

Environmental factors linked to tree regeneration within the Long Island Pine Barrens



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Abstract

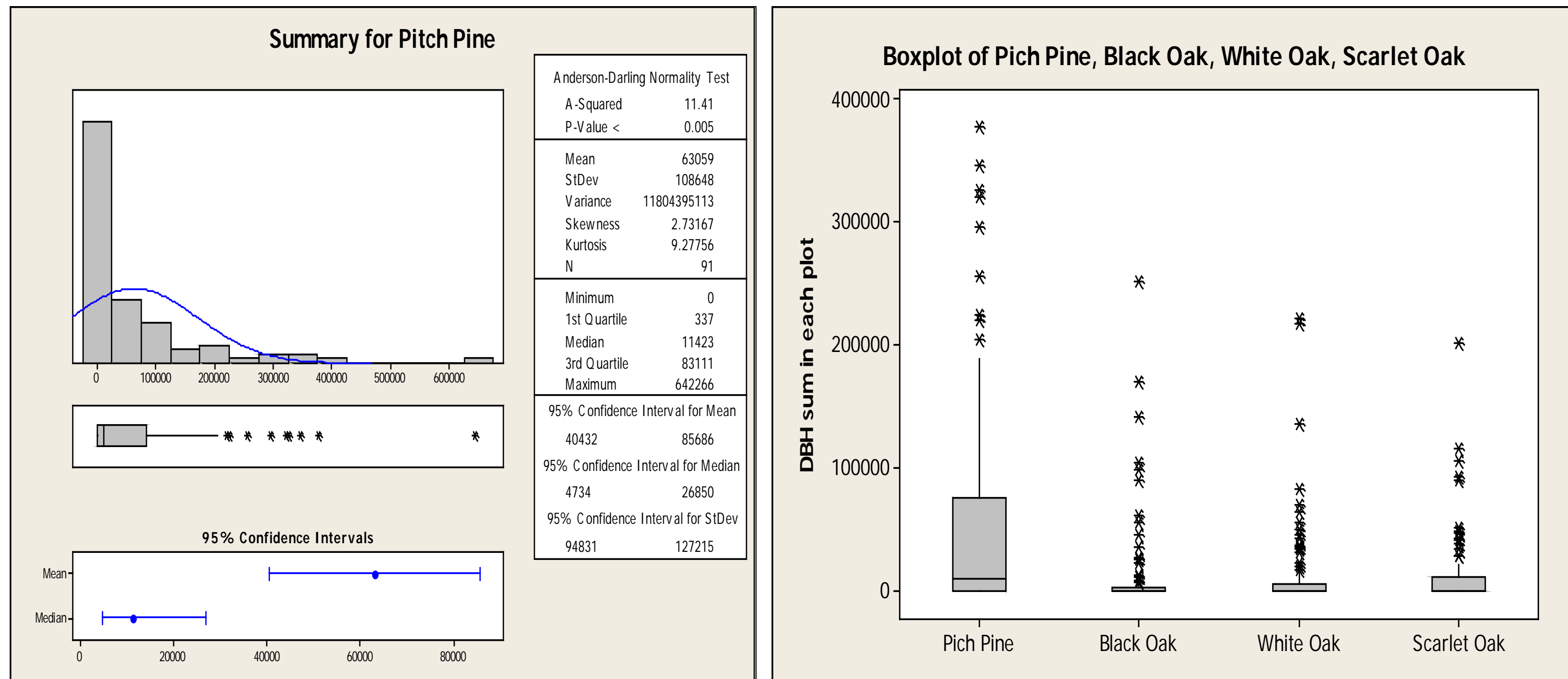
The study of tree regeneration and the life cycles of the species of trees within the Long Island Pine Barrens was conducted to prevent the destruction of the biodiversity of the Long Island Pine Barrens. Because oak trees dominate pitch pine trees in the regeneration cycle, the community of pitch pine trees has already begun to shrink, which could lead to their extinction in the Long Island Pine Barrens. Data and findings have been recorded using 93 designated plots of different forest communities and tree types on Brookhaven National Laboratory (BNL) property as a sample. The data collected consists of recordings from 2005, 2006, and 2011. Using descriptive statistics, non-parametric tests, and Nonmetric Multidimensional Scaling (NMS), we have been able to find correlations and create hypotheses about the nature of the tree regeneration cycle and forest community growth. The overall amount of pitch pine trees in the Long Island Pine Barrens has been diminishing over the time of this study. Throughout this study, both non-metric multidimensional theory and R® the statistical analysis program were necessary to understand as well as the learning of key factors that contribute to forest health and their effect on the forest. This study is being conducted to create a baseline for a continuing study of the Long Island Pine Barrens.

