The effects of anthropogenic disturbance on the bird community at Brookhaven National Laboratory

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Abstract

Brookhaven National Laboratory (BNL), Upton, NY, a multi-disciplinary national laboratory owned by the Department of Energy, contains very large facilities for conducting scientific research. Since 2000, the Environmental Protection Division has used the point count method to survey birds. Bird counts can be used to estimate population size, detect changes in the population or in diversity of species, and possibly determine the cause of any changes. The goal of this project is to analyze the data statistically to determine if the construction of the solar farm has had any significant impact on the populations of birds on site. During 2010 and 2011, the construction of a solar facility removed some of the vegetation and natural habitat along the Biology Fields' Transect, located along the western side of the northern section of the solar facility. Now, several years after the installation of solar panels the vegetation has recovered. We can examine the long-term effects that the solar facility has had on the variety of bird species. All the data collected via point count surveys from April through August annually has been organized into tables in Microsoft Excel. The data were refined and normalized to be relevant for this project and then imported into R; statistical computing software, for analysis. Using ANOVA, it was determined that there was a significant change (p=1.04e-06) in birds present each year from 2008-2017. Then, a Least Significant Difference (LSD) Test was conducted to conclude which years were significantly different from the others. This study helps BNL to understand the impacts of operation, if any, on bird populations found on the BNL Site, and more specifically whether the construction of the solar farm had any continuing impacts.

Introduction

Bird counts can be used to estimate population size, detect changes in the population or in diversity of species, and possibly determine the cause of any changes. Point counts are used to record as many different species of birds based on visual and call identification. BNL has 7 permanent transects that are monitored over a period of several days to determine how many species and numbers of individuals of each species are in an area. One can also evaluate the success of environmental changes that have been made at a location. By conducting surveys before the changes are made, and continuing to take point count surveys over several years, you would be able to compare the original number of species to the number of species after to see if the changes had a significant impact on the number of birds in that location. From October 2010 to November 2011, the construction of a 32 megawatt solar facility was undertaken in the southeast portion of BNL. The construction of the solar facility changed the vegetation inside from forest or grassland to grassland and disturbed. The fences surrounding the solar facility are large enough to provide protection for the ground nesting and the intermediate canopy nesting bird species, by preventing white-tailed deer from interfering with the environment within. Point count bird surveys conducted at BNL can provide ecological evidence and data used to study the impact on bird diversity.

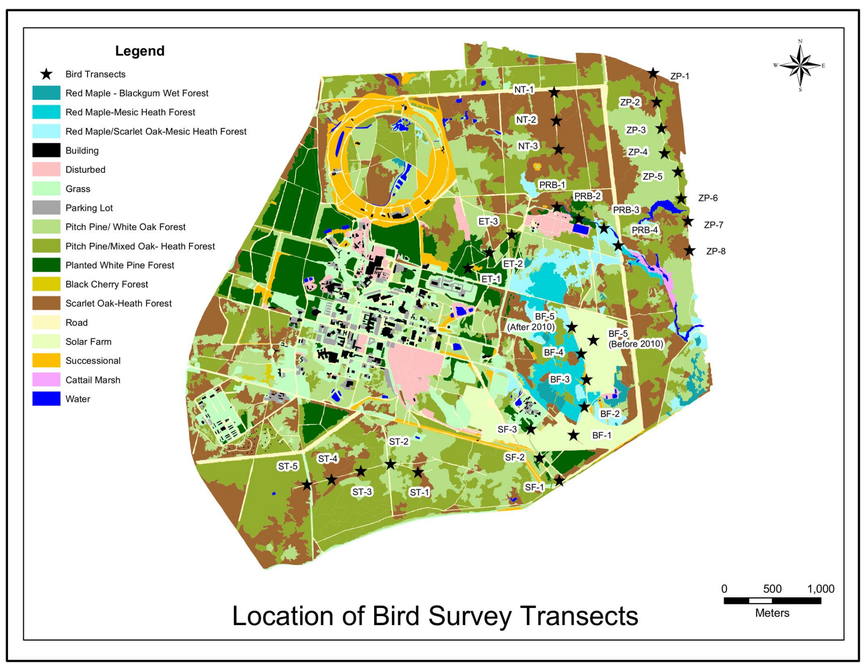


Image 1: Image of map showing transects at BNL.

Methods and Materials

The point count method has been applied in monitoring bird populations by the Environmental Protection Division at BNL annually since 2000.

- Transects: Biology Fields (BF) Transect is separated into five small observation stations. Z-Path (ZP) Transect stations 4-8 were also used in this project.
- The radius of every observation station is approximately 150 meters to ensure that there is enough space for observation.
- All birds seen or heard during 5-minute observation time were recorded.
- The Kestrel 4000 pocket weather meter was used during the survey. All survey data was recorded into a Microsoft Excel® spreadsheet for analysis.
- All statistical analysis was performed using R (Version 3.5.0). Statistical tests performed include the ANOVA and LSD Tests.

