Effects of deer overabundance on bird populations in the Long Island Central Pine Barrens

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Abstract

An increase in the white-tailed deer population recorded over the last thirty years and its effects on the population of birds is being investigated at Brookhaven National Laboratory. In particular, browsing by an overabundance of deer has led to a loss of plant density on the ground floor and lower canopy of the Long Island Central Pine Barrens and, perhaps, changing the composition of the bird population[1] (Rooney and Waller 2003). Deer overabundance may be related to impacts on the population of birds. To study this hypothesis, counts of birds and counts of deer recorded at Brookhaven National Laboratory from the years 2000 to 2014 have been obtained. From our research, we have found that there is no significant impact of deer overabundance on the counts of birds at Brookhaven National Laboratory. By using hypothesis tests in Minitab, we found that differences between the counts of birds on years when there are less than 800 counts of deer and on years when there are greater than 800 counts of deer are not statistically significant. Bird counts were also analyzed on the basis of their nesting types which were divided into four categories: Canopy, ground, cavity, and treetop nesters. The counts of each nesting type were analyzed on a Microsoft Excel spreadsheet and on Minitab. We found that the four nesting types of birds are not being significantly impacted by deer overabundance. The relevance of this investigation to the Department of Energy's mission is to assist Brookhaven National Laboratory's stewardship of the land it uses for various activities such as deer culls. Conducting tests in Microsoft Excel such as regression and correlation tests and in Minitab such as paired t-tests, two-tailed t-tests, and Mann-Whitney tests has aided my research.

I. Introduction

There are four parts to the research conducted: The overabundance of white-tailed deer, solar farm construction, a wildfire that occurred in 2012, and changes in the bird populations in New York State, eastern Long Island, and Brookhaven National Laboratory. All four parts pertain to their hypothesized effects on birds.

A. White-tailed Deer Overabundance

Deer overabundance has been recently recognized as a problem affecting a large portion of the northeastern United States[2] (United States Department of Agriculture 2014). Deer populations at the time of European settlement ranged from 8 to 20 per square mile[3] (Research Review 2012). The deer populations in northeastern United States forests were kept at these levels into the late 1800s and early 1900s. Subsequently, the deer population has increased dramatically, especially in New York State since 1985. The United States Department of Agriculture has identified a target density of 20 deer per square mile and The Office of Environmental Protection at Brookhaven National Laboratory has a target density range of between 10 and 30 deer per square mile. However, counts of deer recorded at Brookhaven National Laboratory and in New York State have exceeded the target deer density range. In New York State, one possible consequence of deer overabundance is a decline in bird populations (figure 1). The incidence of deer overabundance at Brookhaven National Laboratory may be related to impacts on the population of birds there as well.

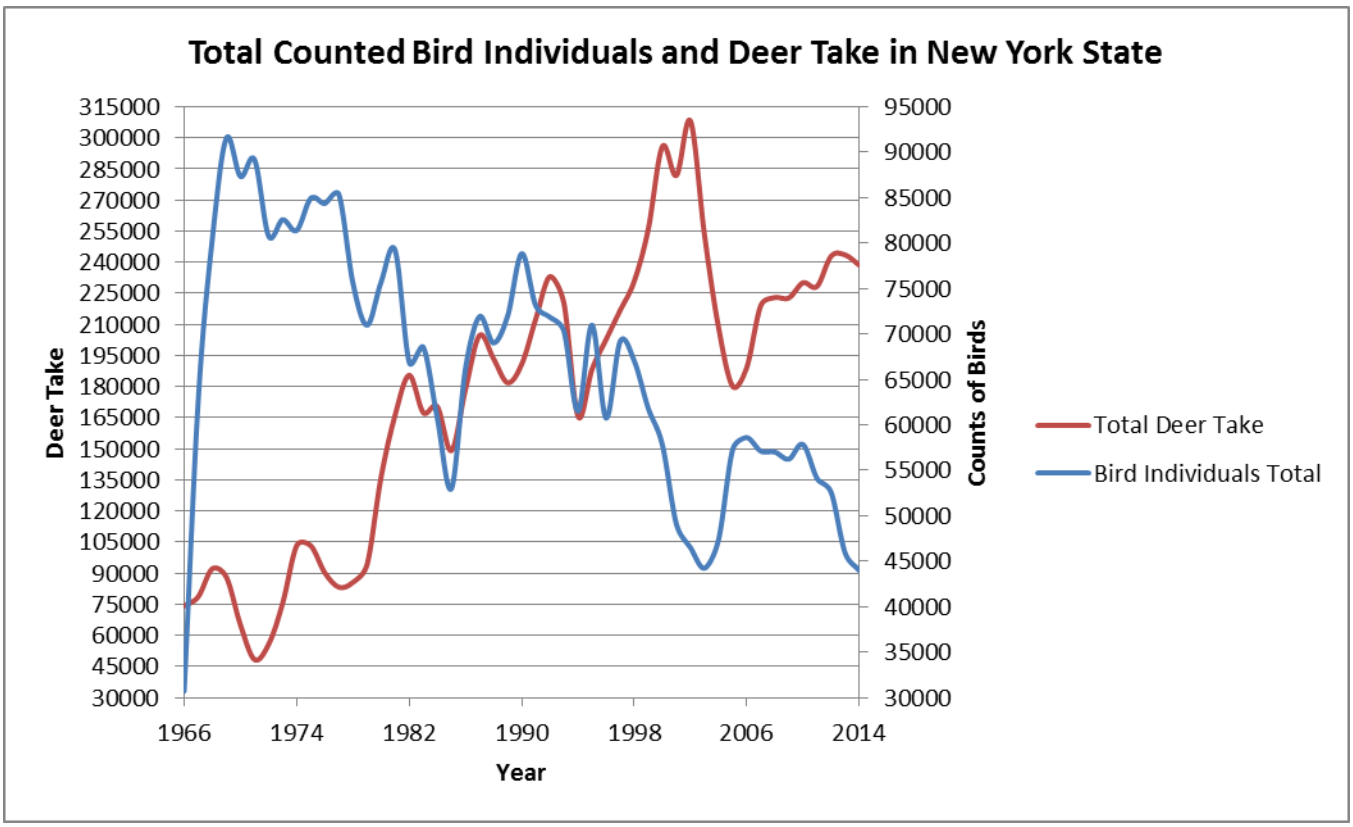

Figure 1. Line graph of total counts of birds and deer take in New York State. Bird counts were recorded from the years 1966 to 2014[6] (North American Breeding Bird Survey 2015). Deer counts were recorded from the year 1954 to the year 2014[7] (New York State Department of Environmental Conservation 2015). Deer counts from the year 1966 to 2014 were only included since the bird counts from the North American Breeding Bird Bird Survey date back only as far as 1966.