Introduction

A study of the Long Island Pine Barrens (LIPB) forest is currently being conducted at Brookhaven National Laboratory (BNL). The LIPB consists of mainly four species of trees: pitch pine, white oak, scarlet oak and black oak. Each of the species can be found in any of the four major community types found in the LIPB: Pitch Pine, Pine-Oak, Oak Pine, and Coastal Oak forests. These tree species in the communities follow a regeneration cycle of natural succession necessary for the conservation of biodiversity within the LIPB. However, there are a multitude of environmental factors which cause the regeneration cycle to be highly variable, predominantly the diet of herbivores within the area such as white-tailed deer, seed availability, the characteristics of forest gaps, and naturally caused forest fires (Millington, 103). Using the data that has been collected in both 2005, 2006 and 2011, models of the distributions of species within the LIPB were made and analyzed in order to determine whether the forest is considered to be healthy. A visual model of the invasion of tree species into different forest communities was also analyzed to give inferences about the interactions of tree species given external environmental factors. After looking at the models created taken from the given years, the conclusion drawn was that the forest is not regenerating as it should compared to natural succession, and further analysis is needed understand the reasoning behind why the forest is not regenerating as expected.

Materials and Methods

The data collected for the analysis was taken from the 91 plots located on site within BNL. That data set for 2005 consisted of the forest community of each plot, the species of trees within each plot and the count of each tree species, and the Diameter at Breast Height (DBH) of each tree. The DBH is the diameter of a given standing tree and is collected to determine a number of characteristics, two of which used for this study are age and growth rate. The DBH is also summed in order to give a basal area estimate of each species within each of the plots (Sarr 1244). Doing this allows the growth of a tree species within a given plot to be analyzed in relation to the other trees in that same community. The DBH of each tree of each species within each plot was split into four quartiles based on height and summed in order to look at the plot as a whole and the biodiversity of each plot. The separation of the DBH of each tree species into quartiles creates a more specific data set when determining the growth of a tree species and whether that species is regenerating within that area.



