Changes in bird biodiversity trends due to environmental events at the Long Island Central Pine Barrens

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Abstract

The Long Island Central Pine Barrens is an ecosystem consisting of pitch pine woodlands, pine oak forests, coastal plain ponds, swamps, marshes, and streams. Within the Pine Barrens is Brookhaven National Laboratory (BNL), a multi-dimensional national laboratory that provides large scale facilities for research. Point Count Bird Surveys were conducted on BNL by the Environmental Protection Division over the past 14 years to monitor bird species diversity. Analysis of the results may imply environmental changes and could provide suggestions for making changes in conservation policies at BNL. The present study examined the trends of bird species diversity during 14 years of observation along different transects at BNL. In 2010, a 200 acre Long Island Solar Farm was constructed at BNL. The point count bird surveys indicated that the bird diversity was impacted by the solar farm due to vegetation changes. The bird counts of ground nesting birds such as Ovenbirds and Eastern Towhees increased at the nearby Biology Fields transect. Also on April 9th 2012, there was a top-kill, intense wildfire that destroyed most of the oak trees and understory at three bird observation points located on the Z-Path transect. The bird populations and species subsequently found in abundance included American Robin, Baltimore Oriole, Pine Warbler, and Red-breasted Nuthatch. The vegetation changes caused by the fire included land clearing, opening up the canopy, and providing more standing dead trees. The fire along with the construction of the solar farm influenced changes in the bird biodiversity at BNL. The Pearson correlation method was implemented to analyze the correlation between white-tailed deer population at BNL and bird species counted at different nesting heights. The bird nests placed under six feet can be impacted by white-tailed deer browse. The computer program R was used for statistical computing and graphs in this project.

Introduction

The Long Island Central Pine Barrens is a large track of preserved land which remains mostly undeveloped. The Pine Barrens overlies Long Island's fresh water aquifer which helps to purify Long Island's drinking water. Most of the Peconic River, the longest river on Long Island, is in Central Pine Barrens. The Peconic River originates in bogs and wetlands near Brookhaven National Laboratory (BNL). BNL is located within Long Island Central Pine Barrens and provides large scale facilities for research. Since 2000, the Environmental Protection Division at BNL has conducted point count bird survey to monitor the bird biodiversity on site. Changes in bird diversity may provide insight into environmental changes at BNL. From October 2010 to November 2011, a 32 megawatts AC Long Island Solar Farm (LISF) was under construction at southeast end of BNL. LISF is the largest solar photovoltaic power plant in the eastern Unites States and generates enough clean solar energy to power approximately 4,500 homes for the local utility, Public Service Enterprise Group (PSEG-LI). LISF also provides research opportunities for BNL such as ecological studies, inverter technologies, and power supply studies. Point count bird surveys conducted at BNL can provide ecological evidence showing the impact on bird diversity due to the LISF. BNL occupies more than 1000 acres of core preservation area of the Central Pine Barrens. On April 9th 2012, a top-kill, intensive wildfire wiped out three point count bird survey stations along the Z-Path transect. Most of the oak tree and understory were burned. Fire changes included reduction in tree density, increased snags (dead standing trees), and reductions in shrub cover and leaf litter. These changes resulted in changes in the relative abundance of breeding bird species and populations post-fire along the Z-Path transect. Compared to New York State Breeding Bird Survey Rout 001 Westhampton and Rout 002 Manorville post the 1995 Sunrise fire, the relative bird species and community shared the similarity that the relative bird species had increased. There is a large white-tailed deer population in the northeastern United States. Approximately 600 white-tailed deer live at BNL which is 2132 hectares. High density white-tailed deer populations at BNL has reduced understory vegetation, disturbed ground nesting bird species, and intermediate canopy nesting bird species. The correlation between deer population and both ground nesting and intermediate canopy nesting bird species are moderate. However, the positive correlation is unexpected. The migration survivability and food source available at South America would be factors that impact both bird species richness and population.