B. Solar Farm Construction at Brookhaven National Laboratory

The construction of the solar farms at Brookhaven National Laboratory between the years 2010 and 2011 may have affected the population of birds. There is a two hundred acre solar farm surrounded by fencing that excludes deer from the area. The exclusion of deer may help mitigate losses of plant life by deer browsing, which allows for more bird species to flourish. However, the clearing of trees in the Biology Fields to create space for solar farm construction may have

adversely affected the canopy nesting bird populations. Additionally, ground nesting birds may have proliferated due to the increased availability of treeless land and vegetation that could be used for inhabitation. The counts of birds by nesting types in the years before and after the solar farms were constructed and examined.

C. Wildfire at Brookhaven National Laboratory

In early April 2012, there was a wildfire in the first North Transect and first, second, and third parts of the Z-Path at Brookhaven National Laboratory. The wildfire had burned away vegetation on the ground floor of the forests and burned down trees, leaving behind stands of dead trees after the fire had dissipated. The resulted losses of plant life by the wildfire probably had prevented any deer from entering the affected areas since there were no plants available to be eaten as a food resource. Instead, the wildfire may have impacted the populations of birds at the affected areas. The counts of birds in the years before and after the wildfire had occurred were examined.

D. Changes in Bird Counts in New York State, Eastern Long Island, and Brookhaven National Laboratory

Changes in the counts of birds by all four nesting types were examined for a fifteen year interval between the years 2000 and 2014 in New York State, Eastern Long Island, and Brookhaven National Laboratory. It was hypothesized that the counts in nesting birds have changed over time. The overabundance of deer may help contribute to significant changes in nesting birds due to the overconsumption of plants. The overconsumption of plants removes potential nesting materials and locations for birds.

II. Materials and Methods

A. Data Collection and Organization

Data containing counts of deer and birds were obtained from the Waste Management Division at Brookhaven National Laboratory[4,5] (Green and Higby, unpublished data 2014). Both sets of data were collected from the years 2000 to 2014. Other counts of deer and birds in New York State were obtained from the New York State Department of Environmental Conservation and from the North American Breeding Bird Survey, respectively. Bird counts for Eastern Long Island were also collected as well. Bird counts were recorded from the years 1966 to 2014[6] (North American Breeding Bird Survey 2015). Deer counts were recorded from the year 1954 to the year 2014[7] (New York State Department of Environmental Conservation 2015).

Datasets containing counts of birds and deer were organized on a Microsoft Excel spreadsheet. Bird counts were organized by using pivot tables and filters to sort the bird counts in alphabetical order by name, transect, and by nesting type, which were classified by using the North American Breeding Bird Survey and the Cornell Lab of Ornithology websites. The nesting types were classified as ground, canopy, cavity, and treetop nesting birds. Counts of birds were summed by total number of birds, bird species, and by each nesting type in every recorded year. Counts of deer collected at Brookhaven National Laboratory had already been classified by the season they were recorded at for each year. Deer counts for each season were summed together to represent the total counts of deer for the entire year.

B. Data Analysis

Datasets containing counts of birds and deer was analyzed on Microsoft Excel by generating graphs. Both datasets were also analyzed in Minitab to test for significant differences between changes in the counts of birds and deer at Brookhaven National Laboratory, changes in

the counts of birds by nesting type in the years 2007, 2008, 2009, and 2014 before the solar farms were constructed and in the years 2011, 2012, 2013, and 2014 after the solar farms were constructed, and changes in the averages of the counts of birds by nesting type and by the averages of all bird in the years 2010 and 2011 before the wildfire and the in the years 2013 and 2014 after the wildfire. The year 2012 was excluded from the analysis since that was the year the wildfire had occurred.

Counts of birds in New York State, Eastern Long Island, and Brookhaven National Laboratory were analyzed for fifteen year intervals between the years 2000 and 2014. This analysis was done by ranking the top 20% of all bird species by count and by nesting type. The top 20% of all bird species were analyzed this way instead of all recorded bird species because the top 20% of all bird species constitute 80% of the total population of birds[8] (Rispoli, Zeng, Green, and Higbie 2014). A chi square test for association was done on Minitab to determine if the counts of birds by nesting type have changed over time.

C. Statistical Testing

The analysis of bird and deer data was conducted by using parametric and nonparametric tests in Minitab. Prior to any formal statistical testing, normality tests were done for all datasets to determine if they follow a normal distribution of data. In particular, Anderson-Darling testing was applied to the testing of normality. In the Anderson-Darling test, a p-value of 0.05 or greater indicates a normal distribution of data, while a p-value of less than 0.05 indicates a non-normal distribution of data. Normally distributed data allows for parametric tests to be conducted. All deer datasets and most of the bird datasets were found to have followed a normal distribution of data, except for treetop nesting bird counts, which were found to be a non-normal distribution. In that case, corresponding nonparametric tests were applied to the dataset.

III. Results and Discussion

A. Differences between Changes in Birds Counts based on Years of Higher and Lower Deer Counts at Brookhaven National Laboratory

Figure 2 shows the counts of birds and white-tailed deer at Brookhaven National Laboratory and Figure 3 shows the counts of birds by all four nesting types at Brookhaven National Laboratory, from the years 2000 to 2014, by both nesting types and by total counts, and counts of white-tailed deer at Brookhaven National Laboratory from the years 2000 to 2014.

