A Study of the Age Class Structure of Quercus alba, Quercus coccinea and Quercus velutina: A Comparative Analysis of Quercus Species Reproduction as an Indicator of Forest Succession within the Long Island Pine Barrens Core Area

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Investigation of the age class structure of Quercus species within the Long Island Pine Barrens Core Area is an important aspect of monitoring the health of the Pine Barrens. The reproduction of Quercus alba, Quercus coccinea and Quercus velutina is a primary indicator of the possibility of the successional change from a pine to an oak dominated forest. The rates of reproduction for Quercus alba, Quercus coccinea and Quercus velutina can also be used to foresee the possible dominance of one particular Quercus species in forest succession. By comparing the numbers of seedlings, saplings and mature trees, the success of reproduction for futures three different Quercus species was analyzed. The numbers of seedlings and saplings were recorded through the use of four two-meter wide belt transects within sixteen by twenty-five meter plots. These plots were located within the Pine Barrens subtargets of Pitch Pine, Pine-Oak, Oak-Pine and Coastal Oak forests. The number of mature trees was recorded within these same plots. This study found the success of reproduction of Quercus velutina all displayed a low number of saplings, indicating that current reproduction of these Quercus species is not very successful. No one Quercus species was repeatedly more successful in reproduction than any other. There are several factors which may influence this trend, including exposure to light, levels of litter and duff, and deer browse. Although the current levels of reproduction of Quercus species are relatively low, they are still important indicators of forest succession from pine to add dominated forests within the Long Island Pine Barrens.

INTRODUCTION

The Long Island Pine Barrens, an area comprising 102,500 acres of central and eastern Long Island, is a region of ecological importance [1: 1]. In order to further understand the importance of the Long Island Pine Barrens, the Foundation for Ecological Research in the Northeast (FERN), in cooperation with the Nature Conservancy, the Upton Ecological Research Reserve and Brookhaven National Lab, has developed a monitoring program in order to collect data to measure indicators of primary ecological attributes of the Pine Barrens region. By collecting data on the current conditions of the Pine Barrens, the monitoring program will be able to provide a baseline of forest health in order to determine the actions of further conservation efforts. The monitoring program will also serve to detect and document the degree and direction of change in forest health, and to identify the priorities of research within the Long Island Pine Barrens [2: 3].

In this paper, the age class structure of Quercus alba, Quercus coccinea and Quercus velutina were compared in order to investigate success of reproduction for each of these species. The reproduction of Quercus species is indicative of the possibility of forest succession from pine dominated forest to an oak dominated forest [3: 14]. The numbers of seedlings, saplings and mature trees were collected within various randomly generated plots within the target of the Central Pine Barrens of Long Island. These plots within the dirferent subtargets of the Central Pine Barrens target were generated using Geographic Information System (GIS) software. The subtargets studied were the communities of Pitch Pine, Pine-Oak, Oak-Pine and Coastal Oak forests.

The purpose of this research is to 1) study the reproductive patterns of Quercus abba, Quercus coccinea and Quercus velutina so that they may be used as primary indicators of the successional change from a pine to an oak dominated forest and 2) use the rates of reproduction of Quercus alba, Quercus coccinea and Quercus velutina to foresee the possible dominance of one particular Quercus species in the stages of forest succession. These findings will help to determine both the current and future ecological integrity of the Long Island Pine Barrens.



A map of the Central Pine Barrens. Courtesy of http://www.pb.state.ny.us.

METHODS

The data for this research was collected by following Monitoring Protocols for Central Pine Barrens Field Plots. The randomly generated plots were established in different areas within each of the four subtargets. These plots had dimensions of sixteen by twenty-five meters, and were located at least fifty meters from any human disturbances, and at least twenty meters from any ecological boundaries or differing community types. Within these plots, the numbers of seedlings, saplings and mature trees were measured.

In order to measure the estimated number of seedlings and saplings within each of the plots, four two by twenty-five meter transcets were used. The entire area that was sampled for seedlings and saplings of different pine and hardwood species was eight by twenty-five meters, or half of the surveyed plot. Species that were found within these transcets were identified and recorded according to genus and species. At times, due to defoliation or indistinguishable characteristics, oak species were classified only according to genus (*Quercus*). Seedlings and saplings that had multiple stems were counted only as one seedling.

In order to measure the number of mature trees within each of the plots, hardwood and pine species that had a dbh (diameter at breast height) greater than 2.5 cm and less than or equal to 10 cm, and those that had a dbh greater than 10 cm were recorded. The diameter of the trees was measured at 1.37 meters from the ground using either calipers or a dbh tape. Trees that fell in these categories were measured by dbh to the nearest millimeter and then tallied. As was the case with seedlings and saplings, if tree split below the diameter at breast height into two or more stems, the tree was still counted as being singular. If the leaves of a tree were defoliated, or if the tree had indistinguishable characteristics, the oak species were classified only according to genus (*Quercus*) and the abbreviation for species (*spp.*).