Method of Sampling

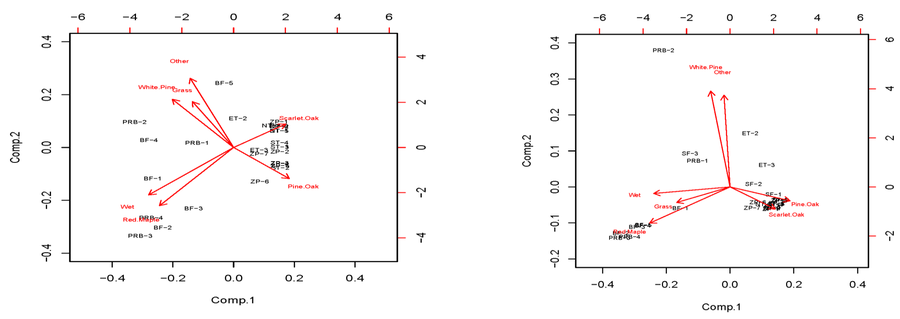
The point count method has been applied in monitoring bird populations by the Environmental Protection Division at BNL annually since 2000.

- Transects: Biology Fields (BF), East Trenches (ET), North Transect (NT), Peconic River (PRB), South Transect (ST), Z-Path (ZP, added 2002), Solar Farm (SF, added 2010). Each transect is separated into several small observation stations.
- The radius of every observation station is approximately 150 meters to ensure that there is enough space for observation, but no two transect location points are adjacent.
- All birds seen or heard during 5-minute observation time were recorded.
- The Kestral 4000 portable weather station 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 3.1.1). Statistical tests performed included the Shapiro-Wilk Normality Test to test if the data sets are normal. However, several data sets, such bird counts at a sample station, failed the normality test. In these cases, non-parametric tests, such as the Mann-Whitney Test and the Kruskal-Wallis test, were used to compare the medians.

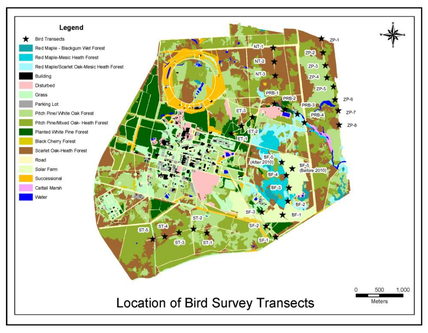
Data Analysis and Discussion

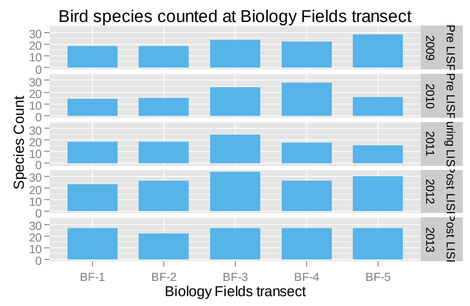
- In October 2010, construction began on the Long Island Solar Farm (LISF) which completed and began operating in November 2011. The vegetation structure in the Biology Fields transect and the Solar Farm transect have been changed from forest or grassland to disturbed. Principal Component Analysis was performed to visualize the different vegetation structures at each survey station.. According to the figure, the Biology Field transect, PRB-3, and PRB-4 share the similar vegetation structure before the construction of the Long Island Solar Farm.