Discussion

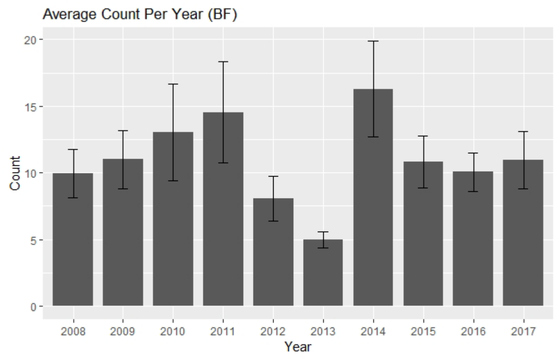
The data were analyzed to examine the interrelationships between bird counts, habitat (various transects), and environmental factors such as wind speed, humidity, and temperature that were collected each year from 2008 to 2017. The years 2008 to 2010 are identified as pre-construction years, prior to the solar facility being built. 2011 to 2013 were years that the vegetation within the solar facility that was disturbed due to the clearing of vegetation. 2014 to 2017 are considered years that the vegetation has recovered. The original habitat in the area included, Red Maple - Black gum Wet Forest, Red Maple-Mesic Heath Forest, Red Maple/Scarlet Oak-Mesic Heath Forest, Pitch Pine/ White Oak Forest, Pitch Pine/Mixed Oak- Heath Forest, Planted White Pine Forest.

https://www.audubon.org/field-guide/bird/american-robin

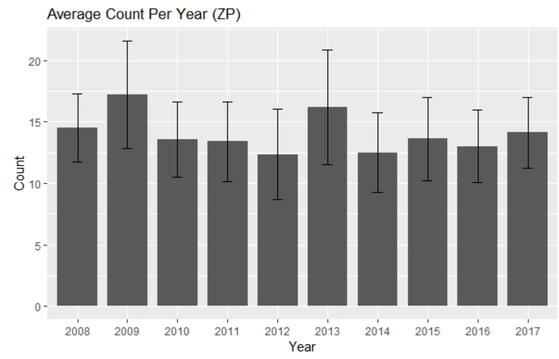
https://www.audubon.org/field-guide/bird/eastern-towhee

Results

Putting the data into a box and whisker plot, it can be observed that the population was different from pre-construction to post construction to the recovery period. After running an ANOVA test, it was proven that there was a significant difference in bird population from 2008 to 2017 ($p = 1.04e-06$). An LSD test was run to determine which individual years are significantly different from each other. The results concluded that using a confidence interval of 95% ($\alpha = 0.05$), 2008 to 2013 ($p = 0.0088$) and 2013 to 2017 ($p = 0.0052$) bird counts were significantly different. To make sure that this trend was exclusive to this area and not possibly due to another factor, data from the ZP transect was plotted using the same 17 bird species and years. Comparing the summary tables 1 & 2 and two graphs (Graph 1 & 2), it is shown that the decline in bird population only occurred in the BF Transect. The average temperature was also taken from each year for both transects. An ANOVA test concluded that there was no significant difference in temperature between years, and the trend of average temperatures does not correlate to average bird count. Since all other factors have not proven to be the cause of the decline in bird population, we can assume that the construction of the solar facility was the cause.



Graph 1: Average count of birds present each year in the BF Transect.



Graph 2: Average count of same species present each year in the ZP Transect.

Bird Community at BF Transect											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
AMRO	24	33	21	69	17	10	22	16	20	28	260
BAOR	6	11	13	4	4	7	9	19	7	16	96
BCCH	14	11	15	7	1	3	14	3	8	1	77
BLJA	15	16	8	12	6	4	7	5	4	3	80
BHCO	4	4	8	5	3	3	64	12	11	12	126
CHSP	19	13	7	26	28	8	35	28	5	11	180
COGR	5	4	66	14	11	6	15	2	8	7	138
EATO	12	7	8	18	12	4	10	9	20	16	116
EAWP	13	10	15	14	5	4	16	9	5	10	101
AMGO	8	4	3	18	2	4	18	9	19	8	93
GCFL	2	4	5	8	9	3	5	9	7	8	60
GRCA	25	29	21	13	11	6	24	23	14	18	184
HOWR	2	9	1	1	5	6	13	20	17	31	105
OVEN	6	8	11	13	12	7	7	5	6	2	77
PIWA	1	2	1	2	1	1	4	1	3	1	17
RBWO	3	2	4	4	2	1	1	1	4	2	24
REVI	10	20	15	19	8	8	13	13	13	12	131
Total	169	187	222	247	137	85	277	184	171	186	

Summary Table 1: Total count of birds present each year in the BF Transect.

Bird Community at ZP Transect											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
AMRO	24	62	9	35	10	44	12	5	8	9	218
BAOR	9	8	13	6	2	11	2	6	5	4	66
BCCH	10	18	29	19	18	14	4	18	18	21	169
BLJA	35	26	29	16	21	10	11		9	12	169
BHCO	7	5	8	6	7	4	12	12	11	13	85
CHSP	19	13	8	18	20	14	23	22	9	24	170
COGR	16	13	6	4	9	38		5	8	2	101
EATO	33	39	38	37	54	69	50	48	45	41	454
EAWP	16	20	11	5	6	11	7	14	15	21	126
AMGO	2	1	2	3	3	5	5	4		3	28
GCFL	0	0	0	0	0	16	7	0	0	0	23
GRCA	9	14	8	9	4	3	8	6	8	13	82
HOWR	0	0	0	0	0	1	0	0	0	0	1
OVEN	13	14	8	15	15	10	16	15	17	17	140
PIWA	23	6	7	1	3	8	15	19	14	17	113
RBWO	1	2	0	0	1	0	0	0	0	1	5
REVI	1	0	0	0	0	1	3	3	2	0	10
Total	218	241	176	174	173	259	175	177	169	198	

Summary Table 2: Total count of birds of the same species in the ZP Transect.

Conclusions

The removal of vegetation caused a decline in bird population for about two years before returning to the normal count. This is useful information because it proves that although this type of disturbance causes a decline in bird population, they will make a return once the vegetation has grown back. If more studies are done, monitoring bird species before and after disturbance, it would be possible to determine what types of disturbance may be permanently detrimental to bird populations in that area, or have the potential to have the community restored given enough time.

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