The Effect of Weather on Deer-Vehicle Collisions

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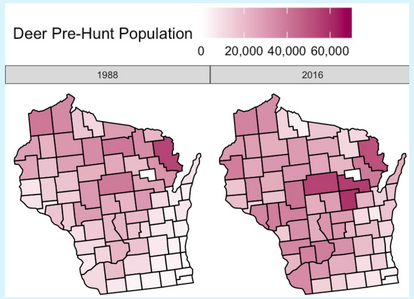
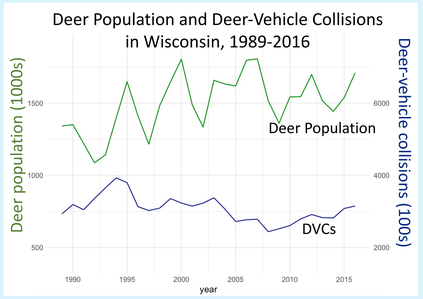
Research Question

- What is the effect of weather on the frequency of deer-vehicle collisions (DVCs)?
- The net effects are ambiguous *a priori* because weather affects both deer and drivers, potentially in opposite ways. For example, in hot or rainy conditions, drivers may be less attentive while deer are less active.

Significance

- There are 1-2 million DVCs every year in the USA, resulting in 29,000 human injuries, 200 human fatalities and over $10 billion in economic losses.[1, 2]
- DVC rates are rising rapidly nationwide, despite broad scale efforts to mitigate them.
- New engineering and communication strategies (e.g., sensors and dynamic signs) show promise; however, appropriate targeting requires understanding how road conditions affect DVCs





Contributions to the Literature

- Gain a better understanding of the interaction between changes in driver and deer behavior based on temperature and precipitation to forecast the likelihood of a DVC.
- Determine if human population, deer population, and wolf presence are associated with the frequency of DVCs when controlling for weather.

Data

- Panel dataset of 71 counties in Wisconsin spanning 1988 to 2016
- Variables: police-reported collisions and deer-vehicle collisions, human population, pre-hunt deer population, wolf presence, precipitation, and daily minimum and maximum temperature
- Over the study period, there were over 3.5 million reported vehicle collisions, of which about 500,000 – or 15% – were DVCs.

Model

$$log\ (C_{imt}) = \boldsymbol{X}_{imt}\boldsymbol{\beta} + \gamma_i + \gamma_m + \gamma_t + \varepsilon_{imt}$$

C_{it} is the crash count for county i, month m, and year t

X_{it} is a matrix of independent variables

$\gamma_i, \gamma_m, \gamma_t$ are vectors of fixed effects for county, month, and year

Results

Dependent Variables:	Deer-vehicle collisions		Non-deer-vehicle collisions	
Model:	(1) Poisson	(2) Neg. Bin.	(3) Poisson	(4) Neg. Bin.
Variables				
Minimum Temp. (C)	0.0016**	0.0016**	-0.0025***	-0.0019***
	(0.0007)	(0.0007)	(0.0004)	(0.0005)
Maximum Temp. (C)	0.0019***	0.0016***	-0.0091***	-0.0099***
	(0.0005)	(0.0006)	(0.0008)	(0.0006)
Precipitation (mm)	-0.0149***	-0.0145***	0.0096***	0.0102***
	(0.0005)	(0.0005)	(0.0005)	(0.0003)
Human pop. (1000s)	-0.0003	0.0002	0.0019***	0.0024***
	(0.0014)	(0.0016)	(0.0003)	(0.0005)
Deer pop. (1000s)	0.0097***	0.0095**	-0.0014	-0.0008
	(0.0036)	(0.0037)	(0.0011)	(0.0010)
Wolf presence (dummy)	-0.1774**	-0.1668**	0.0075	0.0130
	(0.0845)	(0.0817)	(0.0223)	(0.0227)

Clustered (County) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

- Warmer, drier conditions are associated with an increase in DVCs, but a decrease in non-DVCs.
- The estimates for the other covariates are as expected:
  - Larger deer populations increase DVCs
  - Larger human populations increase non-DVCs
  - Wolf presence reduces DVCs

Discussion

- **Non-DVCs**: The effects of minimum temperature and precipitation are consistent with the previous literature. However, we expected hot weather to increase non-DVCs due to driver inattention and slower reaction times; there may be a threshold effect that our model does not capture.
- **DVCs:** The results suggest that deer are more active in warm and dry conditions. This is consistent with ecology as deer huddle in dense, protective cover in cold and rainy conditions. However, we expected fewer DVCs in high temperatures, since deer reduce movement to stay cool; there may be a threshold effect that our model does not capture.

Conclusions

- Weather is important for predicting the frequency of DVCs and should be included in future related work.
- Dynamic signs and sensors may help to reduce non-DVCs during poor-weather conditions, but their effect on DVCs is likely to be limited due to the natural fall of DVCs during these periods.

Acknowledgements

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References

[1] Conover, Michael R., William C. Pitt, Kimberly K. Kessler, Tami J. DuBow, and Wendy A. Sanborn. 1995. “Review of Human Injuries, Illnesses, and Economic Losses Caused by Wildlife in the United States.” Wildlife Society Bulletin 23 (3): 407–14.

[2] Huijser, M.P., P. McGowen, J. Fuller, A. Hardy, A. Kociolek, A.P. Clevenger, D. Smith, and R. Ament. 2008. “Wildlife-Vehicle Collision Reduction Study: Report to Congress.” FHWA-HRT-08-034. McLean, VA: Federal Highway Administration.