Analyzing Tree Regeneration as an Indicator of

The Health of the Long Island Pine Barrens

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Abstract

The Long Island Central Pine Barrens Region is the largest mostly contiguous natural area on Long Island, making it a valuable resource to study to better understand how forests change over time. To analyze the health of a forest, it is critical to monitor the regeneration of tree species through counts of seedlings and saplings while also considering the presence of fully grown trees. In 2005 and 2006, 93 permanent plots were established throughout the pine barrens, and in 2011, seven of the plots on Brookhaven National Laboratory (BNL) property were revisited. Data was collected using the Forest Health Monitoring Protocols for the Long Island Central Pine Barrens set forth by the Foundation for Ecological Research in the Northeast (FERN). In each of the 25 meter by 16 meter plots, half of the plot was divided into four belt transects by running transect tapes at two meter intervals along the 16-meter side, thus creating two-meter by twenty-five-meter belts. Each belt was then visually scanned for seedlings and saplings, and the total counts for each species was recorded and compared to data from the first time the plot was monitored. This comparison was also made with counts of each species of live tree within the plot. A significant increase in scarlet (*Quercus coccinea*) and white oak (*Q. alba*) seedlings was found compared to the data taken in 2005 and 2006. The first set of data did not show any saplings in the plots studied, but in 2011, three oak saplings were found, which signifies that very few seedlings are surviving to become more mature trees. Furthermore, the only plot that had a significant amount of pitch pine (*Pinus rigida*) seedlings was one in which there had been a prescribed fire in 2006. This likely occurred because the fire burned away the leaf litter so that the seeds could reach the mineral soil in which they take root. As dense populations of white-tailed deer

(*Odocoileus virginianus*) also have a profound impact on tree regeneration, plots with fences to prevent the entry of deer were established this year as counterparts to three of the plots studied so that future research can be done on the effect of deer browsing on seedling survival. Overall, the tree regeneration data taken from the plots at BNL may suggest a move toward the Central Pine Barrens becoming oak-dominated, illustrating what may be a late stage in the succession of the forest.

Introduction

The Long Island Central Pine Barrens is situated on over 100,000 acres of land in central and eastern Suffolk County on Long Island, making it the largest natural area on Long Island. It is a mosaic of terrestrial forest types, or sub-targets, including dwarf pine plain and pitch pine scrub shrubland, as well as pitch pine, pine-oak, oak-pine, and coastal oak forests, which are differentiated by the degree to which pitch pine is present, as well as the canopy cover and the presence of other vegetation (1). Communities such as this are rare in that the different types of forest community types within the pine barrens allow it to support the highest diversity of rare species in New York State, including eight endangered species, eighteen threatened species, and seventy three rare species (2,3).

Legal action was taken to protect the biodiversity of the pine barrens in 1993 with the Long Island Pine Barrens Protection Act, which separated the forest into two divisions: the Core Preservation Area, which occupies 52,500 acres, and the Compatible Growth Area, which occupies 47,500 acres (2). Development is strictly prohibited in the Core Preservation Area, whereas the Compatible Growth Area surrounding the Core will allow limited development. Since the forest is largely undisturbed and mostly contiguous, it presents itself as a valuable resource to study in order to better understand the forest transition.

Like all ecosystems, the Central Pine Barrens is dynamic, and the prevalence of different species of flora and fauna is constantly changing. Because of the unique composition of this forest, the Pine Barrens is dependent on active management by humans in order to sustain its natural biodiversity, which many suggest should come in the form of prescribed fires (4). According to studies by Michigan State University, "fire is the single most significant factor in preserving the Pine Barrens landscape," as it maintains an open canopy, promotes grass diversity, and deters invasive plants (5). Fires not only clear the dense layers of leaf litter and duff from the forest floor, but also help serotinous pinecones (closed pinecones that are delayed in opening), as they only open to spread their seeds after reaching a high temperature (3). The Central Pine Barrens are situated amidst the urban and suburban areas of Suffolk County, so appeals for prescribed fires have typically been met with either opposition or a lack of any coordinated effort by the public. Since much of the pine barrens is not exposed to fire, the population of pitch pines is expected to decrease, and the region will then go through a natural succession to a hardwood forest consisting chiefly of oak trees (6).

