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The Effect of the Deer Population on the Number of Car Accidents

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Abstract

This paper examines the relationship between the deer population and the number of car accidents in New York State from 2002-2012. Data collected includes information on the amount of deer hunted, the number of car accidents, and the number of hunting permits issued. This paper also involves a county level analysis within New York State of 56 counties from 2007 - 2012. An important part of analysis of this paper is the examination of the Buck population vs. the Doe population on the number of car accidents. This is an important study because of its possible policy implications regarding the amount of deer hunting permits that should be distributed, and its effects on the deer population and the amount of car accidents.

Keywords

car accidents, deer, permits

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Introduction:

New Yorker's true neighbors are in fact the White-Tailed Deer. With an abundant population, deer are seemingly ubiquitous. Because of their thriving population, car accidents are unfortunately common and drivers must always be on the look out for one to dash across the road at any moment. If left unattended, the deer population could escalate out of control causing more problems for drivers and could throw off the balance in the ecosystem. The Department of Environmental Conservation (DEC) attempts to limit the deer population through the issuance of hunting permits. The DEC adjusts the number of permits they issue year to year in order to achieve the desired effect on the deer population. If they want to reduce the number of deer in the population, they will issue more hunting permits the following year. My hypothesis is that an increase in the amount of deer killed in New York State will lead to a reduction in the amount of car accidents caused by deer. In theory, the more hunting permits that are issued by the DEC, will lead to more deer being taken by hunters in that season, which would lead to less deer out on the road that could possibly be hit by a car. This is an important topic because reducing the amount of car accidents caused by deer will lead to less injuries for the people driving the car, and would also save these people money because if they aren't hitting the deer their car is not going to be damaged or possibly even totaled. Another reason for controlling the deer population is to keep the ecosystem in equilibrium. Too high of a deer population could lead to the deer venturing out of the woods even more and result in them grazing and eating expensive landscaping outside of homes.

Previous Literature:

Other studies have looked at alternative ways of reducing the amount of deer-vehicle crashes (DVC's), besides reducing the deer population. Three approaches that James H. Hedlund, Paul D. Curtis, Gwen Curtis, and Allan F. Williams study in their paper, "Methods to Reduce Traffic Crashes Involving Deer: What Works and What Does Not" include modifying driver behavior, modifying deer behavior, or reducing the number of deer. Some methods for effecting drivers behavior include better education of the driver, whether it be through more published news articles about DVC's, or putting up signs in areas where deer are commonly known to dart across the road. However, altering deer behavior seems to be a more effective way to reduce the amount of DVC's on the road. Numerous studies over the past years have indicated that properly designed and maintained fencing, used together with appropriate underpass, overpass, and one-way deer gates, is the most effective method for reducing DVCs in the United States

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(Danielson and Hubbard, 1998). Less effective methods at altering deer behavior are repellents and deer whistles on cars that make an unpleasant noise to deer in hope that it will keep them away. Finally, deer herd reduction is an appropriate method for reducing DVC's as well as crop and garden losses caused by deer (DeNicola et al., 2000). Other work shows that the state transportation department rated herd management as potentially the most effective DVC control strategy, while state wildlife administrators rated it second behind the effective fencing technique (Sullivan and Messmer, 2003). My paper differs because it also looks at the number of hunting permits that were issued over the years, and breaks down the deer population into Bucks and Does to see if the gender of the deer has an effect on car crashes. Theoretically, more hunting permits should lead to more deer being killed. However, if hunters simply obtained a permit and never utilized it, the deer population would not be altered because not enough are being hunted.

