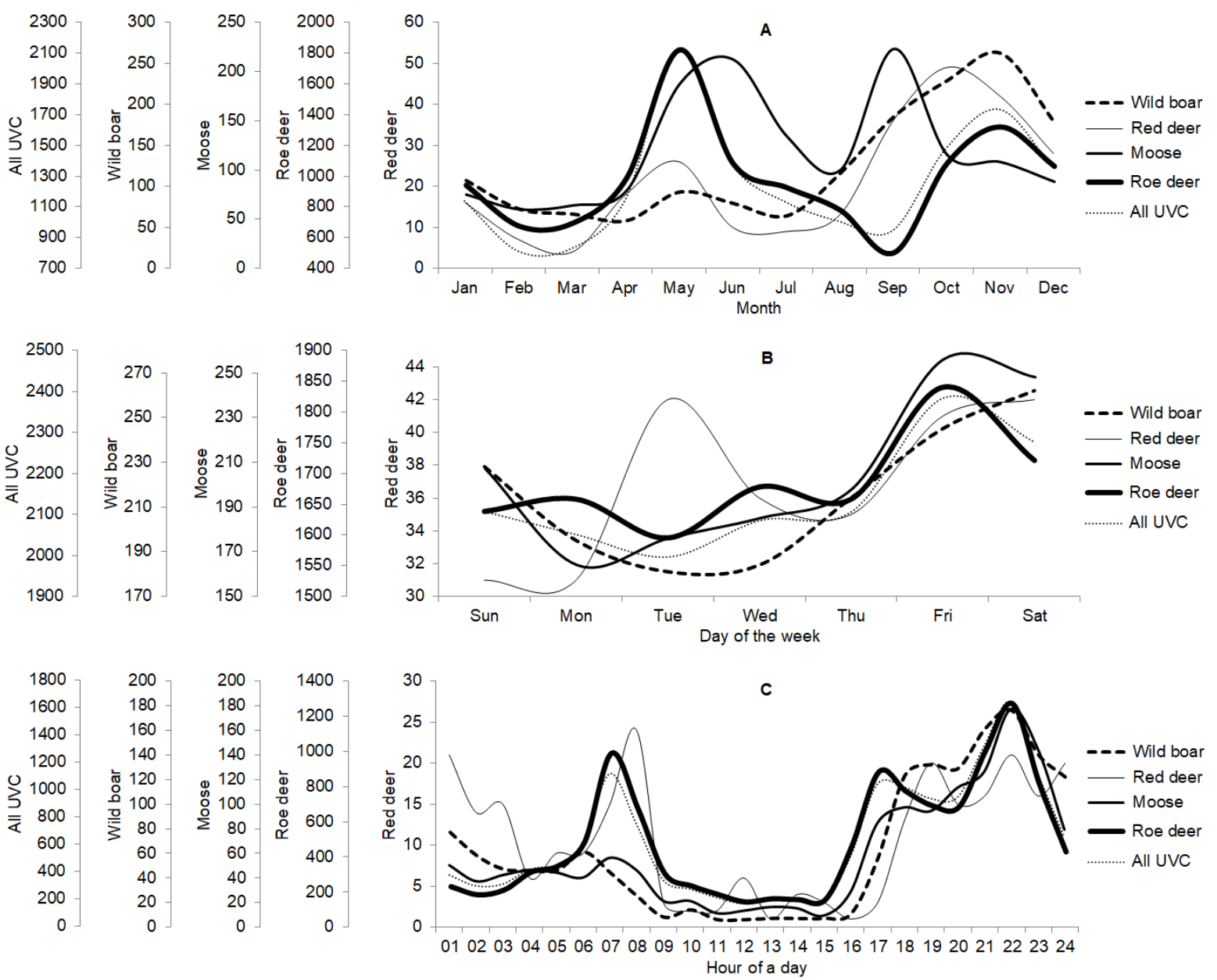
1,434 moose (*Alces alces*), 258 red deer (*Cervus elaphus*), 11,788 roe deer (*Capreolus capreolus*) and 1,509 wild boar (*Sus scrofa*) UVC reports.