The region is also affected by the white-tailed deer population, which can increase by as much as 50% in one year in the absence of mortality (7). In the Spring and Summer of 2005, the deer population at BNL was estimated to be 396 , which jumped to 479 in the Spring of 2006 (8). The deer population at BNL has dropped in the past five years to the current estimated population of 400. White-tailed deer feed on the understory, which includes hardwood seedlings and saplings. Due to increases in population, competition has risen amongst deer, and they resort to eating pitch pine to survive during winter months. Since deer are the chief predators of seedlings and saplings, they greatly influence seedling survival.

For these reasons, in 2005 and 2006, researchers from FERN set out to collect data from 93 randomly chosen plots within the Pine Barrens in order to set a baseline for monitoring changes in the health of the forest. In 2011, seven of these plots on BNL property were revisited to mark the changes and progress of the forest (Fig. 1). One aspect of the plot that was studied was tree regeneration, which took into consideration the forest type, the species and counts of live and dead adult trees, and the species and counts of seedlings and saplings in the plot the first and second time it was monitored. To observe the growth and abundance of seedlings, saplings, and mature trees, comparisons were then made between the data from 2005 and 2006 and the current data. Furthermore, deer exclosure plots were established to study the effect of deer on tree recruitment and other aspects of forest health by providing baseline data regarding vegetation browsed by deer. These plots will later be monitored to determine the effects of deer browsing on the forest and the effectiveness of proposed deer management.

Materials and Methods

Forest plots were analyzed using the Forest Health Monitoring Protocols for the Long Island Central Pine Barrens set forth by FERN, which take into consideration many aspects of the area, including the vegetation composition. The corners and center point of each plot were established using a global positioning system (GPS) unit and permanently marked with stakes and aluminum caps.

For the tree regeneration study, half of the plot was divided into four belt transects by running transect tapes at two meter intervals along the 16-meter side, which created two-meter by twenty-five-meter belts (Fig. 2). The belt transect method was used because it is a relatively quick and efficient way to gather data, it can be applied to large areas, and it is a robust method to use with researchers with varying observational skill levels so as to avoid significant differences in data (9). To collect data, the researcher walked slowly down each of the four belts and visually searched for tree seedlings and saplings, which required a ruler to differentiate between the two types. Young trees are marked as seedlings if they are less than or equal to 0.5 meters tall. Saplings are classified as being either 0.5 to 2.0 meters tall, or above 2.0 meters tall and less than or equal to 2.5 centimeters in diameter at breast height (dbh). A tree identification book was then used as a reference to determine the species of each seedling or sapling. Any tree taller than two meters and with a dbh greater than 2.5 centimeters was considered a full-grown tree. Each tree in the plot was categorized by species, as well as if it was alive or dead, and was tallied and the dbh for each was recorded.

Three new plots were established as counterparts to three of the existing plots to be used as deer exclosures. These exclosures were within the same vegetation subtarget as their twin forest health plot, and established at least fifty meters from the corresponding plot, as well as any surrounding roads. To make the deer exclosure plot as similar as possible to its twin, the plot was selected in an area with similar understory, overstory, and canopy cover. These deer exclosures will have fences around the perimeter to prevent deer from entering the plot and browsing the vegetation, including seedlings, saplings, and trees. Using the baseline data collected when these plots were established, researchers will be able to see which plants may be preferred by deer, as well as the rate of growth of undisturbed vegetation.

Results:

After comparing the data taken this year to the data gathered in 2005 and 2006, a significant increase in white oak and scarlet oak seedlings was found in each plot. In the four oak-pine forest plots studied (Plot 93, 29, 84, and 30), a massive increase in white oak seedlings was found, compared to data collection in 2005 or 2006, Plots 93, 29, and 84 each contained between two and four white oak seedlings, and Plot 30 contained 43 seedlings (Fig. 3). In 2011, Plots 93, 29, and 84 each contained between 38 and 158 white oak seedlings, and Plot 30 contained 267 seedlings. Plot 91, which was situated within a pitch pine forest, also saw the number of white oak seedlings more than quadruple from 2006.