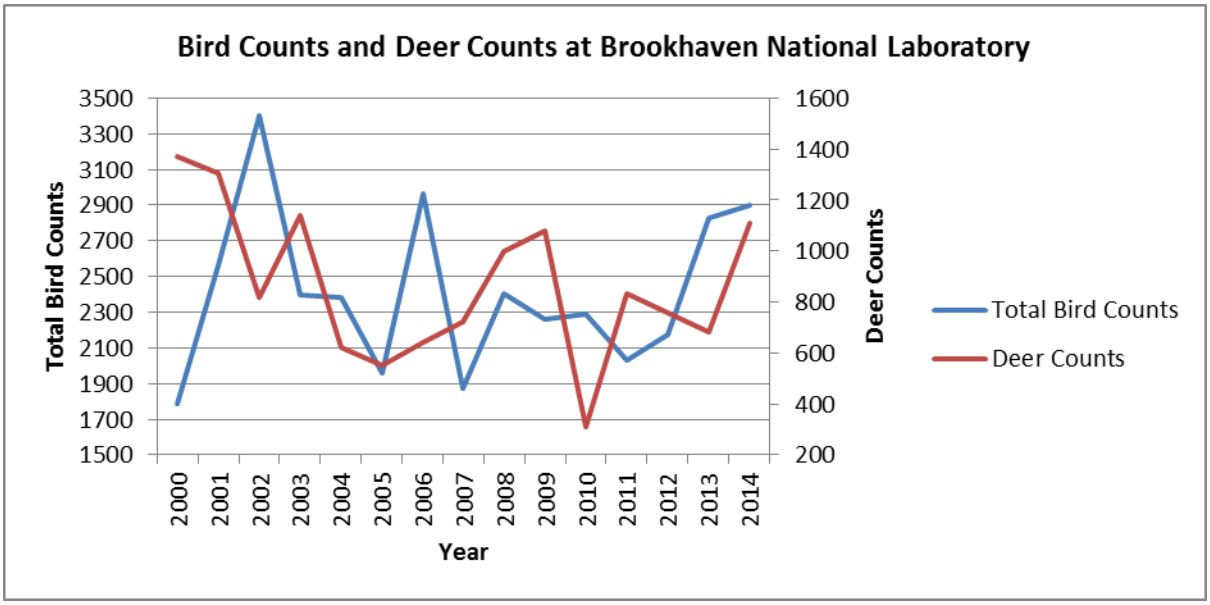

Figure 2. Chart with counts of birds and deer recorded at Brookhaven National Laboratory.

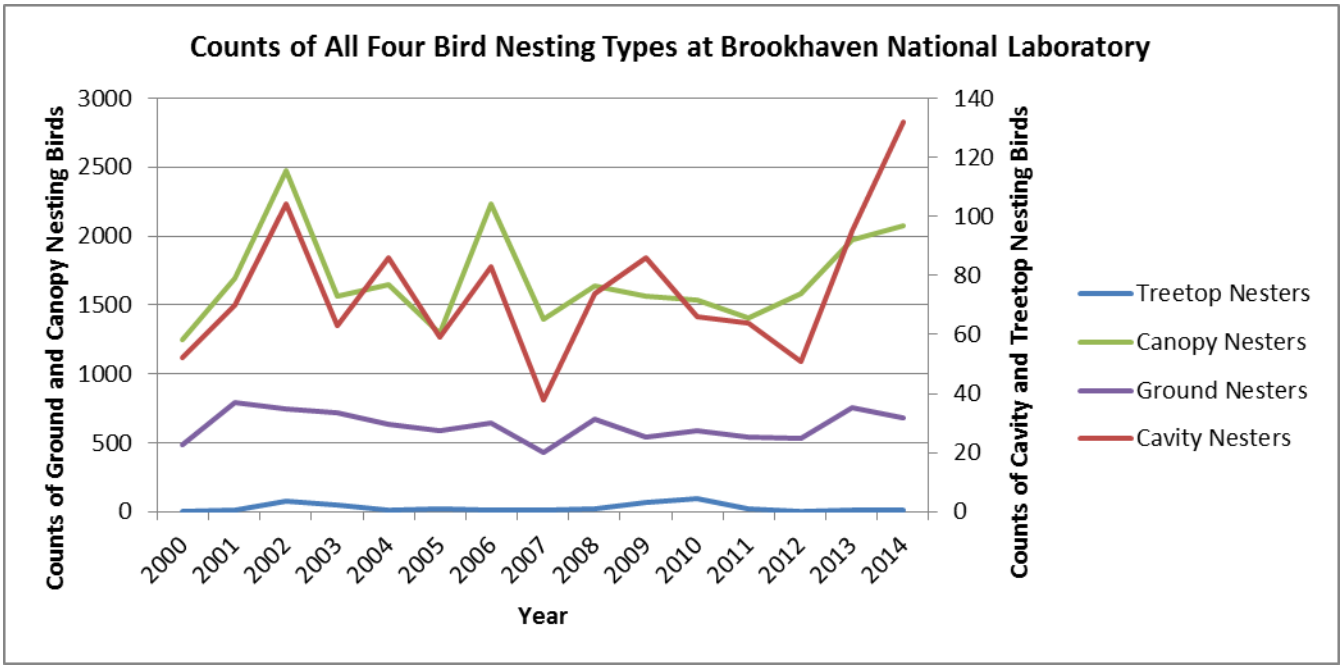

Figure 3. Chart with counts of birds of all four nesting types recorded at Brookhaven National Laboratory. The four nesting types are ground nesting birds, canopy nesting birds, cavity nesting birds, and treetop nesting birds.

Two-tailed t-tests were conducted to consider if a relatively larger deer population affects birds. This analysis was based on periods when there are less than 800 counts of deer and on periods when there are greater than 800 counts of deer. Figure 4 shows that there is no significant difference between the counts of birds and when there are less than 800 counts of deer and when there are greater than 800 counts of deer. Similar results were seen in figures 5, 6, 7, and 8 (in appendix). Table 1 shows that there is no considerable effect of a larger deer population on birds. Similar results are seen in tables 4, 5, 6, and 7 (in appendix).