Results

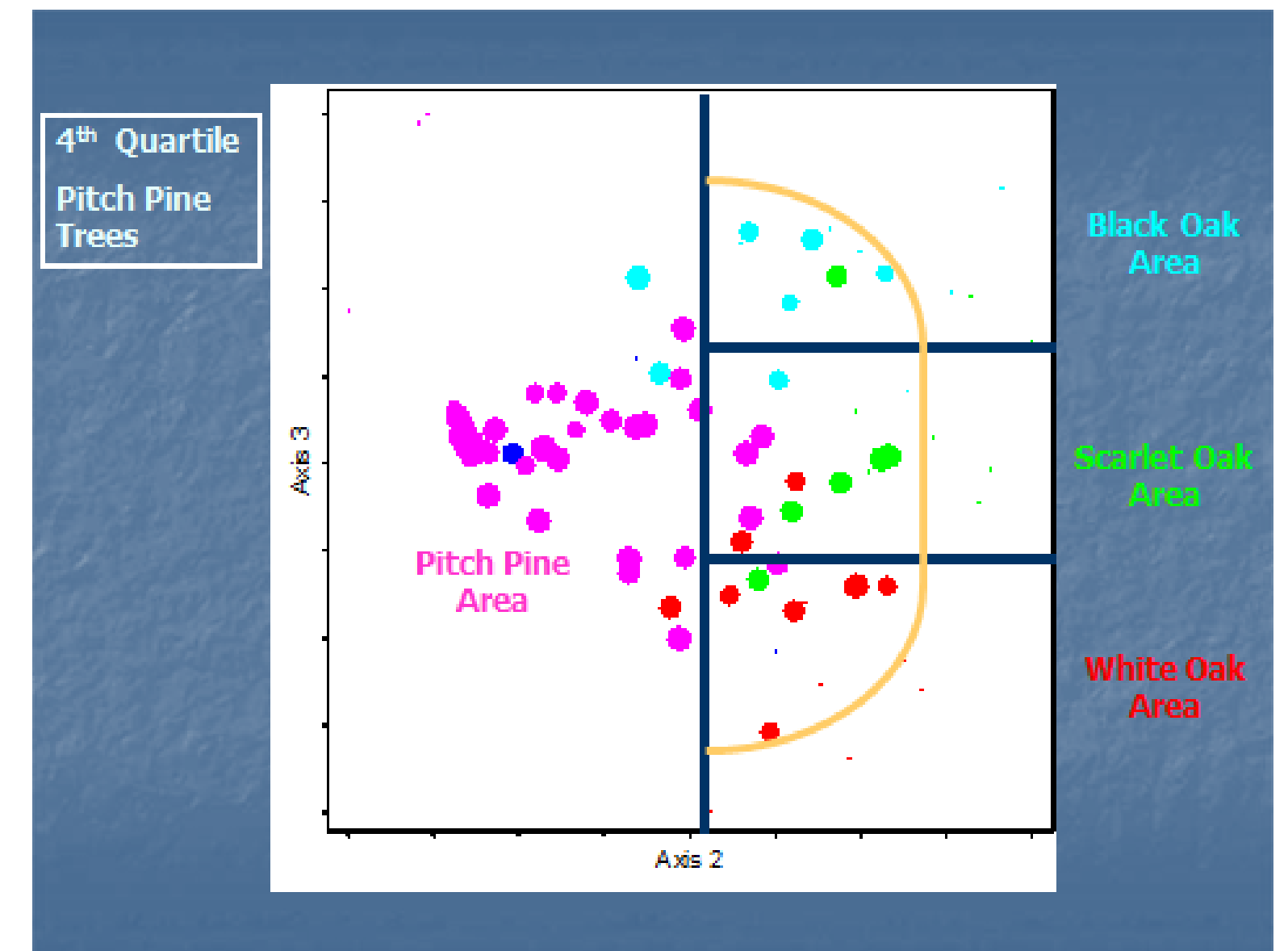
The first analytical test done was a test for normality of all DBH's for each species (see figure 2). Each DBH of each tree of one of the four major species (white oak, black oak, scarlet oak, and pitch pine) was tested for normality using the Anderson-Darling test. The purpose of these tests is to determine whether the tree species within all 91 plots is growing and reproducing normally in the forest community. After the analysis was run, all distributions were skewed to the right (skewness > 2 for all species). The distributions for white, scarlet and black oak revealed the first quartile was zero and that the median for both white and black oak was also zero. The distribution of pitch pine had all four quartiles present. This result makes the inference that there are very minimal seedlings and saplings, given the first quartile is the smallest size of a given tree. With the median of the black and white oak trees also being zero, it revealed there are also very minimal larger standing trees. The percent of coverage each species has over all 91 plots was determined in order to see how much pitch pine makes up the forest compared to the oak species which should dominate over the pitch pine.

In addition to the distribution of each major tree species, boxplots were created using Minitab 16 (see figure 3). Each boxplot uses the summation of all DBH's of each of the four major tree species within each of the 91 plots. Doing this allows a visual look at what the range of the sum of DBH's should be for each species and all existing plots that are outliers. As expected, the majority of the pitch pine trees exist within the range of the minimum and the maximum. Looking at the boxplots of each oak tree and knowing the quartiles from the distributions of each species, there are many major outliers indicating there are more taller standing oak trees than expected within the range. White and black oak both have a median at zero, thus reassuring there are a very minimal amount of small standing oak trees, and concluding the oak trees within the plots are not regenerating for an external reason.