The rise in scarlet oak seedlings was notable in Plot 93 (oak-pine), Plot 5 (coastal oak), and Plot 52 (pine-oak). Plot 93 did not encompass any adult scarlet oaks, though Plot 5 was shown to have a very healthy scarlet oak population, as the number of full-grown scarlet oak trees has risen from six to nine since 2005 (Fig. 4). Plot 52 has also increased by one scarlet oak tree since 2006.

The only plot in which pitch pine seedlings were abundant within the belt transects was Plot 93, which was located in an oak-pine forest, an ecosystem in which the typical tree population is 11-49% pitch pine (1). Within this plot, pitch pines make up approximately 35.9% of the total amount of seedlings, whereas in all other plots, pitch pine seedlings accounted for no more than 4.7% of the total (Fig. 3).

Out of the seven plots surveyed, only two plots had saplings within the belt transects studied – one scarlet oak sapling in Plot 93, and two white oak saplings in Plot 91 (Fig. 3). No pitch pine saplings were found within the belt transects.

The seedling and sapling counts in the three deer exclosures that were established to correspond with three particular plots (Plot 93, 91, and 5) were found to vary only slightly between the deer exclosure and its twin in two sets of plots (Fig. 5), but there was a large difference in Plot 5, which was exactly half scarlet oak seedlings and half white oak seedlings, whereas the deer exclosure was made up of nearly 75% pitch pine with the remaining 25% consisting of white oak and scarlet oak.

Discussion:

The immense increase in oak seedlings in these plots may be a result of the weather that the Central Pine Barrens has experienced within the past year. In the winter of 2010 into 2011, Long Island received approximately 61.9 inches of snow – the most it has had since the winter of 1995-1996 (10). The large amount of snow blanketed the acorns and pine seeds compacted them into the ground, thus hiding the seeds from animals like white-tailed deer, gray squirrels, chipmunks, mice, turkeys, and songbirds. The seeds were able to survive through winter and spring, and were thus able to sprout, whereas the seedlings in the winters of 2004-2005 and 2005-2006 had 41 and 40 inches of snow, respectively, and were more likely to be uncovered and eaten by predators. Acorns fare better than pine seeds in high levels of leaf litter, so though both seed types could be temporarily hidden by snow, acorns were better able to germinate in the leaf litter than pine seeds, which prefer contact with bare mineral soil for germination. It would be interesting to analyze the correlation between the amount of snow in the winter and the amount of seedlings found the following summer to see how viable this explanation is in explaining the abundance of oak seedlings, or if it is the litter and soil combined with a large amount of canopy cover that is providing the perfect environment for oak seedlings to grow. As a study for the future, researchers may want to consider investigating how climate change is affecting acorn production and other aspects of tree regeneration, and if a change causing more snow in the winters would quicken the rate at which succession to hardwood trees occurs in the pine barrens.

The large amount of pitch pine seedlings in Plot 93 stands in stark contrast to the pitch pine seedling counts in the other plots, and is likely the effect of a prescribed fire in 2006 that took place in the section of the forest where the plot is located. As opposed to pitch pines in the other plots, the litter layer was burned away to expose the mineral soil, and the overstory opened, providing excellent conditions for pitch pine seeds to germinate.

Furthermore, Plot 93 showed a significant rise in scarlet oak seedlings even though there were not scarlet oaks in the plot. This data implies that a scarlet oak may be near the plot and the seeds have been successful at being carried by animals to reach this area and germinate.

The data regarding sapling counts in the plots revisited suggest that white oak and scarlet oak species are slowly becoming more abundant as a few seedlings were able to reach the sapling stage. One reason for this small amount of saplings may be the large population of deer browsing scarlet and white oak seedlings, so it would be interesting to see if more seedlings in the deer exclosure plots reach the sapling stage than those in the unfenced twin plot. Existing saplings and trees can be studied to see if more survive due to being protected from deer rubbing – the act of a buck rubbing its antlers on a small tree or sapling in order to remove the velvet that has grown over the summer, as well as to mark their territory – as this often does damage to young trees (11). When looking for these changes, it will be important to note that the baseline data for the deer exclosures were not found to be exactly the same as their twin plot, so careful attention must be paid to these differences.