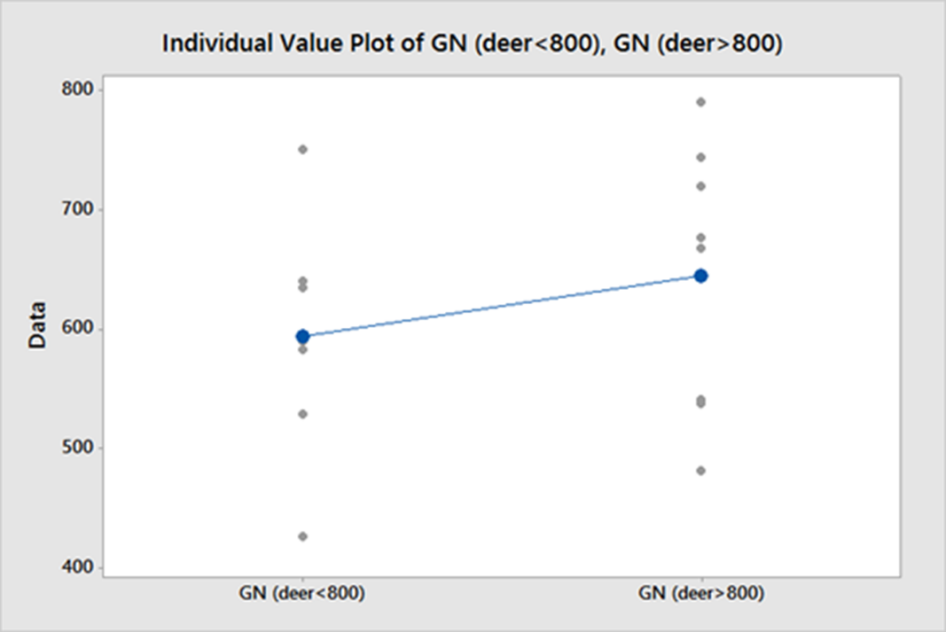

Figure 4. Not a statistically significant test (p-value= 0.368).

The results of the two-tailed t-test indicate that there is no significant difference between the counts of ground nesting birds on years when there are less than 800 counts of deer and on years when there are greater than 800 counts of deer. This may suggest that ground nesting birds are not being affected by higher or lower counts of deer.

Table 1. Correlation test of ground nesting birds and counts of deer.

	% change GN	*% change DC*
% change GN	1	
% change DC	-0.086729825	1

There is no considerable effect of a relatively larger deer population between on ground nesting birds.

B. Differences between Counts of Birds by Nesting Type at the Biology Fields before and after its Construction

There was no significant difference between the changes in the counts of all nesting birds before and after the solar farms were constructed. Even without the presence of deer due to fencing, the lack of browsing activity by deer in the solar farms apparently did not induce a significant change in the counts of all nesting birds. The paired t-test for the total counts of all nesting birds returned a p-value of 0.889. The paired t-test for the counts of ground, canopy, and cavity nesting birds returned p-values of 0.394, 0.649, and 0.696, respectively. Figures 9, 10, 11, and 12 (in appendix) presents the charts from the paired t-test for total nesting birds, ground, canopy, and cavity nesting birds, respectively. For treetop nesting bird counts, the result from the Mann-Whitney test was a p-value of 0.6650. All p-values from each test greatly exceed 0.05, which indicates that the construction of the solar farms did not significantly impact nesting birds at the Biology Fields at Brookhaven National Laboratory.

C. Differences between the Counts of Birds by Nesting Type and Total Bird Counts at the areas affected by the 2012 Wildfire at Brookhaven National Laboratory

There is a significant difference between the average counts of all bird species before and after the wildfire at Brookhaven National Laboratory. Figure 13 presents that the average counts of bird species after the fire are significantly greater than the average counts of species birds before the fire had occurred at North Transect 1 and at Z-Paths 1, 2, and 3. The number of all bird species is less after the fire than before the fire. It might be possible that losses of plants by the wildfire may have disallowed some bird species to nest.

Although the average counts of ground nesting birds had increased after the wildfire in 2012, there is no significant difference between the average counts of ground nesting birds

before and after the wildfire at Brookhaven National Laboratory. Figure 14 presents this lack of significant difference.

The average counts of ground nesting bird species before the wildfire were significantly greater before the wildfire than after the wildfire. Figure 15 presents this significant difference. This might indicate that the areas affected by the wildfire have become less biodiverse. The loss of ground nesting bird biodiversity may be attributed to losses in the plant composition on the forest floor by the wildfire. In other words, there are less plant species that ground nesting bird species could use for nest building.

Figures 16 and 17 presents that the average counts of canopy nesting birds and canopy nesting bird species are significantly greater before the wildfire than after the wildfire. This may indicate that they were adversely affected by the wildfire because of loss of trees. As a result, there are fewer trees available for canopy nesting birds to inhabit. The loss of vegetation by the wildfire may have eliminated deer in the short term since there are not enough plant resources available for the deer to consume as food. This may have prevented any further impact on the birds by deer browsing.

D. Changes in the Counts of Birds by Nesting Type in New York State, Eastern Long Island, and Brookhaven National Laboratory

Prior to performing chi-square test of association on the New York State and Eastern Long Island bird counts, a data adjustment on the counts of the four nesting types was conducted. The data adjustment was done because the collection methods of the North American Breeding Bird Survey were not consistent in the years 2000 and 2014. In fact, the number of routes of in Eastern Long Island were not the same in both years. For example, in the year 2000 at Eastern Long Island, bird counts were collected on two routes, while in the year 2014, bird counts were

collected at three routes. Similarly, bird surveying was done on seventy four routes in New York State in the year 2000 and done on sixty five routes in the year 2014.

