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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August 12, 2005

Prepared in partial fulfillment of the requirements of the Office of Science, Department of Energy's Science Undergraduate Laboratory Internship under the direction of Timothy Green, Ph.D in the Environmental Science Division at Brookhaven National Laboratory.

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ABSTRACT

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 these 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 alba, Quercus coccinea and Quercus velutina within Pitch Pine, Pine-Oak, Oak-Pine and Coastal Oak forests to be relatively low. Within the four different forest communities surveyed, Quercus alba, Quercus coccinea and 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 that may influence this trend, including exposure to light, levels of litter and duff, and deer browse. Although the current level of reproduction for Quercus species is relatively low, it is still an important indicator of forest succession from pine to oak dominated forests within the Long Island Pine Barrens Core Area.

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 structures 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 different 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. Pitch Pine forest is characterized as having over 90% of total tree cover and a subcanopy comprised of scattered scrub oak (*Quercus ilicifolia*) and having a nearly continuous shrub layer of blueberry (*Vaccinium pallidum, Vaccinium angustifolium*) and huckleberry (*Gayluccacia baccata*) [2: 4]. Pine-Oak forest differs from Pitch Pine forest in that it has a canopy of both pine and oak, with pine cover ranging between 51-90%. The understory is similar to that of Pitch Pine, but contains less scrub oak [2: 4]. Oak-Pine forest is defined as having a canopy that consists of 51-90% cover from oak, and an understory that consists of blueberry, huckleberry and scattered scrub oak [2: 4]. Coastal oak forest has a canopy dominated by oaks and a subcanopy with nearly continuous coverage from huckleberry and blueberry species. Coastal oak forest generally has greater species diversity than other subtargets [2:3].

In studying the age class structure of Quercus species, it is important to survey across these four subtargets in order to see how reproduction of Quercus species varies within the different stages of forest succession. The transformation from Pitch Pine forest, to Pine-Oak forest, to Oak-Pine forest, and finally to Coastal Oak forest is the pattern of succession from a pine dominated forest to an oak dominated forest [3: 8]. By studying the recruitment of Quercus species across the different stages of forest succession, indications of succession from one forest community to another can be observed and documented. Additionally, the success of reproduction of any one Quercus species in the stages of succession can be observed and documented.

The purpose of this research is to 1) study the reproductive patterns of Quercus alba, 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.

METHODS

The data for this research was collected by following the 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 (roads, houses, etc) 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 transects 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. Individuals that were found within these transects 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.

RESULTS

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 species following the sapling stage.

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 species 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 all showed a decrease in the average number of species found from seedlings to saplings, and an increase in the average number of species 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 species found decreased from seedlings to saplings, displaying very low numbers of saplings. The average number of species found then increased from saplings to trees for Quercus alba, Quercus coccinea and Quercus velutina.

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 seedlings 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].

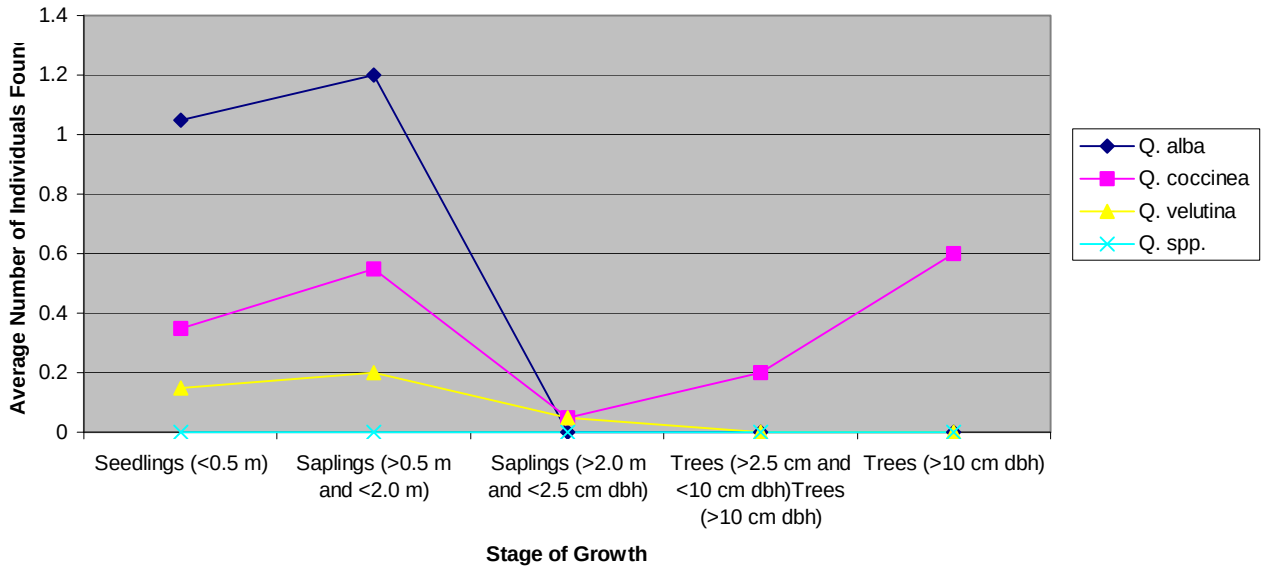
Although the data collected within these forty plots does appear to represent the failure of reproduction of Quercus alba, Quercus coccinea and Quercus velutina, there are other possible explanations for the appearance of the age class structure for these species. One such explanation is that the stages 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]. The number of saplings greater than two meters may be low because seedlings and saplings that are less than two meters have not had enough time to grow to further stages of maturity yet. The fact that the Pine Barrens is an uneven aged forest may also explain why there are higher average numbers of trees found within the surveyed plots while the average number of saplings was low.

