The Effect of Overstory Composition and Cover on Understory Make-up in the Long Island Solar Farm Area.

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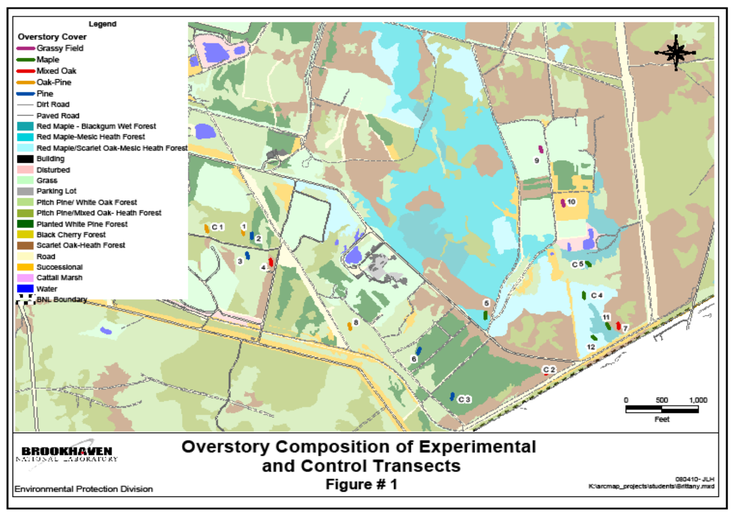
Abstract

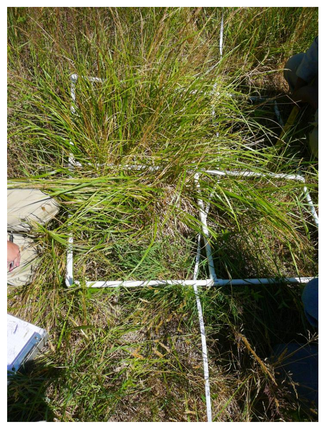
The construction of a two hundred acre, thirty two megawatt, utility scale solar array, set to occur at Brookhaven National Laboratory (BNL) in August 2010, will provide a unique opportunity for BNL to research the effects of this solar array on the surrounding environment. In order to carry out this research, a baseline must be created to outline the current forest composition. For this reason, our group laid 12 twenty-five meter long transects in the various vegetation types present in the future solar array area. One square meter quadrats were placed every five meters along the transect and the number, height, and percent cover of each understory species was recorded. Overstory composition and percent cover over each quadrat was also recorded. The group established five control transects in similar vegetation types in areas that will not be affected by the solar array construction. The understory composition was then analyzed based on overstory cover and composition and the results show that pine only forests produce lower biodiversity than oak-pine, mixed oak and maple areas. The pine only forests had 12 different understory species present and the grassy field area had 14 while the oak-pine had 19, mixed oak had 25 and maple-oak had 28 understory species. The Shannon-Weiner biodiversity indices were calculated and the values are as follows: pine only 0.15, oak-pine 1.63, grassy field 1.63, mixed oak 1.76 and maple 2.11. These values revealed that as forests age and progress from pine only to a mix of maple and oak, the understory becomes more diverse. Once the panels are installed it will be important to see how they affect this process of maturation and change in diversity. The results also show that areas with heavy over story cover have greater biodiversity and these will be particularly interesting to observe after the panels are put in and the over story cover is reduced to zero between arrays and becomes close to 100% under the arrays. It appears that huckleberry, late season low bush blueberry and greenbrier will thrive in the newly cleared areas since they flourish in locations with lower overstory cover. The forest clearing for solar array construction may also have a negative effect on invasive species which could help reduce their population and allow native species to prosper. This vegetation baseline will allow scientists to study how the solar array installation will affect understory composition in the future.

Introduction

Solar energy has become a growing alternative energy source around the world, but the effects of the solar arrays have not been extensively studied. The construction of the Long Island Solar Farm at BNL will allow scientists to pioneer studies on the environmental effects of the solar arrays. Researchers will have a chance to study aspects such as rain pooling at the base of the panels and changes in shading due to solar panel installation. The proposed solar farm area is currently composed mostly of Pine Barrens forests, which need to be cleared in order for construction to occur. The method for clearing was chosen to have minimal disruption on the understory and involves cutting the trees and then removing their stumps (1). This will reduce the overstory over of the forest to zero allowing future research to be conducted on how this affects or changes the understory composition. In order to carry out the various solar array research, a vegetation baseline must be created to outline the current forest composition.

The Pine Barrens forests present in the solar farm area are in various successional stages. As areas progress from bare soil to climax forests the understory and overstory experience changes in their make-up. Newer forests are comprised mainly of softwood species, particularly pitch pine and white pine in Pine Barrens forest, while more mature ones are made up of hardwood species such as oak, hickory, and maple. In previous studies of the Pine Barrens it was noted that mature forests of this type exhibit a greater species diversity of shrub and herb species, so this result is expected to be seen in the more mature, oak-dominated forests of the future solar farm area (4). Since biodiversity can be used to monitor the health of the understory, this project will focus on quantifying the diversity of the understory in different forest areas so changes can be monitored in the future after the panels are installed. The forests of this solar farm area also have varying degrees of overstory cover so this project will also focus on investigating the understory make-up in areas of different percent overstory cover allowing changes in vegetation patterns due to solar panel shading to be tracked.