Daily, weekly and monthly variability of UVC collisions

- Monthly (A),
- Daily (B) and
- Hourly (C)

occurrence of UVC in Lithuania 2002–2017.

The scale of the multiple vertical (Y) axis shows the values for the associated species-specific data series.

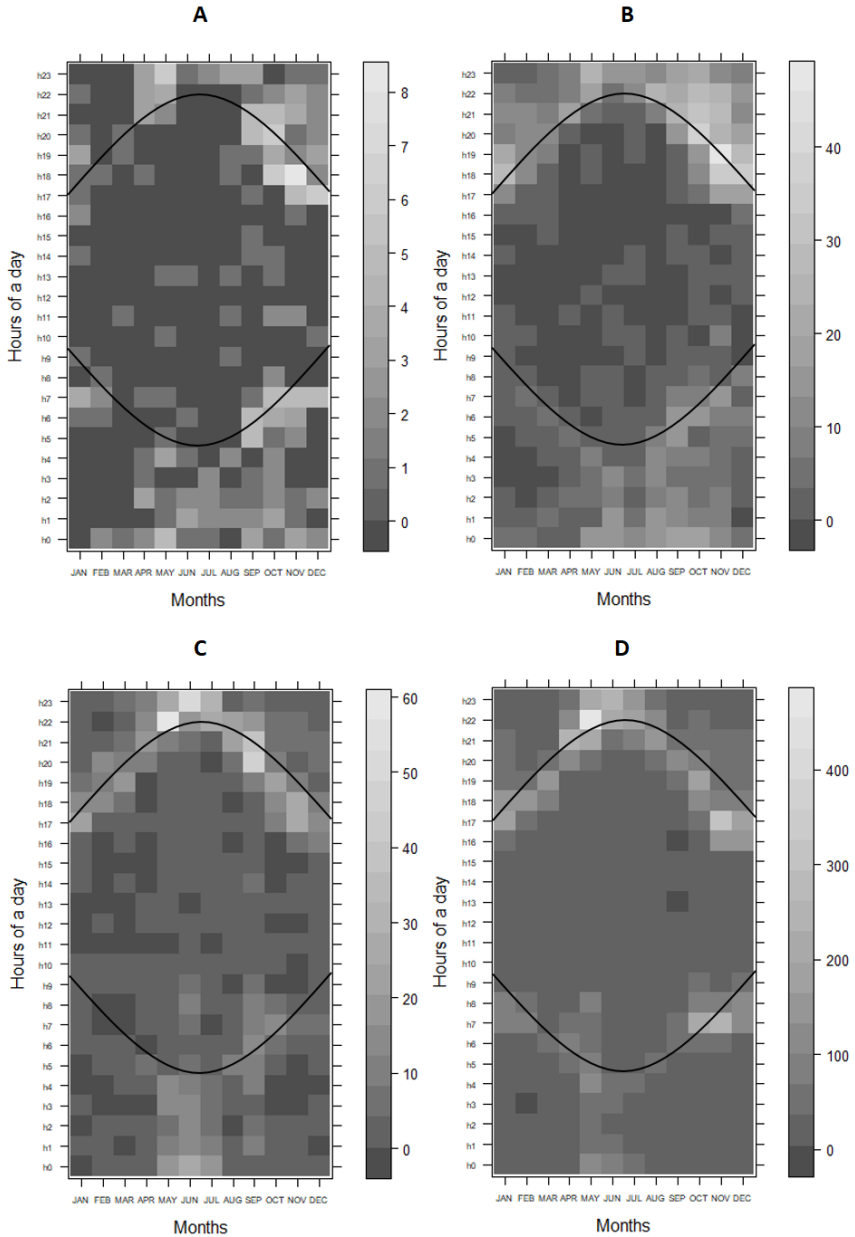


Spatiotemporal patterns in UVC

Hypothesis	Variable	Moose	Red deer	Wild boar	Roe deer	All UVC
A. UVC distribution is random every year	I	0.261586	2.173761	0.503924	0.164027	0.161080
	Var (I)	0.012523	0.255802	0.019861	0.000756	0.000425
	z	2.344222**	4.305943***	3.580772***	5.968838***	7.817597***
B. UVC distribution is random every month	I	0.293548	−0.247128	0.346845	0.041527	0.039050
	Var (I)	0.012530	0.256328	0.019859	0.000756	0.000425
	z	2.629146***	-0.480120^{NS}	2.466280**	1.513618^{NS}	1.897825**
C. UVC distribution is random every weekday	I	0.086200	1.400699	0.284751	0.040340	0.037589
