Factors associated with deer vehicle collision in Oconee County, South Carolina, USA

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Abstract

Every year in the United States approximately 1.5 million deer–vehicle collisions (DVCs) occur resulting in >200 human fatalities, >29,000 human injuries, 1.3 million deer fatalities, and >1 billion dollars’ worth of property damage. The magnitude of this problem is so high, however there are relatively few well designed studies that have evaluated the factors affecting the DVCs and management techniques that can be used to reduce DVCs. Techniques to reduce DVCs include reducing the number of deer, reducing the number of vehicles, modifying deer behavior, changing land cover along roadways, rules on not feeding deer in developed areas, more alert signs during deer season and changing motorist behavior. Data on deer movement patterns across roads are valuable to reduce the occurrence of DVCs on existing roads and to assist planning of future road design and placement. Using DVC data from 2018 to 2021 provided by the Department of transportation and safety, we found that DVCs in Oconee County, South Carolina, USA were not random, and that human-induced deer movement patterns play a role in the frequency and location of DVC occurrence. Deer–vehicle collisions occurred more frequently near developed area and grasslands or hey, in October month and during 6:00PM to 12:00 PM in each day. Proper management along the roadways with deer repellant species, more alert sign during deer season, careful driving during 6:00PM to 1200PM and avoid feeding deer in developed areas may reduce the DVCs.

Introduction

Deer population in North America have increased dramatically (McShea et al. 1997). The human population and development are increasing rapidly which lead to a negative impact to the deer population (Hussein et al. 2007). This leads to the several problems like danger to human, vehicle damage, deer mortality, property loss and ultimately loss of economy. Spreading urban development is, finally, increasing deer human encounters (Huijser et al. 2009). Property damage from ungulate collisions is estimated to be $300 million/year in Canada and over $6 billion/year in the USA, with 90% of deer vehicle collisions (DVCs) ending in deer fatalities, and 56-65% ending in human injury (Huijser et al. 2009, Conover et al. 2995).

Previous study shows that the researchers have found correlation between DVC frequency and a number of landscape and traffic variables. Deer generally choose fragmented wooded areas compared to the entirely wooded areas which might be the case that the deer prefer habitats created by roadways (Farrell and Tappe 2007). It shows that the presence of open ground near wooded areas, higher vehicle speeds and traffic volume, nearby water, and proximity to highly productive non forested vegetation have been correlated with higher deer vehicle collision frequencies, however it shows that the higher road densities, presence of the more buildings and fencing negatively affect the DVC (McShea et al. 2008).

Drivers through the state should be cautious of roaming deer through the year, but specially during the rut or breeding season, typically from October through November. Most vehicle collision occur near dawn and dusk because deer tend to move more during these times. Unfortunately, these are also the times that most humans commute to and from work in their vehicles. The research on the preferences of the landcover for deer, relationship between road network and DVCs and timing is lacking on the Oconee County, SC. In this study, our goals were to 1) examine factors that contribute to the frequency of DVCs within Oconee County, SC, USA and 2) find the temporal occurrences of DVCs by month, day of the week, and time of day in which they occurred.

Methods

Study Area

The study area was Oconee County, SC. The maximum average temperature recorded was 108°F and lowest was -8°F. It has an annual average rainfall of 1.53m. It has an average elevation of 75.89m.

A map of a state

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Figure1: Oconee County, SC with deer vehicle collision points (DVC) from 2018 to 2021, road network and land cover.

Data Collection

The deer vehicle collision (DVC) data from 2018 to 2021 (see Table1) were downloaded from the department of transportation and highway safety website. County data and the road data of USA of 2021 were downloaded from <https://www.census.gov/cgi-bin/geo/shapefiles/index.php> , and NLCD 2021(National land cover dataset) data was added from the living atlas in ArcGIS Pro. These all data were added to the ArcGIS pro.

Table1: Data downloaded for analysis.

|  |  |
| --- | --- |
| Data | Website |
| NLCD | Living Atlas inside ArcGIS Pro |
| County | Tiger line/Shapefile |
| Road | Tiger line/Shapefile |
| Deer Vehicle Collision | Department of Transportation and Highway Safety |

Data Analysis

The DVC data was analyzed using ArcGIS Pro and R (v. 3.6.1 R Core Team 2023) to find the cause of different factors on collision. Different factors were analyzed (see Figure2). Those added data were checked and were converted to the common coordinate system NAD 1983 UTM Zone 17N. The Oconee County was extracted from all counties by going through properties and definition query. The point data of deer vehicle collusion were buffered to 500m to extract the vegetation information from each point. To make the comparison with the DVC points 76 random points were generated using create random points tool in ArcGIS Pro and buffered to 500m. Those buffers from DVC points and random points were compared for landcover to find the effect of landcover on the collision. and were compared with the collision buffer. Kernel Density maps were created for the DVC points and road network. Correlation between the road network and the deer vehicle collision was done. Through the spatial join tool in ArcGIS pro, the DVC points and roads were spatially joined. The roads within 5m from the point of collusion were extracted.