Data:

In order to test my hypothesis that if hunters take more deer we will see a reduction in the amount of car accidents, I gathered data from the New York State Department of Motor Vehicles, and the New York State Department of Environmental Conservation. From the New York State Department of Motor Vehicles I was able to find summaries for Motor Vehicle Accidents in New York State from 2002-2013. From Table 7(p) we can find a row that reads "Accidents with Environmental Factors" and specifically "Animals Action" which is accidents due to animals. In this paper we proxy Animals Action for DVC's. Although this is not a direct number of accidents caused only by deer, it is reasonable to assume that the vast majority of these accidents from animal's action were caused by deer, since other animals you typically would see on the road from car collisions are too small to cause any real damage worth reporting. The New York State Department of Environmental Conservation provided me with two very useful pieces of data that I use in this paper. First, the DEC provided me with the number of Big Game License Sales by year since 2002. This is important data because I can now see year-by-year how many hunting permits were issued in New York State. If the data is consistent with my theory, then years where there are more hunting permits issued by the state, there should be more deer being taken by hunters, which would then decrease the amount of car accidents due to animals action. The other piece of information that I gathered from the DEC's website is Statewide Total Calculated Deer take in New York State. The provided table is very useful because it gives me not only the total amount of deer taken in New York State year-by-year, but even breaks it down into male deer taken and Female deer taken. This is important because I can now test if male deer being taken or if female deer being taken has a bigger impact on the number of car accidents caused by deer. Previous literature has led me to believe that the female deer population is a better predictor for the number of DVC's in a year. The DEC's website states, "each adult female normally has two fawns each year. A female deer (Doe) can begin reproducing when they are only one year old. If only male deer (Bucks) are killed, deer numbers will continue to grow."

Below are the summary statistics for my model that examines New York State as a whole. The included variables are the year (2002-2012), the number of car accidents caused by animal action, the number of big game hunting permits issued, the number of male deer taken, the number of female deer taken, and the total number of deer taken.

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	11	2007	3.316625	2002	2012
CarAccidents	11	14437.73	9164.936	2474	23255
Permits	11	549288.7	26255.36	513303	584170
MDeerTaken	11	127265.2	16181.23	105388	165250
FDeerTaken	11	100495.4	18874.89	74203	142966
TDeerTaken	11	227760.5	34062.3	180214	308216

Empirics:

For this paper I ran three regression models to find the effects of permits issued and the amount of deer taken on the number of DVC's. The most basic form of my regression model is when I regress the number of car accidents on the total number of deer taken for the given years of my data.

The empirical model is:

$Y_t = B_0 + B_1 (TDeerTaken_t) + E_t$

Below, Model A displays the findings of the first results. Y, the dependent variable represents the number of car accidents in New York State, while B_1 represents the change that the total amount of deer taken has on the number of car accidents

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Table A

```
. reg  CarAccidents TDeerTaken
```

Source	SS	df	MS
Model	16043679.9	1	16043679.9
Residual	823916798	9	91546310.9
Total	839960478	10	83996047.8

Number of obs	11
F(1, 9)	0.18
Prob > F	0.6853
R-squared	0.0191
Adj R-squared	-0.0899
Root MSE	9568

CarAccidents	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
TDeerTaken	-.0371859	.0888273	-0.42	0.685	-.2381272	.1637554
_cons	22907.2	20436	1.12	0.291	-23322.24	69136.65

In this first regression, we can see that a one-unit increase in the total amount of deer taken will decrease car accidents by .0371859 accidents. However, this result is not statistically significant, meaning that we cannot reject the null hypothesis that the total number of deer taken has no effect on the number of car accidents caused by animal action.

The next model I will look at examines the relationship between car accidents and the number of hunting permits issued each year. The empirical model for this regression is $Y_t = B_0 + B_1 (Permits_t) + E_t$, with the dependent variable still representing the number of car accidents, and B_1 now showing the change that the distribution of hunting permits has on the number of car accidents in New York State. Below, table B shows the results.

