EFFECT OF AMBIENT LIGHT LEVELS ON UNDERSTORY COMPOSITION IN A PINE BARRENS ECOSYSTEM AT BROOKHAVEN NATIONAL LABORATORY'S PROPOSED SOLAR ARRAY; ESTABLISHING A BASELINE FOR FUTURE STUDIES

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ABSTRACT

The increasing population of the human race and our escalating energy use forces us, as a nation and as a species, to adapt through the use of energy generation technologies that have less impact on our environment. To this end, Brookhaven National Laboratory has partnered with BP Solar to install a 200-acre, 35 MW, solar panel array on site at BNL. My research involved gathering a baseline survey of the existing understory vegetation as it relates to both the overstory type and the relative ambient light. This will allow my research team to draw immediate conclusions as to how the overstory habitat type affects the understory species composition, and will allow us to provide a baseline survey which can then be compared to the understory makeup post-solar-panel-installation, up to twenty years from now. In order to document the habitats, we laid twenty twenty-five meter transects, along which we placed six one meter square quadrats. In each of the quadrats, we identified, counted the number of, and measured the heights of each species. We also estimated percent ground cover of each species, and also overstory percent cover and species composition. I also put up 16 light meters in 12 different habitat types in order to better understand the relationship between light and the understory vegetation. Several variables are expected to be modified by removing the overstory and installing the solar panels, including increased light (all the trees will be removed), changes in water distribution (the solar panels are impervious and will direct rain that falls off their lower edge), and changes in herbivory levels (there will be a deer-proof fence erected around the entire solar array). These changes will have direct effects on the remaining plants, including changing water distribution patterns, easing herbivory stress, and possibly allowing other plant communities to establish due to the different light and moisture regimes. The data we have gathered indicate that the understory has a statistically significant correlation (p<0.8 & 0.14) with overstory, with pine and oak forest associating with mixed *Gaylussacia spp.* and *Vaccinium spp.* understory, and open areas comprised mostly of grasses, *Asclepias spp.*, and other grassland plant species. Whether the removal of the overstory will give an advantage to invasive plants remains to be seen, but there is potential that the solar panels could provide enough shade to allow the existing plant communities to flourish.

Hypothesis: Members of the Genus *Vaccinium* prefer partial shade to either low light or full sun habitats.

Introduction

Energy generation technologies that have less impact on our environment are an important step in America's drive towards sustainable energy independence. To this end, Brookhaven National Laboratory has partnered with BP Solar to install a 200-acre, 35 megawatt, solar panel array on site at BNL. The installation of this large an array gives us a unique opportunity to study how a solar array affects the existing vegetation. Several changes, including deer proof fencing around the entire array, changes in the light and changes in water distribution are among the myriad changes which will occur.

The understory is mostly made up of the plant family Ericaceae (heath family). Members of this family, including *Vaccinium* prefer acidic soils and partial shade. The mixed pine/oak forest of the central Long Island pine barrens provides an excellent habitat for these species, including plentiful members of the genus *Vaccinium* and *Gaylussacia*, comprising most of the understory. The lowbush blueberry (*Vaccinium angustifolium et al. spp.)*, the highbush blueberry (*Vaccinium corymbosum*), and the huckleberry (*Gaylussacia spp.)* are the primary understory vegetation in much of the proposed solar array area.

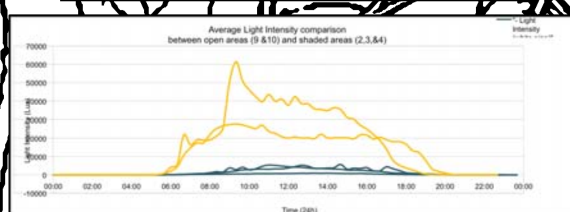


Fig. 1 - Comparison of high light intensities (open fields) and low light intensities (white pine plantations)

Methods

I put up 16 light meters in 12 different habitat types in order to better understand the relationship between light and the understory vegetation. Several variables are expected to be modified by removing the overstory and installing the solar panels, including increased or decreased light, changes in water, and changes in herbivory. We then placed seventeen twenty-five meter transects in the field, and laid 1 meter square quadrats at six points along the twenty-five meter transect. We identified and counted the number of plants contained within each quadrat, and entered this into a spreadsheet. From this raw data, I determined both the number of blueberry plants in each sample transect, and averaged the light meter data into an "average day" with points every twenty minutes throughout the twenty-four hours. (*Fig. 2.1 & 2.2*) I then inputted this information into Stata, a statistical program, which analyzed the data.

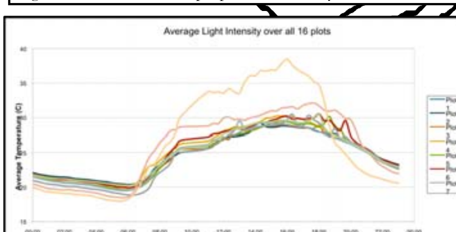


Fig. 2.1 – Line graph of average temperature (ºCelsius) at 20 minute intervals throughout a twenty-four hour period.