To adjust the datasets, the sum of the bird counts of all four nesting types in 2000 and 2014 was calculated. Then, the totals were examined. The lower total was divided by the higher total to obtain a ratio between the two values. Next, the ratio was multiplied by the bird counts of each of the four nesting types in the year when the total bird counts were higher than the other year. Finally, the sum of the bird counts was done to obtain a total value that is equal to the lower total bird counts. A chi-square test of association of adjustment was performed on these adjusted datasets. Tables 2 and 3 show the adjusted data.

Table 2. Adjusted counts of birds by nesting type of New York State.

Year	CN	GN	CVN	TN	Total
2000	24690	13172	7622	1108	46592
2014	18758	12408	3632	763	35561
2000 (Adjusted)	18844	10053	5817	846	35561

Table 3. Adjusted counts of birds by nesting types of Eastern Long Island.

Year	CN	GN	CVN	TN	Total
2000	655	280	241	0	1176
2014	613	413	236	0	1262
2014 (Adjusted)	571	385	220	0	1176

There were significant changes in the counts of birds by nesting type in New York State and on Eastern Long Island between the years 2000 and 2014. Both p-values from the chi-square test of association are 0.00. This indicates that there was a significant difference in the change of the bird counts by nesting type in New York State and Eastern Long Island. In New York State, the counts of ground nesting, canopy nesting, cavity nesting, and treetop nesting birds have decreased since the year 2000. In Eastern Long Island, the counts of canopy and cavity nesting birds have decreased, while counts of ground nesting birds have increased since the year 2000.

Treetop nesting birds had zero counts since they were not among the top 20% of all bird species recorded at Eastern Long Island and Brookhaven National Laboratory.

Brookhaven National Laboratory did not have any significant changes in the counts of birds by nesting type for over a fifteen year interval. The p-value from the chi-square test of association is 0.332. Although there was a recorded increase in ground, canopy, and cavity nesting birds, there is no significant difference in the counts of birds by nesting types between the years 2000 and 2014. The lack of significant change may be due to Brookhaven National Laboratory being a natural preserve for wildlife. In other words, preserved areas such as forests, meadows, and wetlands may provide habitat for a variety of bird species. The abundance of preserved lands and its management may be mitigating some of the impacts of deer overabundance on the bird population at Brookhaven National Laboratory. Yet, in rest of New York State and Eastern Long Island, there are less preserved areas and more development of unprotected land, which reduces the amount of habitat for birds. Deer overabundance throughout New York State and Eastern Long Island may be significantly impacting bird habitat as well through the browsing of plants since there are more areas that are less preserved and undermanaged. These factors may account for the significant decreases in the counts of birds in New York State and on Eastern Long Island.

IV. Conclusion

The overabundance of deer at Brookhaven National Laboratory is not having a significant impact on birds, regardless of nesting type. More research must be done to determine what other environmental variables are inducing changes in the bird population at Brookhaven National Laboratory. Meanwhile, the construction of the solar farms at the Biology Fields did not have any significant impact on birds. However, the wildfire that had occurred in 2012 did significantly

impact the number of bird species at the affected areas. The fencing at the solar farms and the wildfire that had burned down plant life helped exclude deer from these areas. Finally, the number of birds in New York State and Eastern Long Island have significantly changed over time, although they did not at Brookhaven National Laboratory.

V. Acknowledgements

This project was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Visiting Faculty Program (VFP).

VI. References

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VII. Figures

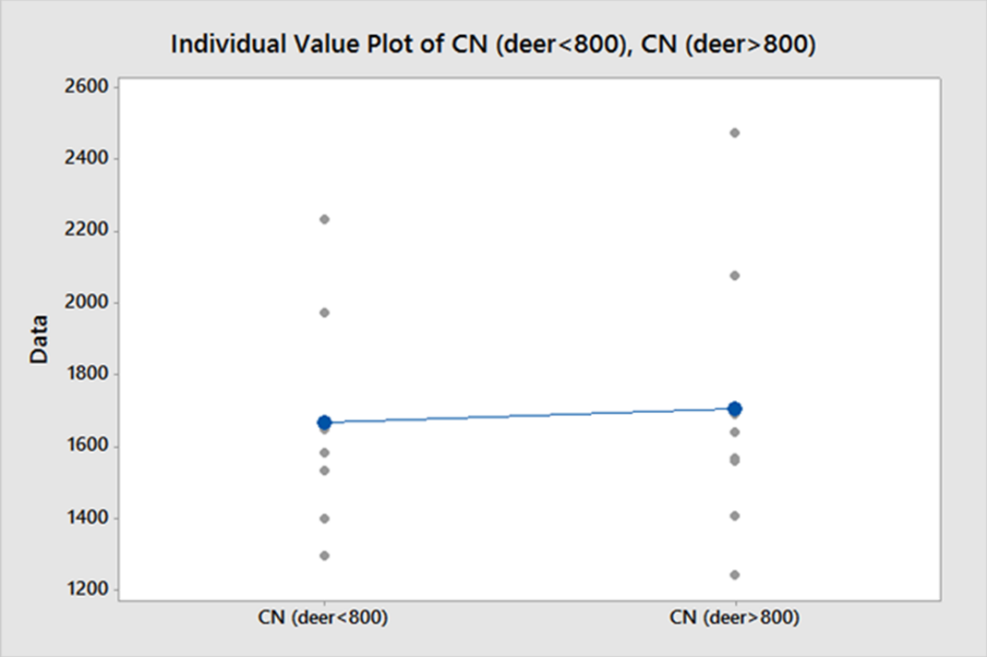

Figure 5. Not a statistically significant test (p-value= 0.832).

Table 4. Correlation test of canopy nesting birds and counts of deer.

	% change CN	*% change DC*
% change CN	1	
% change DC	-0.198162367	1

There is no considerable effect of a relatively larger deer population on canopy nesting birds.

