Characterizing Trends in Long Island Pine Barrens Vegetative Cover for 2000-2009 Using Remote Sensing and Meteorological Station Data

Katherine Schwarting and Deanne Rogers
Dept. of Geosciences, Stony Brook University

Introduction: The Central Pine Barrens reserve is a protected area in a coastal climate regime. We seek to understand how Pine Barrens surface cover, particularly, vegetation abundance, is influenced by climatic variables such as temperature and annual precipitation. This may help with predictions of how Pine Barrens vegetative cover will be affected by climate change. This work examines trends in Pine Barrens natural vegetative cover areal fraction during the time period of 2000-2009, and compares these trends with meteorological data. To start this work, the Pine Barrens protected area was examined as a whole. However, trends in individual vegetative cover classes within the Pine Barrens will be examined in the future. Similarly, areas of interest on Long Island defined by other means (such as by microclimatic regimes) can also be examined.

Methods: Vegetative cover abundance for natural Pine Barrens surfaces was estimated from the Moderate Resolution Imaging System (MODIS) sensor aboard the Earth Observing System Terra satellite. MODIS measures surface reflectance in 36 channels including visible and near-infrared wavelengths. The MODIS instrument team calculates Normalized Difference Vegetation Index (NDVI) maps, which are a proxy for areal fraction of healthy vegetation [e.g., *Boutton and Tieszen*, 1983]. We used 16-day composite maps, which are averages of near-daily data, excluding cloud-covered pixels. A vegetation class map for the Pine Barrens, graciously provided by The Nature Conservancy, was used to constrain the study area to only include natural surfaces in the Pine Barrens reserve (**Figure 1**). Average NDVI values for the study area were extracted from the MODIS data, for each date data was collected, for the period 2000-2010. The peak NDVI value for each year was then extracted from this data as well as the date on which the peak occurred.

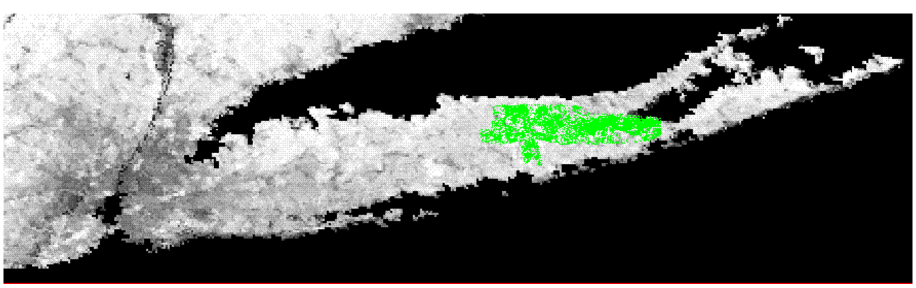

Figure 1: MODIS NDVI image, August 2008. The Pine Barrens area of interest is green.

Daily precipitation and near surface (~2 m) air temperature minimums and maximums from the nearby NOAA Bridgehampton meteorological station were gathered for the period of 1973 to 2009. From these data, average temperature minimums and maximums for the summer (June-August) and winter seasons (January-February) were calculated.

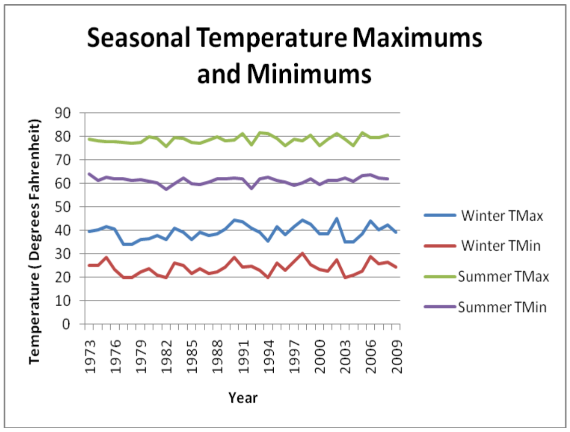

Figure 2 illustrates average minimum and maximum daily temperature for each season of each year.