Overall, the data collected from the plots at BNL show that oaks are faring better in the conditions of this part of the Central Pine Barrens than pitch pine seedlings, which appears to support the transition model of a pine barrens forest moving towards becoming a hardwood forest.

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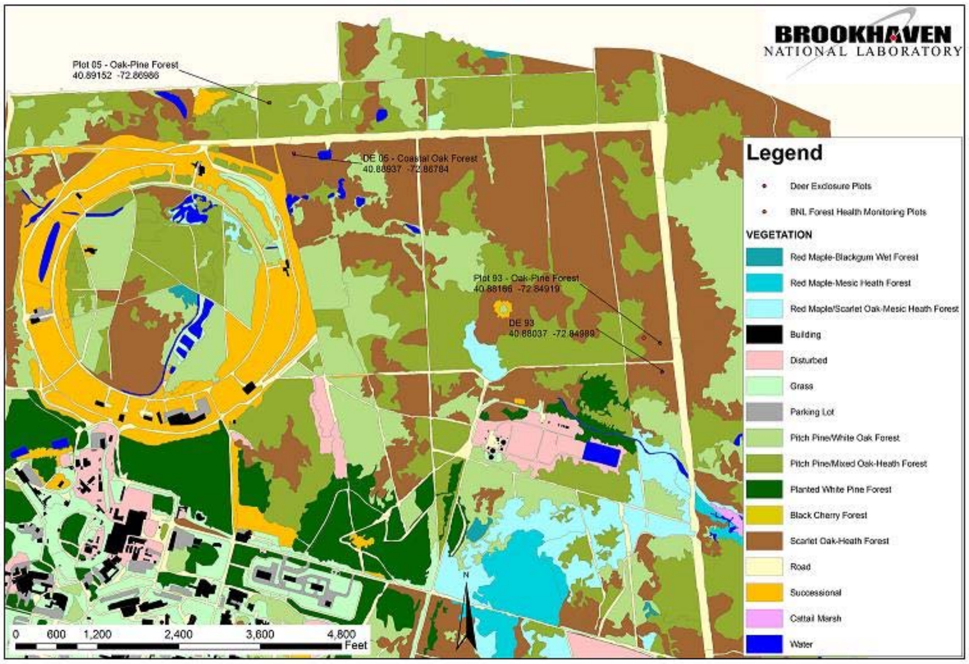
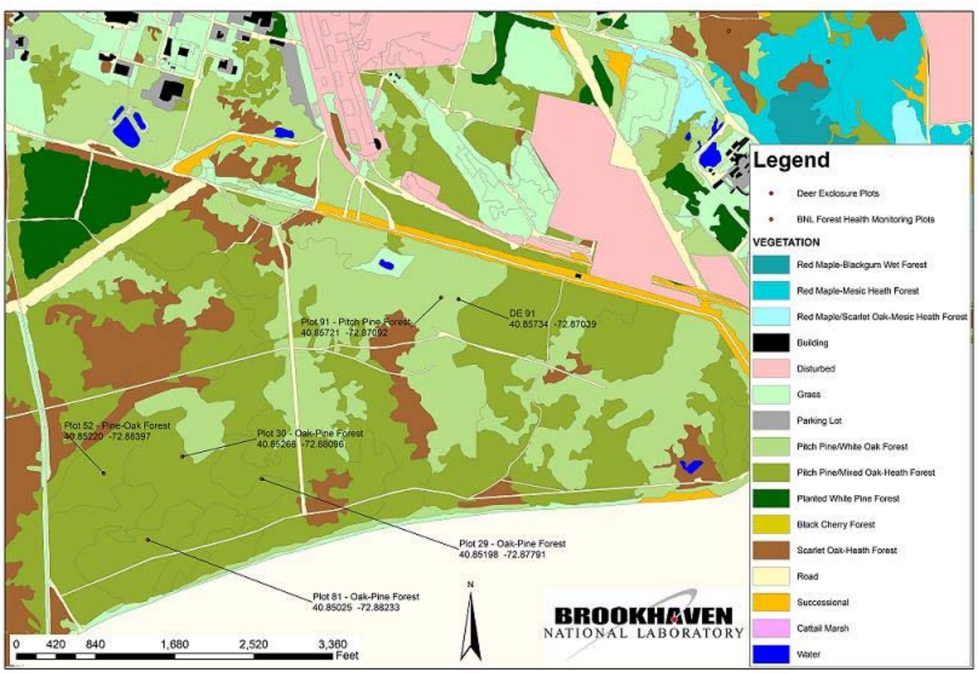
Figures and Charts