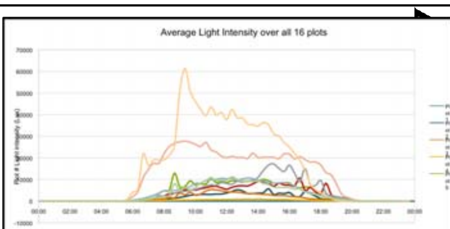


Fig. 2.2 – Line graph of average light intensity (Lux) at 20 minute intervals throughout an average day.

Results

From the averaged light and temperature data and the number of identified *Vaccinium* in each plot, I was able to run regression analysis using Stata, a statistical analysis program. This regression data shows that temperature has no statistical significance at anytime during the day. (*Fig. 1.1, 1.2*) It also shows that morning light levels have a small effect on *Vaccinium spp.*, with higher morning light being correlated with fewer *Vaccinium* plants. Midday light had no statistical significance, while higher levels of afternoon light were positively correlated with *Vaccinium Spp.* This latter statistic was the only variable which was statistically significant at the 90 percent confidence level.

. reg Vaccinium Morning Midday Afternoon

Source	SS	df	MS		
Model	108504.041	3	36168.0136	Number of obs =	11
Residual	102704.687	7	14672.0981	F(3, 7) =	2.47
				Prob > F =	0.1469
				R-squared =	0.5137
				Adj R-squared =	0.3053
Total	211208.727	10	21120.8727	Root MSE =	121.13

Vaccinium	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Morning	-.0405838	.019384	-2.09	0.075	-.0864197	.005252
Midday	-.0208052	.0205669	-1.01	0.345	-.0694383	.0278279
Afternoon	.0716622	.0430533	1.66	0.140	-.0301426	.173467
_cons	217.0787	57.9088	3.75	0.007	80.14618	354.0113

Fig. 3.1 – Stata regression analysis of average morning (05:40-10:20), mid-day (10:40-15:20), and afternoon (15:40-20:20) light intensity in relation to number of blueberries per plot.

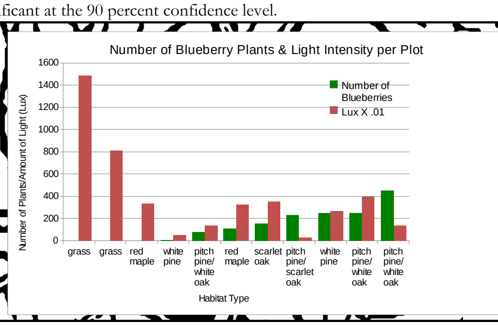


Fig. 3.1 - Number of *Vaccinium* plants alongside the light levels of each plot (divided by 100). Note that *Vaccinium* plants only have a weak negative correlation with lower light levels, while higher light levels exhibit a much stronger negative correlation.

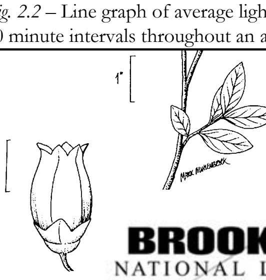
reg Vaccinium TempMorning TempMidday TempAfternoon

Source	SS	df	MS		
Model	80469.7666	3	26823.2555	Number of obs =	11
Residual	130738.961	7	18676.9944	F(3, 7) =	1.44
				Prob > F =	0.3112
				R-squared =	0.3810
				Adj R-squared =	0.1157
Total	211208.727	10	21120.8727	Root MSE =	136.66

Vaccinium	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TempMorning	-63.87159	72.50221	-0.88	0.408	-235.3121	107.5689
TempMidday	-80.95458	54.63055	-1.48	0.182	-210.1353	48.22614
TempAftern~n	49.16561	51.16913	0.96	0.369	-71.83016	170.1614
_cons	2667.002	1715.161	1.55	0.164	-1388.71	6722.713

Fig. 3.2 – Stata regression analysis of average Morning (05:40-10:20), Mid-day (10:40-15:20), and Afternoon (15:40-20:20) temperature in relation to number of blueberries per plot.

Discussion and Conclusions- More transects are needed in order to further strengthen our results, but with the limited time and resources available to our research team, we were able to prove that there is a statistically significant negative correlation between morning light and a positive correlation between afternoon light and *Vaccinium spp.* Most importantly, we provided a baseline survey of the ecosystem before it is significantly altered by human activity. Though it is hard to predict what will happen to the understory in the wake of the overstory removal and the solar panel installation, because of our data collection and research, future researchers will be able to monitor the changes to the habitat for years to come. This vegetation survey is not nearly as important for what we have discovered, but instead for what it will allow us to monitor, analyze, and discover in the years to come.



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