<u>Results</u>: Seasonal minimum and maximum temperature changes are shown in **Figure 2**. Each each season's minimum and maximum have similar curves. They show periodic warming and cooling fluctuations. The annual precipitation visualized in **Figure 3** also shows periodic changes (two deep "Vs" in the graph at years 1990 and 2009 represent missing data). Peak NDVI data is shown in **Figure 4**. Though there is no general increasing or decresing trend, there is a period of four years from 2004 to 2007 where the NDVI value decreases significantly compared to other years and recovers during this period. This corrsponded to a period of average temperatures and average precipitation.

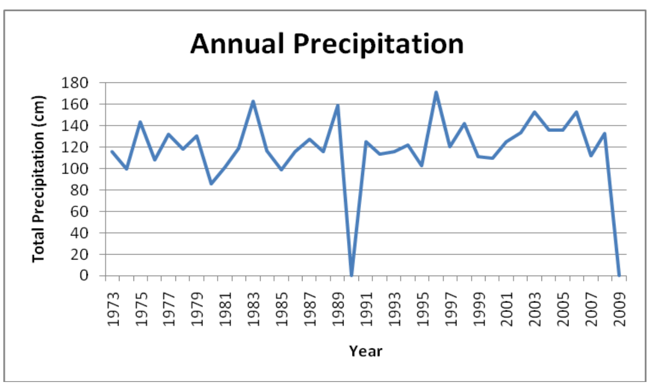

Figure 3 illustrates the annual precipitation for each year. Large dips indicate years with missing data.

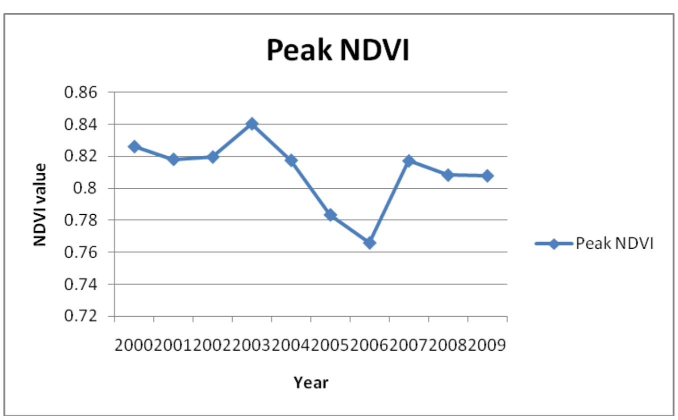

Figure 4 . Peak NDVI for the time period 2000-2009. A decrease in NDVI was observed in 2005-2006.

Figures 5-7 compare the annual peak NDVI value with annual precipitation, average summer maximum temperature and average summer minimum temperature. Surprisingly, the overall trend suggests a decrease in vegetation abundance with increasing precipitation; however we note the R^2 value suggests little dependency on one another. Similarly, there appears to be little connection between summer maximum temperature and peak NDVI.. However, there may be some connection between lower summer minimum temperatures and higher NDVI values. Finally, no trend is observed between the day of the peak NDVI and precipitation (**Figure 8)**.

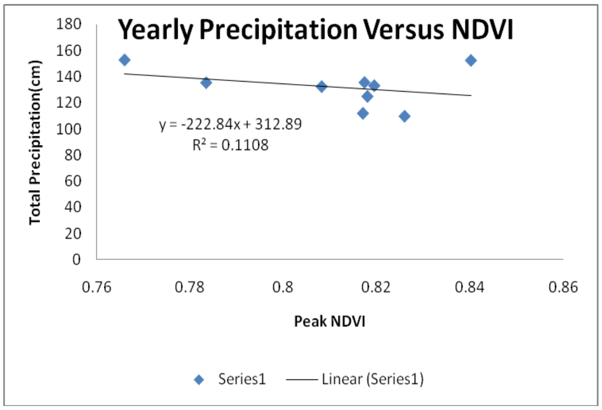

Figure 5 shows yearly precipitation and NDVI with corresponding trend line. Though some follow the trend many points lie too far off for there to be a significant trend during this time period