	Var (I)	0.012533	0.256981	0.019865	0.000756	0.000425
	z	0.776658^{NS}	2.771070***	2.025343**	1.470471^{NS}	1.826961*
D. UVC distribution is random every hour	I	0.383592	0.592483	0.366169	0.053052	0.070304
	Var (I)	0.012534	0.257384	0.019868	0.000756	0.000425
	z	3.433037***	1.175825^{NS}	2.602821***	1.932750*	3.413951***
A, B, C, D	E (I)	−0.000749	−0.004049	−0.000710	−0.000094	−0.000073
	DDT (m)	21,853.91	34,997.71	19,063.38	8,942.51	11,961.98

Spatiotemporal patterns in UVC: yearly (A), monthly (B), weekly (C), and hourly (D), based on Global Moran's I summary statistics: the Global Moran's Index (I), variance (Var (I)), z-score (z). Hypotheses that there are no relationships between temporal patterns and UVC declined with: *** – $p < 0.01$, ** – $p < 0.05$ and * – $p < 0.07$.

Daily and seasonal and cumulative variability of UVC in 2002-2017



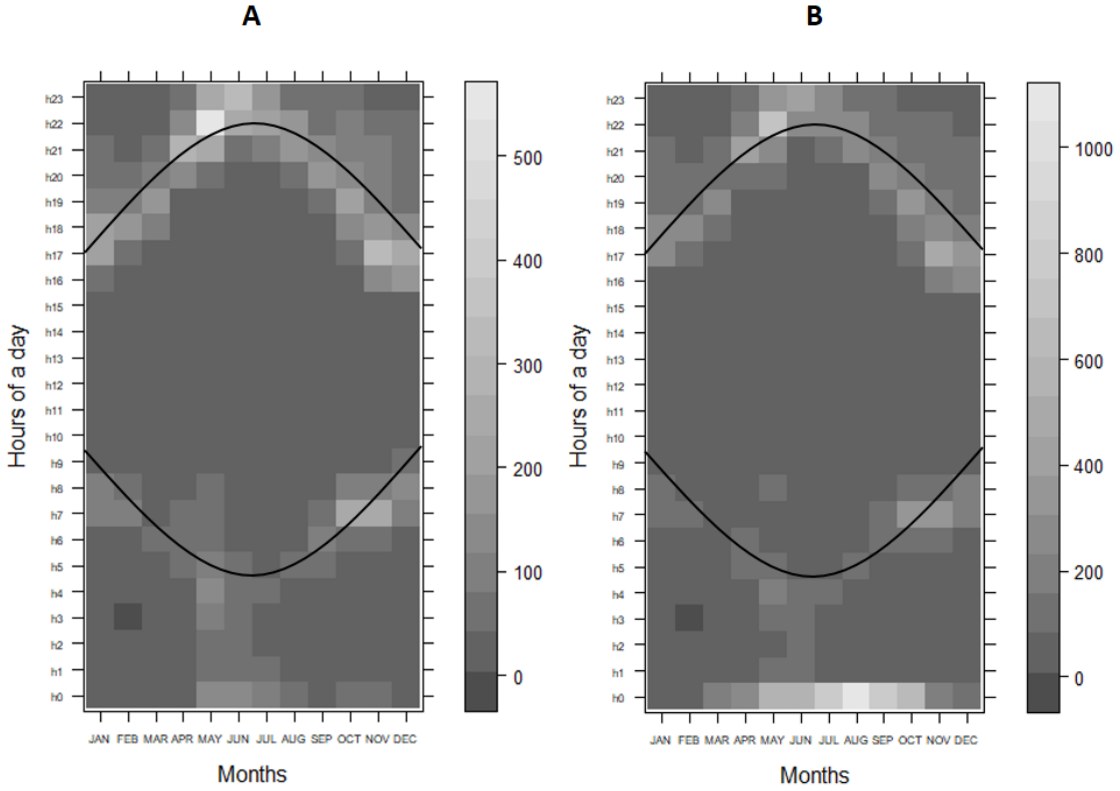
Daily and seasonal variability of UVC for :