Methods and Materials

Locations were chosen so all vegetation types were represented in as much of the solar farm area as possible. These will not only act as areas of comparison for future studies but will help BNL re-vegetate the solar farm area if and when the panels need to be removed after the arranged 20 years of operation (1). Belt transects were chosen as the best way to outline the current forest composition for solar panel research, and a length of 25M was chosen based on previous studies in the Pine Barrens region and elsewhere in the country (4,5).

For each location, an area was chosen that appeared to be a good representation of the understory make-up and allowed for a 25-meter transect to be placed in the N-S direction with the least interference from trees and fallen logs. The wind speed and direction, temperature, humidity and dew point were taken using a Kestrel 4000 weather station to collect data on the weather conditions. For the start and end points of each transect, the latitude and longitude were recorded on the data sheets and logged into the global positioning system (GPS). One square meter quadrats were placed every five meters along the transect, on the 0M, 5M, 10M, 15M, 20M, and 25M marks. The number, percent leaf cover and height of each understory species were recorded. The pH was also recorded for each quadrat to see if changes occurred due to rain water pooling at one end of the solar panels. One quarter of two quadrats along a transect were clipped so biomass estimations could be made, again allowing changes in the future to be seen. Overstory composition and percent cover over each quadrat were also recorded. In total, 12 experimental and 5 control transects were used to get a complete representation of the vegetation for the baseline.

Overstory composition was split into five categories for data analysis: Pine only (>90% pine cover), oak-pine (>50% oak, <50% pine cover), mixed oak (>90% scarlet and white oak cover), maple (>90% maple cover) and grassy field (0% cover). Each transect was placed into one category. The location of each transect along with the category it was classified as can be seen in the map in Figure 1. Overstory cover was also analyzed and broken down into the following categories: 1-20%, 21-40% cover, 41-60%, 61-80% and 81-100%, and each quadrat was placed into one. The quadrats that experienced 0% cover were not included in the analysis because they were comprised of a different understory composition. For each overstory composition and overstory cover category the diversity of the understory was compared by calculating the Shannon-Weiner Biodiversity Index (3). The average number of each understory species per transect was also determined for each overstory composition category to make the results comparable, since each category had a different number of transects. In the past, similar data categories have been used along with these calculations to assess the make-up and health of Pine Barrens understory (2).

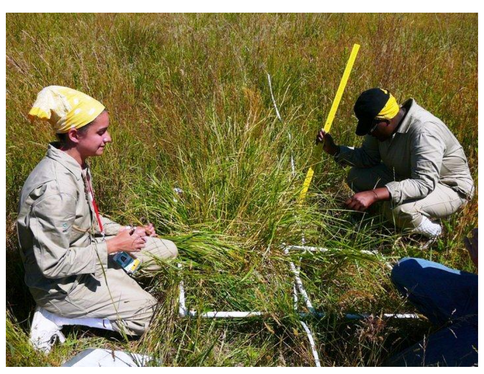


Figure 2: Biodiversity Indices based on overstory composition and percent cover

Overstory composition category	Shannon-Weiner Biodiversity Index
Pine only	0.15
Oak-pine	1.63
Mixed Oak	1.76
Maple	2.11
Grassy Field	1.63

Overstory cover category	Shannon-Weiner Biodiversity Index
1-20%	1.52
21-40%	0.20
41-60%	2.29
61-80%	2.03
81-100%	2.04

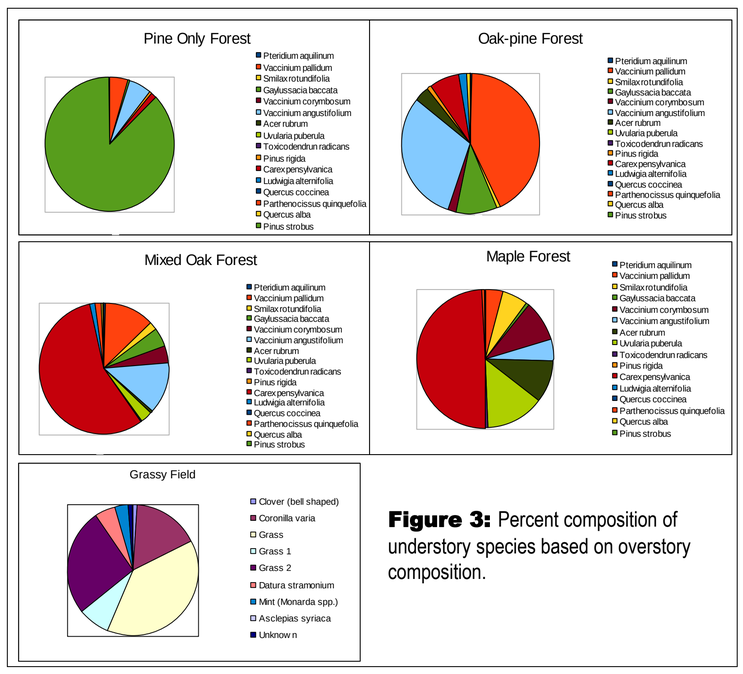


Figure 3: Percent composition of understory species based on overstory composition.