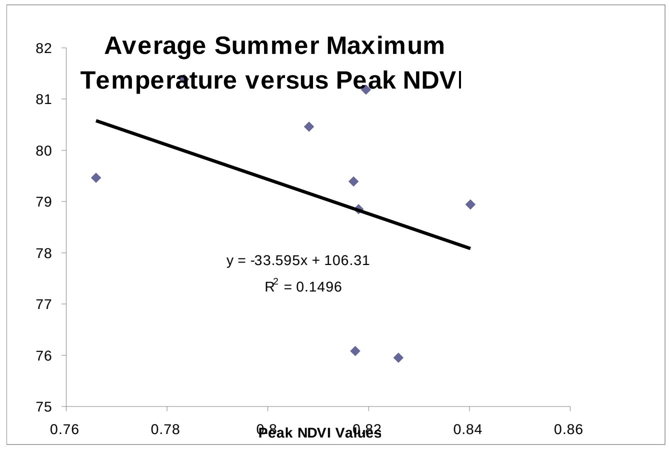

Figure 6 shows the lack of correlation between summer maximum temperatures and NDVI.

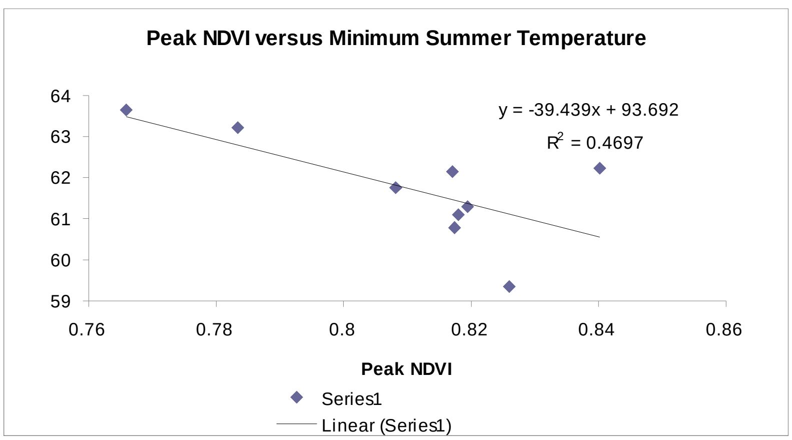

Figure 7 illustrates average minimum summer temperature compared to NDVI. Outlier points represent years 2000 and 2003.

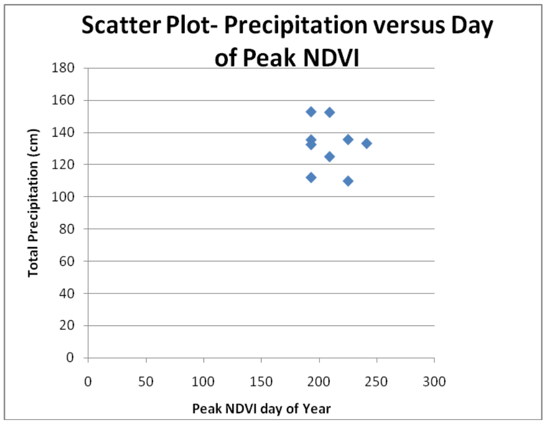

Figure 8 shows the day of year (1-365) of peak vegetation abundance versus annual precipitation. Each occurs over a short range but do not show much connection.

<u>Summary and Further Research</u>: This work shows that 2005 to 2006 were years of uniquely low NDVI; however, thus far, there does not appear to be a clear climatic control on these low values. There appears to be a lack of correlation between peak NDVI and annual precipitation; this might be due to a time lag in response between the vegetation and the precipitation received [e.g., *Wang et al.*, 2003]. Also, only the peak NDVI was plotted; a measure of the sum NDVI value may be a better measure of vegetation response. These issues will be investigated in the future. Further research will utilize Landsat data to extend the period that the NDVI can be examined (as early as 1973). This will aid in telling if the low NDVI occurs periodicly on a longer time scale or whether there was a unique event that occurred. Further research will also narrow the area of interest to areas of known native plant species such as the Pitch Pines in order to identify changes in their abundance and understand why it occurs. This information can then be used to support further preservation and conservation of the Pine Barrens.

<u>References</u>

Boutton, T.W. & Tieszen, L.L. (1983). Estimation of plant biomass by spectra reflectance in an East African grassland. *Journal of Range Management*, **36**: 213-216.

Wang, J., P. M. Rich, K. P. Price, Temporal responses of NDVI to precipitation and temperature in the central Great Plains, USA, *Int. J. Remote Sens.*, 24, 2345-2364, 2003.