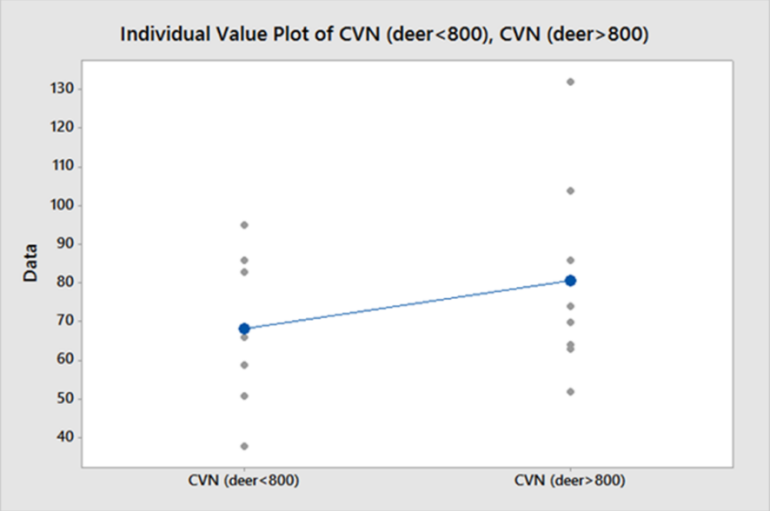

Figure 6. Not a statistically significant test (p-value= 0.327).
Table 5. Correlation test of cavity nesting birds and counts of deer.

	% change CVN	*% change DC*
% change CVN	1	
% change DC	-0.022098933	1

There is no considerable effect of a relatively larger deer population on cavity nesting birds.

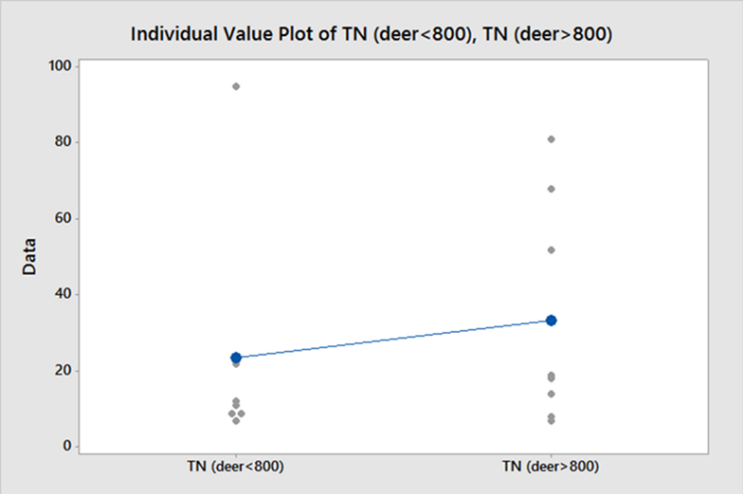

Figure 7. Not a statistically significant test (p-value= 0.548).
Table 6. Correlation test of treetop nesting birds and deer counts.

	% change TN	*% change DC*
% change TN	1	
% change DC	-0.29013871	1

There is no considerable effect of a relatively larger deer population on treetop nesting birds.

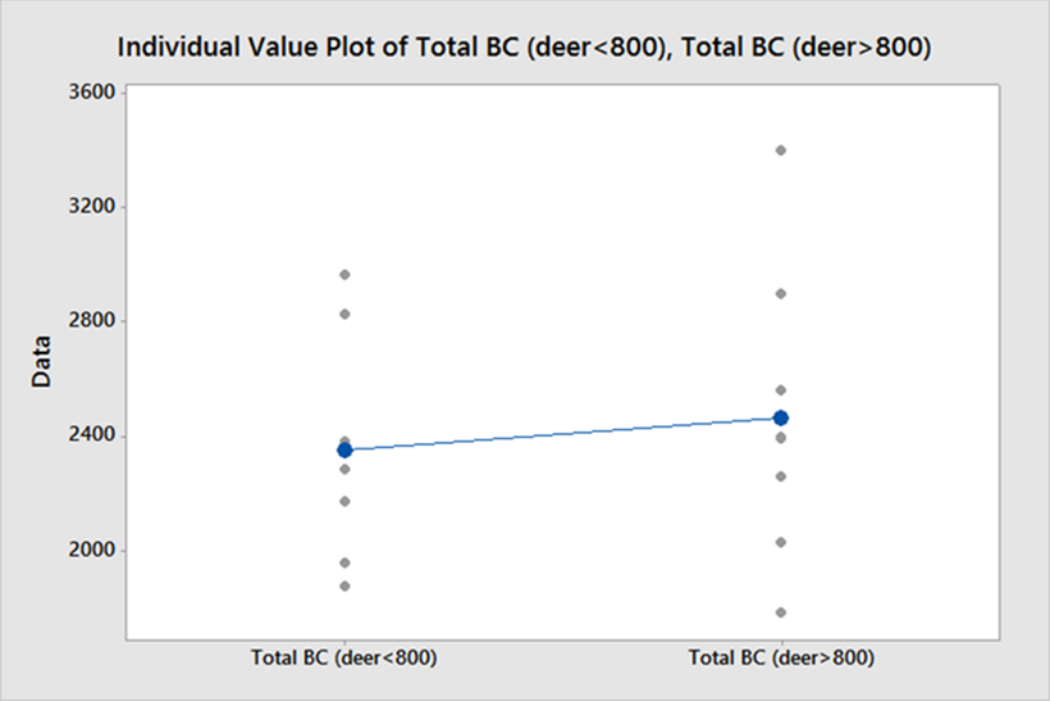

Figure 8. Not a statistically significant test (p-value= 0.640).
Table 7. Correlation test of the total counts of birds and counts of deer.

	% change TBC	*% change DC*
% change TBC	1	
% change DC	-0.209928465	1

There is no considerable effect of a relatively larger deer population on the total number of birds.