1. Vegetation Maps of Brookhaven National Laboratory

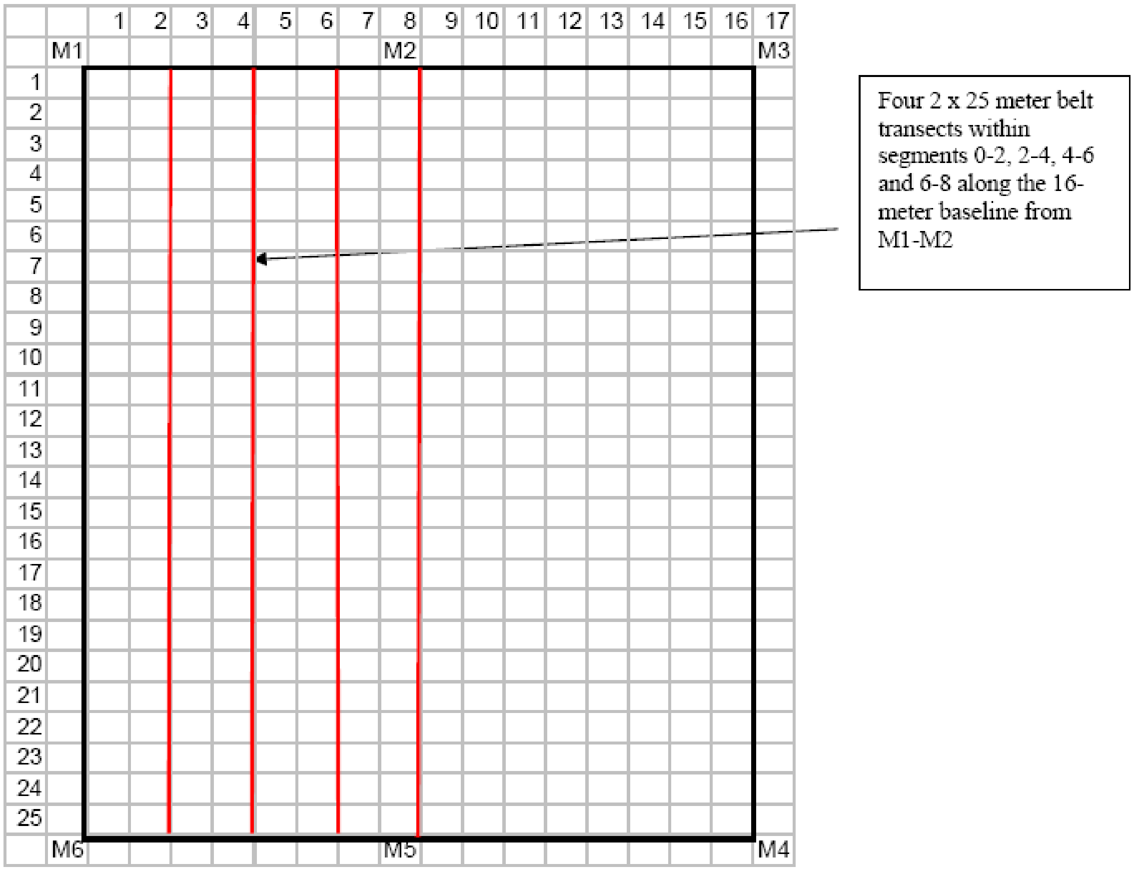
Forest Health Monitoring Plots and Deer Exclosures
BNL North