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Figure2: Overall procedure from data collection to final analysis.

Result and Discussion

Deer vehicle collision (DVC) data from 2018 to 2021 of Oconee County, SC we found that the DVC was high in the month of October, between the time period of 6pm to 12am and in main roads compared to other roads. The landcover on the collision points and randomly generated points tells that the deer vehicle collision occurs more on the road having pasture or hay and developed open space compared to the randomly generated points. Kernel density tells that the density of the collision or high intensity and the road network density.

Figure3: Deer collision in Oconee County from 2018 to 2023.

We found (Figure3) that the higher collision is in the October compared to the other months from the data collected between 2018 to 2021 of Oconee County from department of transportation and vehicle safety. This finding is consistent with the months that deer are actively breeding (Goulden 1981). During fall, males are travelling a lot to find females, and males looking to breed (Beier and McCullough 1990). More findings in regard to DVC occurrences during the fall months were documented in Iowa by Hubbard et al. (2000) and in Edmonton, Alberta, Canada, by Ng et al. (2008).

Figure4: Deer collision at different time of the day.

We found that (Figure4) maximum collision at 6pm to 12am compared to other time of the day. This is not surprising given that white-tail deer are most active during dawn and dusk (Beier and McCullough 1990). Our results are consistent with the earlier works of Bashore et al. (1985), Hubbard et al. (2000), and Nielsen et al. (2003). We found out that DVCs were not spatially random within the county.

Figure5: Deer vehicle collusion and road types within 5m around the collusion points.

We found (Figure5) that the higher collision at the main roads and secondary roads compared to interstate highway and urban roads.

Figure6: Number of cells value between collusion points and randomly generated points.

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Figure7: Buffered points of DVCs and randomly generated point.

We found (Figure6 &7) that the deer prefer the pasture /hay, deciduous forest, and the open space which coincides with the result shown by (Farrell and Tappe, 2007). These are the major land cover factors which cause collision.

Table2: Total surrounding land cover of DVC points and randomly generated points buffered at 500m.

|  |  |  |
| --- | --- | --- |
| Class Name | Collusion\_Buffer500 | Random\_Buffer\_500 |
| Open Water | 1400 | 3757 |
| Developed Open Space | 9032 | 5066 |
| Developed Low Intensity | 4778 | 1790 |
| Developed Medium Intensity | 1650 | 489 |
| Developed High Intensity | 529 | 179 |
| Barren Land | 110 | 129 |
| Deciduous Forest | 17452 | 18985 |
| Evergreen Forest | 4618 | 9540 |
| Mixed Forest | 6195 | 13297 |
| Shrub/Scrub | 438 | 1303 |
| Grassland/Herbaceous | 2134 | 1980 |
| Pasture/Hay | 13236 | 7291 |
| Cultivated Crops | 176 | 0 |
| Woody Wetlands | 259 | 92 |
| Emergent Herbaceous Wetlands | 20 | 14 |

Table 2 indicates the different raster cell count coverage within 500m of the collision point buffer. Collision\_Buffer500 is the buffer of the DVC points to 500m and then counting the different landcover within that point, while the Random\_Buffer\_500 is the randomly generated points buffered at 500m to find landcover around the points. These different buffers for the DVC and randomly generated points were used to compare the landcover. Most DVCs in our study area were adjacent to developed or grasslands or crop land cover types. Sudharsan et al. (2009) and Myers et al. (2008) found that a higher probability of DVCs occur developed area and crop or grassland. Deer vehicle collisions (DVCs) were associated with grasslands and wooded areas (Myers et al. 2008). Researchers have found a higher occurrence of DVCs near woodlots (Finder et al. 1999, Hussain et al. 2007).

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Figure8: Kernel density of the deer vehicle collision on the left and road network on the right.

We applied kernel density estimation to see the effect of roads network on DVC. Figure shows that the road network has a slight effect on the DVC. Clustered distribution of DVCs was observed compared to random. As there is a darker blue at the same location where the road network and DVC is high. Hence, the positive correlation (r = 0.69, p < 0.05) was observed between the deer collision points and road network.

Conclusion

We found that the open pasture or hay, open space with surrounding vegetation favors deer. The collusion data shows that the October month, the nighttime between 6pm to 12am, and main roads are main cause for the DVC. The kernel density map shows us that the there is a positive correlation of road network and DVCs. Our results indicate that DVCs are positively correlated to deer density, certain land-cover types, and that they occur more frequently during certain times of the day and months of the year. Proper management around this type of habitat can help in eradicating the impact of the deer vehicle collision. Management strategies should be specifically designed to focus during the times of day and year when a higher number of DVCs occur. Localized management near key habitat types that are associated with higher numbers of DVCs should be considered.

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