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.

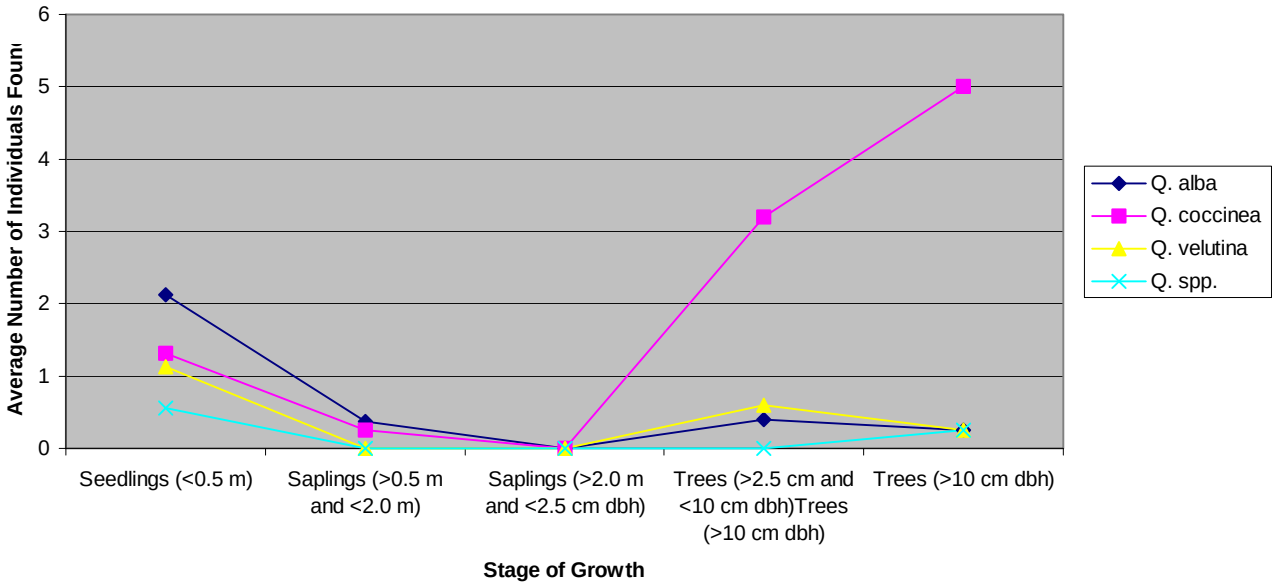
FIGURES

Figure 1



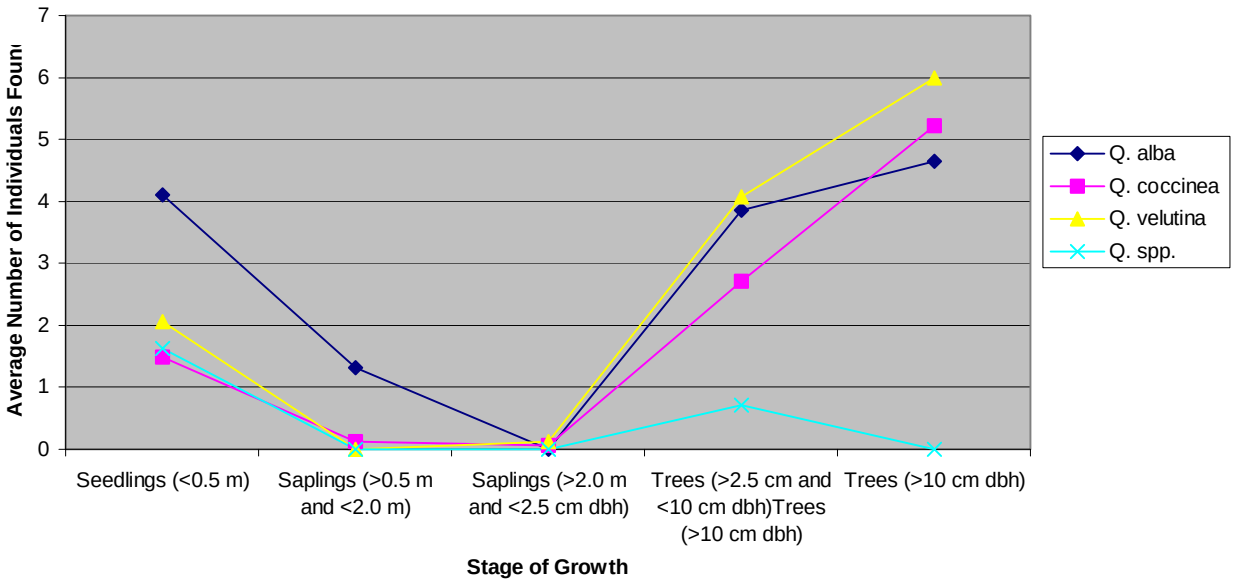
Age class structure of Quercus species within Pitch Pine forest

Figure 2



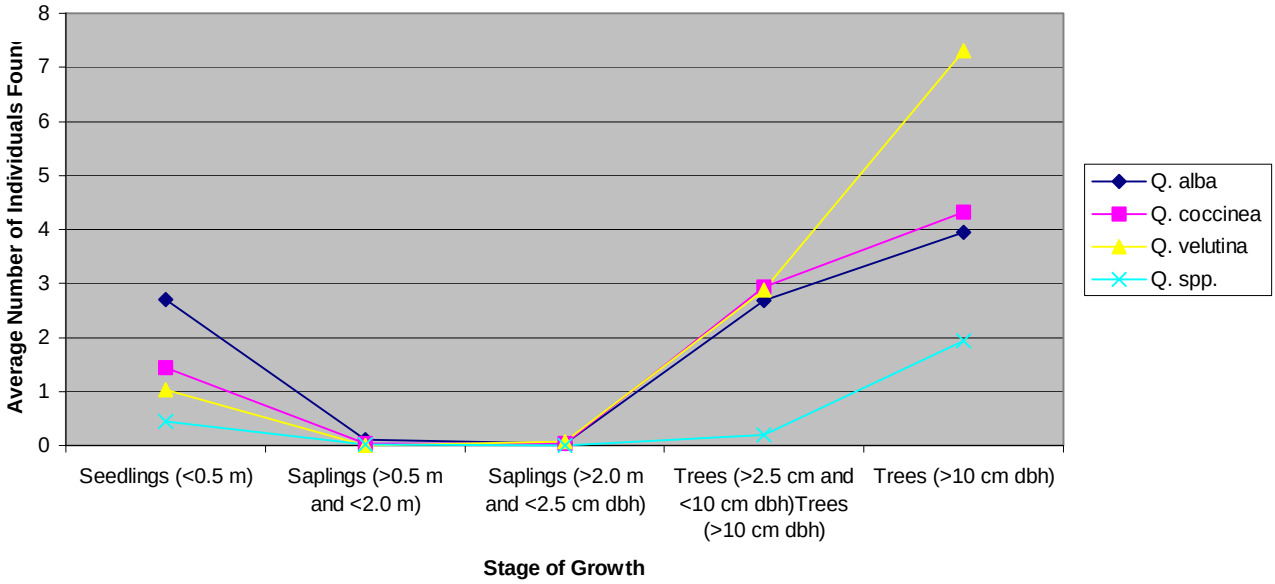
Age class structure of Quercus spceis within Pine-Oak forest

Figure 3



Age class structure of Quercus species within Oak-Pine forest

Figure 4



Age class structure of Quercus spceies within Coastal Oak forest

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ACKNOWLEDGEMENTS

I would like to thank my mentor, Dr. Timothy Green, Brookhaven National Lab, and the Department of Energy for the opportunity to participate in this internship and research experience. Additionally, I would like to thank our crew leader and supervisor Robert Anderson for his guidance. I would also like to thank Marilyn Jordan and Michael Batcher for the time they took to share their knowledge of the Pine Barrens with us. Finally, I would like to thank my fellow interns, Miranda Davis, Matthew Kull, Chauncy Leahy, Andrew Siefert and Dana Tievsky for their hard work and dedication to our research.