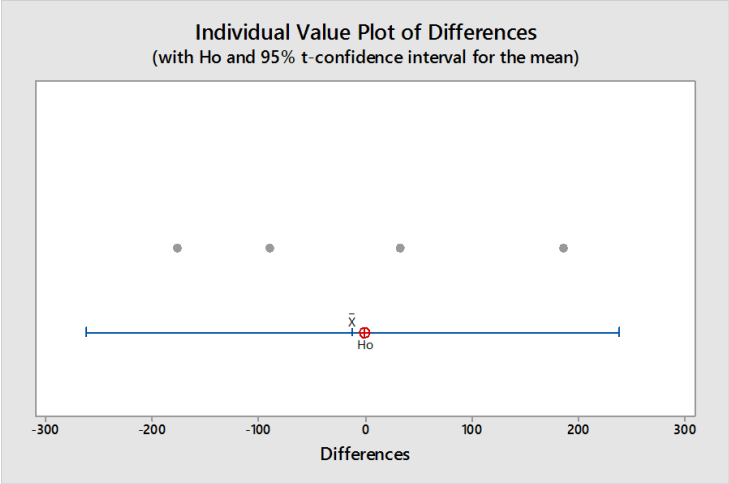

Figure 9. H_0= $X_{\text{before solar farms}}$ not= $X_{\text{after solar farms}}$ Not a statistically significant test.

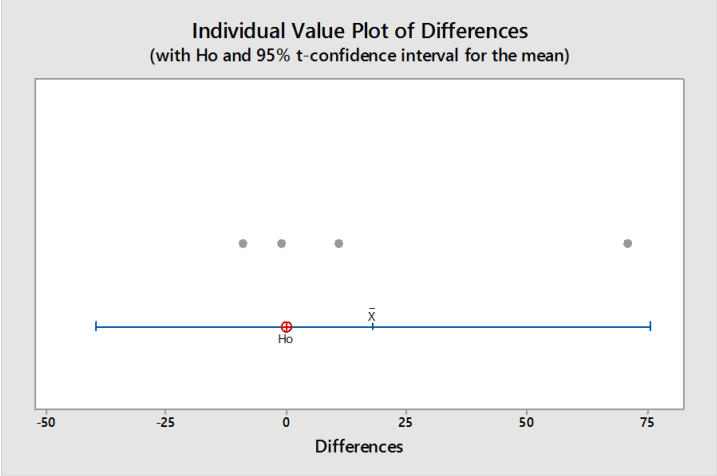

Figure 10. H_0= $X_{\text{ground nesters before}}$ not= $X_{\text{ground nesters after}}$ Not a statistically significant test.

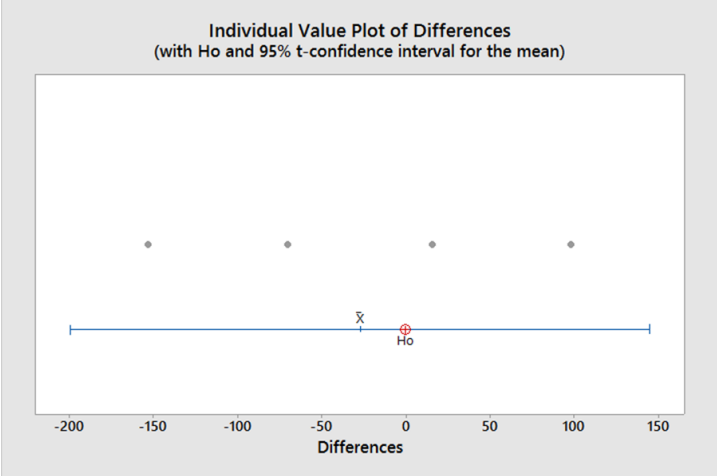

Figure 11. H_0= $X_{\text{canopy nesters before}}$ not= $X_{\text{canopy nesters after}}$ Not a statistically significant test.

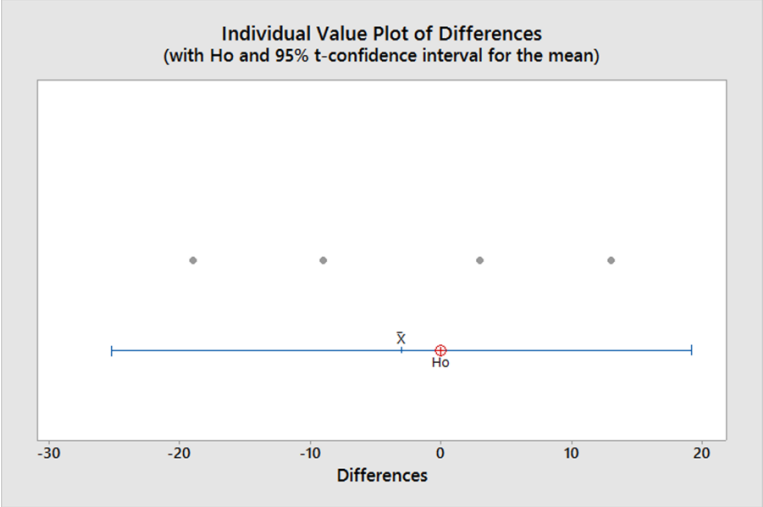

Figure 12. H_0= $X_{\text{cavity nesters before}}$ not= $X_{\text{cavity nesters after}}$ Not a statistically significant test.

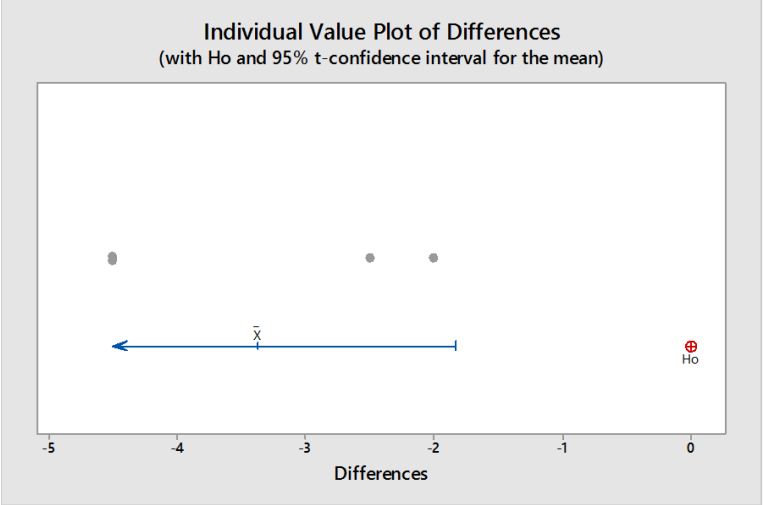

Figure 13. Counts of bird species before and after fire (p-value= 0.007).