Data Analysis and Discussion (continued)

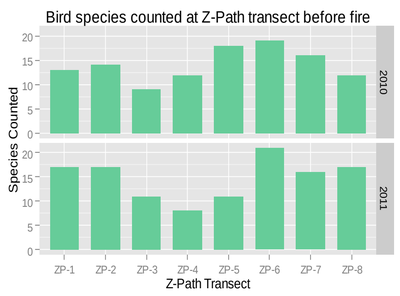


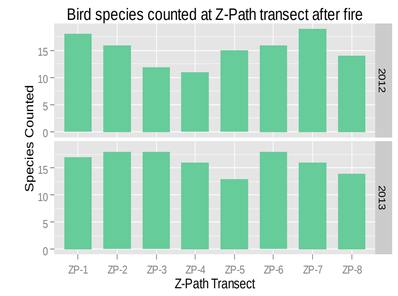
- Since the vegetation at the Peconic River transect's stations #3 and #4 are similar to the vegetation at the Biology Fields transect, we used bird counts at PRB-3 and PRB-4 as the control group and the Biology Field transect as the experimental group to analyze the biodiversity changes. Using 2009-2010 as the LISF pre-construction period, and 2012-2013 as the LISF post-construction period for both the control group and the experimental group, paired t tests were performed. The bird species richness obtained at the control group (PRB-3 and PRB-4) shows no significant difference ($p=0.3024$, $\alpha=0.05$) between two time periods. However, the bird species richness obtained from the experimental group (Biology Field transect) indicates the bird species richness obtained during 2012-2013 is greater ($p=0.0007839$, $\alpha=0.05$, alternative=less) than during 2009-2011. The Biology Field transect survey data shows that the ground nesting bird species and the population are increasing.



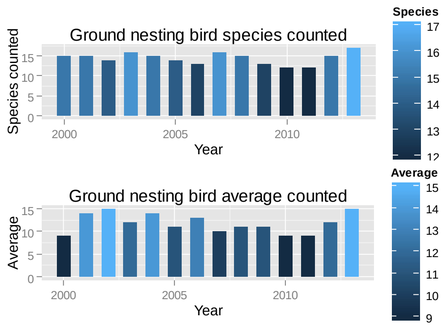


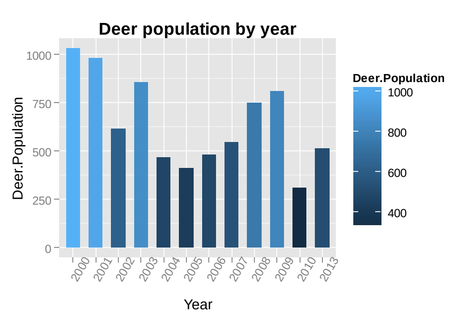
- In April 2012, a top-kill, intensive wildfire burned out at stations 1, 2 and 3 along the Z-Path transect. The fire cleared the understory and leaf litter, opened the canopy, and provided dead standing trees. After the fire, more insects went to post-fire stations. That attracted the insect feeding bird species and the cavity nesting bird species. Paired t tests were performed to analyze the bird species diversity difference pre-fire and post-fire. The statistical test conducted at ZP-1, ZP-2, and ZP-3 shows the bird species richness obtained before fire were significant less than post-fire ($p=0.0186$, $\alpha=0.05$, alternative=less).





- BNL has a large population of white-tailed deer. High density white-tailed deer populations reduce the understory vegetation and the rate of forest regeneration. White-tailed deer disturb vegetation, especially impacting bird species who nest below 6 feet. The correlation between the white-tailed deer population and the species richness of the bird species nesting under 6 feet is 0.4776298 by performing the Pearson Correlation. The correlation is moderate, but unexpected. Bird species richness and population counts are impacted by the migration survivability and the food sources available in South America during the winter. Migratory species are particularly fragile because they depend on success in multiple locations across the globe. Destruction of habitat in either seasonal location lowers the survival rate and is detrimental to world bird species and population.





Conclusion and Future Study

The environmental changes at BNL are impacting bird diversity. The wildfire and existence of the Long Island Solar Farm have changed the vegetation structure. The different vegetation availabe at BNL can cause increases in both bird species and population. The influence of overabundance white-tailed deer population would need further study. Prey-Predator relationships might be available for future study.

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 Science Undergraduate Laboratory Internships Program (SULI).
- This project was supported by Brookhaven National Laboratory.