Table B

```
. reg  CarAccidents Permits
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Source	SS	df	MS
Model	247119976	1	247119976
Residual	592840502	9	65871166.9
Total	839960478	10	83996047.8

Number of obs	11
F(1, 9)	3.75
Prob > F	0.0847
R-squared	0.2942
Adj R-squared	0.2158
Root MSE	8116.1

CarAccidents	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Permits	-.1893372	.0977529	-1.94	0.085	-.4104697	.0317953
_cons	118438.5	53750.31	2.20	0.055	-3153.125	240030.2

This model seems to be a better predictor for the number of DVC's each year. According to the data, an increase in the number of permits issued will have a

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resulting .1893372 decrease in the number of car accidents. The results are significant at the 10% level of significance, meaning that we can reject the null hypothesis that the amount of hunting permits issued does not have an effect on the number of deer related car accidents. More importantly, this regression suggests causality of my second hypothesis that distribution of hunting permits can affect the number of car accidents.

My final regression is a very important model because it takes into account the gender of the deer being killed. Earlier in the paper I stated that decreasing the Doe population is more important then decreasing the Buck population because the Doe's are the ones who give birth, and one Buck can reproduce with several Does.

The following regression is:
$Y_t = B_0 + B_1 (Permits_t) + B_2 (MDeerTaken_t) + B_3 (FDeerTaken_t) + E_t$

In this model, Y_t still represents the Number of Car Accidents, while B_1 still reflects the change that the distribution of hunting permits has on the Number of Car Accidents. However, in this model Deer Take is now separated into Males (Bucks) Taken and Female (Doe) Taken to capture whether the Buck or Doe deer population affects the number of car accidents more. Below, regression C shows the results of the final analysis of the state level analysis.

This model supports my theory that increasing the amount of female deer taken will decrease the amount of car accidents more then the amount of male deer taken. In fact, in this model the coefficient for female deer is negative, which is what we expect, however the coefficient for male deer taken is positive, suggesting that an increase in male deer taken would actually increase the number of car accidents. Additionally in this model, the effect of issuing more hunting permits is consistent with our previous model that it will decrease the amount of DVC's. This model is in fact suggestive of our first hypothesis that the amount of deer taken can have an affect on the number of car accidents, and the Doe population is in fact more important in predicting the amount of car accidents.

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Table C

```
. reg  CarAccidents Permits MDeerTaken FDeerTaken
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Source	SS	df	MS
Model	435869543	3	145289848
Residual	404090936	7	57727276.5
Total	839960478	10	83996047.8

Number of obs	= 11
F(3, 7)	= 2.52
Prob > F	= 0.1419
R-squared	= 0.5189
Adj R-squared	= 0.3127
Root MSE	= 7597.8

CarAccidents	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Permits	-.1857326	.1008229	-1.84	0.108	-.4241409	.0526758
MDeerTaken	.5821266	.3222874	1.81	0.114	-.179962	1.344215
FDeerTaken	-.454835	.2824994	-1.61	0.151	-1.12284	.2131699
_cons	88082.89	53701.48	1.64	0.145	-38900.92	215066.7

The next part of my research examines data at the county level within New York State. In this section, I gathered data from 56 counties within New York over a six-year period (2007 – 2012). Data in this section included a few of the same variables as earlier in the paper, as well as additional control variables. It is important to gather data at the county level as well as the state level because certain locations in the state have a higher deer population than other parts. For example, urban environments have fewer deer than in a rural setting so I would hypothesize that increasing the amount of deer taken in a rural environment would have a larger effect on the number of car accidents than it would in a urban environment. Additional data for this part of the study was collected from the US Census. From the census, the control variables of median income, median age, sex ratio, old age dependency ratio, child dependency ratio, total population, urban population, rural population, and the percent of people with a bachelor's degree or higher were obtained. The summary statistics for the county level data are listed below.