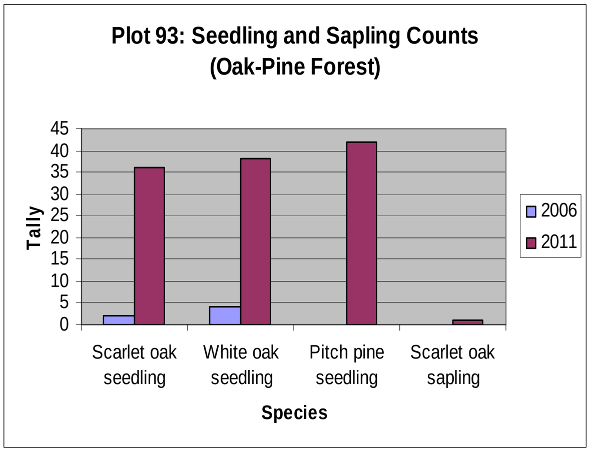
Forest Health Monitoring Plots and Deer Exclosures
BNL South

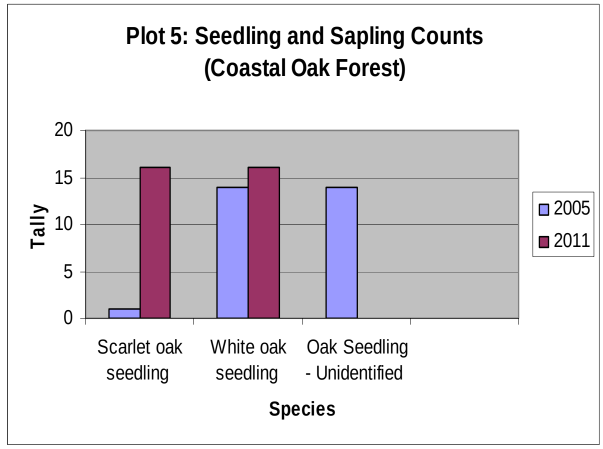


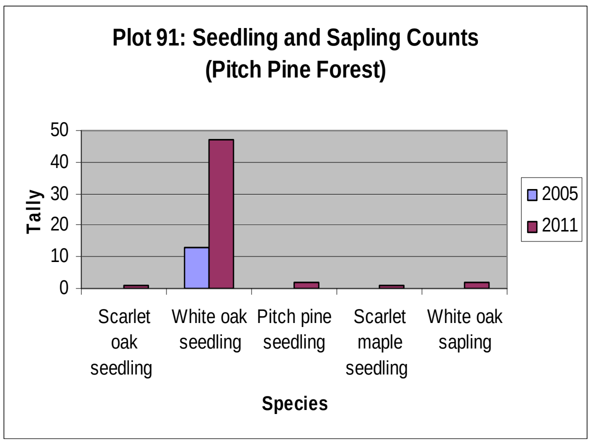
2. Belt Transect Diagram Provided by FERN

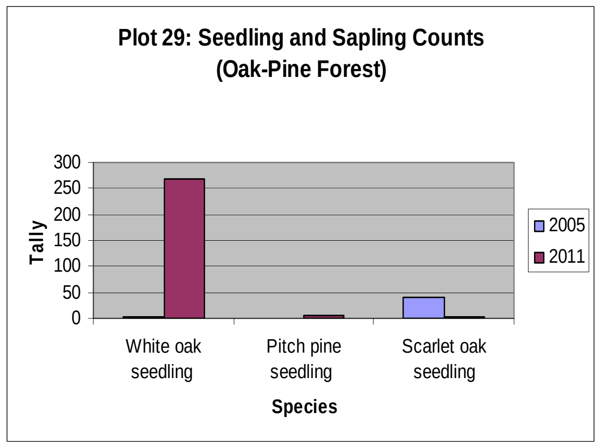


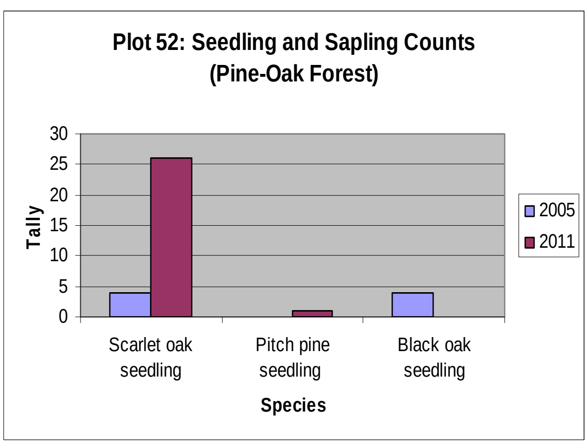
3. Seedling and Sapling Counts in Each Plot