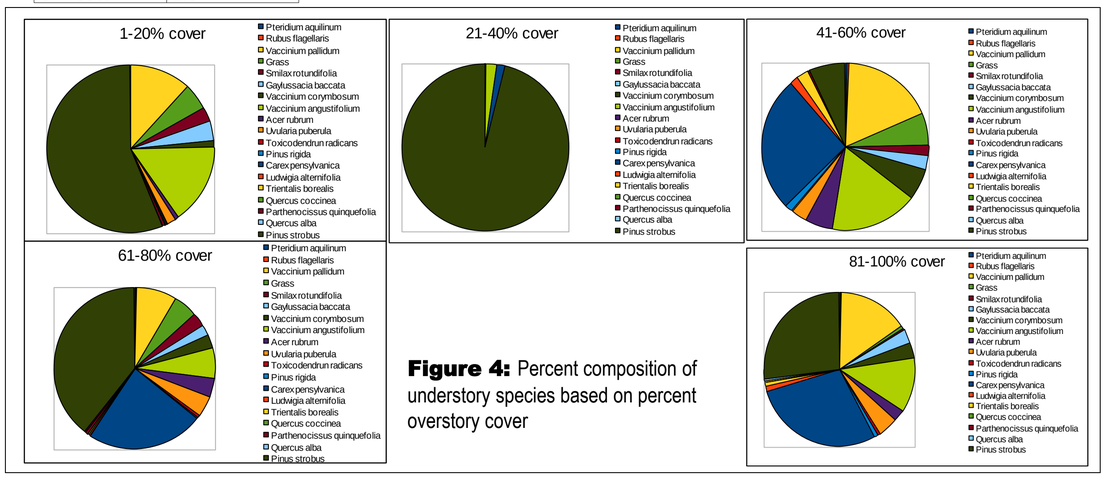


Figure 4: Percent composition of understory species based on percent overstory cover

Results

The data taken for each of the experimental transects provides a snapshot of the understory species present throughout the future solar farm area. All of the compiled data will be retained as the baseline for future comparisons, but for analysis purposes only certain species were taken into account for the biodiversity calculations. After the data was broken down into the various overstory categories, species seen in only 1 or 2 categories were removed from analysis to allow for comparison across the solar farm area.

Figure 2 shows the biodiversity indices that were calculated for the different overstory composition and cover categories. As predicted, pine only and oak-pine forests produce lower biodiversity than the more mature mixed oak and maple areas. This shows that as forests age and progress from pine only to a mix of maple and oak they become more diverse. The percent composition of each understory species was also determined and can be seen in Figure 3.

The biodiversity indices based on percent overstory cover show that the areas that had greater than 41% overstory cover had greater understory diversity. The percent composition of each understory species was again determined based on percent overstory cover, and can be seen in Figure 4.

Discussion

The results show that as forests progress to mixed oak and maple mixes the biodiversity of the understory increases, which is an indication of higher forest health. The effect that the installation of solar panels has on the biodiversity of the region should be studied to determine how they affect forest health over time. The panels could halt the progression of the forests which would prevent them from reaching a state of high biodiversity, and cause a decrease in species such as *Vaccinium corymbosum, Smilax rotundifolia, Uvularia puberula.* They could also speed up this progression by allowing for the introduction and cohabitation of different species.

The results also show that understory diversity is higher in areas that have greater than 41% overstory cover. These will be particularly interesting to observe after the panels are put in and the overstory cover is reduced to zero between arrays and nears 100% under the arrays. The areas with lower overstory cover, that currently exhibit lower biodiversity, provide a guess as to which species will thrive once the area is cleared. It appears that *Smilax rotundifolia, Gaylussacia baccata* and *Vaccinium angustifolium* will thrive in the newly cleared area since they flourish in areas with lower than 20% overstory cover. The results also allow us to predict the vegetation patterns that will occur once panels are installed and some areas experience full shade while others have direct sunlight. The areas that become shaded by the panels could allow species such as *Carex pensylvanica, Vaccinium pallidum, Vaccinium corymbosum* and *Uvularia puberula* to grow while the species that prefer little overstory cover grow in adjacent areas.

The forest clearing could be detrimental, because it may lead to a reduction in diversity and decline in forest health. The forest clearing could also be beneficial because it will give species such as *Smilax rotundifolia, Gaylussacia baccata* and *Vaccinium angustifolium* a chance to thrive. Also, invasive species that exist near the edges of the forest will be cleared, giving native species a chance to spread out into that habitat. The solar farm area will also be completely fenced off which will prevent deer from grazing on plants, again giving native species a chance to grow. The vegetation baseline created before panel installation will allow scientists to study how the solar array will affect understory composition and many other environmental parameters in the future.

References

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