- Red deer (A),
- Wild boar (B),
- Moose (C) and
- Roe deer (D).

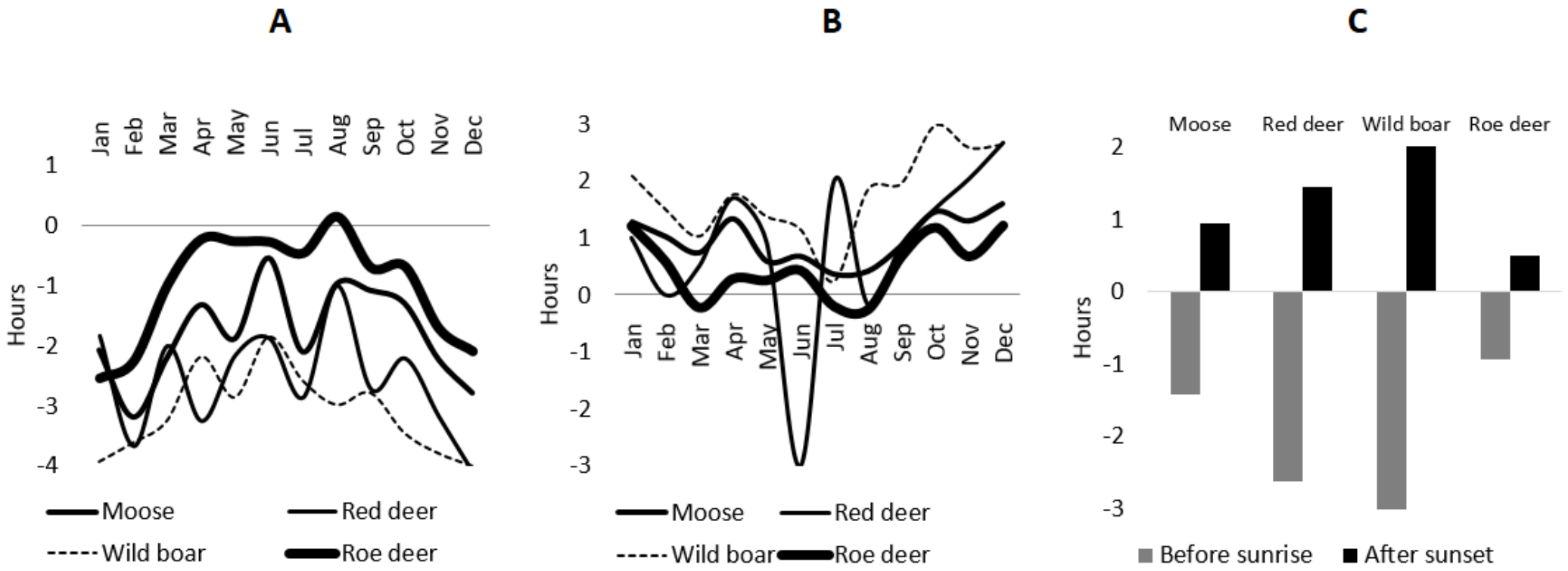
Each square represents number of UVC. The upper black line indicates sunset and the lower black line indicates sunrise.

Cumulative daily and seasonal variability of:

- UVC (A) with all four ungulate species involved and
- All WVC (B).