Variable	Obs	Mean	Std. Dev.	Min	Max
County	0				
Year	336	2009.5	1.710372	2007	2012
BuckTake	336	1929.196	1118.301	135	5657
TotalTake	336	4066.47	2511.268	261	13572
DoeTake	336	2137.274	1504.169	110	8246
NumAccidents	336	3614.571	5138.67	169	31991
MedIncome	336	67340.88	15860	52340	130808
MedanAge	336	40.6375	3.068097	29.8	51
SexRatio	336	99.74643	5.8753	92.8	121.8
OldAgeRatio	336	24.32143	3.807818	15	38.8
ChildRatio	336	34.64643	4.090818	22.3	47.8
TotalPop	336	76226.7	105606.4	8694	569985
UrbanPop	336	55311.41	102944.4	0	530851
RuralPop	336	20915.29	9611.711	793	42643
BachDegree	336	24.51607	7.991804	13.1	49.9

My first empirical model for the county level data is:

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$Y_t = B_0 + B_1 (TotalTake_t) + B_2 (MedianIncome_t) + B_3 (MedianAge_t) + B_4 (SexRatio_t) + B_5 (OldAgeDependencyRatio_t) + B_6 (ChildDependencyRatio_t) + B_7 (TotalPopulation_t) + B_8 (BachDegree_t) + E_t.$

The dependent variable in this first regression reflects the Number of Car Accidents, while there are eight explanatory variables to help explain the model.

NumAccidents	Number of Car Accidents
TotalTake	Total Deer Take
MedIncome	Median Income
MedianAge	Median Age
SexRatio	Sex Ratio
OldAgeRatio	Old Age Dependency Ratio
ChildRatio	Child Dependency Ratio
TotalPop	Total Population
BachDegree	Percent Bachelor's Degree or Higher

Below, Table D shows the result of the first county level regression.

Table D

Source	SS	df	MS
Model	8.5919e+09	8	1.0740e+09
Residual	254130339	327	777157
Total	8.8460e+09	335	26405932.6

Number of obs	= 336
F(8, 327)	= 1381.94
Prob > F	= 0.0000
R-squared	= 0.9713
Adj R-squared	= 0.9706
Root MSE	= 881.57

NumAccidents	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TotalTake	-.0033976	.0225431	-0.15	0.880	-.0477454	.0409503
MedIncome	.0167881	.0084581	1.98	0.048	.0001489	.0334272
MedanAge	17.12739	39.32895	0.44	0.663	-60.2423	94.49708
SexRatio	14.39383	10.97664	1.31	0.191	-7.199914	35.98757
OldAgeRatio	-72.41665	29.7344	-2.44	0.015	-130.9115	-13.92179
ChildRatio	33.18111	18.79667	1.77	0.078	-3.796554	70.15877
TotalPop	.0460746	.0005936	77.61	0.000	.0449068	.0472425
BachDegree	-1.440897	15.62345	-0.09	0.927	-32.17605	29.29425
_cons	-2499.004	1973.167	-1.27	0.206	-6380.707	1382.699

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The main variable of interest in this regression is TotalTake's effect on the Number of Accidents. In this first regression this variable is not statistically significant, however the sign does math the hypothesis that increasing the amount of deer taken will lead to less car accidents. The statistically significant variables in this regression are Median Income, the Old Age Dependency Ratio, and Total Population, with Total Population being the most statistically significant. This is an interesting finding because it suggests that increasing the population has a statistically significant result on the number of car accidents.

The next regression I ran at the county level is a more in depth model that breaks down the effect of Total Deer Take into Buck Take and Doe Take. As in the analysis of New York State as a whole, my hypothesis is that the take on Does will have a bigger impact on the number of car accidents then the take on Bucks will. Furthermore, total population will be broken down into urban population and rural population. Breaking down total population into these two sub categories will help to capture whether changes in the urban or rural population has a larger effect on car crashes. The results for this regression are shown in Table E and the empirical model for this regression is:

$Y_t = B_0 + B_1$ (BuckTake$_t$) + B_2 (DoeTake$_t$) + B_3 (MedianIncome$_t$) + B_4 (MedianAge$_t$) + B_5 (SexRatio$_t$) + B_6 (OldAgeDependencyRatio$_t$) + B_7 (ChildDependencyRatio$_t$) + B_8 (UrbanPopulation$_t$) + B_9 (RuralPopulation$_t$) + B_8 (BachDegree$_t$) + E_t