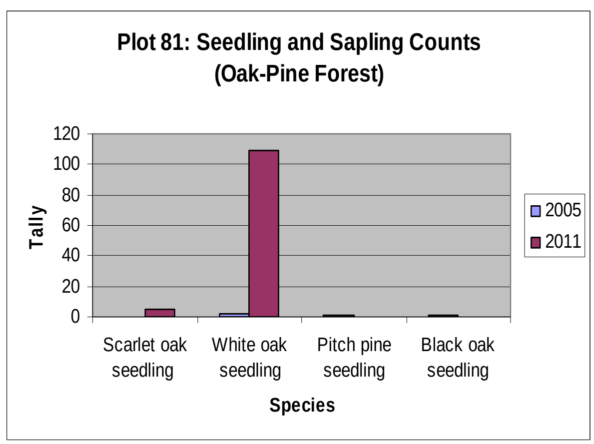


Figure 3 Continued: Seedling and Sapling Counts in Each Plot

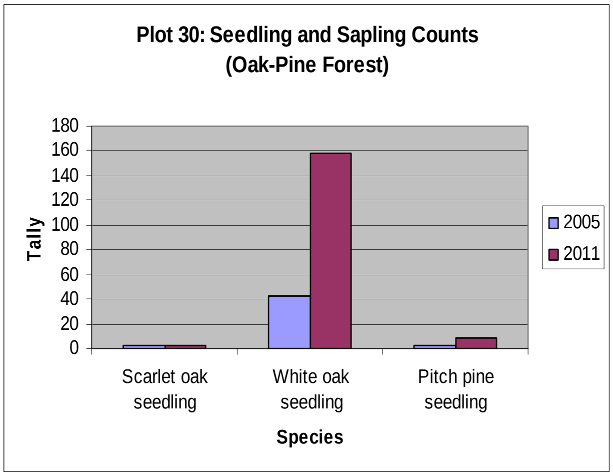
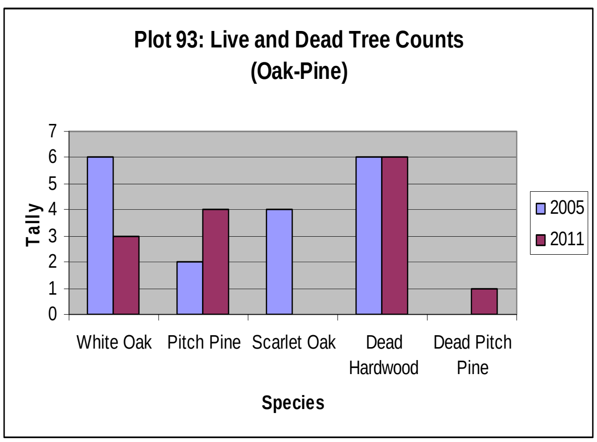
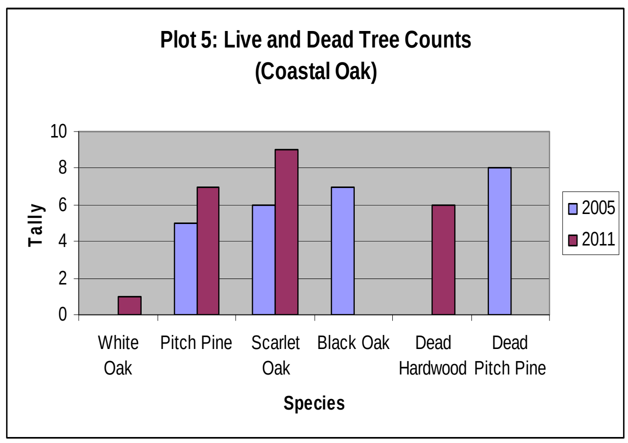
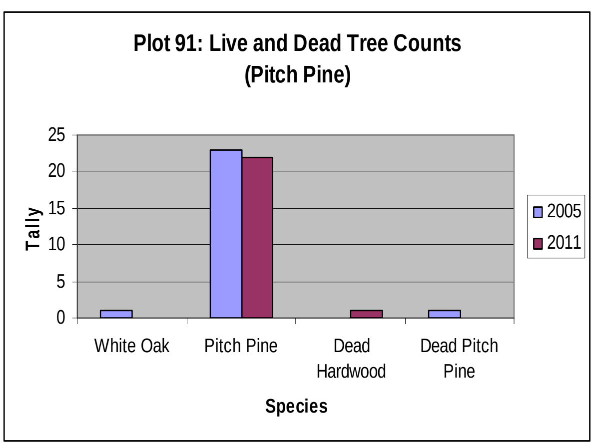
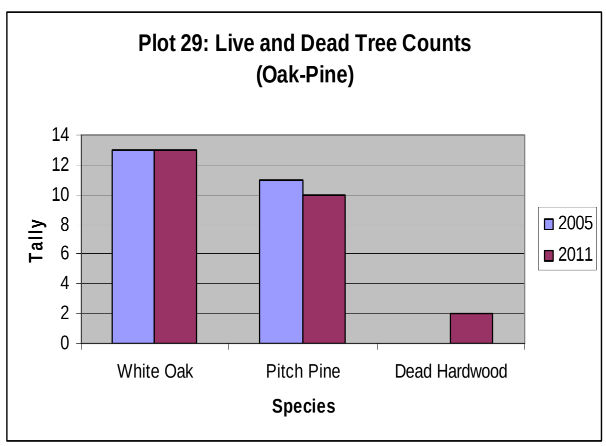