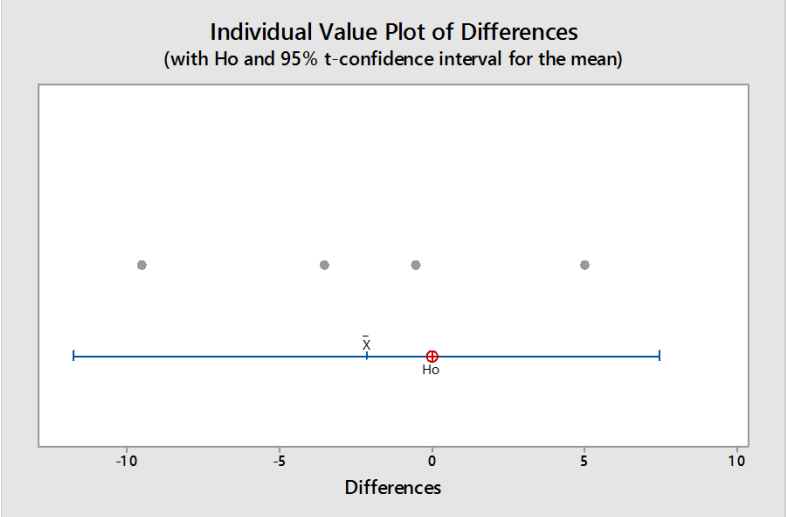

Figure 14. Counts of ground nesting birds before and after fire (p-value= 0.533).

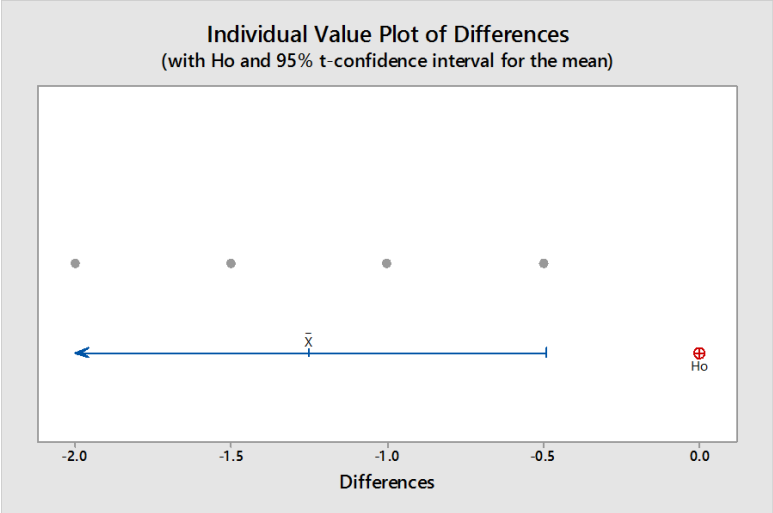

Figure 15. Counts of ground nesting bird species before and after fire (p-value= 0.015).

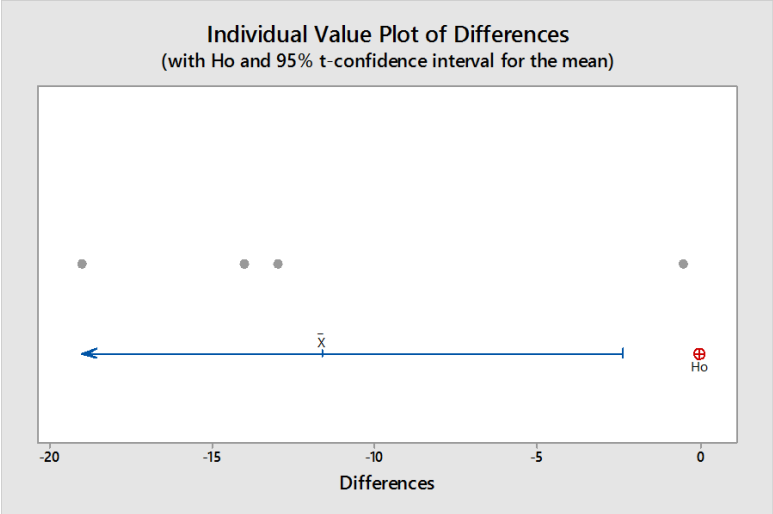

Figure 16. Counts of canopy nesting birds before and after fire (p-value= 0.030).

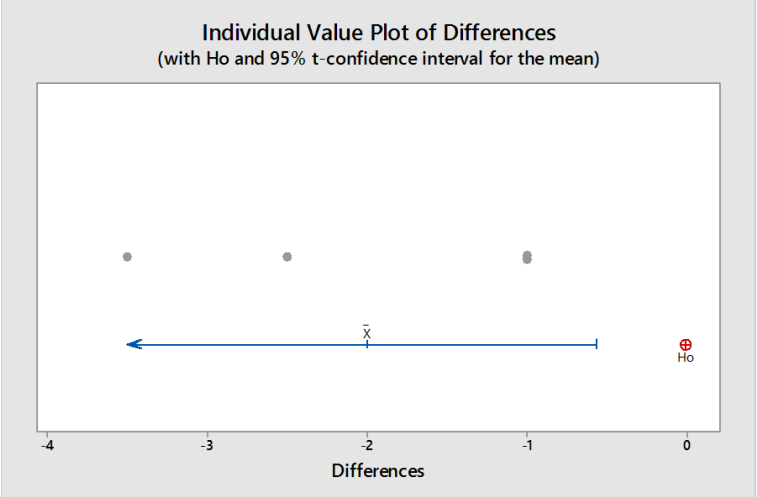

Figure 17. Counts of canopy nesting bird species before and after fire (p-value= 0.023).