The relationship between collisions and day/night cycles



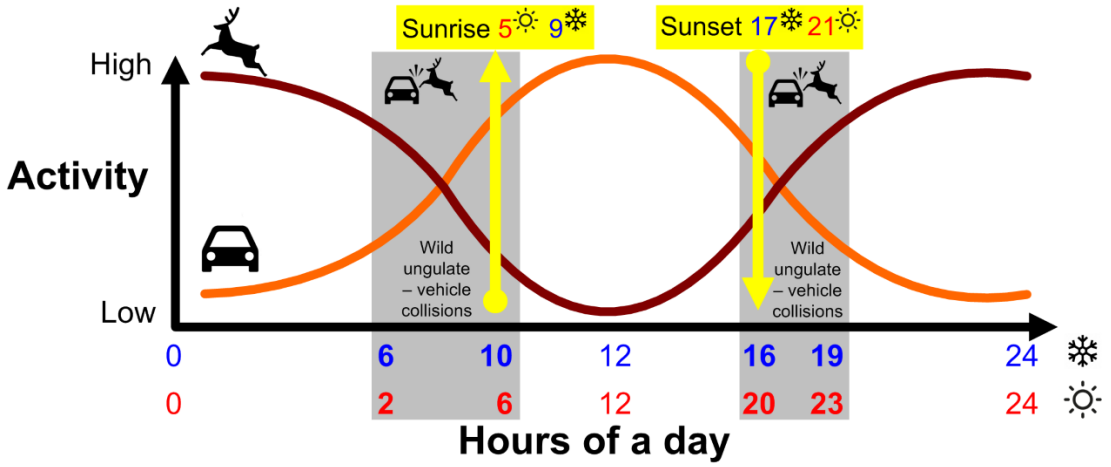
Species specific annual average monthly time difference between:

- UVC time and sunrise time (A),
- UVC time and sunset time (B) and
- UVC time, sunrise time and sunset time (C).

Conclusions and insights

- Planning of any UVC mitigation measures might benefit from temporal UVC data;
- Identifying the most important mitigation measures, species-specific temporal UVC information should be introduced, in order to include adjustments based on the behaviour of animals;

- Our results show that the highest risk of UVC in Lithuania are:
- **winter peak and trough time 5:00–9:00 h and 16:00–19:00 h and**
- **spring peak and early summer 3:00–5:00 h and 19:00–23:00 h.**



- UVC were highly concentrated during or up to 2 hours after sunset and during or up to 4 hours before sunrise;
- Temporal accident analysis suggests that efforts to reduce wildlife collisions should focus on driver attitudes and road conditions, rather than animal movement and behaviour.

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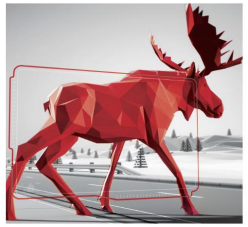
ABSTRACT

Wildlife mortality caused by vehicles is a serious conservation and economic problem as collisions with large mammals are global, pervasive and increasing. We analysed 14,989 reports of ungulate-vehicle collisions (UVC) that occurred in Lithuania from 2002 to 2017. We analysed UVC data for four major ungulate species (roe deer, red deer, moose and wild boar) and checked for potential seasonal or daily trends. The temporal distribution of collisions was species-dependent. UVC analysis showed strong monthly and hourly pattern. Most occurrences took place before or during sunrise (dawn) and after or during sunset (dusk) during the year. In spring, the highest UVC peaks occurred early in the morning and late in the evening, while in winter these peaks occurred in late mornings and early evenings. With most UVC occurring on Fridays, daily variations were weak. We conclude that temporal variations of UVC distributions are result of a complex interaction of phenological factors and animal behaviour. The information provided in this study reinforces the knowledge on the dynamics and patterns of UVC and represents an important element for the identification of mitigation measures. Our findings suggest that efforts to reduce UVC should also focus on driver attitudes considering the seasonal and daily variations in UVC.



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