Figure 4: Tree Survey (Live and Dead) Data









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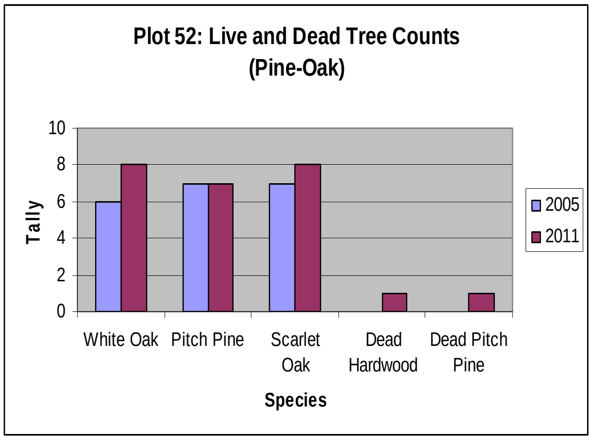

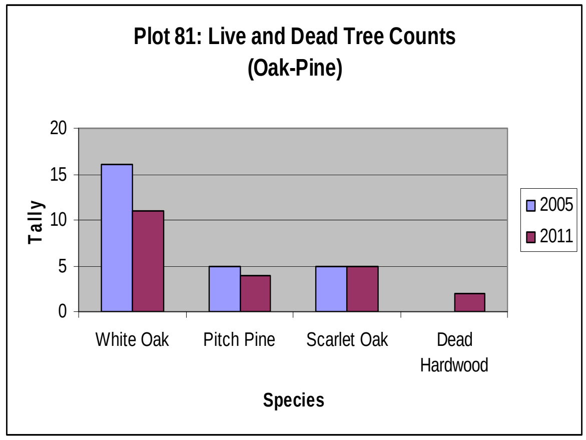

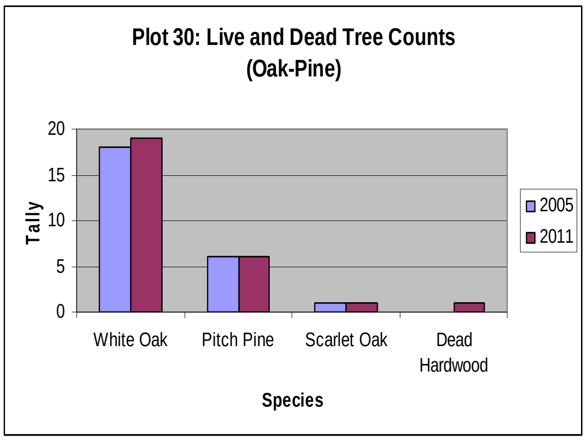

Figure 5: Comparisons of Plots and Corresponding Deer Exclosures