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PC ORD is the multivariate data analysis program that was used to give a visual representation of the summed DBH of each tree type in each plot. With this program, a visual of the summed DBH of each tree type in each plot was created to determine if certain tree species are invading each of the different forest community types. Looking at the quartiles of the pitch pine trees, smaller pitch pine trees remain mainly in pitch pine communities. However, looking at the larger quartile trees, pitch pine trees become more abundant in other communities (see right figure). From this picture, as pitch pine trees age, they are found mostly in areas that are supposedly oak dominated. One hypothesis is that the larger pitch pine trees survive in other communities, but when trying to reproduce, the new seedlings and saplings are dominated by oak. Because of the lack of fire and oak dominance without it, the smaller trees do not reproduce in oak dominated communities.



Conclusions and Discussion

Because pitch pine is an indigenous plant community resulting from natural disturbances, without the upkeep of these natural occurrences, the pitch pines will move to only oak dominated communities and if continued, be dominated and wiped out by different species of oak trees. Oak trees are less fire-tolerant than pitch pine and therefore if a fire occurs in a given area, the pitch pine will survive and the burned oak will create the duff layer that is mineral rich and create the soil needed to pitch pine seedlings and saplings to germinate. This is the reasoning behind why there is a need to create prescribed fires and maintain the biodiversity of the pitch pine trees within the LIPB (Kurzewski 96-97).

In an area where there are both pine and oak trees, the oak trees will grow and dominate the pitch pine trees and cause them to die out. This is contrary to the result that pitch pine trees are invading the oak communities. There must be an external reason as to why the oak trees are not regenerating, possibly due to the diet of white-tailed deer preferring oak over pitch pine. This hypothesis cannot be tested due to the lack of data within the study.

After analyzing the distributions of each of the total species of trees, the conclusion was drawn that oak seedlings and saplings are not being able to reach the minimum of the next quartile, stating that minimal oak trees are being able to grow to a height above the median of oak trees. The reasoning for this finding but be external from that of natural fires because of a lack thereof. A possible hypothesis as to the limited number of small standing oak trees could be due to the high density of the deer population located in the LIPB. The heavy browsing of a high deer population can significantly affect the environment by inhibiting the growth of natural regeneration and even cause the extinction of different plant species (Casabon 112). Deer will eat the species of vegetation with the highest nutritional value. Oak seedlings and saplings are higher in nutritional value than pine and therefore will exhaust all oak seedlings and saplings before pine. The deer density on BNL property is roughly 70 deer per square mile when the optimal density of deer is 10-20 per square mile. With the overpopulation on-site, it is possible that the overpopulation of deer is exhausting the oak seedlings and saplings causing the lack of oak regeneration. However, this requires further data collection and study due to the lack of data containing only estimates of deer densities each season and is difficult to obtain significance from correlating the number of seedlings/saplings and deer densities.

Given the oak dominance over pitch pine in the model of natural succession, pitch pine forest should be converting into oak with the lack of natural occurrences that preserve pitch pine forests. However, as shown in the PC ORD model and analyzed in the regression models between pitch pine seedlings and saplings, older pitch pine trees still exist within oak communities, and both oak and pitch pine trees are failing to regenerate. From the models given, the visual representation shows the invasion of pitch pine trees in oak communities where through normal succession the oak trees should be moving into the pitch pine communities and regenerating into oak dominated communities.

Long term data collection is necessary in order to impact management control decisions and allow the examination of the importance of tree regeneration in upland-hardwood lowland-conifer forests (Millington 111). Multiple years of forestry data are required in order to start to fully understand the regeneration cycle of specific forests as well as stating discoveries with statistical significance. Given the data set only includes data from 2005 and 2011, finding correlations and statistical significance is not easily accomplished. This study, as we as all other forestry studies of regeneration cycles, requires the collection of as many years of data as possible in order to fully determine what defines a forest as healthy and the significance of why a healthy forest must be preserved.

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