The data used for this study was taken from forty plots, which were comprised of five Pitch Pine forest plots, five Pine-Oak forest plots, fourteen Oak-Pine forest plots and sixteen Coastal Oak forest plots. The numbers of seedlings, saplings and trees collected throughout the surveying of these plots were compiled in a database in Microsoft Access. After the completion of forty plots, the averages of the numbers of seedlings, saplings and mature trees were calculated. These averages were then used to generate graphs displaying the relationships between Quercus species reproduction and the stages of forest succession.



Figure 1 shows the age class structure of Quercus species within Pitch Pine forest. Within this forest, Quercus coccinea, Quercus alba and Quercus velutina displayed low average numbers of saplings greater than 2.0 meters and trees, after showing an increase from seedlings to saplings between 0.5 meters and 2.0 meters. Quercus coccinea, however, appears to be the most successful in reproduction within this forest, as it exhibited mature individuals following the sapling stage. Figure 2 shows the age class structure of Quercus species

Figure 2 shows the age class structure of Quercus species within Pine-Oak forest. Quercus alba, Quercus coccinea, and Quercus velutina all displayed a decrease in average number of individuals found from seedlings to saplings, followed by an increase in trees between 2.5 and 10 centimeters dbh. Quercus coccinea was the only species of oak to have an increased average number of trees greater than 10 centimeters dbh.

Figure 3 shows the age class structure of Quercus species within Oak-Pine forest. Quercus alba, Quercus coccinea and Quercus velutina showed a decrease in the average number of individuals found from seedlings to saplings, and an increase in the average number of individuals found from saplings to trees

number of individuals found from saplings to trees. Figure 4 shows the age class structure and tree recruitment of Quercus species within Coastal Oak forest. The average number of individuals found decreased from seedlings to saplings, displaying very low numbers of saplings. The average number of individuals found then increased from saplings to trees for Quercus alba, Quercus coccinea and Quercus velutina.



Quercus coccinea. Photo Courtesy of www.ces.ncsu.edu

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Pictured above is a Quercus alba seedling. At right is a Querc velutina leaf. Photos courtesy of www.pinebarrens.org

DISCUSSION

The age class structure of Quercus alba, Quercus coccinea and Quercus velutina normally shows a high number of seedlings, followed by a decrease in numbers as seedlings mature to saplings, and a slight increase as saplings mature to trees. Therefore, graphs representing the age class structure of Quercus alba, Quercus coccinea and Quercus velutina are supposed to resemble a "reverse J". Although the numbers of an oak species are supposed to decline with maturity, the scarcity of seedlings or saplings is an indicator of the possibility of failure of tree reproduction. If the numbers of seedlings and/or saplings are very low, reproduction can be seen to be struggling [2: 33]

As is indicated by the graphs of the age class structure of the different Quercus species, the reproduction of these three Quercus species displays minimal success. Across the four subtargets, the number of saplings greater than two meters was consistently low. The age class structure shows that seedings are not surviving to maturity, which indicates that reproduction is failing [2:33]. What has been shown through the data collected by the monitoring program is that the number of species found decreases as the species mature from seedlings to saplings, with very few, if any, saplings greater than two meters. After this stage, however, the number of trees found for each species within the four subtargets increased, displaying stages of maturity beyond the sapling stage of growth.

There are several factors which may inhibit the reproduction and growth of Quercus alba, Quercus coccinea, and Quercus velutina within the Long Island Pine Barrens. These factors include exposure to light, litter and duff depth, and the extent of deer browse [2: 34]. In order for Quercus species to grow, they need an adequate amount of light and fairly deep levels of litter and duff [3: 15]. If these conditions are not met, and there is deer overbrowse due to the increasing deer population in the area, the reproduction of Quercus alba, Quercus coccinea and Quercus velutina will be unsuccessful [2: 34].

Although the data collected within these forty plots does appear to represent the failure of reproduction of Quercus alba, Quercus coccinea and Quercus velutina, there are other possible explanations for the appearance of the age class structure for these species. One such explanation is that the stages of forest succession within the Long Island Pine Barrens could allow for the uneven aging of Quercus species within the surveyed plots. The reason why there are few saplings may not just be the fault of inadequate exposure to light, unsuitable levels of litter and duff, or extent of deer browse, but also may be due to different periods of growth exhibited within a surveyed community [3:14].

Quercus alba, Quercus coccinea and Quercus velutina all displayed similar trends in age class structure, and therefore, no one Quercus species was more successful in reproduction than any other within the four different subtargets. There does not appear to be any one species that is dominant in reproduction at any point in forest succession from a Pitch Pine to a Coastal Oak community. Quercus alba, Quercus coccinea, and Quercus velutina all displayed low numbers of saplings, which may be indicative of the failure of reproduction for these Quercus species. Although the current levels of reproduction for Quercus species are relatively low, they still remain an important indicator of forest succession from pine to oak dominated forests, and need to be continually monitored within the Long Island Pine Barrens Core Area.