Table E

Source	SS	df	MS
Model	8.5999e+09	10	859993980
Residual	246047614	325	757069.58
Total	8.8460e+09	335	26405932.6

Number of obs	=	336
F(10, 325)	=	1135.95
Prob > F	=	0.0000
R-squared	=	0.9722
Adj R-squared	=	0.9713
Root MSE	=	870.1

NumAccidents	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
BuckTake	-.3220191	.1050807	-3.06	0.002	-.5287432	-.1152949
DoeTake	.1643711	.0667725	2.46	0.014	.0330103	.295732
MedIncome	.0218212	.0084898	2.57	0.011	.0051193	.0385231
MedanAge	-28.66928	41.28347	-0.69	0.488	-109.8858	52.54728
SexRatio	15.6625	10.8602	1.44	0.150	-5.702664	37.02766
OldAgeRatio	-32.14194	31.83244	-1.01	0.313	-94.76558	30.4817
ChildRatio	29.2183	18.88113	1.55	0.123	-7.926354	66.36295
UrbanPop	.0450579	.0006787	66.39	0.000	.0437227	.0463932
RuralPop	.0652567	.0071603	9.11	0.000	.0511703	.0793432
BachDegree	-10.87041	15.71088	-0.69	0.489	-41.77826	20.03744
_cons	-1803.339	1961.873	-0.92	0.359	-5662.912	2056.234

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In this more detailed regression model, our two main variables of interest, BuckTake and DoeTake became statistically significant. However, going against my hypothesis, the Buck population has a larger effect on the number of car accidents than the Doe population does. In fact, the coefficient next to Doe Take is not even consistent with the hypothesis that hunting and killing more Doe will decrease the number of car accidents. Moreover, when the total population is broken down into urban and rural populations the results remain very statistically significant. This can be explained because an increase in a population will lead to more crowding which will lead to more accidents. Especially in urban environments where everything is more condensed, this population increase will lead to more car crashes then it would in the more rural spread out environment.

Conclusion:

This paper has helped teach me the true relationship between the number of car accidents caused by deer, the number of hunting permits issued, and the total number of deer taken by hunters in the years of 2002-2012. I was happy to see that there was some statistical significance between the number of hunting permits issued and the number of car accidents. Furthermore, I was able to break down the total number of deer taken into two groups, Bucks and Does. It was interesting to look at the idea that hunting female deer reduces the number of car accidents more then reducing the Buck population due to their mating rituals. After looking at state level data, it was important to analyze the county level data as well. In this part of the experiment county level data was collected from 2007 – 2012 from 56 counties within New York State. In this part of the experiment we were able to obtain more statistically significant results then the regressions at the state level analysis produce. This could be due to the low number of observations at the state level, and if data were available for more years then that would have helped to strengthen the experiment. Although evidence against my hypothesis about the Doe population having a larger effect on the number of car accidents existed, my findings still supported that increasing the number of Bucks Taken will have a negative and statistically significant effect on the number of car accidents. Regarding environmental policy, regulating the deer population is important to keeping a balance in the ecosystem. Too high of a deer population could lead to a dangerous amount of car accidents, as well as overgrazing problems causing issues to peoples personal property. Through the issuance of hunting permits, the deer population can be controlled, and even reduced if needed. According to my findings, through the issuing of more big game hunting permits, the DEC can reduce the Buck population, which will in turn decrease the amount of car accidents. A strong next step in research on this subject would be to look at the use of guns while hunting versus the use of a bow while hunting. Since firing a gun is extremely loud, I wonder if deer are more likely to flee out of the woods in areas

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that are being hunted with guns rather then with a silent bow and arrow or cross bow. A gun being fired could cause deer to not feel comfortable in the woods where they are used to living, so they do the natural thing and run away, increasing the chance they run right in the path of an oncoming car. Since hunting with a bow is silent, the deer do not become accustomed to a noise of danger and this could cause them to stay in the woods more then coming out onto the road.

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